Executive summary

This report was commissioned by Wollongong City Council (Council) who engaged GHD to prepare a Dune Management Strategy (Strategy) for parts of the 17 patrolled beaches in the Wollongong Local Government Area (LGA), with a focus on the high usage areas in the vicinity of the Surf Life Saving Clubs (SLSCs).

The need for this Strategy arose from the outcomes of preparing the Draft Wollongong Coastal Zone Management Plan (CZMP). The public consultation carried out for the Draft CZMP identified serious community concerns about coastal dune management, with particular reference to excessive dune heights and scarping, and the role of dune vegetation in these issues. The concerns focussed mainly on the deterioration of sight lines for lifeguard/lifesaving operations, and a reduction in recreational beach amenity from increased scarping and the spread of dune vegetation. In response to this, one of the management recommendations of the Draft CZMP was to prepare a Wollongong Dune Management Strategy, and this was endorsed by Council.

Council has sought to prepare this Strategy to manage the differing coastal interactions in the patrolled areas of the 17 beaches, and these areas were identified in maps provided to GHD. Council already has an on-going dune maintenance program which addresses the routine infrastructure and vegetation maintenance issues around these patrolled areas, as well as in other parts of the coastline. The main aim of this Strategy is to identify specific management options to address the issues that are outside the scope of the routine maintenance program. The tasks undertaken to prepare the Strategy included:

- An initial review of documentation and data records, including a search of the Aboriginal Heritage Information Management System (AHIMS) to compile the data and the key considerations for each beach.
- Consultation with stakeholder groups (Council staff, Council's Estuary and Coastal Zone Management Committee, Surf Life Saving Illawarra, and Beach Care Illawarra), and an on-line community survey, to define the issues and canvass management options.
- Assessment of dune morphology, ecology, and the lifesaving infrastructure and lifeguard/lifesaving operations at each of the beaches, to identify and prioritise the issues to be considered for management. Then, based on the stakeholder consultation and site studies, determination of the relative severity of the key issues at each beach.
- Identification of a suite of management options and subjecting them to a Multi-Criteria Analysis (MCA) that incorporated the management objectives and their relative importance in addressing the issues, in order to determine the most effective options for each beach.
- Exhibition of the Draft Strategy containing the most effective management options for each beach, and based on Council and community feedback, make recommendations for a program of works for Council to implement the Strategy.

The issues identified though the stakeholder consultation process, and considered to be within the scope of the study, can be grouped into two categories. The first category of issues related to the current state of the dunes and vegetation conflicting with the recreational use of the beach, and the issues were:

- Deterioration of line of sight for lifeguard/lifesaving operations as a result of accreting dunes and the height of the vegetation,

- Reduction in recreational amenity from excessive scarping and a reduced useable beach width from encroaching dune vegetation,
- Degradation of beach access ways from uneven dune topography, scarping or encroaching dune vegetation,
- Inappropriate vegetation being planted on the dune which is thought to be exacerbating the recreational amenity issues, in particular, concerns with the Wattle species *Acacia longifolia* subp. *sophorae*, and
- Coastal dune vegetation providing a harbour for pests and vermin and trapping litter.

The second category of issues related to the precautionary measures required if there was management interference with the dunes and vegetation, and the issues were:

- The need to ensure that dune or vegetation removal or modification actions to address any recreational amenity issues do not have an adverse impact on the risk from coastal processes and hazards,
- The need to be mindful of the biodiversity value of the dune vegetation in taking intervention measures to address the line of sight and recreational amenity issues, and
- The need for a community engagement program to improve the general public's understanding of the role of dunes and vegetation in the coastal environment.

The first three issues in the first category (line of sight, recreational amenity, and beach access) relate directly to the usability of a beach, and these were considered to be the key issues for management. The severity of these three key issues was determined for each of the beaches. This was done to identify the beaches with the most pressing requirements for management. The severity scales were 'not applicable', 'minor', 'moderate', or 'severe'. The results show that the beach most adversely affected was City Beach, followed by Towradgi Beach. Many of the beaches in the northern part of the LGA were not found to have any key issues. It is important to note that the severity scales were determined for the conditions that existed at the time of this study, and these could change in the future, given the dynamic nature of the coastal environment on which this study is based.

The report has also undertaken an in-depth assessment of the community concerns around the presence of Coastal Wattle in the dunes. Coastal Wattle *Acacia longifolia* subsp. *sophorae* is considered to be indigenous to the Wollongong coastline, particularly in dune vegetation. Individuals of *Acacia longifolia* subsp. *longifolia* can create sight line issues due to their height. However, both subspecies of *Acacia longifolia* can form monocultures in some locations and may need in some situations, to be managed.

The management options assessed for their potential suitability to address one or more of the key and other issues were of a structural nature (such as making adjustments to existing lifeguard/lifesaving infrastructure or building new structures; improving beach access ways), promote ecological improvement (such as removing weeds and vermin, or removing inappropriate plant species and replacing them with other suitable species), or involve dune profile modifications (either just the frontal zone or a more substantial portion of the dune). Combinations of different options were also considered where an option on its own was not able to address the key issues occurring at a beach. Options involving removal of native vegetation or dune profile changes will be subject to strict regulatory control, and will require significant additional studies and/or approvals before they can be implemented.

The relative effectiveness of the options (individually or in combination) in addressing the issues at a particular beach was determined through the use of an MCA which incorporated criteria covering both categories of issues – those relating to the need to improve beach usability, and those relating to the precautionary measures required. The criteria were:

- Impact on line of sight,
- Impact on recreational amenity,
- Impact on beach access ways,
- Impact on the risk from coastal hazards,
- Impact on ecology, and
- Impact on pests and vermin.

The MCA also factored in the relative importance of these criteria, and this was decided in consultation with Council. The three most important criteria were impacts on line of sight, on recreational amenity, and on the risk from coastal hazards, and these were most influential in determining the relative rankings of the options for a particular beach.

The options from the MCA that had the three highest rankings for each beach were filtered for further consideration. For the northern beaches that did not have any key issues, the top ranked options were removal of weeds and inappropriate plant species and replanting with suitable species. Whilst these options did not feature amongst the top three for beaches with key issues, there is benefit in considering these options for all beaches. These options were therefore included in a list of management options that would benefit all the beaches or would be useful for Council in implementing this Strategy. This list includes:

- Continuation of current dune maintenance activities,
- Management of subspecies of *Acacia longifolia*,
- Additional management of noxious and invasive weed species,
- Implementation of a community engagement program, and
- Implementation of a beach and dune monitoring program.

The beaches with options other than those listed above, in the three most effective options, are shown in the following table. The greatest precaution is required around the 'Reduce dune height by re-profiling' option, as the risk from coastal hazards and processes will be dependent on the beach profile characteristics at the time this option is implemented. Therefore, the timing for the implementation of this option would need to be informed by monitoring.

The draft Strategy report was placed on public display and comments were invited to assist with the finalisation of the Strategy. Comments on the draft document were reviewed and Council's project team prepared a 'submissions in reply report' along with an implementation plan for the Strategy for Council. This report and plan were accepted and the recommended changes incorporated into the final strategy (this document).

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Beach specific management options (listed north to south)

Beach	Management Option	Sight Line Severity	Sight Line Issue addressed	Recreational Amenity Severity	Recreational Amenity Issue addressed	Beach Access Severity	Beach Access Issue addressed	Approximate initial cost*	Total Time to Implement ^	Implementation constraints #
Bulli	Build a tower	Moderate	Yes	Moderate	No	Moderate	No	$150,000	1-3 years	
	Build a tower and remove vegetation from frontal zone	Moderate	Yes	Moderate	Yes	Moderate	Yes	$150,000 and $50,000-$100,000	1-3 years	Risk of impacts from coastal hazards currently high. Further site investigations (e.g. structural integrity of buried seawall) and on-going monitoring required to inform timing for implementation.
	Raise level of observation area in SLSC	Moderate	Yes	Moderate	No	Moderate	No	$100,000-$500,000	1-3 years	
Woonona	Relocate existing tower and remove vegetation from frontal zone	Moderate / Severe	Yes	Moderate	Yes	Moderate	Yes	$10,000-$50,000 and $50,000-$100,000	6-12 months	
	Relocate existing tower	Moderate / Severe	Yes	Moderate	No	Moderate	No	$10,000-$50,000	6-12 months	
	Raise level of observation area in SLSC and remove vegetation from frontal zone	Moderate / Severe	Yes	Moderate	Yes	Moderate	Yes	$100,000-$500,000	1-3 years	
Bellambi	Build a tower and remove vegetation from frontal zone	Minor	Yes	Minor	Yes	Moderate	Yes	$150,000 and $50,000-$100,000	1-3 years	
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Note. Severity scales for issues ■ Severe ■ Moderate ■ Minor □ Nil At Woonona the sight line issue is moderate from the tower and severe from the surf club. At Port Kembla the sight line issue is nil from the tower and severe from the surf club.

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Wollongong City Council

Wollongong Dune Management Strategy for the Patrolled Swimming Areas of 17 Beaches

Final Report

February 2014

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Beach specific management options (listed north to south)

Beach	Management Option	Sight Line		Recreational Amenity		Beach Access		Approximate initial cost*	Total Time to Implement ^	Implementation constraints #
		Severity	Issue addressed	Severity	Issue addressed	Severity	Issue addressed			
Bulli	Build a tower		Yes		No		No	$150,000	1-3 years	
	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000	1-3 years	Risk of impacts from coastal hazards currently high. Further site investigations (e.g. structural integrity of buried seawall) and on-going monitoring required to inform timing for implementation.
	Raise level of observation area in SLSC		Yes		No		No	$100,000-$500,000	1-3 years	
Woonona	Relocate existing tower and remove vegetation from frontal zone		Yes		Yes		Yes	$10,000-$50,000 and $50,000-$100,000	6-12 months	
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Bellambi	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000	1-3 years	
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	Reduce dune height by re-profiling		Yes		Yes		Yes	$100,000-$500,000	1-3 years	
Corrimal	Relocate existing tower and remove vegetation from frontal zone		Yes		Yes		Yes	$10,000-$50,000 and $50,000-$100,000	6-12 months	
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	Remove vegetation from frontal zone		Yes		Yes		Yes	$50,000-$100,000	6-12 months	
Towradgi	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000	1-3 years	Risk of impacts from coastal hazards currently high. On-going monitoring required to inform timing for implementation.
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	Reduce dune height by re-profiling		Yes		Yes		Yes	$100,000-$500,000	1-3 years	
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	Build a tower		Yes		No		No	$150,000	1-3 years	
	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000	1-3 years	Risk of impacts from coastal hazards currently high. On-going monitoring required to inform timing for implementation.
Port Kembla	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000	1-3 years	
	Reduce dune height by re-profiling		Yes		Yes		Yes	$100,000-$500,000	1-3 years	
	Build a tower		Yes		No		No	$150,000	1-3 years	

Note. Severity scales for issues Severe Moderate Minor Nil At Woonona the sight line issue is moderate from the tower and severe from the surf club. At Port Kembla the sight line issue is nil from the tower and severe from the surf club.

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1. Introduction

1.1 Background

The Wollongong Local Government Area (LGA) is located on the New South Wales coast approximately 70km south of Sydney. The coastline covers approximately 60km, consisting of a series of embayed sandy beaches with a headland or rock shelf at each end, separated by sandstone cliffs. Rocky cliffs predominate in the northern portion of the LGA, and long sandy beaches predominate in the south. The Illawarra Escarpment runs parallel with the coast along the length of the LGA, forcing much of the development that has taken place to be concentrated in the coastal strip. The dominant land use is residential, with the beach and back beach areas often containing infrastructure and recreational assets such as roads, cycleways, SLSCs, pools and other leisure facilities.

Most of the beaches in the study area are believed to have been cleared of back beach vegetation in the mid to late 19th century, and problems associated with windblown sand were common. To address these problems, Council and the NSW Soil Conservation Service undertook an extensive program of dune restoration works along some sections of the coastline from the mid 1980's. The vegetation is now well established and the sand volume within the vegetated dunes has also increased, which is important for protecting coastal assets against the impacts of coastal processes and hazards. However, on some beaches, vegetation has spread seaward well beyond the original fence boundaries within which it was planted, and as noted in the *NSW Coastal Dune Management Manual* (DLWC, 2001), beach safety needs can potentially conflict with dune management objectives, particularly in relation to vegetation cover.

Community concerns about coastal dune management were identified during the public exhibition of the Draft Wollongong Coastal Zone Management Plan (CZMP) in 2012. Particular reference was made to excessive dune heights and the occurrence of scarping after storms, and the type, height and extent of vegetation occurring on the dunes. The concerns focussed on the degradation of lifeguard sight lines from the SLSCs to the swimming zones with reduced ability of lifesavers to properly see people in the ocean, and the effect of the seaward spread of vegetation in reducing recreational amenity of the beach. In response to this, one of the management outcomes identified in the Draft CZMP was to prepare a Wollongong Dune Management Study.

Accordingly, GHD has been engaged by Wollongong City Council (Council) to prepare a Dune Management Strategy (Strategy) for parts of the 17 patrolled beaches along the Wollongong LGA coastline with a primary focus on addressing the sight line issues for lifeguards and lifesavers in the high usage areas in the vicinity of the SLSCs.

1.2 Objectives and Scope of Work

The main aim for this study is to identify management options for the high use recreational areas of the 17 patrolled beaches to address safety and recreational amenity issues, whilst considering biodiversity values and the role of the dunes in coastal processes. In doing so, the scope of the study was to:

- Assess the distribution of vegetation across the dune and the dune morphodynamics for each of the 17 beaches, and to compare the plant species distributions with the DLWC (2001) Coastal Dune Management Manual;
- Assess the activities and infrastructure at each beach and identify adaptations that could be made to improve sight lines without the need to undertake significant dune or vegetation management activities; and

- Detail, based on the site specific assessments, management options available to Council to manage the facilities and/or dunes in front of the SLSCs such that sight lines for lifesavers, lifeguards and the amenity for beach users are better established and maintained, within the naturally evolving coastal system.

1.3 Study Area

The 17 beaches from Stanwell Park in the north to Windang Beach in the south were included in the study area (Figure 1). Within each of these beaches, the flagged swimming area as identified by Council was the area of focus for the study at each beach and identified the management zones to be assessed in this study:

- Stanwell Park Beach
- Coalcliff Beach
- Scarborough Beach
- Coledale Beach
- Austinmer Beach
- Thirroul Beach
- Sandon Point Beach
- Bulli Beach
- Woonona Beach
- Bellambi Beach
- Corrimal Beach
- Towradgi Beach
- Fairy Meadow Beach
- North Wollongong Beach
- City Beach
- Port Kembla Beach
- Windang Beach

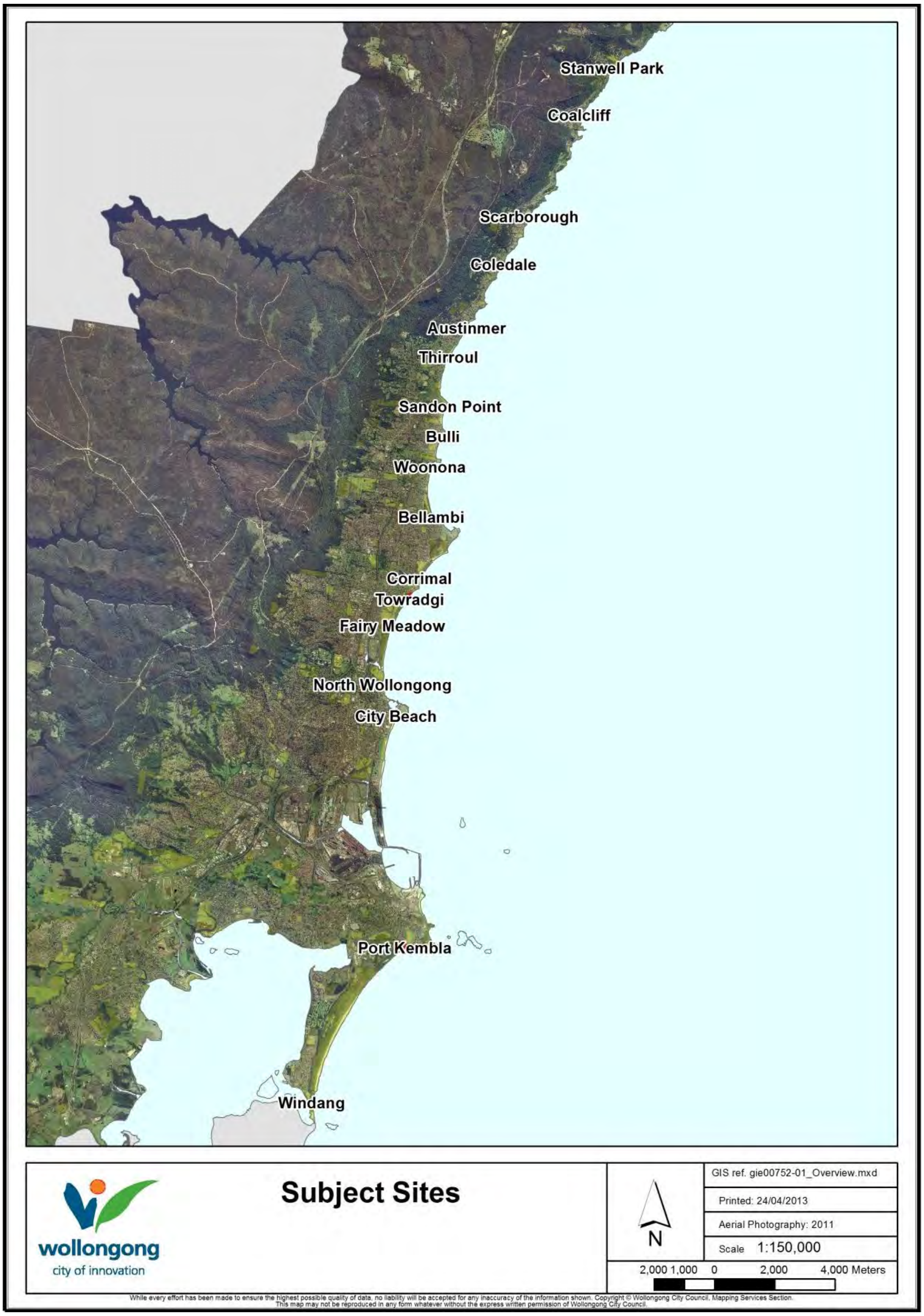


Figure 1 Overview of study area

1.4 Scope and Limitations

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

GHD otherwise disclaims responsibility to any person other than Wollongong City Council 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 (refer section 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Wollongong City Council and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The Indicative Cost Estimates include cost information provided by Wollongong City Council and were prepared for the purpose of comparison and must not be used for any other purpose. The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change.

1.5 Assumptions

As Council has previously undertaken the Coastal Zone (Hazard Definition) Study and Draft Coastal Zone Management Plan for their LGA, GHD has not undertaken any independent verification of the data and information provided by Council as part of this engagement.

2. Project Methodology

2.1 Overview

The study methodology that underpins this report is the product of a process of evolution and refinement. The initial approach was developed to respond strictly to the objectives and tasks as per section 1.2. This was subsequently revised and refocussed in consultation with Council in order to better reflect stakeholder values and opinions as they were progressively revealed.

The study was undertaken in two stages. Stage 1 focused on the study approach and preliminary management options. These were presented to Council and other relevant stakeholders in a workshop environment in order to obtain their feedback and views on the overall approach and to gauge community support for the long list of potential management options at an early stage.

Stage 2 incorporated this feedback, and observations from the final round of field assessments, to further develop and refine the options. These management options were evaluated for all the 17 beaches with consolidated criteria that were previously agreed with Council. A review of the final options was later carried out to understand the effectiveness of the proposed solutions.

A summary of the adopted methodology is presented in Figure 2.

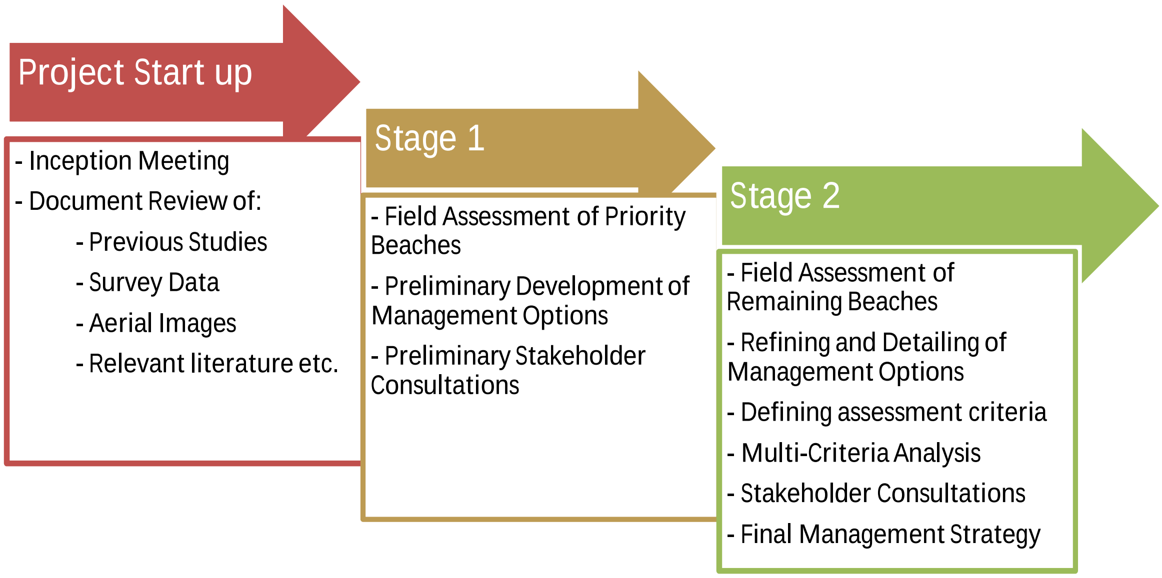


Figure 2 Methodology overview

2.2 Inception Meeting and Document Review

The program and methodology were reviewed at the inception meeting held at Council. Council provided previous study reports for the document review phase. Additional documents and data were provided by Council throughout the project. The document review was undertaken to understand the breadth of work and research that has been previously carried out in the coastline for Wollongong LGA. Since this study is an outcome of the WBM (2012) Draft Coastal Zone Management Plan (CZMP), particular attention was given to this study and the Coastal Zone (Hazard Definition) Study (CZS) Cardno Lawson Treloar (2010) to understand the drivers for this project.

GHD undertook the following activities as part of the document review:

- Review of relevant historical information, beach descriptions provided by Surf Life Saving Australia's online portal and other literature, along with the previous CZS and draft CZMP and previous environmental investigations,
- A literature review of best practice dune management strategies was undertaken, with particular reference to the ecology and management of *Acacia longifolia* subsp. *sophorae*,
- Compiled and analysed the data to obtain and confirm the relevant site conditions,
- Review of relevant documents, relevant bushland database lists and Bushcare records. Searches of relevant wildlife databases and previous flora and fauna studies were undertaken to identify threatened and migratory fauna species of potential relevance to the identified subject sites, and
- Completed a gap analysis to determine any information shortfalls required to be addressed during the field assessment.

The findings of this stage are incorporated in the site specific field assessment (section 6) and in the development of the management options (section 7).

2.3 Stakeholder Engagement and Community Consultation

As part of the study, a range of communication and consultation activities were used to identify stakeholder and community values and issues of concern (Appendix A). A summary of the techniques used and their outcomes is provided in Table 1.

The feedback received from the community and stakeholder groups was used to help guide the development of the assessment criteria, and ultimately the shortlist and final list of options outlined in this Strategy.

Table 1 Communication Type, Method, Purpose and Outcomes

Communication	Method and Purpose	Outcome
Community survey	A survey to determine the general community's issues with dune management, and ideas for improvement, was placed on the Council website. It was open to the public from 19 December 2012 to 28 February 2013. The survey link was also emailed to subscribers on Council's Bushcare and Sustainability emailing lists and to anyone attending the stakeholder workshops.	A total of 234 persons responded to the survey. All the comments received were categorised and used to inform the development of the draft strategy. Refer to Appendix B.
Media releases / Advertisements	A media release was issued by Council at the start of the project and an article was run in the Illawarra Mercury on 15 January 2013. Several other articles were subsequently published in the Illawarra Mercury and the Bulli Times. Two radio interviews were aired on ABC Illawarra. This	Phone calls, emails and letters were received by Council as a result of the media exposure. These included questions about completing the survey and concerns about the survey questions. Concerns were also raised about rips, scarps, overgrown vegetation

Communication	Method and Purpose	Outcome
	included a talk back radio interview with the Lord Mayor on 14 January 2013, and an interview with the Manager Environmental Strategy and Planning on 18 March 2013. Three notices were published in the Wollongong Advertiser to raise community awareness about the development of the Strategy and encourage participation in the online survey. A media release was issued when the draft Strategy was placed on public exhibition.	on beaches, and Coastal Wattle. Community members suggested that a dune management strategy was needed for the whole beach area, including unpatrolled beaches. Several community letters were published in the 'Your Say' section of the Illawarra Mercury. These included comments about the need to remove overgrown vegetation on beaches, the need for vegetation to protect dunes from erosion, and debate over the use of Coastal Wattle in dune plantings.
Website	Council's website was used as an information tool during the development of the strategy. The website hosted the online survey and provided details on the background and purpose, key issues and timeline for the Strategy development. The Draft Strategy was on the website when it was placed on public exhibition.	A total of 1,252 hits were received on Council's website between December 2012, when the section on the Strategy was placed on the website, and the close of the online survey on 28 February 2013.
Estuary and Coastal Zone Management Committee (ECZMC) Meetings	Presentations were made at the ECZMC meetings of 18 December 2012 and 21 March 2013 to provide opportunities for the group to learn more about the development of the Strategy, comment on the assessment criteria and provide input into the management options.	A total of 12 committee members attended the first meeting and eight attended the second meeting. The feedback received was used to guide the development and short-listing of potential management options.
Aboriginal Reference Group (ARG) Meeting	A presentation on the aims and progress status of the Strategy was made to the ARG on 27 March 2013.	A total of nine members were present. Members requested details of the AHIMS searches carried out for the Strategy, and these were provided to them after the meeting.
Meetings with key Council staff	An initial meeting was held with key internal Council stakeholders on 22 November 2012. Workshops on the draft multi-criteria analysis and draft Strategy were held with Council staff on 19 March and 9 April 2013.	Council staff provided input to the draft Strategy before the document was placed on public exhibition.
Other Stakeholder workshops	A number of workshops were held to engage other stakeholders. The workshops gave an opportunity for these groups to voice their	Totals of 11 and 15 people attended the SLSI workshops. Totals of six and five people

Communication	Method and Purpose	Outcome
	concerns, learn more about the methodology behind the strategy development, and contribute to the identification of management options for the dunes. The groups were: Surf Life Saving Illawarra (SLSI) (Monday 17 December 2012 and Monday 25 March 2013); and Beach Care Illawarra (BCI) (Tuesday 18 December 2012 and Monday 25 March 2013).	attended the BCI workshops. The feedback received was used to guide the development and short-listing of potential management options. Background information including historical photos was also provided by the groups.
Continued telephone and email contact provision	All stakeholders were able to call or email the project team throughout the project to raise any concerns, submit feedback and ask any questions.	The majority of calls and emails were to raise issues and comment on how the process should be undertaken and what the Strategy should cover.
Public exhibition of the draft Strategy	The public exhibition was publicised via a media release. Advertisements were placed in the local media (the Wollongong Advertiser and the Illawarra Mercury) and on Council's webpage and social media outlets.	The draft Strategy was placed on exhibition at Council's Customer Service Centre at the Administration Building and the Council libraries (Wollongong, Corrimal, Dapto, Thirroul, Warrawong, Unanderra, and Helensburgh), as well as on Council's website.
Submissions in reply and finalisation of Strategy	Comments on the draft document were reviewed and Council's project team prepared a 'submissions in reply report' along with an implementation plan for the Strategy for Council.	This report and plan were accepted and the recommended changes incorporated into the final Strategy (this document).

2.4 Methodology for Morphology, Ecology and Structural Assessments

The assessments were undertaken by discipline specialists to further understand the key issues at each beach, and to gain an appreciation for the various management options that might be developed. The field assessments considered the following:

- Identification of high use recreation areas,
- Lines of sight,
- Flora/fauna assessment,
- Constraints on management options,
- Narrowing of beach width and loss of amenity,
- Pests and vermin, and
- Issues identified by Council and stakeholders during the draft CZMP review process and the consultation undertaken as part of this project.

2.4.1 Assessment of Dune Morphology

The dune morphology component of the assessment focused on the physical coastal processes along a beach profile (i.e. offshore (nearshore, surfzone, swash zone) beach berm, incipient dune, foredune and hind dune) (refer Figure 3) and included undertaking a time series analysis where change over time was identified using historical aerial photographs, and cross-sections (as presented in the Coastal Zone (Hazard Definition) Study (CZS) and the recent 2013 cross-sections surveyed by Council (Table 2).

Table 2 Aerial Photography, Photogrammetry ALS and On-ground Survey Dates

Beach	Aerial Photography	Photogrammetry	On-ground survey
Stanwell Park	1948 1955 1961 1977 1986 1993 2001 2006 2011		
Coalcliff	1955 1961 1966 1984 1993 2001 2006 2011		
Scarborough	1948 1955 1961 1966 1984 1993 2001 2006 2011		
Coledale	1948 1955 1961 1966 1986 1993 2001 2006 2011	1936 1948 1955 1961 1966 1974 1976 1981 1987 1993 2001 2007	
Austinmer	1948 1955 1966 1977 1986 1993 2001 2006 2011	1955 1961 1966 1974 1976 1984 1993 1999 2007	
Thirroul	1955 1966 1977 1986 1993 2001 2006 2011	1961 1972 1974 1993 1999 2007	
Sandon Point	1948 1961 1966 1977 1993 2012	1961 1972 1974 1984 1993 2005	
Bulli	1948 1955 1966 1977 1987 1993 2001 2006 2011 2012	1961 1972 1974 1984 1993 2005	2013
Woonona	1948 1955 1966 1977 1986 1993 2001 2006 2011 2012	1955 1961 1966 1972 1974 1987 1993 1999 2001 2007	2013
Bellambi	1948 1955 1961 1977 1986 1993 2001 2006 2011 2012	1955 1961 1966 1972 1974 1987 1993 1999 2001 2007	2013
Corrimal	1948 1955 1961 1966 1977 1984 2001 2006 2011 2012	1961 1972 1974 1976 1988 1990 1993 1999 2001	2013
Towradgi	1948 1955 1961 1966 1977 1986 2001 2006 2011 2012	N/A 2007 Airborne Laser Scanning (ALS) data	2013
Fairy Meadow	1948 1955 1961 1966 1977 1986 2001 2006 2011 2012	N/A 2007 ALS data	2013
North Beach	1948 1955 1966 1977 1987 1993 2001 2006 2011 2012	1937 1955 1974 1993	
City	1948 1955 1966 1977 1987 1993 2001 2006 2011 2012	1938 1951 1955 1966 1974 1984 1993 2007	2013
Port Kembla	1948 1955 1966 1977 1986 1993 2001 2006 2011 2012	1961 1974 1988 1999 2007	2013
Windang	1948 1955 1966 1977 1986 1993 2001 2006 2011 2012	1961 1974 1988 1999 2007	2013

This time series analysis allowed for identification of change in the beach/dune profile, in particular the foredune and incipient dune, which was further confirmed through changes over time in the distribution of vegetation, as observed in the historical aerial photographs. Key concerns such as types and extent of vegetation across the dune were further assessed in the field and during consultation with stakeholders.

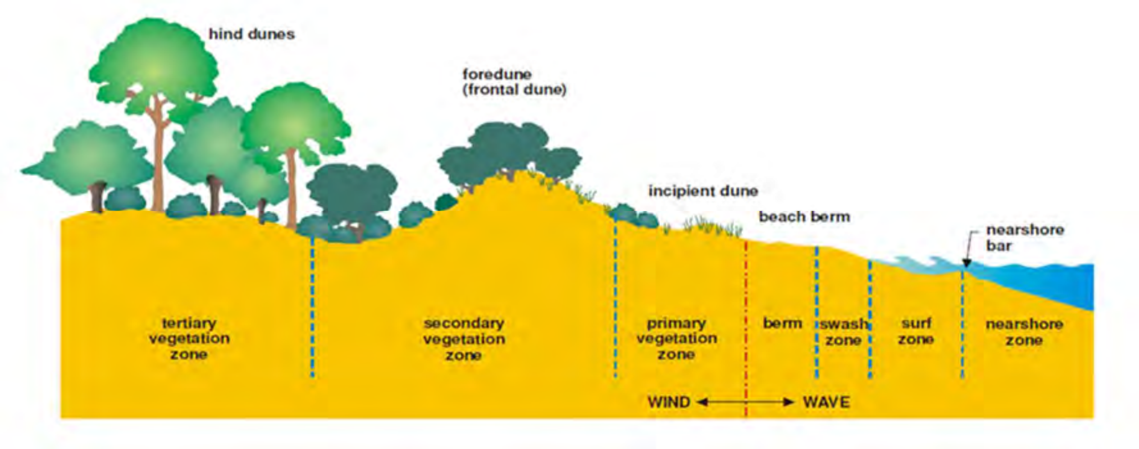


Figure 3 Typical dune profile

(Source: Coastal Dune Management, DLWC 2001)
Note: Dunes in Wollongong LGA differ from this typical profile due to previous vegetation clearing, sandmining and urban development behind the dunes.

2.4.2 Assessment of Ecology

Desktop Assessment of Flora and Fauna

A desktop literature and database review was undertaken to identify threatened flora and fauna species, endangered populations and threatened ecological communities listed under the NSW *Threatened Species Conservation (TSC) Act* 1995 and Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act* 1999 that could be expected to occur in the locality, based on previous records, known distributional ranges and habitats present. Biodiversity databases and literature pertaining to the study area and locality (i.e. within a 10km radius of the study area) that were reviewed prior to conducting field investigations included:

- Office of Environment and Heritage (OEH) Wildlife Atlas database (licensed) for records of threatened species, populations and ecological communities listed under the TSC Act that have been recorded within the locality (OEH, 2012b);
- OEH threatened species profiles online database (OEH, 2012c), including records of endangered populations and communities listed under the TSC Act recorded within the locality;
- Department of Primary Industries (DPI) online protected species viewer for records of threatened aquatic species in the Wollongong LGA (DPI, 2012a), and data obtained for the Southern Rivers Catchment Management Authority (DPI, 2012b);
- Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) Protected Matters Search Tool for Matters of National Environmental Significance (MNES) listed under the EPBC Act (and their habitats) that are predicted to occur within the locality (DSEWPaC, 2012a);
- DSEWPaC online species profiles and threats database (DSEWPaC, 2012b);
- Broad scale vegetation mapping of the NSW South Coast and ‘eastern tablelands’ (Tozer *et al.*, 2010) to identify native vegetation types occurring within the study area and the likely presence of any threatened ecological communities. Given the scale of the Tozer *et al.* (2010) regional vegetation mapping there are likely to be inaccuracies at the scale of the study area. It was used as a guide to the vegetation types that are likely to be present in the study area rather than a precise location or extent of vegetation types. This

information was used only for the assessment of habitat resources for threatened biota. Higher resolution vegetation mapping (NPWS, 2002) was provided by Council at a later stage to provide further clarity on location of vegetation communities in the management areas;

- Aerial photography (Google Earth, 2013) was also used to identify vegetated, cleared and residential areas;
- Aerial photography of the locality provided by Council; and
- Existing assessment reports, community records and photos provided by Council for the project were reviewed as part of this assessment to identify threatened biota previously recorded within the study area.

The habitat resources with the potential to exist within the study areas were compared with the known habitat requirements of the threatened biota predicted to occur, to determine their likelihood of occurring within or being affected by any future works in the study areas. The likelihood of threatened and migratory biota occurring in the study area was assessed based on records from the locality, species distribution and habitat preferences, and quality of potential habitat present in the study area and broader beach landscape (Table 3). This provides a key to the likelihood of occurrence in the study area of threatened biota (including migratory species) predicted to occur or previously recorded within the locality of the study areas as identified in Appendix C and Appendix D.

Table 3 Key to Likelihood of Occurrence for Threatened Species

Likelihood	Definition
Likely	Species previously recorded within a 10km radius of the study area and suitable habitat likely to occur within the study area.
Possible	Species previously recorded within a 10km radius of the study area, however only marginal suitable habitat likely to occur within the study area, OR Species not previously recorded within a 10km radius of the study area, however the study area is within the species known distribution and suitable habitat likely to occur within the study area.
Unlikely	Species previously recorded within a 10km radius of the study area, however no suitable habitat likely to occur within the study area.
Nil	Species not previously recorded within a 10km radius of the study area, suitable habitat unlikely to occur within the study area, and/or study area outside species known distribution.

Field Assessment of Flora

The focus for the detailed botanical and habitat assessment related to the marked management areas in front of the SLSCs identified in section 1.3. Belt transects from beach to hind dune were surveyed, with the numbers of transects determined according to area and variation in vegetation types at specific sites. An assessment of the abundance of each species, approximate heights of each tree and shrub species, calculation of average, minimum and maximum heights, growth rates and “spread”, based on historical Aerial Photography Interpretation (API), was undertaken. A schematic diagram of vegetation across the dune profile is included for the nine beaches where a sight line issue was found to occur (Appendix E).

All beaches (in front of the SLSC and tower) were surveyed and assessed for the presence of threatened flora species.

In addition to the detailed assessments, an overall assessment of patterns of vegetation cover along each beach was undertaken. This was completed by applying API, the local knowledge of the senior botanist, interviews with local bush regenerators and rapid ground-truthing during the field surveys. Plant species lists from the survey for each beach are included in Appendix F. Presence and abundance of each species obtained from the transects in front of the SLSC, as well as general surveys in the broader beach area are included in the lists.

Surveys were carried out on weekdays. If Council lifeguards were available, interviews were carried out, in order to assess particular concerns relating to vegetation. Beaches were also visited on Sunday mornings, in order to assess strand widths for Nipper competition and to interview SLSC members.

In addition, an assessment of the status of *Acacia longifolia* subsp. *sophorae* as an environmental weed in the Wollongong LGA was undertaken. This involved an assessment of the distribution of this species in Wollongong based on the results of historical API, historical plant species lists, specific data collection at beaches of most concern (e.g. Woonona, Bulli, Fairy Meadow, Towradgi, Corrimal and Windang). A review of relevant literature was undertaken to identify the occurrence and management of *A. longifolia* subsp. *sophorae* in other coastal locations, assess management actions currently being implemented and make recommendations for ongoing management options for this species in the Wollongong LGA. The results of the assessment are incorporated into this Strategy.

Field Assessment of Fauna

Habitat values for native fauna and opportunistic fauna records were recorded during the flora survey.

Damage to dunes and vegetation resulting from rabbits and/or other pests was assessed, particularly at sites where rabbits are known to be a problem and where management measures have been implemented previously.

An assessment of habitat values for snakes was completed and evidence of any snake activity (incidental sightings, tracks, skins, etc.) was recorded, noting that members of the public have expressed concern regarding snakes and may include native snakes in their categorisation of 'vermin'.

Survey limitations

No targeted fauna surveys of the study areas have been undertaken at this stage. Assessment of potential biodiversity constraints relating to native fauna was predominantly undertaken via desktop review.

With regard to the targeted threatened flora surveys that were undertaken, given the short-duration and timing of the field survey (summer) it is likely that some species were not detected during the survey. These species are likely to include annual, ephemeral or cryptic species that flower at other times of year.

The assessment of the likely occurrence of threatened species has relied, in part, upon data obtained from the Atlas of NSW Wildlife (OEH). These data should be viewed as indications of which species might be present in a given area, and does not provide the full distributions of species or indicate their movements or utilisation of habitats. For the purposes of environmental assessment, Wildlife Atlas data alone are not adequate surrogates for thorough field surveys (OEH, 2012d; OEH, 2012e). Some threatened species are "sensitive" (such as some glider species) and precise locations for such species are not provided or buffered (OEH, 2012d; OEH, 2012e). To verify the likelihood of threatened species locations (particularly threatened fauna) within study areas, further field survey would be required.

2.4.3 Assessment of Surf Life Saving Facilities

The structural assessment of all existing lifesaver/lifeguard patrol facilities consisted of a desktop study of all 17 beaches, site inspections and a more detailed site assessment of the nine (9) sites with line of sight (LOS) issues. These beaches included:

- Bulli,
- Woonona,
- Bellambi,
- Corrimal,
- Towradgi,
- Fairy Meadow,
- City Beach,
- Port Kembla, and
- Windang.

A desktop review of the beaches and lifeguard facilities was undertaken prior to the site inspection and involved a study of aerial photographs, current photos, line of sight report and relevant information in the Council's asset register. This was carried out to obtain a general idea on the current facilities, location of the lifeguard stations, distances of lifeguard towers from other amenities and the beach.

The site inspections were undertaken to assess current lifeguard amenities, distance of amenities from the beach, as well as the extent and cause of the line of sight issues. Data collected from the site visit was used to evaluate viable options to address line of sight issues, with a number of options presented for each site. Considerations were made with regards to safety include visibility of the most populated sections of the beach (flagged area) and emergency response time (i.e. how long will it take for lifeguards to access the beach from the lifeguard station).

2.5 Aboriginal Heritage Information Management System (AHIMS)

The Aboriginal Heritage Information Management System (AHIMS) database was searched to identify any information about Aboriginal objects and places that have been reported to the Office of Environment and Heritage. Searches were undertaken for a 200m buffer area around the management areas at each of the 17 beaches. These locations were mapped and provided by Council to GHD for consideration whilst preparing the Strategy.

2.6 Development of Management Options

A long list of management options was initially developed from the literature review (Appendix G). Following the data and information gathered during the preliminary rounds of stakeholder consultation, desktop study and field work, this list was refined to a shortlist by comparing the list of examples of other dune management projects and refining it based on what was considered appropriate for the Wollongong LGA beaches and their constraints. These were discussed and agreed with Council. The refined shortlist of options was deemed to be those that reflected viable and appropriate options for the Wollongong LGA. The refined management options have been categorised as:

- Maintain current management,

- Structural,
- Ecological, and
- Morphological.

2.7 Multi-Criteria Analysis

Following the development and agreement of the shortlist of options, a Multi-Criteria Analysis (MCA) was carried out in order to identify the most effective management options for each beach. An overview of the evaluation process for the MCA undertaken is shown below (Figure 4) and described in detail in the following sections.

Figure 4 Option evaluation process

2.7.1 Establishing Criteria

The criteria were developed in consultation with Council and informed by stakeholder feedback to reflect all the key issues at hand. These criteria were used to assess each beach. This is described with further detail in section 8.1.

2.7.2 Weighting of Criteria

The next stage in comparing the different options was to assess the criteria in order of importance. The relative importance of a criterion was decided by individually comparing it to each of the other criteria based on the following points system:

- 3 High,
- 2 Medium,
- 1 Low (i.e. the two criteria are regarded as being of close importance).

Further information on this process is available in section 8.2.

From the prioritising matrix the scores for each criterion were tallied to determine the overall score for each. Weighting of the criteria was then calculated on the following basis:

$$\text{Weighted Score} = \frac{\text{(Criterion Score)} \times 10}{\text{(Total Score)}}$$

2.7.3 Ranking of Options for each Beach

The final step in the evaluation was the assessment of how each option was perceived to satisfy each of the criteria. Each option was rated from +3 to -3, based on a value system of +3 points for large improvements, to 0 points where there would be no change, to -3 points for large deterioration.

This value was then multiplied by the weighted score for each criterion. The scores for each option were subsequently added to achieve a total point rating.

Establishment of the criteria, weighting of criteria and ranking of options were presented to Council and further refined in consultation with Council.

Viable management options for each beach have been ranked according to the outcome of the MCA and are presented in section 8.4 of this report.

2.7.4 Prioritisation of Recommendations across the Study Area

In addition to the MCA process described above, the severity of the key recreational issues present at each beach relative to other beaches in the study area was assessed and classified as being either severe, moderate, minor or nil.

The key recreational issues were:

- Sight line from lifeguard facilities to patrolled zone of beach,
- Beach access, and
- Recreational amenity.

This assessment supplemented the MCA in order that the overall strategy implementation priorities reflect both the efficacy of the particular management option at a particular beach, and the relative condition and need of each beach compared to others in the study area.

Beaches with at least one key issue have been shortlisted, and the top (up to) three management options for those beaches identified, along with indicative costs and timing in section 8.5.2 of this report.

This shortlist was then sorted on the basis of the number and severity of issues present at each beach detailed in section 6 of this report. This information can be utilised by Council as a decision framework to help allocate available funds to undertake works to improve beaches for the upcoming swimming seasons.

3. Legislation and Policy Framework

There is a wide range of laws, policies and guidelines that are relevant to the management of beaches and coastal dunes. Management options need to comply with the legislative and policy framework before they can be considered for implementation. This section has been provided to GHD by Council.

3.1 Legislation

3.1.1 Coastal Protection Act 1979

The *Coastal Protection Act 1979* (CP Act) is the principal legislation relating to coastal management in New South Wales, and has been amended by the *Coastal Protection and Other Legislation Amendment Act 2010* and the *Coastal Protection Amendment Act 2012.*

The CP Act makes provisions relating to the use and occupation of the coastal region in order to preserve and protect these areas whilst encouraging sustainable use of the coastal zone. The objectives of the Act include protecting and enhancing the coastal environment, ensuring use of the coastal zone complies with the principles of ecologically sustainable development, and promoting beach amenity.

The CP Act requires councils to obtain the concurrence of the Minister for Environment and Heritage to carry out any development in the coastal zone that will:

- Be inconsistent with the principles of ecologically sustainable development,
- Adversely affect the behaviour (or be adversely affected by the behaviour) of the sea, and
- Adversely affect a beach or dune.

3.1.2 Local Government Act 1993

The *Local Government Act 1993* (LG Act) creates local governments and grants them the power to perform their functions, which involve management, development, protection, restoration, enhancement and conservation of the environment. In carrying out these functions, council, councillors and employees must have regard for the principles of ecologically sustainable development.

This Act also sets out the responsibilities relating to the classification, use and management of public land. Council must classify public land into 'operational' or 'community' land. The community land classification recognises the importance of a parcel of land to the community, which:

- Cannot be sold,
- Cannot be leased, licenced or any other estate granted over the land for more than 21 years, and
- Must have a plan of management (PoM) prepared for it.

The PoM identifies objectives and performance targets for the management of the land.

The relevant PoMs to be considered are:

- Generic Plan of Management for the Community Land of Wollongong City Council 2011,
- Wollongong City Foreshore Plan of Management 2008,
- Plan of Management for Coledale Beach Reserve 2012, and

- Plan of Management for Stanwell Park and Bald Hill 2009.

3.1.3 Crown Lands Act 1989

The *Crown Lands Act 1989* (CL Act) provides for the administration and management of Crown land for the benefit of the people of NSW. Many parcels of Crown land exist along the coast, including the dunes, which are in the care and control of Council. In this case, Council is the reserve trust manager or trustee appointed by the Minister for Lands to care, control and manage the land in accordance with its public purpose and the principles of Crown lands management (section 11 of the CL Act).

For all Crown reserves, a PoM is required to be prepared and adopted. The PoM is to identify the key attributes and values of the area, general physical improvements to enhance the values and to specify the permissible uses for the land.

3.1.4 Threatened Species Conservation Act 1995

Endangered Ecological Communities (EECs) are identified within the *Threatened Species Conservation Act 1995* (TSC Act) as assemblages of species that are in decline. EECs occur near the management areas of some of the SLSCs (see section 6), although none have been recorded seaward of the SLSC buildings. If management activities are proposed for areas containing EECs, a Species Impact Statement is required to determine the potential impact of the proposed activity on the EEC.

3.1.5 Environment Protection and Biodiversity Conservation Act 1999 (Cmth)

Some EECs are also listed on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Activities that may impact on these EECs will also require assessment under this act.

3.1.6 National Parks and Wildlife Act 1974

Native fauna species, including snakes, are protected under the *National Parks and Wildlife Act 1974* (NPW Act) and it is an offence to harm these species. A range of native flora species are also protected under the NPW Act and it is an offence to pick these plants. Aboriginal objects, relics and places are protected under the NPW Act. It is an offence to knowingly destroy, deface or damage an Aboriginal object or place. The Act also specifies the details of the Aboriginal Heritage Information Management System database, which contains information and records regarding Aboriginal objects whose existence and location have been reported to the Director-General.

3.1.7 Native Vegetation Act 2003

The *Native Vegetation Act 2003* (NV Act) identifies foredunes, beach areas and sand dunes as sensitive terrains, which are very susceptible to environmental harm arising from clearing of native vegetation. Under Property Vegetation Plans, clearing of dune and beach areas is not permitted, as it is not considered possible to offset the impacts of clearing in these areas.

While there are some exceptions to the NV Act for infrastructure works that affect small areas, activities carried out under those exemptions require thorough consultation with the Southern Rivers Catchment Management Authority, and must meet the requirement that the works will improve or maintain environmental outcomes.

3.1.8 Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* (NW Act) provides for the identification, classification and control of noxious weeds. In the Wollongong LGA, 64 weeds have been declared noxious by the Illawarra District Noxious Weeds Authority and at least nine of these have been recorded in the management areas around the SLSC facilities (Appendix H).

Weeds listed as noxious are classified into control classes identifying the required level of response by landholders to control the species. Council management of noxious weeds on beaches and dunes is coordinated with control efforts carried out by the Illawarra District Noxious Weeds Authority.

3.1.9 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) regulates land-use planning by making provision for the development of local, regional and state plans. Under Part 5 of the Act, Council is the 'determining authority' for landscaping works, which means that Council determines whether the works can go ahead in accordance with the objectives of the Act.

The objectives of the Act which relate to dune management include to encourage:

- The proper management, development and conservation of resources, including natural areas, for the purpose of promoting the social and economic welfare of the community and a better environment,
- The protection of the environment, including the protection and conservation of native animals and plants and their habitats, and
- Ecologically sustainable development.

To comply with the requirements of the EP&A Act, Council must not only consider recreational amenity and public safety issues, but also biodiversity issues, protection of assets from coastal hazards, and the ongoing sustainability of any management action.

Under the Act, Council must take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of any proposed activity, including whether works will adversely impact:

- Threatened species,
- Endangered populations,
- Endangered ecological communities,
- The habitat of any of the above, and
- Critical habitat.

Activities also need to be consistent with any relevant recovery plan or threat abatement plan, and must not contribute to a key threatening process.

3.1.10 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve threatened species, populations and ecological communities of fish and marine vegetation and promote ecologically sustainable development, including the conservation of biological diversity.

Part 7 of the FM Act relates to the protection of aquatic habitats, and circumstances in which a local government authority (i.e. Council) can carry out activities that impact on marine vegetation (such as dredging and reclamation). Activities may trigger the need for a permit from the Minister for Primary Industries.

3.2 Policies and Plans

3.2.1 Wollongong Local Environmental Plan 2009

The Wollongong Local Environmental Plan 2009 (LEP) has been made by Council under Part 3 of the EP&A Act. The LEP identifies land use zones and assigns these zones to parcels of land. The LEP establishes what types of development may and may not be permitted within different land use zones (and therefore parcels of land).

Management areas around the SLSC facilities are zoned within the LEP for particular purposes, with certain activities permitted with or without consent, and other activities prohibited.

3.2.2 NSW Coastal Policy 1997

The NSW Coastal Policy 1997 sets the context for population growth and economic development in the coastal zone while protecting the natural, cultural, spiritual and heritage values of the coastal environment. To achieve this, the Policy has a strong integrating philosophy based on the principles of ecologically sustainable development:

- The precautionary principle – i.e. if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation,
- Inter-generational equity – i.e. the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,
- Conservation of biological diversity and ecological integrity, and
- Valuation, pricing and incentive mechanisms – i.e. environmental factors should be included in the economic valuation of assets and services.

Of particular relevance to the issues and management options identified in this Strategy, the NSW Coastal Policy 1997 identifies the following objectives:

- To manage the coastline and estuarine environments in the public interest to ensure their health and vitality,
- To give the impacts of natural processes and hazards a high priority in the planning and management of coastal areas,
- To recognise and consider the potential effects of climate change in the planning and management of coastal development,
- To increase public access to foreshores when feasible and environmentally sustainable options are available,
- To ensure risks to human safety from the use of coastal resources is minimised,
- To develop adequate formal and informal education and awareness programs addressing coastal management issues,
- To ensure Government agencies (including councils) efficiently and effectively implement the Coastal Policy in a coordinated and collaborative manner, and
- To ensure local government coastal policy and management is integrated and involves community participation and information exchange.

3.2.3 Coastal Crown Lands Policy 1991

The Coastal Crown Lands Policy 1991 applies to all Crown land up to 1km landward and 3 nautical miles seaward from the low water mark in NSW, whether reserved, dedicated, under tenure, or under trusteeship. The objectives of the Coastal Crown Lands Policy 1991 are:

- Conserve and maintain the intrinsic environmental and cultural qualities of coastal Crown lands,
- Retain all coastal Crown lands of an environmentally sensitive nature and/or required for a public purpose, in public ownership,
- Optimise public access and use of coastal Crown lands,
- Provide Crown lands, as appropriate, for recreation, tourism, residential and commercial coastal development with regard to the nature and consequences of coastal processes,
- Encourage the rehabilitation of degraded coastal Crown lands, and
- Continue to acquire significant coastal lands for future public use.

3.2.4 State Environmental Planning Policy No. 71 – Coastal Protection (SEPP 71)

SEPP71 relates to development within the coastal zone, however it has been made under the *Environmental Planning and Assessment Act 1979* to ensure:

- Development in the NSW coastal zone is appropriate and suitably located,
- There is a consistent and strategic approach to coastal planning and management, and
- There is a clear development assessment framework for the coastal zone.

SEPP 71 identifies consultation and planning requirements for specific types of development in sensitive coastal locations.

3.2.5 State Environmental Planning Policy No. 26 - Littoral Rainforest (SEPP 26)

This Policy seeks to protect Littoral Rainforests (an EEC) by requiring development consent for development in or adjacent to mapped littoral rainforest areas. Littoral Rainforest is known to occur in the vicinity of some of the SLSCs in the north of the LGA (see section 5.4.1).

Under this Policy, an environmental impact statement and the concurrence of the Director-General of OEH may also be required for activities that impact on Littoral Rainforest.

3.2.6 State Environmental Planning Policy (Infrastructure) 2007

The Infrastructure SEPP allows a range of infrastructure development proposals to be assessed by Council under Part 5 of the EP&A Act. Activities that can be assessed in this way include landscaping works on parks and other public reserves, and waterway and foreshore management activities. Where management options identified for the management areas around the SLSC facilities comply with the provisions of the Infrastructure SEPP, they may be subject to this type of assessment.

4. Identification of Key Stakeholder and Community Concerns

4.1 Stakeholder Consultation

As outlined in section 2, a range of community consultation and stakeholder engagement activities, including an online survey on Council's website, has been undertaken as part of this project. Community members and stakeholders from Council's Estuary and Coastal Zone Management Committee, environmental and community groups, and representatives from relevant state government agencies and Council divisions were consulted with during the development of the Strategy. Details of the specific community and stakeholder responses received throughout this project are listed in detail in Appendix A. The results of the Council website survey are detailed in Appendix B. The sections below discuss the key themes or issues that underpin this feedback and outline how each issue has been addressed in this project. The key issues are:

- Line of sight issues for lifeguards and lifesavers observing beach users,
- Impact of dune vegetation on dune morphology (related to frequency and severity of scarping and risks to beach users, decrease in beach width over time and impact on beach amenity),
- Impact on rips and currents,
- Beach access,
- Need to retain vegetated dunes for coastal protection and ecology,
- Choice of dune vegetation,
- Pests, vermin and litter,
- Vegetation impacts on anti-social behaviour,
- Need for education as a strategy, and
- Other general matters.

4.1.1 Line of sight issues

This issue relates to the reduced line of sight from SLSCs and patrol towers to the beach area and the risk it presents to the safety of beachgoers. Community consultation and stakeholder feedback held these issues to be the result of a combination of growth of vegetation on the dunes, an increase in the extent of dune vegetation and an increase in dune size and height due to accumulation of sand. The site specific severity of this issue was considered as part of the individual beach assessments presented in section 6.

4.1.2 Dune morphology and impact on rips and currents

This issue relates to changes in the beach profile over time and perceived impacts on the frequency of occurrence and strength of rip currents that has occurred as a result. Community consultation and stakeholder feedback held that these issues are attributable to the influence of increasing dune vegetation on dune morphology, which in turn may be ascribed to compromising beachgoer safety. Key aspects of this issue regarding the variation in morphology of beaches in the Wollongong LGA are discussed in section 5.1, and a review of the nature and causes of rips in relation to beach profiles is discussed in section 5.2.

4.1.3 Retention of vegetated dunes for coastal protection and ecological value

This issue relates to the role of vegetation within a coastal system in regards to coastal protection and its ecological value. Key aspects of this issue relate to the role of vegetated dunes influencing coastal processes, as protection against coastal hazards, and in minimising sand drift. In addition, a number of comments have related to the importance of dunes as a habitat for native flora and fauna. Both of these issues are discussed generally in section 5. Site specific vegetation and dune morphology issues are considered in the assessments of individual beaches presented in section 6.

4.1.4 Impact of dune vegetation on dune morphology

Many stakeholder comments relate to the increase in the extent of dune vegetation, to increased frequency and severity of scarping, risks to beach users, a decrease in beach width over time, and impacts on beach amenity. Key aspects of this issue are discussed in section 5, and were considered during the site assessments presented in section 6.

4.1.5 Choice of dune vegetation types

This issue relates to the question as to what constituted the appropriate types of plant species that should occur across the dune system, based on the NSW Coastal Dune Management Manual (DLWC, 2001), and was a strong theme within the stakeholder feedback. Of particular note was the status of *Acacia longifolia* subsp. *sophorae* (Labill.) Court (Coastal Wattle) and its perceived dominance in the vegetation in the foredunes of a number of beaches. Key aspects of this issue regarding Coastal Wattle and other *Acacia* species occurring in the dunes are discussed in section 5. The presence and extent of different vegetation types across the dunes was recorded during the site assessment, with the results of these surveys presented in section 6 and Appendix F. A list of appropriate species for planting in dunes is found in Appendix I.

4.1.6 Deterioration of beach access

This issue related to the reduced amenity of beach access ways as a result of vegetation overgrowth, poorly maintained infrastructure, buildup of sand on pathway edges, width of access ways and the occurrence of steep gradients on the beaches due to the presence of scarping that occurs after storm events. This issue was considered during the assessments of individual beaches presented in section 6.

4.1.7 Vegetated areas being conducive to pest, vermin and litter problems

Many stakeholders felt that the increased vegetation of dunes has contributed to a prevalence of pests and vermin within the coastal zone, and acted as a trap that captured litter and other rubbish, that was then difficult or unable to be removed. Site specific pest and vermin issues are considered in the assessments of individual beaches presented in section 6. Litter collection is undertaken by lifeguards as part of their current duties.

4.1.8 Vegetated areas being conducive to anti-social behaviour

Many stakeholders felt that the cover provided by heavily vegetated dunes provided too great an opportunity for anti-social behaviour. While this is an important social issue, it is not within the scope of this study and will be addressed as part of Council's general operational programs.

4.1.9 Need for education

The implementation of the Strategy was identified as an opportunity to provide an education program in parallel. This has been included as an action that would benefit all beaches and is presented in section 8.

4.2 Public Exhibition and Submissions in Reply

The draft Strategy report was placed on public display and comments were invited to assist with the finalisation of the Strategy. Comments on the draft document were reviewed and Council's project team prepared a 'submissions in reply report' along with an implementation plan for the Strategy for Council. This report and plan were accepted and the recommended changes incorporated into the final Strategy (this document).

5. Discussion of Key Stakeholder and Community Concerns

Below is a discussion on several of the key concerns identified as part of the stakeholder engagement process and the community survey (as outlined in section 4):

- Changes in beach profiles and characteristics as a result of the dune vegetation works (section 5.1 and 5.3),
- Role of vegetated dunes as part of a coastal system and the occurrence of rips, scarps and reduced beach width in a coastal system (section 5.2 and 5.3),
- Definition of environmental weeds and specifically, the suitability of *Acacia longifolia* subsp. *sophorae* as a dune species (section 5.4), and
- Dunes as valuable habitats – threatened and migratory species and dunes as habitat for threatened and migratory fauna (section 5.5).

This section of the report aims to provide a technical discussion of these key issues that reflects what is a complex natural environment. The framework of this technical discussion is based on latest published literature and recent research. An appreciation of these technical issues is essential in order to make informed decisions that respond to Stakeholder and Community key concerns.

5.1 Characteristics of Wollongong Beaches

The morphology of a beach at any particular time is a function of its sediment characteristics, wave height and period, tidal range, wind conditions and the current beach state. However, over the long term, a given beach will tend to exhibit a most frequently recurrent state which depends on the local environmental conditions. Each of the beaches along the Wollongong coast can be classified, based on its wave dynamics, morphology, sediment characteristics and stability within a general dynamic characterisation that applies to most beaches world wide. This classification ranges from dissipative beaches, through transitional beaches to reflective beaches (Figure 5).

Descriptions of the characteristics and variability in morphology of different beach types around south eastern Australia have been extensively reviewed by Short and Hesp (1982), Wright and Short (1984) and Short (2007), and are summarised below.

Dissipative beaches are a response to average high wave conditions, coupled with an abundant supply of medium to fine sand. They are characterised by a wide low-gradient beach face and shore parallel bars and channels, with a high potential for aeolian (wind driven) transport and potentially large foredunes. They experience a low temporal frequency of erosion, which is spatially continuous alongshore, causing parallel backbeach foredune scarping.

Reflective beaches occur under low swell conditions or in sheltered compartments, and are often associated with coarse sediment. They are characterised by a narrow steep beach face with the surf zone dominated by cusp circulation (Figure 5). They have limited potential for aeolian sand transport and have small foredunes.

Intermediate or transitional beaches occupy the continuum of morphological states between fully dissipative and fully reflective beaches. The most obvious characteristic is the presence of a horizontally segregated surf zone with rips and bars, and these beaches can exhibit a range of complex morphologies over time, depending on prevailing conditions. They occur in a wide range of environmental conditions that range from 0.5 to 2.5m waves and they tend to be the most dynamic beach type. They are classified into four separate types (Figure 5). Immediately below the high energy dissipative beach is the longshore bar and trough, then the rhythmic bar and beach, followed by the transverse bar and rip, and finally to the low tide terrace. During periods of erosion and accretion, a beach can fluctuate between beach types in response to a change in wave climate (Short, 1999; Wright and Short, 1984). At intermediate beaches, as the morphology moves from the dissipative to the reflective state, the rip spacing and size decreases, surf zone width decreases, and subaerial beach gradient increases as width decreases. Potential aeolian sand transport and foredune size decreases as intermediate beaches trend from dissipative to reflective.

Potential aeolian sand transport is greatest on dissipative beaches and least on reflective beaches. Accordingly, foredunes are potentially largest on dissipative beaches, of moderate size on intermediate beaches and smallest on reflective beaches. High-energy dissipative beaches potentially have the largest foredunes which can range from highly stable, well vegetated; topographically laterally continuous forms to highly unstable, poorly vegetated, hummocky residuals. Instability in the dune morphology often results from large scale laterally continuous wave erosion during extreme storm events.

Moderate-energy intermediate beaches encompass a transition zone from high to low potential aeolian transport and from large to small foredunes as they tend from the more dissipative to the more reflective beach state. Foredunes are characterised by lateral morphological variation, often displaying a cusped form alongshore (greater than 100m), and multiple phases of erosion and accretion (Figure 5). Foredune instability and morphology is related to regular scarping at discrete locations (in the lee of rip embayment's), which are spatially variable over time. In south east Australia, foredune instability appears greatest in the lee of high-energy intermediate beaches and least in the lee of low-energy intermediate beaches.

In NSW, one end of a beach is often more exposed than the other i.e. the sheltered end tends to be more reflective (typically steep in profile with a narrow shoaling and surf zone) and beach morphology grades into more dissipative conditions towards the exposed end where the beach is typically wider and flatter in profile, with a wide shoaling and surf zone. Similarly, as morphology is controlled by the degree of accretion or erosion on a beach, it is possible for a beach to shift towards the reflective or dissipative end of the morphological spectrum over time. As a reflective beach erodes, the berm and foreshore sediment moves offshore to form bars with subsequent surf zone, longshore current and rip development. On a dissipative beach, fair weather accretion drives the bars shorewards welding them to the beach as shoals or moving sediment onto the foreshore in berm development. The surf zone is increasingly attenuated and rips and longshore currents diminish in area and strength (Bryant, 1981; Wright and Short, 1984).

The structural setting of the Illawarra coastline controls the morphology of beach development. The proximity of irregular topography near the coast, the narrow shelf width and landward dipping bedrock has led to the formation of small, semi-compartmentalized ephemeral beaches which are steep and reflective at high tide however, dissipative with attendant longshore currents and rips at low tide. Bryant (1981) describes these types of beaches as having mixed characteristics.

Where the coastal plain is wider or sand more abundant, long fully dissipative beaches have developed. Bryant (1981) has characterised the 17 beaches in this study into dissipative, transitional (intermediate) or mixed beaches (e.g. Stanwell Park beach is characterised as a transitional beach, while North Wollongong beach is characterised by a mixed beach type). In addition, the beaches have a range of sediment supply types, being either fixed, starved or in surplus and supplying to the dunes (e.g. Stanwell Park and North Wollongong are fixed beaches).

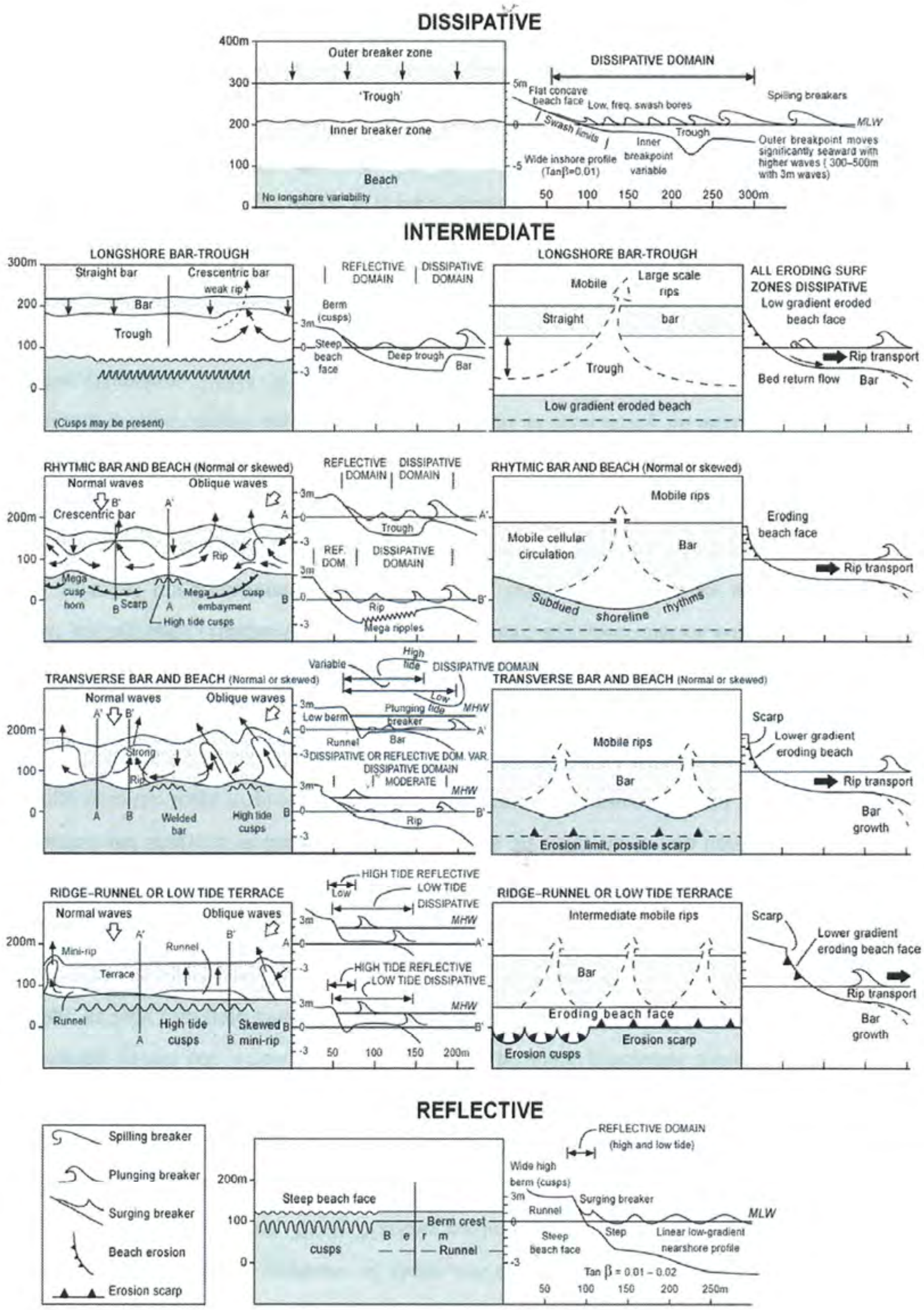


Figure 5 The 'Australian beach model', a three dimensional sequence of wave dominated beach types and states for accretionary (left) and erosional (right) wave conditions (source: Short, 1999)

Table 4 outlines the characteristics including beach type, aspect, compartmentalisation type and sediment supply status for the 17 beaches assessed in this study. The only fully reflective beaches in the Wollongong LGA are Belmore Basin at Wollongong and MM and Fisherman's beaches at Port Kembla (Bryant, 1981), which are not considered in this study as they are not patrolled swimming beaches.

Table 4 Characteristics of beaches in the Wollongong LGA by Bryant (1981)

Beach	Type	Aspect	Compartmentalisation	Sediment Supply
Stanwell Park	Transition	SE	Opens south	fixed
Coalcliff	Mixed	ENE	open	starved
Scarborough/ Wombarra	Mixed	ESE	open	fixed
Coledale	Mixed	E	open	starved
Austinmer	Mixed	ESE	partially open	fixed
Thirroul	Transition	ESE	open	fixed
Sandon Point	Mixed	E	normally closed	starved
Bulli	Mixed	ESE	partially open	fixed
Woonona/ Bellambi	Transition	ENE	open	fixed
Corrimal	Transition	SE	open	to dunes
Towradgi/ Fairy Meadow	Dissipative	SE	open	to dunes
North Wollongong	Mixed	ENE	open	fixed
South Wollongong/ Coniston	Transition	E	opens N?	Fixed
Port Kembla/Perkins	Dissipative	ESE	to dunes	from south

A more recent characterisation of NSW beaches has been undertaken by Short (2007). Table 5 shows the beach type for the 17 beaches assessed in this study. Diagrams explaining these beach types are shown in Figure 5. More detailed descriptions of each beach from Short (2007) can be found in Section 6.

Table 5 Characteristics of beaches in the Wollongong LGA by Short (2007)

Beach	Type
Stanwell Park	TBR/RBB
Coalcliff	TBR
Scarborough/ Wombarra	TBR
Coledale	TBR
Austinmer	TBR
Thirroul	TBR/RBB
Sandon Point	TBR→LTT
Bulli	TBR
Woonona	TBR/RBB→ TBR
Bellambi	TBR→LTT
Corrimal	TBR/RBB→ TBR
Towradgi	TBR/RBB
Fairy Meadow	TBR/RBB
North Wollongong	TBR/LTT
Wollongong City	TBR
Port Kembla	Inner TBR/RBB Outer RBB
Windang	Inner TBR/RBB Outer RBB

RBB – Rhythmic bar and beach; TBR – Transverse bar and rip; LTT – Low tide terrace

5.2 Role of Dunes as Part of a Coastal System and the Occurrence of Rips, Scarps and Reduced Beach Width

The relationship of beach-dune development within a coastal compartment (e.g. a coastal compartment may be defined by two rocky barriers that mark the extent of a beach) is described as a process-response model. The conceptual setting of this process-response model is based on the premise that a coastal compartment contains a sediment budget. This budget may be basically fixed, or alternatively it may vary depending upon the proximity of natural sediment sources (such as river transportation) or sinks (such as might occur by deposition into an estuary). The range of processes in the offshore zone (i.e. waves, currents and tides), the beach profile (swash, surge and aeolian processes) and the dune system (aeolian processes, vegetation growth, storm cut erosion) interact to allocate proportions of the overall sediment budget across the different elements of the coastal compartment at any one time.

According to Psuty (2004), beach-dune interactions and sediment distribution are elements in understanding the development of incipient foredunes and foredunes under a variety of sediment budget scenarios including short term changes (i.e. daily) through to seasonal and decadal changes. Conceptually, the location of the contact between the foredune and the backshore will evolve and is determined by erosion of the foredune during storms and subsequent dune and beach accretion (Nordstrom and Jackson, 2013). At times, storm wave run-up may eliminate the seaward portion of the foredune and create an erosional scarp; however post-storm beach accretion establishes the sediment budget and the subsequent re-formation of the dune.

According to Hesp (2002), incipient foredunes are new or developing foredunes forming within pioneer plant communities. They may be formed by sand deposition within discrete or relatively discrete clumps of vegetation, or individual plants, or driftwood, flotsam, etc. These may form at various locations ranging from the immediate backshore to back-barrier flats (Carter *et al.*, 1992). Incipient foredunes may be seasonal where formed around annual plants and require colonisation by perennial plants in order to withstand storm erosion/events. Morphological development depends on a range of factors as presented in Table 6.

Hesp (2002) describes established foredunes as often having developed from incipient foredunes and are commonly distinguished by complex morphology, dune height and width, dune geographical position and the growth of intermediate plant species. Foredunes range from very low scattered dunes less than a metre in height to large complexes reaching 30-35m high.

Table 6 Factors that affect the development of established foredunes, as modified from Hesp 2002 by Bitton (2013)

Factors affecting development	Role of factor in development
sand supply	sediment available for transport is required to build foredunes; in negative budget conditions dune erosion may occur
sediment transport rate	sediment transport potential into and over the foredune, often limited by sediment transport conditions including beach width, wave inundation and beach moisture content, lag deposits, vegetation and other obstacles to flow
wave and wind forces	wave conditions affect the beach types and subsequent flow and transport conditions
wind flow over dunes	variations in sediment transport, erosion and deposition are related to slope angles, incident wind angles, and presence and percent cover of vegetation on foredunes
long-term beach state	eroding, stable, or prograding beaches can lead to different scarping, building or stranding of the foredune from beach processes
occurrence and magnitude of storm events	storms play a significant role in beach and dune inundation, scarping and overwash
vegetation cover	the amount of vegetation cover will affect sediment transport potential over the dune; different species will exist in varying biogeographical regions
human impact and use	vegetation destruction and erosion may be induced by foot traffic and recreational vehicles

The role of vegetation on a dune (incipient foredune, foredune or secondary dune) is the establishment of a natural protection from storm erosion through dune growth. This growth occurs by trapping and stabilising aeolian (wind blown) sand which enhances natural development above the limit of direct wave attack. Vegetation on dunes will not fully prevent erosion; however it will assist in the recovery after storms as it creates a reservoir of sand within the dunes that allow the beach to better withstand the next period of storm impact and potential erosion. This in turn provides a buffer or protection to infrastructure behind the dunes. Accordingly, incipient foredunes and foredunes are important natural features as they serve as the first line of defence against storms.

From analysis of early historical photos from around the 1900's (Appendix J) most of the foredune systems on Wollongong beaches were vegetated. However, due to subsequent clearing (Appendix L), by the 1940s the dunes were susceptible to modification and sediment loss due to aeolian processes. Large scale erosion of beaches also occurred during major storms such as occurred in 1964 and 1974. Primarily in response to these concerns, a program of extensive dune stabilisation works was undertaken during the mid-1980's along ten beaches within the Wollongong LGA. The work was jointly funded by Council and the NSW Public Works Department (PWD). The on-ground dune reshaping and planting work was undertaken by staff from the NSW Soil Conservation Service. Details including the timing and costs of the works, the detailed site plans for each beach (refer to plan for Woonona beach Appendix K), and the numbers of types of plants installed are contained in Council's files and this work has been summarised by Hazelwood (2007) based on consultation with council staff who managed the works. The dune stabilisation works involved re-shaping of the existing un-vegetated foredune features to conform to an engineering specification with an approximate dune height of 4.5 m above AHD and a maximum seaward dune face gradient of 1 in 4. The existing dune was sectioned into uniform rectangular areas and fenced to prevent further sand loss and provide protection from damage caused by pedestrian access. Chain and timber pedestrian beach access paths were constructed between these sections. Following reprofiling of the dune, a staged program of revegetation work was undertaken as per the site plan prepared for each beach. In the first stage, the seaward dune face was planted with spinifex and marram grass that were planted in a grid pattern and regularly fertilised and watered. In the next stage, once the grasses were established, the landward dune face was planted with shrubs and trees such as Coastal Wattle (*Acacia longifolia* subsp. *sophorae*) as well as *Acacia longifolia* subsp. *longifolia* and Coastal Tea- tree (*Leptospermum laevigatum*). In the final stage, Coastal Banksia (*Banksia integrifolia)* was also planted at the rear of the dune. Other species that were subsequently planted in the dunes include Lomandra (*Lomandra longifolia*), Coastal Rosemary (*Westringia fruticosa*), Golden Wreath Wattle (*Acacia saligna)* and Boobialla (*Myoporum insulare)*. Ongoing maintenance of the dunes following the initial work, including weed control, planting, fence and track maintenance has been undertaken by Council's dune crew.

Notwithstanding the role of dunes as a natural defence, storm cut erosion or scarps and beach rips can still occur whether infrequently or frequently. For instance, in recent times the role of dunes (vegetated and unvegetated) as a natural defence has become quite a pertinent issue with the Wollongong LGA with regards to the development of scarps (which at times are high (>1.5m high) and steep (i.e. vertical)), and the development of rips. Coastal systems such as beaches and dunes are dynamic. As such, the occurrence and severity of features such as scarps and rips is constantly changing over a range of time scales, depending on the prevailing environmental conditions. Below is an outline of scarps and rips:

Storms cut erosion can in just a few hours, dramatically reshape beaches, lower beach levels and erode dunes. In turn, this can result in steep **scarps** where a gently sloping dune previously existed. Storm cut and recovery is not abnormal, and is a natural process that characterises sandy beaches. The extent of scarping is determined by the morphology of the beach/dune profiles (height and proximity of the dune to the waves) and the direction of energy of the incoming storm waves. Given sufficient time and wave conditions, scarps will recover as fair weather conditions allow sand to be redeposited in the eroded dunes.

Rips are an intrinsic part of surf-zone circulation, particularly on wave dominated and some tide-modified intermediate beach systems. Rip currents have been recognized as a major hazard to bathers and are responsible for more than 90% of all surf rescues (Short and Brander, 1999). Beach (or fixed) rips are defined as rip currents associated with sandy beaches and bar systems, while topographic rips are associated with a fixed topographic boundary, such as headlands, rocks, reefs, and groynes, which deflect the beach-initiated rip current seaward. Beach rips are driven by beach–surf zone morphodynamics and tend to have a regular spacing related to wave period and edge wave length. As they are driven by the prevailing wave conditions, they are also prone to change in size and spacing and hence location. Topographic rips, in contrast, are fixed in location, usually existing against the controlling boundary. They tend to occur whenever waves are breaking and a surf zone exists against the boundary. During high wave conditions, most increase in size and velocity and become megarips, that is, large-scale topographically controlled rips (Short, 2006; Short and Brander, 1999). Flash rips are the opposite to beach rips and can occur when waves heights have suddenly increased, and can appear and disappear very quickly. They are very unstable, and move around and appear as more turbulent areas of water.

The traditional paradigm concerning rips concluded that rip currents flows extended considerable distances seaward of the surf zone. This was based on 'visual' observations made on beaches of convenience where rip currents were strongly influenced by piers or submarine canyons. Results from recent field experiments on open coast rip currents using drifters fitted with GPS equipment have increased knowledge of how rips function (MacMahan *et. al.,* 2010). They have shown that the cellular rip circulation is maintained within the surf zone approximately 80% of the time, with only 20% of drifters and water actually exiting the surf zone (Figure 6).

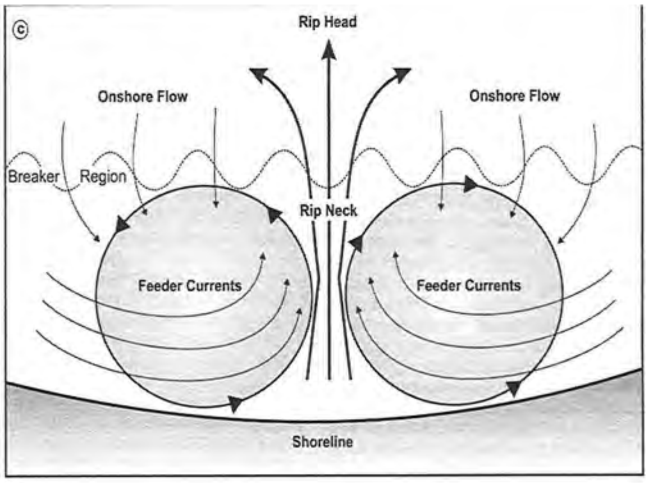


Figure 6 Modified view of rip currents based on recent field measurements indicating that rip currents exhibit circulatory behaviour fully contained within the surf zone with only 20% of water exiting the surf zone (source: MacMahan, *et al.*, 2010)

The need for education of swimmers about rips and how best to act if they are caught in a rip, is an area of considerable discussion. A recent Australian survey found that almost all of the respondents were caught in rip currents because they chose to swim outside of patrolled areas or on unpatrolled beaches (Drozdzewski *et. al.,* 2012). This was a reflection of their swimming experience and overconfidence in assessing the potential risk of rip currents. The study concluded that future rip current education and awareness strategies should adopt a dual focus and seek innovative methods to motivate experience swimmers to swim in patrolled locations, while also educating inexperienced swimmers of rip current hazards.

5.3 Recent Studies of Wollongong Beaches

Historically, the most studied beach in the Wollongong LGA is Stanwell Park beach which has been studied by Ted Bryant from the University of Wollongong (Bryant, 1983a, 1983b, 1985, 1987 and 1998). In a series of papers he assessed changes in the high tide wave run up position at Stanwell Park, measured from a series of photographs of the beach from 1895-1980. A number of factors were found to influence the amount of beach erosion and accretion that affected the high tide level over time. These included the effects of major storms (Bryant, 1988) and regional sea-level variation and changes in the Southern Oscillation Index (Bryant, 1983). Another factor that was also identified as causing dune erosion was the amount of rainfall, which affects the beach water table levels. The analysis showed that a 100mm increase in annual rainfall resulted in a 0.79m retreat of the average high tide position of Stanwell Park beach (Bryant, 1985).

Over the past seven years, five research studies undertaken by students from the University of Wollongong have investigated coastal process and changes in dune morphodynamics at a number of Wollongong beaches. A study on coastal processes and hazards has also been undertaken by consultants Cardno, Lawson Treloar (2010). The results of these studies have been included herein in order to provide the latest research pertinent to this study within the Wollongong LGA.

- Baker (2006) conducted an analysis of a time series of beach profiles from 1961 to 2000 and shoreline indicators from 1947 to 2000. The analysis was conducted for Woonona/Bellambi, Corrimal and Fisherman's beaches. The results highlighted the fluctuations that have historically occurred in the sub-aerial beach volume and the High Water Level (HWL) shoreline position of the four beaches. These indicate that Wollongong's beaches oscillate through periods of erosion and accretion. Beach response to storm events was shown to be a major contributor to beach change as identified by the impacts of the1974 and 2006 erosive swell storm events.

  Changes in the position of the HWL and morphology of the beach profiles were observed at the southern and northern ends of Woonona/Bellambi and Corrimal beaches, suggesting that beach rotation is occurring as identified in the Ranasinghe *et al.,* (2004) model.

- Hazelwood (2007) assessed the potential impacts of climate change on the behaviour of the shoreline in response to sea level rise. The study assessed changes in the position of the shoreline from the 1940s to 2007 at Bulli, Woonona, Bellambi and Corrimal Beach using historical aerial photographs and photogrammetric data. The results indicated that at Corrimal Beach, there was a clear trend from 1988 to the present of the established foredune migrating seaward, between 1988 and 1993. In addition, between 1988 and 1993, development of an incipient foredune was observed, and from 1999 to the present, the incipient foredune had also migrated seaward. The increase in dune development was considered to be due to transport of sand from the nearshore zone and its deposition on the sub-aerial portion of the shoreface to confirm to an engineering specification during engineering works in the 1980's (refer to Section 5.2 and Appendix K). Following the works, sand previously lost from the shoreface due to aeolian processes was trapped on the shoreface by the planted vegetation, resulting in an increase in dune elevation, seaward migration of the modified foredune and subsequent development of an incipient foredune. The study results also supported the existence of an accretion dominated period from the mid 1980s to 2007 that was first identified by Thom and Hall (1991). This followed on from an erosion dominated period from 1974 to 1978 identified by Thom and Hall (1991). Storm and swell events were the main drivers of morphological change on the study beaches through variation of wave climate, direction, duration and frequency. The study also suggested that whilst the beaches in the Wollongong LGA are subject to periodic erosion from storms, under favourable conditions they are able to repair naturally.

- Tedder (2008) observed changes in the subaerial beach face (i.e. above the water mark) at Thirroul, Woonona and North Wollongong beaches using a time series of aerial photography from 1948 to 2006. The study found that the shoreline on the three beaches fluctuated with time and space, and that each of the study beaches were affected by wave conditions at an individual level. This was linked to the exposure of waves resulting from the degree of wave refraction and the embayed nature at each beach. Thirroul Beach was the most vulnerable of the three beaches to erosion by south swell, however repairs rapidly given appropriate low energy conditions. Woonona Beach was the most dynamic of the study beaches and accreted under south swell conditions. North Wollongong Beach was the most stable and south swell protected of the study beaches.

- Abuodha (2009) assessed the impacts of predicted sea level rise on beaches and assessed changes in the shoreline change of the HWL and vegetation line indicators for 11 Illawarra beaches from 1961 to 2006. The beaches assessed were Stanwell Park, Coledale, Thirroul, Bulli, Woonona-Bellambi, Corrimal, Towradgi, Wollongong City, Fisherman's, Perkins and Warilla Beach. The patterns of change in the Illawarra beaches over time were found to be highly variable, and many beaches were found to have accreted when the vegetation line was mapped over time, however different trends and rates were observed between beaches, and in some cases within the same beach.

- Talbert (2012) observed changes in the subaerial beach face at Woonona/Bellambi and Thirroul Beach using a time series of aerial photography and photogrammetry from 1955 to 2007 for Woonona/Bellambi Beach, and 1961 to 2007 for Thirroul Beach. Dune behaviour at Woonona/Bellambi Beach was characterised by an erosion dominated period between 1966 and 1972. In the period 2001 to 2007, the dune volume at Woonona/Bellambi Beach experienced periods of recession, despite the vegetation line continuing to move seawards, while the inverse occured at other times in the period 1966 to 1972. At Thirroul Beach, the vegetation line in the northern part of the beach continually accreted and did not appear to recede, even at times when there was recession in the dune volume. Most net accretion, as well as large variability, occurred at the exposed northern end which is probably due to the southerly swell that dominates the coast along the southeastern coast (Short and Woodroffe, 2009). Accretion and erosion dominated periods were identified in the study and were found to have strong similarities with comparative studies conducted at Moruya (Thom and Hall, 1991; McLean and Shen, 2006), Collaroy/Narrabeen (Short and Trembanis, 2004) and Warilla (Clarke and Eliot, 1987) beaches.
- As the first stage towards preparing a Coastal Zone Management Plan for Wollongong, Council commissioned a report on coastal processes and hazards for the area (Cardno, Lawson, Treloar, 2010). This study used photogrammetric analysis of historical aerial photographs, dating from 1938 to 2007, to describe beach changes at Coledale, Austinmer, Thirroul, Sandon Point, Bulli, Woonona, Bellambi, East Corrimal, North Wollongong, City, Coniston, Port Kembla and Windang beaches. The indicators studied were beach width from the photogrammetric reference point to the 2m AHD contour and the beach volume. Both of these indicators showed fluctuations with time, in keeping with the occurrence of previous coastal storms. However, the general trend noted was an increase in beach width and volume with time, which was more apparent at the northern end of the beaches. The study also included an assessment of the exposure of some of the beaches and back beach areas to coastal erosion and inundation.

5.4 Acacia longifolia subsp. sophorae

This section of the report provides a discussion of the status of *Acacia longifolia* subsp. *sophorae* (Labill.) Court (Coastal Wattle) in the Wollongong LGA. This discussion has been included in response to views held by some members of the public that this species is an environmental weed.

In this section, *A. longifolia* subsp. *sophorae* will be referred to as Coastal Wattle unless an alternative taxon is directly quoted, in which the alternative taxon will be followed by (sic).

5.4.1 Definition of 'Environmental Weed'

Murrumbidgee CMA (2013) describes 'Environmental Weeds' as a collective term that refers predominantly to bushland and aquatic weeds and includes the following definition: "Plant species that have established self-propagating populations in native vegetation, terrestrial or aquatic environments, outside their natural range". An example of an environmental weed growing in native vegetation on coastal dunes is Bitou Bush **Chrysanthemoides monilifera* subsp. *rotundata*. The first herbarium specimen of **C. monilifera* subsp. *rotundata* was collected in June 1908 at Stockton (Gray, 1976). Cooney *et al*. (1982) mention that it had become particularly well established in the Stockton area by the early decades of the twentieth century and could have been introduced with ballast dumped on the north bank of the Hunter River.

"In the early 1950s its 'naturalised' distribution was still limited to the Newcastle area, where it was proclaimed a noxious weed" (Mort and Hewitt, 1953). However, at that time the subspecies was already used in other locations for dune reclamation by the NSW Soil Conservation Service because of its excellent sand-stilling and sand-binding qualities. After its disastrous influence on the native vegetation was recognised, the practice was stopped and replaced by control programs (Heyligers, 2008).

As detailed in section 5.2, the work undertaken in the mid-1980s to replant vegetation on the dunes was undertaken by staff from the NSW Soil Conservation Service under contract to Council. Review of the files detailing this program of work indicate that seedlings of both *A. sophorae* (sic) in the foredune, and *A. saligna* in the hind dune, were planted as part of this program. In addition, *A. sophorae* (sic) seed was broadcast spread at some beaches. Although, *A. sophorae* (sic) was recommended as the species to plant, *A. longifolia* subsp. *longifolia* was also available from the Soil Conservation nursery and it is possible that this species was also planted along the Wollongong beaches.

Coastal Wattle, growing in foredunes (Figure 7), cannot be considered an environmental weed in the Wollongong LGA because it is not growing outside its range. Further explanation follows.

Figure 7 Zonation on foredune at Bellambi

5.4.2 Taxonomy and distribution of *Acacia longifolia* subsp. *sophorae* (Labill.) Court. (Coast Wattle)

A search through the literature for records of this subspecies is difficult, in that the currently accepted taxon was only published in 2001 (Kodela and Tindale, 2001). Previous taxa include *Acacia longifolia* var. *sophorae* (Labill.) F. Muell. (Maiden, 1915) and *Acacia sophorae* (Labill.) R. Br. (Lebler, 1981).

With regard to the full scientific name, "Labill." refers to Jacques-Julien Houtou de Labillardière, who mainly collected specimens from Tasmania, however also from southeast Australia, and proposed the specific epithet *"sophorae",* for Coastal Wattle in *Novae Hollandiae Plantarum Specimen,* published between 1804 and 1807.

A specimen of Coastal Wattle was collected by either Sir Joseph Banks or Daniel Solander between April and May 1770. This specimen is held by the British Museum and was included in a plant list of the Banks and Solander collections by Edwards (2004). It is proposed by Benson and Eldershaw (2007) that the specimen was collected from vegetation described as "foreshore scrub on sand," possibly from Woolooware Bay.

"R. Br" refers to Robert Brown, who inherited the Banks Collections, which he transferred to the British Museum, where in 1827 he became the first Keeper of the Botanical Department.

In the following discussion, *A. longifolia* subsp. *sophorae* (Labill.) Court will be referred to as *A. longifolia* subsp. *sophorae* or Coastal Wattle, unless there is a direct quotation, in which an earlier taxon is used.

5.4.3 Definition of subspecies

The subspecies is generally understood as having defining characteristics that are usually geographically separated, although they may occupy different ecological niches (Spencer *et al.,* 2007).

The natural habitat of *A. longifolia* subsp. *sophorae*, Coastal Wattle is described as "heath and sclerophyll forest on coastal headlands, sand dunes and adjacent alluvial flats" (RBGT, 2011). Its distribution extends from coastal southeast Queensland to the Southern Eyre Peninsula, South Australia, and includes coastal Tasmania. Benson and McDougall (1996) describe the associated vegetation as "Heath and hind dune scrub e.g. with *Banksia integrifolia*, and woodland, on sandy soil on coastal sand dunes, low nutrients". Benson and McDougall (1996) identify as select locations for this subspecies, inter alia, Kurnell, Cronulla, Corrimal, Wollongong and Bass Point.

Acacia longifolia (Andrews) Willd. subsp. *longifolia* (Sydney Golden Wattle) is "widespread in eastern New South Wales, eastern Victoria with an isolated occurrence close to the Queensland/New South Wales border in the Tenterfield district". It does not occur naturally in Tasmania and does not occur as extensively in South Australia, in comparison with Coastal Wattle. Coastal Wattle "occurs mostly along the coastal strip….and Sydney Golden Wattle occurs more towards the hinterland. However, in some localities the two subspecies appear to grade almost imperceptibly into one another, for example in the Bargo – Wollongong district" (CSIRO, 2009).

Benson and McDougall (1996) describe the vegetation associated with Sydney Golden Wattle as "moist open-forest e.g. with *Eucalyptus radiata* to open-forest e.g. with *Eucalyptus sieberi, E. piperita, E. gummifera, Angophora costata*" on "low nutrient sandy loam from sandstone, also on more fertile basalt soils". Benson and McDougall (1996) identify as select locations for this subspecies, inter alia, Austinmer, Liverpool, Thirlmere, Lithgow and Moss Vale.

5.4.4 Morphological differences between the subspecies

In terms of usefulness for dune rehabilitation, the growth habits of the two subspecies of *A. longifolia* are most relevant:

Benson and McDougall (1996) described the growth habit of Sydney Golden Wattle as "erect or spreading shrub or tree 1 – 8m high", and that of Coastal Wattle as "prostrate or decumbent shrub 0.5 – 3m high". The habit of Coastal Wattle is therefore more appropriate for growth on coastal dunes.

The phyllodes of *A. longifolia* subsp. *longifolia* are 5-20cm long and 5-15mm wide, generally broadest near the middle, mostly thin and narrowing gradually towards the apex (Figures 8 and 9).

The phyllodes of *A. longifolia* subsp. *sophorae* are 5-12cm long and 10-30mm wide, thick, broadest above the middle and narrowing abruptly towards the apex (Figures 8 and 10).

Flowering time of *A. longifolia* subsp. *longifolia* is July to October, with a peak in August. Seeds mature from October to December. Flowering time of *A. longifolia* subsp. *sophorae* is July to September and the seeds mature between October and November. The seeds of *A. longifolia* subsp. *sophorae* are larger than those of *A. longifolia* subsp. *longifolia*.

The pods of *A. longifolia* subsp. *longifolia* are generally straight and up to 12cm long, while the pods of *A. longifolia* subsp. *sophorae* are usually coiled or contorted and up to 10cm long.

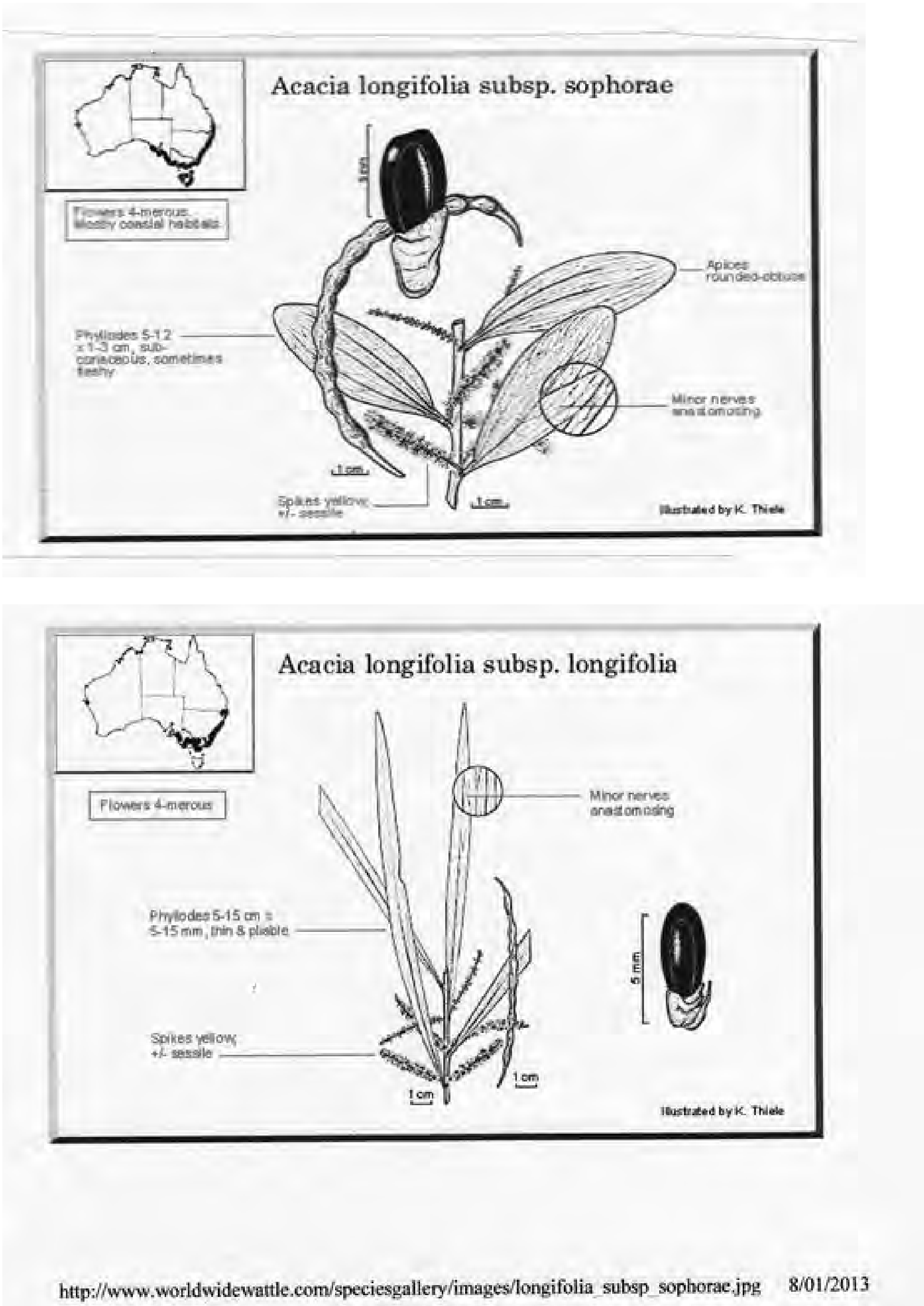


Figure 8 Comparison of *A. longifolia* subsp. *sophorae* and *A. longifolia* subsp. *longifolia*

Figure 9 Foliage of *A. longifolia* subsp. *longifolia*. Note lanceolate phyllodes with acute apices.

Figure 10 Foliage of *A. longifolia* subsp. *sophorae.* Note oblanceolate phyllodes and rounded apices.

5.4.5 *Acacia longifolia* subsp. *sophorae* and uses

Maiden (1889) described Coastal Wattle and suggested uses for the seeds (seed pods were harvested while green and steamed, then eaten) and the sap of stems (for tanning skins).

Ray (Dootch) Kennedy (pers. comm.) has demonstrated that the indigenous people used the phyllodes to make soap (Figure 11).

Figure 11 Uses of *A. longifolia* subsp. *sophorae*

Benson and McDougall (1996) notes that Coastal Wattle is "used in dune rehabilitation programs". Of particular interest for dune rehabilitation is the presence of vesicular arbuscular mycorrhizae (VAM) in the roots of dune plants.

VAM are expected to improve the capacity of plants to take up nutrients – an attribute likely to be important in sand dunes (Harley and Smith, 1983). VAM may also assist in sand-binding on dunes (Koske, 1975). However, sand binding capacity, efficacy in nutrient uptake, and taxonomic occurrence of mycorrhizas remain largely unknown (Logan *et al.,* 1989).

In the case of native dune plant species, the relatively high proportion of species in which VAM was detected may reflect a high mycorrhizal status in the plants of dunes. Sand dune soils are likely to be initially poor in plant nutrients, subject to severe leaching, and to have a poor water-holding and nutrient-holding capacity; in these circumstances the possession of VAM may be an important factor in plant survival. Additionally, VAM fungi can be involved in formation of soil aggregates in sand-dune soils and this is likely to have significance for the management of beach dune vegetation (Logan *et al.,* 1989). Brockhoff (1985) found variable, low levels of VAM fungal infection in *A. longifolia* var. *sophorae* (sic) in sand-dunes at Bridge Hill, on the NSW coast. Brockhoff and Allaway (1988) demonstrated that *A. longifolia* var. *sophorae* (sic) possessed root nodules, enabling growth in nutrient poor sands.

DLWC (2001) observes that "Coastal Wattle has been one of the most successful and widely used secondary species in coastal dune revegetation programs…..In exposed locations, Coastal Wattle develops a typically prostrate spreading habit, establishing roots on the nodes of branches that are in contact with the soil surface. These characteristics make it particularly suitable for planting seaward of the foredune crest".

5.4.6 *Acacia longifolia* subsp. *sophorae* (Coastal Wattle) in coastal vegetation types

The NPWS (2002) vegetation mapping for the Illawarra lists Coastal Wattle as a diagnostic species for the vegetation type Map Unit (MU) 45 Coastal Sand Scrub.

MU45 Coastal Sand Scrub

Coastal Sand Scrub is a low and dense scrub of *Banksia integrifolia* subsp. *integrifolia* and *Leptospermum laevigatum* growing on coastal sand foreshores. Locations are highly exposed to strong, salt laden winds. A number of salt tolerant species are present such as *A. longifolia* subsp. *sophorae*, *Monotoca elliptica, Westringia fruticosa* and *Carpobrotus glaucescens*. With increased shelter and deeper soils this community grades into MU25 Coastal Sand Bangalay-Blackbutt Forest. Coastal Sand Scrub suffers from chronic infestation by the weed Bitou Bush (*C. monilifera* subsp. *rotundata*).

Example locations: Puckeys Estate, Bellambi Lagoon, Primbee.

“Coastal Sand Scrub has been cleared from many of the beach dunes in the LGA. Relatively recent revegetation programs to restore dune vegetation and stability have re-established components of this community on some dunal systems” (NPWS, 2002).

Coastal Sand Scrub is a feature of many coastal zones in NSW. There are similar assemblages described by Kevin Mills & Associates (2000) for Shellharbour LGA and by NPWS (2000a, 2000b) for coastal regions north and south of the study area. Some examples include:

NSW Coast

Clarke (1989 a,b) conducted a survey of the structure and floristic composition of the holocene sand dunes at 247 sites along the NSW coast, including seven sites in the Wollongong LGA. The surveys at each site extended from the strandline up to 500m inland of the beach. The vegetation occurring across the dune was assessed in four general zones: strandline complex (incipient dune), foredune complex, littoral rainforest and dry sclerophyll forest (hind dune). The strandline complex vegetation was dominated by a variety of native and introduced grasses and forbs such as Spinifex, Cakile and Hydrocotyle and shrubs such as *Acacia sophorae* (sic). The foredune complex vegetation was dominated by a variety of native and introduced grasses and forbs such as *Lomandra longifolia*, and *Carpobrotus glaucescens*, shrubs such as *Acacia sophorae* (sic) *and Leptospermum laevigatum,* and the introduced *Chrysanthemoides monilifera* subsp. *rotundata,* and trees such as *Banksia integrifolia* subsp*. integrifolia.* In the hind dunes, the vegetation in the Littoral rainforest community had a closed to mid-dense canopy cover with *Acmena smithii* and the occasional *Eucalyptus,* a shrub layer to 3m and generally sparse ground cover. The dry sclerophyll forest community had a mid-dense to open forest with *Angophora costata*, *Eucalyptus pilularus, Eucalyptus botryoides* and *Banksia serrata,* a variable shrub layer and a ground stratum of small shrubs and herbs to 0.5m.

South Coast NSW

Tozer *et al.* (2010) identifies Coastal Wattle as comprising part of the vegetation type DSF e61 - Coastal Foredune Scrub: “Coastal Foredune Scrub is restricted to foredunes immediately adjacent to the coast. This mapping unit occurs along the coastline from the Hawkesbury River north of Sydney, to the Victorian border (the northern and southern extent of this mapping project).

More than half of Coastal Foredune Scrub has been cleared for coastal development. Although most of the remainder is represented within reserves, some of these reserved areas and some off-reserve sites are threatened by intense recreational usage and development pressures. Causes of continuing degradation include rubbish dumping, small-scale clearing and burning, firewood harvesting, trampling and weed invasion". Tozer *et al.* (2010) data for the Coastal Foredune Scrub vegetation type indicates that Coastal Wattle has a frequency of 91% with a cover abundance of 1, indicating that although it is widespread, and commonly occurring in sample sites, it is rarely the dominant species.

This observation that Coastal Wattle "is rarely the dominant species" needs to be assessed in the context of the observation by some members of the public that Coastal Wattle forms a monoculture. It would appear at some sites, at a given time, that Coastal Wattle is the most commonly occurring species. Coastal Wattle is short-lived and some consider the species to establish appropriate conditions for other, longer-living species. The concept of allelopathy (or the ability of a plant species to inhibit the growth and development of other plant species), has also been proposed in the context of Coastal Wattle, although no long-term research data relating to allelopathy in Coastal Wattle were found during the desk-top survey.

Sydney

Acacia sophorae (sic) is described as widespread on "marine sands of the Holocene age on Sydney beaches" (Benson and Howell, 1994). The vegetation type in which it occurs is Map Unit 21b(ii) Coastal Dune Heath; Open Scrub*: Monotoca elliptica – Banksia integrifolia – Leptospermum laevigatum*.

Acacia longifolia subsp. *sophorae* is listed as "occasional" in historical records and species lists for various locations within Sydney Harbour National Park.

Central Coast NSW

Heyligers (2008) comments that "on the dune terrace vegetation of North Stockton, only about 20% of the 50 species are native to Australia, the only one of any prominence being *A. longifolia* subsp. *sophorae*".

Acacia sophorae (sic) is described by Brewer and Whelan (2003) as "strongly associated with coastal dunes". There were occurrences of *A. sophorae* (sic) at all quadrats within the study site at Hawks Nest, although *L. laevigatum, M. elliptica* and *B. integrifolia* subsp. *integrifolia* generally occur in greater numbers. These three species are also indigenous to Wollongong beaches, moreover, there is evidence in established dunes, e.g. to the north of Stanwell Park SLSC, at Puckey's Estate, and to the north of Windang SLSC, that *L. laevigatum* and *M. elliptica* are self-recruiting.

Acacia sophorae (sic) was recorded in coastal dunes at Hawks Nest in 1941 by Pidgeon (1942) and at Bennetts Beach, Hawks Nest in 1939 by Osborn and Robertson (1939).

Acacia longifolia subsp. *sophorae* is listed as occurring within MU111 Coast Tea Tree/Old Man Banksia Coastal Shrubland and MU119 Coast Tea Tree, Coast Banksia, *Ficinia nodosa* low open forest on beach dunes in the Hunter, Central and Lower North Coast (HCCREMS, 2009).

5.4.7 Conclusion of Discussion of *Acacia longifolia* subsp. *sophorae*

The key points arising from the above discussion can be summarised as follows:

- *Acacia longifolia* subsp. *sophorae* is indigenous to the Wollongong coastline, particularly in dune vegetation.
- *Acacia longifolia* subsp. *sophorae* occurred in dune vegetation at Botany Bay when Banks and Solander carried out their first surveys in 1770, and is a component of many described vegetation units along the NSW coastline. It is therefore reasonable to assume that this subspecies also occurred along the Wollongong coastline prior to European disturbance.

- *Acacia longifolia* subsp. *sophorae* cannot be considered as an environmental weed in coastal dunes of Wollongong, because it is within its natural range. It is, however, reasonable to argue that *A. longifolia* subsp. *longifolia* is not within its natural range, when growing on Wollongong dunes.
- There are large patches of *A. longifolia* subsp. *sophorae* in dunes at most Wollongong beaches. It is, apparent that both *A. longifolia* subsp. *sophorae* and *A. longifolia* subsp. *longifolia* are susceptible to storm damage and other disturbance and tend to die back completely. Large patches of dead wattle were evident at Towradgi beach, at the time of the survey (Figure 12). These dead patches require monitoring, in order to determine the rate and extent of recruitment by indigenous and exotic plant species.
- In some areas, e.g. Corrimal, Towradgi, Fairy Meadow, Woonona and Bulli beaches, subspecies of *A. longifolia* have extended beyond the original planting area. It may be necessary for some trimming to be carried out where the spread of vegetation interferes with beach amenity or access (Figure 13), however it is likely that the spreading growth will dieback due to salt spray (Figure 14).
- A research paper by Costello, *et al.* (2000) has been submitted by some members of the public as a justification for considering Coastal Wattle as being invasive on coastal dunes. It should be noted that this research paper only considers ‘invasion’ by Coastal Wattle of agricultural pastures, rather than of coastal dunes.
- A report prepared by EcoLogical Australia (ELA) (2008) makes recommendations relating to the distribution of Coastal Wattle at a beach within the Eurobodalla LGA. The findings in ELA (2008) should not be regarded as a justification that Coastal Wattle may have been introduced to, or has become an invasive species in, Wollongong. This report is of specific reference to one foredune on Long Beach, in the Eurobodalla LGA (approx. 160kms south of the study area).
- Claims made by ELA (2008) that Coastal Wattle is an invasive “non-indigenous” species at Long Beach are not supported by peer reviewed literature, rather is based on a weight of evidence assessment of its current presence and perceived management issues.
- ELA (2008) does not present any data to justify its claims that native species diversity or abundance is reduced due to the presence of Coastal Wattle at Long Beach. Indeed, an analysis of the quadrat data in this report indicates that there is less native species diversity in the quadrat in which Coastal Wattle is absent.
- It is reasonable to conclude that in some areas the spread of this subspecies into inappropriate areas may require monitoring and management, as considered by ELA (2008), however the proposition to exclude this species from future dune revegetation is unjustified.

Figure 12 Die-back of Coastal Wattle on dune crest at Towradgi

Figure 13 *A. longifolia* subsp. *sophorae* at Bellambi, spreading onto track edge

Figure 14 Die-back of Coastal Wattle on foredune at Woonona

5.5 Threatened and Migratory Species

5.5.1 Threatened ecological communities

Threatened Ecological Communities (TEC) is the generic name given to ecological communities which are listed under the NSW TSC Act or the Commonwealth EPBC Act. In most cases these communities are listed as 'endangered', and therefore can be referred to as Endangered Ecological Communities (EECs). The desktop assessment (Appendix C) reveals that 31 EECs are known or predicted to occur within the locality (where locality is defined as within a 10km radius of the study area). Of these, seven occur, within the study area. These communities include:

- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions, which is listed under the TSC Act,
- Bangalay Sand Forest of the Sydney Basin and South East Corner Bioregions, which is listed under the TSC Act,
- Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions which is listed under the TSC Act and equivalent to Littoral Rainforest and Coastal Vine Thickets of Eastern Australia, a critically endangered community under the EPBC Act,
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions, which is listed under the TSC Act,
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions, which is listed under the TSC Act,
- Themeda Grassland on Seacliffs and Coastal Headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions, which is listed under the TSC Act, and

- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions, which is listed as an EEC under the TSC Act.

The remaining 23 threatened ecological communities predicted to occur have an 'unlikely' likelihood of occurrence, based on location, topography and existing vegetation mapping of the study area. A total of 17 beaches were surveyed for vegetation type and flora sampling as part of the current investigation. Although no examples of EECs were recorded within any of the areas immediately in front of SLSC buildings, some patches of EEC were observed in adjacent areas of dune systems. For example, Littoral Rainforest occurs to the north-west of Stanwell Park SLSC and west of Coalcliff SLSC; Bangalay Sand Forest occurs to the north-west of Stanwell Park and Windang SLSCs, as well as to the south-west of Port Kembla and Fairy Meadow SLSCs; Coastal Saltmarsh occurs to the south-west of Windang SLSC; small patches of Themeda Grassland on Seacliffs occurs on the headland to the north of Austinmer Beach and on Flagstaff Hill, north of City Beach; Swamp Oak Floodplain Forest occurs to the south-west of Windang and Fairy Meadow SLSCs; and narrow bands or patches of Swamp Sclerophyll Forest occur at the outlets of most creeklines.

5.5.2 Endangered populations

The Atlas of NSW Wildlife database (OEH, 2012c) identifies three threatened flora populations listed under the TSC Act previously recorded in the locality including: *Callitris endlicheri* (Black Cypress Pine), *C. parviflorum* and *Lespedeza juncea* subsp. *sericea.* Of these, a small patch of *Chorizema parviflorum* was recorded just to the north of the study area, at Garie Beach. No individuals or populations of any of these species were recorded within vegetation in front of club houses during the surveys, nor is it likely that appropriate habitat occurs at any of the sites surveyed.

The Greater Glider (*Petauroides volans*) is listed as an endangered population under the TSC Act. While the database searches revealed no records for this species within the study areas, potential foraging (heath) habitat was recorded during surveys and individuals have been recorded as far south as Austinmer in the last two years (pers. comm. Gary Leonard, 2013).

5.5.3 Threatened species

Threatened flora species

The Atlas of NSW Wildlife database (OEH, 2012c) identifies 40 threatened flora species listed under the TSC Act previously recorded in the locality. Of these, 27 are also listed under the EPBC Act.

The Protected Matters Search Tool (DSEWPaC, 2012b) identifies two additional threatened flora species listed under the EPBC Act as potentially occurring in the locality.

These threatened flora species occur in five broad habitat associations, comprising swamps and riparian areas, heath, sclerophyll forests, grassy woodlands and grassland.

Threatened flora species known or likely to occur based on habitat present are discussed in more detail in section 6. These species are listed in Appendix C.

Threatened fauna species

The Atlas of NSW Wildlife database (OEH, 2012b) identifies 66 threatened fauna species (37 bird species, 17 mammal species, three reptile species, six frog species, two fish species and one invertebrate species) and one endangered population listed under the TSC Act as having been previously recorded in the locality.

The Protected Matters search (DSEWPaC, 2012b) identifies 32 threatened fauna species listed under the EPBC Act as potentially occurring in the locality, including 13 bird species, nine mammal species, two reptile species, six frog species and four fish species (Appendix C). Threatened fauna species known or considered likely to occur based on habitats present are discussed in more detail in section 6.

Based on an assessment of the habitats likely to be present within the study area, API regional scale vegetation mapping (Tozer *et al*., 2010), and NSW NPWS (2002), four fauna species are considered ‘likely’ to occur, with 30 fauna species considered to have a ‘possible’ likelihood of occurrence. All other threatened fauna species are considered to either have a ‘nil’ or ‘unlikely’ occurrence, due to a predicted lack of suitable potential habitat within the study area, limited localised distribution or specific geomorphic requirement (Appendix C and D).

Several of the more highly mobile species (such as the Grey-headed Flying Fox, Gang-gang Cockatoo and migratory offshore seabirds) may use habitats within the study area on a seasonal or transient basis only. Such use may be in response to flowering events or while moving through home ranges or roosting between migratory movements and these species are unlikely to rely on habitats within the study area for important life cycle stages. However, less mobile species such as the Eastern Pygmy Possum have the potential to live within habitats present within the study area on a permanent basis.

It is important to note that the study area is contiguous with extensive tracts of native vegetation and vast areas of ocean, and it is likely that some records of threatened biota identified in the desktop review are associated with these extensive areas, rather than the areas immediately surrounding the beaches.

5.5.4 Migratory species

Three international agreements relate to the management of the dunes and adjacent wetlands. They are: the Japan - Australia Migratory Bird Agreement (JAMBA), the China - Australia Migratory Bird Agreement (CAMBA) and the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA). JAMBA, CAMBA and ROKAMBA are bilateral agreements which commit the governments of Australia, Japan, China and Korea to protect threatened and migratory bird species listed in the agreements such as the Common Tern (*Sterna hirundo*) and Broad-billed Sandpiper (*Limicola falcinellus*). All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as matters of national environmental significance under the EPBC Act. These governments agree to establish sanctuaries for the protection of these migratory birds and their habitats, to prevent damage to the listed birds and their habitats, to encourage joint research programs and to share the information gained by research, and to prohibit the removal or trade of the listed species or their eggs. The agreements do not list specific sites for protection.

The desktop assessment identifies 60 migratory species listed as potentially occurring in the study area (DSEWPaC, 2012b; OEH, 2012b) as shown in Appendix D. Several beaches within the study area provide valuable roosting and feeding habitats, which are often shared with migratory shorebird species, resident shorebirds and also depend on the shorelines for breeding. These species would be present within a variety of coastal and wetland vegetation communities across the region, and only a subset are likely to be present in the study areas. Many of these species have the potential to use a wide variety of habitats, including urban and modified areas, as well as wetlands and forested areas. As such, 22 species have a ‘possible’ likelihood of occurrence within the study area, a further seven species are ‘likely’ to occur. Populations of some of these shorebirds are of international and national significance, including species observed during field surveys such as the Little Tern (*Strenula albifrons;* listed as a marine and migratory under CAMBA, JAMBA and ROKAMBA under the EPBC Act). Resident shorebirds are particularly prone to disturbance while breeding, from direct impacts at nesting areas and indirect impacts on food sources and roosts.

5.5.5 Other Matters of National Environmental Significance

The assessment indicates that no Wetlands of International Significance, RAMSAR wetlands and no World Heritage properties or marine areas occur within the locality of the investigation area (DSEWPaC, 2012b).

The assessment indicates that there is one National Heritage Place and six Nationally Important Wetlands identified within the locality of the investigation area, however none of these are in close proximity to any beach management areas.

5.6 Habitat for Threatened and Migratory Fauna

The potential for numerous threatened species to occur within the study area is influenced by the proximity of extensive tracts of native vegetation and a suite of complex habitat features including coastal dune vegetation, swamps, cliffs, rock outcrops and waterways within the locality of the study area.

Areas within the study area that have been cleared of native vegetation or which have been highly modified through the establishment of urban areas and infrastructure provide minimal potential habitat for threatened or migratory biota.

Dune vegetation is recognised widely as an integrated botanical system exhibiting unique community structure and flora species. The need to protect, maintain and restore these sensitive and interconnected ecosystems is a key factor in conserving biodiversity. Dunes provide food, nest sites and shelter for a variety of fauna including some listed threatened species such as the Little Tern (*Sterna albifrons*).

It is important to recognise the relationship between the dune ecosystems and those of other coastal environments nearby. Beaches, dunes and associated vegetation may host cross-continental (including migratory shorebirds) fauna and fauna that visit from nearby headlands, islands, rock platforms and wetlands as they seek food and nesting material. Migratory shorebirds and waders, such as the Pied Oystercatcher (*Haematopus longirostris*), may feed along the waterline however may also forage and roost above the high tide line. Various birds, reptiles and mammals which usually reside within woodlands may forage amongst spinifex grasses on the foredunes.

A number of threatened species are noted to have been previously recorded utilising foredune habitats within the study area:

- Little Tern (*Sterna albifrons*),
- Australasian Bittern (*Botaurus poiciloptilus*),
- Sooty Oystercatcher (*Haematopus fuliginosus*),
- Pied Oystercatcher (*Haematomus longirostris*),
- Green and Golden Bell Frog (*Litoria aurea*); records of individuals at Hewitts and Woodlands Creeks, 1km north of Sandon Point, as well as the Port Kembla area. This species is known to disperse up to 3km from breeding sites and may travel up to 1.5km in a night (DEC, 2005). It is therefore conceivable that individuals may occur within the study areas on an occasional basis,
- Sanderling (*Calidris alba*),
- Whimbrel (*Numenius phaeopus*),
- Rufous Fantail (*Rhipidura rufifrons*), and
- White-bellied Sea Eagle (*Haliaeetus leucogaster*).

- A number of egret species, White-throated Needletail (*Hirundapus caudacutus),* Black Faced Monarch, Ruddy Turnstone *(Arenaria interpres)* have been recorded nearby the study area, and while they may roost on occasion, are unlikely to rely on the habitats present. A number of migratory species associated with wetland habitats have the potential to use the study area on occasion to roost or as a movement corridor between sites.

Appendix D provides a summary of the likelihood of occurrence of threatened and migratory biota within the study area.

Areas that contain native vegetation have the potential to provide habitat for threatened biota with more general habitat requirements (e.g. species which are likely to use or occur in heath vegetation). Such areas include patches of intact native vegetation which adjoin extensive areas of vegetation outside of the study area. Detailed field surveys would be required to determine if actual suitable habitat for threatened biota exists within these areas. If threatened biota is found to occur within these areas, then the areas would be classified as high constraint. These areas have the potential to provide habitat for threatened species such as:

- Small mammals such as the Eastern Pygmy Possum,
- Gang-gang Cockatoo, and
- Microbats such as the Large-eared Pied Bat and Eastern Bentwing-bat.

A range of fauna habitats occur within the study area, including coastal foredune vegetation, woodland areas and disturbed areas. Vegetation within the surrounding area provides habitat for a greater diversity of species including wetland and forest dependant species which may occur transiently within the study area.

5.7 Habitat Value for Snakes

No snakes were recorded during current surveys. Potential habitat is present for snakes within all study areas, although width and connectivity of vegetation, presence of food resources (i.e. rabbits and rats) and proximity to creeks and lagoons would be limiting factors for the assemblage and persistence of snake species. Snakes live in a variety of habitats including dune vegetation. This is because, in general terms, dunes receive large amounts of sun however also provide vegetative cover for protection. A variety of common species have been recorded in the general locality, and are likely to occur in the study areas, including the Red-bellied Black Snake (*Pseudechis porphyriacus*) and the Eastern Small Eyed Snake (*Cryptophis nigrescens*) (OEH, 2012b).

All native snakes in NSW are protected under the *National Parks and Wildlife Act 1974.*

5.8 Summary

Dunes play a key role in the ongoing development and ever changing morphodynamics of a coastal system. This includes the minimisation of wind blown (aeolian) sand transport and protection from extensive erosion, acting as a natural defence.

What needs to be considered now though is how a naturally morphodynamic system can be accommodated within an urban environment. In such cases, the value of natural system dynamics needs to weigh against community interaction and their values of this natural system. For instance, within the Wollongong LGA, consideration needs to include how a coastal system evolves naturally, noting that the dune vegetation is a combination of natural vegetation and planted vegetation, with the needs of the local community. Without enough management, dune systems can prograde, build up in volume and have increased spread and density of vegetation, all of which change the nature of how the coastal system evolves and how the local community interacts with it. Hence, Council needs a strategy to balance the conflicting community expectations within this zone.

These key concerns have been considered as part of the site assessments presented in section 6 and the development of the management options within the MCA in section 7.

6. Site Specific Assessments

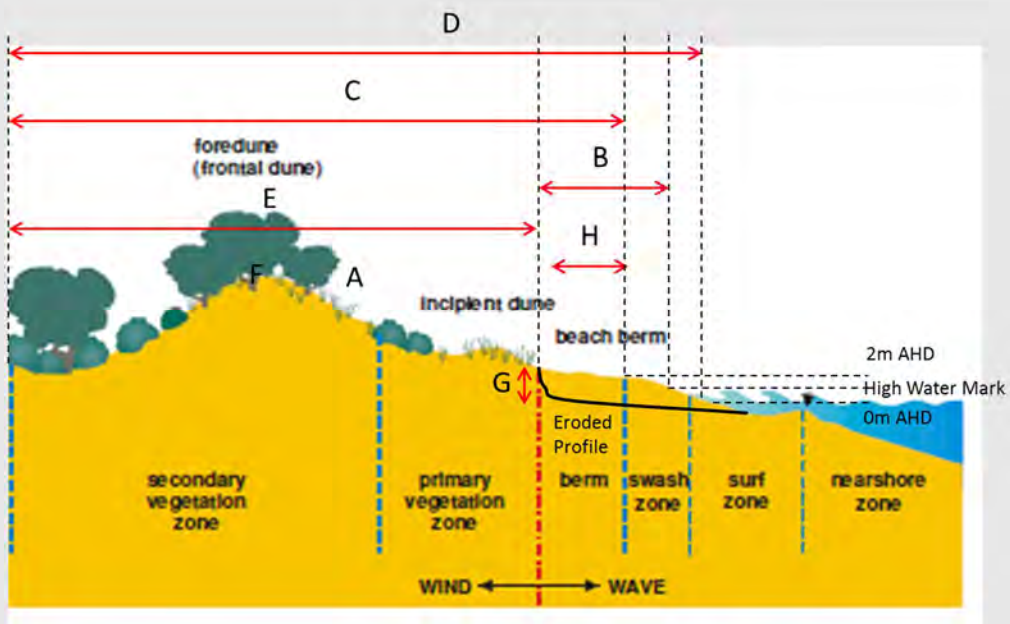
6.1 General

The focus of these assessments was as follows:

- The dune morphology assessment was carried out in collaboration between Wollongong City Council and GHD, and consisted of analysis of aerial photographs (Appendix L), photogrammetry and Airborne Laser Scanning records (where available), on-ground surveys during 2013, and observations made during site visits to each beach. This analysis focussed on a number of beach and dune indicators in the management zones pertinent to this study as outlined in Table 7. Where analysis of profile cross sections is required, it is based on a selected transect in the management zone (Appendix M). It should be noted that these observations record beach characteristics at a point in time and may not represent conditions at other times. The results are reported in the following sections.
- The ecology assessment included the transect surveys across the dune to determine the presence of flora species within and between sites and the abundance of each species (Appendix F); and an assessment of habitat value for native fauna. In addition, spread of vegetation past fence lines as part of the dune seaward migration was also observed. The site assessment allowed for an understanding of the types of vegetation on the Wollongong LGA beaches, and the role vegetation is playing in the beach/dune environment.
- The structural assessment included determining the extent of loss of line of sight and identifying the cause of any obstructions from the range of patrol locations. This involved assessing line of sight from the patrol locations looking toward the beach area, as well as the reciprocal view from the flagged area looking back toward the patrol locations. Discussions were also undertaken with lifeguards/lifesavers. The outputs of this site assessment identified the flagged areas of beaches not visible from patrol stations and potential locations to position towers for patrol (Appendix N).

Table 7 Beach and Dune Morphology Indicators (Adapted from: Coastal Dune Management, DLWC, 2001)

Indicator	Assessment method/description
Vegetation extent and density (A)	Visual inspection of aerial photography for relative coverage of the beach/dune space.
Width of bare sand (B)	Distance between the vegetation front and the high water mark from analysis of aerial photography.
Beach width (C)	Distance between the back of the beach and the 2m AHD mark (note: includes both vegetated and bare zones); obtained from profile cross sections.
Beach volume (D)	Volume from the back of the beach to the 0m AHD mark; obtained from profile cross sections.
Dune volume (E)	Volume from the back of the beach to the 2012 vegetation front (determined from the 2012 aerial photography); obtained from profile cross sections.
Dune height (F)	Height at the location of the dune peak in the most recent profile cross section available (varies from beach to beach, however for most beaches it is the 2013 profile); obtained from profile cross sections.
Scarp height in 2013 (G)	Height difference at the location of the 2013 scarp; obtained from the 2013 on-ground survey.
Scarp distance from 0m AHD in 2013 (H)	Distance between the toe of the scarp and the 0m AHD mark in 2013; obtained from the 2013 on-ground survey.



Note: Beach is used in the generic sense and includes both the beach and dune components (if dune components are present). 'Back of beach' is a fixed reference point and was determined from the 2012 aerial photography as the location where the beach/ dune profile starts.

Furthermore, the range of impact that the three key issues had at each beach (at the time of this study) was also assessed and is presented in this section. It is important to note that the severity of the sight line and beach access issues have been determined as at the time of the project only. Recreational amenity was determined from 2012 aerial photography, 2013 on-ground surveys where relevant, and site observations at the time of the project. The three key issues are:

- Sight Line - Impact on line of sight within patrolled areas for lifeguards and lifesavers monitoring activities on the swimming beaches, aerial photographs and recent survey,
- Beach Access - Impact on beach access ways, including width, grade and structures. This addresses improved access for the general public and rescue equipment and vehicles, and
- Recreational Amenity - Impact on the usable width of the sandy beach above the high tide mark and the frequency and severity of scarping.

The level of severity for each key issue was defined as follows in Table 8.

Table 8 Key Issues Index

	Severe	Moderate	Minor	Nil
Sight Line	Approximately 75-100% of patrol view is not visible	Approximately 25-75% of patrol view is not visible	Approximately 0-25% of patrol view is not visible	Flagged area visible at all times
Beach Access	75-100% of beach access ways, width and grade not suitable for use	25-75% of beach access ways, width and grade not suitable for use	25% of beach access ways, width and grade not suitable for use	All beach access ways, width and grade suitable for use
Recreational Amenity	No beach at high tide and/or scarps present (>2m height). Beach and dune not readily recoverable	Minimal beach width at high tide and/or moderate scarps. Beach and dune could recover over time	Moderate beach width at high tide and/or scarps present which are readily recoverable	No/negligible impact on beach width or scarping

6.2 Stanwell Park

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Stanwell Park beach can be described as follows:

- The 850m long beach faces the southeast and is exposed to waves averaging 1.6m (Hs), which usually generates four strong rips: one against each headland, and 2-3 shifting beach rips,
- The bar separating the rips is often separated from the beach by a wide, deep trough, with waves reforming to surge up the steep beach face, and
- This beach has a Hazard Rating of 7/10 (highly hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 109,240 people per season, and an average of 116 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

This beach has an active Bushcare group.

Figure 15 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.2.1 Dune Morphology

In order to assess the dune morphology for Stanwell Park beach, an analysis of the aerial photographs was undertaken. Photogrammetry of the beach was not available for this beach.

Analysis of the aerial photography (1948 to 2011) does not allow a reliable estimate of beach width changes with time because of the possible influence of tides on the land/water interface. Notwithstanding this, visual inspections show no significant change in beach width over time. Beach width has not been raised as a significant issue for Stanwell Park Beach, therefore the lack of other more reliable records for beach width estimation (e.g. photogrammetry) is not critical.

Changes in vegetation extent from the aerial photography are more informative. Between 1948 and 1977, the coastal zone was characterised by a wide beach and a dune with minimal or no vegetation. There is evidence of vegetation appearing at the back of the beach from 1986, and increasing in density and extent since then. In the 2011 aerial photograph, the vegetation has spread to only about a third of the way from the back of the beach to the high water mark, and at least 35m of bare sandy area still remains within this zone.

During the site visits undertaken for this study, Stanwell Park Beach had scarps that had formed after storm events, which were undergoing rapid recovery to reform a stable dune system, a gently sloping beach, and a distinct beach berm.

Figure 15 Map illustrating the dune management area and patrolled area – Stanwell Park

6.2.2 Ecology

Management Area

Dune vegetation directly in front of the SLSC is currently lower than 1.2m and Coastal Wattle *Acacia longifolia* subsp. *sophorae* forms dense, low thickets. Other species growing within the Wattle thickets are *Lomandra longifolia, Tetragonia tetragonioides, Carex pumila* and *Senecio spathulatus* subsp. *attenuatus.* These are all low-growing species. In the foredune, the most common species are *Spinifex sericeus, *Hydrocotyle bonariensis, *Cakile maritima, *Cakile edentula* and *Ficinia nodosa.*

Views to the south from the clubhouse will not be affected by increased vegetation heights, although views to the north may eventually be impaired because of several tall-growing species, especially Coastal Tea-tree *Leptospermum laevigatum* and Coastal Banksia *Banksia integrifolia* subsp. *integrifolia*.

Weed species also occur within the vegetation to the north of the clubhouse. Species include **Lantana camara, *Solanum nigrum, *Pennisetum clandestinum, *Stenotaphrum secundatum, *Araujia sericifera* and **Asparagus plumosus*.

Further to the north of the clubhouse is a well-developed dune vegetation system with climax vegetation in the hind dune, adjacent to mown parkland. Tree species in the climax vegetation include Cabbage Palm *Livistona australis,* Blackwood *Acacia melanoxylon,* Lilly Pilly *Acmena smithii*, Cheese Tree *Glochidion ferdinandi* var. *ferdinandi* and *Glochidion ferdinandi* var. *pubens*, Blackbutt *Eucalyptus pilularis* and Brush Daphne *Pittosporum undulatum.*

A plant species list for this beach is included in Appendix F.

NPWS (2002) vegetation mapping demonstrates the area immediately in front of the tower is mown grass, with Coastal Sand Scrub on the dune below the mown area. Coastal Foredune Scrub patches provide habitat for threatened species. They are also important for migratory and nomadic nectar and insect feeding birds because they contain many plants that flower in autumn and winter, thereby providing a food resource generally unavailable elsewhere (Sydney Water, 1999).

Broader Beach Area

Sections of the hind dune vegetation comply with the description of SEPP 26 Littoral Rainforest.

NPWS (2002) vegetation mapping indicates that Coastal Headland Banksia Scrub and Littoral Rainforest (Endangered Ecological Community (EEC) can be found on the sand dunes and gentle slopes along the broader beach area of Stanwell Park Beach and Swamp Oak Floodplain Forest, also an EEC, into the lagoon area south of the management area. Open Forest occurs on the slopes and in gullies and includes species such as Blackbutt, Turpentine, Grey Ironbark and Smooth-barked Apple (Sydney Water, 1999). Reedland and associated aquatic vegetation occurs on the margins of the southern lagoon of Stanwell Park and includes Native Reed and Swamp Oak (Sydney Water, 1999). There are creeks that run approximately 250m north (Hargraves Creek) and 100m south (Stanwell Creek) of the dune study area. These vegetation types and associated aquatic habitats provide important high tide roosts for migratory wading birds and predatory seabirds (Osprey). The open, rocky area at the entrance of Stanwell Creek provides potential foraging habitat for the threatened Sooty Oystercatcher (*Haematopus fuliginosus*), which may also utilise the dune vegetation.

There are also extensive tracts of native vegetation to the north associated with Lawrence Hargrave Memorial Park, which has the potential to provide habitat for a range of threatened species.

6.2.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

The inspection indicated that there was no line of sight issue at Stanwell Park, which is consistent with advice provided by Council. Accordingly, a structural assessment was not carried out at this beach.

6.2.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Scarping is periodically observed and recovers readily, and
- Dune height has been observed to be increasing according to stakeholder consultation.

Based on the above assessment for this beach, the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered not applicable (nil),

- Beach access issue is considered not applicable (nil), and
- Recreational amenity issue is considered not applicable (nil).

6.3 Coalcliff Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Coalcliff Beach is described as follows:

- The main Coalcliff Beach fronts the valley, and is a 500m long east-southeast facing coarse sand beach, with a mix of sand and rock seafloor off the beach, and the small Stony Creek draining across the southern end,
- Average wave height is 1-1.5m (Hs) maintaining three dominant rips, a strong rip against the southern rocks, a shifting central rip and one flowing north past the northern rocks, and
- This beach has a Hazard Rating of 6/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 18,940 people per season and an average of 13 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

Figure 16 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.3.1 Dune Morphology

In order to assess the dune morphology for Coalcliff Beach, an analysis of the aerial photographs was undertaken. Photogrammetry of the beach was not available for this beach.

Notwithstanding the possible influence of tides on the land/water interface, inspection of the aerial photography (1955 to 2011) shows fluctuations in beach width over time. Beach width has not been raised as a significant issue for Coalcliff Beach, therefore the lack of other records for beach width estimation (e.g. photogrammetry) is not critical.

The aerial photographs show vegetation appearing at the back of the beach from 1997 and prograding seaward since then. There is no evidence of vegetation at the back of the beach prior to 1997. The 2011 aerial photograph shows that the vegetation appears to be restricted to the slopes only, and not spreading onto the beach itself. The width of the bare sandy area from the back of the beach to the high water mark is approximately 13m. This could be considered narrow, however this is not due to prograding dune vegetation and is instead the result of the sloping back beach topography.

During the site visits undertaken for this study, Coalcliff Beach was characterised by a relatively undulating beach.

Figure 16 Map illustrating the dune management area and patrolled area – Coalcliff

6.3.2 Ecology

Management Area

Rather than dune vegetation, the plants on the slopes below the SLSC are growing in soils derived from Illawarra Coal Measures. The original vegetation on these slopes was probably Coastal Headland Banksia Scrub. There are several Coastal Banksias *Banksia integrifolia* subsp. *integrifolia* on the banks which may eventually grow taller, however at their current height of 2.5m, they do not impair views to the shoreline.

An exotic tree (a Rubber Plant *Ficus decora*) located to the south of the clubhouse and driveway would, if allowed to grow, eventually cause visibility problems from the SLSC, as well as disrupting the road surface, and should therefore be removed.

At the base of the slopes, there are scattered clumps of pioneer dune plants, including **Hydrocotyle bonariensis, *Cakile maritima, *Cakile edentula* and *Ficinia nodosa.*

The vegetation patch upslope of the clubhouse has a range of rainforest species, including *Scolopia braunii, Notelaea venosa, Brachychiton acerifolius, Cryptocarya microneura* and *Ceratopetalum apetalum*.

The area in front of the viewing tower is predominantly grass, with scattered mid-storey vegetation. However, the presence of the tracts of vegetation in the surrounds of the tower increases the potential for threatened fauna to occur transiently within native vegetation in the study area.

A plant species list for this beach is included in Appendix F.

Broader Beach Area

NPWS (2002) vegetation mapping demonstrates the native vegetation in the broader area is predominantly mapped as Coastal Headland Banksia Scrub. Coalcliff Beach is part of an extensive patch of intact native vegetation which is generally in good condition and contains a wide range of habitat resources, including: foraging resources associated with nectar, seed and fruit bearing native plants; a variety of tree age and size classes; and structurally diverse vegetation, including patches of dense understorey.

Coalcliff Beach has little headland vegetation, possibly due to excavation back to subsoil. Coastal Tea-tree and Banksia scrub are prevalent, along with Cheese Tree, Lilly Pilly and Eucalypts which would provide foraging habitat for various birds and small mammals. There is some limited habitat present for threatened and migratory species. Species such as the Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Bentwing Bat (*Miniopteris schreibersii* subsp*. oceansis*) and Regent Honeyeater (*Xanthomyza phrygia*) may forage on occasion among these trees. Offshore and seabirds, such as the Sooty Shearwater, have been recorded in significant numbers on occasion along the beach (Dovers, 1983; Hazelton and Tille, 1990; Longmac, 1991).

6.3.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

The inspection indicated that there was no line of sight issue at Coalcliff, which is consistent with advice provided by Council. Accordingly, a structural assessment was not carried out at this beach.

6.3.4 Summary of Issues

No critical issues were observed at this beach throughout the project duration.

Based on the above assessment for this beach, the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered not applicable (nil),
- Beach access issue is considered not applicable (nil), and
- Recreational amenity issue is considered not applicable (nil).

6.4 Scarborough Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Scarborough Beach is described as follows:

- The beach commences amongst the rocks at the northern end and trends south-southwest for 560m. The beach typically has steep slopes,
- The beach is separated from Wombarra Beach by 100m of rocks at the southern end. Two creeks drain across the beach either side of the Scarborough-Wombarra SLSC,
- Scarborough Beach is subject to average wave heights of 1.4m (Hs) and usually has 3-4 well developed rips, one at each end close to the rocks and one to two shifting beach rips, and
- This beach has a Hazard Rating of 6/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 29,030 people per season and an average of 11 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

Figure 17 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.4.1 Dune Morphology

In order to assess the dune morphology for Scarborough Beach, an analysis of the aerial photographs was undertaken. Photogrammetry of the beach was not available. Notwithstanding the possible influence of tides on the land/water interface, inspection of the aerial photography (1948 to 2011) shows no significant change in beach width over time, except in 1993, when the beach appeared wider than at other times. Beach width has not been raised as a significant issue for Scarborough Beach, therefore the lack of other records for beach width estimation (e.g. photogrammetry) is not critical.

Vegetation is present in the back beach area from 1948, and there is no indication of any significant progradation with time. In the 2011 aerial photograph, the width of bare sandy area from the back of the beach to the high water mark is approximately 13m. This could be considered narrow, however this is not due to prograding dune vegetation, but the result of the sloping back beach topography.

During the site visits undertaken for this study, Scarborough Beach was characterised by a stable dune system with minimal beach width at high tide.

Figure 17 Map illustrating the dune management area and patrolled area – Scarborough

6.4.2 Ecology

Management Area

Like Coalcliff beach, the vegetation on the slopes below the SLSC is growing on Illawarra Coal Measures soil, rather than on sand. Apart from a few scattered Coastal Banksia, mainly to the north of the clubhouse, there are several clumps of Lantana **Lantana camara*, Morning Glory **Ipomoea indica* and Bitou Bush **Chrysanthemoides monilifera* subsp. *rotundata.*

The groundcover is mostly exotic, consisting of Kikuyu **Pennisetum clandestinum*, Buffalo Grass **Stenotaphrum secundatum* and Rhodes Grass **Chloris gayana*. Where drainage lines flow down the slopes, Common Reed *Phragmites australis* and Cumbungi *Typha orientalis* form narrow patches.

At the base of the slopes, there are scattered clumps of pioneer and exotic dune plants, including **Hydrocotyle bonariensis, *Cakile maritima, *Cakile edentula* and *Ficinia nodosa.*

The vegetation patch upslope of the clubhouse mainly consists of a continuation of the Coastal Headlands Banksia Scrub which occurs along sections of the cliff line to the north and south.

A plant species list for this beach is included in Appendix F.

Rabbit scats were recorded to the west of the clubhouse, although no areas of disturbed soil were evident.

Broader Beach Area

NPWS (2002) vegetation mapping demonstrates the area immediately in front of the tower is mown grass, with Coastal Headland Banksia Scrub to the south, and Littoral Rainforest (EEC) behind and to the north of the club house.

Native vegetation contains a wide range of habitat resources, including: foraging resources associated with nectar, seed and fruit bearing native plants; a variety of tree age and size classes; and structurally diverse vegetation, including patches of dense understorey. Fauna species expected to be found in this area include possums, macropods and reptiles. Several hundred species of bird exist in this region, including threatened species such as the White-bellied Sea Eagle and Red Crowned Fruit Dove, which may forage in the area on occasion. Suitable habitat is provided by vegetation on the Escarpment and within the dune vegetation (Illawarra Escarpment Environment Inquiry, 1973).

There is a natural water course 170m north of the site, and Horse's Creek 80m south of the site. The opening of these creeks would provide limited habitat for most migratory shorebirds which prefer wide mudflats and sandflats, although several migratory shorebirds have been recorded within the broader locality including the Australian Painted Snipe (*Rostratula australis*), Terek Sandpiper (*Xenus cinereus*), Great Knot (*Calidris tenuirostris*) and Curlew Sandpiper (*Calidris ferruginea*; refer to Appendix D; OEH, 2012b) and could forage in the area on occasion.

The Scarborough rock platform and the adjacent embayment produce food resources for a variety of seabirds, including the Sooty Oystercatcher and the Great Cormorant (WCL, 2013).

6.4.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

The inspection indicated that there was no line of sight issue at Scarborough, which is consistent with advice provided by Council. Accordingly, a structural assessment was not carried out at this beach.

6.4.4 Summary of Issues

No critical issues were observed at this beach throughout the project duration.

Based on the above assessment for this beach, the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered not applicable (nil),
- Beach access issue is considered not applicable (nil), and
- Recreational amenity issue is considered not applicable (nil).

6.5 Coledale Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Coledale Beach is described as follows:

- Coledale Beach is a 400m long beach that faces east-southeast and is bordered by cliffs to the north and extensive rock platforms at either end, with the sandy surf zone 270m in length,
- It is exposed to average wave heights of 1.5m (Hs), which maintain permanent rips against the rocks at either end, and usually a shifting central beach rip, and
- This beach has a Hazard Rating of 5/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 50,850 people per season and an average of 78 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

Figure 18 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.5.1 Dune Morphology

In order to assess the dune morphology for Coledale Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2011) shows no indication of any vegetation at the back of the beach at any time. In the 2011 aerial photograph, the width of the bare sandy area from the back of the beach to the high water mark is about 20m.

From photogrammetry records (1936 to 2007), beach width was widest in 1938 at 44m. It reduced to about 10m or less from 1948 to 1966, and then started to recover. In 2007, it still had not reached the width evident in 1938, and was only 30m wide.

Beach volume showed similar trends as beach width, with the highest volume (160m^3/m) recorded in 1938. It reduced to about a third of this value over 1948 to 1966, and then started to recover. The 2007 beach volume was approximately 100m^3/m.

During the site visits undertaken for this study, Coledale Beach was characterised by a relatively undulating beach.

Figure 18 Map illustrating the dune management area and patrolled area – Coledale

6.5.2 Ecology

Management Area

The main landscape feature of Coledale Beach is provided by a line of mature Norfolk Island Pines *Araucaria heterophylla*. Only small patches of dune vegetation occur, and are mostly confined to the northern and southern ends of the beach. In front of the SLSC there is a low, incipient dune, which is regularly eroded by a creek outlet. Dune species include *Spinifex sericeus, *Cakile edentula, *Cakile maritima, *Hydrocotyle bonariensis, Ficinia nodosa, Cyperus laevigatus* and *Pelargonium australe*. In the creekline, there are several salt tolerant species including *Selliera radicans, Zoysia macrantha* and *Lobelia alata*, as well as *Phragmites australis* and Taro **Alocasia esculenta.*

Behind the SLSC are planted trees. Common species are Swamp Oak *Casuarina glauca*, Coastal Banksia *Banksia integrifolia* subsp. *integrifolia,* Mangrove Boobialla *Myoporum acuminatum* and Honey Bracelet-myrtle *Melaleuca armillaris.*

A plant species list for this beach is included in Appendix F.

Broader Beach Area

NPWS (2002) vegetation mapping demonstrates Coastal Headland Banksia Scrub occurs to the south of the SLSC.

Aerial photography indicates that the site is bounded by residential development and there is very little dune vegetation within the study area. There is some limited habitat present for threatened and migratory terrestrial species. Species such as the Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Bentwing Bat and Regent Honeyeater (*Xanthomyza phrygia*) may forage on occasion among these trees.

The large rock outcrops to the north and south of the site would provide habitat for migratory shorebirds and waders such as the Sooty Oystercatcher, which has several records within the area.

6.5.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

The inspection indicated that there was no line of sight issue at Coledale, which is consistent with advice provided by Council. Accordingly, a structural assessment was not carried out at this beach. Furthermore, from the information gathered, it is noted that a patrol tower is scheduled to be constructed within the next year to replace the temporary shed currently being used by Council lifeguards.

6.5.4 Summary of Issues

No key issues were observed at this beach throughout the project duration.

Based on the above assessment for this beach, the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered not applicable (nil),
- Beach access issue is considered not applicable (nil), and
- Recreational amenity issue is considered not applicable (nil).

6.6 Austinmer Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Austinmer Beach is described as follows:

- The beach is wedged between two low headlands and their extensive rock platforms and is approximately 250m long and has an orientation of 117º,
- Average wave height has been determined to be approximately 1.4m (Hs) with a wave period of 10s, which maintains strong permanent rips against the rocks at each end, and
- This beach has a Hazard Rating of 7/10 (highly hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 156,660 people per season and an average of 136 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

Figure 19 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.6.1 Dune Morphology

In order to assess the dune morphology for Austinmer Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2011) does not show the presence of beach vegetation at any time. In the 2011 aerial photograph, the width of the bare sandy area from the back of the beach to the high water mark is about 40m.

From photogrammetry records (1955 to 2007), beach width reduced from about 45m in 1955 to about 30m from 1961 to 1984, and then increased to about 50m in the 1990's. The most recent photogrammetry record of 2007 indicated a decrease again to about 30m.

Beach volume showed similar trends as beach width between 1955 and 2007. Beach volume was highest in 1955 at 230m^3/m. It reduced to about 150m^3/m in the period from 1961 to 1984, and recovered to about 200m^3/m in 2007.

During the site visits undertaken for this study, Austinmer Beach was characterised by a relatively undulating beach and a slight beach berm.

Figure 19 Map illustrating the dune management area and patrolled area – Austinmer

6.6.2 Ecology

Management Area

No dune vegetation occurs at this beach. A strong landscape and heritage feature of the beach is provided by the mature Norfolk Island Pines *Araucaria heterophylla* which extend along the boundary between Lawrence Hargrave Drive and the beach.

The view from the lifeguard rooms towards the beach is partly restricted by several mature Norfolk Island Pines.

Mown grasses occupy the flat area above the sea wall. Species include Couch *Cynodon dactylon*, Kikuyu **Pennisetum clandestinum*, Winter Grass **Poa annua* and Panic Veldtgrass **Ehrharta erecta*.

A list of plant species recorded at the beach is included in Appendix F.

Broader Beach Area

At the northern end of the beach, on the south-facing headland batters of Bells Point, are trees and shrubs that are mainly introduced species, including Century Plant **Agave americana*, Mirror Bush **Coprosma repens*, Norfolk Island Hibiscus **Lagunaria patersonii* and Karo **Pittosporum crassifolium*. Native species include Coastal Banksia *Banksia integrifolia* subsp. *integrifolia* and Coastal Rosemary *Westringia fruticosa*.

On top of the headland is a large, healthy patch of Kangaroo Grass *Themeda australis*. This patch complies with the description of the Endangered Ecological Community (EEC) *Themeda* Grassland on Seacliffs and Coastal Headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions. Unfortunately, this patch is regularly mown, with the result that invasive exotic grasses are competing successfully against the native species. This EEC is extremely rare in the Wollongong LGA, therefore sympathetic management is required if the patch is to survive.

Some of the fauna species to be found are reptiles, parrots, possums, frogs, snails, numerous arthropods and other invertebrates (WCL, 2013). Seabirds such as the threatened Sooty Oystercatcher and Pied Oystercatcher have been previously recorded, and would commonly feed at the waterline, however could also be expected to fossick and roost above the high water line amongst the spinifex dune vegetation. Off shore seabirds, such as the Little Shearwater, have been recorded on occasion along the beach (OEH, 2012b).

6.6.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

The inspection indicated that there was no line of sight issue at Austinmer caused by dune height or dune vegetation, which is consistent with advice provided by Council. Accordingly, a structural assessment was not carried out at this beach. However, there is a Norfolk Island Pine in front of the lifeguard rooms that causes some inconvenience. Council is currently in the process of designing a new lifeguard viewing facility which will be located at the northern end of the beach.

6.6.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- There is a Norfolk Island Pine in front of the SLSC which may partially block viewing. However, the tree is heritage listed.

Based on the above assessment for this beach the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered not applicable (nil),
- Beach access issue is considered not applicable (nil), and
- Recreational amenity issue is considered not applicable (nil).

6.7 Thirroul Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Thirroul Beach is described as follows:

- The beach is 1km long and faces the east-southeast,
- The beach is typically subject to wave heights of 1-1.5m (Hs) usually maintaining a single bar cut by six rips, including permanent rips against the boundary rocks, and
- This beach has a Hazard Rating of 6/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 125,550 people per season and an average of 132 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

Figure 20 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.7.1 Dune Morphology

In order to assess the dune morphology for Thirroul Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1955 to 2011) does not show the presence of beach vegetation at any time. In the 2011 aerial photograph, the width of the bare sandy area from the back of the beach to the high water mark is about 30m.

From photogrammetry records (1961 to 2007), beach width consistently ranged between 50 to 60m, except in 1974 when it reduced to about half this width. Similarly beach volume has been consistent at about 200 to 250m^3/m, except in 1974, when it was half this volume. The decrease in 1974 has been attributed to the occurrence of a major coastal storm in that year (Cardno Lawson Treloar, 2010).

During the site visits undertaken for this study, Thirroul Beach was affected by sand drift associated with aeolian processes and characterised by a relatively undulating beach.

Figure 20 Map illustrating the dune management area and patrolled area – Thirroul

6.7.2 Ecology

Management Area

Aerial photography mapping indicates that the site is bounded by residential and recreational development. To the north of the patrolled area, adjacent to the outlet off Flanagans Creek, an incipient dune has formed. No tall shrubs have recruited on this dune, although the lifeguard interviews during the inspection expressed concern that at mid–high tide during rougher seas, access between the dune and the shoreline was inhibited as the vegetation had spread past the original fence line. Vegetation on the incipient dune mainly consists of Coastal Spinifex *Spinifex sericeus*, growing in association with self-recruited dune pioneer species, including *Ficinia nodosa*, Sand Couch *Sporobolus virginicus*, Strand Sedge *Carex pumila* and the cosmopolitan species Sea Rocket **Cakile* spp. and Kurnell Curse **Hydrocotyle bonariensis*. At the back of the incipient dune, Coastal Wattle *Acacia longifolia* subsp. *sophorae* has self-recruited and, in places, forms dense mats which extend back to the hind dune.

The average height of vegetation on the incipient dune is 150mm.

The landward end of this incipient dune intergrades with a band of planted trees and shrubs which extend from north of the SLSC car park to Flanagan's Creek. Species include Sydney Golden Wattle *A. longifolia* subsp. *longifolia, *A. saligna*, Coastal Tea-tree *Leptospermum laevigatum*, Coastal Banksia *Banksia integrifolia* subsp. *integrifolia*, Boobialla *Myoporum acuminatum* and *Correa alba.* Weed species include **Ipomoea cairica, *Asparagus* spp., **Conyza* spp. and **Gazania rigens.* An exotic fig tree, probably *Ficus benghalensis* is growing in a group of banksias. Although this is a large-growing Banyan Fig species, it is unlikely to develop into a huge tree in this location.

Norfolk Island Pine **Araucaria heterophylla* forms a landscape feature along the road and carparks.

A list of plant species recorded at the beach is included in Appendix F.

Broader Beach Area

A variety of birds may on occasion utilise habitats within and surrounding the site. Regularly recorded birds in the northern suburbs of Wollongong include the Australian King Parrot, Crimson Rosella, and the Brown Gerygone which may forage in the native vegetation on occasion. The Channel-billed Cuckoo, and Pied Currawong are most often found in or near fig trees which provide their preferred food. Honeyeaters, Satin Bowerbirds and the threatened Rose-crowned Fruit Dove commonly visit gardens adjacent to the escarpment (WCL, 2013) and may forage in the fig, acacias, banksias and planted trees recorded.

6.7.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

The inspection indicated that there was no line of sight issue at Thirroul, which is consistent with advice provided by Council. Accordingly, a structural assessment was not carried out at this beach.

6.7.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- The incipient dune restricts access during some high tide conditions, however this issue is not considered to be critical, as it is not impacting on the high use area of the beach.

Based on the above assessment for this beach, the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered not applicable (nil),
- Beach access issue is considered not applicable (nil), and
- Recreational amenity issue is considered not applicable (nil).

6.8 Sandon Point Beach

With reference to the document ‘Beaches of the New South Wales Coast’ (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Sandon Point Beach is described as follows:

- The beach is impacted by average waves heights of 1m (Hs),
- As a result, the bar is usually attached the length of the beach with 2-3 rips forming along the northern half, and
- This beach has a Hazard Rating of 5/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 32,570 people per season and an average of 14 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified record/s within 200m of the management area.

This beach has an active Bushcare group.

Figure 21 illustrates the dune management area as advised by Council and the patrolled area as advised by the Lifeguards.

6.8.1 Dune Morphology

In order to assess the dune morphology for Sandon Point Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2012) shows the presence of vegetation at the back of the beach from 1993. Prior to 1993, there is no evidence of vegetation on the dunes. Since 1993, the vegetation has become well established. However, this appears to be restricted to the slopes and the very back of the beach, rather than on the beach itself. In the 2012 aerial photograph, the width of the bare sandy area from the back of the beach to the high water mark is about 15m. This could be considered to be narrow, however this is not the result of prograding dune vegetation, but the sloping back beach topography.

From photogrammetry records (1961 to 2005), the following has been calculated:

- Beach width gradually increases from about 30m in 1961 to about 40m in 2005.
- Beach volume does not show much variation and has been consistent at 200 to 240m^3/m,
- Dune volume has also remained consistent at about 150 to 160m^3/m; and
- Dune height has been about 3m AHD through the period of the photogrammetry record, except over 1974 to 1984 when it was about 2.3m AHD.

These indicators suggest no major impact of the dune vegetation on beach characteristics. During the site visits undertaken for this study, Sandon Point Beach was characterised by a stable and vegetated dune and gently sloping beach, with minimal beach width at high tide.

Figure 21 Map illustrating the dune management area and patrolled area – Sandon Point

6.8.2 Ecology

Management Area

Dune vegetation to the north of the SLSC has recently been planted, as a component of construction of the new building. Further upslope, the vegetation is low, mainly consisting of Coast Rosemary *Westringia fruticosa* and White Correa *Correa alba* var. *alba*. Vegetation height is generally less than 0.5m.

Although there is well-developed dune vegetation to the south, the clubhouse is situated so that any increased height in dune vegetation will not hinder views to the patrolled shoreline.

Typical foredune species include *Spinifex sericeus, *Cakile edentula, *Cakile maritima, *Hydrocotyle bonariensis* and *Ficinia nodosa.* Coastal Wattle *Acacia longifolia* subsp*. sophorae* forms a dense layer to 0.8m, then intergrades with the vegetation on the slopes where *Banksia integrifolia* subsp. *integrifolia, A. longifolia* subsp. *longifolia, Myoporum acuminatum, Monotoca elliptica* and *Leptospermum laevigatum* form dense thickets to 2m. Vandalism to vegetation is evident on the slopes, with shrubs, especially Coastal Banksia being poisoned (drill holes are evident), uprooted seedlings and torn branches. A historic Norfolk Island Pine on the headland is also displaying evidence of poisoning, and is necrotic at the terminal leader.

A list of plant species recorded at the beach is included in Appendix F.

Evidence of scratching by rabbits and scats were recorded along the vegetation edges on the headland above the SLSC. No burrows were recorded within the dunes adjacent to the clubhouse.

Broader Beach Area

The locality area has undergone residential development and the remnant dune vegetation is surrounded by mostly cleared and modified areas. NPWS (2002) vegetation mapping demonstrates Coastal Headland Banksia Scrub patches which provide habitat for threatened species and are also important for migratory and nomadic nectar and insect feeding birds. Tramway Wetlands Planning Committee, NIRAG (2003) have previously recorded the Brown Quail breeding on the site, Southern Emu-Wren, White-cheeked Honeyeaters and Cattle Egrets. White-faced Herons and the Australian Night Heron have been identified as resident 'refugee' species at the nearby Sandon Point wetlands, and may on occasions forage or roost in the dune vegetation within the study area.

Threatened species such as the Australasian Bittern, Lewin's Rail, Latham's Snipe, as well as Cormorant species use the area of Tramway Creek lagoon and could forage or refuge in the dune vegetation on occasion. These areas also include a number of tall eucalypt and banksia species, which would provide foraging and roosting habitat for various birds (such as the White-bellied Sea Eagle *Haliaeetus leucogaster*) and mammals including the threatened, Eastern Pygmy Possum. Mammals such as Short Beaked Echidna, Bandicoot, Large-footed Myotis Fishing bat, reptiles and frogs may forage on occasion among the dune scrub and adjoining grasslands.

The large rock platform to the north of the site would provide habitat for migratory shorebirds and waders such as the Sooty Oystercatcher (which has several records within the area) and Eastern Reef Egret (*Egretta scara)*. Off-shore seabirds such as the Southern Great Petrel and White-throated Needle Tail *(Hirundapus caudacutus)* may fly over the area on occasion, however they are unlikely to rely on the habitats within the site.

6.8.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

The inspections indicated that there was no line of sight issue at Sandon Point, which is consistent with advice provided by Council. Accordingly, a structural assessment was not carried out at this beach.

6.8.4 Summary of Issues

Based on the above assessment for this beach, the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered not applicable (nil),
- Beach access issue is considered not applicable (nil), and
- Recreational amenity issue is considered not applicable (nil).

6.9 Bulli Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Bulli Beach is described as follows:

- The entire beach is exposed to wave heights of 1.5m (Hs), and typically maintains 4-6 rips, including permanent rips against the rocks at either end, and 2-4 shifting beach rips,
- The intervening bars are usually attached to the beach, however are separated by a trough during and following periods of high waves; conditions that can also generate a second outer bar running the length of the beach, and
- This beach has a Hazard Rating of 6/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 110,310 people per season and an average of 44 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified record/s within 200m of the management area.

Figure 22 illustrates the dune management area as advised by Council and the patrolled area as advised by the Lifeguards.

6.9.1 Dune Morphology

In order to assess the dune morphology for Bulli Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2012) shows no evidence of any dune vegetation in front of the Bulli SLSC from 1948 to 1986. Dune reconstruction works including planting were carried out by Council around this time across a number of beaches in Wollongong, including at this beach (section 5.2). From 1993, established dune vegetation is evident, which has increased in extent and density since then. The 2012 aerial photograph shows that the dune vegetation has spread approximately half the way from the back of the beach to the high tide mark. The width of the remaining bare sandy area within this zone is approximately 20m.

From photogrammetry records (1961 to 2005) and the 2013 on-ground survey, the following has been calculated:

- Beach width ranged from 15 to 50m prior to the dune construction works, and from 30 to 40m in the period after these works,
- Beach volume ranged from 70 to 180m^3/m before the works, and from 160 to 190m^3/m after the works,
- Dune volume ranged from 60 to 90m^3/m in the pre dune works period, and from 120 to 130m^3/m in the post works period, and
- Dune height ranged from 2 to 3m AHD before the works, and from 4 to 5m AHD after the works.

Accordingly, these results suggest that the size of the dune has increased significantly since the dune works and the dune volume and height indicators are the clearest signal for this. The 2013 on-ground survey showed the presence of a 1.5m high scarp, located within 23m of the 0m AHD mark.

During the site visits undertaken for this study, Bulli Beach was characterised by a well-established dune system and wide beach. Steep scarping after storm events was noted on the northern portion of the beach.

Figure 22 Map illustrating the dune management area and patrolled area – Bulli

6.9.2 Ecology

Management Area

Dune vegetation extends from the south side of Waniora Point southwards towards Woonona. Although the band of dune vegetation is narrow, the vegetation is mostly dense in the hind dune and appears to provide habitat for a range of small passerine birds. Species composition is homogeneous along the dune, and vegetation height increases from <0.5m on the foredune to >2m adjacent to the fence line. The tallest species near the fence line is Coastal Tea-tree *Leptospermum laevigatum*, although Mangrove Boobialla *Myoporum acuminatum* and the introduced Golden Wreath Wattle **Acacia saligna* is also common. Coastal Banksia *Banksia integrifolia* subsp. *integrifolia* is an occasional emergent to 3m. Shorter shrub species include White Correa *Correa alba* var. *alba* and Coastal Rosemary *Westringia fruticosa*.

On the foredune the most commonly occurring shrubs are a mixture of subspecies of *Acacia longifolia.* Height varies from 1m to 1.8m, although wind shear appears to influence height in the seaward section of the foredune.

The incipient dune, where it occurs, has a sparse covering of Coastal Spinifex *Spinifex sericeus*, Kurnell Curse **Hydrocotyle bonariensis* and *Ficinia nodosa*. Where there is a scarp, there are scattered clumps of the cosmopolitan Seablight **Cakile edentula* and **C. maritima.*

In some areas, the top growth of Sydney Golden Wattle *A. longifolia* subsp. *longifolia* has been trimmed back. It is apparent that a great deal of die-back has taken place since the pruning, and, where gaps in the canopy have developed, it is apparent that second-succession species, especially *Monotoca elliptica, M. acuminatum* and *L. laevigatum* are self-recruiting.

To the south of the SLSC there is a complete, continuous band of dune vegetation. Coastal Tea-tree is the tallest species along this section, with Coastal Banksia occurring as an occasional emergent. At the outlet of Whartons Creek, there are some salt tolerant tree species, including Swamp Oak *Casuarina glauca* and Swamp Mahogany *Eucalyptus robusta*, growing in association with *Phragmites australis.*

A vegetation cover profile is included in Appendix E. A list of plant species recorded at the beach is included in Appendix F.

Broader Beach Area

Bulli Beach Reserve is mapped as Coastal Sand Scrub and a rock platform is adjacent to the north of the site (NPWS, 2002).

Estuarine habitat is present 100m south of the site in Whartons Creek, in which the coastal scrub and associated aquatic habitat provide important high tide roosts for migratory wading birds, and a range of other birds may also utilise the adjacent dune vegetation on occasion. The threatened Black Bittern (*Ixobrychus flavicollis*) and Black-faced Monarch (*Monarcha melanopsis*), which has been previously recorded in Whartons Creek could forage in the area on occasion. Several migratory shorebirds have been recorded within the locality including the Australian Painted Snipe (*Rostratula australis*), Terek Sandpiper *(Xenus cinereus*), Great Knot (*Calidris tenuirostris*) and Curlew Sandpiper (*Calidris ferruginea)* (refer to Appendix D; OEH, 2012b) and could forage in the area on occasion.

6.9.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

An assessment of Bulli SLSC was undertaken on 13 March 2013 to assess the line of sight issues from the lifeguard station. A visual assessment of the line of sight was checked from the lifeguard station, and from the beach, and visibility issues were discussed on site with lifeguards (Appendix N).

Bulli SLSC is a two storey masonry and concrete structure. The lifeguard station is located on the second floor of the southeast corner of the club house. Extensions are currently being prepared for the south side of the clubhouse.

The line of sight between the lifeguard station and the northern end of the beach (near the rocks adjacent to the ocean baths) is compromised by the height of the dunes. It is unlikely that the extensions to the clubhouse will improve the line of sight issues at the north end of the beach.

Any improvement to sight lines achieved by raising the floor level of the observation area *within the constraints of the existing building envelope* would be negligible and would not materially reduce the extent of dune and vegetation management actions required to improve the line of sight from this location.

6.9.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Beach access is obstructed with overgrown vegetation and steep scarps,
- The northern end of the beach is not clearly visible from the lifeguard station in the SLSC, and
- Complaints have been received regarding pests and vermin.

Based on the above assessment for this beach, the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered moderate,
- Beach access issue is considered moderate, and
- Recreational amenity issue is considered moderate.

6.10 Woonona Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Woonona Beach is described as follows:

- The southern section of the beach is classified as Transverse Bar and Rip, while the northern end that receives more swell, fluctuates between Transverse Bar and Rip and Rhythmic Bar and Beach,
- The beach is typically subjected to wave heights of 1-1.5m (Hs) and usually has an attached bar cut by rips every 200m, with a permanent rip against the northern rocks,
- During big seas, a second bar forms further offshore, and
- This beach has a Hazard Rating of 6/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 67,450 people per season and an average of 57 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

Figure 23 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.10.1 Dune Morphology

In order to assess the dune morphology for Woonona Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2012) shows the presence of sparse and patchy dune vegetation up to 1986, around when dune reconstruction works were carried out at this beach. From 1993, established dune vegetation is evident, which has increased in extent and density since then. The 2012 aerial photograph shows that the dune vegetation has spread more than three-quarters of the way from the back of the beach to the high tide mark. The width of the remaining bare sandy area within this zone is only about 10m.

From photogrammetry records (1955 to 2007) and the 2013 on-ground survey, the following has been calculated:

- Beach width ranged from 10 to 70m prior to the dune construction works, and from 50 to 80m in the period after these works,
- Beach volume ranged from 100 to 230m^3/m before the dune works, and from 220 to 280m3/m after the works,
- Dune volume ranged from 60 to 160m^3/m in the pre dune works period, and from 160 to 200m^3/m in the post works period, and
- Dune height ranged from 1 to 3m AHD before the works, and from 3 to 4m AHD after the works.

Accordingly, these indicators suggest a notable increase in beach and dune accretion since the dune works. The 2013 on-ground survey showed the presence of a 1m scarp, 36m from the 0m AHD mark.

During the site visits undertaken for this study, Woonona Beach was characterised by a stable dune system and a wide beach. During storm events, scarps formed along the seaward vegetation line and along the berm and resulted in reduced beach width. Following these events, the beach was undergoing recovery and forming a moderately sloping beach and beach berm.

Figure 23 Map illustrating the dune management area and patrolled area – Woonona

6.10.2 Ecology

Management Area

Dune vegetation increases in height from <0.5m on the foredune to >2m adjacent to the upslope fence line. The tallest species near the fence line is Coastal Tea-tree *Leptospermum laevigatum*, although the introduced Golden Wreath Wattle **Acacia saligna* is also common. Coastal Banksia *Banksia integrifolia* subsp. *integrifolia* is an occasional emergent to 3m. Shorter shrub species include White Correa *Correa alba* var. *alba* and Mangrove Boobialla *Myoporum acuminatum* to 1.4m. On the foredune, the most commonly occurring shrubs are a mixture of subspecies of *A. longifolia.* Height varies from 1m to 1.8m, although wind shear appears to influence height in the seaward section of the foredune. The incipient dune, where it occurs, has a sparse covering of Coastal Spinifex *Spinifex sericeus*, Kurnell Curse **Hydrocotyle bonariensis* and *Ficinia nodosa*. Where there is a scarp, there are scattered clumps of the cosmopolitan Seablight **Cakile* spp.

To the north of the SLSC, Lantana **Lantana camara* and Bitou Bush **Chrysanthemoides monilifera* subsp. *rotundata* occur in scattered patches within a dense band of dune vegetation.

Acacia longifolia subsp. *longifolia* is common along the upslope edge, adjacent to the cycleway.

A vegetation cover profile is included in Appendix E. A list of plant species recorded at the beach is included in Appendix F.

Rabbit scats were recorded to the south of the clubhouse. No burrows were recorded in the dune vegetation in front of the SLSC.

Broader Beach Area

NPWS (2002) vegetation mapping demonstrates Coastal Sand Scrub and Beach Sands Spinifex in the area. Nicholson Park to the west of the tower comprises mown grass along with a few scattered trees. The large rock platform to the north of the site would provide habitat for migratory shorebirds and waders such as the Sooty Oystercatcher, which has several records within the area. The location adjacent to the study area has undergone residential development, and the remnant dune vegetation is surrounded by mostly cleared and modified areas. Coastal Sand Scrub patches provide habitat for threatened species and are also important forage and refuge habitat for migratory and nomadic nectar and insect feeding birds. A wide range of small woodland birds such as Brown Thornbills (*Acanthiza pusilla*) and Eastern Yellow Robins (*Eopsaltria australis*) would also occur in these habitats. There is some limited habitat present for threatened and migratory species. Species such as the Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Bentwing Bat and Regent Honeyeaters (*Xanthomyza phrygia*) may forage on occasion among these trees. Offshore and seabirds, such as the Black Browed Albatross, have been recorded are in along the beach (Dovers, 1983; Hazelton and Tille, 1990; Longmac, 1991). White-bellied Sea Eagles and Ospreys may use the forests at the edge of the escarpments on occasion for roosting habitat. The threatened Black Bittern (*Ixobrychus flavicollis*), which has been previously recorded in Collins Creek could forage in the area on occasion.

6.10.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

An assessment of Woonona SLSC was undertaken on 13 March 2013 to assess the line of sight issues from the SLSC and the observation tower. A visual assessment of the line of sight was checked from the beach to the observation tower, and from the second floor of the SLSC (Appendix N).

Woonona SLSC is a two-storey masonry and concrete structure located approximately 150m from the north end of the beach. The ground floor of the clubhouse is generally used for storage, while the second floor is intended to be used for patrols by the SLSC. However, due to visibility issues, patrols have been moved onto the beach during all weather conditions.

The lifeguard station is a bolted structure approximately 5m high founded on a precast concrete slab. The observation tower to the south of the SLSC is utilised by council lifeguards, and it is understood that this facility is not currently available for use by the SLSC. The lifeguard tower is located behind the dune vegetation, approximately 50m from the shore. The line of sight is limited to approximately 60m south of the tower, and potentially 40-50m north of the tower during high tide.

Due to the large ceiling height on the first floor of the club house, it may be possible to construct a small mezzanine observation platform within the existing building. However, it is unlikely that this would solve the sight line issues completely, and if undertaken, would require complementary maintenance of the vegetation height in front of the club house.

6.10.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Beach access is obstructed with overgrown vegetation and steep scarps,
- Vegetation is growing beyond the original fenceline,
- Areas of the beach are not readily visible from the tower or SLSC,
- Complaints have been received about antisocial behaviour, and
- Complaints have been received regarding pests and vermin.

Based on the above assessment for this beach the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered moderate from the tower and severe from the SLSC,
- Beach access issue is considered moderate, and
- Recreational amenity issue is considered moderate.

6.11 Bellambi Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Bellambi Beach is described as follows:

- Bellambi Beach has quite an easterly aspect and hence is protected from east and southeast swells,
- Waves decrease south along the beach, with the rips decreasing and usually a continuous attached bar in the south, except during northeast conditions, which will generate strong rips along the beach,
- The beach type is Transverse Bar and Rip for most of its length, however sometimes a Low Tide Terrace develops at the southern end (section 5.1), and
- This beach has a Hazard Rating of 5/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 36,720 people per season and an average of 26 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

Figure 24 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.11.1 Dune Morphology

In order to assess the dune morphology for Bellambi Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2012) shows the presence of sparse and patchy dune vegetation on the northern side of the cycleway bridge up to 1986, about when dune restoration works were carried out at this beach. From 1993, established dune vegetation is evident at this location, which has increased in extent and density since then. The 2012 aerial photograph shows that the dune vegetation has spread approximately half of the way from the back of the beach to the high tide mark. The width of the remaining bare sandy area within this zone is still substantial at 60m. On the southern side of the bridge, vegetation cover was starting to emerge from 2006, however it is still quite patchy.

From photogrammetry records (1955 to 2007) and the 2013 on-ground survey, the following has been calculated:

- Beach width ranged from 20 to 60m in the period both before and after dune works,
- Beach volume ranged from 70 to 250m^3/m before the dune works, and from 150 to 220m^3/m after the works,
- Dune volume ranged from 70 to 160m^3/m in the pre dune works period, and from 100 to 140m^3/m in the post works period, and
- Dune height ranged from 1 to 4m AHD before the works, and from 2 to 4m AHD after the works.

At this beach, none of these indicators suggest a significant change in beach and dune characteristics since the dune works were undertaken. The 2013 on-ground survey showed the presence of a scarp of less than one metre, 40m from the 0m AHD mark.

During the site visits undertaken for this study, Bellambi Beach was characterised by a stable dune system, and a wide relatively undulating beach and beach berm.

Figure 24 Map illustrating the dune management area and patrolled area – Bellambi

6.11.2 Ecology

Management Area

An incipient dune has developed in front of the SLSC, possibly as an artefact of flows from the outlet of Bellambi Creek. The incipient foredune has a sparse covering of Coastal Spinifex *Spinifex sericeus*, *Zoysia macrantha* and *Hydrocotyle bonariensis, with occasional clumps or individuals of *Ficinia nodosa* and **Cakile edentula.* There are also several seedlings of *A. longifolia* subsp. *sophorae,* which are currently growing as prostrate forms.

To the north of Bellambi Creek, at the pedestrian entrance to the beach, there is a clump of tall vegetation (>2m), formed from *Myoporum acuminatum* and *Leptospermum laevigatum.* Downslope of this tall clump, the foredune slopes fairly steeply seawards and is mainly covered by subspecies of *A. longifolia,* which reduces in height, from hind dune to foredune from 1.8m to <0.5m, probably as a result of wind-shear. A natural watercourse occurs 80m north-west of the study area.

A vegetation cover profile is included in Appendix E. A list of plant species recorded at the beach is included in Appendix F.

Broader Beach Area

At Bellambi Point is Bellambi Lagoon Reserve, a protected reserve area in which are the lagoon and small islands of that name, mostly forested in Swamp Oaks (*Casuarina glauca*), coastal sclerophyll and saltmarsh. NPWS (2002) vegetation mapping demonstrates the occurrence in the area of Coastal Sand Scrub, Swamp Oak Floodplain Forest (EEC) and Swamp Sclerophyll Forest on Coastal Floodplains (EEC).

Bellambi Lagoon Reserve, the natural watercourses and rivers and the associated swale contains records and habitat for the threatened Green and Golden Bell Frog. Although this species is unlikely to rely in the dune vegetation habitats, the close proximity to recorded occurrences in Bellambi Lagoon and their long distance dispersal habits, this species may turn up on site on occasion.

Wetland vegetation types mapped within the study area contains important habitat for threatened bird species such as the Australasian Bittern which has been observed along the Bellambi Lagoon, and may refuge or roost in the native vegetation within the study area on occasion (although there are no records along the shoreline) (OEH, 2012b).

Sooty Oystercatchers have been frequently observed along the rocky parts of the shoreline and foraging on the rocky areas of the beach, with several records to the south east of the site. Little Tern (*Sterna albifrons*), Sooty Tern (*Sterna fuscata*) and White Tern (*Gygis alba*) have occasionally been observed along Bellambi Beach, however are unlikely to prefer or rely on the shoreline and dune vegetation for breeding due to the disturbance from recreational users.

Migratory birds may use the dune habitats for refuge particularly as fly-overs from the nearby Five Islands (which are a well-known stop-over), and while these species are unlikely to rely on the dune habitats in the long term, as long as the more suitable habitat on the Five Islands is conserved and protected.

Rabbit scats were recorded to the north of the clubhouse. No burrows were recorded in the dune vegetation in front of the SLSC.

6.11.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

An assessment of Bellambi SLSC was undertaken on 13 March 2013 to assess the line of sight issues from the lifeguard station. Visual site inspection of line of sight was checked from the lifeguard station, and from the beach (Appendix N).

Bellambi SLSC is a two-storey masonry and concrete structure. Currently, the lifeguard station is located on the ground floor of the clubhouse, approximately 150m from the shoreline.

Discussions with SLSC club personnel indicate that the patrols are generally undertaken from the shore. However, during inclement weather, this is not possible and there is an observation area on the first floor of the building.

Line of sight issues occur approximately 20-30m north of the main access track and are largely caused by the berm and vegetation height. Both the Lifeguard and SLSC observation areas are located in the same building, and both observation areas suffer from the same line of sight issues. Line of sight may be improved by moving the lifeguard station to the first floor of the building.

6.11.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Beach access is obstructed with overgrown vegetation,
- Areas of the beach are not readily visible from the SLSC, and
- Increase in dune height over time.

Based on the above assessment for this beach, the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered minor,
- Beach access issue is considered moderate, and
- Recreational amenity issue is considered minor.

6.12 Corrimal Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Corrimal Beach is described as follows:

- The beach faces the east-southeast and receives waves averaging 1.5m, which maintain an energetic surf usually containing a single bar cut by 5-6 rips, including permanent rips against the rocks at each end,
- During periods of lower waves, the bar is attached between the rips, however during and following higher waves a trough often separates the bar from the beach, particularly toward the central-northern end, and at times a second bar forms further seaward with more widely spaced rips, and
- This beach has a Hazard Rating of 6/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 79,270 people per season and an average of 57 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

This beach has an active Bushcare group.

Figure 25 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.12.1 Dune Morphology

In order to assess the dune morphology for Corrimal Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2012) shows the presence of sparse and patchy dune vegetation up to 1984. Dune reconstruction works have been carried out at this beach soon after this date. The next aerial photograph is for 2001, which shows established dune vegetation, which has increased in extent and density since then. The 2012 aerial photograph shows that the dune vegetation has spread more than three-quarters of the way from the back of the beach to the high tide mark. The width of the remaining bare sandy area within this zone is about 25m.

From photogrammetry records (1961 to 2001) and the 2013 on-ground survey, the following has been calculated:

- Beach width ranged from 15 to 55m prior to the dune construction works, and from 60 to 100m after these works,
- Beach volume ranged from 110 to 260m^3/m before the dune works, and from 200 to 380m^3/m after the works,
- The dune volume ranged from 100 to 220m^3/m in the pre dune works period, and from 140 to 300m^3/m in the post works period, and
- The dune height ranged from 0.1 to 2m AHD before the works, and from 0.8 to 5m AHD after the works.

All of these indicators suggest a notable increase in beach and dune accretion at this beach since the dune works. The 2013 on-ground survey showed the presence of a 1.5m scarp, 45m from the 0m AHD mark.

During the site visits undertaken for this study Corrimal Beach was characterised by a stable dune system, gently sloping beach and beach berm. Beach width was narrow at high tide.

Figure 25 Map illustrating the dune management area and patrolled area – Corrimal

6.12.2 Ecology

Management Area

The SLSC is located between the outlet of Towradgi Creek and Corrimal Beach Tourist Park.

Dune vegetation is tall (>2m) in the hind dune, adjacent to the upslope fence, reducing to <0.5m towards the foredune. Along the fence line, possibly as a response to increased shelter, the vegetation is tall (>2m). Common species include subspecies of *Acacia longifolia*, *Myoporum acuminatum, Leptospermum laevigatum* with occasional emergent *Banksia integrifolia* subsp. *integrifolia* and the introduced **A. saligna*.

On the foredune, the most common occurrence are subspecies of *A. longifolia*, although large patches are beginning to senesce and are being replaced by secondary succession species including *M. acuminatum, L. laevigatum, Monotoca elliptica* and the lower-growing *Westringia fruticosa* and *Correa alba* var. *alba.* In the open patches, especially on more exposed sites, groundcover species including *Tetragonia tetragonioides*, *Carpobrotus glaucescens* and *Lomandra longifolia* are self-recruiting.

In some sections of the foredune, scarping has occurred, and the roots of *Spinifex sericeus* will either been exposed to further wave erosion or reburial, depending on future surf conditions. Common foredune pioneers like *Ficinia nodosa*, Marram Grass **Ammophila arenaria, *Cakile maritima* and **Gazania rigens* occur either within patches of Coastal Spinifex or in scattered clumps.

A vegetation cover profile is included in Appendix E. A list of plant species recorded at the beach is included in Appendix F.

There is evidence of extensive rabbit activity in the dune vegetation, including two carcasses of recently deceased rabbits, scats and scratchings, especially within vegetation edges.

Broader Beach Area

NPWS (2002) vegetation mapping demonstrates the occurrence of Coastal Sand Scrub and Beach Sand Spinifex in the area.

Similar comments regarding fauna habitats for Bellambi Beach can also be applied to Corrimal Beach. The locality adjacent to study area has undergone extensive residential development. Much of the natural habitat has been disturbed and less than 8% of natural cover remains along the coastal plain of the Illawarra Region, though remnant patches of woodland, wetland and forest can still be found.

Potential habitat for a range of threatened species exists within the mapped coastal foredune vegetation. The vegetation retained adjoins the Towradgi Creek, south of the site and Towradgi Park. Seabirds such as the threatened Sooty Oystercatcher and Pied Oystercatcher have been previously recorded, and would commonly feed at the waterline, however are also expected to fossick and roost above the high water line amongst the spinifex dune vegetation. An Australian Fur Seal has been recorded on the rock platform about 100m north of the site.

Common species previously recorded and that may occur within native vegetation in the study area included bird species such as Sulphur Crested Cockatoo, Kookaburra, Native Pigeon, Butcher Bird, King Parrot, Mountain Lowry, Eastern Whip Bird, Rufus Fantail, Black Duck and Magpie (WCL, 2013). Mammals such as Echidna, Wallabies and Bandicoots have been found in the foothills and may forage on occasion in the study area, particularly in the mown lawns and undergrowth (Davis, 1995).

6.12.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

An assessment of Corrimal SLSC was undertaken on 13 March 2013 to assess the line of sight issues from the lifeguard station. Visual site inspection line of sight was checked from the lifeguard station and from the beach (Appendix N).

Corrimal SLSC is a masonry and concrete clubhouse located in Corrimal Beach Park, while an observation tower (used by lifeguards and lifesavers) is located within dune vegetation approximately 30m from beach. The observation tower is founded on a reinforced concrete slab.

Line of sight issues from the observation tower were present to the south at the location of Towradgi Creek, and from approximately 30m north of the access track to the beach. Line of sight issues are caused by a combination of dune and vegetation height, and the distance the tower is set back from the shore.

Line of sight from the SLSC building is non-existent, and is blocked by vegetation in the dune between the SLSC building and the beach (this building is not used for observation of the beach).

6.12.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Recreational amenity is periodically impacted by minor scarps which recover readily,
- During certain tide conditions only, areas of the beach are not always visible from the tower,
- Decrease in surf conditions, and
- Complaints have been received about pests, vermin and snakes.

Based on the above assessment for this beach the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered minor,
- Beach access issue is considered minor, and
- Recreational amenity issue is considered minor.

6.13 Towradgi Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and information included on the Geosciences Australia OZCoasts portal, Towradgi Beach is described as follows:

- The beach is exposed to wave heights of 1.5m (Hs) which maintain usually well-developed bars and rips, and
- This beach has a Hazard Rating of 6/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 37,080 people per season and an average of 26 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified record/s within 200m of the management area.

This beach has an active Bushcare group.

Figure 26 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.13.1 Dune Morphology

In order to assess the dune morphology for Towradgi Beach, an analysis of the aerial photographs was undertaken. Photogrammetry of the beach was not available. Aerial photography (1948 to 2012) shows the appearance of dune vegetation from 1986, around when dune restoration works were carried out at this beach. The vegetation has increased in extent and density since then. The 2012 aerial photograph shows that the dune vegetation has spread more than three-quarters of the way from the back of the beach to the high tide mark. The width of the remaining bare sandy area within this zone is only about 10m.

Whilst photogrammetry is not available to enable comparison of beach and dune characteristics in the pre and post dune work periods, more recent trends can be detected by comparing the 2013 survey profile with the 2007 profile obtained from Airborne Laser Scanning records. This comparison shows the following has been calculated:

- A decrease in beach width from 60m in 2007 to 45m in 2013,
- A change in beach volume from 330 to 270m^3/m for the same period,
- Dune volume was unchanged at 230m^3/m, and
- An increase in dune height from 6.5 to 6.9m.

These indicators imply significant erosion in the lower, unvegetated part of the beach, whilst the upper vegetated part has remained largely intact. The 2013 on-ground survey showed the presence of a 3.5m scarp, 18m from the 0m AHD mark.

During the site visits undertaken for this study, Towradgi Beach was characterised by a stable dune system that had been subjected to storm erosion. Steep scarps had formed at the seaward vegetation line and at the berm as a result of storm events. At high tide, minimal or no beach width was reported.

Figure 26 Map illustrating the dune management area and patrolled area – Towradgi

6.13.2 Ecology

Management Area

The dune vegetation commences at the northern end, at Towradgi Point, and continues southwards to the outlet of Fairy Creek, at Puckey's Estate. The suite of species along this section of dune is homogeneous, consisting of a mixture of Coastal Tea-tree *Leptospermum laevigatum*, Mangrove Boobialla *Myoporum acuminatum*, the introduced Golden Wreath Wattle **Acacia saligna* and subspecies of *A. longifolia.* Coastal Banksia *Banksia integrifolia* subsp. *integrifolia* is an occasional emergent.

Vegetation height near the fence at the start of the open beach area is generally less than 2m, although occasional emergents to >3m occur. There are large open patches within the wattle growth, possibly as a result of senescence caused by plant age, combined with weather conditions. The most common secondary succession species which appears to be recruiting in these gaps is Mangrove Boobialla *M. acuminatum*. This species has the capability of growing taller than Coastal Wattle, although it is likely that windshear will restrict plant height to <1.5m, which is the current average height of the wattle patches.

In the foredune, *Tetragonia tetragonioides* and *Carpobrotus glaucescens* occur within thickets of *Spinifex sericeus.* Other species include *Ficinia nodosa*, Marram Grass **Ammophila arenaria, *Cakile maritima* and **Gazania rigens*.

A vegetation cover profile is included in Appendix E. A list of plant species recorded at the beach is included in Appendix F.

There is evidence of rabbit activity in the dune vegetation and grass area near the observation tower.

Broader Beach Area

NPWS (2002) vegetation mapping demonstrates the occurrence of Coastal Sand Scrub and Beach Sand Spinifex in the area. The vegetation within the dunes and wetland vegetation types to the west of the study area, would provide habitat for threatened migratory bird species such as the Little Tern. Towradgi Beach is listed as a nesting site within the Little Tern Recovery Plan. Nesting individuals have historically been recorded on the sand dunes behind the beach, although no records exist after 1950.

The large rock platform to the north of the study area would provide habitat for migratory seabirds, shorebirds and waders such as the Sooty Oystercatcher which has several records within the area, and may seek refuge or roost in the dune vegetation in the study area.

6.13.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

An assessment of Towradgi observation tower was undertaken on 13 March 2013 to assess the line of sight issues. A visual site inspection of line of sight was checked from the tower observation area and from the beach (Appendix N).

The observation tower is a two storey masonry and concrete structure approximately 30m from the shore. Due to the steep drop off at the vegetation line, and the location of the lifeguard tower, there is extremely poor visibility of the shoreline. At the time of the inspection, the beach was not visible at all from the observation tower.

6.13.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Recreational amenity is impacted by scarps which recover over time,
- None of the beach is visible from the tower,
- Minimal beach width for nippers/SLSC activities, and
- Reported decrease in surf conditions.

Based on the above assessment for this beach the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered severe,
- Beach access issue is considered moderate, and
- Recreational amenity issue is considered severe.

6.14 Fairy Meadow Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and on the Geosciences Australia OZCoasts portal, Fairy Meadow Beach is described as follows:

- The beach is impacted by 1.5m (Hs) high waves in the north-centre, decreasing to 1m towards the south, which results in a single bar cut by rips every 200m, with up to 14 rips along the beach,
- Rip size and intensity usually decreases down the beach, and
- This beach has a Hazard Rating of 6/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 60,430 people per season and an average of 178 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified record/s within 200m of the management area.

Figure 27 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.14.1 Dune Morphology

In order to assess the dune morphology for Fairy Meadow Beach, an analysis of the aerial photographs was undertaken. Photogrammetry of the beach was not available. Aerial photography (1948 to 2012) shows the presence of patchy vegetation with blow out areas up to 1986, around when dune restoration works were carried out at this beach. The next aerial photograph is for 2001, which shows established dune vegetation and this has increased in extent and density since then. The 2012 aerial photograph shows that the dune vegetation has spread about halfway from the back of the beach to the high tide mark. The width of the remaining bare sandy area within this zone is about 20m.

Whilst photogrammetry is not available to enable comparison of beach and dune characteristics in pre and post dune work periods, more recent trends can be detected by comparing the 2013 survey profile with the 2007 profile obtained from Airborne Laser Scanning records. From these surveys the following has been calculated:

- A decrease in beach width from 55m in 2007 to 50m in 2013,
- A decrease in beach volume from 270 to 250m^3/m,
- A decrease in dune volume from 190 to 180m^3/m for the same period, and
- An unchanged dune height at about 5.5m.

These indicators suggest that both the beach and dune have been affected by erosion in 2013. The 2013 on-ground survey showed the presence of a 1.5m scarp, 30m from the 0m AHD mark.

During the site visits undertaken for this study, Fairy Meadow Beach was steep after storm events and undergoing beach recovery. The dune system was reported to be stable and the beach width relatively narrow.

Figure 27 Map illustrating the dune management area and patrolled area – Fairy Meadow

6.14.2 Ecology

Management Area

The dune vegetation at Fairy Meadow is a continuation of the more-or-less homogeneous patch extending from Towradgi to Fairy Creek. The exposed patches left by necrotic Coastal Wattles are, however, more extensive. The patches may be filled by self-recruiting native dune species, although there is also the possibility that weed species, especially Lantana and Bitou Bush may invade these gaps.

It is apparent that many of the mature Coastal Banksia *Banksia integrifolia* subsp. *integrifolia* which were growing along the fence line are either necrotic or senescent. This is unfortunate, because Coastal Banksia is an important source of nectar for birds in dune vegetation.

A vegetation cover profile is included in Appendix E. A list of plant species recorded at the beach is included in Appendix F.

Broader Beach Area

The locality adjacent to this part of the study area has undergone heavy residential and recreational development, resulting in a heavily degraded coastal catchment. Potential habitat for a range of threatened species exists within the study area in the form of dune vegetation (Coastal Sand Scrub, NPWS, 2002). Coastal Sand Scrub patches provide habitat for threatened species and are also important for migratory and nomadic nectar and insect feeding birds because they contain many plants that flower in autumn and winter, thereby providing a food resource generally unavailable elsewhere. Reedland and associated aquatic vegetation occurs on the margins of Fairy Creek and includes Native Reed and Swamp Oak (Cardno Lawson Treloar, 2005). A realigned tributary of Para Creek runs southwards, to the west of the SLSC, where it flows into a small lagoon system in Puckey's Estate, to the south-west of the SLSC. These vegetation types and associated aquatic habitat provide important high tide roosts for migratory wading birds and predatory seabirds (Osprey). The presence of native vegetative tracts of floodplain (surrounding) to the west of the study area, also increases the potential for threatened fauna to occur transiently within native vegetation in the study area.

6.14.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

An assessment of Fairy Meadow SLSC and observation tower was undertaken on 13 March 2013 to assess the line of sight issues. Visual site inspection of the line of sight was checked from the observation tower (Appendix N).

The Fairy Meadow observation tower (used by lifeguards and lifesavers) is constructed on a concrete pad footing approximately 20m from the beach. Some visibility issues were present from approximately 50m north and south of the tower and are mainly caused by overgrown vegetation and height of vegetation.

There is generally no line of sight from the SLSC building to the beach.

6.14.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Recreational amenity is impacted by scarps which recover over time,
- Beach width is relatively small,
- Beach access is narrow, and
- Areas of the beach are not readily visible from the tower at certain tides.

Based on the above assessment for this beach the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered moderate,
- Beach access issue is considered moderate, and
- Recreational amenity issue is considered moderate.

6.15 North Wollongong Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and on the Geosciences Australia OZCoasts portal, North Wollongong Beach is described as follows:

- The beach is orientated to the east-northeast and receives some protection from southeast waves from Flagstaff Point, and as a result is typically subject to wave heights of 1.2m (Hs),
- These maintain a single bar usually cut by 3-4 rips, and
- This beach has a Hazard Rating of 5/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 173,740 people per season and an average of 213 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified record/s within 200m of the management area.

Figure 28 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.15.1 Dune Morphology

In order to assess the dune morphology for North Wollongong Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2012) does not show the presence of dune vegetation at any time. In the 2011 aerial photograph, the width of the bare sandy area from the back of the beach to the high water mark is about 40 to 60m.

From photogrammetry records (1937 to 1993), the following has been calculated:

- Beach width has ranged from 30 to 40m, except in 1974 when it reduced 4m, and
- Beach volume has ranged from 110 to 140m^3/m, except in 1974, when it was 30m^3/m.

The significant decreases in 1974 are attributed to the occurrence of a major coastal storm in that year, and the lack of a dune system at the back of the beach.

During the site visits undertaken for this study, North Wollongong Beach was characterised by a gently sloping beach and beach berm.

Figure 28 Map illustrating the dune management area and patrolled area – North Wollongong

6.15.2 Ecology

Management Area

A narrow band of dune vegetation occurs to the north of the SLSC, and extends north to Fairy Creek. The area immediately in front of the SLSC is predominantly mown grass. The vegetation to the north and west of the SLSC includes Norfolk Island Pines **Araucaria heterophylla* and other exotic tree species, including Karo **Pittosporum crassifolium* and Norfolk Island Hibiscus **Lagunaria patersonii*. Native species which occur include *Leptospermum laevigatum, Melaleuca ericifolia, Melaleuca armillaris* and *Myoporum boninense.* This planting is located on a thin layer of sandy alluvium, rather than dune sand.

At the south end of the beach, a large number of exotic ornamental species have been planted. On the banks above the pavilion, growing on soils of the Shoalhaven Series are remnants of the original Coastal Headlands Banksia Scrub, growing in association with a range of self-recruited or planted exotic species.

A list of plant species recorded at the beach is included in Appendix F.

Broader Beach Area

The locality adjacent to this part of the study area has undergone high density residential and recreational development, resulting in a heavily degraded coastal catchment. NPWS (2002) vegetation mapping demonstrates the occurrence of some Coastal Sand Scrub north of the management area on the slopes above the beach, which would provide foraging habitat for various birds. A range of common birds recorded included species such as Galah (*Eolophus roseicapillus*) and Rainbow Lorikeet (*Trichoglossus haematodus*). There is some limited habitat present for threatened and migratory terrestrial species. Species such as the Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Bentwing Bat and Regent Honeyeaters (*Xanthomyza phrygia*) may forage on occasion among these trees.

Potential habitat for a range of threatened species exists in the form of dune vegetation (Coastal Sand Scrub), Fairy Lagoon and associated aquatic habitat to the north of the site. Coastal Sand Scrub patches provide habitat for threatened species and are also important for migratory and nomadic nectar and insect feeding birds because they contain many plants that flower in autumn and winter, thereby providing a food resource generally unavailable elsewhere. Reedland and associated aquatic vegetation occurs on the margins of the lagoon of Stuart Park and includes Native Reed and Swamp Oak (Cardno Lawson Treloar, 2005). These vegetation types and associated aquatic habitat provide important high tide roosts for migratory wading birds and predatory seabirds (Osprey). The open, rocky area at the entrance of Fairy Creek provides potential foraging habitat for the threatened Sooty Oystercatcher (*Haematopus fuliginosus*) which may also utilise the dune vegetation. Offshore and seabirds, such as the Wandering Albatross, have been recorded on occasion along the beach (Dovers, 1983; Hazelton and Tille, 1990; Longmac, 1991).

6.15.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

The inspection indicated that there was no line of sight issue at North Wollongong, which is consistent with advice provided by Council. Accordingly, a structural assessment was not carried out at this beach.

6.15.4 Summary of Issues

No critical issues were observed at this beach throughout the project duration.

Based on the above assessment for this beach, the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered not applicable (nil),
- Beach access issue is considered not applicable (nil), and
- Recreational amenity issue is considered not applicable (nil).

6.16 City Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and on the Geosciences Australia OZCoasts portal, City Beach is described as follows:

- The beach is exposed to wave heights of 1.5m (Hs), which produce up to 20 rips along the beach,
- The single bar between the rips is usually attached to the beach, however does detach, with a trough linking the rips, during high waves, and
- This beach has a Hazard Rating of 6/10 (moderately hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 146,830 people per season and an average of 134 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified record/s within 200m of the management area.

Figure 29 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.16.1 Dune Morphology

In order to assess the dune morphology for City Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2012) shows the presence of sparse and patchy vegetation up to 1987, around when dune restoration works were carried out at this beach. From 1993, established dune vegetation is evident, which has increased in extent and density since then. The 2012 aerial photograph shows that the dune vegetation has spread more than halfway from the back of the beach to the high tide mark. The width of the remaining bare sandy area within this zone is about 20m.

From photogrammetry records (1938 to 2007) and the 2013 on-ground survey, the following has been calculated:

- Beach width ranged from 40 to 70m prior to the dune construction works, and from 50 to 120m in the period after these works,
- Beach volume ranged from 200 to 400m^3/m before the dune works, and from 400 to 700m^3/m after the works,
- Dune volume ranged from 140 to 260m^3/m in the pre dune works period, and from 290 to 310m^3/m in the post works period, and
- Dune height ranged from 3 to 6m AHD before the works, and from 7 to 8m AHD after the works.

Accordingly, all of these indicators suggest a significant increase in beach and dune accretion since the dune works. The 2013 on-ground survey showed the presence of a 3m scarp, 14m from the 0m AHD mark.

During the site visits undertaken for this study, City Beach was characterised by steep scarps after storm events, minimal or no beach width, and several closed access points.

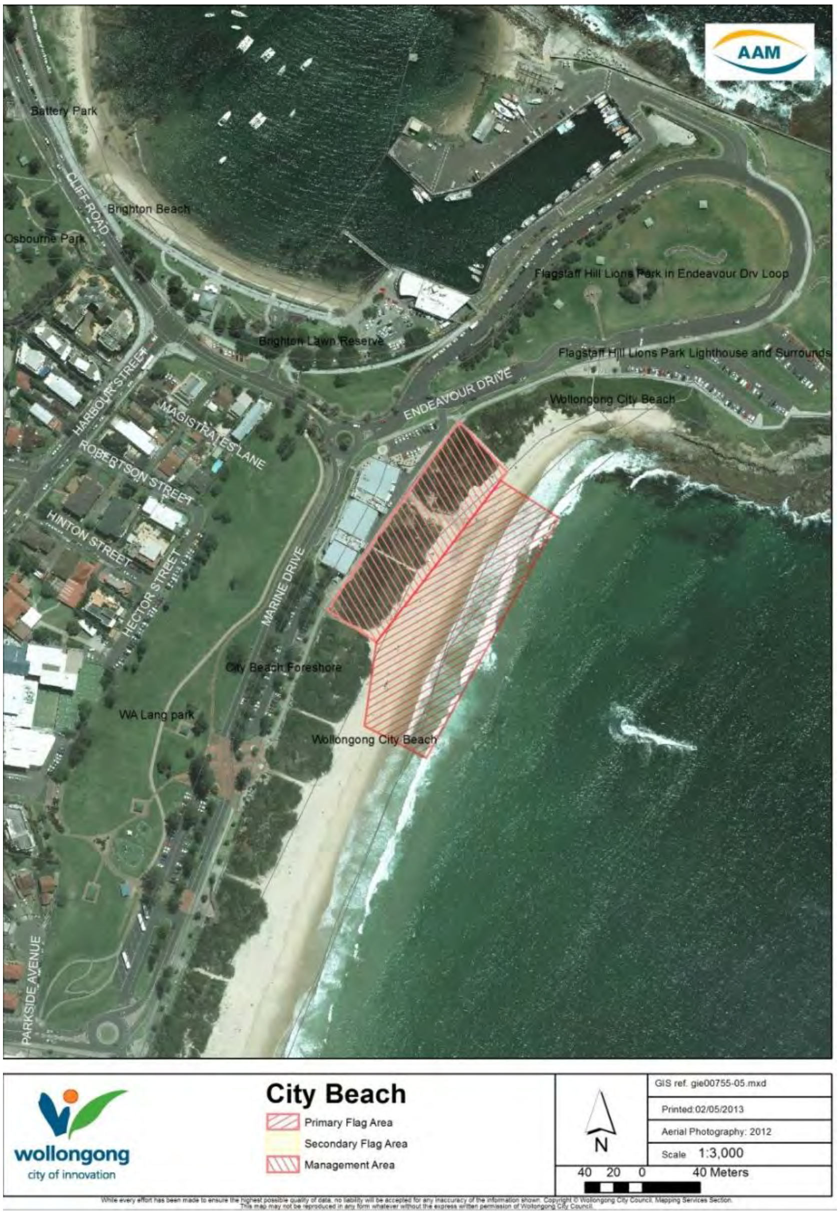


Figure 29 Map illustrating the dune management area and patrolled area – City Beach

6.16.2 Ecology

Management Area

The dune vegetation at the northern end of the beach is sparse, in comparison to areas further south, towards Coniston beach. This may be an artefact of rapid drainage, through the rubble which forms this part of the dune system, however it is also likely that pedestrian traffic contributes to the sparse, low cover on the dune crests and foredune.

The most commonly planted dune species are well represented, including *Acacia longifolia* subsp. *sophorae, A. longifolia* subsp. *longifolia, Leptospermum laevigatum, Myoporum boninense* and *M. acuminatum,* as well as lower-growing species including *Lomandra longifolia, Carpobrotus glaucescens, Westringia fruticosa* and *Correa alba*. The introduced **A. saligna* is an occasional occurrence, although it is noted that most individuals have been removed recently. It is assumed that there is a seed bank of this invasive species, therefore management of seedlings will be necessary for the next few years.

The usual foredune pioneer species are generally absent because of factors including steep slopes and scarping as well as high beach use. Pioneer species including **Cakile* spp., *Carpobrotus glaucescens* and *Tetragonia tetragonioides* are more common along track edges and in close proximity to showers.

A vegetation cover profile is included in Appendix E. A list of plant species recorded at the beach is included in Appendix F.

Broader Beach Area

The study area has undergone urban and residential development and the remnant dune vegetation occurs on previously cleared and modified landforms. NPWS (2002) vegetation mapping demonstrates the occurrence of Coastal Sand Scrub, which provides habitat for threatened species and is also important for migratory and nomadic nectar and insect feeding birds.

Gurungaty Creek occurs to the south of the study area, and the opening of this creek would provide limited habitat for most migratory shorebirds which prefer wide mudflats and sandflats, although several migratory shorebirds have been recorded within the locality including the Broad Billed Sandpiper, and could forage or refuge in the study area on occasion.

Offshore and seabirds, such as the Wandering Albatross and Black Browed Albatross, have been recorded on occasion along the beach comprising the boundaries of the study area.

6.16.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

An assessment of City Beach SLSC was undertaken on 13 March 2013 to assess the line of sight issues from the SLSC and Council Lifeguard observation towers. Visual site inspection of the line of sight was checked from the observation towers and from the beach.

The observation towers are located on the eastern side of City Beach Function Centre and are two storey concrete and masonry structures (Appendix N).

Due to the steep drop off at the vegetation line, and the location of the observation towers, there is extremely poor visibility of the shoreline. At the time of the inspection, the beach in front of the observation towers was not visible at all.

Discussions with SLSC personnel suggest that patrols are generally undertaken from the beach with the tower used to observe the southern end of the beach.

The ceiling height of the observation areas may allow for a small mezzanine observation platform to be constructed within the towers. However, the spatial constraints of the floor plan may prevent this from being a viable option. Furthermore, any sight line improvement achieved by this means is likely to be modest, and would not materially reduce the requirement to implement other management actions to improve the line of sight issue.

6.16.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Beach access is obstructed by steep scarps. Some walkways were closed as they were deemed dangerous,
- Beach width is relatively small,
- Recreational amenity is impacted by steep scarps which are not readily recoverable, and
- Patrolled areas of the beach are not visible from the SLSC facilities.

Based on the above assessment for this beach the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered severe,
- Beach access issue is considered severe, and
- Recreational amenity issue is considered severe.

6.17 Port Kembla Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and on the Geosciences Australia OZCoasts portal, Port Kembla Beach is described as follows:

- Persistent and often strong rips spaced every 200–300m dominate this beach,
- There is a permanent rip against the northern headland, and up to 3–4 rips in the north, and
- This beach has a Hazard Rating of 7/10 (highly hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 93,470 people per season and an average of 27 Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified no records within 200m of the management area.

Figure 30 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.17.1 Dune Morphology

In order to assess the dune morphology for Port Kembla Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2012) shows no significant vegetation cover from 1948 to 1955. Between 1955 and 1986, small patches appear at the northern end of the dune. The 1986 aerial photograph shows the presence of planted dune vegetation, and subsequent dates show an increase in the extent and density of the vegetation. The 2012 aerial photograph shows that the dune vegetation has spread more than halfway from the back of the beach to the high tide mark. The width of the remaining bare sandy area within this zone is about 40m.

From photogrammetry records (1961 to 2007) and the 2013 on-ground survey, the following has been calculated:

- Beach width ranged from 80 to 120m prior to the dune construction works, and from 120 to 140m in the period after these works,
- Beach volume ranged from 500 to 730m^3/m before the dune works, and from 740 to 830m^3/m after the works,
- Dune volume ranged from 460 to 530m^3/m in the pre dune works period, and from 520 to 530m^3/m in the post works period, and
- Dune height ranged from 2 to 4m AHD before the works, and from 4 to 6m AHD after the works.

Accordingly, these indicators show that at this beach, the most significant change since the dune works has been in the dune height. The 2013 on-ground survey showed the presence of a 3m scarp, 14m from the 0m AHD mark.

During the site visits undertaken for this study, Port Kembla Beach was characterised by scarps after storm events, which were undergoing recovery with a gently sloping beach and beach berm. At high tide, the beach width was reported to be minimal.

Figure 30 Map illustrating the dune management area and patrolled area – Port Kembla

6.17.2 Ecology

Management Area

Dune vegetation in the sand intergrades upslope with vegetation growing on soils derived from the Shoalhaven Series. At the top of the slope, adjacent to the SLSC building, many tree species are able to reach their natural height, because they are growing in clay loam soils. This includes Coastal Banksia *Banksia integrifolia* subsp. *integrifolia,* Swamp Oak *Casuarina glauca* and Bangalay *Eucalyptus botryoides*. Sydney Golden Wattle *Acacia longifolia* subsp. *longifolia* also forms tall, dense thickets. Height of vegetation at the top of the slope varies from 1.5m to >3m. At the foot of the slope, in beach sand, more typical dune vegetation, with an average height of <2m occurs. The most common species are *Leptospermum laevigatum, A. longifolia* subsp. *sophorae, Westringia fruticosa* and *Myoporum boninense.*

A vegetation cover profile is included in Appendix E. A list of plant species recorded at the beach is included in Appendix F.

Broader Beach Area

NPWS (2002) vegetation mapping demonstrates the occurrence of Coastal Sand Scrub and Beach Sand Spinifex, all of which has the potential to provide habitat for a range of threatened species. Vegetation forms a connecting corridor to Coomaditchy Lagoon Reserve. These areas included a number of eucalypt and banksia species, which would provide foraging habitat for various birds. A range of common birds have been recorded within vegetation comprising the study area, and included species such as Galah (*Eolophus roseicapillus*) and Rainbow Lorikeet (*Trichoglossus haematodus*). There is some limited habitat present for threatened and migratory terrestrial species. Species such as the Grey-headed Flying-fox (*Pteropus poliocephalus*), Eastern Bentwing Bat and Regent Honeyeaters (*Xanthomyza phrygia*) may forage on occasion among these trees and mid-storey vegetation in the study area.

Dune vegetation would provide important high tide roosts for migratory wading birds, and a range of other birds may also utilise Coastal Foredune Scub and Heath on the formed dunes, on occasion (OEH, 2012b). Sooty Oystercatchers and Pied Oystercatchers have been previously recorded, and would commonly feed at the waterline, however would also be expected to fossick and roost above the high water line amongst the spinifex dune vegetation. Off shore and seabirds, such as the Artic Jaegar and Lesser Frigatebird, have been recorded on occasion along the beach (OEH, 2012b).

The drainage line which extends from Coomaditchy Lagoon towards the coastline contains patches of aquatic and riparian vegetation. The drainage line and associated aquatic habitat may represent marginal potential habitat for the threatened Green and Golden Bell Frog which has several records within the vicinity of the study area. Although this species is unlikely to rely on the dune vegetation habitats, the close proximity to records and creeklines and their long distance dispersal habits, indicates that this species may turn up on site on occasion.

6.17.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

An assessment of Port Kembla SLSC was undertaken on 13 March 2013 to assess the line of sight issues from the lifeguard observation tower and the SLSC (Appendix N).

The Port Kembla SLSC is a two storey concrete and masonry structure located on top of the hill at Port Kembla Beach.

Discussions on site with the personnel from the SLSC suggest that patrols during good weather are undertaken adjacent to the storage and amenities building at the north end of the beach, and generally the visibility of the beach is suitable. However, during inclement weather, the patrol viewing area is moved to the ground floor of the SLSC, where the visibility of the northern end of the beach is blocked by vegetation. Due to the poor visibility, the patrol viewing area has had to be moved to the first floor/meeting room and there are concerns over safety, as this area is also used to store oxygen tanks, defibrillators and other items that could be hazardous to the general public if the door to this area is left unlocked. As such, the preference of the SLSC is to keep the viewing area on the ground floor. This obviously limits the scope for building modifications that may improve elevation and line of sight.

In addition to the SLSC building, there is a lifeguard tower in the building near the swimming pool at the northern end of the beach which is used for lifeguard patrols. However, it is understood that this facility is not currently available for use for the SLSC.

6.17.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Recreational amenity is impacted by minor scarps which readily recover,
- Dune vegetation is overgrown in some areas,
- Areas of the beach are not visible from the SLSC when patrols are undertaken from the clubhouse during inclement weather,
- Beach access pathway/s are degraded, and
- Complaints about pests and vermin.

Based on the above assessment for this beach the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered nil from the tower and severe from the SLSC ,
- Beach access issue is considered moderate, and
- Recreational amenity issue is considered moderate.

6.18 Windang Beach

With reference to the document 'Beaches of the New South Wales Coast' (Short, 2007), data provided by Council lifeguards and on the Geosciences Australia OZCoasts portal, Windang Beach is described as follows:

- Waves are similar to that experienced in Port Kembla. However, rips continue to dominate, with the intervening bars usually attached to the shore, and
- This beach has a Hazard Rating of 7/10 (highly hazardous). Council lifeguard data collected over the past four swimming seasons (since 2009-10) shows a beach usage of approximately 25,160 people per season and an average of five Council lifeguard rescues per season.

The Aboriginal Heritage Information Management System (AHIMS) search undertaken for this project identified record/s within 200m of the management area.

Figure 31 illustrates the dune management area as advised by Council and the patrolled area as advised by the lifeguards.

6.18.1 Dune Morphology

In order to assess the dune morphology for Windang Beach, an analysis of the aerial photographs and photogrammetry (cross sections) was undertaken. Aerial photography (1948 to 2012) shows no significant vegetation cover to 1986, when dune construction works become evident. Since then the vegetation has increased in extent and density. The 2012 aerial photograph shows that the dune vegetation has spread more than halfway from the back of the beach to the high tide mark at the ends of the management zone, and less than a quarter of the way in front of the SLSC. The width of the remaining bare sandy area in front of the SLSC is about 60m.

From photogrammetry records (1961 to 2007) and the 2013 on-ground survey, the following has been calculated:

- Beach width ranged from 120 to 180m prior to the dune construction works, and from 130 to 170m in the period after these works,
- Beach volume ranged from 420 to 580m^3/m before the dune works, and from 470 to 580m^3/m after the works,
- Dune volume ranged from 300 to 330m^3/m in the pre dune works period, and from 320 to 350m^3/m in the post works period, and
- Dune height ranged from <0 to 3m AHD before the works, and from <0 to 3m AHD after the works.

Accordingly, these indicators suggest no significant change in beach and dune characteristics since the dune works. The 2013 on-ground survey did not show any scarping at this beach.

During the site visits undertaken for this study, Windang Beach was characterised by a stable dune system, gently sloping beach and a distinct beach berm.

Figure 31 Map illustrating the dune management area and patrolled area – Windang

6.18.2 Ecology

Management Area

The dune vegetation at Windang has great ecological value because of the known use of the available habitat by several threatened and migratory bird species. To the south of the SLSC is the mouth of Lake Illawarra. To the north, the extensive dune environment of Perkins Beach extends to Port Kembla Beach.

Vegetation in front of the SLSC clubhouse is low, although to the south there is a patch of tall (>3m) vegetation, which inhibits views towards the lake mouth. Species in the tall vegetation include Bangalay *Eucalyptus botryoides* and Coastal Banksia *Banksia integrifolia* subsp. *integrifolia*.

Although there is a broad incipient foredune with *Spinifex sericeus* cover, in association with **Hydrocotyle bonariensis, Ficinia nodosa* and *Carpobrotus glaucescens*, there are also numbers of *Acacia longifolia* subsp. *longifolia, Leptospermum laevigatum* and *Monotoca elliptica*, which have the capability of exceeding 2m in height.

A vegetation cover profile is included in Appendix E. A list of plant species recorded at the beach is included in Appendix F.

Broader Beach Area

NPWS (2002) vegetation mapping demonstrates the occurrence of Coastal Sand Scrub and Beach Sand Spinifex. The sandy shoals of the lake entrance channel to the south and foreshore provide feeding and roosting sites for many wader and seabird species including the Little Tern (listed as Endangered under the TSC Act 1995) and Eastern Reef Egret. A very small Little Tern colony returns to breed every year on a site at Windang near the Lake inlet (WCL, 2013). The number and variety of bird species varies considerably with the season. The foreshore area provides suitable habitats for several small mammal species (WCL, 2013).

Lake Illawarra is located to the west and south of the SLSC and Pelican, Black Swan, Tern, Egret, Cormorant, Spoonbill, White-faced Heron, Curlew, Teal, Ibis and Duck are the most prolific species of birds found on the Lake, and may fly over and roost in the dune vegetation on occasion (WCL, 2013).

Pied Oystercatchers, Bar-tailed Godwit, Red Necked Stint, Double Banded Plover and Red-capped Plover have also been observed where the entrance meets the sea between Windang and Lake Illawarra (LIA, 2005; OEH, 2011) and would be expected to fossick and roost above the high water line amongst the spinifex dune vegetation.

Migratory seabirds have also been recorded over the site, including the Wandering Albatross, which may fly over on occasion.

A female fox which had established a den in the constructed breakwater to the south of the SLSC was recently killed by gassing (Gary Leonard *pers. comm.*, 2013).

6.18.3 Assessment of Surf Life Saving Clubs and Lifeguard Towers

An assessment of Windang SLSC was undertaken on 13 March 2013 to assess the line of sight issues from the lifeguard station. Visual site inspection of the line of sight was checked from the lifeguard station and from the beach (Appendix N).

The Windang SLSC is a single storey masonry and concrete structure. The lifeguard station is attached to the northeast corner of the SLSC and is approximately 50m from the beach.

The line of sight is generally good in front of the SLSC building. However, there are some visibility issues to the north and some minor visibility issues to the south. Line of sight is compromised by overgrown vegetation/dune profile, the relatively low elevation of the lifeguard station, and the distance between the lifeguard station and the beach.

It is noted that Council is currently in the process of designing a new viewing tower, for use by lifeguards and lifesavers, which will be located in the dune to the north of the main access track.

6.18.4 Summary of Issues

As observed throughout the project duration, this beach has the following issue(s):

- Areas of the beach have minor visibility issues from the SLSC,
- Complaints about antisocial behaviour, and
- Complaints about increases in number of rips.

Based on the above assessment for this beach the following has been observed for the key issue(s) in accordance with Table 8:

- Sight line issue is considered minor,
- Beach access issue is considered not applicable (nil), and

- Recreational amenity issue is considered not applicable (nil).

6.19 Summary of Key Issues

Table 9 summarises the severity of the key issues at each beach:

Table 9 Summary of Key Issues

Beach	Sight Line Issue		Recreational Amenity Issue	Beach Access Issue
Stanwell Park	Nil		Nil	Nil
Coalcliff	Nil		Nil	Nil
Scarborough	Nil		Nil	Nil
Coledale	Nil		Nil	Nil
Austinmer	Nil		Nil	Nil
Thirroul	Nil		Nil	Nil
Sandon Point	Nil		Nil	Nil
Bulli	Moderate		Moderate	Moderate
Woonona	Moderate from tower	Severe from SLSC	Moderate	Moderate
Bellambi	Minor		Minor	Moderate
Corrimal	Minor		Minor	Minor
Towradgi	Severe		Severe	Moderate
Fairy Meadow	Moderate		Moderate	Moderate
North Wollongong	Nil		Nil	Nil
City	Severe		Severe	Severe
Port Kembla	Nil from tower	Severe from SLSC	Moderate	Moderate
Windang	Minor		Nil	Nil

In addition, site notes of vegetation cover and line of sight overlain on 2013 cross-sections for beaches with at least one key issue are presented in Appendix M. These site notes are indicative of the potential line of sight obstruction from the vegetation and/or dune profile at these sites, and the elevation of the patrol area currently. These give an indication of the potential moderations required for the management options detailed in section 7 (e.g. lowering of dune profile, trimming/removing vegetation, and raising the patrol viewing height), in order to achieve improvements in line of sight.

Both the results in Table 9 and observations during the site visits (presented in Appendix N) were utilised in assessing suitable management options as part of the MCA.

7. Management Options

Council is required to work within the legislative and policy framework around coastal management (see section 3). This framework recognises the range of values of the coastal zone, its environmental significance and sensitivity and the competing demands for the use of the coastal zone.

The concerns as set out in section 4 and further discussed in sections 5 and 6, illustrate the broad spectrum of issues arising at the 17 subject beaches, and within the coastal areas of the Wollongong LGA. Accordingly, a range of management options were developed in the preliminary stages of the study (refer Appendix G for the long list of management options).

These management options were proposed following the assessment of the site conditions, available literature, stakeholder concerns (including results from the online survey question regarding management options, refer Appendix B) and an understanding of the opportunities and constraints at each of the beaches. The initial long list of potential management options was then condensed to a shorter list which excluded options that were considered not feasible for Wollongong or combined several related options into an integrated option (Appendix P). This shorter list of options was subjected to the multi-criteria analysis to determine the options appropriate for each beach. The options can broadly be classified into the following disciplines:

- Maintain current management actions,
- Structural improvements,
- Ecological enhancements, and
- Dune morphological changes.

7.1 Shortlist of Management Options

The management options considered for the multi-criteria analysis are described below in Table 10.

Table 10 Description of Management Options

Management Action	Description	Time[1]	Approximate Initial Cost[2]	Annual Approximate Maintenance Cost[3]
Build a tower	Relocatable lifeguard towers have been considered. Tower design could be similar to that currently in place at Corrimal which is made of aluminium on a precast pad footing. Suggested minimum floor plan dimensions are 2.5 by 2.5 metres. For further detailed information refer to Appendix O. Consideration needs to be made with regards to safety; design must incorporate anti-climbing measures and be lockable to prevent vandalism. Design should take into consideration the environmental aspects of the area, with consideration to changing dune profiles (tower should be relocated if/when necessary), design should be durable (structure subject to corrosive environment). Structure will require a regular maintenance schedule (repainting, etc.) to minimise effects of corrosion. It is envisaged that this option will dramatically improve the line of sight issues at the beach with minimal impact on coastal processes. This option may have a slight impact on ecology and pests. Typically suitable for SLSCs that currently do not have a patrol tower close to the beach. This management option would not address recreational amenity due to beach width, scarping and the like.	6-12 months (longer if a DA is required)	$150,000	Minimal maintenance required. Approximately 2% of initial cost.
Relocate existing tower	Move existing lifeguard tower to a location that will improve line of sight of the beach, provided it is landward of the immediate hazard line at the beach. Where lifeguard towers are a considerable distance set back from the beach, line of sight is	Less than 6 months (longer if a DA is	Less than $10,000	Maintenance costs would not vary from those already

Management Action	Description	Time[1]	Approximate Initial Cost[2]	Annual Approximate Maintenance Cost[3]
	often affected by the dune profile – usually by the height of the dune and vegetation compared to the shoreline. In these circumstances, relocation of the lifeguard tower to a more suitable location may be the most cost effective solution. The site inspection undertaken found that the lifeguard towers were predominantly bolted, allowing for the partial disassembly and reassembly in the new location. Consideration will need to be made with regards to the structural integrity of the members during the relocation process to ensure members are not damaged. This may include installation of additional bracing during relocation or partial disassembly of the structure. This option would be suitable for current lifeguard towers at Woonona, Corrimal and Fairy Meadow. Towers at Corrimal and Woonona could also be dragged on their slab base. Fairy Meadow tower has a fixed slab and would require another slab to be constructed at the new site. Maintenance requirements would not change from the existing maintenance schedule for the towers. It is envisaged that this option will dramatically improve the line of sight issues at the beach with minimal impact on coastal processes. This option may have a slight impact on ecology and pests. Suitable for SLSCs that currently have a patrol tower at the beach, except at Towradgi which is a permanent structure. This management option would not address recreational amenity due to beach width, scarping and the like.	required)		allocated
Raise level of observation area in SLSC	Modify or extend existing SLSC or lifeguard towers to improve line of sight to the beach. Options may include: • adding an extra level to current SLSC,	1-3 years	\$100,000-\$500,000	Minimal maintenance required initially

Management Action	Description	Time[1]	Approximate Initial Cost[2]	Annual Approximate Maintenance Cost[3]
	• plan extensions to lifeguard stations (where attached to SLSC), • addition of a small 'mezzanine' style platform within the existing building structure, • utilise a higher level of the building and associated retrofit (note cost and time does not apply to this option which would be considerably cheaper and quicker to implement). Building restrictions will need to be considered for any extensions to existing structures (e.g. height restrictions, boundary restrictions, etc.). Will require an engineered solution taking into consideration the arrangement of the current building (i.e. there will be no 'one size fits all' solution for all sites). Extensions should tie in with the existing building (may require architect input). Maintenance requirements would not change from the existing maintenance schedule for the building. This option will improve the line of sight issues at the beach with minimal impacts on the ecology and coastal processes. Typically applicable for beaches where monitoring is carried out from the SLSC. This management option would not address recreational amenity due to beach width, scarping and the like.			
Improve beach access ways	Most vehicular access tracks are sufficiently wide, although some overhanging branches may require seasonal trimming. Scarping appears to be a problem at several beaches, such as Wollongong, Fairy Meadow and Towradgi, in which case, there may be a steep incline from the dune down to the beach strand. Other issues related to grade, track surface and infrastructure, insufficient width for rescue and SLSC vehicles, and sand build-up at edges. Any overhanging branches should be removed back to the main leader. All cuts should be made by clean, sharp secateurs. Steep inclines are best managed by use of light machinery.	Less than 6 months	$10,000-$50,000	Less than $10,000

Management Action	Description	Time[1]	Approximate Initial Cost[2]	Annual Approximate Maintenance Cost[3]
	For further detailed information, refer Appendix O. This option will improve beach access, however, it is unlikely to have any impact on the other issues.			
Remove trees and shrubs affecting line of sight	Community concerns have been raised relating to the height of vegetation at Port Kembla, Corrimal, Towradgi, Fairy Meadow, Woonona and Bulli beaches affecting line of sight from SLSC viewing points to the shoreline of patrolled areas. Identify any trees and shrubs in the affected line of sight. Any removal of vegetation from existing dune vegetation would require an assessment of impact on the dune environment, and, in particular whether any vegetation removal is likely to have a significant impact on any threatened flora and fauna species, as well as consideration of any inconsistencies between vegetation clearing and the core objectives listed above. For further detailed information, refer Appendix O. This option will slightly improve the line of sight issues. However, it may also have a negative impact on ecology, and a slight positive impact on pests and vermin.	6-12 months	Less than $10,000	Less than $10,000
Remove vegetation from frontal zone	This option can provide some benefit at Bulli, Woonona, Bellambi, Corrimal, Towradgi and Fairy Meadow beaches, either because the vegetation has extended too far onto the beach, thereby reducing the beach width available for recreational amenity (e.g. Woonona), or because the frontal zone of the foredune has increased in height as sand is trapped within vegetation growing on the foredune. Vegetation that has spread seaward would best be removed manually, in order to ensure that any cuts to stems are made cleanly and appropriately (i.e. back to nodes or stem unions). Associated organic matter should be gathered after removal of live plant material, otherwise the newly exposed foredune will appear untidy and unattractive. The removed live material and organic matter should be scattered over vegetated areas further upslope.	6-12 months	$50,000-$100,000	Less than $10,000

Management Action	Description	Time[1]	Approximate Initial Cost[2]	Annual Approximate Maintenance Cost[3]
	There may be a need to reshape the foredune, especially if steep scarping has occurred. This should be carried out by light machinery. Prior to works being undertaken, the amount of re-profiling required, and the potential impact on the risk from coastal hazards including any potential end effects would need to be determined. A detailed design of the desired beach profile, and the subsequent landscaping requirements, would need to be prepared. This action is short term only and will require ongoing maintenance. Over time, natural wave processes and storm actions may re-shape any alterations made. Further storm events may occur and cause scarping, potentially further inland from the mean high water mark due to the absence of stabilising vegetation. Therefore, a monitoring program would need to be established to track changes with time and take corrective action to prevent reversal to the original situation. For further information on this option, refer Appendix O. This option could provide an improvement to the line of sight and recreational amenity issues, as well as to beach access in some occasions. However, there could be adverse consequences to ecology and coastal hazard impacts.			
Reduce dune height by re-profiling	This option may be appropriate for beaches where there has been a significant increase in dune height, resulting in steep scarps after storm events which do not recover readily (for example at Towradgi, City and Port Kembla beaches). This option would result in the destruction or removal of vegetation over a substantial area of the dune system; therefore this management option requires a Review of Environmental Factors. Prior to undertaking the work, a detailed plan would need to be prepared that outlines the specifications (the profile and angle of repose that would achieve the desired objectives whilst not exacerbating the coastal hazard risks). Following the re-profiling of the selected area, the nominated low lying plant species should be planted to ensure that the dune is stabilised. Timing of implementation will be dependent on the current beach profile. Beach profiles which	1-3 years	$100,000-$500,000	$10,000-$50,000

Management Action	Description	Time[1]	Approximate Initial Cost[2]	Annual Approximate Maintenance Cost[3]
	are highly eroded when this option is implemented could have increased coastal hazard risks. Therefore, this option would be more appropriate to be undertaken only after a period of beach accretion when the increased volume of sand in the profile can buffer the impact of storms. Consequently, the decision to implement this option would be needed to be informed by monitoring of the beach profile to determine when the conditions are appropriate. This action is short term only and will require ongoing maintenance. Over time, natural wave processes and storm actions may re-shape any alterations made. Further storm events may occur and cause scarping, potentially further inland from the mean high water mark due to the absence of stabilising vegetation. Monitoring would also be required after the re-profiling works are finished, to track changes with time and take corrective action to prevent reversal to the original situation. This option may be suitable for beaches with numerous issues such as line of sight, recreational amenity and poor beach access ways. However, there could be adverse consequences to ecology and coastal hazard impacts.			
Build seawall	A seawall would provide protection from coastal hazards and allow the creation of a wide unvegetated beach for recreational amenity and maintenance of lines of sight. A detailed design would need to be prepared that considers the beach profile, recreational amenity objectives, and off-site impacts. This option would require the attainment of the necessary approvals and permits to remove all vegetation in the area of interest and construct a seawall. Following the construction of the seawall, nominated low lying plant species can be grown to ensure that the area immediately in front of the seawall is stabilised. This option may be a short term solution for beaches with numerous issues such as line of sight, recreational amenity, poor access and pests. However, in the long term, it can result in the loss of the beach itself and the recreational opportunities associated with the beach.	3-5 years	Greater than $500,000	Less than $10,000

Management Action	Description	Time[1]	Approximate Initial Cost[2]	Annual Approximate Maintenance Cost[3]
Management of subspecies of *Acacia longifolia*	At some beaches, much of the wattle growth on dunes is inappropriate in terms of growth habit and height. Beaches where subspecies of *Acacia longifolia* may have already grown to an unsatisfactory height include City, Fairy Meadow, Towradgi, Corrimal, Bellambi, Woonona and Bulli beaches. Problems may also eventuate in the next few years at Stanwell Park, Windang and Port Kembla. Subspecies of *Acacia longifolia* in the management areas will be managed to improve sight lines, reduce monocultures and increase biodiversity. These activities will include removal of dead plants, plants of excessive height and seedlings, and their replacement with appropriate low growing species. Removal of this species should be gradual and should not involve large patches. Ideally, removal should begin from fence lines and track edges, and should always be followed by replanting of lower-growing species. An alternative to removal of this species is to replant lower-growing species within the gaps left by senescent plants. This method would cause fewer disturbances to adjacent vegetation and would be more cost-effective. The replanted gaps should be monitored over at least the next twelve months, in order to ensure survival of the planted seedlings, and to remove wattle seedlings that have recruited from the seedbank. For further detailed information, refer Appendix O. This option will have a beneficial impact on ecology and some impact on pests and vermin.	6-12 months	\$10,000-\$50,000	Less than \$10,000
Additional management of noxious and invasive weed species	This option will involve replacement of weeds with suitable native species. The study area contains at least nine flora species declared as noxious weeds in the Wollongong LGA, as shown in Appendix H. Bitou Bush *Chrysanthemoides monilifera* and Lantana *Lantana camara* are noxious species which are regularly maintained by Council's dune crew. Bridal Creeper *Asparagus*	6-12 months	Less than \$10,000	Less than \$10,000

Management Action	Description	Time[1]	Approximate Initial Cost[2]	Annual Approximate Maintenance Cost[3]
	asparagoides species are probably becoming more invasive in coastal vegetation, and there will be a need to carry out targeted removal. Windang, Port Kembla, Bulli, Woonona, Bellambi, Corrimal and Towradgi are beaches where management action should not be delayed. The most appropriate long-term practice, while clumps are small and scattered, is that plants should be removed prior to flowering, and if removed manually, care should be taken to dig out and remove all tubers. Follow-up management action is essential, in order to remove or re-spray regrowth and seedlings, and to plant suitable native species. There are extensive infestations of environmental weeds throughout the study area and these will require regular management. Species include Turkey Rhubarb *Acetosa sagittata* (most beaches, especially Bulli, Woonona, Corrimal, Port Kembla and Windang), Green Cestrum *Cestrum parqui* (Woonona and Windang) and Mother of Millions *Bryophyllum delagoense* (Towradgi, City, Port Kembla and Windang). Some non-native species are too well-established to consider removal. In particular, Kurnell Curse *Hydrocotyle bonariensis, Gazania rigens* and Seablight *Cakile maritima* and *Cakile edentula* may even be beneficial, because of their ability to colonise in the foredune. For further detailed information, refer Appendix O. This option will have a beneficial impact on ecology and some impact on pests and vermin.			
Maintain current management	Continue undertaking dune management actions as per legislative and regulatory requirements at each beach. Some of these standard tasks include the following: • Weed removal, • Maintenance of vegetation on access paths, • General maintenance, • Revegetation,	Immediate	Portion of the currently allocated funds	Portion of the currently allocated funds

Management Action	Description	Time[1]	Approximate Initial Cost[2]	Annual Approximate Maintenance Cost[3]
	• Repair of fences, • Any identified emergency management, and • Renewal/maintenance of assets. Current viewing areas can also be modified slightly. This option would be ideal for beaches that have minimal sight line/recreational/ecological issues.			

[1] Time – This provides an indicative account of the total time taken to obtain the necessary approvals, design, build and implement (where appropriate) each management option. It does not consider time taken to obtain funding. Categories are: less than 6 months; 6-12 months; 1-3 years; 3-5 years.

[2] Approximate initial cost – Cost would vary greatly depending on beach, therefore indicative costs have been provided in the following categories: less than $10,000; $10,000-$50,000; $50,000-$100,000; $100,000-$500,000, greater than $500,000. Note - more accurate costs were available for the tower as this cost\s had already been investigated by Council.

[3] Annual approximate maintenance cost – yearly maintenance cost for the first five years.

7.2 Management Options – Approval Pathways

Section 3 outlines the legislation and policy framework within which dune management activities must be carried out. This section presents approval pathways identified by Council that could be applied to each of the shortlisted management options in section 7.1.

In many cases, assessment of the potential impacts of the management options will be carried out under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). A Part 5 assessment requires Council to carry out a Review of Environmental Factors (REF) assessing the potential environmental impacts of the activities, taking into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of that activity (section 111 of the EP&A Act and Clause 228 of the *Environmental Planning & Assessment Regulations 2000*).

The assessment process for each management option will also need to include:

- obtaining owners consent and/or authorisation for use of Crown land for any activities on Crown land (which will ensure activities are consistent with the principles of Crown land management),
- ensuring activities comply with the objectives of the community land classification and any relevant Plan of Management,
- ensuring activities comply with the Local Environmental Plan zoning, heritage requirements and Clause 5.5 – Development within the coastal zone,
- following the Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW to avoid damage to cultural sites, and
- consideration of the NSW Coastal Policy 1997 and the principles of SEPP 71 Coastal Protection.

Also, if previous revegetation works have been carried out in any of the areas where works are proposed, conditions of any grant funding contributing to those projects should be checked to determine whether conditions relating to future management apply. For example, clearing of land that has been vegetated using grant money from the Southern Rivers Catchment Management Authority is not permitted because those areas are considered to be offset areas in the meaning of a Property Vegetation Plan (PVP).

Planting works have been carried out by state government agencies within the management areas around the SLSCs. Planting activities were intended to stabilise sand movements, and build sand dunes to provide protection to built assets. While these activities did not involve a binding agreement for ongoing maintenance by Council, consideration should be given to the reason the vegetation was established in that location in the first place, and the potential consequences of removing the vegetation.

7.2.1 Maintain current management

Continuing current management activities at beaches that have minimal sight line, recreational and ecological issues will in some cases be carried out under the existing REF for dune management activities (Council REF00761).

Division 12 of the Infrastructure SEPP allows development for the purpose of landscaping to be carried out by, or on behalf of, Council without consent on a public reserve under the control of or vested in the Council. For land below the mean high water mark, appropriate approvals will be sought from Crown Lands.

Where the management options identified in this strategy are different to the activities covered by the existing REF, a new REF under Part 5 of the EP&A Act will be prepared to determine the potential environmental impacts of the activities.

7.2.2 Raise level of observation area in SLSC

Part 4 of the EP&A Act outlines the development assessment process for a range of developments, including developments such as raising the level of an observation area in a SLSC. Council would need to submit a Development Application, accompanied by a Statement of Environmental Effects (SEE).

As the activity is within the coastal zone, the determination of the Development Application will need to include consideration of the matters identified in Clause 8 of the *State Environmental Planning Policy 71 Coastal Protection* (SEPP 71).

7.2.3 Build a tower

Division 12 of the Infrastructure SEPP allows development for the purpose of a viewing platform (s.65(3)(a)) to be carried out by or on behalf of Council without consent on a public reserve under the control of or vested in the Council. However, a development application is being prepared for the tower that is planned to be installed at Windang Beach due to the complex environmental issues (e.g. bushfire hazard and Aboriginal sites).

A site specific assessment should be undertaken of potential environmental issues at the site to determine if a Development Application is required and an SEE prepared.

If development consent is not required, the potential environmental impacts of the activities must be assessed in an REF, under Part 5 of the EP&A Act.

Should the tower/s be considered to be temporary in nature (e.g. to enable relocation due to storm damage or further accretion of dunes inhibiting sight lines), the SEPP (Temporary Structures) 2007 will also apply. The Temporary Structures SEPP aims to ensure public safety and environmental and heritage protection at sites where temporary structures are erected.

7.2.4 Relocate existing tower

Division 12 of the Infrastructure SEPP allows development for the purpose of a viewing platform (s.65(3)a) to be carried out by or on behalf of Council without consent on a public reserve under the control of or vested in the Council.

A site specific assessment should be undertaken of potential environmental issues at the site to determine if a Development Application is required and an SEE prepared. If consent is not required, the potential environmental impacts of the activities must be assessed in an REF, under Part 5 of the EP&A Act.

As consent is not required, the potential environmental impacts of the activities can be assessed in an REF, under Part 5 of the EP&A Act.

Should the tower/s be considered to be temporary in nature (e.g. to enable relocation due to storm damage or further accretion of dunes inhibiting sight lines), the SEPP (Temporary Structures) 2007 will also apply. The Temporary Structures SEPP aims to ensure public safety and environmental and heritage protection at sites where temporary structures are erected.

7.2.5 Remove trees and shrubs affecting line of sight

Division 12 of the Infrastructure SEPP allows development for the purpose of landscaping to be carried out by, or on behalf of, Council without consent on a public reserve under the control of or vested in the Council. The *Wollongong DCP 2009* exempts Council from requiring approval to lop or remove vegetation.

As consent is not required, the potential environmental impacts of the activities must be assessed in an REF, under Part 5 of the EP&A Act.

7.2.6 Additional management of noxious and invasive weed species

Division 25 of the Infrastructure SEPP allows coastal management activities, including weed management, to be carried out by, or on behalf of, a public authority without consent on any land.

As consent is not required, the potential environmental impacts of the activities must be assessed in an REF, under Part 5 of the EP&A Act.

7.2.7 Remove vegetation from frontal zone

Division 12 of the Infrastructure SEPP allows development for the purpose of landscaping to be carried out by, or on behalf of, Council without consent on a public reserve under the control of or vested in the Council. The *Wollongong DCP 2009* exempts Council from requiring approval to lop or remove vegetation.

As consent is not required, the potential environmental impacts of the activities must be assessed in an REF, under Part 5 of the EP&A Act.

7.2.8 Improve beach access ways

Division 25 of the Infrastructure SEPP allows coastal management activities, including foreshore access ways, to be carried out by, or on behalf of, a public authority without consent on any land.

As consent is not required, the potential environmental impacts of the activities must be assessed in an REF, under Part 5 of the EP&A Act.

7.2.9 Management of subspecies of *Acacia longifolia*

Division 12 of the Infrastructure SEPP allows development for the purpose of landscaping to be carried out by, or on behalf of, Council without consent on a public reserve under the control of or vested in the Council. The *Wollongong DCP 2009* exempts Council from requiring approval to lop or remove vegetation.

As consent is not required, the potential environmental impacts of the activities must be assessed in an REF, under Part 5 of the EP&A Act.

7.2.10 Reduce dune height by re-profiling

Division 12 of the Infrastructure SEPP allows development for the purpose of landscaping and environmental management works to be carried out by, or on behalf of, Council without consent on a public reserve under the control of or vested in the Council. Dune reshaping, along with vegetation removal and replanting, is considered to fall within the definition of ‘landscaping’ and/or ‘environmental management works’ in the Infrastructure SEPP.

This approach is supported by precedents set by other councils, which have carried out dune reshaping works under EP&A Act Part 5 assessments via the Infrastructure SEPP.

As consent is not required, the potential environmental impacts of the activities must be assessed in an REF, under Part 5 of the EP&A Act.

7.2.11 Build seawall

Section 129A of the Infrastructure SEPP allows development for the purposes of a seawall to be carried out by any person with consent on the open coast. Therefore, a Development Application would be required for the construction of a seawall.

If a Coastal Zone Management Plan (CZMP) does not apply to the land on which any such development is to be carried out, the Coastal Panel has the function of determining the development application for the seawall.

The CZMP for the Wollongong coastline is currently in draft form. Should the CZMP be adopted by Council, Council would become the consent authority for a development application to build a seawall.

In considering the Development Application, the consent authority (either the Coastal Panel or Council) would need to address the provisions of the CZMP and the matters set out in clause 8 of SEPP 71 (Coastal Protection), including:

- The aim to protect and preserve beach environments and beach amenity,
- The aim to protect and improve existing public access to and along coastal foreshores to the extent that this is compatible with the natural attributes of the coastal foreshore,
- The aim to encourage a strategic approach to coastal management,
- Consideration of the likely impact of coastal processes and coastal hazards on the development - and any likely impacts of the development on coastal processes and coastal hazards, and
- Consideration of the suitability of development given its type, location and design and its relationship with the surrounding area.

A permit under Part 7 of the *Fisheries Management Act 1994* (FM Act) may also be required. Applications for permits are considered by the Department of Primary Industries in reference to the objectives of the FM Act and the *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation 1999*.

As the activity is within the coastal zone, the determination of the Development Application will need to include consideration of the matters identified in Clause 8 of the *State Environmental Planning Policy 71 Coastal Protection* (SEPP 71). Seawalls are considered to be ‘significant coastal development’ under SEPP 71, as they extend below the mean high water mark. Therefore, Council is required to submit the Development Application to the Executive Officer of the Office of Environment and Heritage and take into account any additional matters specified by the Executive Officer when determining the application.

8. Multi-Criteria Analysis

This section details the results from the multi-criteria analysis that was carried out as detailed in section 2.7.

8.1 Establishing Criteria / Functional Objectives

Prior to scoring the management options, criteria were required to be developed. Based on consultation with Council and data gathered from stakeholder consultations, the following criteria were developed. These have been categorised as summarised in Table 11.

Table 11 Assessment Criteria

Social/Safety	Coastal/Safety	Environmental
Beach Access	Coastal Hazard Impacts	Ecology
Recreational Amenity	Sight Lines	Pest Animals and Vermin

The definition and scoring conditions for the above criteria are presented below:

Table 12 Criteria Definitions

Ref	Criteria	Definition
A	Sight Lines	Impact on line of sight within patrolled areas for lifeguards and lifesavers monitoring activities on the swimming beaches.
B	Beach Access	Impact on beach access ways, including width, grade and structures. This addresses improved access for the general public and rescue equipment and vehicles.
C	Recreational Amenity	Impact on the usable width of sandy beach above high tide mark and the frequency and severity of scarping.
D	Coastal Hazard Impacts	Impacts on coastal hazard risk relating to undermining of assets and infrastructure, or loss of beach in the long term.
E	Ecology	Impact on biodiversity and habitat for native and threatened species.
F	Pest Animals and Vermin	Impact on abundance of pest animals and vermin.

8.2 Weighting of Criteria

Using the methodology described in section 2.7.2 each criterion was compared against each other to determine the relative importance and their weighting in consultation with Council. This is shown in Figure 32.

PRIORITISING MATRIX

	B	C	D	E	F			A	B	C	D	E	F
A	2A	1A	1A	3A	3A		10	10					
	B	1C	1D	2B	3B		7		5	1	1		
		C	1D	3C	3C		7			6	1		
			D	3D	3D		6				6		
				E	2E		2					2	
						Total	32	10	5	7	8	2	0
							32						

CRITERIA

A	Sight line
B	Beach access
C	Recreational amenity
D	Coastal hazards impacts
E	Ecology
F	Pests and vermin

Scores and Weighting of Criteria

Functional Objectives		Score	Weighted Score	Rank
A	Sight line	10	3.13	1
B	Beach access	5	1.56	4
C	Recreational amenity	7	2.19	3
D	Coastal hazards impacts	8	2.50	2
E	Ecology	2	0.63	5
F	Pests and vermin	0	0.00	6
TOTAL		32	10.00	

Figure 32 Weighting of Criteria

For example, criterion A, Sight line, is rated as more important than B, Beach access, and was given 2 points (2A). Similarly criterion C, Recreational amenity is rated only slightly more important than B, so 1 point would have been allocated for C. This process was continued for the reminder of the combinations.

The weightings suggest that line of sight, impacts on coastal hazards and impact on recreational amenity will govern the MCA analysis.

8.3 Ranking of Options

Using the methodology described in section 2.7.3. The following evaluation matrix in Table 13 was adopted to score each of the management options against the criteria:

Table 13 Dune Management Evaluation Matrix Scoring Definitions

Ref	Criteria	Description	Score of 3	Score of 2	Score of 1	Score of 0	Score of -1	Score of -2	Score of -3
A	Sight Lines	Impact on line of sight within patrolled areas for lifeguards and lifesavers monitoring activities on the swimming beaches.	Large Improvement Line of sight a major issue and action results in achieving full line of sight for a prolonged period, e.g. considerable increase in observation level of club or tower.	Medium Improvement Line of sight a major issue and action results in partial achievement of line of sight or full line of sight for some years, e.g. when vegetation growth or increasing dune height can cause problems again.	Small Improvement Line of sight a major issue however action results in minor improvement, e.g. achievement over a relatively short period, such as with vegetation pruning.	No Change No discernible change.	Small Deterioration A small loss in line of sight however does not become a major issue.	Medium Deterioration Line of sight a major issue and action results in partial blockage of line of sight.	Large Deterioration Line of sight a major issue and action results in total blockage.
B	Beach Access	Impact on beach access ways, including width, grade and structures. This addresses improved access for the general public and rescue equipment and vehicles.	Large Improvement Beach access a major issue and action is specifically targeting issue, e.g. when specifically allocating resources for this issue.	Medium Improvement Beach access a major issue and actions can indirectly improve access, such as re-profiling or vegetation removal from frontal zone.	Small Improvement Beach access not a major issue however action can potentially result in minor improvements in access.	No Change No discernible change.	Small Deterioration A small deterioration however does not become a major issue.	Medium Deterioration Beach access a major issue and action results in substantial deterioration of access ways.	Large Deterioration Beach access a major issue and action results in complete blockage of beach access ways.
C	Recreational Amenity	Impact on the usable width of sandy beach above high tide mark and the frequency and severity of scarping.	Large Improvement Recreational amenity a major issue and action ensures a wide beach and low scarps in the foreseeable future,	Medium Improvement Recreational amenity a major issue and action will result in increase in beach width and reduction in	Small Improvement Recreational amenity not a major issue however action can potentially result in minor	No Change No discernible change.	Small Deterioration A small loss in recreational amenity that does not become a major issue.	Medium Deterioration Loss of further beach width and more steep scarps that cause more community concern.	Large Deterioration Beach becomes totally unusable in the long term, e.g. vegetation all the way up to waterline or loss of beach.

			e.g. regular re-profiling and sand nourishment.	scarping severity, e.g. re-profiling and occasional maintenance works.	improvements.				
D	Coastal Hazard Impacts	Impacts on coastal hazard risk relating to undermining of assets and infrastructure, or loss of beach in the long term.	Large Reduction Distance between assets and infrastructure and the hazard lines increases by more than 20m, e.g. through asset relocation or beach nourishment.	Medium Reduction Distance between assets and infrastructure and the hazard lines increases by 10 to 20m, e.g. through asset relocation or beach nourishment.	Small Reduction Distance between assets and infrastructure and the hazard lines increases by up to 10m, e.g. through asset relocation or beach nourishment.	No Change No discernible change or distance between assets and infrastructure decreases however is more than 50m.	Small Increase Distance between assets and infrastructure and the hazard lines decreases and is between 20 and 50m.	Medium Increase Distance between assets and infrastructure and the hazard lines decreases and is between 10 and 20m of infrastructure and assets.	Large Increase Distance between assets and infrastructure and the hazard lines decreases to less than 10m and/or loss of beach in the long term.
E	Ecology	Impact on biodiversity and habitat for native and threatened species.	Large Improvement Eradication of all vegetation not suitable for a dune environment and replacement with appropriate native species.	Medium Improvement Eradication of weeds and non-native species and replacement with appropriate native species.	Small Improvement Eradication of monoculture of subspecies of *Acacia longifolia* and replacement with a more diverse range of appropriate native species.	No Change No discernible change.	Small Deterioration Clearing around the footprint of a structure to be built, such as a tower, or within line of sight.	Medium Deterioration Loss of more than 1/3 of the beach vegetation in the management zone.	Large Deterioration Loss of most of the existing vegetation from the dunes, e.g. would happen with re-profiling the dunes.
F	Pest animals and vermin	Impact on abundance of pest animals and vermin.	Large Improvement Action directly addresses this issue and results in significant removal of pest animals and vermin.	Medium Improvement Action results in considerable removal of pest animals and vermin.	Small Improvement Action can lead to a small decrease in pest animals and vermin.	No Change No discernible change.	Small Deterioration Action can lead to a small increase in pest animals and vermin.	Medium Deterioration Action can result in considerable increase in pest animals and vermin.	Large Deterioration Action can result in significant increase in pest animals and vermin.

Based on the scoring scales developed, scores for each individual management option were assigned against the above criteria for all beaches where that management option was relevant. It is important to note that where applicable, the scores were assigned on a relative to each option at each beach basis rather than absolute. The highest score was the best option for that particular beach. Details of the scoring for each beach are available in Appendix P.

Note that cost and time were not considered in this analysis on the basis that it was to be investigated in future stages as required

8.4 Results

The ranking of the management options that can provide benefit over current management in addressing one or more of the issues identified for each beach is presented below. Where combined options appeared viable, these were reassessed in the MCA. Note that only options with positive scores are ranked below. Building a seawall received an overall negative score.

It is important to note that there may be heightened risk to coastal hazard impacts associated with re-profiling for the two following management options, remove vegetation from the frontal zone (depending on extent of removal and re-profiling), and reduce dune height by re-profiling. Accordingly, the potential impacts of these management options would need to be considered prior to implementing either of these as a preferred management option.

8.4.1 Stanwell Park

No key issues were identified for this beach at the time of this study. However, the management options that can provide benefit over current management are listed below.

Table 14 MCA Results for Stanwell Park

Rank	Management Option	Score
1	Additional management of noxious and invasive weed species	1.25
2	Management of subspecies of *Acacia longifolia*	0.63
3	Maintain current management	0

Sight line, beach access or recreational amenity was not a significant issue at this beach. However, the vegetation survey (Appendix F) recorded a range of weeds and occasional subspecies of *Acacia longifolia* that require ongoing management.

8.4.1 Coalcliff

No key issues were identified for this beach at the time of this study. However, the management options that can provide benefit over current management are listed below.

Table 15 MCA Results for Coalcliff

Rank	Management Option	Score
1	Additional management of noxious and invasive weed species	1.25
2	Management of subspecies of *Acacia longifolia*	0.63
3	Maintain current management	0

Sight line, beach access or recreational amenity was not a significant issue at this beach. However, the vegetation survey (Appendix F) recorded a range of weeds and occasional subspecies of *Acacia longifolia* that require ongoing management.

8.4.2 Scarborough

No key issues were identified for this beach at the time of this study. However, the management options that can provide benefit over current management are listed below.

Table 16 MCA Results for Scarborough

Rank	Management Option	Score
1	Additional management of noxious and invasive weed species	1.25
2	Management of subspecies of *Acacia longifolia*	0.63
3	Maintain current management	0

Sight line, beach access or recreational amenity was not a significant issue at this beach. However, the vegetation survey (Appendix F) recorded a range of weeds and occasional subspecies of *Acacia longifolia* that require ongoing management.

8.4.3 Coledale

No key issues were identified for this beach at the time of this study. However, the management options that can provide benefit over current management are listed below.

Table 17 MCA Results for Coledale

Rank	Management Option	Score
1	Additional management of noxious and invasive weed species	1.25
2	Management of subspecies of *Acacia longifolia*	0.63
3	Maintain current management	0

Sight line, beach access or recreational amenity was not a significant issue at this beach. However, the vegetation survey (Appendix F) recorded a range of weeds and occasional subspecies of *Acacia longifolia* that require ongoing management. Furthermore, from the information gathered, it is noted that a patrol tower is scheduled to be constructed within the next year to replace the temporary shed currently being used by Council lifeguards.

8.4.4 Austinmer

No key issues were identified for this beach at the time of this study, therefore no additional management options are required (Table 18). There is no dune vegetation, however a seawall exists at the back of this beach. It is noted that a Norfolk Island Pine tree is located directly in front of the lifeguard viewing area in the SLSC building. However, Council is currently in the process of designing a new lifeguard viewing facility which will be located at the northern end of the beach.

Table 18 MCA Results for Austinmer

Rank	Management Option	Score
1	Maintain current management	0

8.4.5 Thirroul

No key issues were identified for this beach at the time of this study, therefore no additional management options are required (Table 19). There is no dune vegetation, however a seawall exists at the back of the beach.

Table 19 MCA Results for Thirroul

Rank	Management Option	Score
1	Maintain current management	0

8.4.6 Sandon Point

No key issues were identified at this beach at the time of this study. However, the management options that can provide benefit over current management are listed below.

Table 20 MCA Results for Sandon Point

Rank	Management Option	Score
1	Additional management of noxious and invasive weed species	1.25
2	Management of subspecies of *Acacia longifolia*	0.63
3	Maintain current management	0

Sight line, beach access or recreational amenity was not a significant issue at this beach. However, the vegetation survey (Appendix F) recorded a range of weeds and occasional subspecies of *Acacia longifolia* that require ongoing management.

8.4.7 Bulli

Bulli had moderate sight line, moderate beach access and moderate recreational amenity issues. The following management options were determined to be suitable at this beach (Table 21). Note that combinations of two management options were also assessed for this beach to determine if combined options were more suitable than single options.

Table 21 MCA Results for Bulli

Rank	Management Option	Score
1	Build a tower	8.75
2	Build a tower and remove vegetation from frontal zone	6.56
3	Raise level of observation area in SLSC	6.25
4	Reduce dune height by re-profiling	4.38
5	Improve beach access ways	4.06
6	Management of subspecies of *Acacia longifolia*	3.75
7	Raise level of observation area in SLSC and remove vegetation from frontal zone	3.44
8	Remove trees and shrubs affecting line of sight	2.5

Rank	Management Option	Score
9	Additional management of noxious and invasive weed species	1.25
10	Remove vegetation from frontal zone	0.31
11	Maintain current management	0

‘Build a tower’ was ranked the highest option for this beach as although it only addresses the sight line issue it has no impact on coastal hazard risk and only a minor negative impact on ecology. The second option ‘build a tower and remove vegetation from frontal zone’ would address issues of sight line and recreational amenity, and beach access to a lesser extent, however receives a lower score as it increases the risks of impacts from coastal hazards. This option would require further beach profile monitoring and hazard studies to determine if and when this option could be undertaken without placing infrastructure at risk.

‘Raising the level of the observation area in the SLSC’ without any associated dune or vegetation changes was not considered to have as great an impact in improving sight line as building a tower, as the SLSC is located further back from the shoreline.

An option not considered as part of this beach assessment was:

- Relocate existing tower – there is no existing tower.

8.4.8 Woonona

Woonona had moderate beach access and moderate recreational amenity issues. Sight line issues were severe from the SLSC and moderate from the tower. The following management options were determined to be suitable at this beach (Table 22). Note that combinations of two management options were also assessed for this beach to determine if combined options were more suitable than single options.

Table 22 MCA Results for Woonona

Rank	Management Option	Score
1	Relocate existing tower and remove vegetation from frontal zone	11.56
2	Relocate existing tower	8.75
3	Raise level of observation area in SLSC and remove vegetation from frontal zone	8.44
4	Raise level of observation area in SLSC	6.25
5	Remove vegetation from frontal zone	5.31
5	Reduce dune height by re-profiling	5.31
7	Remove trees and shrubs affecting line of sight	5
8	Improve beach access ways	4.06
9	Management of subspecies of *Acacia longifolia*	3.75
10	Additional management of noxious and invasive weed species	1.25

Rank	Management Option	Score
11	Maintain current management	0

The number one ranked option ‘relocate the existing tower and remove vegetation from frontal zone’ would address sight line and recreational amenity, and to a lesser extent beach access, however increases the risk of impacts from coastal hazards. However, at this beach the current erosion hazard line is further seaward of infrastructure than at Bulli, therefore the risk of impacts from coastal hazards is not as high as for Bulli and this is why the top two options for Woonona and Bulli beaches are ranked in different orders, although the beaches have similar issues.

The third ranked option ‘raise level of observation area in SLSC and remove vegetation from frontal zone’ would improve sight line but not to the same extent as moving the tower, as the building is set further back from the shoreline.

One option was not considered as part of this beach assessment:

- Build a new tower –there is an existing tower in use.

8.4.9 Bellambi

Bellambi has minor sight line, moderate beach access and minor recreational amenity issues. The following management options were determined to be suitable (Table 23). Note that combinations of two management options were also assessed for this beach to determine if combined options were more suitable than single options.

Table 23 MCA Results for Bellambi

Rank	Management Option	Score
1	Build a tower and remove vegetation from frontal zone	12.50
1	Raise level of observation area in SLSC and remove vegetation from frontal zone	12.50
3	Reduce dune height by re-profiling	11.88
4	Raise level of observation area in SLSC	9.38
5	Build a tower	8.75
6	Remove vegetation from frontal zone	6.25
7	Improve beach access ways	4.06
8	Management of subspecies of *Acacia longifolia*	3.75
9	Remove trees and shrubs affecting line of sight	1.88
10	Additional management of noxious and invasive weed species	1.25
11	Maintain current management	0

The highest ranked options were ‘build a tower and remove vegetation from frontal zone’ and ‘raise level of observation area in SLSC and remove vegetation from frontal zone’. These options would address the issues of sight line, recreational amenity and beach access. At this beach the option of ‘raise level of observation area in SLSC’ is suggesting that Council lifeguards could relocate upstairs for their patrol purposes, should it be deemed viable. This option would result in minimal cost implications and can be implemented immediately once an external staircase has been built. Furthermore, although building a new tower is considered an option for this beach, vandalism has been an issue in the past and would need to be considered during the design.

'Reduce dune height by re-profiling' was ranked third as it also addresses sight line, recreational amenity and beach access. However, for this option the criterion 'improvement to sight line', received a lower score relative to other high scored options in recognition that the dune could accrete over time. At this beach, the current erosion hazard line is located reasonably seaward of infrastructure, and there was sufficient accretion of the dune at the time of study to allow re-profiling works without causing any significant change to the hazard line.

One option was not considered as part of this beach assessment:

- Relocate existing tower – there is no existing tower.

8.4.10 Corrimal

Corrimal has minor sight line, minor beach access and minor recreational amenity issues. The following management options were determined to be suitable at this beach (Table 24). Note that combinations of two management options were also assessed for this beach to determine if combined options were more suitable than single options.

Table 24 MCA Results for Corrimal

Rank	Management Option	Score
1	Relocate existing tower and remove vegetation from frontal zone	15.63
2	Reduce dune height by re-profiling	11.88
3	Remove vegetation from frontal zone	9.38
4	Relocate existing tower	8.75
5	Management of subspecies of *Acacia longifolia*	4.38
6	Improve beach access ways	4.06
7	Remove trees and shrubs affecting line of sight	1.88
8	Additional management of noxious and invasive weed species	1.25
9	Maintain current management	0

The highest ranked option 'relocate existing tower and remove vegetation from frontal zone' would address sight line, recreational amenity and beach access, although there would be a negative impact on ecology.

The second option 'reduce dune height by re-profiling' would address the sight line, beach access and recreational amenity, although there would be a more negative impact on ecology. For this option the criterion 'improvement to sight line', received a lower score compared to the option of relocating the tower in recognition that the dune could accrete over time.

At this beach, the current erosion hazard line is a reasonable distance seaward of infrastructure, and there was sufficient accretion of the dunes at the time of the study to allow re-profiling works to be carried out without any significant change to the risk of impacts from coastal hazards.

The third option 'remove vegetation from frontal zone' would address the same issues, however would have less of an impact on line of sight.

Options not considered as part of this beach assessment were:

- Raise level of observation area in SLSC – patrols not undertaken from SLSC and the building is a considerable distance back from the beach, and
- Build a new tower – there is an existing tower in use.

8.4.11 Towradgi

Towradgi has severe sight line, moderate beach access and severe recreational amenity issues. The following management options were determined to be suitable at this beach (Table 25). Note combination/s of two management options were also assessed for this beach to determine if combined options were more suitable than single options.

Table 25 MCA Results for Towradgi

Rank	Management Option	Score
1	Build a tower and remove vegetation from frontal zone	10.63
2	Build a tower	8.75
3	Reduce dune height by re-profiling	4.38
3	Remove vegetation from frontal zone	4.38
5	Improve beach access ways	4.06
6	Management of subspecies of *Acacia longifolia*	3.75
7	Remove trees and shrubs affecting line of sight	2.5
8	Additional management of noxious and invasive weed species	1.25
9	Maintain current management	0

'Build a tower and remove vegetation from frontal zone' would address sight line, beach access and recreational amenity, however would increase the risk of impacts from coastal hazards, and have a negative impact on ecology. The second option of 'build a tower' would address only the sight line; however the risk of impact from coastal hazards would remain unchanged and there would be less of an impact on ecology.

'Reduce dune height by re-profiling' and 'remove vegetation from frontal zone' received the same overall score. Although 'reduce dune height by re-profiling' would provide a greater improvement in line of sight, it would also have a higher risk of impacts from coastal hazards. Note that the dune could also accrete over time. Under the conditions current at the time of the study, this option could not be undertaken without placing infrastructure at greater risk. Further beach profile monitoring and hazard studies would be required to determine if and when this option can be implemented.

Two options were not considered as part of this beach assessment:

- Raise level of observation area in SLSC – patrols are not undertaken from SLSC and it is situated back from the beach, and
- Relocate existing tower – the current tower is a permanent structure.

8.4.12 Fairy Meadow

Fairy Meadow has moderate sight line, moderate beach access and moderate recreational amenity issues. The following management options were determined to be suitable at this beach (Table 26). Note combinations of two management options were also assessed for this beach to determine if combined options were more suitable than single options.

Table 26 MCA Results for Fairy Meadow

Rank	Management Option	Score
1	Relocate existing tower and remove vegetation from frontal zone	11.56
2	Reduce dune height by re-profiling	9.38
3	Relocate existing tower	8.75
4	Raise level of observation area in SLSC and remove vegetation from frontal zone	8.44
5	Raise level of observation area in SLSC	6.25
6	Remove vegetation from frontal zone	5.31
7	Improve beach access ways	4.06
8	Management of subspecies of *Acacia longifolia*	3.75
9	Remove trees and shrubs affecting line of sight	1.88
10	Additional management of noxious and invasive weed species	1.25
11	Maintain current management	0

‘Relocate existing tower and remove vegetation from frontal zone’ received the highest overall score as it would address the sight line and recreational amenity and beach access to a lesser extent, without a large increase in the risk of impacts from coastal hazards. The second highest ranked option ‘reduce dune height by re-profiling’ would address the same issues, however may not achieve as great an improvement on sight line (as the dune could accrete over time), and would also have a more negative impact on ecology. At this beach the current erosion hazard line is located reasonably seaward of infrastructure therefore risk of impact from coastal hazards is not as high as at other beaches. The third option ‘relocate the tower’ would only address line of sight, however would have minimal impact on ecology.

One option was not considered as part of this beach assessment:

- Build a new tower – there is an existing tower in use.

8.4.13 North Wollongong

No key issues were identified at this beach at the time of this study, therefore no additional management options are required (Table 27). Parts of the beach are protected by a seawall.

Table 27 MCA Results for North Wollongong

Rank	Management Option	Score
1	Maintain current management	0

8.4.14 City

City Beach has severe sight line, severe beach access and severe recreational amenity issues. The following management options were determined to be suitable at this beach (Table 28). Note that combinations of two management options were also assessed for this beach to determine if combined options were more suitable than single options.

Table 28 MCA Results for City

Rank	Management Option	Score
1	Reduce dune height by re-profiling	5.94
2	Build a tower	5.63
3	Build a tower and remove vegetation from frontal zone	5
4	Improve beach access ways	4.06
5	Management of subspecies of *Acacia longifolia*	3.75
6	Remove vegetation from frontal zone	1.88
7	Additional management of noxious and invasive weed species	1.25
8	Maintain current management	0

'Reduce dune height by re-profiling' received the highest overall score as it would address the sight line, beach access and recreational amenity. However, note the much lower score for this option at this beach compared to some other beaches (e.g. Corrimal and Bellambi). Under conditions current at the time of the study, 'dune re-profiling' and 'removal of vegetation from frontal zone' as management options could not be undertaken without placing infrastructure at much greater risk. These management options may be possible in the future if and when the beach profile changes. This would require ongoing monitoring of the beach profile and further hazard studies.

'Build a tower' would only address sight line, however it is the only one of the top three options that could be implemented under the current conditions.

In addition, also note that implementation of management options at City Beach will need to consider the rubble that was placed under the dunes when the new SLSC building was constructed. Further investigation is required into the nature, depth below the surface and extent of rubble prior to implementing management options that could expose this rubble.

Three options were not considered as part of this beach assessment:

- Raise level of viewing area in SLSC – this is not a viable management option,
- Relocate existing tower – there is no existing tower, and

- Remove trees and shrubs affecting line of sight – this is not a viable management option as sight line was affected by the dune profile.

8.4.15 Port Kembla

Port Kembla has moderate sight line, moderate beach access and moderate recreational amenity issues. Sight line problems are severe from the SLSC but not an issue from the lifeguard tower. The following management options were determined to be suitable at this beach (Table 29). Note that combinations of two management options were also assessed for this beach to determine if combined options were more suitable than single options.

Table 29 MCA Results for Port Kembla

Rank	Management Option	Score
1	Build a tower and remove vegetation from frontal zone	12.50
2	Reduce dune height by re-profiling	11.88
3	Build a tower	8.75
4	Improve beach access ways	4.06
5	Management of subspecies of *Acacia longifolia*	3.75
6	Remove vegetation from frontal zone	3.13
7	Remove trees and shrubs affecting line of sight	1.88
8	Additional management of noxious and invasive weed species	1.25
9	Maintain current management	0

'Build a tower and remove vegetation from frontal zone' received the highest overall score as it would address sight line for the lifesavers (who currently use their club building during inclement weather), as well as recreational amenity and beach access to some extent.

Option two 'reduce dune height by re-profiling' would also address sight line, beach access and recreational amenity. However, for this option the criterion 'improvement to sight line' received a lower score compared to the option of building a new tower in recognition that the dune could accrete over time.

Dune re-profiling or removal of frontal vegetation would have negative impacts on ecology, however the increase in risk of impact from coastal hazards was not considered critical, as the infrastructure distance would still be reasonably far away from any new hazard zones.

Option three 'build a tower' would address the sight line for SLSC lifesavers. However, the SLSC lifesavers should consider patrolling from the Council lifeguard observation area at the swimming pool at the northern end of the beach, as this would appear to be a much more cost effective approach. Note that activity at the northern rock reef end may not be visible from this tower.

Two options were not considered as part of this beach assessment:

- Raise level of viewing area in SLSC – this is not a viable management option, and
- Relocate existing tower – there is not a current tower.

8.4.16 Windang

Windang has a sight line issue which is currently being addressed by Council through the design of a new tower. However, other management options that can provide benefit over current management are listed below.

Table 30 MCA Results for Windang

Rank	Management Option	Score
1	Management of subspecies of *Acacia longifolia*	3.75
2	Additional management of noxious and invasive weed species	1.25
3	Maintain current management	0

The vegetation survey (Appendix F) recorded a range of weeds and occasional subspecies of *Acacia longifolia* that require ongoing management.

8.5 Highest Ranked Options for the Beaches

8.5.1 Options Appropriate for all Beaches

The management options considered beneficial for most of the northern beaches with no key issues are:

- Continuation of current management actions,
- Management of subspecies of Acacia longifolia, and
- Additional management of noxious and invasive weed species.

These options would not require a large financial outlay, and they may also be implemented at other beaches as well to further improve the outcomes at those locations.

In addition to the above, other actions that would add value to the implementation of this Strategy are the implementation of a community engagement program, and a beach and dune monitoring program.

Community Engagement Program

Some of the comments provided through the community survey and stakeholder engagement program for this study illustrate the existence of widespread misconceptions regarding the coastal processes at work in the beach and dune environment, and the potential impact of intervention actions. This could result in unrealistic expectations from the implementation of this management strategy. A community engagement program will assist in addressing this issue. This could take a variety of forms ranging from communicating knowledge about the local beaches, to involving the community in monitoring and data gathering.

Beach and Dune Monitoring Program

A beach and dune monitoring program to detect the environmental and other factors influencing the beach and dune profile changes is highly recommended. It will not only assist in improving the understanding of the behaviour of the Wollongong beaches, but will also help determine how effective any management action is and when and what corrective action may be necessary. Beach and dune characteristics change over varying timeframes. Therefore, the monitoring frequency should be adjusted to capture the dynamic nature of the beaches and dunes.

The implementation of this Strategy will not guarantee that there will be no further occurrence of scarping at the local beaches. Scarping is a natural response to storm waves and its extent is dependent on the characteristics of the beach environment and the energy and direction of the storm waves. While the characteristics of the beach environment can be manipulated to some degree, controlling the storm energy impacting on the beaches is a lot more challenging. Therefore, there will be occasions when scarping is experienced and the scarps will need a management response. On these occasions, the implementation of the Coastal Erosion Emergency Action Sub Plan prepared for the Draft Wollongong Coastal Zone Management Plan, may be useful. A copy of this plan is included in Appendix Q.

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8.5.2 Beach-specific Management Options

Beaches with at least one key issue as per Table 9 have been extracted and the top three (up to) management options from the MCA analysis for each beach are presented below, with beaches listed in order from north to south.

Based on the severity analysis, Wollongong City and Towradgi are the beaches with the most severe key issues. The table can be used by Council as a framework tool to determine the beaches that can be improved for the upcoming swimming seasons based on the available time, funding and approvals.

Table 31 Beach-specific management options (sorted from north to south)

Beach	Management Option	Sight Line		Recreational Amenity		Beach Access		Approximate initial cost*	Total Time to Implement ^	Implementation constraints #
		Severity	Issue addressed	Severity	Issue addressed	Severity	Issue addressed			
Bulli	Build a tower		Yes		No		No	$150,000	1-3 years	
	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000	1-3 years	Risk of impacts from coastal hazards currently high. Further site investigations (e.g. structural integrity of buried seawall) and on-going monitoring required to inform timing for implementation.
	Raise level of observation area in SLSC		Yes		No		No	$100,000-$500,000	1-3 years	
Woonona	Relocate existing tower and remove vegetation from frontal zone		Yes		Yes		Yes	$10,000-$50,000 and $50,000-$100,000	6-12 months	
	Relocate existing tower		Yes		No		No	$10,000-$50,000	6-12 months	
	Raise level of observation area in SLSC and remove vegetation from frontal zone		Yes		Yes		Yes	$100,000-$500,000	1-3 years	
Bellambi	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000	1-3 years	
	Raise level of observation area in SLSC and remove vegetation from frontal zone		Yes		Yes		Yes	$10,000-$50,000 (at this site the option means relocate to the first floor, no extension) and $50,000-$100,000	6-12 months	
	Reduce dune height by re-profiling		Yes		Yes		Yes	$100,000-$500,000	1-3 years	
Corrimal	Relocate existing tower and remove vegetation from frontal zone		Yes		Yes		Yes	$10,000-$50,000 and $50,000-$100,000	6-12 months	
	Reduce dune height by re-profiling		Yes		Yes		Yes	$100,000-$500,000	1-3 years	
	Remove vegetation from frontal zone		Yes		Yes		Yes	$50,000-$100,000	6-12 months	
Towradgi	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000.	1-3 years	Risk of impacts from coastal hazards currently high. On-going monitoring required to inform timing for implementation.
	Build a tower		Yes		No		No	$150,000	1-3 years	
	Reduce dune height by re-profiling		Yes		Yes		Yes	$100,000-$500,000	1-3 years	Risk of impacts from coastal hazards currently high. On-going monitoring required to inform timing for implementation.
	Remove vegetation from frontal zone		Yes		Yes		Yes	$50,000-$100,000	6-12 months	
Fairy Meadow	Relocate existing tower and remove vegetation from frontal zone		Yes		Yes		Yes	$10,000-$50,000 and $50,000-$100,000	6-12 months	
	Reduce dune height by re-profiling		Yes		Yes		Yes	$100,000-$500,000	1-3 years	
	Relocate existing tower		Yes		No		No	$10,000-$50,000	6-12 months	
Wollongong City	Reduce dune height by re-profiling		Yes		Yes		Yes	$100,000-$500,000	1-3 years	Risk of impacts from coastal hazards currently high. On-going monitoring required to inform timing for implementation.
	Build a tower		Yes		No		No	$150,000	1-3 years	
	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000.	1-3 years	Risk of impacts from coastal hazards currently high. On-going monitoring required to inform

Beach	Management Option	Sight Line		Recreational Amenity		Beach Access		Approximate initial cost*	Total Time to Implement ^	Implementation constraints #
		Severity	Issue addressed	Severity	Issue addressed	Severity	Issue addressed			
										timing for implementation.
Port Kembla	Build a tower and remove vegetation from frontal zone		Yes		Yes		Yes	$150,000 and $50,000-$100,000	1-3 years	Build a tower and remove vegetation from frontal zone
	Reduce dune height by re-profiling		Yes		Yes		Yes	$100,000-$500,000	1-3 years	Reduce dune height by re-profiling
	Build a tower		Yes		No		No	$150,000	1-3 years	Build a tower

Note. Severity scales for issues Severe Moderate Minor Nil

At Woonona the sight line issue is moderate from the tower and severe from the surf club. At Port Kembla the sight line issue is nil from the tower and severe from the surf club.

*Indicative cost.

^Subject to approvals and funding.

Implementation Constraints refers to a preliminary investigation of the current (based on beach profiles in March 2013) hazard line and its distance from infrastructure and calculation of potential beach volume change from re-profiling and impacts on the hazard line. A risk is noted only where the score was -2 or -3 for coastal hazard impacts based on scoring matrix definitions in Section 8.3.

9. Conclusion

9.1 General

The purpose of this study was to prepare a Dune Management Strategy for parts of the 17 patrolled swimming beaches along the Wollongong LGA coastline with a focus on the high usage areas in the vicinity of the SLSC as identified by Council. This was done in consultation with the identified key stakeholders and Council to understand the issues. Following this, suitable assessment criteria and management options were developed which were analysed in an MCA. The output of the study is a decision support framework for implementation of the management options by Council.

9.2 Effectiveness of the Approach

The approach adopted for this strategy allowed for comprehensive engagement with the stakeholders and community throughout the process. Along with detailed site assessments, care was taken to integrate issues and options raised during the engagement process in the MCA process and allowed for the identification of the most suitable management options for each of the 17 beaches.

9.3 Future Implementation of the Dune Management Strategy

Based on Council's approach to implement this decision support framework, the following steps may be required to be undertaken prior to implementation:

- a cost-benefit analysis to determine which options can be implemented and when,
- environmental assessment of proposed works,
- development approval for each management option to be implemented (where relevant), and
- generation of detailed designs prior to tendering for construction/implementation of the management options.

The management options are a combination of short term, medium term and long term approaches which will need to be monitored regularly (e.g. annually). Evaluation requirements could include monitoring of how effective the management options have been (once implemented) in addressing the key issues over the various timeframes (i.e. short term, medium term and long term). Depending on the success of the monitoring undertaken, the Strategy should be reviewed and updated regularly (e.g. in the medium term – 3 to 5 years).

Accordingly, the decision support framework presented here may be utilised as a tool to inform decisions by Council on which management options will be implemented and when in order to meet the objectives of the 17 patrolled swimming beaches in the Wollongong LGA.

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Appendix A – Summary of comments received from stakeholders

A summary of the issues raised by the community during various consultation activities. These comments include those received via email and letter correspondence, as well as through the facilitated stakeholder meetings held early in the process.

It should be noted that consultation also occurred on the management options for the Wollongong Dunes in the form of an interactive discussion at the stakeholder workshops held in December 2012. These management options fell under the broad headings of; maintain current management actions, manage vegetation, reshape dunes, structural solutions, education, improved ongoing maintenance of dunes and other. The input received from the community and stakeholder consultation was used to form the long list of options.

Issue	Sub-categories	
Safety	Beach erosion / Scarping (Scarping or erosion caused by storm events, stormwater flow, changed wave conditions and high tide activity. Scarping caused by *Acacia* spp.)	• Vegetation roots in dunes form steep scarps after large storms have eroded away the base of the scarp. By preventing the dune from collapsing, these roots hinder the formation of a gradual wind profile, necessary for the beach to repair its damage. • Woonona, Bulli and Wollongong City Beaches are high risk beaches and require management of the scarping dunes. There is a risk that children may tunnel into the face of the dunes and this could make it collapse (fatality risk). • Coastal Dune system erosion at Woonona Beach is at extreme levels now. The Coastal Zone Management Plan states in matrix 6.11.2 'Treatment Options' that nothing should be done which the club concedes is unacceptable. The extreme beach erosion needs to be controlled by removing the vegetation as far back as the original containment fence. • Council should consider pro-active management of beaches and coastal dunes to maximise the volume of sand in front of existing development to protect the shoreline especially where existing council assets exist (e.g. cycle ways). • A detailed risk assessment should be undertaken on a site specific basis. Future shoreline recession as a result of sea level rise in the CZMP is questionable. • Most beaches identified in the Public Safety Risk Assessment report have suffered erosion as a result of storm events and wave action. As a result there is a scarp affecting some parts of the beaches. There are stormwater outlets where runoff is also causing a scarp. This has a high risk factor in relation to collapse and falls. This may affect walkers and children that may dig into the walls of the scarp. Temporary signage, barriers and surveillance could help to manage these

Issue	Sub-categories	
		issues for the time being. More sustainable and effective mitigation measures, however, are required.
	Line of sight impediment (Impaired visibility from the 'crow's nest', Surf Life Saving Club (SLSC), tower or other beach facilities)	• Vegetation within 200m either side of a SLSC or Lifesaver 'Crow's Nest' should be lopped to a height of no more than 4ft to improve line of sight down to the water's edge. • Line of sight issues at Towradgi, Bellambi, Windang and Fairy Meadow beaches. The height of the vegetation makes it difficult to view the beach and water line from the observation areas in and around the SLSC clubhouses. • The increased vegetation is causing loss of sight issued for lifesavers and Woonona patrolling members, who cannot watch swimmers from the shelter of the Woonona SLSC during inclement weather. This is similar for all nine beaches with line of sight issues, during the beach season the majority of the patrols by SLSC are undertaken from the shore. Unless they have access to the towers most patrols are moved back to the shelter of the SLSC in inclement weather which is often too far back from the shoreline to be effective. Ideally where towers are present (Woonona, Corrimal, Fairy Meadow, Port Kembla) both WCC Lifeguards and SLSC could share these facilities • Dune vegetation has impacts on the surveillance ability of lifeguards and lifesavers. To address this issue dune management programmes need to ensure that species selected for planting do not adversely impact on the sight lines of emergency services and lifeguards. Species that have been planted should be regularly monitored to ensure that they are not negatively impacting on the provision of safety and emergency services at a location. • Dune vegetation/surveillance hazard has been identified on Perkins Beach. This is considered to be a very high risk area due to the limited line of sight caused by poor dune vegetation management. • Line of sight issues along the cycle way. • Line of sight issues impacting on kite boarders, particularly in high tide near the launch area. Hazard of kites getting tangled in bushes.

Issue	Sub-categories	
		• Line of sight issues for holiday makers, in particular the caravan parks. • There should be less reliance on the ideas of new towers. • There is no line of sight from Corrimal SLSC. • The tall vegetation needs to be removed to improve the line of sight which should be 100m north and 200m south of the beaches. • The water at high tide mark needs to be visible from the SLSC at all times. • There is no line of sight at the north end of Bulli beach, this needs to be corrected.
	Swimming conditions (Changed shoreline currents causing the formations of strong rips. *Acacia* spp. trapping sand and changing currents causing rips)	• Conditions are dangerous due to the changed shoreline currents. The vegetation makes the safe shoreline gradient non-existent, only deep gutters in their place. • The formations of strong rips, which are not only perilous to people, but accelerate the loss of sand out to sea in the wave zone. • Rips and gullies are occurring which can impact the safety of holiday makers, especially those from the caravan parks.
	Anti-social or Illegal behaviour (Behaviour that disturbs others at the site, such as alcohol and drug use and offensive or intimidating behaviour)	• New towers would encourage vandalism. • Vegetation hides anti-social behaviour such as rape, theft, drugs and homicide.
	Snakes (Presence of snakes posing a threat to safety)	• The excessive vegetation encourages snakes. • Snakes are a cause of concern for nippers.
Vegetation and Ecology	Overgrown vegetation (Specific mention to native or planted vegetation that has encroached beyond the existing fence line or the overgrowing of the beach)	• Request for Council to consider a Vegetation Management Plan. Stakeholder has claimed that the 'out of control' vegetation is one of the most significant contributors to beach erosion. • The forward progression of secondary vegetation towards the shoreline need to be stopped. If the incipient dune becomes over-run by secondary vegetation, the sand which this vegetation

Issue	Sub-categories	
		‘locks up’ is no longer available to aid natural beach repair mechanisms and erosion results. • Concerns surrounding the uncontrolled spread of dune vegetation plants that affect the Lifesaving Club. • The containment fences at Woonona Beach have not been successful in containing the spread of vegetation which is now out of control. This makes the beach space unusable during high tide periods. • City beach is in poor condition because of the shoreward encroachment of vegetation. Vegetation has forces scarping to occur on the front of the beach meaning that sand is always wet and cannot be blown and wave action becomes reflective and erosive. • All vegetation larger than 1m should be removed.
	Dune replanting (Native or planted vegetation that has been introduced or replanted on the dune surfaces. Inappropriate species have been planted and should be replaced by other species)	• All beaches and beach dunes are under ‘high’ or ‘extreme’ risk at the current timeframe, and as such, dune revegetation works need to be given the highest priority. • Dune planting has very serious long-term effects and should be halted immediately. Where the dunes have been planted, the vegetation should be removed or thinned. Wind blow-outs should be left undisturbed. • Dune re-vegetation plants hold the shoreline so tightly that the wave action causes steep shoreline drop-offs. The public is put at risk of being washed into the sea by plunging or surging breaker. High risk for young children. • Dunes do not need to be stabilised.
	Vegetation removal (Existing dune vegetation needs to be removed to leave bare sand)	• Vegetation must be cleared from intertidal zones, a wide beach berm must be maintained, only appropriate beach grasses should be planted on the incipient dune and Council should acknowledge only a narrow width of secondary vegetation to protect land assets from sand blow-outs. • Immediately remove the vegetation back to the original fence. Shape the beach slope at the

Issue	Sub-categories	
		dangerous locations at the beaches in question. • The vegetation should be removed from out the front of the SLSCs. • Reduce the vegetation 250m either side of SLSCs. • The vegetation should be removed south of the bridge at Bellambi. • SLSCs are willing to assist in removing vegetation where needed. • All non-complying vegetation should be removed.
	Acacia sophorae should be removed (Specific mention of the need to remove Coastal Wattle *Acacia sophorae*)	• There should be regular maintenance to protect the dunes. • SLSCs should be involved in the maintenance of the dunes. • All large plants should be removed. • Coastal wattle should be removed.
	Vegetation protecting from erosion/dune stability (The role of vegetation in stabilising the dunes and providing protection from erosion)	• The dunes used to be held together by spinifex and pigface. • Vegetation should be maintained south facing towards Fairy Meadow at Towradgi.
	Education about the role of vegetation and dunes (The community lack of understanding of the positive function of vegetation or natural beach processes)	• Dune vegetation maintenance needs to be conducted in an educated manner by the SLSCs and community groups. • A dune care group should be established for beach maintenance. • Defined management plans should be developed and maintained.

Issue	Sub-categories	
Weeds and Vermin	Weed encroachment (Introduction/encroachment of weed vegetation inhibiting natural beach repair. Weed defined as what the community considered to be a weed i.e. Can include *Acacia sophorae*)	• *Acacia longifolia* subsp. *sophorae* is a bush tucker plant and is identified as a weed in the Dune Management manual and should be treated as such. This weed runs horizontally over sandy beach soils. It is aggressive and all-consuming on beach environments, devouring beach grasses. Council should not seek to legitimise the presence of this weed on the beaches for cost reasons. • Coastal Wattle has disfigured the regions beaches as it has accidentally spread to where it is not supposed to be. It totally covers the intertidal zone on Bulli, Woonona, Corrimal, Towradgi, Fairy Meadow, City Beach and Port Kembla Beaches down to The Lake Entrance.
	Vermin (Feral animals and pests (e.g. rats, rabbits)	• Rats and vermin, including poisonous snakes infest the dune vegetation. • The excessive vegetation encourages rats and rabbits and they then encroach on the Bulli Caravan Park.
Access	Impaired access (Access to the beach is restricted)	• Impaired access for kite surfers. • It is impossible to walk over the dunes near Bellambi Lagoon. • There needs to be rear access for ATV patrols above the high tide mark.
Beach Amenity	Recreational use (Reduced beach width impacts on recreational use. Recreational use of the beach is inhibited at high tide and/or during times of increased wave activity)	• Saving lives and dune protection for beach amenity should be the first priority. • The dunes need to be maintained at Towradgi to enable the beach to be used for SLSC activities.
	Litter (Beach users leave litter on the beach)	• Wind borne litter gets trapped in the vegetation, and it's unsightly.
Property and Assets	Property Value (Perception of changes to property values as a result of changed beach conditions or proposed coastal management plans. e.g.	• Council should reject the proposal retreat as an option for Woonona Beach. Instead there should be a draft Implementation Plan that highlights management of the dunes. • Council may decide to reduce the rates of those properties that will be listed in the new Coastal

Issue	Sub-categories	
	Negative Impact on private views)	DCP Chapter, causing significant property devaluations.
	Property Impacts/Damage (Damage or perceived potential damage as a result of changed beach conditions or proposed coastal management plans. Positive asset protection value of dunes)	• The frontal dunes (e.g. at Fairy Meadow) has no ability to wash up and lose energy. Therefore, it hits property with full force. • Property damage along the fence line at the northern end of Corrimal Beach, due to the encroaching vegetation. • The dunes changes at Bulli have exposed the sandstone wall.
Coastal Processes	Dune abnormalities (Any abnormal/unusual dune formation as a result of changed environmental conditions (e.g. dune deflation hollows). e.g. sand building up in the wrong place)	• Prior to the revegetation in the area the dunes were nice and undulating. The vegetation has caused the dunes to now grow and have deflation hollows form.
Out of Scope	Non-related (Any comment or query unrelated to the project or out of scope	• The whole beach should be assessed not just the 100m area in front of the SLSCs.

Appendix B – Online survey - community responses

Prepared by Wollongong City Council May 2013

Wollongong Dune Management Strategy

Online Survey – Summary of Results

Prepared by Wollongong City Council 9 May 2013

INTRODUCTION

The Wollongong Dune Management Strategy was available on the Council website from 19 December 2012 until 28 February 2013, during which time 234 responses were received.

The survey involved four questions. Some components were prescriptive; asking respondents to respond to provided lists (Question 1a and Question 4); others were of an open ended nature (Questions 1b, 2 and 3). Due to the range of responses received for the open questions, responses were grouped into a series of categories and sub-categories. One set, shown in Table 3, related to 'issues'; and were adapted from the Wollongong Coastal Zone Management Plan (2010). The other set, shown in Table 4, related to 'management actions' derived from the survey responses.

Responses that did not fit into a category but still had relevance to the project have been grouped as ‘other’. Responses that were beyond the scope of the project were also noted.

Question 1a

Below is a list of issues that have been raised regarding dune management. Please rank the issues in order of importance, where 1 is the most important.

- *Accumulation of sand in vegetated areas*
- *Aesthetic value of dune vegetation*
- *Biodiversity value of dune vegetation*
- *Dune scarps after storms*
- *Line of sight for surf lifesavers (dune height and vegetation)*
- *Loss of beach (width) amenity*
- *Presence of Coastal Wattle (Acacia sophorae)*
- *Role of dunes in asset protection*
- *Vermin/fire*

Note: You do not have to include all issues in your ranking

The survey defined nine issues for ranking. Of the 234 responses, 227 (97%) ranked at least one issue, with 186 (79%) respondents ranking all nine categories. In order to define an overall rank, a simple weighting system was applied. A score of 9 was allocated for a number one ranking, a score of 8 for a number two ranking, and so on until an aggregate score for each priority was established. The aggregate score for each priority was then calculated as a percentage of the total and is displayed in Table 1 as the "Weighted Proportion".

Issues were prioritised relatively evenly, with issues ranked three through to eight separated by a maximum of 0.6% between adjacent ranks. The response indicates that each of these priority areas have at least moderate support across the survey group. The largest differences in responses occurred with the first two ranked priorities which were separated from the adjacent rankings by a 1% and 2% margin respectively.

'Loss of beach (width) amenity' or 'Line of sight for surf lifesavers (dune height and vegetation)' was favoured for ranking as either the number one or number two issue. 'Vermin/fire' and 'Presence of Coastal Wattle (*Acacia sophorae*)' were favoured for the lowest ranking of ninth.

'Biodiversity value of the dune vegetation' scored highly as a number one priority. However, its aggregate weighted score was below 'Dune scarps after storms' and 'Accumulation of sand in vegetated areas'.

Table 1. List of dune management issues and ranking.

		RANK								
PRIORITY	Weighted Proportion	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Loss of beach (width) amenity	14.5%	58	49	27	12	16	15	12	14	8
Line of sight for surf lifesavers (dune height and vegetation)	13.5%	50	31	25	25	20	21	15	11	12
Dune scarps after storms	11.5%	6	26	41	30	28	32	20	17	4
Accumulation of sand in vegetated areas	11.3%	21	18	31	28	29	23	20	24	14
Biodiversity value of dune vegetation	10.8%	38	27	8	20	18	15	28	23	22
Role of dunes in asset protection	10.3%	22	24	23	17	19	22	26	23	25
Aesthetic value of dune vegetation	9.8%	6	21	31	25	23	21	25	23	24
Vermin/fire	9.2%	9	13	19	32	26	28	14	25	40
Presence of Coastal Wattle (*Acacia sophorae*)	9.2%	17	14	15	23	24	20	26	26	37
TOTAL		227	223	220	212	203	197	186	186	186

Question 1b

Are there any other important issues you feel need to be addressed in the strategy that were not listed above? If so, please list them below.

Responses to Question 1b were grouped into categories of issues with accompanying definitions. The number and percentage of responses within each category were noted and the types of responses are listed for each sub-category in Table 3. The categories used in interpreting Question 1b (Table 3) did not directly correspond to the issues stated in Question 1a (Table 1), although there is significant overlap (Table 2). The categories and sub-categories listed in Table 3 provide a more comprehensive framework for considering the survey responses than the nine issues stated in Question 1a. Additional categories are included for comments related to beach access and the study itself. These categories are then explored in further detail through an additional 31 sub-categories.

Table 2. Comparison of categories of issues used in Question 1a and those generated for interpretation of responses to Question 1b.

Question 1b Category of Issue	Question 1a Issue
Safety	Line of sight for surf lifesavers (dune height and vegetation) Dune scarps after storms
Vegetation and ecology	Biodiversity value of dune vegetation
Weeds and vermin	Vermin/fire
Access	
Beach amenity	Loss of beach (width) amenity
Property and assets	Role of dunes in asset protection
Study process	
Coastal processes	Accumulation of sand in vegetated areas
Tourism value/loss of business	

A total of 317 issues were mentioned in the 234 survey responses. No single issue emerged significantly more frequently than others. Of the 317 issues raised, only 29 were beyond the nine categories and 31 sub-categories outlined in Table 3. Significant additional issues identified involved the scope and timing of the Dune Management Strategy, the relationship between dune management and tourism, local employment and property values. Also, additional mention was made relating to vandalism and anti-social behaviour.

Table 3: Issues: Categories, sub categories, definitions, number of mentions, percentage of survey responses , percentage of the total number of times an issue was mentioned and a summary of the responses. Note: Survey respondents could suggest multiple issues.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
1. Safety (63)	a. Beach Erosion / Scarping	Scarping or erosion caused by storm events, stormwater flow, changed wave conditions and high tide activity. Scarping caused by Acacia spp.	21	6.6%	• Dune vegetation causes erosion scarps that lead to an increase in beach erosion due to reflected energy from wave run up. • Sand cliffs present after moderate storms indicate that beach width is insufficient. • Unintended erosion and presence of unstable dune system which wouldn't have happened if Council followed the Coastal Dune Management Manual. Scarps remain present for months even after moderate swell, not just storms. • Sand scarps are formed as the sand builds up in the Coastal Wattle at the back of the beach, depriving the foreshore of sand. The sand deposits become higher at the back of the beach as sand cannot return to the foreshore. • Safety issue for small children playing on dune scarps in back wash area. • Sand scarps could collapse due to tunnelling by children. • Council is risking legal action from the unsafe conditions created. • Dangers of sitting close to unstable dune scarps. • Dangers of walking at high tides under drops offs. • If there is human traffic, the sand dunes should be tapered. • Our beaches are eroding at an increased rate due to the scarps. • Spinifex grass and Coastal Rosemary would be effective dune stabilisers. • Deep rooted vegetation which has been planted along our beaches is causing erosion. e.g. Loss of beach between Flagstaff Hill and Bank Street, Wollongong, where current dune management is taking place compared with the large amount of beach/sand along Coniston Beach between Bank Street and the coal loader breakwater, which has never received dune management or planted vegetation (SLSC member for 56 years, many observations). • There is a 35 degree slope on City Beach.
	b. Line of Sight impediment	Impaired visibility from the 'crow's nest', Surf Life Saving Club (SLSC), tower or other beach	17	5.4%	• Existing tall vegetation and height of dunes prohibits view of ocean and beach. • Large amount of beach/sand and lowest height of sand dunes in the area along Coniston Beach between Bank Street and coal loader breakwater, which has never received dune management or planted vegetation.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
		facilities.			• Dune vegetation height allows almost nil view of City Beach shoreline from Steelers Stadium to the ramp at Wollongong City SLSC. • You can't see the shoreline from either the Lifeguard or SLSC observation towers at City Beach. • Lifesavers can’t see the beach from most club houses. • Restricted sight for lifesavers who sit in the club room during wet weather. • Risk of someone walking onto beach and entering the water and not being seen by lifeguards.
	c. Swimming Conditions	Changed shoreline currents causing the formations of strong rips. *Acacia* spp. trapping sand and changing currents causing rips.	8	2.5%	• Vegetation has prevented natural movement of sand and made safe swimming locations dangerous. • Dangerous inshore conditions have developed e.g. rips, deep gutters, troughs, holes and stronger wave action caused by steep beaches and loss of sand banks. • Dangerous conditions even on calm days influenced by lack of sand on the beach. • Beach width is insufficient to dissipate wave energy which in turn causes stronger backwash and consequently strong rips along the beach. e.g. Fairy Meadow and Woonona. • Increase in rip strength may have contributed to drownings on City and Puckey’s beaches.
	d. Anti social or illegal behaviour	Behaviour that disturbs others at the site, such as alcohol and drug use and offensive or intimidating behaviour.	11	3.5%	• Camping in bushes on dunes. • Alcohol consumption included underage binge drinking. • Drugs e.g. shooting up and dealing of drugs. • Risk of assaults because the vegetation height restricts sight. • Loitering, vagrants, perverts, sexual predators, flashers, thugs, drunks and a murderer. • Fire crackers and noise. • Dumping of stolen property. • SLSC members have been approached by people about these issues e.g. at Port Kembla Beach. • Beaches specifically mentioned are Woonona, Puckeys and Port Kembla.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
	e. Snakes	Presence of snakes posing a threat to safety.	6	1.9%	• Overgrown dune vegetation has increased the snake population. • Brown snakes have ready meals of rodents and rabbits. • SLSC members have been approached by people about increased sighting of snakes e.g. at Port Kembla Beach.
2. Vegetation and Ecology (81)	a. Overgrown Vegetation	Specific mention to native or planted vegetation that has encroached beyond the existing fence line or the overgrowing the beach.	16	5.0%	• The beaches are disappearing. • Our award winning beaches are compromised by excessive and uncontrolled vegetation growth. • The plants should be maintained within the fenced areas, not the fences moved as the vegetation encroaches. • There is no maintenance program to control overgrowth. • Sand needs space to have its natural movements, introducing so much vegetation destroys that space. • Man made vegetation is spreading towards the water causing unsafe steep sand dunes, loss of natural flow of sand and loss of once gentle sloped beaches. • Vegetation is encroaching on the use of the beach during high tide. • We have lost 50% of our local beach to vegetation (specific beach not mentioned). • Council has failed to maintain a wide beach berm as required in the Coastal Dune Management Manual as it has let the beaches become overgrown with Coastal Wattle. • Massive reduction in size and width of the beach (Port Kembla). • Some areas are well managed for vegetation encroachment onto beach, others are not and there is little beach left. Sandon Point seems to work but Bulli does not. • Woonona and Port Kembla beaches are specifically mentioned.
	b. Dune Replanting	Native or planted vegetation that has been introduced or replanted on the dune surfaces. Inappropriate species have been	11	3.5%	• Planting on the front of the dune has seen the dune advance, reducing beach width, sometimes by more than 50 metres. • Question the appropriateness of current planting regime to natural dune processes. • Improper use of non local vegetation. • Grasses should be planted not large trees.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
		planted and should be replaced by other species.			• The dunes should have Spinifex grass only, which has less visual impact, is more salt resistant that wattle and will re-establish its growth in newly deposited sand quicker than wattle. • The current planted vegetation has done more damage in 20 years than the hundreds of years beforehand. • Species planted by volunteers are too large and block sunlight to properties. • Deep rooted vegetation has caused erosion on Wollongong City Beach (see above in 1a).
	c. Vegetation Removal	Existing dune vegetation needs to be removed to leave bare sand.	5	1.6%	• Remove vegetation from the beaches. • Beaches have been sustaining themselves before Council planted vegetation. • Vegetation will not protect the coast from tsunamis. • Vegetation has been planted where it did not exist before. • Vegetation is unnecessary; sand should flow to the ocean from westerly winds and return to the beach via surf. • Vegetation is causing more problems than what is supposed to protect. • Austinmer, Thirroul and North Wollongong beaches are the widest and least eroded so why is vegetation needed to stabilise the dunes?
	d. *Acacia sophorae* should be removed	Specific mention of the need to remove Coastal Wattle *Acacia sophorae.*	7	2.2%	• Coastal Wattle and other introduced plants are causing the beaches to become increasingly narrow. • Coastal Wattle (secondary dune vegetation) is not supposed to cover the incipient dune or beach berm. • Coastal Wattle can become a weed. • Stop the Wattle creep now. • Wattle is an unsuitable plant.
	e. Ecological function	Importance of vegetation, habitat and biodiversity value. Need for native vegetation.	10	3.2%	• Concern that vegetation will be cleared without due consideration of ecological function and the future generation's use of beaches. • *Acacia sophorae* is a coloniser of dune vegetation – conditions soil, provides the microclimate suitable for other coast species such as *Leucopogan parviflorus, Leptosperum laevegatum, Pelargonium australis* etc. to become established. The habitat value of *Acacia sophorae* for birds, lizards, insects etc should not be

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
					under-estimated. The role of coastal sand scrub, (MU45), including *A. sophorae* provides other important amenity values such as windbreak, salt screen and shade. This vegetation often traps windblown plastic litter that would otherwise be blown into the ocean. • *Acacia sophorae* is a bush tucker and medicine plant. • Importance of protection of habitat for small birds, reptiles - provide fresh air, shade, protection from salt spray and wind. e.g. Blue Tongue Lizards and Black Shouldered Kites near Woonona. • It is the ocean cycles, weather patterns, climatic changes that will dictate the overall management capacity for the coastal zone, including the dunes, e.g. growth during wet summers and dieback during drought. • Dynamic system that must have the ability to adjust to the prevailing conditions. • As a lifeguard, the conditions change season to season – line of sight, beach width etc, with no intervention. • Port Kembla – before vegetation, sand was lost as it was blown across the road and taken away in trucks or dumped in one corner of the beach where after one storm it was back on the road. • Accounts from botanist from the first fleet describe dunes systems completely covered by vegetation, most notably Coastal Wattle. Wattle provides habitat and stops sand from being lost forever. • Original vegetation was destroyed and the current situation is the best compromise. • Ecological and cultural value far outweighs need for greater space or views. • Infrastructure and recreation needs should be designed so as to minimise impact on these fragile and important areas. There is more value in a healthy intact dunal system than a wide beach with minimal diversity. • *Acacia longifolia* var. *sophorae* is native to the Illawarra. Even if it was planted on some beaches a long time ago, it has great value, providing habitat for plants and animals, protecting Aboriginal cultural heritage and helping to stabilise dune systems.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
	f. Vegetation protecting from erosion/dune stability	The role of vegetation in stabilising the dunes and providing protection from erosion.	16	5.0%	• The coastal vegetation traps sand and prevents wind blown movement of sand particles into parks, private property and adjacent roads. • Preservation of vegetation for dune stability. • Would rather see dune maintenance by vegetation than hard engineering solutions. • Concern that vegetation will be cleared without consideration for asset protection. • Coastal Wattle is a good dune stabiliser. • Scarps indicate dune is stable, otherwise it would collapse. • Dunes need vegetation to accrete and provide stability. • Sand depletion and accumulation is a natural process. • If vegetation was removed at Towradgi or City beaches, the SLSCs will be washed away, filled with seaweed after storms. • There are many images showing adverse impacts before dunes were stabilised by vegetation (blowouts on road, SLSCs undermined etc). • Following, recent storm evens on 28^{th} and 29^{th} January 2013, I believe plants and trees must remain to provide necessary barrier against such events. • Stability of the coastline is more important than lines of sight. • Some systems can recover naturally - Port Kembla has changed recently due to a series of large storms, sand was washed 200m out to sea. It has since moved slowly back to shore, currently at 50m from the shore. Scarps have collapsed and the beach has changed from 30 degrees slope to flat. Other beaches (Towradgi and City Beach) are narrow, with assets built too close, so dunes are not able to readjust. • Wave and wind action will strip vegetation off beaches if the system needs to; it is not for Council to keep intervening in nature. With rising sea levels and extreme storm events likely to have a major impact on the region, dune vegetation will be a critical first line of defence for Council infrastructure and homes built along the coastal strip.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
	g. Provision of shade	The role of vegetation in providing shade. Need for more shade.	3	0.9%	• Acacia provides shade. • Provide shade, possibly with mechanical structures but preferably high pruned banksias to minimise sun exposure to beach users and users of adjacent pathways.
	h. Protection from vandalism	Vandalism of dune vegetation.	6	1.9%	• Vandalism, illegal clearing and poisoning of dune vegetation for views. • Protect vegetation from vandalism using fence areas. • Leaving vegetation debris after vandalism of vegetation, leaving mess, attracting pests/vermin.
	i. Education about the role of vegetation and dunes	The community lack an understanding of the positive function of vegetation or natural beach processes.	7	2.2%	• Public awareness of dunes, dune vegetation, their importance, role and history of disturbance. Include biodiversity values and role on asset protection. • Education needed about the role of dune vegetation will play in stabilising beach areas as beaches migrate landward. • Signage to inform public about native vegetation growing on the dune, e.g. *Acacia sophorae* is a bush tucker plant. • Don't take coastal management back to the 1970s because people lack the knowledge of dune stabilisation.
3. Weeds and Vermin (23)	a. Weed removal	Removal of existing weeds. Specific mention of *Acacia sophorae* is included in 2d above however some community members consider *Acacia sophorae* a weed but have not identified a weed species.	16	5.0%	• Moth Vine, Turkey Rhubarb, Bitou Bush, Asparagus Fern, Lantana, and many other environmental weed species threaten the integrity of native coastal vegetation on the dunes. • We will have no beach left if the weeds keep growing. • Council should control weed infestation on the Blue Mile. • Weeds are invading; fences are caging in ugly weeds. • The dunes are under a canopy of feral plants/weeds. • Its weed infestation in the name of the green movement.
	b. Vermin	Feral animals and pests (e.g. rats, rabbits).	7	2.2%	• The overgrown vegetation has brought vermin and pests in huge numbers. • The build up of rubbish in the vegetation causes odour and attracts vermin. • Rodents and rabbits attract snakes.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
					• Rats, rabbits and foxes are seen on a weekly basis near WEC and Stadium and in the thick bush at Woonona and Bellambi beaches. • Vermin at City Beach and Woonona due to the scale of dunes and vegetation.
4. Access (15)	a. Impaired Access	Access to the beach is restricted.	12	3.8%	• Need well maintained and controlled access. • Need easy access for SLSC lifesavers, fire fighters, dune managers and public. Includes wide access on cycle paths behind dunes as well. • Unable to transport necessary safety/rescue equipment up and down the beach efficiently. • WCC Lifeguards & Wollongong City SLSC patrols on many occasions can't access the beach with motorised rescue equipment. The past two seasons it has been necessary to travel along the Blue Mile walkway to the Crown Street ramp to place/remove IRB & Patrol equipment on the beach. • Maintenance on the pathway at Port Kembla beach has not been done for some time, it's unsafe. • Entry tracks onto the beach between Woonona and Bellambi are so overgrown that it is very easy to become tangled in the outgrowth of the Acacia and trip over.
	b. Need for access for less able	Access for less able people and wheelchair access.	3	0.9%	• Access for those less mobile. • Recreational value of bicycle/wheelchair/walking paths.
5. Beach Amenity (20)	a. Recreational use	Reduced beach width impacts on recreational use. Recreational use of the beach is inhibited at high tide and/or during times of increased wave activity.	10	3.2%	• In 1960 the beach had sufficient space to hold a surf carnival, now only beaches without vegetation on the dunes, e.g. North Wollongong Beach can do that. • SLSCs struggle to hold events due to limited space. • Need for structures to be able to watch beach events (e.g. steps). • Need improved recreational areas surrounding populated SLSC beach areas. • Vegetation of dunes has led to reduction in the size of beach which reduces the availability of space for people to conduct activities. • At Woonona Beach, you used to be able to sit on grass and watch children playing on the beach, this is no longer possible. • Dune height reduces public activity in the area.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
					• The beaches are currently not a pleasant place to visit.
	b. Litter	Beach users leave litter on the beach.	10	3.2%	• Build up of rubbish in vegetation, causing odour and attracting vermin. • Dunes allow dumping of rubbish. • Council management of rubbish. • Dog faeces. • Syringes. • Rubbish can harm sea and bird life and people.
6. Property and Assets (6)	a. Property Value	Perception of changes to property values as a result of changed beach conditions or proposed coastal management plans. e.g. Negative Impact on private views.	2	0.6%	• Property views being blocked by inappropriate vegetation planting.
	b. Property Impacts / Damage	Damage or perceived potential damage as a result of changed beach conditions or proposed coastal management plans. Positive asset protection value of dunes.	4	1.3%	• Any further loss of sand from the foreshore zone is a recipe for disaster in relation to coastal recession and the loss of infrastructure. Dune vegetation provides the stability and protection needed for much of the infrastructure foolishly built too close to the coastline. • Protection of public infrastructure.
7. Study (17)	a. Scope and timing of study	Any queries relating to scope, timing of the study or project milestones.	13	4.1%	• The project should not be tailored only to please the vested interests of developers or some the residents living in the very front rows of houses along the coast - about house prices rather than the proper use of public land. • I urge you to heed reason and research, not anecdotes given as "evidence" by an angry mob.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
					• This survey seems to be pitched towards the vocal minority that want dune vegetation removed. • This strategy seems overly focused on a problem that is perceived by a small community at one location along the Wollongong coast. • Council is confusing healthy environmental growth with issues of tree hating. • The strategy must be independent. Political influences should not come into play. • Council lifeguards work as paid lifeguard six days a week, surf lifesavers volunteer one day a week. • The study should be whole of beach, not just SLSC areas. • Waiting could cost lives. No more studies, time for action, delays and inactivity is frustrating.
	b. Inadequate consultation	Comments made relating to a perceived lack of consultation with stakeholders and/or the broader community.	4	1.3%	• Get input from locals who know their local beaches. • Recommendations from lifeguards who work six days a week on the beaches should be taken seriously. • Tick a box survey does not allow room to say anything. • Study should be available online, not just in the library to allow better accessibility.
8. Coastal Processes (33)	a. Changed surf conditions or currents	Changed coastal conditions/shoreline currents such as rips. Changed surf conditions (negative changes).	13	4.1%	• Increased rip strength. • Decreased wave quality. Many surf locations changed from excellent to poor for surfing. Only surf is a shore dump. • Degraded surfability of beaches where revegetation has occurred. • Changing of the immediate ocean floor topography affecting the way the waves hit the sand banks. • Need some of the dunes to be mobile to provide sand for surf banks. • At Woonona, Towradgi, East Corrimal and City beaches surfability has noticeably declined in the last 20 years (due to planting of Coastal Wattle).
	b. Dune Repair	Natural dune repair is hindered due to other environmental causes. e.g. Scarp repair.	4	1.3%	• The Acacia have taken away beaches and created unnatural systems where eroding beach fronts are not repairing naturally after storm events. • Previously dunes and the sand width and depth have generally recovered after huge tides and storms, but not anymore.

Issue (total)	Sub-categories	Definition	No. mentions	% of total issues raised (n = 317)	Summary of the responses
	c. Dune Abnormalities	Any abnormal/unusual dune formation as a result of changed environmental conditions (e.g. dune deflation hollows). e.g. sand building up in the wrong place.	16	5.0%	• Vegetation has prevented the natural movement and transfer of sand. • Loss of sand after huge tides and storms. • Sand cannot return to the beach because it is locked up in vegetation. • Accumulation of sand on the sea floor instead of on the once wider beach. • Loss of beach has affected the total structure of most beaches. • Correlation of sand locked in the dunes and the absence of sand banks. • Bellambi Beach - one of the main suppliers of sand to the north has been stagnated; sand cannot reach the creek because impeding wattle which has stopped flow of sand to Bellambi Creek. • Stanwell Park Beach dune has gone from a small mound to a hill that hang gliders fly off, about 300mm per year and accelerating.
9. Business/ Tourism Value (19)	Reduced business/ tourism value	Reduced business and tourism value of the beach, including scenic views from walkways and cycle tracks.	19	6.0%	• Lower wave quality contributes to loss of tourism. • Quality of surf has clear economic impact. • Commercial and recreational value of Puckeys/Stuart Park/North Wollongong. • Height of vegetation reduces views, leading to loss of public viewing amenity of beach and ocean from beach-side picnic areas and cycleway. • People now prefer north coast as holiday destination because of their pristine beaches and the way in which they are managed. • Woonona used to be a good tourist drawcard. • The Blue Mile is an eyesore; you cannot see the beach from the pathways. • Businesses suffer – e.g. kiosk closing (Wollongong City Beach). • Council-owned holiday parks, e.g. Corrimal, running risk of losing tourist dollar.
10. Other (29)		See below for summary of 'other' issues.	29	9.1%	These issues are detailed below.
11. Out of Scope (11)	a. Non-related	Any comment or query unrelated to the project or out of scope. See below for a summary.	11	3.5%	These issues are detailed below.

Other Issues

There were many issues suggested that did not fit into the above categories and are included here for the consideration within the Dune Management Strategy:

- Overdevelopment in coast zone, including development encroachment onto the beach and the need to maintain buffer zones behind the dunes;
- Council has not followed Coastal Dune Management Manual;
- Preservation of Aboriginal heritage, e.g. middens;
- Protection of natural visual amenity;
- Sand was exported out of the region in the past;
- Need for guidance on what/where people can plant;
- Dunecare/Bushcare work is not appropriate and groups move on with no follow up maintenance;
- Removal of marine life from rock platforms and the beach;
- Vegetation traps litter;
- Tidal erosion;
- Pesticide use;
- Wildlife attracted by vegetation wrongly planted on the beach will be washed out to sea in a storm;
- Fire hazard posed by leaf litter under the canopy of Coastal Wattle and Tea Tree at Towradgi Beach;
- It's a 'furphy' that dune vegetation makes a beach unsafe. Beaches can be unsafe due to currents, dumping surf, rips, swimmer competence and surf awareness but are not less safe due to dune vegetation;
- Beach patrols should be done from the beach;
- Lack of disabled access to viewing tower at City Beach;
- Council's flimsy method of closing off unsafe beaches out of patrol and lifeguards hours;
- Wollongong City SLSC's dunes are the result of the fill from the new club house/function centre;
- Why are SLSI getting priority over lifeguards?
- SLSCs are essentially sporting clubs, providing 'life saving' services on Sundays and public holidays. Efforts to manage the environment to meet their needs need to be proportionate to their contribution. Would we be better off with professional lifeguards who need far less infrastructure?
- Need to understand who are GHD and what are their qualifications; and
- A specific recommendation to contact an ex Woonona High School teacher who carried out his thesis back in the 1970's on sand bank setup at Woonona and Bulli Beach.

Out of scope issues

A range of issues have been categorised as out of scope of this project, including matters at specific locations (e.g. East Corrimal Beach, Bellambi Lagoon, Sharkey's

Beach, MM Beach, Wollongong Golf Course, Towradgi Pool (boulders), Port Kembla Harbour) or relating to other issues (e.g. urban development and sediment runoff, smoking, and studies on predicted sea level rise along the coast (the latter is already done)).

Question 2

What management activities do you think Council should consider to address these important issues? Please list them below.

A total of 401 management options were mentioned in the 234 surveys submitted to Council. The following management options were drawn from responses to Question 2 as well as where management options were mentioned in answers to Question 3.

The most common response related to options involving the management of vegetation on the dunes (189 responses). Other management activities suggested by respondents included further research and education on dune management and coastal zone processes, increased services and maintenance activities around dunes, modifications to existing lifesaving facilities and modifications of the dunes.

A number of comments related to the consultation process and the study itself. These comments are detailed in the 'Other Management Activities' section.

Table 4: Management Activities; Categories, subcategories, definitions, number of responses matching the subcategory, percentage of the total number of times activities were mentioned and a summary of the responses. Note; Survey respondents could suggest several activities.

Management Activity (total)	Sub Categories (where relevant)	Definition	No. of Responses	% of total Suggested Activities (N = 401)	Summary of the types of responses
1. Do nothing (adapt) (13)		Leave the dunes as they currently are and adapt to the existing conditions.	13	3.2%	• Maintain dune vegetation to continue to stabilise dunes. Without this planting Wollongong would have lost its beaches. • Support for current vegetation to provide seed banks for natural dynamic dune cycles. • Vegetation and dunes provide protection of our coastal biodiversity. Removal would threaten our coastal communities. • Maintain good work already done. • Vegetation catches litter rather than it going in ocean. • *Acacia longifolia var. sophorae* is native to the Illawarra. • Leave the dunes alone. Let them return to natural state.
2. Manage Vegetation (189)	a. Remove all vegetation	Removal of all dune vegetation.	21	5.2%	• Remove all vegetation from in front of SLSCs. • Remove all vegetation so beaches will return to their natural state. • Let the beaches do their own remediation. • Restore beaches to how they were 40 years ago, no trees or grass. • Bulldoze the vegetation. • In the short term, removal of vegetation to allow the dunes to obtain a greater height. As it stands the dunes are too low to withstand a major storm • Removal of the encroaching vegetation on our beaches, and a return to the dunes that were just as effective at keeping the sand stable over the long term. Bulli beach, between Bulli and Sandon Point, has none of the vegetation we see at Woonona beach yet it is very stable and the beach has a nice width. • Remove all the vegetation - Even though there are no sand dunes, Coastal Wattle or vegetation at North Wollongong Beach and there is a long concrete wall along most of the length of the beach, it has

Management Activity (total)	Sub Categories (where relevant)	Definition	No. of Responses	% of total Suggested Activities (N = 401)	Summary of the types of responses
					been proven time and time again that after very big seas when the Bombora is sending high waves onto the beach, the beach always recovers. This helps in the reasoning that high sand dunes with high vegetation are not required in front of the Wollongong City SLSC building. • North Wollongong and Thirroul beaches don't have the vegetation. They are two of the Illawarra's best beaches.
	b. Manage the vegetation species type	Manage the species of vegetation on the dunes by determining appropriate species, removal of inappropriate species and regeneration with appropriate species. This includes specific references to *Acacia sophorae*.	67	16.7%	• Remove Coastal Wattle (29 mentions). • Remove all the Coastal Wattle – this can be achieved by letting the community help. • Remove excess grass and undergrowth. • Remove inappropriate vegetation and plant species that would have naturally occurred there. • Use historically appropriate vegetation. • Use appropriately heighted vegetation. • Replace with ground covers, grasses such as Spinifex and Marram Grass and Coastal Rosemary. • Use salt resistant grasses. • Maintain some natural structure to dune vegetation including Banksia/Tea Tree for the hind dune. • Establish greater diversity of species in the dunes. • Do not plant tall trees. • Replant everything that grows above 1m in front of lifeguard facilities. • Remove all planted/imported vegetation. • Follow Coastal Dune Management Manual and remove non-complying vegetation. • Investigate dune vegetation that allows sand to be redirected to where it is needed. • Investigate current research of UoW Biology Department. • Publish a list of acceptable native plants, no planting outside this list.

Management Activity (total)	Sub Categories (where relevant)	Definition	No. of Responses	% of total Suggested Activities (N = 401)	Summary of the types of responses
					• Specific mention to remove of trees between Port Kembla beach and the SLSC. • Planting of trees that can obtain a height of >25m on maturity and preferably within 30 years that can form a wind break for sand being blown off the beach. The trees need to be planted at the back of the natural line for the pre 1960 dunes. • Vegetation on the sand dunes should be low growing to allow a clear line of sight for any beach users.
	c. Trim the height of vegetation	Trim the height of the existing vegetation to maintain sightlines.	15	3.7%	• Trim vegetation to a height that does not obstruct view of the beach for lifeguards. • Prune only in front of patrol locations. • Trim where appropriate. • Regularly survey vegetation height.
	d. Remove weeds	Remove weeds, including Bitou Bush and Lantana.	25	6.2%	• Remove Bitou Bush, Lantana, Sassafras Grass. • Remove noxious and environmental weeds. • Specific reference to removal of Bitou Bush and other non native plant from Bellambi, Woonona, East Corrimal, City, Port Kembla and Bulli beaches. • Note - This category does not include specific references to *Acacia sophorae* (these are included above in ‘Manage the vegetation species type’). This includes only the weeds listed above or ‘weeds’ in general (i.e. some respondents may be referring to Acacia because they believe it is a weed but it is impossible for this to be confirmed).
	e. Reduce the area of vegetation encroachment onto beach	Remove the vegetation that has encroached onto the beach.	25	6.2%	• Set defined vegetation area and maintain it within boundaries. • Reduce encroachment to widen beaches. • Reduce area of vegetation that traps sand to prevent steep gradients. • Remove all vegetation back to the vegetation line of 1965. Move the top 2m of the sand that was planted to the surf to reduce the seed load in the sand. • Specific mention to Port Kembla and encroachment of marram grass

Management Activity (total)	Sub Categories (where relevant)	Definition	No. of Responses	% of total Suggested Activities (N = 401)	Summary of the types of responses
					30m past fence line. • Council needs to determine a defined dune width (e.g.5-10m of vegetation) and maintain this width. This is opposed to the current policy of constructing a fence line and letting the dunes grow freely over time, then simply constructing a new fence line to meet the extended growth of the dune. • Each beach should have a specified distance (width) that the vegetation covers. • Any vegetation needs to be kept to the sand dunes only. It should not invade the beach and normal tidal area.
	f. Undertake bush regeneration activities on cleared areas of dunes	Revegetate cleared areas with appropriate dune species.	21	5.2%	• Larger buffer zones and more planting. • Continued planting to prevent erosion. • Plant more vegetation. • Re-vegetate cleared dunes. • Fencing off of native vegetation from human activities. Limiting the area in which people could disrupt ecological processes of the dunes. Planting of native vegetation to stabilise dunes.
	g. Support community involvement in dune vegetation maintenance	Provide support to community groups to assist in dune vegetation maintenance, including Bushcare, Dunecare, and SLSCs.	15	3.7%	• A lot of people want to help with physical work and fundraising. • Includes Landcare, Bushcare, Dunecare, and SLSCs. • Continued and expanded Bushcare activities. Ongoing and adequate Bushcare education. • Vocal support of Landcare and Bushcare groups. • Fund groups to restore the dunes and clean up rubbish. • Allow Dunecare groups to replant and maintain. • Allow SLSCs to maintain vegetation with their machinery and members to help. • Organise community working bees to target specific areas. • Allow SLSC volunteers to replant the area around the SLSCs with Spinifex and low growing species.

Management Activity (total)	Sub Categories (where relevant)	Definition	No. of Responses	% of total Suggested Activities (N = 401)	Summary of the types of responses
					• Organise mass volunteer days to target small areas at a time to better garner broad support.
3. Reshaping dunes (18)		Change the height and/or width of dunes and reduce steep scarps.	18	4.5%	• Flatten the dune into a useable area. • Reduce height of dunes. • Create a tapered sand dune. • Level dunes to an appropriate level in areas around SLSCs. • Dunes to be levelled at street/path height, and then shaped at a slight angle eastward towards the ocean, following this small ground cover to be added. It is universally recognised that large/heavy seas, should be able to wash up on a slight gradient without encountering hard/stubborn objects including root systems from large vegetation. • Dune profiling to maintain sand on the beach not the vegetation. • Push sand into water before, during and after summer season. • Profile the beaches to give a 'beach' as defined in the Coastal Dune Management Manual. • City Beach dunes are the result of fill from the old club house and should be flattened into a useable area and perhaps grassed. • Redistributing sand to correct areas when needed.
4. Structural (37)	a. Changes to existing or new buildings/ structures	Modify structures to allow improved sightlines.	9	2.2%	• Use towers such as at Towradgi Beach. • New towers to be prepared so they cannot be blocked by vegetation. • Consider structures e.g. steps, to provide access and sightlines. • Relocate life saving towers.
	b. Construction/ maintenance of access points and pathways	Construct and maintain access points and pathways through the dunes to the beach.	20	5.0%	• Fencing of dunes bordering pathways. • Create many walkways through dunes from cycleway to beach. • Better and longer lasting walkways. • Structured environmentally sensitive walkways. • Greater expenditure and maintenance of walkways. • Clearly indicated walkways. • Maintenance and widening of pathways.

Management Activity (total)	Sub Categories (where relevant)	Definition	No. of Responses	% of total Suggested Activities (N = 401)	Summary of the types of responses
					• Allow vehicular access near SLSCs. • Ensure access points do not contribute to erosion. • Specific mention of the access path between Port Kembla SLSC and the beach needing repair. • City Beach - It is completely unsafe to use a number of walkways and there is a duty of care as Council has provided these walkways using government money and should maintain them to a certain standard.
	c. Construct retaining walls and grass	Remove dunes and construct retaining wall and grasses areas, e.g. what exists at North Wollongong Beach.	8	2.0%	• Dunes flattened into useable turfed area. • Construct retaining walls. • Replace with lawn. • Retaining walls like at North Beach. • Removal of the overgrown weeds and replace with usable lawn areas with retaining walls holding back sand like North Beach, Thirroul and Austinmer beaches. • This would result in good recreational areas, improved commercial prospects, and good sightlines. • In front of City Beach SLSC, retaining wall and grassed area like North Beach. • Also proposed for Woonona Beach.
5. Education/ Research (38)		Provide education to the community about dune processes, management and the purpose of dune vegetation. Education on caring for dunes and activities that are not appropriate. Conduct additional research on coastal processes and issues.	38	9.5%	• Present the facts e.g. Coastal Wattle is not a weed. • Educate about the ecological role and significance of dune systems, sustainability of coastal areas and importance of beach dune systems in protecting human and natural environments, biodiversity values, natural coastal processes such as sand erosion and accumulation. • Visual representations of pre-European, post storm event and future (raised sea level) coastal zone states. • Signage about the correct use of dunes and importance of protecting dunes. • Anti-litter signage.

Management Activity (total)	Sub Categories (where relevant)	Definition	No. of Responses	% of total Suggested Activities (N = 401)	Summary of the types of responses
					• Experts should present facts during consultation so the community is informed. • Better public awareness campaigns about why dune vegetation is important. Education is key. Have expert consultants/coastal management scientists available at public meetings who will address confrontational community members who are spreading not entirely correct information throughout the community and gaining support without hard science.
6. Coastal Zone Planning (8)		Develop policy related to planning and management of assets near dunes.	8	2.0%	• Buy back currently developed land and return to dune. • Prioritise beaches most at risk. • Work with the State Government to plan for the medium to long term. • Develop a setback strategy. • Manage dunes in the context of coastal hazards.
7. Improved Services (50)	Improve ongoing maintenance	Improved maintenance of overall dune areas, including vegetation.	25	6.2%	• Maintain any vegetation that is introduced. • Maintain vegetation in front of lifeguard facilities. • Monitoring dunes to ensure necessary maintenance is done. • Establish clear boundaries for dune vegetation and maintain that width. • Active control not 'plant and forget'. • Properly funded workable maintenance program. • Dune stabilisation has been effective, but neglected in last decade. • Maintenance to ensure visibility and amenity. • Maintenance of fences, pathways and amenities. • Maintenance is also essential to ensure that species composition remains in a balanced state. It would appear that very little of this type of management occurs.

Management Activity (total)	Sub Categories (where relevant)	Definition	No. of Responses	% of total Suggested Activities (N = 401)	Summary of the types of responses
	Manage Pests	Undertake pest control	10	2.5%	• Remove feral rabbits. • Remove Myna Birds. • Control snakes and vermin.
	Increase Regulation and Enforcement	Increase the regulation and enforcement of dunes	8	2.0%	• Prosecute vegetation vandalism. • Enforce dogs on beaches policy. • Erect signage to deter vandalism. • Increase patrols.
	More Bins and Litter Collection		7	1.7%	• Make more bins available at beaches. • Increase litter collection activities.
7. Other (46)		See below for details of ‘other’ management activities.	46	11.5%	• See section below for full details.
8. Out of scope (2)			2	0.5%	• Remove Bitou Bush at MM Beach. • Support Federal Government policies which seek to reduce reliance on the use of fossil fuels.

‘Other’ Management Activities

There were many specific suggestions for management activities that did not fit into the above categories and are included here for the consideration within the Dune Management Strategy:

- The role of Lifeguards – review the compatibility of their infrastructure and process with healthy dune systems, surveillance from the beach not the clubhouse with appropriate facilities/equipment, lifeguards should be on the beach; use of camera surveillance, duties to include dune management activities such as vermin control and litter collection (Note - litter collection is already part of the Lifeguard’s role);
- More community consultation – including local community near beach, Bushcare groups, Aboriginal tent embassy elders, beach users and staff that work on the beaches, have experts available at consultation forums to better inform community while engaging and include the study online for accessibility. Suggestion that Council facilitate opposing sides in a room together (bush regenerators and Woonona SLSC) rather than favouring one side. It was also mentioned to inform community of the issues and the pros and cons of solutions then seek comment;
- Safety – suggestions related to emergency vehicle access, blue lights, signage about scarps, installing shoring to prevent scarps collapsing, levelling of scarps after storm fronts have passed, disaster recovery plans for severe storm scarps and the consideration of ‘Crime Prevention Through Environmental Design’;
- Sand Nourishment – consider redistributing sand; investigate dumping or replacing sand (similar to the Burleigh Heads/ Snapper rocks). The removal of dunes from East Corrimal and Port Kembla should be factored back into this long term plan. A suggestion is to put back the sand that was shipped off shore.
- Planning and research – there were some specific comments related to the way in which Council should be undertaking the development of the Dune Management Strategy, including:
    - Prioritising beaches more at risk;
    - Plan for the medium to long term;
    - Undertaken science based study of sand movement and impact of development, prior to making recommendations;
    - Survey beach profile changes over time, e.g. Bulli, Woonona and City Beaches;
    - Research what conditions were pre-European settlement and how the local original inhabitants managed the coast;
    - Look at management of dunes in other council areas;
    - Seek expert advice on sand movement along the WCC coast;
    - Utilise the knowledge of coastal zone experts like Professor Short (Sydney University) and experts from UoW;

- People's personalities and personal agendas should not be a factor in decision making, and these should be recognised and eliminated from decision making processes;
- Study the effects of local inshore sand banks;
- Consider science behind coastal processes;
- Study whether the vegetation helps erosion or whether is it changing the balance;
- Undertake studies that measure the amount of sediment that moves through the various compartments within the WCC jurisdiction. This could be done during periods of accretion as well as erosion. It is also important to know where the sediment is stored and how long it stays there (on average). If we don't know how much sediment is on the move and where it moves to, making changes to dune management could result in the net loss of sediment from our beaches;
- Look at the historical positions of the dunes particularly the back and height of the dune, the slope on the front of the dune (to determine the minimum width of the dune) to allow for sand to be blown up the dune to build its height to a level near the height of the dunes in 1960. Also consider the width of the beach to absorb a storm wave run up in a 1-in-10 year event (nominally at least 50m above the berm) and the height and type of vegetation to hold the back of the dune and intermediate positions. The use of artificial high dunes as per Coniston beach should be considered as a back dune to form the initial barrier whilst the trees are growing behind them;
- At Towradgi Beach there is the remains of a fence which has been overgrown by vegetation up to about 20m towards the sea. Council should say where the dunes are meant to end and maintain this as it can cause animosity between Bushcare groups and SLSC members;
- Better information on just what is occurring at our beaches in regards to sand movement, recent building and other developments in the City Beach area and the effect they have had on the way the weather and seas affect the sand and dunes;
- Survey what vermin and wildlife are present;
- The strategy needs to ensure the coastal zone (beach, dune, vegetation) is reviewed at regular intervals (e.g. annually) and recommendations from the review are incorporated into the management plan for next twelve months.
- Council should think of the long term consequences of coastal management in terms of climate change and sea level rise - how this will threaten aboriginal heritage (middens and burial grounds), important EECs (behind dune systems) and community assets (SLSCs, roads, bike paths etc);
- Outcomes need to clearly reflect a respect for biodiversity and habitat value with solid scientific backing, understand geological and coastal zone processes and the dynamic nature of these processes in dune evolution, consider climate change and sea level rise and acknowledge past disturbance due to anthropological impacts,

acknowledge and respect Aboriginal and cultural heritage in the management of coastal sites. Education and examples of areas where vegetation has been removed and what can happen to assets and beaches after major storm events could be effective;
  - Look at the whole dune system (whole of beach);
  - Considering strategies in context of coastal hazards;
  - Remove vegetation on the dunes least exposed to high tidal ranges and study the effects on the local inshore sand banks;
  - Develop clear vegetation management plans;
  - Adopt correct use of NSW Government guidelines (e.g. Coastal Dune Management Manual generally and specifically page 44, 4.2.2, page 3, Figure 2.1, page 93, 6.8.2.);
  - Council should follow the State Government Coastal Dune Management Manual and stop allowing the Bushcare groups to plant species that are not on the approved dune management list.
  - New dune vegetation works should not be undertaken until a complete review is undertaken as to the effectiveness of dunal vegetation. Era and Burning Palms beaches at the north of the City boundary are still in their natural state and are surviving quite well without the intrusion of dunal vegetation. Remove all existing dunal vegetation from a strip of beach say 200-300 metres long and compare the long term performance of this section of beach to that of adjoining sections that retain their vegetation.
  - Avoid the use of out of date reports,
  - Concerns regarding the costly nature of studies,
  - Generally let nature take care of everything, generally for dune and specifically after scarps (natural repair);
  - Use Port Kembla Beach and dune system as a model for other dunes areas; and
  - Return to pre-European conditions.

- Other suggestions included preserve Aboriginal middens, lookout platforms, a step structure like at Scarborough Beach in Perth, artificial reefs to protect foreshores, coastal development setbacks, controlled back burning, plant Norfolk Pines, minimise plastic use near beaches, monitor creek flows, don't remove sand from the region, clear development 1km back from the dunes, remove infrastructure that interferes with natural sand movement, establish an agreement with the State Government authorisation bodies regarding dune management so it doesn't take so long for works to be approved, lobbying the State Government to revise their dune management guidelines as it was felt that the authors were too biased towards bush regeneration, consider the proposals of GHD, remove the fences; and generally changing the dune system back to how it used to be (with no specific strategy mentioned).

Question 3

If you have any additional comments or suggestions regarding the Wollongong Dune Management Strategy, please list them below.

The responses to this question were considered in conjunction with questions 1b and 2 above. Each response has been included as either an issue or a management activity or both, where relevant.

Question 4

Which of the below best described you?
Check any that apply (Y/N)

Surf life saving club member
Surfer
Local resident
Bushcare member
Swimmer
Beach walker
Other…

Table 3: What best describes the respondent.

What best describes the respondent	Number of Responses (out of 226)	% of responses
Local resident	187	79.9%
Swimmer	132	56.4%
Beach walker	127	54.3%
Surfer	105	44.9%
Surf Life Saving Club member	68	29.1%
Other	36	15.4%
Bushcare member	28	12.0%

Other responses provided:

- Local business owner (2);
- Environmentalist (2);
- Marine scientist;
- Student (3);
- Geography teacher;
- Windsurfer;
- Dog owner;
- Tourist (2);
- Fisherman (3);
- Lifeguard (7);
- Ratepayer sick of the mismanagement of our beaches;

- Bird watcher;
- Ex Branch President of the Surfrider Foundation;
- Born and raised in Woonona;
- Ex local resident;
- Bike track walker;
- Concerned Australian;
- Beach user;
- Coast Care advocate;
- Coffee drinker;
- Parent;
- I wanted to be a bushcare worker until they started planting at Sandon Point against their grants conditions, and I am not the only one who thinks this way; and
- Stud.

Attachment 1 – Online survey

Question 1a

Below is a list of issues that have been raised regarding dune management. Please rank the issues in order of importance, where 1 is the most important.

Accumulation of sand in vegetated areas
Aesthetic value of dune vegetation
Biodiversity value of dune vegetation
Dune scarps after storms
Line of sight for surf lifesavers (dune height and vegetation)
Loss of beach (width) amenity
Presence of Coastal Wattle (Acacia sophorae)
Role of dunes in asset protection
Vermin/fire

Note: You do not have to include all issues in your ranking

Question 1b

Are there any other important issues you feel need to be addressed in the strategy that were not listed above? If so, please list them below.

Question 2

What management activities do you think Council should consider to address these important issues? Please list them below.

Question 3

If you have any additional comments or suggestions regarding the Wollongong Dune Management Strategy, please list them below.

Question 4

Which of the below best described you?
Check any that apply (Y/N)

Surf life saving club member
Surfer
Local resident
Bushcare member
Swimmer
Beach walker
Other…

Appendix C – Threatened communities and species listed under the EPBC and TSC Acts

A desktop assessment was undertaken to determine Endangered Ecological Communities (EECs) and threatened flora and fauna within a 10 kilometre radius of the study area. The following tables show the EECs (Table A), threatened flora and fauna (Table B) that are 'present', 'likely' or 'possible' to occur within the study area, based on field surveys and observations. Tables C and D show the EECs, threatened flora and fauna that have been determined 'unlikely' to occur or do not occur ('nil').

All information in these tables taken from NSW OEH and Commonwealth DSEWPaC Threatened Species profiles (OEH, 2012b; DSEWPaC, 2012b) unless otherwise stated. The codes used in these tables are: CE – Critically Endangered; E – Endangered; V – Vulnerable; EP – Endangered Population; CEEC – Critically Endangered Ecological Community; EEC – Endangered Ecological Community; M - Migratory.

Table A: Endangered Ecological Communities that are present, likely or possible to occur within the study area

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions	EEC		Currently known from parts of the LGAs of Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions (OEH, 2012b).	Recorded at several locations	Present. Examples near Windang Beach and within the study area.
Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	EEC		Occurs in coastal areas subject to periodic flooding with standing fresh water for at least part of the year. Typically on silts, muds or humic loams below 20m elevation in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes. Structure and composition varies spatially and temporally depending on the water regime, though is usually dominated by herbaceous plants and has few woody species.	**Recorded** within 10km (OEH, 2012b)	Present. Recorded at several locations, e.g. where creeks and lagoons occur near dunes.
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East	EEC	CEEC	Occurs along the NSW coast, usually within 2km of the ocean on a variety of substrates. Variable structure and composition, typically with closed canopy. Generally	**Recorded** within 10km (OEH, 2012b) **Predicted** to occur	Present. Some small examples within native vegetation

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
Corner Bioregions			rainforest species with vines a major component.	within 10km (DSEWPaC, 2012b)	surrounding the beaches at Stanwell Park, Coalcliff Wombarra and Scarborough (NPWS, 2002).
Swamp Oak Floodplain forest of the NSW North Coast, Sydney basin and South East Corner Bioregions	EEC		Typically occurs below 20m asl on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes on coastal floodplains of NSW. Associated with grey-black clay-loams and sandy loams, saline or sub-saline groundwater. Structure variable from open forests to scrubs or reedlands with scattered trees. Canopy dominated by *Casuarina glauca* (north of Bermagui) or *Melaleuca ericifolia* (south of Bermagui). Understorey characterised by frequent occurrences of vines, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter.	**Recorded** within 10km (OEH, 2012b)	Present. Examples occur at several beaches where creeks flow out to sea; e.g. Stanwell Park, Bellambi, Corrimal, Puckey's (near Fairy Meadow and North Wollongong) (NPWS, 2002).
Swamp Sclerophyll forest on Coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	EEC		Usually occurs below 20m asl (sometimes up to 50m). Associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Characterised by open to dense tree layer of eucalypts and paperbarks, with trees up to or higher than 25m. Includes areas of fern land and tall reed or sedge land, where trees are sparse or absent.	**Recorded** within 10km (OEH, 2012b)	Present. Examples occur at Bellambi (NPWS, 2002).
Sydney Turpentine-Ironbark Forest	EEC	CEEC	Occurs on the Cumberland Plain, with most remnants in Baulkham Hills, Hawkesbury, Hornsby, Ku-ring-gai, Parramatta, Ryde, Sutherland and Wollondilly LGAs. Open forest characterised by *Syncarpia glomulifera, Eucalyptus*	**Recorded** within 10km (OEH, 2012b) **Predicted** to occur within 10km	Present. One example at MacCauley's Beach, but this is not near a

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
			punctata, Eucalyptus paniculata and E. eugenoides. In areas of high rainfall (over 1050mm per annum) E. saligna is more dominant. Sparse shrub stratum of *Pittosporum undulatum* and *Polyscias sambucifolia*.	(DSEWPaC, 2012b)	study area.
Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions	EEC		*Themeda australis* is the dominant species in the *Themeda* Grassland on seacliffs and coastal headlands EEC. The EEC is found on a range of substrates *Themeda australis* is an extremely widespread species, but in this community it may have a distinctive appearance, being prostrate and having glaucous leaves. *Banksia integrifolia* subsp. *integrifolia, Westringia fruticosa* and *Acacia sophorae* occurs as an emergent shrub or as a dense cover where they have recruited over grasslands. Smaller shrubs occur often as prostrate to dwarf forms.	**Recorded** within 10km (OEH, 2012b)	Present. Small patches occur, although inappropriately maintained at north Austinmer, Brickyard Point and City Beach.
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions	EEC		Occurs on landward side of mangrove stands in intertidal zones along the shores of estuaries and lagoons that are permanently or intermittently open to the sea. Characterised by *Baumea juncea, Juncus kraussii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis and Zoysia macrantha*, with occasional scattered mangroves occurring throughout the saltmarsh. Saltpans and tall reeds may also occur.	**Recorded** within 10km (OEH, 2012b)	Likely. Some appropriate habitat at mouths of creeks and Lake Illawarra near Windang and Port Kembla Beach, not recorded inside the study area.

Table B: Threatened Flora and Fauna that are present or likely to occur within the study area

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
Flora						
Callistemon linearifolius	Netted Bottlebrush	V		Recorded from the Georges to Hawkesbury Rivers in Sydney, and north to Nelson Bay. There is also a recent record from the northern Illawarra. In Sydney, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. Grows in dry sclerophyll forest on the coast and adjacent ranges.	**2 records** within 10km (OEH, 2012b)	Possible. No individuals recorded.
Chorizema parviflorum		EP; in Wollongong and Shellharbour LGAs		Recorded from between Austinmer and Albion Park in the local government areas of Wollongong and Shellharbour. All known sites occupy woodland or forest dominated by Forest Red Gum (*Eucalyptus tereticornis*) and/or Woollybutt (*E. longifolia*). May occur on coastal heathland (OEH, 2012b).	**4 records** within 10km (OEH, 2012b)	Possible. Small population occurs at Garie Beach which is not in study area.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Occurs in coastal areas from East Gippsland to southern Queensland. Habitat preferences not well defined. Grows mostly in coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest. Prefers open areas in the understorey and is often found in association with *Cryptostylis subulata* and the *Cryptostylis erecta.* Soils include moist sands, moist to dry clay loam and occasionally in accumulated eucalypt leaves. Flowers November-February.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. No individuals of this or associated species recorded.
Cynanchum elegans	White-flowering Wax Plant	E	E	Occurs from Gerroa (Illawarra) to Brunswick Heads and west to Merriwa in the upper Hunter. Most common near Kempsey. Usually occurs on the edge of dry rainforest or littoral rainforest, but also occurs in Coastal Banksia Scrub, open forest and woodland, and Melaleuca scrub. Soil and	**60 records** within 10km (OEH, 2012b) **Predicted** to occur within	Possible. No individuals recorded.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
				geology types are not limiting.	10km (DSEWPaC, 2012b)	
Pimelea spicata	Spiked Rice Flower	E	E	Disjunct populations within the Cumberland Plain (from Mount Annan and Narellan Vale to Freemans Reach and Penrith to Georges Hall) and Illawarra (from Mt Warrigal to Gerroa) (DEC, 2005a). In the Cumberland Plain region, restricted to areas which support or historically supported Cumberland Plain Woodland. Grows on well-structured clay soils derived from Wianamatta Shale. In the Illawarra, grows on variable soils in close proximity to the coast on hills or coastal headlands. Inhabits coastal woodland or grassland with emergent shrubs (DEC, 2005a).	**16 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. No individuals recorded.
Prostanthera densa	Villous Mint-bush	V	V	This species has been recorded from the Currarong area in Jervis Bay, Royal National Park, Cronulla, Garie Beach and Port Stephens (Gan Gan Hill, Nelson Bay). Also recorded in Bass and Flinders Point in Cronulla (OEH, 2012b). Generally grows in sclerophyll forest and shrubland on coastal headlands and near coastal ranges, chiefly on sandstone, and rocky slopes near the sea (OEH, 2012b).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. No individuals recorded.
Senna acclinis	Rainforest Cassia	E		Coastal districts and adjacent tablelands of NSW from the Illawarra in NSW to Queensland. Grows in or on the edges of subtropical and dry rainforest (OEH, 2012b).	**1 record** within 10km (OEH, 2012b)	Possible. No individuals recorded.
Streblus pendulinus	Siah's backbone		E	Siah's Backbone occurs from Cape York Peninsula to Milton, south-east New South Wales (NSW), as well as Norfolk Island (ATRP, 2010; Jessup, 2003; RBGT, 2011). Siah's Backbone is found in warmer rainforests, chiefly along watercourses. The species grows in well-developed rainforest, gallery forest and drier, more seasonal	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. No individuals recorded.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
				rainforest (ATRP, 2010).		
Syzygium paniculatum	Magenta Lilly Pilly	V	V	Occurs in narrow coastal strip from Bulahdelah to Conjola State Forest. Grows in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas, often in remnant littoral or gallery rainforests.	**2 records** within 10km (OEH, 2012b)	Possible; no individuals recorded. One specimen known in creekline upslope of Coalcliff.
Thesium australe	Austral Toadflax	V	V	ound in small, scattered populations along the east coast, orthern and southern tablelands. Occurs in grassland or rassy woodland, and is often found in association with angaroo Grass (*Themeda australis*).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. No individuals or populations recorded.
Birds						
Botaurus poiciloptilus	Australasian Bittern	E	E	Widespread but uncommon over most NSW except the northwest. Favours permanent freshwater wetlands with tall dense reedbeds particularly *Typha spp*.and *Eleocharis* spp., with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds mainly at night on frogs, fish, yabbies, spiders, insects and snails.	**7 records** within 10km (OEH, 2012b) Sighted within Swamp Oak forest along the banks of Tramways Creek (WCC, 2010). Council field surveys (2001) Bird flushed north of pumping station on Woodlands	Likely. Records from several surveys within the study areas including nearby Sandon Point study area and Bellambi Beach. May refuge within other study areas, or use parts of a movement corridor.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
					Creek (nearby Sandon Point), flew south west up Tramway Creek until disappeared behind vegetation. OEH, 2012b records at Bellambi Beach.	
Ixobrychus flavicollis	Black Bittern	V		Occurs from southern NSW to Cape York and the Kimberley, and southwest WA. Inhabits terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. May occur in flooded grassland, forest, woodland, rainforest and mangroves as long as there is permanent water. Roosts by day in trees or within reeds on the ground. Nests in branches overhanging water and breeds from December to March.	**15 records** within 10km (OEH, 2012b)	Likely. Records present from Bulli Beach and Woonona Beach. May forage within study area, or use parts of study area as a movement corridor.
Haematomus longirostris	Pied Oystercatcher	E		Scattered along NSW coast. Favours intertidal flats of inlets and bays, open beaches and sandbanks. Forages on exposed sand, mud and rock at low tide. Nests mostly on coastal or estuarine beaches; occasionally saltmarsh or grassy areas.	**15 records** within 10km (OEH, 2012b), records on Austinmer Beach. **Known habitat** on several beaches within	Likely. Breeding record at Windang Island 2011

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
					the Wollongong LGA (WCC, 2010).	
Haematopus fuliginosus	Sooty Oystercatcher	V	M	Evenly distributed along NSW coast, including offshore islands. Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries. Forages on exposed rock or coral at low tide. Breeds almost exclusively on offshore islands, and occasionally on isolated promontories.	**68 records** within 10km (OEH, 2012b), records on Coledale, Austinmer, Sandon Point Beaches. Records from McCauley's Beach Thirroul, 2010 (WCC, 2010). Field survey observations of individuals at Sandon Point.	Likely. Known habitat on several beaches and rocky shores within the Wollongong LGA (WCC 2010). Including Towradgi Beach, McCauley's Beach, Thirroul and Sandon Point.
Sternula nereis nereis	Australian Fairy Tern		V	Occurs along NSW coast. Inhabit offshore, estuarine or lake islands, wetlands, beaches and spits. Nests on coral shingle on continental islands or coral cays, on sandy islands and beaches inside estuaries and on open sandy beaches.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. Previously occurred along the east coast of NSW, but unknown whether it persists in NSW (DSEWPaC, 2012).

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
Rostratula australis	Australian Painted Snipe	E	V, M	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and seeds. Prefers fringes of swamps, dams and nearby marshy areas with cover of grasses, lignum, low scrub or open timber.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. Beaches such as Bellambi and Corrimal Beach study areas adjoin waterbodies and riparian vegetation potentially suitable for foraging for this species.
Ninox connivens	Barking Owl	V		Occurs from coast to inland slopes and plains, though is rare in dense, wet forests east of the Great Dividing Range and sparse in higher parts of the tablelands and in the arid zone. Inhabits eucalypt woodlands, open forest, swamp woodlands, and, especially in inland areas, timber along watercourses. Roosts along creek lines in dense, tall understorey foliage (e.g. in Acacia and Casuarina), or dense eucalypt canopy. Nests in hollows of large, old eucalypts including *Eucalyptus camaldulensis, Eucalyptus albens, Eucalyptus polyanthemos* and *Eucalyptus blakelyi*. Birds and mammals important prey during breeding. Territories range from 30 to 200 hectares.	**4 records** within 10km (OEH, 2012b)	Possible. Beaches such as Bellambi and Corrimal Beach study areas adjoin watercourses potentially suitable for foraging for this species. Dune vegetation continuous with wet forest vegetation may also provide foraging habitat. Unlikely to roost or breed in the study area given the lack of suitable hollows.
Esacus neglectus	Beach Stone-curlew	CE	Marine	In NSW occurs regularly from the Manning River north, with occasional vagrants to SE NSW and Victoria. Inhabit a range of beaches, islands, reefs and in estuaries. Often seen near mangroves. Forage in the intertidal zone of beaches and estuaries, on islands, flats, banks and spits of sand, mud, gravel or rock, and among mangroves. Nests area shallow scrape above the littoral zone, among low	**1 record** within 10km (OEH, 2012b)	Possible Could forage in the intertidal zones of the study areas. Preferred breeding habitat (low vegetation; as described in habitat association) also

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
				vegetation of grass, scattered shrubs or low trees; also among open mangroves or on sandbanks.		available within study areas containing dune vegetation such as Windang Beach.
Ephippiorhynchus asiaticus	Black-necked Stork	E		In NSW, becomes increasingly uncommon south of the Northern Rivers region, and rarely occurs south of Sydney. Breeding recorded as far south as Buladelah, though most breeding in NSW occurs in the north-east. Primarily inhabits permanent freshwater wetlands and surrounding vegetation including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters. Will also forage in inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water. Breeds during summer, nesting in or near a freshwater swamp.	**1 record** within 10km (OEH, 2012b)	Possible. Beaches such as Bellambi and Corrimal Beach study areas adjoin or encompass waterbodies and riparian vegetation potentially suitable for foraging for this species.
Dasyornis brachypterus	Eastern Bristlebird	E	E	Occurs in three disjunct areas of south-eastern Australia: southern Queensland/northern NSW, the Illawarra Region and in the vicinity of the NSW/Victorian border. Illawarra population comprises an estimated 1600 birds, mainly from Barren Grounds Nature Reserve, Budderoo National Park and the Jervis Bay area. Habitat characterised by dense, low vegetation including heath and open woodland with a heathy understorey. The fire history of habitat is important, and the Illawarra and southern populations reach maximum densities in habitat	34 records within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. Suitable heath vegetation within the study areas such as Bulli Beach, Port Kembla and Sandon Point. May use parts of study areas as a movement corridor.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
				that have not been burnt for over 15 years.		
Stictonetta naevosa	Freckled Duck	V		Breeds in large, ephemeral swamps in the Murray-Darling, particularly along the Paroo and Lachlan Rivers and other Riverina rivers. In drier times moves to more permanent waters. Disperses during extensive inland droughts and may be found in coastal areas during such times. Prefers freshwater swamps/creeks with dense Cumbungi, Lignum or tea-tree. Nests in dense vegetation at or near water level.	**7 records** within 10km (OEH, 2012b)	Possible Beaches such as Bellambi and Corrimal Beach study areas adjoin or encompass waterbodies and riparian vegetation potentially suitable for foraging for this species.
Callocephalon fimbriatum	Gang-gang Cockatoo	V		Restricted to SE coast and highlands south from the Hunter Valley. Spends summer in tall mountain forests and woodlands, usually heavily timbered and mature wet sclerophyll forests. Winters at lower altitudes in drier more open eucalypt forest and woodlands, particularly in coastal areas. Nests in summer in large tree hollows, often close to water, usually in tall mature sclerophyll forests with a dense understorey, and occasionally in coastal forests. Feeds on seeds, particularly Eucalyptus and Acacia, also berries, fruit and insects (Higgins, 1999).	**83 record** within 10km (OEH, 2012b)	Possible. May forage in the study areas such as Stanwell Park, Coalcliff Beach, Sandon Point and Bulli Beach. Unlikely to roost or breed in the study area given the lack of suitable hollows sited during GHD surveys.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		Widespread but uncommon from coast to southern tablelands and central western plains. Feeds almost exclusively on the seeds of Allocasuarina species. Prefers woodland and open forests, rarely away from Allocasuarina. Roost in leafy canopy trees, preferably eucalypts, usually <1km from feeding site. Nests in large	**14 records** within 10km (OEH, 2012b)	Possible. May forage in tall trees adjoining continuous vegetation in some study areas. Unlikely to roost or breed in the study area

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
				(approx. 20cm) hollows in trees, stumps or limbs, usually in Eucalypts (Higgins, 1999).		given the lack of suitable hollows.
Tyto novaehollandiae	Masked Owl	V		Occurs across NSW except NW corner. Most common on the coast. Inhabits dry eucalypt woodlands from sea level to 1100m. Roosts and breeds in large (>40cm) hollows and sometime caves in moist eucalypt forested gullies. Hunts along the edges of forests and roadsides. Home range between 500ha and 1000ha. Prey mostly terrestrial mammals but arboreal species may also be taken.	**11 records** within 10km (OEH, 2012b)	Possible. Beaches such as Bellambi and Corrimal Beach study areas adjoin watercourses potentially suitable for foraging for this species. Dune vegetation continuous with wet forest vegetation may also provide foraging habitat. Unlikely to roost or breed in the study area given the lack of suitable hollows.
Ninox strenua	Powerful Owl	V		Occurs from the coast to the western slopes. Solitary and sedentary species. Inhabits a range of habitats from woodland and open sclerophyll forest to tall open wet forest and rainforest. Prefers large tracts of vegetation. Nests in large tree hollows (> 0.5m deep), in large eucalypts (dbh 80-240cm) that are at least 150 years old. Pairs have high fidelity to a small number of hollow-bearing nest trees and defend a large home range of 400 - 1,450ha. Forages within open and closed woodlands as well as open areas.	**42 records** within 10km (OEH, 2012b)	Possible. Dune vegetation continuous with wet forest vegetation may also provide foraging habitat. Unlikely to roost or breed in the study area given the lack of suitable hollows.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
Charadrius ruficapillus	Red-capped Plover		Marine	This species is widespread throughout Australia and is vagrant in New Zealand. Found in pairs or small groups along sandy beaches, coastal lagoons, estuaries, bays and inland saline wetlands	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. Could potentially forage in some patches. Records have been observed outside the study area of Windang Beach.
Xanthomyza phrygia	Regent Honeyeater	E	E	In NSW confined to two known breeding areas: the Capertee Valley and Bundarra-Barraba region. Non-breeding flocks occasionally seen in coastal areas foraging in flowering Spotted Gum and Swamp Mahogany forests, presumably in response to drought. Inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	**2 records** within 10km (OEH, 2012b)	Possible. May forage in native vegetation within study areas such as Coledale Beach, Bulli Beach and Woonona or use parts of study area as a movement corridor.
Ptilinopus regina	Rose-crowned Fruit-Dove	V		Occurs along the coast and ranges of eastern NSW and Queensland, from Newcastle to Cape York; occasionally found further south to Victoria. Occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful (OEH, 2012b).	**8 records** within 10km (OEH, 2012b)	Possible. Some suitable fig trees present at Thirroul Beach. May forage on occasion. Suitable breeding habitat not present.
Tyto tenebricosa	Sooty Owl	V		Occurs in the coastal, escarpment and tablelands regions of NSW. More common in the north and absent from the western tablelands and further west. Inhabits tall, moist	**77 records** within 10km	Possible. May forage in the study

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
				eucalypt forests and rainforests, and are strongly associated with sheltered gullies, particularly those with tall rainforest understorey. Roosts in tree hollows, amongst dense foliage in gullies or in caves, recesses or ledges of cliffs or banks. Nests in large (>40cm wide, 100 cm deep) tree hollows in unlogged/unburnt gullies within 100m of streams or in caves.	(OEH, 2012b)	area. Unlikely to roost or breed in the study area given the lack of suitable hollows.
Ptilinopus superbus	Superb Fruit-Dove	V	Marine	Occurs mainly north from NE NSW, much less common further south and largely confined to pockets of habitat south to Moruya. Vagrants occur south to Victoria and Tasmania. Inhabits rainforest and closed forests, may also forage in eucalypt or acacia woodland with fruit-bearing trees. Nests 5-30m above ground in rainforest/rainforest edge tree and shrub species. Part of the population migratory/nomadic.	**2 records** within 10km (OEH, 2012b)	Possible. May forage on occasion. Suitable breeding habitat not present. Some suitable fig trees present at Thirroul Beach. May forage on occasion. Suitable breeding habitat not present.
Lathamus discolor	Swift Parrot	E	E	Migratory, travelling to the mainland from March to October. Breeds in Tasmania from September to January. On the mainland, it mostly occurs in the southeast foraging on winter flowering eucalypts and lerps, with records of the species between Adelaide and Brisbane. Principal over-winter habitat is box-ironbark communities on the inland slopes and plains. *Eucalyptus robusta, Corymbia maculata* and C. *gummifera* dominated coastal forests are also important habitat.	31 records within 10km (OEH, 2012b) Predicted to occur within 10km (DSEWPaC, 2012b)	Possible. May forage on occasion within study areas such as Woonona Beach. Suitable breeding habitat not present.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
Neophema pulchella	Turquoise Parrot	V		Occurs from coast to inland slopes. In coastal area, most common between Hunter and Northern Rivers, and further south in S Coast. Inhabits open eucalypt woodlands and forests, typically with a grassy understorey. Favours edges of woodlands adjoining grasslands or timbered creek lines and ridges. Feeds on the seeds of native and introduced grasses and other herbs. Grasslands and open areas provide important foraging habitat for this species while woodlands provide important roosting and breeding habitat. Nests in tree hollows, logs or posts from August to December.	**4 records** within 10km (OEH, 2012b)	Possible. May forage on occasion within grasslands present at various sites. Suitable breeding habitat not present.
Daphoenositta chrysoptera	Varied Sittella	V		Sedentary, occurs across NSW from the coast to the far west. Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Sensitive to habitat isolation and loss of structural complexity, and adversely affected by dominance of Noisy Miners. Cleared agricultural land is potentially a barrier to movement. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	**9 records** within 10km (OEH, 2012b)	Possible. Where dune vegetation is continuous with forest vegetation may provide foraging habitat such as Macauley's Beach and Sandon Point.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
Epthianura albifrons	White-fronted Chat	V		This species occurs from southern Queensland to Western Australia and down to Tasmania, mostly in temperate to arid climates and very rarely in sub-tropical areas. It is found in damp open habitats, particularly wetlands containing saltmarsh areas that are bordered by open grasslands. Along the coast they are found in estuarine and marshy habitats with vegetation <1m tall, and in open grasslands and areas bordering wetlands. Inland, they are often observed in grassy plains, saltlakes and saltpans along waterway margins.	**8 records** within 10km (OEH, 2012b)	Possible. May forage in dune vegetation on occasion. Suitable Coastal Saltmarsh nearby Windang.
Mammals						
Petauroides volans	Greater Glider	EP; Eurobodalla LGA		Occurs in Eucalypt forests and woodlands along the east coast from North Queensland to the Central Highlands of Victoria. Feed predominantly on eucalypt leaves, buds, flowers and mistletoe. Shelters in tree hollows, and can use up to 18 hollows within their range (OEH, 2012b).	Records as far south as Austinmer Beach. Gary Leonard *pers. Comm*, 2013.	Possible. Foraging habitat available in heath vegetation at Austinmer Beach, Bulli Beach, Port Kembla and Stanwell Park.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		Generally occurs east of the Great Dividing Range along NSW coast (Churchill, 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest. Essentially a cave bat but may also roost in road culverts, stormwater tunnels and other man-made structures. Only four known maternity caves in NSW, near Wee Jasper,	**47 records** within 10km (OEH, 2012b).	Possible. May fly over and forage within the study area on occasion; vegetation within Bulli Beach, Coledale Beach, Woonona, North Wollongong Beach

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
				Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony (Churchill, 2008).		and Port Kembla Beach may provide foraging habitat.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		Occurs on southeast coast and ranges. Prefers tall (>20m) and wet forest with dense understorey. Absent from small remnants, preferring continuous forest but can move through cleared landscapes and may forage in open areas. Roosts in hollow trunks of Eucalypts, underneath bark or in buildings. Forages in gaps and spaces within forest, with large foraging range (12km foraging movements recorded) (Churchill, 2008, Law et al., 2008).	**8 records** within 10km (OEH, 2012b)	Possible. May forage within study area, or use parts of study area as a movement corridor along study areas within continuous vegetation.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
Cercartetus nanus	Eastern Pygmy-possum	V		Occurs along the east coast of NSW, and inland to the Pillaga, Dubbo, Parkes and Wagga Wagga. Inhabits range of habitats from coastal heath and woodland though open and closed forests, subalpine heath and rainforest (Tulloch and Dickman, 1995). Inhabits rainforest, sclerophyll forests and heath. Banksia spp. and myrtaceous shrubs and trees are favoured food sources and nesting subject sites in drier habitats. Diet mostly pollen and nectar from *Banksia* spp., *Eucalyptus* spp., *Callistemon* spp. and insects (Ward and Turner, 2008). Nests in hollows in trees, under the bark of Eucalypts, forks of tea-trees, abandoned bird nests and *Xanthorrhoea* bases (Ward and Turner, 2008, Tulloch and Dickman, 2006).	**63 records** within 10km (OEH, 2012b)	Possible. Suitable foraging habitat present within the study areas such as Bulli Beach and Sandon Point Beach.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Roosts in camps within 20km of a regular food source, typically in gullies, close to water and in vegetation with a dense canopy. Forages in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and street trees, particularly in eucalypts, melaleucas and banksias. Highly mobile with movements largely determined by food availability (Eby and Law, 2008). Will also forage in urban gardens and cultivated fruit crops.	**58 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. Could forage throughout the study areas.
Arctocephalus pusillus doriferus	Australian Fur Seal	V		Reported from New South Wales to South Australia. Breeds at ten known locations in Bass Strait, may have historically bred at Seal Rocks. Haul out sites are present	**Predicted** to occur within 10km	Possible. Possible use of beaches in

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
				along the NSW coast, notably Montague Island, Steamers Beach and Green Cape. Uses flat or sloping rocky sites for breeding and haul out sites. Preys on squid, school fish and bottom-dwelling fish, octopus and crustaceans.	(DSEWPaC, 2012b)	Wollongong LGA for resting or if injured or tired.
Myotis macropus	Southern Myotis	V		Mainly coastal but may occur inland along large river systems. Usually associated with permanent waterways at low elevations in flat/undulating country, usually in vegetated areas. Forages over streams and watercourses feeding on fish and insects from the water surface. Roosts in a variety of habitats including caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage, typically in close proximity to water (Campbell, 2011). Breeds November or December (Churchill, 2008).	**44 records** within 10km (OEH, 2012b)	Possible. May forage within study area, or use parts of study area as a movement corridor.
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750ha and males up to 3,500ha, usually traversed along densely vegetated creek lines.	**7 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. May forage within study area, or use parts of study area as a movement corridor. Unlikely to breed in these habitats.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
Reptiles						
Chelonia mydas	Green Turtle	V	V	Typically found in tropical waters around Australia but also occurs in coastal waters of NSW, where it is generally seen on the north or central coast, with occasional records from the south coast (OEH, 2012b). Ocean-dwelling species spending most of its life at sea. Eggs laid in holes dug in beaches throughout their range (OEH, 2012b).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible use of beaches in Wollongong LGA for resting or if injured.
Frogs						
Litoria aurea	Green and Golden Bell Frog	E	V	Formerly occurred from Brunswick Heads to Victoria, but >80% populations now extinct. Inhabits marshes, natural and artificial freshwater to brackish wetlands, dams and in stream wetlands (DEC, 2005b). Prefers sites containing cumbungi *(Typha* spp.) or spike rushes (*Eleocharis* spp.), which are unshaded and have a grassy area and/or rubble as shelter/refuge habitat nearby. *Gambusia holbrooki* is a key threat as they feed on Green and Golden Bell Frog eggs and tadpoles.	**485 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b) Three records of individuals at Hewitts and Woodlands Creeks (WCC, 2010).	Possible. May forage within study area, or use parts of study area as a movement corridor. Records nearby Sandon Point. Wetland vegetation types nearby Bellambi Beach, Corrimal Beach and Towradgi Beach. Bellambi Lagoon Reserve may also contain suitable habitat.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of record	Likelihood of occurrence within the study areas
Litoria littlejohni	Littlejohns Tree frog	V	V	Occurs on plateaus and eastern slopes of the Great Dividing Range south from Watagan State Forest. Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground.	**10 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. Heath based vegetation present within Bulli Beach Port Kembla and Sandon Point. May forage on occasion. Suitable breeding habitat not present.

Table C: Endangered Ecological Communities that are unlikely to or do not occur within the study area

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
Kurnell Dune Forest in the Sutherland Shire and City of Rockdale	EEC		Occurs within Sutherland and Rockdale LGAs. Occurs on coastal dune sand. Kurnell Dune Forest has a forest structure rather than the predominantly scrub structure of Eastern Suburbs Banksia Scrub (ESBS); and KDF occurs on younger sands than those of ESBS.	**Recorded** within 10km (OEH, 2012b)	Unlikely. Study area does not extend into these LGAs.
Agnes Banks Woodland in the Sydney Basin Bioregion	EEC		Most remnants occur near Agnes Banks in Penrith LGA, on eastern bank of the Hawkesbury River. Occurs on aeolian sands overlaying Tertiary alluviums. Structure varies from low woodland on higher ridges to sedgeland in low-lying depressions. Characteristic species include *Eucalyptus sclerophylla*, *Angophora bakeri* and *Banksia serrata*.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Blue Gum High Forest in the Sydney Basin Bioregion	EEC	CEEC	Occurs on the Hornsby Plateau, north eastern edge of the Cumberland Plain with most remnants in Hornsby, Ku-ring-gai and Baulkham Hills LGAs. Typically occurs in high rainfall areas on fertile soils derived from Wianamatta shale. Grades into Sydney Turpentine-Ironbark Forest at lower rainfall areas. Moist, tall open forest characterised by *Eucalyptus saligna* and E. *pilularis*. Usually has small tree layer of *Pittosporum undulatum*, *Elaeocarpos reticulatus* and *Allocasuarina torulosa* over a low, open shrub layer and an understorey of grasses, herbs and ferns.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion	VEEC		Occurs almost exclusively on soils derived from Tertiary alluvium, or on sites located on adjoining shale or Holocene alluvium, with known occurrences in the Bankstown, Blacktown, Campbelltown, Hawkesbury, Liverpool and Penrith LGAs. Typically on sandy soils and on slightly higher ground than Castlereagh Ironbark Forest or Shale Gravel Transition Forest (Tozer, 2003). Dominated by *Eucalyptus parramattensis subsp. parramattensis*, *Angophora bakeri* and *E. sclerophylla*. A small tree stratum of *Melaleuca decora* is sometimes present, generally in areas with poorer drainage. It has a well-developed sclerophyllous shrub stratum over a diverse range of forbs.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion	EEC		Occurs on the Cumberland Plain with the most extensive stands in Castlereagh and Holsworthy areas. Smaller remnants in Kemps Creek area and eastern section of the Cumberland Plain. Ranges from open forest to low woodland, with a canopy dominated by *Eucalyptus fibrosa* and *Melaleuca decora* along with other species of eucalypt. Dense shrubby understorey of *Melaleuca nodosa*, *Lissanthe strigosa* and *Fabaceae sp* over sparse ground layer of grasses and herbs.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Cumberland Plain Woodland in the Sydney Basin Bioregion	EEC	CEEC	Grassy woodland/forest endemic to the hills and plains of the Cumberland Plain. Canopy typically dominated by *Eucalyptus moluccana*, and *E. tereticornis*, with *E. crebra*, *Corymbia maculata* and *E. eugenoides* occurring less frequently. Shrub layer dominated by *Bursaria spinosa*, and	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
			grasses such as *Themeda australis* and *Microlaena stipoides* var *stipoides*.		
Elderslie Banksia Scrub Forest	EEC		Occurs only in the Elderslie area, near Camden, in Sydney's south-west (15ha in total). Unique as includes plants, such as coastal Banksia and other sandstone region species, which do not occur in the surrounding Cumberland Plain communities (OEH, 2012b.) Occurs only on sand deposits on the old terraces deposited by ancient river systems of what is now the Nepean River and requires deep sand soils to regenerate (OEH, 2012b).	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Illawarra subtropical rainforest in the Sydney Basin Bioregion	EEC		Occurs on Illawarra coastal plain and foothills and rarely upper escarpment slopes. NPWS (2002) vegetation mapping demonstrates the occurrence of some Coastal Sand Scrub to the Shoalhaven in the south and Kangaroo Valley in the west. Canopy height and density varies greatly depending on disturbance and some stands may be scrub. Characteristic tree species include *Baloghia inophylla, Brachychiton acerifolius, Dendrocnide excelsa, Diploglottis australis, Ficus* spp., *Pennantia cunninghamii*, and *Toona ciliata*.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Melaleuca armillaris Tall Shrubland in the Sydney Basin Bioregion	EEC		Occurs in Shellharbour and Kiama LGAs, on very dry rocky ridges away from the coast, usually where volcanic soils overlay latite. Typically a dense, dry shrubland to 5m tall, dominated *by Melaleuca armillaris*. Does not include dense stands of *M. armillaris* on coastal headlands.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
Moist Shale Woodland in the Sydney Basin Bioregion	EEC		Occurs on clay soils from Wianamatta Shale in the southern half of the Cumberland Plain, and is intermediate between Cumberland Plain Woodland and Western Sydney Dry Rainforest. Similar to Cumberland Plain Woodland but with more mesic shrub understorey. Dominant canopy trees include Forest Red Gum *Eucalyptus tereticornis*, Grey Box *E. moluccana*, Narrow-leaved Ironbark *E. crebra* and Spotted Gum *Corymbia maculata*. Small trees, such as Hickory Wattle *Acacia implexa* and Sydney Green Wattle *A. parramattensis ssp parramattensis* are also common. The shrub layer includes *Breynia oblongifolia*, *Hairy Clerodendrum Clerodendrum tomentosum* and *Indian Weed Siegesbeckia orientalis ssp orientalis.*	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	EEC		Occurs above 4-500m asl on undulating tablelands and plateaus, typically on basic volcanic , fine grained sedimentary substrates or occasionally granite. Associated with accumulations of peaty or organic mineral sediments on poorly drained flats in stream headwaters. Dense, open or sparse layer of shrubs with soft-leaved sedges, grasses and forbs. Only type of wetland that may contain more than trace amounts of mosses (*Sphagnum* spp.). Small trees may be absent, or present as scattered emergent.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
Mount Gibraltar Forest in the Sydney Basin Bioregion	EEC	EEC	Confined to a small number of pockets in the Southern Highlands region mainly near Bowral and Mittagong. Occurs in the Wingecarribee LGA, but may occur elsewhere in the Sydney Basin Bioregion. Restricted to clay soils on microsyenite intrusions in the central parts of the Southern Highlands. Occurs on gentle to steep slopes with correspondingly deep and shallow soils respectively; combined with aspect, these factors contribute to the variability evident in the floral composition of this community (OEH, 2012b).	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
O'Hares Creek Shale Forest	EEC		The community occupies approximately 286ha within the LGAs of Campbelltown, Wollondilly and Wollongong between the Cataract Special Area and Appin Road to Helensburgh (OEH, 2012b). Forms part of a network of vegetation communities that occupy the remnant shales soils that lie above the sandstone plateau. The community is a component of the more broadly occurring Red Bloodwood - Smooth-barked Apple shrubby forest on shale or ironstone of coastal plateau, Sydney Basin community (OEH, 2012b).	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	EEC		Occurs on flats, drainage lines and river terraces of coastal floodplains where flooding is periodic and soils generally rich in silt, lack deep humic layers and have little or no saline (salt) influence. Occurs south from Port Stephens in the NSW North Coast, Sydney Basin and South East Corner bioregions. Characterised by a tall open canopy layer of eucalypts with	**Recorded** within 10km (OEH, 2012b)	Unlikely. This community is more common in the broader floodplain of West Dapto, on heavier clay soils. It shares some similarities with Swamp Sclerophyll Forest which is

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
			variable species composition.		found within the study area on the coastline.
Robertson Basalt Tall Open-forest in the Sydney Basin Bioregion	EEC		Typically restricted to occurrences of Robertson Basalt in the southern highlands, also on Cambewarra range to the south. Grows on highly fertile soils derived from basalt, on the slopes of rolling hills in areas of 1000-1600mm annual rainfall. Open forest or woodland to 30m tall with a sparse to moderately dense shrub layer and a dense herbaceous ground layer. Dominant tree species include *Eucalyptus fastigata, E. viminalis, E. radiata* and *E. cypellocarpa. Acacia melanoxylon* is a common small tree species in this community.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Robertson Rainforest in the Sydney Basin Bioregion	EEC		Occurs mainly on the Robertson Plateau, also on the higher parts of the Cambewarra Range. Grows between 500-700m asl and appears to be restricted to Robertson Basalt. Warm or cool temperate rainforest with generally dense structure. Dominated by *Quintinia sieberi, Polyosma cunninghamii, Doryphora sassafras* and *Acacia melanoxylon*.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
Shale gravel Transition Forest in the Sydney Basin Bioregion	EEC	CEEC	Primarily in the northern section of the Cumberland Plain, also found in Liverpool/Holsworthy, Bankstown, Yennora, Villawood and Kemps Creek areas. Occurs primarily where shallow deposits from ancient river systems overlay shale soils, but also associated with localised concentrations of iron-hardened gravel. Open forest with canopy dominated by *Eucalyptus fibrosa*, *E. moluccana* and *E. tereticornis*, often with small tree layer of *Melaleuca decora* over a sparse shrub layer. Grades into Cumberland Plain Woodland where the influence of gravel soil declines, and into Cooks River/Castlereagh Ironbark Forest or Castlereagh Scribbly Gum Woodland where gravel deposits are thick.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Shale/Sandstone Transition Forest	EEC	EEC	Occurs mainly in the north of the Cumberland Plain in Richmond, Marsden Park and Windsor districts, but is also found in Liverpool/Holsworthy, Bankstown, Yennora, Villawood and the Kemps Creek areas. Open forest structure with canopy dominated by *Eucalyptus fibrosa*, *E. moluccana* and *E. tereticornis*, with *Melaleuca decora* also common. Shrub layer characterised by *Bursaria spinosa*, *Daviesia ulicifolia*, and *Lissanthe strigosa*.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Southern Highlands Shale Woodlands in the Sydney Basin Bioregion	EEC		Restricted to sheltered heads and upper slopes of gullies on transitional zones where sandstone outcrops may exist, but where soils are influenced by lateral movement of moisture, nutrients and sediment from more fertile substrates in an area bounded by Hurstville, Carss Park, Bundeena, Otford, Stanwell Tops, Darkes Forest, Punchbowl Creek and Menai.	**Recorded** within 10km (OEH, 2012b)	Nil Not recorded; no appropriate habitat

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
			Open forest dominated by *Angophora costata*, *Eucalyptus piperita* and occasional *E. pilularis* over scattered subcanopy trees, a diverse shrub layer and well-developed groundcover of ferns, forbs, grasses and graminoids. Variable species composition.		
Southern Sydney sheltered forest on transitional sandstone soils in the Sydney Basin Bioregion	EEC		Restricted to sheltered heads and upper slopes of gullies on transitional zones where sandstone outcrops may exist, but where soils are influenced by lateral movement of moisture, nutrients and sediment from more fertile substrates in an area bounded by Hurstville, Carss Park, Bundeena, Otford, Stanwell Tops, Darkes Forest, Punchbowl Creek and Menai. Open forest dominated by *Angophora costata, Eucalyptus piperita* and occasional *E. pilularis* over scattered subcanopy trees, a diverse shrub layer and well-developed groundcover of ferns, forbs, grasses and graminoids. Variable species composition.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.
Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions	EEC		Occurs on plateaus and tablelands between 600-900m asl with loam or clay soils derived primarily from basalt, but may also be derived from mudstones, granites, alluvium and other substrates. Known from Bathurst Regional, Goulburn Mulwaree, Oberon, Palerang, Shoalhaven, Upper Lachlan and Wingecarribee LGAs. Open, variable canopy which may include Ribbon Gum, Narrow-leaved Peppermint, Mountain Gum and Snow Gum, over a sparse shrub layer and dense groundcover of herbs and grass. Community also includes	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.

Community	TSC Act	EPBC Act	Habitat Association	Details of record	Presence in study areas
			derived native grasslands where trees have been removed.		
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion		EEC	Generally confined to the Sydney Basin IBRA Bioregion although some occurrences may extend outside the Sydney Basin Bioregion boundary, e.g. the southern extent at Sassafras, east of Nerriga NSW, and patches on the Boyd Plateau and Mt Werong. Generally tall open eucalypt forests found on igneous rock (predominately Tertiary basalt and microsyenite) in, or adjacent to, the Sydney Basin Bioregion.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Nil. Not recorded; no appropriate habitat.
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	EEC		Restricted to hilly country where it occurs on clay soils derived from Wianamatta shale on sheltered lower slopes and gullies. Very restricted and occurs mostly in the Razorback Range near Picton. Outlying occurrences at Grose Vale and Cattai. Canopy trees include *Melaleuca styphelioides*, *Acacia implexa* and A*lectryon subcinereu*s. Shrub layer includes rainforest species *Notolaea longifolia, Clerodendrum tomentosum* and *Pittosporum* revolutum. The shrub layer combines with vines to form dense thickets in sheltered locations.	**Recorded** within 10km (OEH, 2012b)	Nil. Not recorded; no appropriate habitat.

Table D: Threatened Flora and Fauna that are unlikely occur within the study area

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Flora						
Acacia baueri subsp. aspera		V		Restricted to the Sydney region; Kings Tableland in the central Blue Mountains and with sporadic occurrences on the Woronora Plateau in the Royal National Park, Mt. Keira district and at Wedderburn, Woronora Plateau in the Flat Rock Junction and Stanwell Tops area of the Illawarra. Occurs in low, damp heathlands, often on exposed rocky outcrops over a wide range of climatic and topographical conditions (OEH, 2012b).	**8 records** within 10km (OEH, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Acacia bynoeana	Bynoe's Wattle	E	V	Endemic to central eastern NSW, currently known from only 34 locations, many of only 1-5 plants. Grows mainly in heath/ dry sclerophyll forest on sandy soils, prefers open, sometimes slightly disturbed sites such as trail margins, road edges, and in recently burnt open patches. Flowers September to March, and fruit matures in November.	**41 records** within 10km (OEH, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Arthropteris palisotii	Lesser Creeping Fern	E		Occurs on the Illawarra Escarpment, North-eastern NSW and also in Queensland. Occurs in rainforest, mainly on tree trunks (OEH, 2012b).	**1 record** within 10km (OEH, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Astrotricha crassifolia	Thick-leaf Star-hair	V	V	Occurs near Patonga (Gosford LGA), and in Royal NP and on the Woronora Plateau (Sutherland and Campbelltown LGAs). There is also a record from near Glen Davis (Lithgow LGA). Grows on dry ridge tops to 30m altitude, associated	**155 records** within 10km (OEH, 2012b) **Predicted** to	Unlikely. Not recorded; no appropriate habitat.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
				with very rich heath, or dry sclerophyll woodland on sandstone.	occur within 10km (DSEWPaC, 2012b)	
Boronia deanei	Deane's Boronia	V	V	This small erect shrub is found in scattered populations between the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves. The species grows on the margins of high altitude swamps, in wet heath on sandstone, and in drier open forest.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Caladenia tessellata		E	V	Occurs from Central Coast NSW to southern Victoria. Mostly coastal but extends inland to Braidwood in southern NSW. In NSW grows in grassy dry sclerophyll woodland on clay loam or sandy soils, and less commonly in heathland on sandy loam soils (Duncan, 2010).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Callitris endlicheri	Black Cypress Pine, Woronora Plateau population	EP		Occurs on Woronora Plateau, in the Wollongong LGA, represents the coastal limit of the species' range and is disjunct from other known populations of the species. Restricted to a single outcrop of sandstone (2ha). Usually found on stony hills or ridges from both plains and coastal ranges (OEH, 2012b)	**4 records** within 10km (OEH, 2012b)	Unlikely. Not recorded; no appropriate habitat

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Daphnandra johnsonii	Illawarra Socketwood	E	E	Rainforest tree to 20 metres tall. Restricted to the Illawarra region where it has been recorded from the local government areas of Shoalhaven, Kiama, Shellharbour and Wollongong. Occupies the rocky hillsides and gullies of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Daphnandra sp. C Illawarra	Illawarra Socketwood	E	E	Rainforest tree to 20 metres tall. Restricted to the Illawarra region where it has been recorded from the local government areas of Shoalhaven, Kiama, Shellharbour and Wollongong. Occupies the rocky hillsides and gullies of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes.	**6 records** within 10km (OEH, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Epacris purpurascens var. purpurascens		V		Occurs from Gosford in the north, Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South. Grows in a range of sclerophyll forest, scrubs and swamps, most of which have a strong shale soil influence.	**20 records** within 10km (OEH, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Eucalyptus camfieldii	Camfield’s Stringybark	V	V	Occurs from Raymond Terrace to Waterfall, with populations known from Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai and the Royal NP. Occurs in exposed situations on sandstone plateaus, ridges and slopes near the coast, often on the boundary of tall coastal heaths or low open woodland. It grows in shallow sandy soils overlying Hawkesbury sandstone.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Eucalyptus corticosa	Creswick Apple Box	V		Restricted to a small area near Mount Coricudgy in the Rylstone area on the Central Tablelands. Occurs in sclerophyll woodland on shallow infertile soils on sandstone ridges associated with the upper reaches of the Cudgegong River; often associated with *Eucalyptus rossii* (OEH, 2012b).	**1 record** within 10km from 1994; location details not released (OEH, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V	Occurs between Moss Vale/Bargo and lower Hunter Valley, with most occurrences in Appin, Wedderburn, Picton and Bargo. Broad habitat range including heath, shrubby woodland and open forest on light clay or sandy soils, and often in disturbed areas such as on the fringes of tracks.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Irenepharsus trypherus	Illawarra Irene	E	E	Recorded from 18 sites within the Kiama, Shellharbour, Shoalhaven, Tallaganda, Wingecarribee and Wollongong LGAs. Typically occurs on steep rocky slopes near cliff lines and ridge tops. Associated vegetation includes moist sclerophyll forest, *Backhousia myrtifolia* thicket and rainforest. Typically occurs on steep rocky slopes near cliff lines and ridge tops. Associated vegetation includes moist sclerophyll forest, *Backhousia myrtifolia* thicket and rainforest.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Lespedeza juncea subsp. sericea		EP; in the Wollongong LGA		Occurs south of Dapto in the Wollongong LGA. Disjunct from the other non-endangered populations which occur in western Sydney. The known population comprised about 200 plants; located in a small strip of open forest	**1 record** within 10km (OEH, 2012b) **Predicted** to	Unlikely. Not recorded; no appropriate habitat.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
				dominated by *Eucalyptus tereticornis* (Forest Red Gum), *E. longifolia* (Woollybutt), and *Melaleuca decora* (White Feather Honeymyrtle), on Budgong Sandstone (OEH, 2012b).	occur within 10km (DSEWPaC, 2012b)	
Leucopogon exolasius	Woronora Beard-heath	V	V	Occurs along the upper Georges River and in Heathcote NP, Royal NP and is also known from the Blue Mountains along the Grose River. Grows in woodland on sandstone and prefers rocky hillsides along creek banks up to 100m altitude. Associated species include *Eucalyptus piperita* and *E. sieberi* and *Pultenaea flexilis, Leptospermum trinervium* and *Dillwynia retorta.*	**27 records** within 10km (OEH, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Melaleuca biconvexa	Biconvex Paperbark	V	V	Only found in NSW, with scattered and dispersed populations exist in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects (OEH, 2012b).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Melaleuca deanei	Deane's Paperbark	V	V	Occurs from Nowra-St Albans and west to the Blue Mountains, with most records in Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas. Mostly grows on broad flat ridge tops, dry ridges and slopes and strongly associated with low nutrient sandy loam soils, sometimes with ironstone. Grows in heath-open forest, often in sandstone ridge top woodland communities.	**4 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Pelargonium sp Striatellum	Omeo's Storkbill	E	E	Omeo Storksbill *Pelargonium* sp. (G.W. Carr 10345), syn. *P. striatellum*, is a tufted perennial forb known from only three locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Persoonia hirsuta	Hairy Geebung	E	E	Occurs within the Blue Mountains, Southern Highlands and Sydney coastal regions from Hilltop to Glen Davis and Royal NP to Gosford. Population within the Hills Shire particularly important due to high density of plants. Grows on sandy soils in dry sclerophyll open forest, woodland and heath on sandstone up to 600m above sea level.	**1 record** within 10km (OEH, 2012c)	Unlikely. Not recorded; no appropriate habitat.
Pimelea curviflora var. curviflora	Pimelea curviflora var. curviflora	V	V	Confined to area between north Sydney in the south and Maroota in the north-west. Former range extended to Parramatta River including Five Dock, Bellevue Hill and Manly. Grows on shale/lateritic soils over sandstone and shale/sandstone transition soils on ridge tops and upper slopes amongst woodlands. Often grows amongst dense grasses and sedges. Flowers October to May.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded; no appropriate habitat.
Pomaderris adnata	Sublime Point Pomaderris	E		Known from Sublime Point (north of Wollongong). Occurs near the edge of the plateau behind the Illawarra escarpment; associated with *Eucalyptus sieberi* (Silver-top Ash) - *Corymbia gummifera* (Red Bloodwood) forest with	**27 records** within 10km (OEH, 2012b)	Unlikely. Not recorded during GHD field surveys; no

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
				occasional *Hakea salicifolia* (Willow-leaved Hakea).		appropriate habitat.
Prostanthera marifolia	Seaforth Mintbush	CE	CE	Only known from a 2 x 2km area in Seaforth, North Sydney. Associated with the endangered Duffys Forest ecological community. Grows on deeply weathered clay-loam soils associated with ironstone and scattered shale lenses.	**9 records** within 10km (OEH, 2012b)	Unlikely. Not recorded during GHD field surveys; no appropriate habitat.
Pterostylis gibbosa	Illawarra Greenhood	E	E	Known from a small number of populations in the Illawarra, Nowra and Hunter regions. First collected in western Sydney. Only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. Grows in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, *the* species grows in woodland dominated by *Eucalyptus tereticornis, E. longifolia* and *Melaleuca decora*. Near Nowra, the species grows in an open forest of *Corymbia maculata, E.tereticornis* and *E. paniculata*.	**12 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded during GHD field surveys; no appropriate habitat.
Pterostylis saxicola	Sydney Plains Greenhood	E	E	Occurs in western Sydney between Picton and Freemans Reach. Grows in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. Associated vegetation above these rock shelves is sclerophyll forest or woodland on shale or shale/sandstone transition soils.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded during GHD field surveys; no appropriate habitat.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Pultenaea aristata	Prickly Bush-pea	V	V	Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mt. Keira above Wollongong (OEH, 2012b). Occurs in either dry sclerophyll woodland or wet heath on sandstone.	**4980 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded during GHD field surveys; no appropriate habitat.
Pultenaea glabra	Smooth Bush-pea	V	V	In NSW restricted to higher Blue Mountains in the Katoomba-Hazelbrook and Mt Victoria areas. Unconfirmed sightings in Mt. Wilson and Mt. Irvine areas. Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone.	**1 record** within 10km (OEH, 2012b)	Unlikely. Not recorded during GHD field surveys; no appropriate habitat.
Sarcochilus fitzgeraldii	Ravine Orchid	V		Occurs north-east NSW, north of the Macleay River, to Maleny in south-east Queensland. Grows mainly on rocks, amongst organic matter, in cool, moist, shady ravines, gorges and on cliff faces in dense subtropical rainforest at altitudes between 500 and 700m (OEH, 2012b). Occasional clumps are found on the bases of fibrous-barked trees (OEH, 2012b).	**1 record** within 10km from 1994; location notes withheld (OEH, 2012b)	Unlikely. Not recorded during GHD field surveys; no appropriate habitat.
Thelymitra sp. Kangaloon	Kangaloon Sun-orchid		CE	Only known from three locations near Robertson in the Southern Highlands. Grows in seasonally swampy sedgeland on grey silty clay loam at 600–700m above sea level. Flowers in late October and early November.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded during GHD field surveys; no appropriate habitat.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Zieria granulata	Illawarra Zieria	E	E	A tall bushy shrub that grows to 6m. Restricted to the Illawarra region where it is recorded from a number of sites. The species primarily occupies the coastal lowlands between Oak Flats and Toolijooa. The typical habitat is dry ridge tops and rocky outcrops on shallow volcanic soils, usually on Bombo Latite. Less frequently found on the moist slopes of the Illawarra escarpment and in low-lying areas on Quaternary sediments.	**54 records** within 10km (OEH 2012c) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Not recorded during GHD field surveys; no appropriate habitat.
Birds						
Sternula nereis nereis	Australian Fairy Tern		V	Occurs along NSW coast. Inhabit offshore, estuarine or lake islands, wetlands, beaches and spits. Nests on coral shingle on continental islands or coral cays, on sandy islands and beaches inside estuaries and on open sandy beaches.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Possible. Previously occurred along the east coast of NSW, but unknown whether it persists in NSW (DSEWPaC, 2012b).
Coracina lineata	Barred Cuckoo-shrike	V		Coastal eastern Australia from Cape York to the Manning River in NSW. Generally uncommon in their range, and are rare in NSW. Prefers rainforest, eucalypt forests and woodlands, clearings in secondary growth, swamp woodlands and timber along watercourses (OEH, 2012b).	**2 records** within 10km from 1998 from the Wollongong Botanical Gardens (OEH, 2012b)	Unlikely. Outside of known distribution (OEH, 2012b) May forage within study areas, or use parts of study area as a movement corridor.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Oxyura australis	Blue-billed Duck	V		Partly migratory, travels short distances between breeding swamps and over-wintering lakes. Young birds disperse in April-May from breeding swamps in inland NSW to Murray River system and coastal lakes. Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. Nests in Cumbungi over deep water or in trampled Lignum, sedges or spike-rushes. Completely aquatic, swimming along the edge of dense cover.	**4 records** within 10km (OEH, 2012b)	Unlikely. May forage within study area, or use parts of study area as a movement corridor.
Pezoporus wallicus wallicus	Eastern Ground Parrot	V		Occurs in high rainfall coastal and near coastal low heathlands and sedgelands, generally below one metre in height and very dense (up to 90% projected foliage cover). Ground Parrots can re-colonise burnt habitat after 1-2 years and reach maximum densities after 15-20 years without fire. Home ranges of adult birds is typically 10ha and overlapping with other birds, while juveniles have a significantly larger home range. Ground Parrots feed mostly on seeds from a large range of plant species, which varies seasonally. Eggs are laid in a shallow bowl of fine sticks and grass, well hidden under overhanging tall, coarse grass, sedge or low, heathy shrubs.	**5 records** within 10km (OEH, 2012b)	Unlikely. Limited suitable habitat present.
Petroica phoenicea	Flame Robin	V		Breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. Migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains. Forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs	**1 record** within 10km (OEH, 2012b)	Unlikely. Limited suitable habitat present.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
				and other coarse woody debris. Fallen logs and coarse woody debris are important habitat components. Open cup nest of plant fibres and cobweb is often built near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.		
Hieraaetus morphnoides	Little Eagle	V		Occurs throughout NSW except most densely forested parts of the Dividing Range escarpment. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring.	**11 records** within 10km (OEH, 2012b)	Unlikely. May fly over, refuge and forage within study areas on occasion. Unlikely to rely on habitats present in study areas.
Glossopsitta pusilla	Little Lorikeet	V		Occurs from coast to western slopes of the Great Dividing Range. Inhabits dry, open eucalypt forests and woodlands. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, groundcover, logs, fallen branches and litter. Feed primarily on profusely-flowering eucalypts and a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands *Eucalyptus albens* and E. *melliodora* are particularly important food sources for pollen and nectar respectively. Mostly nests in small (opening approx. 3cm) hollows in living, smooth-barked eucalypts, especially *Eucalyptus viminalis*, E. *blakelyi* and E. *dealbata*.	**3 records** within 10km (OEH, 2012b)	Unlikely. Could potentially occur in some patches. Unlikely to rely on habitats present in study areas.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
				Most breeding records are from the western slopes.		
Pachycephala olivacea	Olive Whistler	V		Has a disjunct distribution along NSW predominantly occupying areas around Barrington Tops, the Macpherson Ranges and from the Illawarra south to Victoria (OEH, 2012b).Mostly inhabit wet forests above about 500m and during the winter months they may move to lower altitudes (OEH, 2012a).Forage in trees and shrubs and on the ground, feeding on berries and insects. Make nests of twigs and grass in low forks of shrubs.	**2 records** within 10km (OEH, 2012b)	Unlikely. May fly over and forage within the study area on occasion.
Grantiella picta	Painted Honeyeater	V		Nomadic, occurring in low densities across most of NSW. Highest concentrations and almost all breeding occur on inland slopes of the Great Dividing Range. Inhabits Boree, Brigalow and Box Gum woodlands and Box-Ironbark forests. Specialist forager on the fruits of mistletoes, preferably of the *Amyema* genus. Nests in outer tree canopy.	**1 record** within 10km (OEH, 2012b)	Unlikely. Limited suitable habitat present.
Petroica rodinogaster	Pink Robin	V		In NSW occurs mainly in the South Coast and Southern Tablelands regions. It is vagrant in the Sydney and Illawarra areas, with generally only individual birds recorded in these areas. It prefers a dense shrub layer in damp or wet forests or rainforests. It generally breeds in wet gullies. It forages for insects on the ground or in low undergrowth. It may be partly migratory or dispersive in autumn and winter. It is generally seen in pairs, occasionally small flocks.	3 records within 10km (OEH, 2012b)	Unlikely. Limited suitable habitat present.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Erythrotriorchis radiatus	Red Goshawk	CE	V	Typically occurs in coastal and subcoastal areas, with 90% of recent records in NSW confined to the Northern Rivers and Northern Tablelands regions, north of the Clarence River. Formerly occurred south to Port Stephens. Prefer woodlands and forests with a mosaic of vegetation types that are open enough for fast manoeuvring flight, avoiding very open or very dense habitats. In NSW inhabits mixed subtropical rainforest, Melaleuca swamp forest and open eucalypt forest along coastal rivers. Nests built within 1km of a permanent freshwater body in a large, tall tree (>20m) within a remnant stand. Home ranges large (120-200km^2).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. May fly over and forage on occasion, although no records are present in the study area.
Polytelis anthopeplus monarchoides	Regent Parrot (eastern subspecies)	E	V	Restricted to areas around the Murray River in South Australia, Victoria and NSW. In NSW it occurs along the Murray River downstream of Tooleybuc, the Wakool River downstream of Kyalite, and the Murrumbidgee River immediately upstream from the junction with the Murray River and adjoining areas of mallee (OEH, 2012b). Foraging habitat is mallee woodlands and occasionally riverine forests and woodlands. Nests within River Red Gum forests along the Murray, Wakool and lower Murrumbidgee Rivers, and possibly the Darling River downstream of Pooncarie. Typical nest trees are large, mature healthy trees with many spouts (though dead trees are used) and are usually located close to a watercourse (OEH, 2012b).	**1 record** within 10km from 1990 (OEH, 2012b)	Unlikely. Outside of known distribution. Unlikely to roost or breed in the study area given the lack of suitable River Red Gum.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Petroica boodang	Scarlet Robin	V		In NSW occurs from coast to inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within open understorey of shrubs and grasses and sometimes in open areas. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. Abundant logs and coarse woody debris are important habitat components.	**8 records** within 10km (OEH, 2012b)	Unlikely. Limited suitable habitat present.
Circus assimilis	Spotted Harrier	V		Occurs throughout Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Inhabits grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods). Most commonly in native grassland, but also in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn).	**1 record** within 10km (OEH, 2012b)	Unlikely. May fly over and forage within the study area on occasion. Unlikely to rely on the habitats present within the study areas.
Lophoictinia isura	Square-tailed Kite	V		Occurs across NSW, resident in North, northeast and along west-flowing rivers. Summer breeding migrant to southeast of state. Inhabits a variety of habitats including woodlands and open forests, with preference for timbered watercourses. Favours productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes, and Coolibah River Red Gum on the inland plains. In Sydney area nests in mature living trees within 100m of	**6 records** within 10km (OEH, 2012b)	Unlikely. May fly over study area on occasion – particularly where continuous vegetation is present. Suitable breeding habitat not present.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
				ephemeral/permanent watercourse. Large home range > $100km^2$.		Unlikely to rely on the habitats present within the study areas.
Polytelis swainsonii	Superb Parrot	V	V	Occurs as a single population in the South-west Slopes and Riverina bioregions. Two core breeding areas: between Cowra and Yass – Grenfell, Cootamundra and Coolac in the SW Slopes, and along the Murray, Edward and Murrumbidgee Rivers in the Riverina. Birds breeding in the SW slopes migrate north to the Namoi/Gwydir Rivers for winter. Inhabits Box Gum, Box – Cypress Pine and Boree woodlands and River Red Gum Forest. Nest in hollow trees, in tall riparian River Red Gum communities (Riverina area) or open Box Gum woodland or isolated paddock trees (SW Slopes). Mainly forages in grassy box woodlands, up to 10km from breeding sites.	**1 record** within 10km (OEH, 2012b)	Unlikely. Outside of known distribution. Unlikely to roost or breed in the study areas given the lack of suitable hollows.
Mammals						
Petrogale pencillata	Brush-tailed Rock-wallaby	E	V	Occurs from the Shoalhaven north to the Queensland border. Now mostly extinct west of the Great Dividing Range, except in the Warrumbungles and Mt Kaputar. Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Diet consists of vegetation in adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. No suitable habitat present and study area is outside of known distribution.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Mormopterus norfolkensis	Eastern Freetail-bat	V		Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Forages in natural and artificial openings in vegetation, typically within a few kilometres of its roost. Roosts primarily in tree hollows but also recorded from man-made structures or under bark (Churchill, 2008).	**8 records** within 10km (OEH, 2012b)	Unlikely. May forage within study area, or use parts of study area as a movement corridor. Unlikely to roost or breed in the study area given the lack of suitable hollows.
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Occurs on the east coast and Great Dividing Range. Inhabits a variety of habitats from woodland to wet and dry sclerophyll forests and rainforest, also remnant paddock trees and timber-lined creeks, typically below 500m asl. Forages in relatively uncluttered areas, using natural or man-made openings in denser habitats. Usually roosts in tree hollows or fissures but also under exfoliating bark or in the roofs of old buildings. Females congregate in maternal roosts in suitable hollow trees (Hoye and Richards, 2008, Churchill, 2008).	**6 record** within 10km (OEH, 2012b).	Unlikely. May forage in the study area. Unlikely to roost or breed in the study area given the lack of suitable hollows.
Petaurus norfolcensis	Squirrel Glider	V		Occurs along the drier inland slopes as well as coastal habitats. Inhabits woodland and open forest with a Eucalyptus, Corymbia or Angophora overstorey and a shrubby understorey of Acacia or Banksia. Key habitat components include reliable winter and early-spring flowering Eucalypts, Banksia or other nectar sources, and hollow-bearing trees for roost and nest sites (van der Ree	**1 record** within 10km (OEH, 2012b).	Unlikely. Suitable foraging habitat present within the study areas such as Bulli Beach and Sandon Point Beach, although unlikely to breed given

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
				and Suckling, 2008, Quin et al., 1996), with social groups moving between multiple hollows. Social groups include one or two adult males and females with offspring, and have home ranges of 5-10ha within NSW (van der Ree and Suckling, 2008, Kavanagh, 2004).		the lack of hollow-bearing trees.
Phascolarctos cinereus	Koala	V	V	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred hectares.	**23 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. May forage on occasion. Most study areas are too fragmented for this species. Suitable breeding habitat not present.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Occurs from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz, 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill, 2008). In southern Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.	**15 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Limited suitable habitat present.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Potorous tridactylus	Long-Nosed Potoroo	V	V	Restricted to east of the Great Dividing Range, with annual rainfall >760mm. Inhabits coastal heath and dry and wet sclerophyll forests. Requires relatively thick groundcover and appears restricted to areas of light and sandy soil (Johnston 2008). Feeds on fungi, roots, tubers, insects and their larvae, and other soft-bodied animals in the soil.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Could potentially occur in some patches, although no records present in the study area.
Pseudomys novaehollandiae	New Holland Mouse		V	Occurs in disjunct, coastal populations from Tasmania to Queensland. In NSW inhabits a variety of coastal habitats including heathland, woodland, dry sclerophyll forest with a dense shrub layer and vegetated sand dunes (Wilson and Bradtke, 1999). Populations may recolonise/increase in size in regenerating native vegetation after wildfire, clearing and sandmining. Presence strongly correlated with understorey vegetation density, and high floristic diversity in regenerating heath (Lock and Wilson, 1999).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Could potentially occur in some patches, although no records present in the study area.
Pseudomys fumeus	Smoky Mouse	E	E	In NSW recorded from Kosciuszko NP and adjacent areas, and Mt Poole, Nullica SF and South East Forests NP near Eden. Occurs from subalpine regions to sea-level. Appears to prefer heath habitat on ridge tops and slopes in sclerophyll forest, heathland and open-forest from the coast, characterised by floristically diverse shrub layer including abundance of *Epacridaceae, Fabaceae* and *Mimosaceae* spp. Also occurs in damp fern gullies. Nesting burrows have been recorded in rocky areas and under *Xanthorrhoea* bases.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Could potentially occur in some patches, although no records present in the study area.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Isoodon obesulus obesulus	Southern Brown Bandicoot	E	E	Occurs mainly in two areas: Ku-ring-gai Chase and Garigal National Parks north of Sydney, and far south-east NSW including Ben Boyd National Park, East Boyd State Forest, Nadgee Nature Reserve, Nadgee State Forest, South East Forest and Yambulla State Forest but also occurs between these areas. Inhabits scrubby vegetation, including heath, shrubland, and heathy forest and woodland. Often associated with well-drained soils and dry heathland communities, and prefers periodically burnt areas as this increases insect abundance.	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Could potentially occur in some patches, although no records present in the study area.
Reptiles						
Hoplocephalus bungaroides	Broad-Headed Snake	E	V	Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter, and spring, moving to shelters in hollows of large trees within 200m of escarpments in summer. Feeds mostly on geckos and small skinks, and occasionally on frogs and small mammals.	**33 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. May forage within study area, or use parts of study area as a movement corridor.
Varanus rosenbergi	Rosenberg's Goanna	V		In NSW mainly occurs on the mid coast region from Wollemi NP to Nowra; the ACT and Goulburn regions and the South-west Slopes. Inhabits coastal heathlands, wet and dry sclerophyll forests, woodlands and mallee communities. Termite mounds are an important habitat feature: eggs are	**24 records** within 10km (OEH, 2012b)	Unlikely. May forage within study area, or use parts of study area as a

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
				laid in the mounds in summer and incubate till spring, when the young dig themselves out. Young may return to the mound as a refuge for some months, while adults shelter in burrows dug under rocks or logs, or in rock crevices, hollow logs or even rabbit burrows (Sass, 2008).		movement corridor.
Frogs						
Mixophyes iteratus	Giant Barred Frog	E	E	Occurs on the coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW, particularly in Coffs Harbour - Dorrigo area. Forage and live amongst deep, damp leaf litter in rainforest, moist eucalypt forest and nearby dry eucalypt forest. Breed in shallow, flowing rocky streams. Within Sydney Basin, confined to small populations in tall, wet forest in the Watagan Mountains north of the Hawkesbury and the lower Blue Mountains (White, 2008a).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Could potentially occur in some patches, although no records present in the study area
Heleioporus australiacus	Giant Burrowing Frog	V	V	Occurs along the coast and eastern slopes of the Great Dividing Range south from Wollemi National Park. Appears to exist as two populations with a 100km gap in records between Jervis Bay and Eden. Northern population occurs on sandy soils supporting heath, woodland or open forest. Breeds in ephemeral to intermittent streams with persistent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	**44 records** within 10km (OEH, 2012b) **Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. May forage within study area, or use parts of study area as a movement corridor.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Pseudophryne australis	Red-crowned Toadlet	V		Restricted to Sydney Basin, from Nowra to Pokolbin and west to Mt. Victoria. Inhabits heathland and open woodland on Hawkesbury and Narrabeen Sandstones, within 100m of ridgelines. Breeds in ephemeral feeder creeks or flooded depressions, requiring unpolluted water between 5.5 and 6.5pH. Shelters under rocks, amongst masses of dense vegetation or leaf litter. Populations restricted to immediate vicinity of breeding areas.	**88 records** within 10km (OEH, 2012b)	Unlikely Limited preferred sandstone ridges within study area. May forage on occasion. Suitable breeding habitat not present.
Litoria raniformis	Growling Grass Frog, Southern Bell Frog, Green and Golden Frog		V	Currently, the species is known to exist only in isolated populations in the Coleambally Irrigation Area, the Lowbidgee floodplain and around Lake Victoria. Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. They are also found in irrigated rice crops, particularly where there is no available natural habitat (OEH, 2012b).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Outside of known distribution. Could potentially occur in some patches, although no records present in the study area.
Mixophyes balbus	Stuttering Barred Frog	E	V	Occurs along the east coast of Australia. Found in rainforest and wet, tall, open forest. Shelter in deep leaf litter and thick understorey vegetation on the forest floor. Feeds on insects and smaller frogs, breeding in streams during summer after heavy rain. Within Sydney Basin the species is now confined to populations in the Watagan Mountains, the southern Blue Mountains and Macquarie Pass (White, 2008b).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. Could potentially occur in some patches, although no records present in the study area.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
Fish						
Prototroctes mairaena	Australian Grayling		V, M	Occurs in coastal rivers and streams south from the Shoalhaven River. Inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and streams as adults. Most of their lives are spent in freshwater rivers and streams in cool, clear waters with a gravel substrate and alternating pool and riffle zones, however can also occur in turbid water. The species can penetrate well inland, being recorded over 100km inland from the sea. (Backhouse et al., 2008).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. No rivers and streams within the area of impact. No records present in the study area.
Epinephelus daemelii	Black Rockcod, Black Cod, Saddled Rockcod		V	Occurs from southern Queensland through NSW to northern Victoria. Generally inhabits near-shore rocky and offshore coral reefs at depths down to 50m (DSEWPaC, 2012b)	**Predicted** to occur within 10km (DSEWPaC 2012); Records within Southern Rivers CMA (DPI, 2007)	Unlikely. No rivers and streams within the area of impact. No records present in the study area.
Macquaria australasica	Macquarie Perch	V	E	Occurs in the upper reaches of the Lachlan, Murrumbidgee and Murray Rivers, and in parts of the Hawkesbury and Shoalhaven catchment areas. Inhabits river and lake habitats, especially the upper reaches of rivers and their tributaries. Requires clear water with deep, rocky holes and abundant cover (including aquatic vegetation, woody debris, large boulders and overhanging banks). Spawning	**Predicted** to occur within 10km (DSEWPaC 2012) Records within	Unlikely. No rivers and streams within the area of impact. No records present in the study area.

Scientific Name	Common Name	TSC Act	EPBC Act	Habitat Association	Details of Record	Likelihood of occurrence within the study area
				occurs in spring and summer in shallow upland streams or flowing sections of river systems.	Wollongong LGA between 1994-2006. (DPI, 2012a)	
Maccullochella macquariensis	Trout Cod	E	E	There are three known breeding populations in NSW: a naturally occurring population below Yarrawonga Weir in the Murray River, a stocked population in the Murrumbidgee River at Narrandera and a translocated population in Cataract Dam in coastal NSW. There are stocked (breeding unconfirmed) populations within the Murray, Murrumbidgee and Macquarie Rivers, and in Talbingo Dam in Koscisuko NP (DPI, 2006). The species occurs in a range of habitats, but is strongly associated with the presence of woody debris and snags (DPI, 2006).	**Predicted** to occur within 10km (DSEWPaC, 2012b)	Unlikely. No rivers and streams within the area of impact. No records present in the study area.
Invertebrates						
Austrocordulia leonardi	Sydney Hawk Dragonfly	E (FM Act)		The Sydney Hawk Dragonfly has a very restricted distribution. The known distribution of the species includes three locations in a small area south of Sydney, from Audley to Picton. The species is known from the Hawkesbury-Nepean, Georges River, Port Hacking and Karuah drainages. The Sydney Hawk Dragonfly has specific habitat requirements, and has only ever been collected from deep and shady riverine pools with cooler water. Larvae are found under rocks where they co-exist with *Austrocordulia refracta*.	Recorded within the Southern Rivers CMA (DPI, 2013b)	Unlikely. Limited suitable habitat present.

Appendix D – Migratory fauna listed under the EPBC Act

A desktop assessment was undertaken to determine the migratory fauna within a 10 kilometre radius of the study area. Table A shows the species that are 'present', 'likely' or 'possible' to occur within the study area, based on field surveys and observations of suitable habitat. Table B shows the species that are 'unlikely' to occur within the study area.

All information in these tables taken from NSW OEH and Commonwealth DSEWPaC Threatened Species profiles (OEH, 2012c, DSEWPaC, 2012b) unless otherwise stated. The codes used in these tables are: CE – Critically Endangered; E – Endangered; V – Vulnerable; EP – Endangered Population; CEEC – Critically Endangered Ecological Community; EEC – Endangered Ecological Community; M - Migratory.

Table A: EPBC Act-listed migratory fauna that are likely or possible to occur, from the locality, habitat association and suitable habitat present at the study area

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Migratory Birds						
Wetland or Marine species						
Limosa lapponica	Bar-tailed Godwit		M -CAMBA, JAMBA, ROKAMBA; Marine; Wetland	Occurs along NSW coast, with important sites including the Hunter River estuary. Non-breeding visitor to Australia. Mainly inhabits coastal habitats including intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. Often found around seagrass beds and sometimes in nearby saltmarsh. Also recorded from sewage farms, saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats.	20 records within 10km (OEH, 2012b)	Possible. Observations of this species along Windang Beach near the entrance of Lake Illawarra. May fly over study area on occasion or roost. Suitable breeding habitat not present.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Monarcha melanopsis	Black-faced Monarch		M -Terrestrial	This species of bird usually inhabits dense gullies of rainforest, sclerophyll forests and eucalypt woodlands along the coastal regions from Victoria to Cape York and is migratory over much of its range (Slater *et al.*, 1989).	Predicted to occur within 10km (DSEWPaC, 2012b). Recorded near Wharton's Creek, Bulli (WCC, 2004).	Possible May forage in study area on occasion. Suitable breeding habitat not present.
Limosa limosa	Black-tailed Godwit	V	M - CAMBA, JAMBA, ROKAMBA; Marine; Wetland	The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the north and south coast, and inland. Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. It is usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. It has also been found around muddy lakes and swamps, wet fields and sewerage treatment works.	1 record within 10km (OEH, 2012b)	Possible. May fly over on occasion particularly in association with Lake Illawarra. Potential beaches include Windang Beach, Bellambi and Stanwell Park. Suitable roosting habitat available. Suitable breeding habitat not present.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Limicola falcinellus	Broad-billed Sandpiper		M-CAMBA, JAMBA, ROKCAMBA; Marine	In NSW, occurs in coastal areas, from Ballina, south to Shoalhaven Heads. In Victoria, they are an annual visitor in small numbers in coastal regions, with rare inland records. Occurs in sheltered parts of the coast, favouring estuarine mudflats but also occasionally occur on saltmarshes, shallow freshwater lagoons, saltworks and sewage farms, and in areas with large soft intertidal mudflats, which may have shell or sandbanks nearby. Occasionally they occur on reefs or rocky platforms. They have also been recorded in creeks, swamps and lakes near the coast, particularly those with bare mudflats or sand exposed by receding water (OEH, 2012b).	2 records within 10km from 1983 & 1995 (OEH, 2012b)	Possible. Suitable roosting habitat available. Suitable breeding habitat not present. Beaches such as Bellambi and Corrimal Beach study areas adjoin watercourses potentially suitable for foraging for this species. Nearby Stanwell Park outside the study area may also provide suitable foraging habitat.
Hydroprogne caspia	Caspian Tern		M – CAMBA, JAMBA; Marine	Occurs east of the Great Divide, mainly in coastal regions, and also in the Riverina and Lower and Upper Western Regions, with occasional records elsewhere (Higgins & Davis, 1996).	25 records within 10km (OEH, 2012b)	Possible. May forage within study areas that encompass intertidal zones such as Stanwell Park (amongst

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
						others), or use parts of study area as a movement corridor.
Ardea ibis	Cattle Egret		M - CAMBA as *Ardeola ibis*, JAMBA as *Bubulcus ibis*; Marine; Wetland	Occurs across NSW. Principal breeding sites are the central east coast from Newcastle to Bundaberg. Also breeds in major inland wetlands in north NSW (notably the Macquarie Marshes). Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. Uses predominately shallow, open and fresh wetlands with low emergent vegetation and abundant aquatic flora. Sometimes observed in swamps with tall emergent vegetation and commonly use areas of tall pasture in moist, low-lying areas.	Predicted to occur within 10km (DSEWPaC, 2012b) Recorded at Sandon Point and surrounds (QEM, 1992; Chafer, 1997; Sefton, 1983)	Possible. May forage in the study areas opportunistically; Bellambi Beach and Sandon Point are nearby suitable habitat. Unlikely breed in the study areas.
Tringa nebularia	Common Greenshank		M - CAMBA JAMBA, ROKAMBA; Wetland	The species has been recorded in most coastal regions' especially west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions (Higgins & Davies, 1996). Typically is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity including sheltered coastal habitats such as embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both	22 records within 10km (OEH, 2012b)	Possible. May forage on occasion. Suitable breeding habitat not present. Beaches such as Bellambi and Corrimal Beach study areas adjoin watercourses

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
				permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats. It will also use artificial wetlands generally of mud or clay, occasionally of sand, and may be bare or with emergent or fringing vegetation, including short sedges and saltmarsh, mangroves, thickets of rushes, and dead or live trees.		potentially suitable for foraging for this species. Nearby Stanwell Park outside the study area may also provide suitable foraging habitat.
Sterna hirundo	Common Tern		M-CAMBA, JAMBA, ROKAMBA; Marine	Common Terns are marine, pelagic and coastal. However, off Wollongong, NSW, Common Terns were recorded in all marine zones but generally recorded in offshore and pelagic waters, 11–55km from shore (DSEWPAC, 2013b). This species nest on the ground in the open, usually on bare substrates, occasionally near vegetation or in it, or on a floating mat of vegetation. They usually nest on islands, either marine or in lakes, only sometimes on mainland beaches or promontories or salt or freshwater marshes. Common Terns often nest in sites washed over by winter storms or floods.	7 records within 10km (OEH, 2012b)	Likely. Could forage throughout the study area. May forage within study areas that encompass intertidal zones such as Stanwell Park, Woonona Beach, Towradgi Beach (amongst others), or use parts of study area as a movement corridor. Potential breeding habitat present.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Calidris ferruginea	Curlew Sandpiper		M – CAMBA, JAMBA, ROKAMBA; Wetland	Occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. The Curlew Sandpiper breeds in Siberia and migrates to Australia (as well as Africa and Asia) for the non-breeding period, arriving in Australia between August and November, and departing between March and mid-April. Occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. The Curlew Sandpiper breeds in Siberia and migrates to Australia (as well as Africa and Asia) for the non-breeding period, arriving in Australia between August and November, and departing between March and mid-April.	10 records within 10km (OEH, 2012b)	Possible. May fly over study area on occasion or roost. Suitable breeding habitat not present.
Charadrius bicinctus	Double-banded Plover		M; Wetland	Occurs along the coast and inland areas of NSW. Non-breeding visitor. Important sites in NSW include Lake Bathurst and Botany Bay (Penrhyn Estuary and Sydney Airport). Inhabits littoral, estuarine and fresh/saline terrestrial wetlands as well as saltmarsh, grasslands and pasture.	Predicted to occur within 10km (DSEWPaC, 2012b)	Possible. Could potentially forage in some patches. Records have been observed outside the study area of Windang Beach.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Numenius madagascariensis	Eastern Curlew		M –CAMBA, JAMBA, ROKAMBA;Marine; Wetland	Primarily coastal. Non-breeding visitor to Australia. Associated with sheltered coasts with large intertidal mudflats or sandflats, often with seagrass and are often recorded among saltmarsh. Occasionally found on open beaches, coral reefs, rock platforms or islets. Also recorded from saltworks and sewage farms.	14 records within 10km (OEH, 2012b)	Possible. May fly over study areas on occasion or roost. Suitable breeding habitat not present.
Ardea alba	Eastern Great Egret		M; Marine – CAMBA, JAMBA	Occurs across NSW. Within NSW there are breeding colonies within the Darling Riverine Plains and Riverina regions, and minor colonies across its range including the north and north-east of the state. Reported from a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial).	Predicted to occur within 10km (DSEWPaC, 2012b) Recorded at Sandon Point and surrounds (QEM, 1992; Chaffer, 1997; Sefton, 1983)	Likely. May forage within study area, or use parts of study area as a movement corridor
Pandion haliaetus	Eastern Osprey		M; Marine	Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. They feed on fish over clear, open water. Breeding takes place from July to September in NSW, with nests being built high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	1 record within 10km from 1995 (OEH, 2012b)	Likely. Could forage in the study area and roost in trees within the site.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Charadrius leschenaultii	Greater Sand-plover	V	M -Bonn, CAMBA, JAMBA, ROKAMBA; Wetland	In NSW, the species has been recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries (OEH, 2012b). Occurs mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks (OEH, 2012b). Roosts during high tide on sandy beaches and rocky shores; begin foraging activity on wet ground at low tide, usually away from the edge of the water; individuals may forage and roost with other waders (OEH, 2012b).	7 records within 10km (OEH, 2012b)	Possible. May roost or forage on occasion. Limited suitable habitat present.
Pluvialis squatarola	Grey Plover		M; Bonn, CAMBA, JAMBA, ROKAMBA; Marine; Wetland	Breed north of 65° N in the Northern Hemisphere, in northern Siberia, from the White Sea east to the Gulf of Anadyr, and in Alaska and northern Canada from the shores of the Bering Sea east to Baffin Island. In Australia, occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes.	15 records within 10km (OEH, 2012b)	Possible. May roost or forage on occasion. Limited suitable habitat present
Heteroscelus brevipes	Grey-tailed Tattler		M – JAMBA, CAMBA and ROKAMBA; Wetland	Occurs along NSW coast, more common north of Sydney. Non-breeding visitor to Australia. Inhabits sheltered coasts with reefs and rock platforms or with intertidal mudflats. Usually forages in shallow water on hard intertidal substrates, but also recorded foraging on intertidal mudflats with mangroves/seagrass and occasionally on intertidal sandflats.	11 records within 10km (OEH, 2012b)	Possible. Suitable foraging habitat available within study area.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Thinornis rubricollis	Hooded Plover (eastern)	CE	M; Marine	The Hooded Plover is endemic to southern Australia and is nowadays found mainly along the coast from south of Jervis Bay. In the late 1920s and early 1930s the species was recorded from Port Stephens but are now considered locally extinct. It has not been seen in the Sydney area since the 1940s. Occasionally, individual birds are sighted slightly further north to the Shoalhaven River and Comerong Beach and one bird was sighted at Lake Illawarra in March 2001. Hooded Plovers prefer sandy ocean beaches backed by sparsely vegetated sand-dunes for shelter and nesting. Hooded Plovers display high nest site fidelity and nest solitarily. Occasionally Hooded Plovers are found on tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, and small beaches in lines of cliffs. They regularly use near-coastal saline and freshwater.	2 records within 10km (OEH, 2012b)	Likely. Could forage throughout the study area. Potential breeding habitat present.
Gallinago hardwickii	Latham's Snipe		M – Bonn as *Gallinago hardwickii*, CAMBA as *Gallinago hardwickii*, JAMBA as *Gallinago hardwickii*, ROKAMBA as *Gallinago hardwickii*;	Occurs along the coast and west of the Great Dividing Range. Non breeding visitor to Australia. Inhabit permanent and ephemeral wetlands up to 2000m asl. Typically in open, freshwater wetlands with low, dense vegetation (incl. swamps, flooded grasslands and heathlands). Can also occur in saline/brackish habitats and in modified or artificial habitats close to human activity.	Predicted to occur within 10km (DSEWPaC, 2012b) Closest records from Seaford Swamp in Victoria (Bamford et al., 2008) Observed at Tramway Creek and Woodlands Creek (WCC, 2004)	Possible. May forage in the study area. Unlikely breed in the study area.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
			Marine; Wetland			
Charadrius mongolus	Lesser Sand-plover	V	M -Bonn, CAMBA, JAMBA, ROKAMBA;Marine; Wetland	In NSW, occurs along the coastline preferring beaches of sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats; occasionally occurs on sandy beaches, coral reefs and rock platforms (OEH, 2012b). Roosts during high tide on sandy beaches, spits and rocky shores; forage individually or in scattered flocks on wet ground at low tide, usually away from the water's edge (OEH, 2012b).	2 records within 10km (OEH, 2012b)	Possible. May roost and forage on occasion within the study area.
Sterna albifrons	Little Tern		M-CAMBA, ROKAMBA; Marine	In NSW occurs mainly north of Sydney, with smaller numbers south to Victoria. Almost exclusively coastal, preferring sheltered environments; may occur several kilometres from the sea in harbours, inlets and rivers . Nests in low dunes or sandy beaches just above high tide mark near estuary mouths/ adjacent to coastal lakes and islands. Forage in shallow waters of estuaries, coastal lagoons and lakes, also along open coasts, less often at sea, and usually within 50m of shore.	135 records within 10km (OEH, 2012b) Known breeding habitat at Perkins Beach Windang (WCC, 2010). Towradgi Beach listed in Species Recovery Plan.	Likely. Known breeding site at Perkins Beach Windang.
Pluvialis fulva	Pacific Golden Plover		M – Bonn, CAMBA, JAMBA, ROKAMBA; Marine; Wetland	Widespread along coast, may occur inland along major river systems. Important sites in NSW comprise the Hunter and Shoalhaven estuaries and Richmond and Clarence Rivers. Does not breed in Australia. Usually forages on sandy or muddy shores or margins of sheltered areas such as estuaries and lagoons, though it also feeds on rocky shores, islands or reefs. Occasionally forage among vegetation,	10 records within 10km (OEH, 2012b)	Possible May forage within study area on occasion.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
				such as saltmarsh, mangroves or in pasture or crops.		
Rostratula benghalensis	Painted Snipe (was Australian Painted Snipe)	E	V; M -CAMBA; Wetland	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and seeds. Prefers fringes of swamps, dams and nearby marshy areas with cover of grasses, lignum, low scrub or open timber.	Predicted to occur within 10km (DSEWPaC, 2012b)	Possible. Refer to Appendix C.
Calidris canutus	Red Knot		M – CAMBA, JAMBA, ROKAMBA; Marine, Wetland	Found along much of the NSW coast. inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps (Higgins & Davies, 1996) (DSEWPaC, 2012b.	10 records within 10km (OEH, 2012b)	Possible. May forage on occasion. Suitable breeding habitat not present.
Calidris ruficollis	Red-necked Stint		M – Bonn, CAMBA, JAMBA, ROKAMBA, Marine; Wetland	Found in most coastal areas. inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps (Higgins & Davies, 1996)	12 records within 10km (OEH, 2012b)	Possible. May forage or roost on occasion. Suitable breeding habitat not present. Has been observed along the

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
				(DSEWPaC, 2012b).		beach at Windang.
Anthochaera phrygia	Regent Honeyeater	CE	E; M; Terrestrial	In NSW confined to two known breeding areas: the Capertee Valley and Bundarra-Barraba region. Non-breeding flocks occasionally seen in coastal areas foraging in flowering Spotted Gum and Swamp Mahogany forests, presumably in response to drought. Inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	Predicted to occur within 10km (DSEWPaC, 2012b)	Possible. Refer to Appendix C.
Arenaria interpres	Ruddy Turnstone		M - Bonn, CAMBA, JAMBA, ROKAMBA; Marine; Wetland	Widespread throughout Australia during non-breeding periods. Mainly found on coastal regions with exposed rock coast lines or coral reefs. It also lives near platforms and shelves, often with shallow tidal pools and rocky, shingle or gravel beaches. It can, however, be found on sand, coral or shell beaches, shoals, cays and dry ridges of sand or coral. It has occasionally been sighted in estuaries, harbours, bays and coastal lagoons, among low saltmarsh or on exposed beds of seagrass, around sewage ponds and on mudflats (DSEWPaC, 2012b)	26 records within 10km (OEH, 2012b) Observed passing through on northerly migration route to northern hemisphere (our Autumn). Gather in small flocks and feed before departing (WCC, 2004).	Possible. May roost or forage on occasion in the foredunes observations at Sandon Point.
Rhipidura rufifrons	Rufous Fantail		M; Terrestrial	Found along NSW coast and ranges. Inhabits rainforest, dense wet forests, swamp woodlands and mangroves. During migration, it may be found in more open habitats or urban areas (Birds Australia, 2008).	Predicted to occur within 10km (DSEWPaC, 2012b). Recorded near Hewitts	Possible. May forage within study area, or use parts of study area

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
					Creek, Bulli (WCC, 2004)	as a movement corridor.
Calidris alba	Sanderling		M -Bonn, CAMBA, JAMBA, ROKAMBA; Wetland	Sanderlings occur along the NSW coast, with occasional inland sightings. Often found in coastal areas on low beaches of firm sand, near reefs and inlets, along tidal mudflats and bare open coastal lagoons; individuals are rarely recorded in near-coastal wetlands Roosts on bare sand, behind clumps of beach-cast kelp or in coastal dunes.	17 records within 10km (OEH, 2012b) The main area where this species has been recorded is Windang, with occasional records at Bellambi (WCC, 2010)	Likely. Could forage throughout the study area. Potential breeding habitat located Bellambi and Windang.
Onychoprion fuscata	Sooty Tern		M; Marine	Occurs over tropical and subtropical seas and islands around northern NSW. Occasionally seen along coastal NSW, especially after cyclones. Breeds in sand or coral scrapes on offshore islands and cays including Lord Howe and Norfolk Islands.	3 records within 10km (OEH, 2012b)	Possible. Possible rare use of Beaches in Wollongong LGA such as Coledale Beach, Sandon Point Bulli, Woonona (amongst others).

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Numenius phaeopus	Whimbrel		M- Bonn, CAMBA, JAMBA, ROKAMBA; Marine	Occurs along NSW coast. Non-breeding visitor to Australia. Often found on intertidal mudflats (with/without mangroves) of sheltered coasts, also harbours, lagoons, estuaries and river deltas. Also uses saltflats with saltmarsh, saline grasslands and sewage farms/ saltworks.	Predicted to occur within 10km (DSEWPaC, 2012b) Solitary bird observed in 2001 (WCC, 2004).	Possible. May forage on occasion. Suitable breeding habitat not present.
Haliaeetus leucogaster	White-bellied Sea-Eagle		M; Terrestrial	This species of large bird occurs along the coastline of Australia and also range inland over large rivers and wetlands, favouring forested coasts and forested margins of inland waterways. Nests are usually near water, in tall live or dead trees or on remote coastal cliffs. River Red Gum (*Eucalyptus camaldulensis*), Forest Red Gum (*E. tereticornis*) and Southern Mahogany (*E. botryoides*) are commonly used as nest trees (Emison & Bilney, 1982). On islands free of predators, nests may be close to the ground in shrubs or rocky platforms (Marchant & Higgins, 1993).	30 records within 10km (OEH, 2012b) Predicted to occur within 10km (DSEWPaC, 2012b) One adult seen from Sandon Point surf club as it fished offshore and along McCauleys beach where it caught a fish at the exit of Tramway Creek. Then flew to the turpentine forest (WCC, 2004)	Likely. Known roost tree in Turpentine Forest; cuttlefish shells usually at base.

Table B: EPBC Act-listed migratory fauna that are unlikely to occur, from the locality, habitat association and suitable habitat present at the study area

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Migratory Birds						
Wetland or Marine species						
Stercorarius parasiticus	Arctic Jaeger		M; Marine – JAMBA ROKAMBA	Occurs along the coasts of Australia. Nests near other seabird colonies.	7 records within 10km (OEH, 2012b)	Unlikely. May fly over on occasion or rest on the shoreline. Unlikely to rely on habitats in the proposal footprint.
Sula leucogaster	Brown Booby		M – CAMBA, JAMBA, ROKAMBA; Marine	In NSW, occurs and is recorded in the southern parts of NSW to Tweed Heads. Occurs in both marine and terrestrial habitat; including coastal waters, harbours and estuaries and near offshore islands but seldom flying over land (Marchant & Higgins 1990). Nests in on the ground in a variety of sites, from rugged rocky terrain (cliffs, steep slopes) on larger islands, to beaches, coral rubble and guano flats on cays (OEH, 2012b).	1 record within 10km from 1985 (OEH, 2012b)	Unlikely. Limited suitable habitat.
Irediparra gallinacea	Comb-crested Jacana	V		Occurs on freshwater wetlands in northern and eastern Australia, mainly in coastal and subcoastal regions, from the north-eastern Kimberley Division of Western Australia to Cape York Peninsula then south along the east coast to the Hunter region of NSW – some recorded in south-eastern NSW potentially in response to	2 records within 10km (OEH, 2012b)	Unlikely. May roost on occasion in the study area.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
				unfavourable conditions (OEH, 2012b).		
Actitis hypoleucos	Common Sandpiper		M – CAMBA, JAMBA, ROKAMBA, Marine; Wetland	Widespread in small numbers; predominantly concentrated in northern and western Australia (Higgins & Davies, 1996). The species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. Has also been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties.	1 record within 10km from 1989 (OEH, 2012b)	Unlikely. May roost on occasion in the study areas. Beaches such as Bellambi and Corrimal Beach study areas adjoin watercourses potentially suitable for foraging for this species. Nearby Stanwell Park outside the study area may also provide suitable foraging habitat.
Egretta scara	Eastern Reef Egret		M-CAMBA; Marine	Occurs along much of the Australian coastline except Victoria, Tasmania (Birdlife, 2013). They usually inhabit rocky shorelines and coral islands and reefs, where they forage for fish, crustaceans and molluscs.	9 records within 10km (OEH, 2012b) Recorded by Sandon Point and surrounds (Chafer et al, 1992)	Unlikely. May forage in the study areas opportunistically; Bellambi Beach and Sandon Point are

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
						nearby suitable habitat. Unlikely breed in the study areas.
Puffinus carneipes	Flesh-footed Shearwater	V	M-JAMBA, ROKAMBA ; Marine	Ranges throughout the Pacific and Indian Oceans. There are two main breeding areas: one in the South West Pacific includes Lord Howe Island and New Zealand; the other along the coast of Western Australia (OEH, 2012b). Nests in forests near sandy soils.	9 records within 10km (OEH, 2012b)	Unlikely. Could forage in the surrounds and occasionally roost in vegetation within the study area.
Apus pacificus	Fork-tailed Swift		M; Marine-CAMBA, JAMBA, ROKAMBA	Recorded in all regions of NSW. Non-breeding, and almost exclusively aerial while in Australia. Occurs over urban and rural areas as well as areas of native vegetation. Sightings have been recorded at Milparinka, the Bulloo River and Thurloo Downs (Higgins, 1999).	Predicted to occur within 10km (DSEWPaC, 2012b)	Unlikely. Could potentially occur in some patches, although no records present in the study area.
Plegadis falcinellus	Glossy Ibis		M- Bonn, CAMBA; Marine	Generally located east of the Kimberley in Western Australia and Eyre Peninsula in South Australia.	6 records within 10km (OEH, 2012b)	Unlikely. Limited suitable habitat present.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Calidris tenuirostris	Great Knot		M; Wetland	In NSW, the species has been recorded at scattered sites along the coast to about Narooma. It has also been observed inland at Tullakool, Armidale, Gilgandra and Griffith. Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms (OEH, 2012b).	10 records within 10km (OEH, 2012b)	Unlikely. May roost on occasion. Limited suitable habitat present.
Fregata ariel	Lesser Frigatebird		M, CAMBA JAMBA ROKAMBA	Common and widespread on Australian seas (Lindsey, 1986). It is common in tropical seas, breeds on remote islands, including Christmas Island in the Indian Ocean. Mostly commonly seen from the mainland prior to onset of a tropical cyclone. Predominantly aerial birds, they do use trees and bushes to nest. Diet mainly consists of squid and flying fish.	1 recorded within 10km (OEH, 2012b)	Unlikely. May fly over on occasion. Limited suitable habitat available. This species has been records on the rocky outcrops of Port Kembla outside the study area.
Numenius minutus	Little Curlew		M - CAMBA, JAMBA, ROKAMBA ; Marine,	In NSW, most records are scattered east of the Great Dividing Range, from Casino, south to Greenwell Point with a few scattered records west of the Great Dividing Range (Higgins & Davies, 1996). Congregates around pools, river beds and water-filled tidal channels, and shallow water at edges of billabongs. The species prefers pools with bare dry mud (including	Predicted to occur within 10km (DSEWPaC, 2012b)	Unlikely. Limited suitable habitat present.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
			Wetland	mudbanks in shallow water) and they do not use pools if they are totally dry, flooded or heavily vegetated (Higgins & Davies, 1996).		
Sterna albifrons	Little Shearwater		M; Marine	Widespread; Lord Howe Island has one of the larger breeding colonies in the Australian region; Breeding sites at Lord Howe Island include Roach Island, Muttonbird Island, Blackburn Island and on the main Island at Muttonbird Point and Transit Hill (OEH, 2012b).	3 records within 10km (OEH, 2012b). One record at Austinmer Beach from NPWS, (2002).	Unlikely. May fly over on occasion. Limited suitable habitat available.
Tringa stagnatilis	Marsh Sandpiper		M- Bonn, CAMBA, JAMBA, ROKAMBA; Marine	It is recorded in all regions of NSW but especially the central and south coasts and (inland) on the western slopes of Great Divide and Western Plains (OEH, 2012b). It lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes (DSEWPaC, 2012b)	6 records within 10km (OEH, 2012b)	Unlikely. Limited suitable habitat present.
Neophema chrysogaster	Orange-bellied Parrot	CE	CE; M-Bonn; Marine; Terrestrial	Breeds in Tasmania and migrates in winter to SE South Australia and southern Victoria. There are occasional reports from NSW, including Shellharbour, Maroubra and the Shoalhaven. In winter, usually found within 3km of the coast in saltmarsh and strandline/foredune vegetation. May also occur on golf-courses and other grassy areas, including improved pasture.	1 record within 10km (OEH, 2012b) Predicted to occur within 10km (DSEWPaC, 2012b)	Unlikely. May forage in nearby grasslands but unlikely to be impacted by proposed works.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
Calidris melanotos	Pectoral Sandpiper		M – Bonn, JAMBA, ROKCAMBA; Marine	In NSW, the Pectoral Sandpiper is widespread, but scattered. Records exist east of the Great Divide, from Casino and Ballina, south to Ulladulla (DSEWPaC, 2013a). Prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	4 records within 10km (OEH, 2012b)	Unlikely. Limited suitable habitat present.
Merops ornatus	Rainbow Bee-eater		M – JAMBA; Terrestrial	Widespread across mainland Australia. Mainly inhabits open forests and woodlands and shrublands, often in proximity to permanent water. Also occurs in cleared/semi-cleared habitats including farmland and residential areas. Excavates a nest burrow in flat/sloping ground in banks of waterways, dams, roadside cuttings, gravel pits or cliff faces. Southern populations migrate north for winter after breeding.	Predicted to occur within 10km (DSEWPaC, 2012b)	Unlikely. Could potentially occur in some patches, although no records present in the study area.
Myiagra cyanoleuca	Satin Flycatcher		M; Terrestrial	In NSW widespread on and east of the Great Divide, sparsely scattered on the Western Slopes, very occasional records on the Western Plains. Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, often near wetlands and watercourses. On migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Generally not in rainforests.	Predicted to occur within 10km (DSEWPaC, 2012b)	Unlikely. Could potentially occur in some patches, although no records present in the study area.
Calidris acuminata	Sharp-tailed Sandpiper		M - Bonn, CAMBA, JAMBA, ROKAMBA;	Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent	8 records within 10km (OEH, 2012b)	Unlikely. Limited suitable habitat present.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
			Wetland	sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. (DSEWPaC, 2012b)		
Puffinus tenuirostris	Short-tailed Shearwater		M – JAMBA, ROKAMBA; Marine	This species breeds on Tasmania and off the coast of south Australia, with the bulk of the population in the south-east. It undergoes transequatorial migration, wintering north of Japan near the Aleutian Islands (USA), with some moving north of the Bering Strait. The return migration route incorporates the central Pacific, with some moving down the western coast of North America. Breeding occurs mainly on coastal islands, typically in areas of grassland or other vegetation, but sometimes cliffs or bare ground.	304 records within 10km (OEH, 2012b)	Unlikely. May fly over study area on occasion.
Puffinus griseus	Sooty Shearwater		M-CAMBA, JAMBA; Marine	Breed on small islands in the south Pacific and south Atlantic Oceans, mainly around New Zealand, the Falkland Islands, Tierra del Fuego and also in the Auckland Islands and Phillip Island off Norfolk Island.	7 records within 10km (OEH, 2012b)	Unlikely. May fly over study area on occasion – limited suitable habitat present.
Macronectes giganteus	Southern Giant	E	E, M; Marine	Nests in open vegetation on Antarctic and subantarctic islands, including Macquarie and Heard Islands and in Australian Antarctic	Predicted to occur within 10km (DSEWPaC,	Unlikely

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
	Petrel			territory (OEH, 2012b). It is an opportunistic scavenger and will poach from fishing vessels or animal carcases on land (OEH, 2012b).	2012b) Records along the shoreline at McCauley's Beach Thirroul (WCC, 2010)	May fly over study areas on occasion. Unlikely to rely on these habitats.
Calonectris leucomelas /Puffinus leucomelas	Streaked Shearwater		M – CAMBA, JAMBA, ROKAMBA; Marine	This species is pelagic, but also occurs in inshore waters. It occurs in the Pacific Ocean, nesting in Japan and many of its offshore islands. After breeding, the Streaked Shearwater migrates toward southern Australia. Feeds mainly on fish and squid. It follows fishing boats, attracted to anchovy crawls off Japan. Streaked Shearwater uses burrows to nest in, and prefers forested hills.	4 records within 10km (OEH, 2012b)	Unlikely. May fly over study area on occasion – limited suitable habitat present.
Xenus cinereus	Terek Sandpiper	V	M; Marine	The two main sites for this species in NSW are the Richmond River and Hunter River estuaries. Inhabits coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks near mangroves, also observed on rocky pools and reefs and up to 10km inland around brackish pools. Roost communally in mangroves or dead trees. Forages in open intertidal mudflats.	6 records within 10km (OEH, 2012b)	Unlikely. May fly over study area or roost within dune vegetation on occasion – limited suitable habitat present.
Tringa incana	Wandering Tattler		M- CAMBA, JAMBA, ROKAMBA;	This species is vagrant in the East-Asian Australasian Flyway and is uncommon in Australia (DSEWPaC, 2012b). Found on rocky coasts with reefs and platforms, points, spits, piers, offshore islands and	7 records within 10km (OEH, 2012b)	Unlikely. Limited habitat

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
			Marine	shingle beaches or beds. It is occasionally seen on coral reefs or beaches, and tends to avoid mudflats (Higgins & Davies, 1996). Foraging habitat is among rocks or shingle, or in shallow pools at edges of reefs or beaches, mainly along the tideline. Wandering Tattlers have been recorded roosting or perching on top of boulders surrounded by or close to water (Higgins & Davies, 1996).		present.
Puffinus pacificus	Wedge-tailed Shearwater		M- JAMBA; Marine	Breeds on the east and west coasts of Australia and on off-shore islands. Areas where breeding occurs include Cocos-Keeling Island (WA), islands off the west coast of WA, islands and cays of the Great Barrier Reef (Queensland), islands along the eastern coast of eastern Australia, including Montague Island (NSW), and Lord Howe Island and Norfolk Island (NSW). A pelagic, marine bird known from tropical and subtropical waters. The species has been recorded in offshore waters of eastern Victoria and southern NSW, mostly over continental slope with sea-surface temperatures of 13.9–24.4°C and usually off the continental shelf in north-west Australia.	6546 records within 10km (OEH, 2012b)	Unlikely. Limited habitat present.
Phaethon lepturus	White-tailed Tropicbird		M- CAMBA, JAMBA, Marine	In Australia, the White-tailed Tropicbird (Indian Ocean) nests in Pisonia trees amongst Pisonia-coconut vegetation, and on sandy ground. In Australia, the White-tailed Tropicbird (Indian Ocean) breeds in the Cocos-Keeling Islands in the main atoll, where breeding was last recorded in 1941), and at Ashmore Reef (on West, Middle and East Islands) and Rowley Shoals off the northern coast of Western Australia (D. James, 2005, pers.	4 records within 10km (OEH, 2012b)	Unlikely. Limited habitat present.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
				comm.; Johnstone & Storr, 1998; Marchant & Higgins, 1990).		
Hirundapus caudacutus	White-throated Needletail	*Hirundapus caudacutus*	M –CAMBA, JAMBA, ROKAMBA, Marine; Terrestrial	This species of migratory bird migrates from breeding grounds in Siberia, the Himalayas, and Japan to Australia in Summer, arriving mid-October and departing mid-April. It is known to inhabit a variety of habitats including forests, woodlands, farmlands, plains, lakes, coasts and towns (Pizzey and Knight, 1999). Feeds on insects during flight, chiefly ahead of weather changes. In Australia, this species is nomadic, responding to local weather changes (DSEWPaC, 2012b).	9 records within 10km (OEH, 2012b) Predicted to occur within 10km (DSEWPaC, 2012b) Recorded by a Thirroul resident at Sandon Point (WCC, 2004)	Unlikely. May fly over study area on occasion or roost on the shoreline.
Chlidonias leucopterus	White-winged Black Tern		M -CAMBA, JAMBA, ROKAMBA; Marine	In NSW, the species is widespread east of the Great Divide, mainly south to Wollongong, but with scattered records found further south (Morris, 1971). The species mostly inhabits fresh, brackish or saline, and coastal or subcoastal wetlands. White-winged Black Terns frequent tidal wetlands, such as harbours, bays, estuaries and lagoons, and their associated tidal sandflats and mudflats.	16 records within 10km (OEH, 2012b). Scattered records in the Wollongong region (DSEWPaC, 2012b).	Unlikely. May fly over study area on occasion; limited habitats present.
Tringa glareola	Wood Sandpiper		M - Bonn, CAMBA, JAMBA, ROKAMBA; Marine	In NSW there are records east of the Great Divide, from Stratheden and Casino, south to Nowra and elsewhere, mostly from the Riverina, but also from the Upper and Lower Western Regions (DSEWPaC 2013). The Wood Sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated	1 records within 10km from 1987 (OEH, 2012b)	Unlikely. Limited habitat present.

Scientific Name	Common Name	TSC Status	EPBC Status	Habitat Association	Details of Record	Likelihood of Occurrence within study areas.
				by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially *Melaleuca* and River Red Gums *Eucalyptus camaldulensis* and often with fallen timber.		

Appendix E – Vegetation cover profiles

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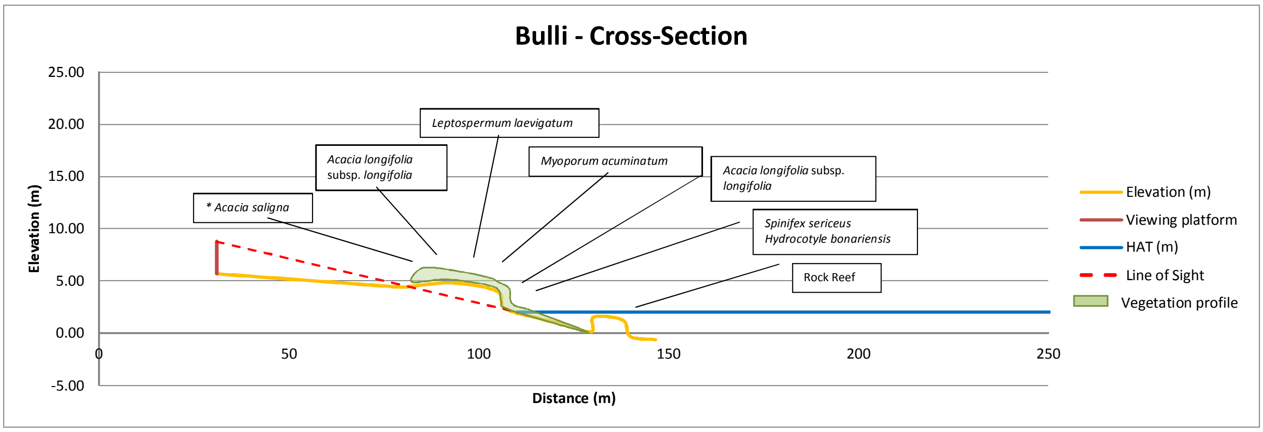
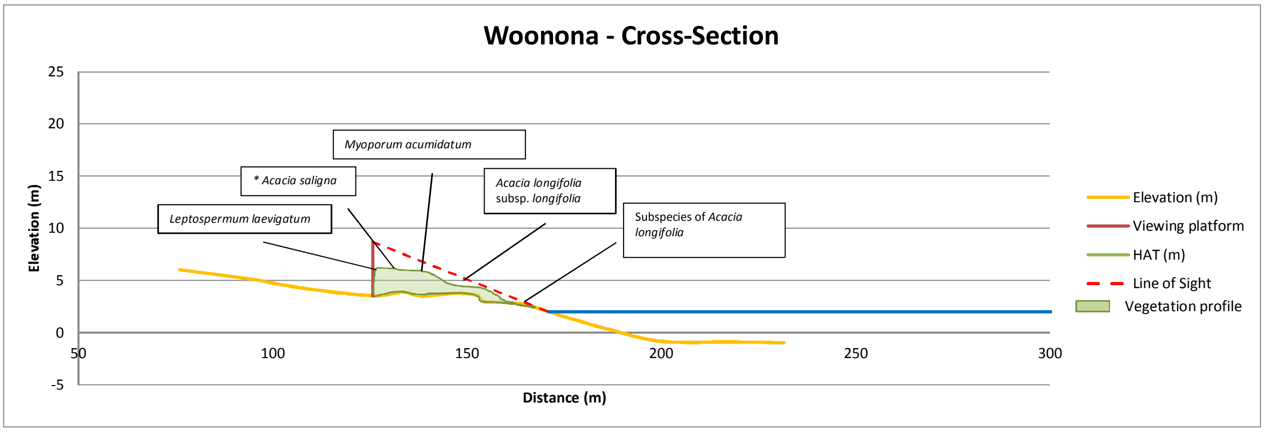
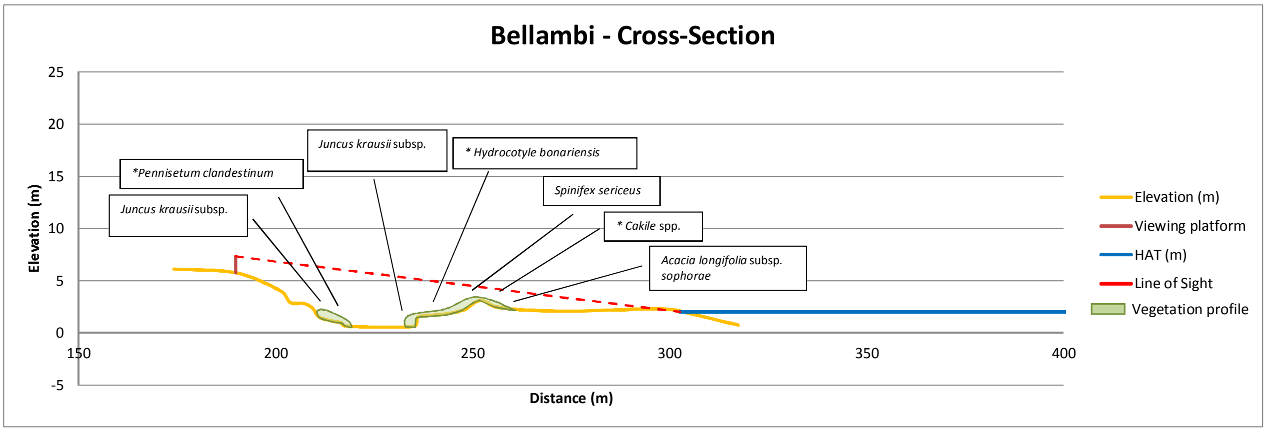
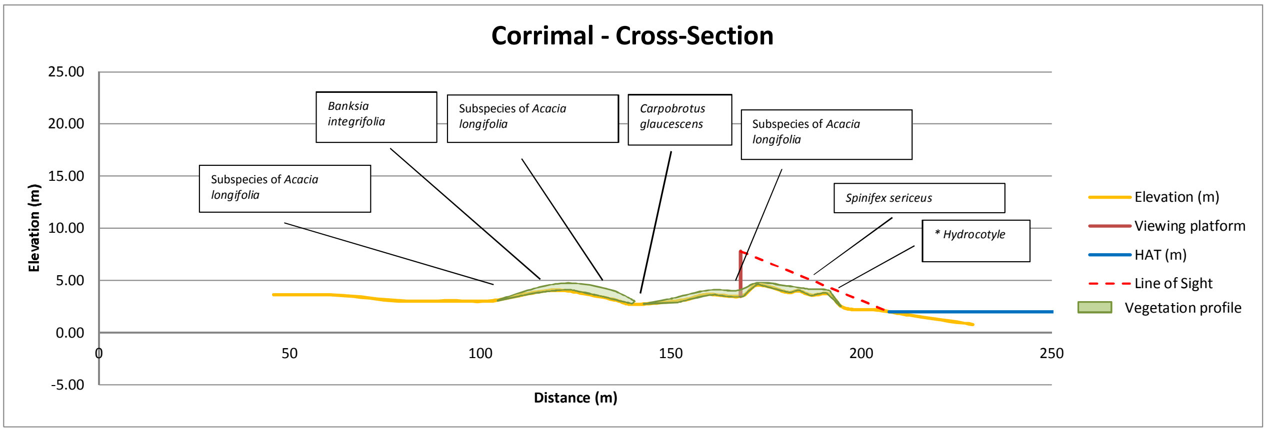
2013 Survey Site Notes Illustrating Extent of Vegetation (and Species), Viewing Platform and Line of Sight

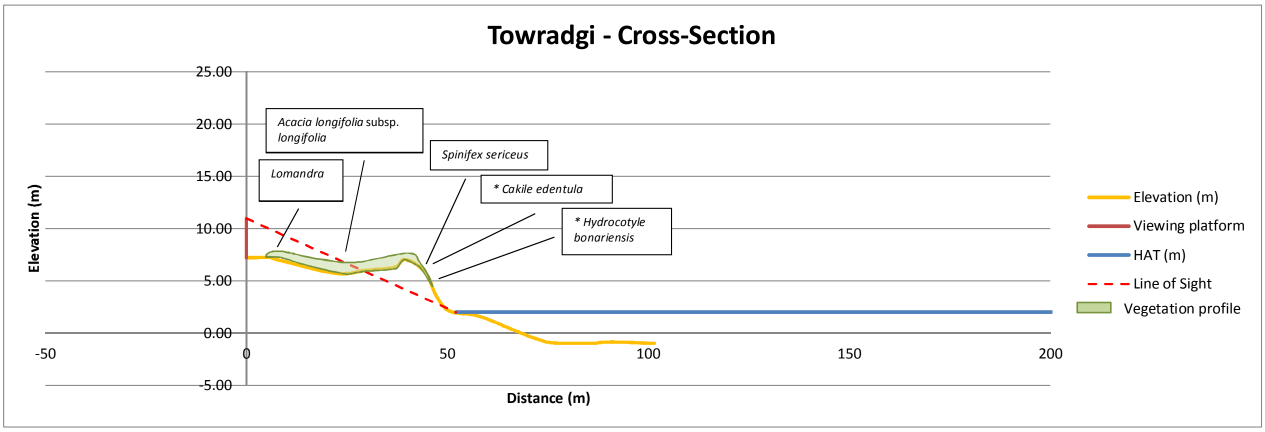


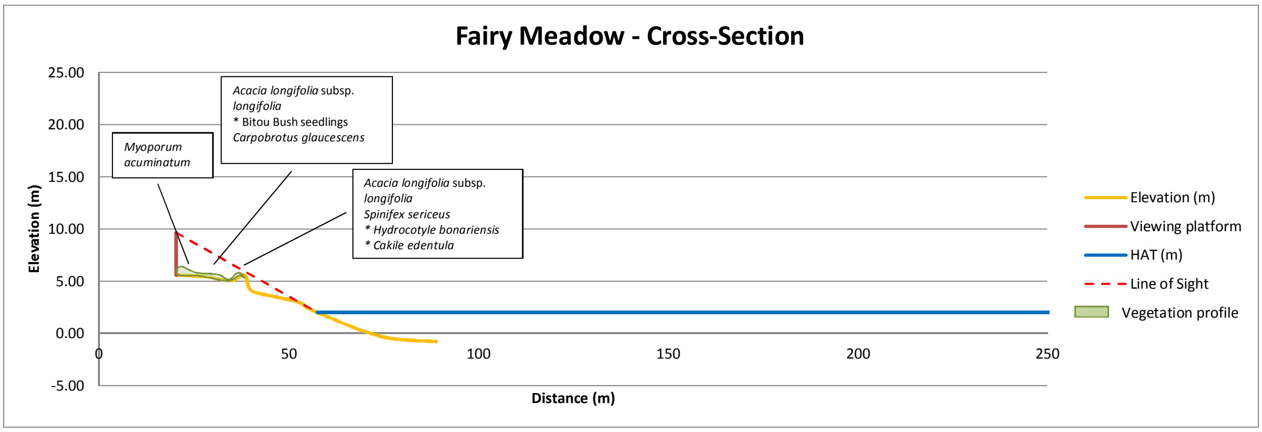




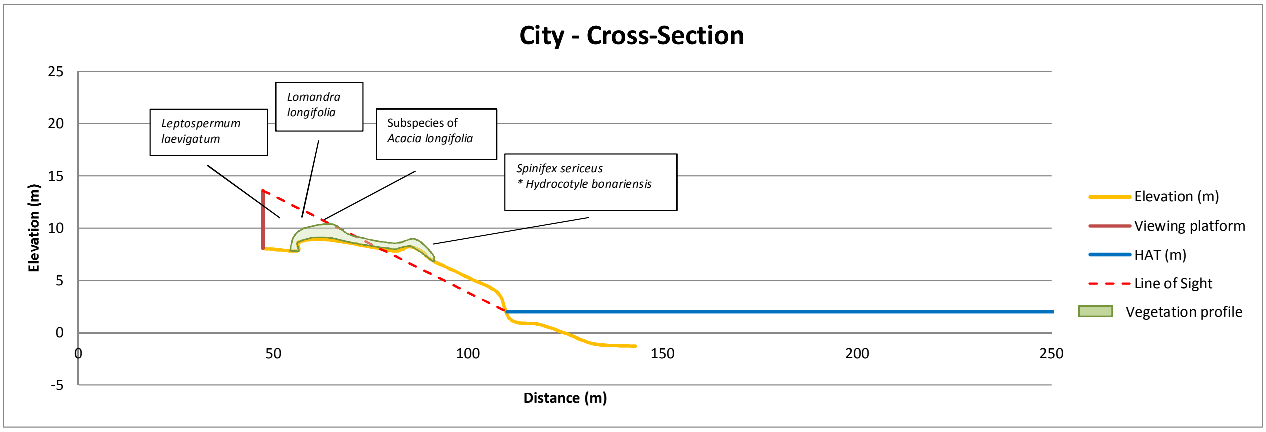
2013 Survey Site Notes Illustrating Extent of Vegetation (and Species), Viewing Platform and Line of Sight

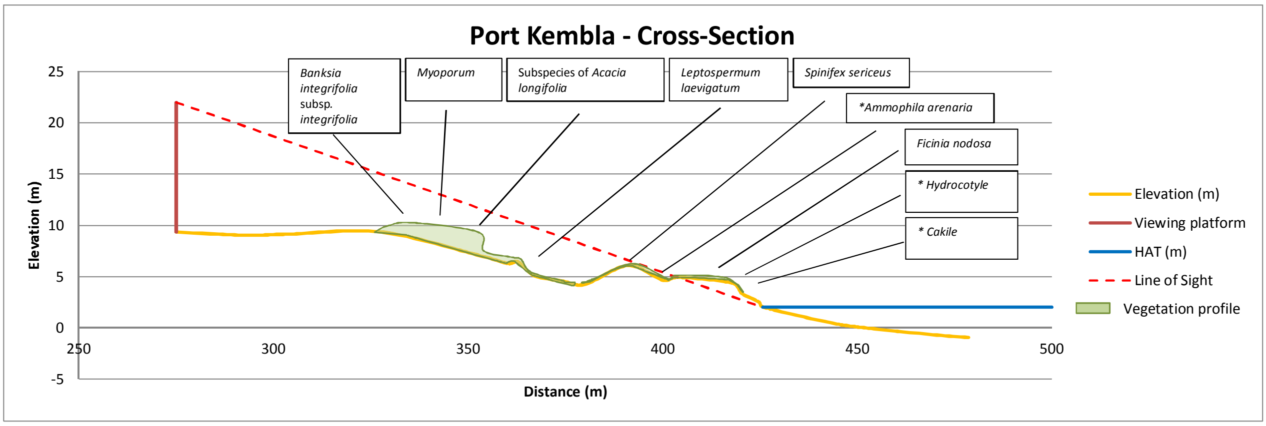


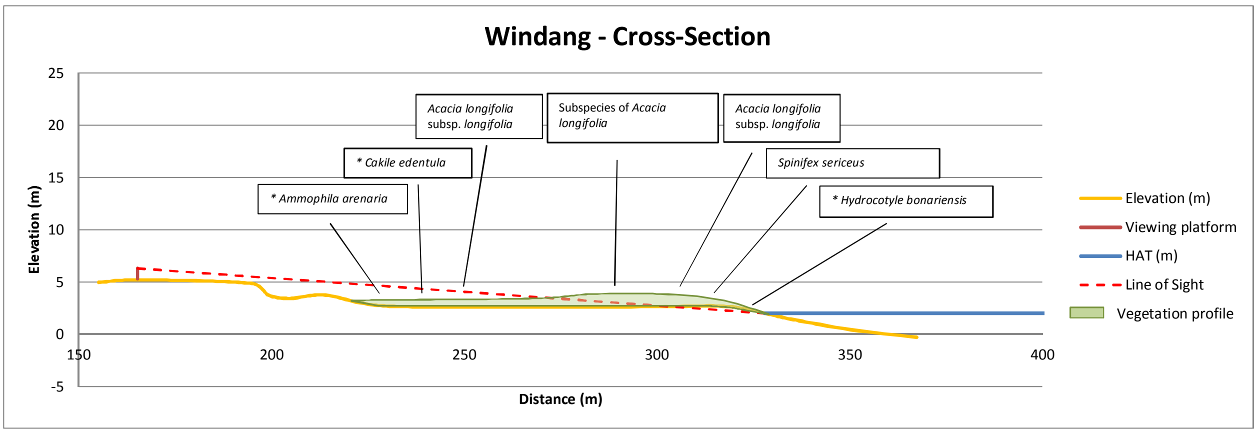




2013 Survey Site Notes Illustrating Extent of Vegetation (and Species), Viewing Platform and Line of Sight







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Appendix F – Plant species lists

Plant species lists:

Legend:

1 Species recorded in study area
2 Species recorded in vegetation adjacent to the study area.
C commonly occurring
O occasional
U uncommon

Stanwell Park

Family	Plant Name	1	2
PTERIDOPHYTA			
Davalliacae	**Nephrolepis cordifolia*		u
Dennstaedtiaceae	*Pteridium esculentum*		o
Dicksoniaceae	*Calochlaena dubia*		o
LILIIDAE			
Amaryllidaceae	*Crinum pedunculatum*		u
Arecaceae	*Livistona australis*		u
Asparagaceae	**Asparagus aethiopicus*		u
	**Asparagus asparagaoides*		
	**Asparagus plumosus*	u	u
Commelinaceae	*Commelina cyanea*	o	o
	**Tradescantia fluminensis*		o
Cyperaceae	*Baumea juncea*		u
	Carex pumila	u	u
	Cyperus laevigatus	u	u
	Ficinia nodosa	o	o
Juncaceae	*Juncus continuus*		u
	Juncus usitatus	u	o
Lomandraceae	*Lomandra longifolia*	o	o
Philesiaceae	*Eustrephus latifolius*		u
	Geitonoplesium cymosum		u
Phormiaceae	*Dianella congesta*	o	o
Poaceae	**Aira caryophyllea*		u
	Anisopogon avenaceus		u
	Cynodon dactylon	c	c
	Digitaria breviglumis		
	**Ehrharta erecta*	c	c
	Entolasia stricta		u
	Imperata cylindrica var. *major*	o	o
	Microlaena stipoides var.*stipoides*	o	o
	Oplismenus aemulus		o
	**Panicum effusum*		u
	**Paspalum dilatatum*		u
	**Pennisteum clandestinum*	c	o
	Poa poiformis	u	u
	**Setaria viridis*	u	
	Spinifex sericeus	c	c
	Sporobolus virginicus		o
	**Stenotaphrum secundatum*	u	
	Themeda australis		o

MAGNOLIOPSIDA			
Acanthaceae	*Pseuderanthemum variabile*		u
Aizoaceae	*Carpobrotus glaucescens*	o	o
	Tetragonia tetragonioides	o	o
Amaranthaceae	*Alternanthera denticulata*		u
	**Alternanthera pungens*	u	u
Apiaceae	*Apium prostratum* var.*filiforme*	u	u
	Centella asiatica	u	o
	**Hydrocotyle bonariensis*	c	c
	**Foeniculum vulgare*	u	u
Apocynaceae	*Parsonsia straminea*		u
Asclepiadaceae	**Araujia sericifera*		u
Asteraceae	*Actites megalocarpa*		u
	**Ageratina adenophora*	u	u
	Bidens pilosa	u	u
	**Chrysanthemoides monilifera* subsp.*rotundata*		u
	**Conyza bonariensis*		u
	**Gazania rigens*	u	u
	**Hypochaeris radicata*	u	u
	Melanthera biflora		u
	Ozothamnus diosmifolius		u
	Senecio spathulatus subsp. *attenuatus*	u	u
Basellaceae	**Anredera cordifolia*		u
Bignoniaceae	*Pandorea pandorana* subsp. *pandorana*		u
Boraginaceae	*Ehretia acuminata* var. *acuminata*		u
Brassicaceae	**Cakile edentula*	o	o
	**Cakile maritima*	o	o
	**Hirschfeldia incana*		u
	**Cardamine hirsuta*		u
Casuarinaceae	*Allocasuarina verticillata*		o
Celastraceae	*Elaeodendron australis* var. *australis*		o
Chenopodiaceae	*Atriplex australasica*		o
	Atriplex cinerea		u
	Rhagodia candolleana subsp.*candolleana*	o	o
Convolvulaceae	*Calystegia sepium*		u
	Dichondra repens	o	o
	**Ipomoea cairica*	u	u
	**Ipomoea indica*		u
Crassulaceae	**Bryophyllum delagoense*		u
Dilleniaceae	*Hibbertia scandens*	u	o
Ericaceae (sens. lat.)	*Leucopogon parviflorus*		u
	Monotoca elliptica	u	o
Euphorbiaceae	**Chamaesyce hirta*		u
	Homolanthus populifolius		u
Fabaceae Caesalpinioideae	**Senna pendula* var.*glabrata*		u
Fabaceae Faboideae	*Desmodium varians*		u
	Glycine clandestina		o
	Glycine tabacina		u
	Hardenbergia violacea	u	u
	**Trifolium subterraneum*	u	
Fabaceae Mimosoideae	*Acacia implexa*		u
	Acacia longifolia subsp. *longifolia*	o	o
	Acacia longifolia subsp. *sophorae*	o	o
	Subspecies of *Acacia longifolia*	o	o
	Acacia melanoxylon		u
	**Acacia saligna*	o	o
Geraniaceae	**Geranium molle* subsp. *molle*	u	
	Pelargonium australe	u	u

Goodeniaceae	*Scaevola calendulacea*	u	u
Lamiaceae	*Westringia fruticosa*	o	o
Lobeliaceae	*Lobelia alata*		u
Menispermaceae	*Stephania japonica* var.*discolor*	u	u
Moraceae	*Ficus rubiginosa*		u
Myoporaceae	*Myoporum acuminatum*	u	u
	Myoporum boninense subsp. *australe*	o	o
Myrtaceae	*Eucalyptus botryoides*		u
	Eucalyptus pilularis		o
	Leptospermum laevigatum	c	c
	Melaleuca armillaris		o
	Melaleuca ericifolia		u
	.Acmena smithii		u
Phyllanthaceae	*Breynia oblongifolia*	o	o
	Glochidion ferdinandi var. *ferdinandi*		o
	Glochidion ferdinandi var. *pubens*		u
	Phyllanthus hirtellus		u
Pittosporaceae	*Billardiera scandens* var. *scandens*		u
	Pittosporum undulatum		o
Plantaginaceae	*Plantago hispida*		u
	**Plantago lanceolata*	u	u
Polygonaceae	**Acetosa sagittata*		u
Primulaceae	**Anagallis arvensis*		u
Proteaceae	*Banksia integrifolia* subsp.*integrifolia*	o	c
Rosacae (s. str.)	*Rubus parvifolius*		u
Rutaceae	*Correa alba* subsp. *alba*	o	o
Sapindaceae	*Guioa semiglauca*		o
Verbenaceae	**Lantana camara*	u	o
	**Verbena bonariensis*		u
Vitaceae	*Cayratia clematidia*		u

Coalcliff and Scarborough-Wombarra

Family	**Plant Name**	**1**	**2**
LILIIDAE			
Arecaceae	*Livistona australis*		u
Asparagaceae	**Asparagus aethiopicus*	u	u
Commelinaceae	*Commelina cyanea*	u	o
	**Tradescantia fluminensis*		u
Cyperaceae	*Baumea juncea*	u	
	Carex pumila	o	
	Cyperus laevigatus	u	
	Ficinia nodosa	o	
Juncaceae	*Juncus continuus*	u	
	Juncus usitatus	o	o
Lomandraceae	*Lomandra longifolia*	o	o
Philesiaceae	*Eustrephus latifolius*		u
	Geitonoplesium cymosum		u
Poaceae	*Cynodon dactylon*	c	c
	Digitaria breviglumis		u
	**Ehrharta erecta*	c	c
	**Eleusine indica*	u	
	Entolasia marginata		u
	Imperata cylindrica var. *major*	u	o
	Microlaena stipoides var. *stipoides*	o	o
	Oplismenus aemulus		o
	**Pennisetum clandestinum*	c	o
	Phragmites australis	o	o

	**Poa anua*		o
	Poa labillardieri		u
	Poa poiformis	u	
	**Setaria viridis*		u
	Spinifex sericeus	c	o
	Sporobolus virginicus	o	o
	**Stenotaphrum secundatum*	u	
	Themeda australis		u
	Zoysia macrantha	u	
Typhaceae	*Typha orientalis*		u
MAGNOLIOPSIDA			
Aizoaceae	*Carpobrotus glaucescens*	u	
	Tetragonia tetragonioides	o	o
Apiaceae	*Apium prostratum* var. *filiforme*	u	
	Centella asiatica	o	o
	**Hydrocotyle bonariensis*	o	o
Apocynaceae	*Parsonsia straminea*		u
Asclepiadaceae	**Araujia sericifera*		u
Asteraceae	**Ageratina adenophora*	u	u
	Bidens pilosa	u	u
	**Chrysanthemoides monilifera* subsp. *rotundata*		o
	**Delairea odorata*		u
	**Gazania rigens*	u	u
	Senecio spathulatus subsp. *attenuatus*	u	
	**Senecio madagascariensis*		u
	**Sonchus oleraceus*		u
Basellaceae	**Anredera cordifolia*		u
Boraginaceae	*Ehretia acuminata* var. *acuminata*		o
Brassicaceae	**Cakile edentula*	o	o
	**Cakile maritima*	o	o
Casuarinaceae	*Casuarina glauca*		o
Celastraceae	*Elaeodendron australis* var. *australis*		o
Chenopodiaceae	*Atriplex cinerea*	u	
	Rhagodia candolleana subsp. *candolleana*	u	
Convolvulaceae	*Dichondra repens*	o	o
	**Ipomoea cairica*		u
	**Ipomoea indica*		u
Dilleniaceae	*Hibbertia scandens*		u
Ericaceae (sens. lat.)	*Monotoca elliptica*		u
Euphorbiaceae	*Homolanthus populifolius*		o
Fabaceae Caesalpinioideae	**Senna pendula* var. *glabrata*		u
Fabaceae Faboideae	*Glycine clandestina*		u
	Hardenbergia violacea		u
	**Trifolium subterraneum*	u	
Fabaceae Mimosoideae	*Acacia implexa*		u
	Acacia longifolia subsp. *longifolia*		u
	Acacia longifolia subsp. *sophorae*		o
	Acacia melanoxylon		u
Geraniaceae	*Pelargonium australe*	u	
Goodeniaceae	*Scaevola calendulacea*	u	
	Selliera radicans	u	
Lamiaceae	*Westringia fruticosa*	u	u
Malvaceae sens. lat.	**Lagunaria patersonii*		u
	**Sida rhombifolia*		u
Menispermaceae	*Stephania japonica* var. *discolor*		u
Moraceae	**Ficus decora*		u
	Ficus rubiginosa		u
Myoporaceae	*Myoporum acuminatum*	u	u

	Myoporum boninense subsp. *australe*	u	
Myrtaceae	*Eucalyptus botryoides*		u
	Leptospermum laevigatum	o	o
	Acmena smithii		o
Ochnaceae	**Ochna serrulata*		u
Oleaceae	**Ligustrum lucidum*		u
	Notelaea venosa		u
Passifloraceae	**Passiflora subpeltata*		u
Phyllanthaceae	*Breynia oblongifolia*		o
	Glochidion ferdinandi var. *ferdinandi*		u
Pittosporaceae	*Pittosporum revolutum*		o
	Pittosporum undulatum		o
Polygonaceae	**Rumex crispus*	u	
Proteaceae	*Banksia integrifolia* subsp. *integrifolia*	o	c
Rosacae (s. str.)	*Rubus parvifolius*		u
Rubiaceae	**Coprosma repens*		o
Rutaceae	*Correa alba* subsp. *alba*	u	u
Sapindaceae	*Guioa semiglauca*		u
Solanaceae	**Solanum nigrum*		u
Ulmaceae	*Trema tomentosa* var. *aspera*		u
Verbenaceae	**Lantana camara*		u

Austinmer and Coledale

Family	**Plant Name**		
PTERIDOPHYTA			
Dennstaedtiaceae	*Pteridium esculentum*		u
Dicksoniaceae	*Calochlaena dubia*		u
CONIFEROPSIDA			
Aracauriaceae	**Araucaria heterophylla*	o	c
LILIIDAE			
Agavaceae	**Agave americanum*		u
Araceae	**Alocasia esculentum*		u
Arecacae	**Phoenix canariensis*		u
Asparagaceae	**Asparagus aethiopicus*		u
Commelinaceae	*Commelina cyanea*		u
	**Tradescantia fluminensis*		u
Cyperaceae	*Carex pumila*		u
	Cyperus laevigatus		u
	Ficinia nodosa		o
Juncaceae	*Juncus krausii* subsp. *australiensis*		u
	Juncus usitatus		u
Lomandraceae	*Lomandra longifolia*		o
Poaceae	**Aira caryophyllea*		u
	**Briza minor*		u
	Cynodon dactylon		c
	**Ehrharta erecta*		o
	Imperata cylindrica var. *major*		u
	Microlaena stipoides var. *stipoides*		o
	Oplismenus aemulus		u
	**Panicum effusum*		u
	**Paspalum dilatatum*		c
	Paspalum distichum		u
	**Pennisteum clandestinum*		c
	**Phleum pratense*		u
	Phragmites australis		u

	Spinifex sericeus		o
	Sporobolus virginicus		u
	**Stenotaphrum secundatum*		o
	Themeda australis		o
	Zoysia macrantha		u
Typhaceae	*Typha orientalis*		u
MAGNOLIOPSIDA			
Acanthaceae	*Pseuderanthemum variabile*		u
Aizoaceae	*Carpobrotus glaucescens*		u
	Tetragonia tetragonioides		o
Amaranthaceae	*Alternanthera denticulata*		u
Apiaceae	*Centella asiatica*		u
	**Hydrocotyle bonariensis*	u	o
	**Foeniculum vulgare*		u
Asteraceae	**Ageratina adenophora*		u
	Bidens pilosa		u
	**Chrysanthemoides monilifera* subsp. *rotundata*		u
	**Gazania rigens*		u
	**Hypochaeris radicata*		u
	Senecio lautus subsp. *maritimus*		u
	**Senecio madagascariensis*		u
	**Sonchus oleraceus*		u
Brassicaceae	**Cakile edentula*		o
	**Cakile maritima*		o
	**Cardamine hirsuta*		u
Casuarinaceae	*Casuarina equisetifolia* subsp. *incana*		u
	Casuarina glauca		u
Chenopodiaceae	*Einadia nutans*		u
Convolvulaceae	*Dichondra repens*		o
Euphorbiaceae	**Chamaesyce hirta*		u
Fabaceae Faboideae	*Desmodium varians*		u
	Hardenbergia violacea		u
	**Trifolium subterraneum*		o
Fabaceae Mimosoideae	*Acacia implexa*		u
	Acacia longifolia subsp. *sophorae*		u
	Subspecies of *Acacia longifolia*		u
	Acacia melanoxylon		u
	**Acacia saligna*		u
Geraniaceae	**Geranium molle* subsp. *molle*		u
	Pelargonium australe		u
Goodeniaceae	*Selliera radicans*		u
Lamiaceae	*Westringia fruticosa*		u
Lobeliaceae	*Lobelia alata*		u
Malvaceae sens. lat.	**Lagunaria patersonii*		o
	**Sida rhombifolia*		u
Myoporaceae	*Myoporum boninense* subsp. *australe*		u
Myrtaceae	*Eucalyptus botryoides*		u
	Leptospermum laevigatum		o
	Melaleuca armillaris		o
Phyllanthaceae	*Breynia oblongifolia*		u
	Glochidion ferdinandi var. *ferdinandi*		o
Pittosporaceae	*Billardiera scandens* var. *scandens*		u
	**Pittosporum crassifolium*		u
	Pittosporum undulatum		u
Plantaginaceae	**Plantago lanceolata*		o
Polygonaceae	*Persicaria hydropiper*		u
Primulaceae	*Samolus repens*		u

Proteaceae	*Banksia integrifolia* subsp. *integrifolia*		c
Ranunculaceae	**Ranunculus repens*		u
Rubiaceae	**Coprosma repens*		o
Rutaceae	*Correa alba* subsp. *alba*		u

Thirroul

Family	**Plant Name**		
CONIFEROPSIDA			
Aracauriaceae	**Araucaria heterophylla*		c
LILIIDAE			
Asparagaceae	**Asparagus aethiopicus*		u
Commelinaceae	*Commelina cyanea*		u
	**Tradescantia fluminensis*		u
Cyperaceae	*Carex pumila*		o
	Cyperus laevigatus		u
	Ficinia nodosa		o
Juncaceae	*Juncus usitatus*		o
Lomandraceae	*Lomandra longifolia*		o
Poaceae	*Anisopogon avenaceus*		u
	**Austrofestuca littoralis*		u
	Cynodon dactylon		c
	**Ehrharta erecta*		o
	**Eleusine indica*		u
	Entolasia stricta		u
	Hemarthria uncinata		u
	Microlaena stipoides var. *stipoides*		u
	**Paspalum dilatatum*		o
	Paspalum distichum		o
	**Pennisteum clandestinum*		c
	Phragmites australis		u
	**Poa anua*		o
	Spinifex sericeus		u
	Sporobolus virginicus		u
	**Stenotaphrum secundatum*		o
	Zoysia macrantha		u
Typhaceae	*Typha orientalis*		o
MAGNOLIOPSIDA			
Aizoaceae	*Carpobrotus glaucescens*		o
	Tetragonia tetragonioides		u
Apiaceae	*Centella asiatica*		o
	**Hydrocotyle bonariensis*	u	o
	**Foeniculum vulgare*		o
Asteraceae	*Actites megalocarpa*		u
	Bidens pilosa		u
	**Conyza albida*		u
	**Erechtites valerianifolia*		u
	**Gazania rigens*		u
	**Hypochaeris radicata*		u
	**Senecio madagascariensis*		u
	**Sonchus oleraceus*		u
Brassicaceae	**Cakile edentula*		o
	**Cakile maritima*	u	o
Casuarinaceae	*Casuarina equisetifolia* subsp. *incana*		o
	Casuarina glauca		o
Chenopodiaceae	*Atriplex australasica*		u

	**Chenopodium album*		u
	Einadia nutans		u
Convolvulaceae	*Dichondra repens*		o
	**Ipomoea cairica*		u
Ericaceae (sens. lat.)	*Monotoca elliptica*		u
Euphorbiaceae	**Chamaesyce hirta*		u
Fabaceae Caesalpinioideae	**Senna pendula* var. *glabrata*		u
Fabaceae Faboideae	*Desmodium varians*		u
	Glycine clandestina		o
	Hardenbergia violacea		u
	**Trifolium subterraneum*		o
Fabaceae Mimosoideae	*Acacia longifolia* subsp. *sophorae*		o
	Acacia longifolia subsp. *longifolia*		o
	Acacia melanoxylon		o
Geraniaceae	*Pelargonium australe*		u
Goodeniaceae	*Scaevola calendulacea*		u
	Selliera radicans		u
Lamiaceae	*Westringia fruticosa*		u
Malvaceae sens. lat.	**Lagunaria patersonii*		o
	**Sida rhombifolia*		o
Moraceae	**Ficus benghalensis*		u
Myoporaceae	*Myoporum boninense* subsp. *australe*		u
Myrtaceae	*Eucalyptus botryoides*		o
	Leptospermum laevigatum		o
	Melaleuca armillaris		u
Phyllanthaceae	*Breynia oblongifolia*		u
	Glochidion ferdinandi var. *ferdinandi*		u
Pittosporaceae	**Pittosporum crassifolium*		u
	Pittosporum undulatum		u
Plantaginaceae	**Plantago lanceolata*		o
Polygonaceae	*Persicaria decipiens*		u
	Rumex brownii		u
	**Rumex crispus*		u
Portulacaceae	*Portulaca oleracea*		u
Primulaceae	*Samolus repens*		u
Proteaceae	*Banksia integrifolia* subsp. *integrifolia*		o
Rosacae (s. str.)	*Rubus parvifolius*		u
Rubiaceae	**Coprosma repens*		u
Rutaceae	*Correa alba* subsp. *alba*		u
Sapindaceae	**Cupaniopsis anacardioides*		p
	Guioa semiglauca		u
Scrophulariaceae	*Bacopa monniera*		u
Solanaceae	**Solanum nigrum*		u

Sandon Point, Bulli and Woonona

Family	**Plant Name**	**1**	**2**
PTERIDOPHYTA			
Davalliaceae	**Nephrolepis cordifolia*		u
Dennstaedtiaceae	*Pteridium esculentum*		u
Dicksoniaceae	*Calochlaena dubia*		u
CONIFEROPSIDA			
Aracauriaceae	**Araucaria heterophylla*		o
LILIIDAE			
Amaryllidaceae	*Crinum pedunculatum*		u
Asparagaceae	**Asparagus aethiopicus*		u

	**Asparagus asparagaoides*		u
Commelinaceae	*Commelina cyanea*		o
	**Tradescantia fluminensis*		u
Cyperaceae	*Carex pumila*	u	u
	Cyperus laevigatus		u
	Ficinia nodosa	o	o
Juncaceae	*Juncus krausii* subsp. *australiensis*		u
	Juncus usitatus		o
Lomandraceae	*Lomandra longifolia*	u	o
Phormiaceae	*Dianella congesta*	u	
Poaceae	**Aira caryophyllea*		u
	Anisopogon avenaceus		u
	Cynodon dactylon	o	c
	**Ehrharta erecta*		o
	**Eleusine indica*		u
	Hemarthria uncinata		o
	Imperata cylindrica var. *major*		o
	Microlaena stipoides var. *stipoides*		u
	Oplismenus aemulus		u
	**Paspalum dilatatum*		o
	Paspalum distichum	u	u
	**Pennisetum clandestinum*	o	c
	Phragmites australis		u
	**Poa anua*		u
	Poa billariderei	u	
	Poa labillardieri		u
	Poa poiformis	u	
	Spinifex sericeus	c	c
	Sporobolus virginicus	u	o
	**Stenotaphrum secundatum*		u
	Themeda australis		u
MAGNOLIOPSIDA			
Acanthaceae	*Pseuderanthemum variabile*		u
Aizoaceae	*Carpobrotus glaucescens*	o	o
	Tetragonia tetragonioides	o	o
Amaranthaceae	*Alternanthera denticulata*		u
Apiaceae	*Apium prostratum* var. *filiforme*	u	
	Centella asiatica		o
	**Hydrocotyle bonariensis*	o	o
Asteraceae	*Actites megalocarpa*		u
	**Ageratina adenophora*		u
	Bidens pilosa		u
	**Chrysanthemoides monilifera* subsp. *rotundata*		u
	**Delairea odorata*		u
	**Erechtites valerianifolia*		u
	**Gazania rigens*		u
	Melanthera biflora	u	
	Senecio spathulatus subsp. *attenuatus*	u	
	**Senecio madagascariensis*		u
	**Sonchus oleraceus*		u
Brassicaceae	**Cakile edentula*	o	o
	**Cakile maritima*	o	o
	**Hirschfeldia incana*		u
	**Cardamine hirsuta*		u
Casuarinaceae	*Casuarina glauca*		o
Chenopodiaceae	*Atriplex australasica*	u	
	**Chenopodium album*		u
	Einadia nutans		u

	Rhagodia candolleana subsp. *candolleana*	u	
Convolvulaceae	*Calystegia sepium*		u
	Dichondra repens		o
	**Ipomoea cairica*		u
	**Ipomoea indica*		u
Dilleniaceae	*Hibbertia scandens*	u	
Ericaceae (sens. lat.)	*Leucopogon parviflorus*		u
Fabaceae Faboideae	*Glycine tabacina*		u
	Hardenbergia violacea		u
	Kennedia rubicunda		u
Fabaceae Mimosoideae	*Acacia longifolia* subsp. *longifolia*		o
	Acacia longifolia subsp. *sophorae*	o	
	Subspecies of *Acacia longifolia*	o	o
Geraniaceae	**Geranium molle* subsp. *molle*	u	
	Pelargonium australe		u
Goodeniaceae	*Scaevola calendulacea*	u	
Lamiaceae	*Westringia fruticosa*	o	o
Malvaceae sens. lat.	**Lagunaria patersonii*		u
	**Sida rhombifolia*		u
Myoporaceae	*Myoporum acuminatum*		o
	Myoporum boninense subsp. *australe*	u	o
Myrtaceae	*Leptospermum laevigatum*	o	o
	Melaleuca armillaris		o
	Melaleuca ericifolia		u
Ochnaceae	**Ochna serrulata*		u
Phyllanthaceae	*Breynia oblongifolia*		u
Plantaginaceae	*Plantago hispida*		u
	**Plantago lanceolata*		u
Portulacaceae	*Portulaca oleracea*		u
Proteaceae	*Banksia integrifolia* subsp. *integrifolia*		o
Rubiaceae	**Coprosma repens*		o
Rutaceae	*Correa alba* subsp. *alba*	u	o
Verbenaceae	**Lantana camara*		
	**Verbena bonariensis*		

Bellambi, Corrimal, Towradgi & Fairy Meadow

Family	**Plant Name**		
PTERIDOPHYTA			
Dennstaedtiaceae	*Pteridium esculentum*		o
Dicksoniaceae	*Calochlaena dubia*		o
CONIFEROPSIDA			
Aracauriaceae	**Araucaria heterophylla*		o
LILIIDAE			
Amaryllidaceae	*Crinum pedunculatum*		u
Asparagaceae	**Asparagus aethiopicus*	u	o
Commelinaceae	*Commelina cyanea*		u
	**Tradescantia fluminensis*		u
Cyperaceae	*Carex pumila*	u	u
	Cyperus laevigatus	u	
	Ficinia nodosa	o	o
Juncaceae	*Juncus continuus*		u
	Juncus kraussii subsp. *australiense*	u	
	Juncus usitatus		o
Lomandraceae	*Lomandra longifolia*	o	o
Phormiaceae	*Dianella congesta*	u	

Poaceae	**Aira caryophyllea*	u	
	**Ammophila arenaria*	o	o
	**Avena fatua*	u	
	**Briza minor*	u	u
	**Bromus catharticus*		u
	**Chloris gayana*		u
	Cynodon dactylon	o	o
	**Ehrharta erecta*	o	o
	Entolasia marginata	u	
	Hemarthria uncinata	u	u
	Imperata cylindrica var. *major*	u	o
	Microlaena stipoides var. *stipoides*		u
	Oplismenus aemulus		u
	**Paspalum dilatatum*		u
	**Pennisetum clandestinum*	o	c
	Phragmites australis		u
	**Poa anua*		u
	Poa labillardieri		u
	Poa poiformis	u	
	**Setaria viridis*		u
	Spinifex sericeus	o	o
	Sporobolus virginicus	u	o
	**Stenotaphrum secundatum*		u
	Themeda australis		u
	Zoysia macrantha		u
MAGNOLIOPSIDA			
Acanthaceae	*Pseuderanthemum variabile*		u
Aizoaceae	*Carpobrotus glaucescens*	o	o
	Tetragonia tetragonioides	o	o
Amaranthaceae	*Alternanthera denticulata*		u
	**Alternanthera pungens*		u
Apiaceae	*Apium prostratum* var. *filiforme*	u	
	Centella asiatica	u	o
	**Hydrocotyle bonariensis*	o	o
	**Foeniculum vulgare*		u
Asteraceae	**Ageratina adenophora*		u
	Bidens pilosa	u	u
	**Chrysanthemoides monilifera* subsp. *rotundata*	o	o
	**Conyza bonariensis*	u	u
	**Delairea odorata*		u
	**Erechtites valerianifolia*		u
	**Gazania rigens*	u	u
	**Hypochaeris radicata*		u
	Melanthera biflora	u	
Brassicaceae	**Cakile edentula*	o	o
	**Cakile maritima*	o	o
	**Cardamine hirsuta*		o
Cactaceae	**Opuntia stricta*		u
Casuarinaceae	*Casuarina glauca*		o
Chenopodiaceae	*Rhagodia candolleana* subsp. *candolleana*	u	u
Convolvulaceae	*Dichondra repens*		o
	**Ipomoea cairica*	u	u
	**Ipomoea indica*	u	u
Crassulaceae	**Bryophyllum delagoense*	u	
Dilleniaceae	*Hibbertia scandens*	u	u
Ericaceae (sens. lat.)	*Leucopogon parviflorus*	u	u
	Monotoca elliptica	o	o
Euphorbiaceae	**Chamaesyce hirta*	u	

Fabaceae Caesalpinioideae	**Senna pendula* var. *glabrata*		u
Fabaceae Faboideae	*Desmodium varians*	u	u
	Glycine clandestina		u
	Glycine tabacina		u
	Hardenbergia violacea	u	u
Fabaceae Mimosoideae	*Acacia longifolia* subsp. *longifolia*	o	o
	Acacia longifolia subsp. *sophorae*	o	
	Subspecies of *Acacia longifolia*	o	o
	**Acacia saligna*	o	o
Lamiaceae	*Westringia fruticosa*	o	o
Malvaceae sens. lat.	**Lagunaria patersonii*		u
	**Sida rhombifolia*	u	u
Myoporaceae	*Myoporum acuminatum*	o	o
	Myoporum boninense subsp. *australe*	o	u
Myrtaceae	*Callistemon salignus*	u	
	Eucalyptus botryoides		o
	Eucalyptus robusta		u
	Leptospermum laevigatum	c	c
	Melaleuca armillaris		u
Oxalidaceae	*Oxalis rubens*	u	
Phyllanthaceae	*Breynia oblongifolia*	u	u
	Phyllanthus hirtellus	u	u
Pittosporaceae	*Billardiera scandens* var. *scandens*		u
	Pittosporum undulatum		u
Plantaginaceae	*Plantago hispida*		u
	**Plantago lanceolata*		u
Polygonaceae	**Acetosa sagittata*	o	o
	Persicaria decipiens		u
	Rumex brownii		u
	**Rumex crispus*		u
Portulacaceae	*Portulaca oleracea*	u	
Primulaceae	**Anagallis arvensis*		u
Proteaceae	*Banksia integrifolia* subsp. *integrifolia*	o	o
Rosacae (s. str.)	*Rubus parvifolius*		u
Rubiaceae	**Coprosma repens*	u	o
Rutaceae	*Correa alba* subsp. *alba*	o	o
	**Ricinus communis*	u	U
Solanaceae	**Cestrum parqui*		u
	**Solanum mauritianum*		u
	**Solanum nigrum*		u
Verbenaceae	**Lantana camara*	u	o

Wollongong (City)

Family	Plant Name		
PTERIDOPHYTA			
Davalliacae	**Nephrolepis cordifolia*		u
CONIFEROPSIDA			
Aracauriaceae	**Araucaria heterophylla*		o
LILIIDAE			
Amaryllidaceae	*Crinum pedunculatum*	u	u
Asparagaceae	**Asparagus aethiopicus*	u	u
	**Asparagus asparagaoides*	u	u
Commelinaceae	*Commelina cyanea*	u	u
	**Tradescantia fluminensis*	u	u

Cyperaceae	*Baumea juncea*		u
	Carex pumila	o	o
	Cyperus laevigatus		u
	Ficinia nodosa	u	o
Juncaceae	*Juncus continuus*		u
	Juncus usitatus	u	u
Lomandraceae	*Lomandra longifolia*	o	o
	**Lomandra* cultivars		u
Phormiaceae	*Dianella congesta*	u	
Poaceae	**Aira caryophyllea*		u
	**Avena fatua*		u
	**Briza minor*	u	u
	**Bromus catharticus*	u	u
	Cynodon dactylon	o	o
	Digitaria breviglumis		u
	**Ehrharta erecta*	u	o
	**Eleusine indica*		u
	Entolasia marginata	u	u
	Entolasia stricta		u
	Hemarthria uncinata		u
	Imperata cylindrica var. *major*	o	o
	Microlaena stipoides var. *stipoides*	u	u
	Oplismenus aemulus	u	o
	**Panicum effusum*		u
	**Paspalum dilatatum*		u
	Paspalum distichum	u	u
	**Pennisetum clandestinum*	u	o
	**Pennisetum setaceum*		o
	**Phleum pratense*	u	
	**Poa anua*		o
	Poa poiformis	u	u
	Spinifex sericeus	c	c
	Sporobolus virginicus	o	o
	**Stenotaphrum secundatum*		u
	Themeda australis	u	u
MAGNOLIOPSIDA			
Acanthaceae	*Pseuderanthemum variabile*		u
Aizoaceae	*Carpobrotus glaucescens*	o	o
	Tetragonia tetragonioides	o	o
Amaranthaceae	*Alternanthera denticulata*	u	u
	**Alternanthera pungens*		o
Apiaceae	*Apium prostratum* var. *filiforme*	u	u
	Centella asiatica	u	u
	**Hydrocotyle bonariensis*	c	c
Asteraceae	*Actites megalocarpa*		u
	**Ageratina adenophora*		u
	Bidens pilosa	u	u
	**Chrysanthemoides monilifera* subsp. *rotundata*		o
	**Conyza bonariensis*	u	u
	**Gazania rigens*		u
	Melanthera biflora	u	u
Brassicaceae	**Cakile edentula*	o	o
	**Cakile maritima*	o	o
	**Cardamine hirsuta*		u
Casuarinaceae	*Casuarina glauca*		u
Chenopodiaceae	*Atriplex australasica*	u	u
	Atriplex cinerea		u
	**Atriplex hastata*	u	

	*Chenopodium album		u
	Einadia nutans		u
	Rhagodia candolleana subsp. candolleana	u	u
Convolvulaceae	Dichondra repens		o
	*Ipomoea cairica		u
	*Ipomoea indica		u
Crassulaceae	*Bryophyllum delagoense		u
Dilleniaceae	Hibbertia scandens	u	u
Ericaceae (sens. lat.)	Leucopogon parviflorus		u
	Monotoca elliptica	u	o
Fabaceae Faboideae	Desmodium varians		u
	Glycine clandestina		u
	Glycine tabacina		u
	Hardenbergia violacea		o
	Kennedia rubicunda		o
Fabaceae Mimosoideae	Acacia longifolia subsp. longifolia	o	o
	Acacia longifolia subsp. sophorae	o	o
	Subspecies of Acacia longifolia	o	o
	*Acacia saligna	u	o
Geraniaceae	*Geranium molle subsp. molle		u
	Pelargonium australe	u	
Lamiaceae	Westringia fruticosa	o	o
Lobeliaceae	Lobelia alata		u
Malvaceae sens. lat.	*Lagunaria patersonii		u
	*Sida rhombifolia		u
Menispermaceae	Stephania japonica var. discolor		u
Myoporaceae	Myoporum acuminatum	o	o
	Myoporum boninense subsp. australe	o	o
Myrtaceae	Leptospermum laevigatum	c	c
	Melaleuca armillaris		o
Phyllanthaceae	Breynia oblongifolia	u	u
Portulacaceae	Portulaca oleracea	u	u
Primulaceae	*Anagallis arvensis	u	u
Proteaceae	Banksia integrifolia subsp. integrifolia	o	o
Rosacae (s. str.)	Rubus parvifolius	u	u
Rubiaceae	*Coprosma repens	u	u
Rutaceae	Correa alba subsp. alba	o	o
Sapindaceae	*Cupaniopsis anacardioides		u
Verbenaceae	*Lantana camara		u
	*Verbena bonariensis		u

North Wollongong (no dune vegetation in front of clubhouse)

Family	Plant Name		
PTERIDOPHYTA			
Dennstaedtiaceae	Histiopteris incisa		u
Gleicheniaceae	Gleichenia rupestris		u
CONIFEROPSIDA			
Aracauriaceae	*Araucaria heterophylla		o
LILIIDAE			
Asparagaceae	*Asparagus aethiopicus		u
Commelinaceae	Commelina cyanea		o
	*Tradescantia fluminensis		u
Cyperaceae	Carex pumila		u
	Cyperus laevigatus		u
	Ficinia nodosa		o

Juncaceae	*Juncus continuus*		u
	Juncus krausii subsp. *australiensis*		u
	Juncus usitatus		o
Lomandraceae	*Lomandra longifolia*		o
	**Lomandra* cultivars		u
Phormiaceae	*Dianella congesta*		u
Poaceae	**Aira caryophyllea*		u
	Cymbopogon refractus		u
	Cynodon dactylon		c
	**Ehrharta erecta*		o
	Entolasia marginata		u
	Imperata cylindrica var. *major*		u
	Microlaena stipoides var. *stipoides*		u
	Oplismenus aemulus		u
	**Panicum effusum*		u
	**Paspalum dilatatum*		o
	Paspalum distichum		u
	**Paspalum urvillei*		u
	**Pennisteum clandestinum*		c
	Spinifex sericeus		o
	Sporobolus virginicus		o
	**Stenotaphrum secundatum*		o
	Themeda australis		o
	Zoysia macrantha		u
Themidaceae	**Dracaena draco*		
MAGNOLIOPSIDA			
Aizoaceae	*Carpobrotus glaucescens*		o
	Tetragonia tetragonioides		o
Apiaceae	*Apium prostratum* var. *filiforme*		u
	Centella asiatica		o
	**Hydrocotyle bonariensis*		c
	**Foeniculum vulgare*		u
Asteraceae	*Actites megalocarpa*		u
	**Ageratina adenophora*		u
	Bidens pilosa		o
	**Chrysanthemoides monilifera* subsp.*rotundata*		u
	**Delairea odorata*		o
	**Erechtites valerianifolia*		u
	**Gazania rigens*		u
	**Gnaphalium americanum*		u
	**Hypochaeris radicata*		u
	Senecio spathulatus subsp. *attenuatus*		o
	**Senecio madagascariensis*		u
	**Sonchus oleraceus*		u
Basellaceae	**Anredera cordifolia*		u
Brassicaceae	**Cakile edentula*		u
	**Cakile maritima*		u
Casuarinaceae	**Casuarina equisetifolia* subsp. *incana*		u
	Casuarina glauca		c
Chenopodiaceae	*Rhagodia candolleana* subsp. *candolleana*		o
	Suaeda australis		o
Convolvulaceae	*Dichondra repens*		o
	**Ipomoea cairica*		u
	**Ipomoea indica*		u
Crassulaceae	**Bryophyllum delagoense*		u
Dilleniaceae	*Hibbertia scandens*		o
Fabaceae Faboideae	**Dipogon lignosus*		o

	Glycine clandestina		u
	Glycine tabacina		u
	Hardenbergia violacea		u
	Kennedia rubicunda		o
	**Trifolium subterraneum*		u
Fabaceae Mimosoideae	*Acacia implexa*		u
	Acacia longifolia subsp. *sophorae*		o
	Subspecies of *Acacia longifolia*		o
Flacourtiaceae	*Scolopia braunii*		u
Geraniaceae	**Geranium molle* subsp. *molle*		u
	Pelargonium australe		u
Lamiaceae	*Westringia fruticosa*		o
Malaceae	**Cotoneaster glaucophyllus*		u
Malvaceaesens. lat.	**Lagunaria patersonii*		o
	**Sida rhombifolia*		o
Myoporaceae	*Myoporum acuminatum*		u
	Myoporum boninense subsp. *australe*		o
Myrsinaceae	*Myrsine variabilis*		u
Myrtaceae	*Leptospermum laevigatum*		c
	Melaleuca armillaris		u
	Melaleuca ericifolia		o
Phyllanthaceae	*Breynia oblongifolia*		u
	Glochidionferdinandi var. *ferdinandi*		u
	Phyllanthus hirtellus		u
Pittosporaceae	*Billardiera scandens* var.*scandens*		u
	**Pittosporum crassifolium*		u
	Pittosporum undulatum		o
Plantaginaceae	*Plantago hispida*		u
	**Plantago lanceolata*		o
Polygalaceae	**Polygala myrtifolia*		u
Proteaceae	*Banksia integrifolia* subsp. *integrifolia*		c
Ranunculaceae	*Clematis glycinoides*		u
Rosacae (s. str.)	*Rubus parvifolius*		u
Rubiaceae	**Coprosma repens*		o
Rutaceae	*Correa alba* subsp. *alba*		u
Sapindaceae	*Guioa semiglauca*		u
Solanaceae	**Lycium ferocissimum*		u
	**Solanum nigrum*		o
Verbenaceae	**Lantana camara*		o

Port Kembla & Windang

Family	**Plant Name**		
PTERIDOPHYTA			
Davalliaceae	**Nephrolepis cordifolia*		u
Dicksoniaceae	*Calochlaena dubia*		o
CONIFEROPSIDA			
Aracauriaceae	**Araucaria heterophylla*		o
LILIIDAE			
Amaryllidaceae	*Crinum pedunculatum*	u	u
Asparagaceae	**Asparagus aethiopicus*	u	u
	**Asparagus asparagaoides*	u	u
Commelinaceae	*Commelina cyanea*	u	o
	**Tradescantia fluminensis*	u	u
Cyperaceae	*Baumea juncea*	u	
	Carex pumila	u	

	Cyperus laevigatus	o	o
	Ficinia nodosa	o	o
Juncaceae	*Juncus continuus*		u
	Juncus krausii subsp. *australiensis*	o	o
	Juncus usitatus	o	o
Lomandraceae	*Lomandra longifolia*	o	o
	**Lomandra* cultivars		u
Philesiaceae	*Eustrephus latifolius*		u
	Geitonoplesium cymosum		u
Phormiaceae	*Dianella congesta*	u	
Poaceae	**Aira caryophyllea*		u
	**Ammophila arenaria*	u	u
	Anisopogon avenaceus		o
	**Bromus catharticus*		o
	**Chloris gayana*		o
	Cymbopogon refractus		u
	Cynodon dactylon	c	c
	Digitaria breviglumis		u
	**Ehrharta erecta*	o	c
	**Eleusine indica*		u
	Entolasia marginata		u
	Hemarthria uncinata	u	u
	Imperata cylindrica var. *major*	o	o
	Microlaena stipoides var. *stipoides*	u	u
	Oplismenus aemulus	u	o
	**Panicum effusum*		u
	**Paspalum dilatatum*		u
	Paspalum distichum	o	o
	**Pennisetum clandestinum*	u	o
	**Phleum pratense*		u
	Phragmites australis		o
	**Poa anua*		u
	Poa billardierei		u
	Poa labillardieri	u	u
	Poa poiformis	u	
	Spinifex sericeus	c	c
	Sporobolus virginicus	o	o
	**Stenotaphrum secundatum*	u	u
	Themeda australis	u	o
MAGNOLIOPSIDA			
Aizoaceae	*Carpobrotus glaucescens*	o	o
	Tetragonia tetragonioides	o	o
Amaranthaceae	*Alternanthera denticulata*	u	u
	**Alternanthera pungens*	u	
Apiaceae	*Apium prostratum* var. *filiforme*	u	
	Centella asiatica	u	o
	**Hydrocotyle bonariensis*	c	o
Apocynaceae	*Parsonsia straminea*		u
Asclepiadaceae	**Araujia sericifera*		u
Asteraceae	*Actites megalocarpa*	u	
	**Ageratina adenophora*	u	u
	Bidens pilosa	u	u
	**Chrysanthemoides monilifera* subsp. *rotundata*	o	o
	**Conyza bonariensis*	u	
	**Delairea odorata*		u
	**Gazania rigens*	o	o
	Melanthera biflora	u	
Brassicaceae	**Cakile edentula*	o	o

	**Cakile maritima*	o	o
	**Cardamine hirsuta*		u
Casuarinaceae	*Casuarina glauca*		o
Chenopodiaceae	*Atriplex australasica*	u	u
	Atriplex cinerea		u
	**Atriplex hastata*		o
	**Chenopodium album*		u
	Einadia nutans		u
	Rhagodia candolleana subsp. *candolleana*	u	u
Convolvulaceae	*Calystegia sepium*		u
	Dichondra repens	u	o
	**Ipomoea cairica*		o
	**Ipomoea indica*		u
Crassulaceae	**Bryophyllum delagoense*	u	u
Dilleniaceae	*Hibbertia scandens*	u	o
Ericaceae (sens. lat.)	*Leucopogon parviflorus*	u	u
	Monotoca elliptica	o	o
Euphorbiaceae	**Chamaesyce hirta*	u	
Fabaceae Caesalpinioideae	**Senna pendula* var. *glabrata*		u
Fabaceae Faboideae	*Desmodium varians*		u
	Glycine clandestina		o
	Glycine tabacina		u
	Hardenbergia violacea		o
	Kennedia rubicunda		o
Fabaceae Mimosoideae	*Acacia implexa*	u	u
	Acacia longifolia subsp. *longifolia*	o	o
	Acacia longifolia subsp. *sophorae*	o	o
	Subspecies of *Acacia longifolia*	o	o
	Acacia melanoxylon		u
	**Acacia saligna*	o	o
Geraniaceae	**Geranium molle* subsp. *molle*		u
	Pelargonium australe	u	u
Goodeniaceae	*Scaevola calendulacea*	o	o
Lamiaceae	*Westringia fruticosa*	o	o
Lauraceae	**Cinnamomum camphora*		u
Lobeliaceae	*Lobelia alata*	u	
Malvaceae sens. lat.	**Lagunaria patersonii*		u
	**Sida rhombifolia*		o
Menispermaceae	*Stephania japonica* var. *discolor*		u
Moraceae	*Ficus rubiginosa*		u
Myoporaceae	*Myoporum acuminatum*	o	o
	Myoporum boninense subsp. *australe*	o	o
Myrtaceae	*Eucalyptus botryoides*	u	o
	Eucalyptus pilularis		o
	Leptospermum laevigatum	c	c
	Melaleuca armillaris	o	o
	Melaleuca ericifolia		u
	Acmena smithii		u
Ochnaceae	**Ochna serrulata*		o
Oleaceae	**Ligustrum lucidum*		u
	**Ligustrum sinense*		u
	Notelaea venosa		u
Onagraceae	*Epilobium billardieranum* subsp. *cinereum*		u
Oxalidaceae	*Oxalis rubens*	u	
Passifloraceae	**Passiflora subpeltata*		u
Phyllanthaceae	*Breynia oblongifolia*	o	u
	Glochidion ferdinandi var. *ferdinandi*		o
	Phyllanthus hirtellus	u	o
Pittosporaceae	*Billardiera scandens* var. *scandens*		u

	Pittosporum undulatum		o
Plantaginaceae	*Plantago hispida*		u
	**Plantago lanceolata*	o	o
Polygonaceae	**Acetosa sagittata*	o	o
	Persicaria decipiens		u
	Rumex brownii		u
	**Rumex crispus*	u	u
Portulacaceae	*Portulaca oleracea*	u	u
Primulaceae	**Anagallis arvensis*		u
Proteaceae	*Banksia integrifolia* subsp. *integrifolia*	c	c
Rosacae (s. str.)	*Rubus parvifolius*		o
Rubiaceae	**Coprosma repens*	o	o
Rutaceae	*Correa alba* subsp. *alba*	o	o
Sapindaceae	**Cupaniopsis anacardioides*		u
	Guioa semiglauca		u
Solanaceae	**Cestrum parqui*		u
	**Solanum nigrum*	u	o
Ulmaceae	*Trema tomentosa* var. *aspera*		u
Verbenaceae	**Lantana camara*	u	o
	**Verbena bonariensis*		u
Vitaceae	*Cayratia clematidia*		u

Appendix G – Long list of management options

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Preliminary Long List of Management Options

No.	Management Option
1	Removal and control of weed species
2	Reduction in width/extent of dune vegetation/removal of secondary vegetation
3	Construction of protective fence
4	Selectively remove middle storey and dying/dead vegetation
5	Selective dune vegetation/revegetate and reinstate the wide beach berm/plant grasses only in dunes
6	Remove and relocate amenity buildings
7	Upgrade existing buildings
8	Construction of viewing platforms
9	Construction of new seawall
10	Do a test case at one beach and ‘remove all the dunes and *Acacia* , to be replaced with a sandstone retaining wall, at the upper limits of an ocean storm and it’s destructive waves’ and the use of sandstone boulders
11	Remove introduced vegetation and associated vermin
12	Remove ‘non-complying’ plants as per guidelines
13	Review the type and suitability of plants currently inside the designated sightline zone
14	Portable viewing towers
15	Remove some of the vegetation to the original restoration fence and level the sand
16	Relocate Surf Life Saving Club (SLSC) closer to headlands
17	Sand nourishment
18	Do nothing
19	Complete a vegetation management plan for the dunes
20	Removal of vegetation roots that lead to steep scarps following storms/ let wind blow outs happen naturally
21	Manage the scarping of dunes to protect assets/manage stormwater outlets that contribute to scarping
22	Construct warning signage, barriers and surveillance due to safety risks
23	Improve line of sight for SLSCs by reducing vegetation within 200m either side of the club to less than 4ft
23	Regularly monitor planted species on the dunes
24	Address the issue of *Acacia sophorae* (Coastal Wattle)
25	Reshaping the dunes
26	Reducing the dune height
27	Reducing the dune width
28	Education
29	Use of surveillance devices

Appendix H – Noxious plant species

Noxious plant species

The following noxious plant species were recorded in the study area

Bitou Bush **Chrysanthemoides monilifera* subsp. *rotundata*
This species occurs at varying levels of abundance at all beaches with dune vegetation. Council has an ongoing management programme for this species, and the need to carry out gradual removal, in order to retain existing habitat for small passerines is recognised. At the time of the survey, numerous seedlings were recorded, especially in bare patches and along tracks. Planting of appropriate native species in gaps and manual removal of seedlings is an appropriate, albeit labour intensive management strategy.

Lantana **Lantana camara*
This species also occurs at all beaches with dune vegetation, although not as frequently as Bitou Bush. Seedlings of Lantana were also scarce. Manual removal of Lantana clumps and replanting with appropriate species is recommended for management where scattered clumps occur within the dune vegetation, e.g. Bulli Beach.

Bridal Creeper **Asparagus asparagoides*
Bridal Creeper and other Asparagus species occur at all beaches, whether in the dune vegetation or in adjacent forest, woodland or scrub. It is likely that the most common seed vectors are frugivorous birds. This species is difficult to manage, because the entire root clump needs to be removed. It is apparent that Asparagus species will become more invasive in dune vegetation, if no management practices are implemented.

Mexican Poppy **Argemone mexicana*
This species is not common, and was not recorded at any beach north of City Beach. No individuals were recorded in the study area of any beach, although scattered individuals were observed in adjacent areas, especially at Port Kembla. Manual removal of individuals prior to seed set, or spot spraying would be appropriate management practices.

Blackberry **Rubus fruticosus* sens. lat.
Blackberry was not recorded within any dune vegetation in the study area, although small, scattered clumps were observed in some areas of dense vegetation, particularly on batters above creeks, e.g. Bellambi Creek, upstream of the bridge. It was noted that some Blackberry clumps have recently been spot-sprayed.

Grasses
Several noxious grass species were recorded in dune vegetation, especially between Corrimal and Fairy Meadow and Port Kembla. No large patches of any species were recorded in the study area, and most infestations are sufficiently small for control either by spot spraying or manual removal.

The most commonly occurring species are African Lovegrass **Eragrostis curvula* and Giant Parramatta Grass **Sporobolus fertilis*. It was noted that the native species, *Sporobolus virginicus* was more common and wide-spread than the introduced Giant Parramatta Grass.

A cultivar of Fountain Grass **Pennisetum setaceum* has been planted along the walkway at City Beach. It is not known whether this cultivar produces viable seed and no seedlings were observed during the survey.

Appendix K – Plans for Beach Improvement Program at Woonona Beach, 1985

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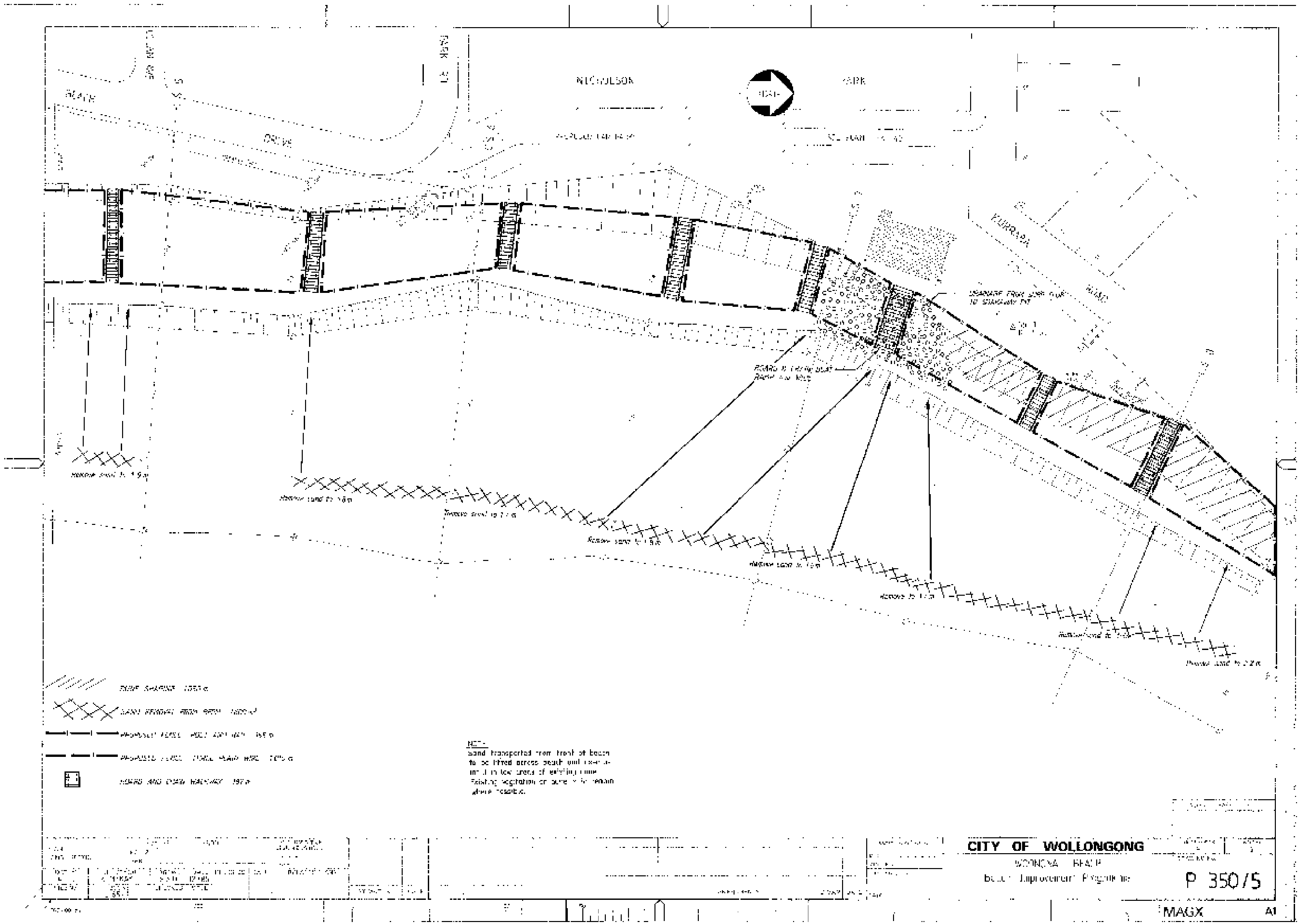
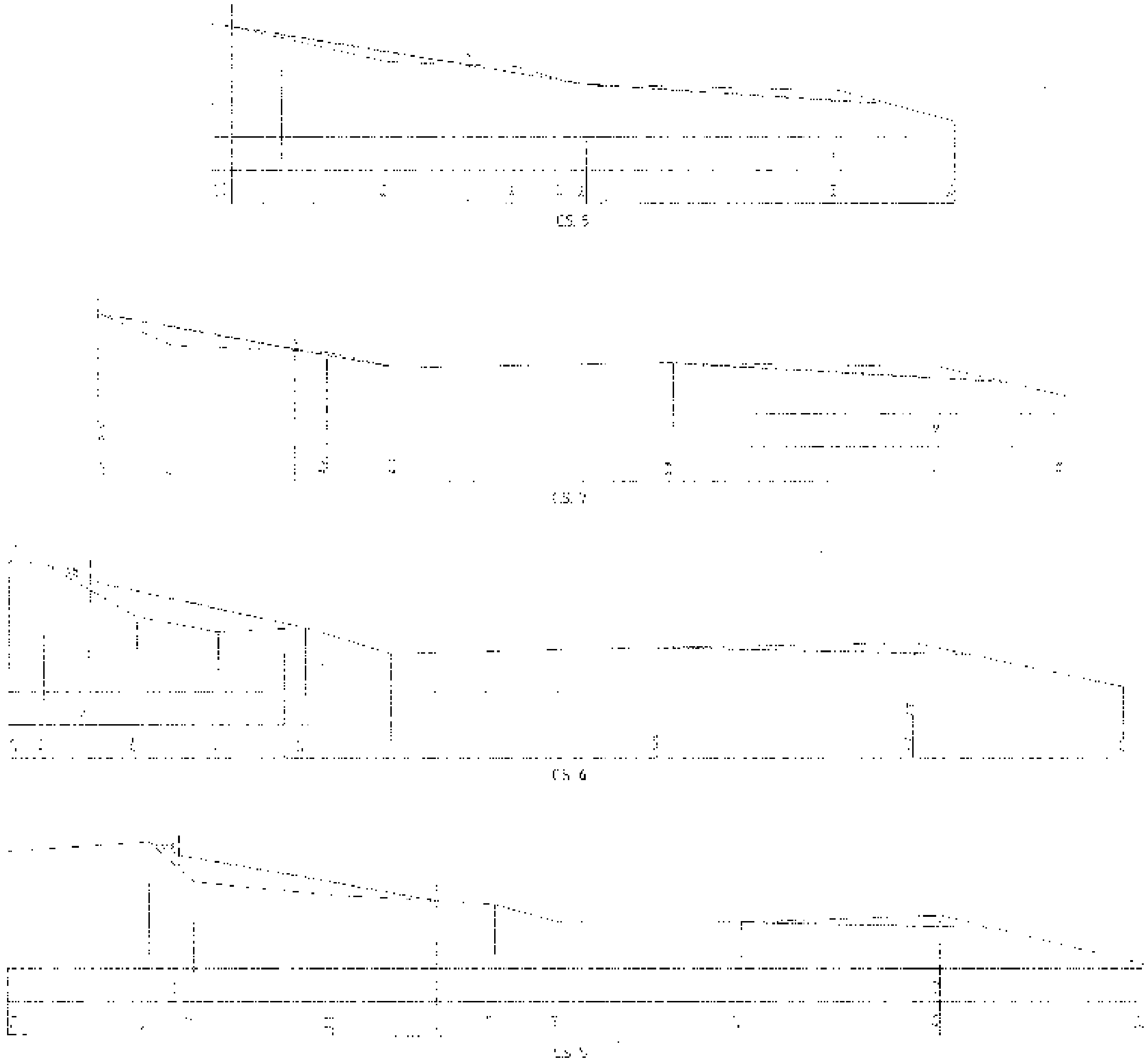

NICHOLSON
PARK
PARK ST
BEACH
DRIVE
KURRABA
ROAD
CITY OF WOLLONGONG
Beach Improvement Programme
P 350/5
MAGX
A1



NOTE.

CITY OF WOLLONGONG

WOONONA BEACH

Beach Improvement Programme

P 350/5

MAGX

A1/2

Appendix L – Time-series of aerial photographs

Photographs are provided for comparison only. Not to scale.

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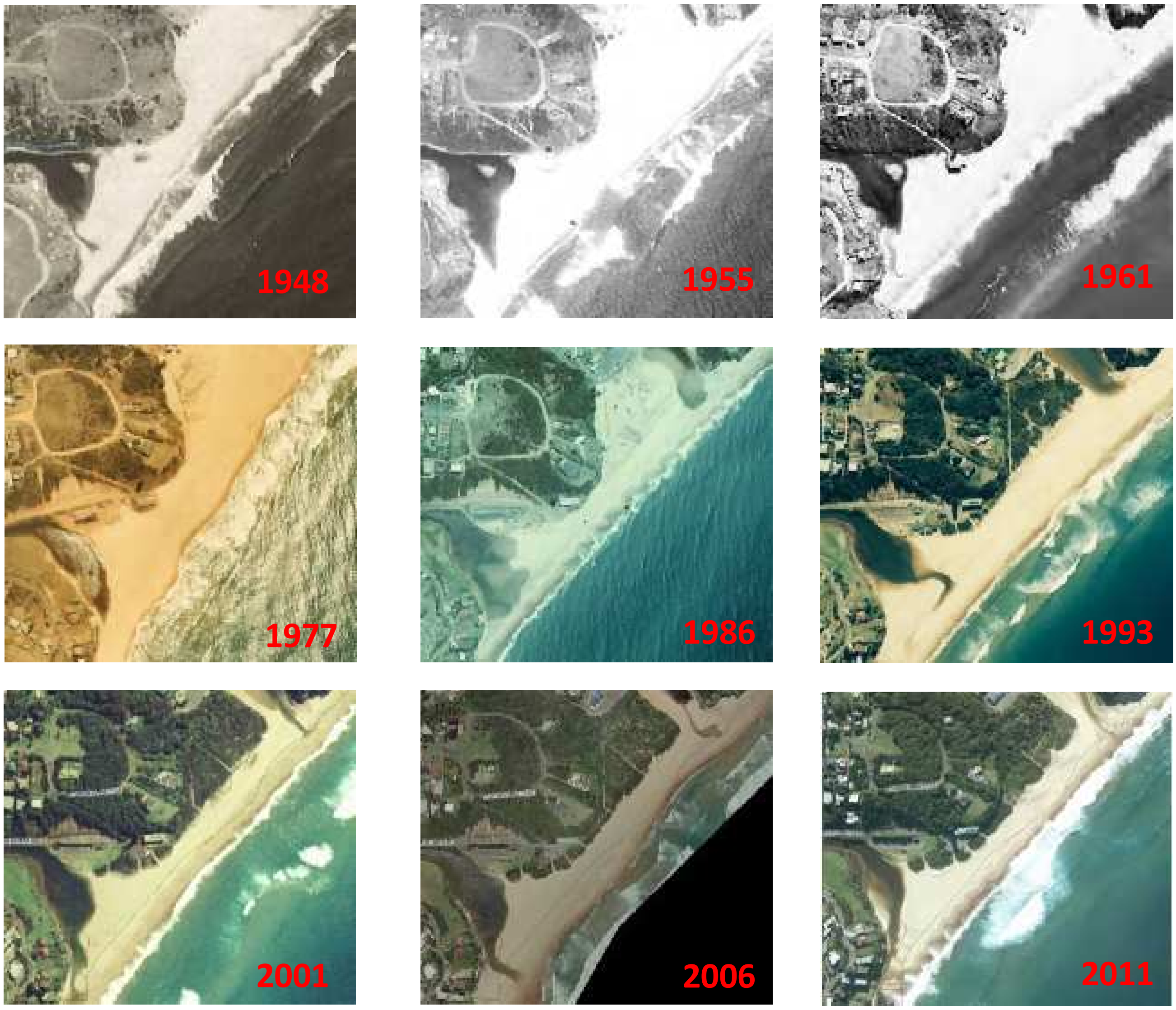
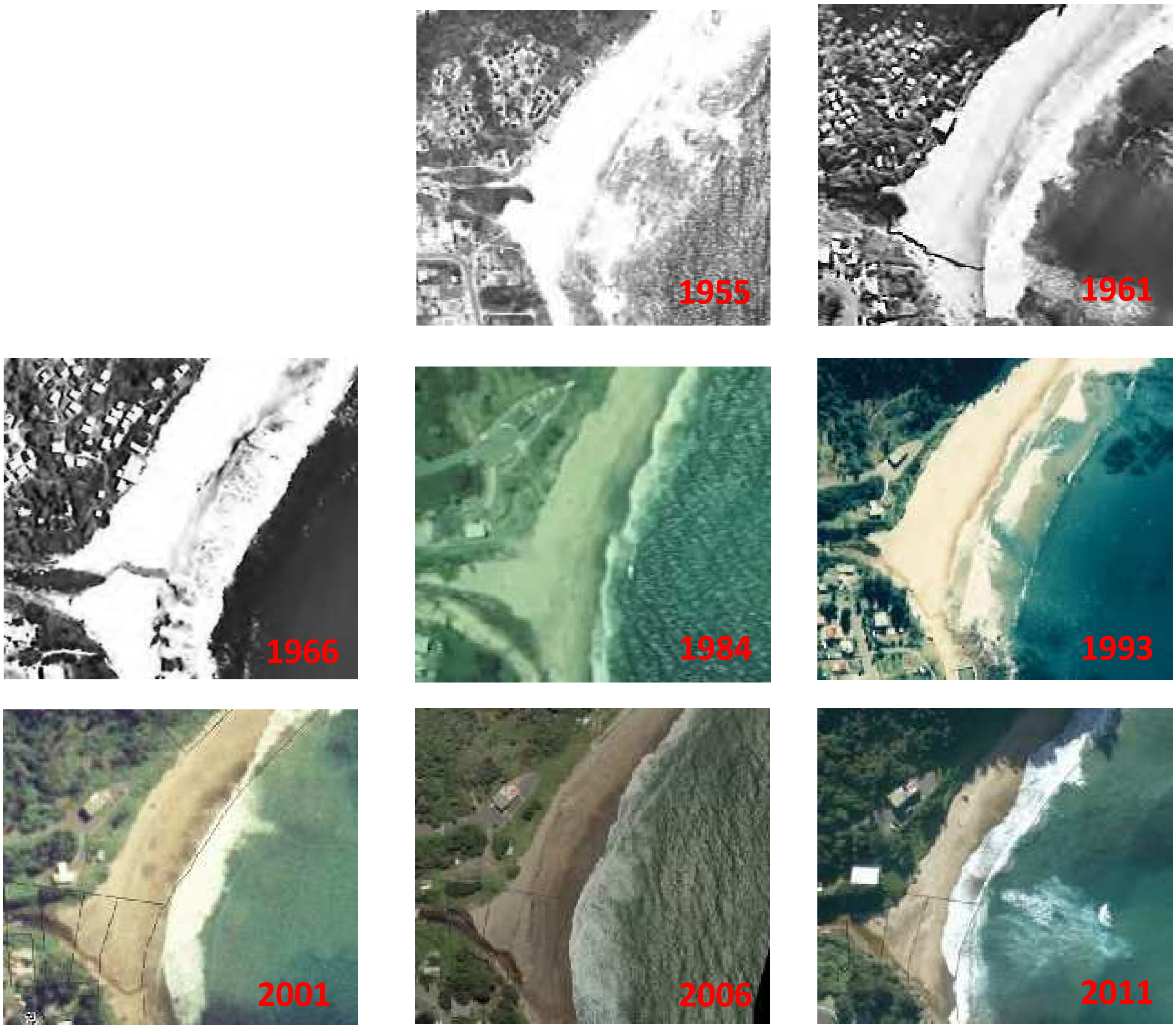
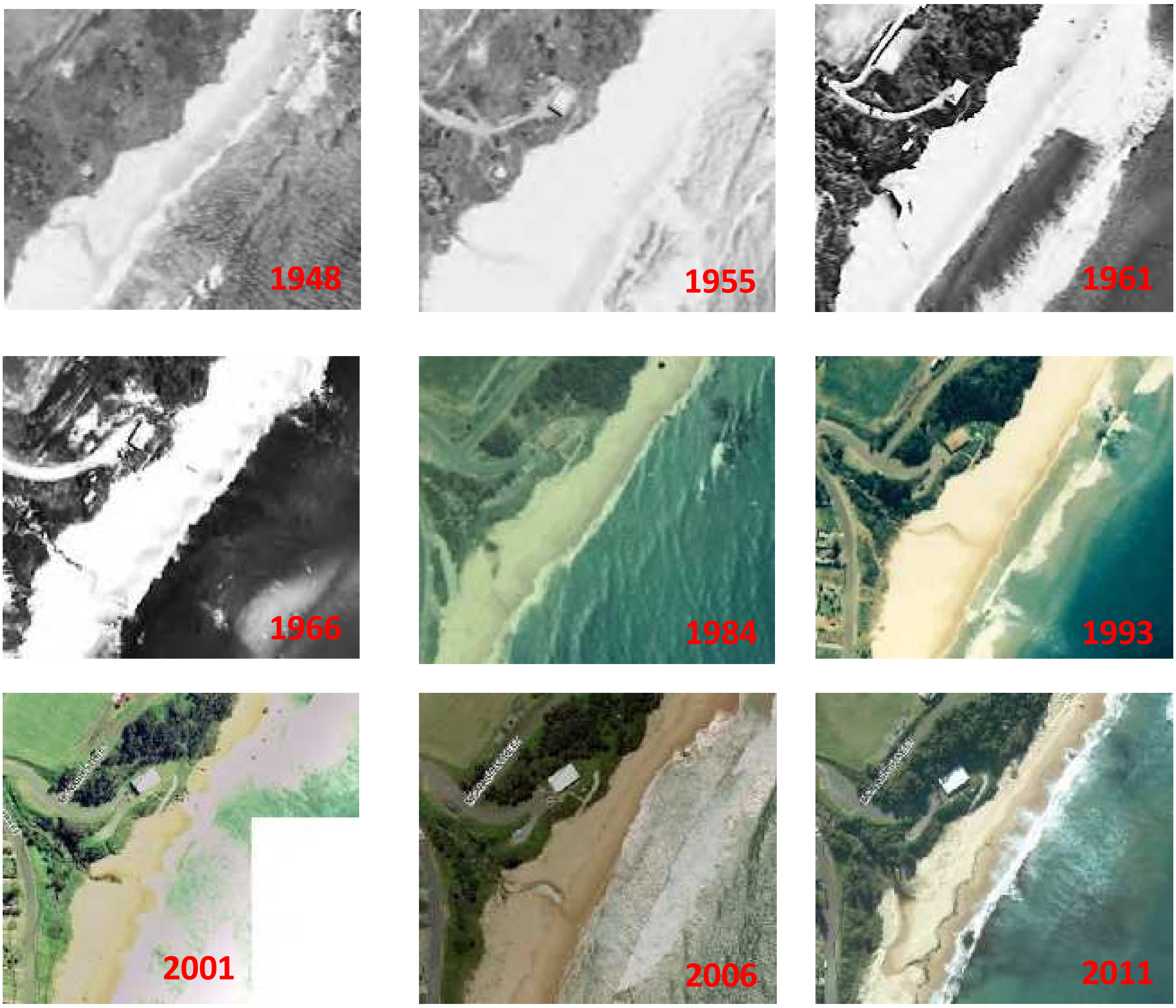
STANWELL PARK



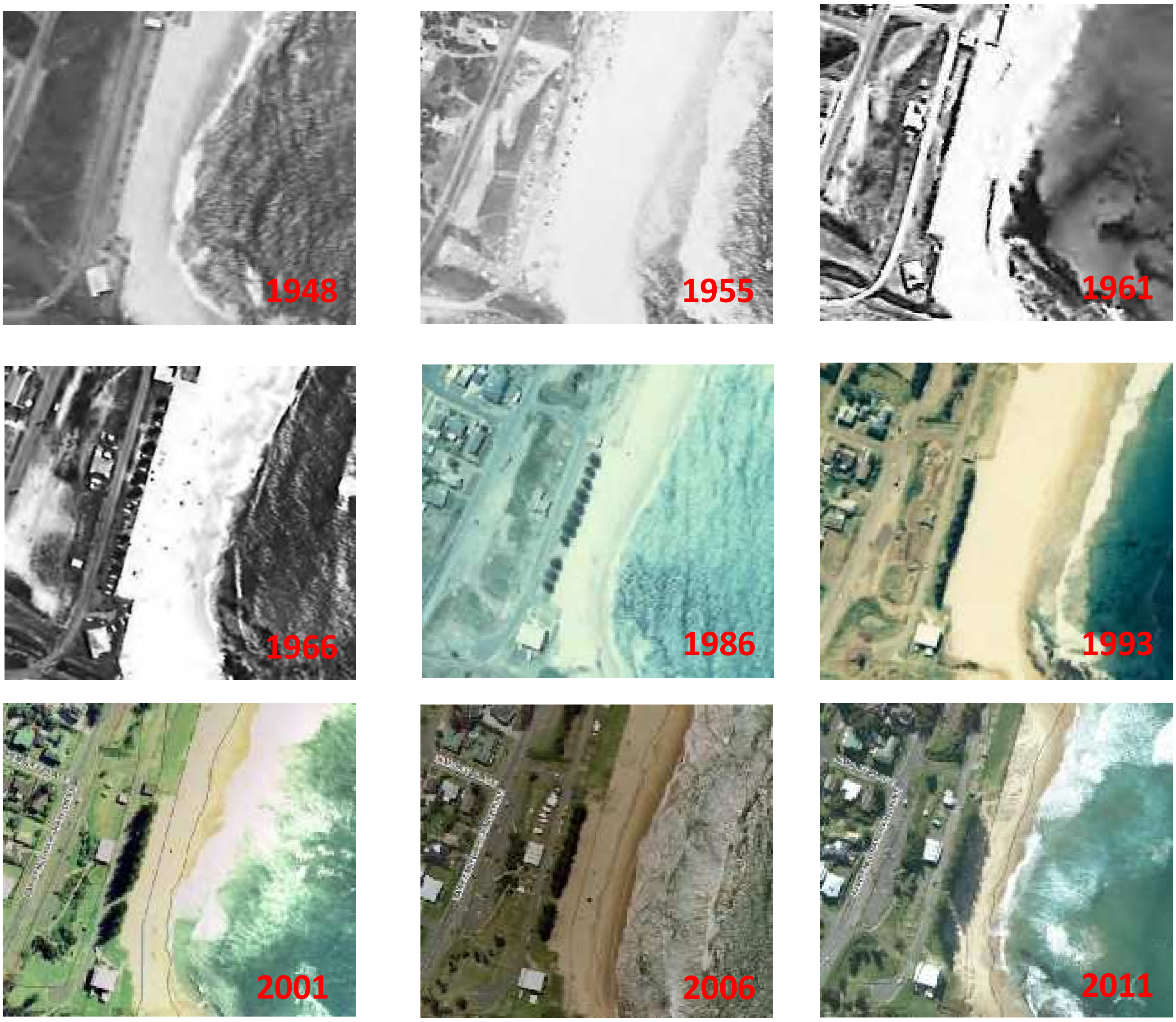
COALCLIFF



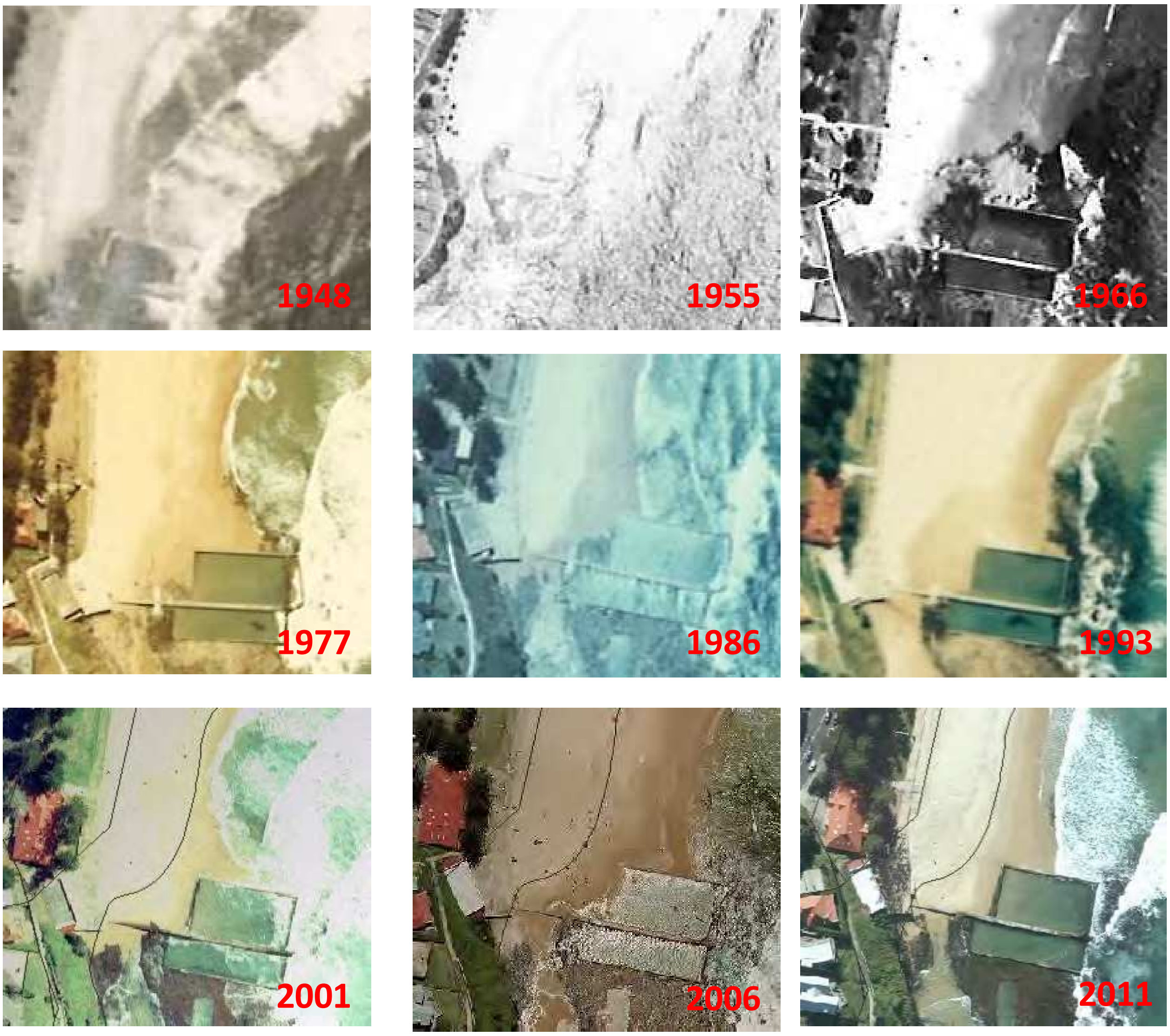
SCARBOROUGH



COLEDALE



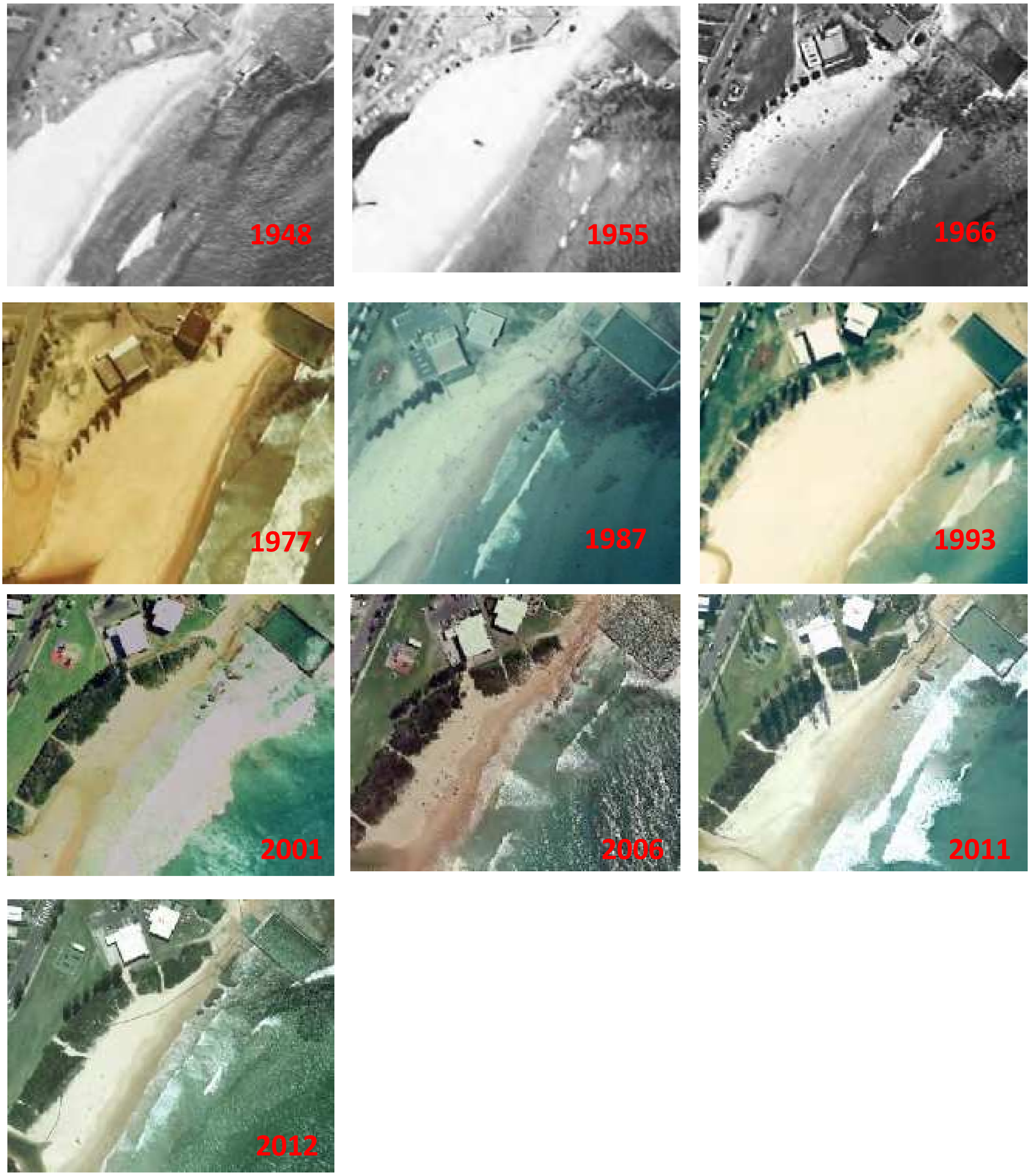
AUSTINMER



THIRROUL

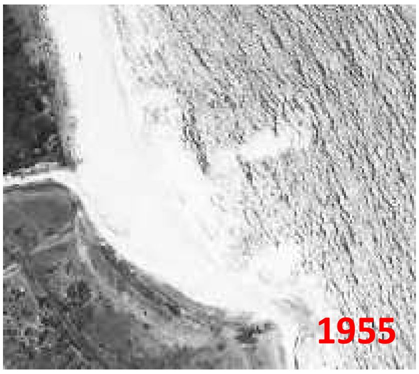
SANDON POINT

BULLI

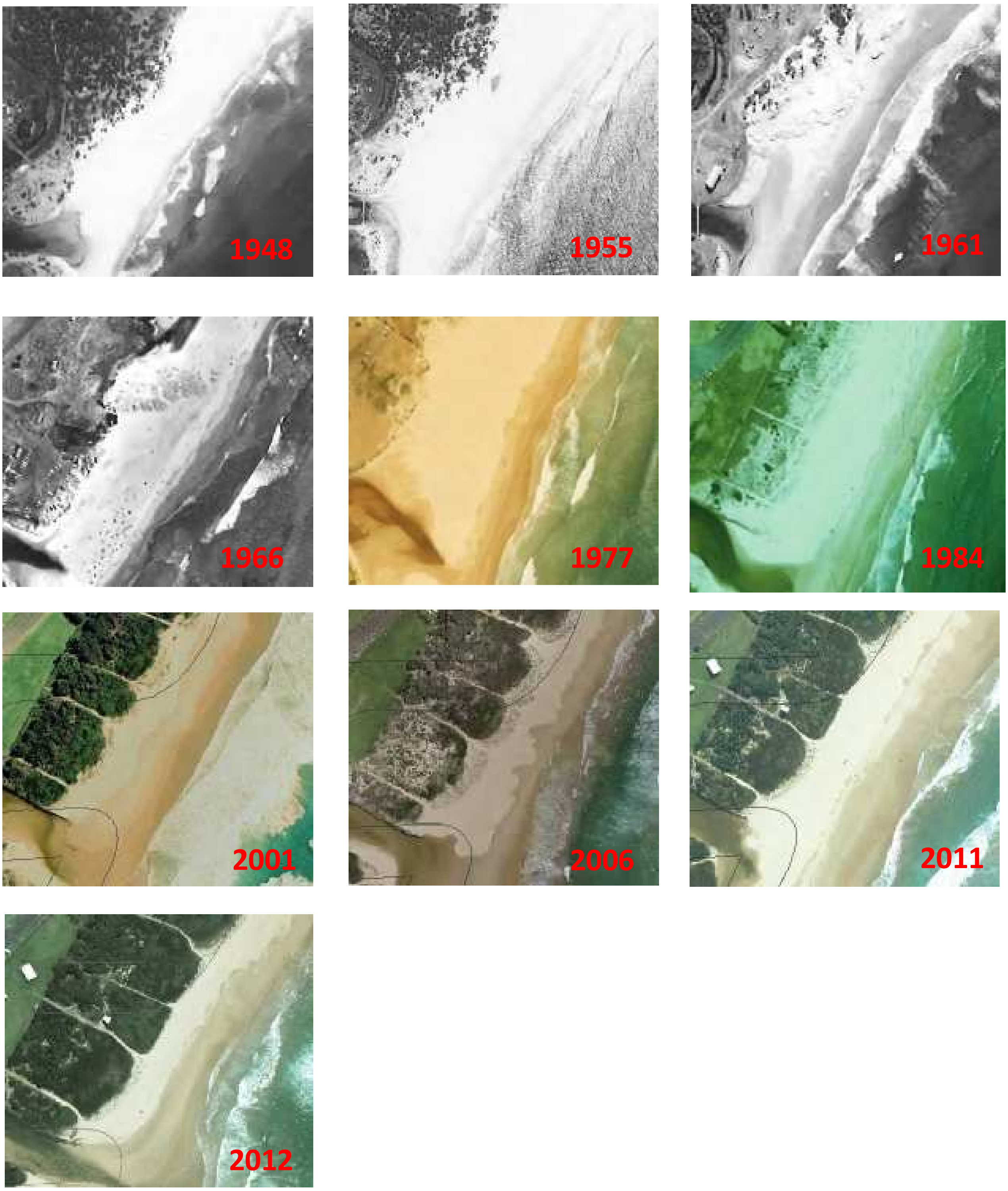


WOONONA

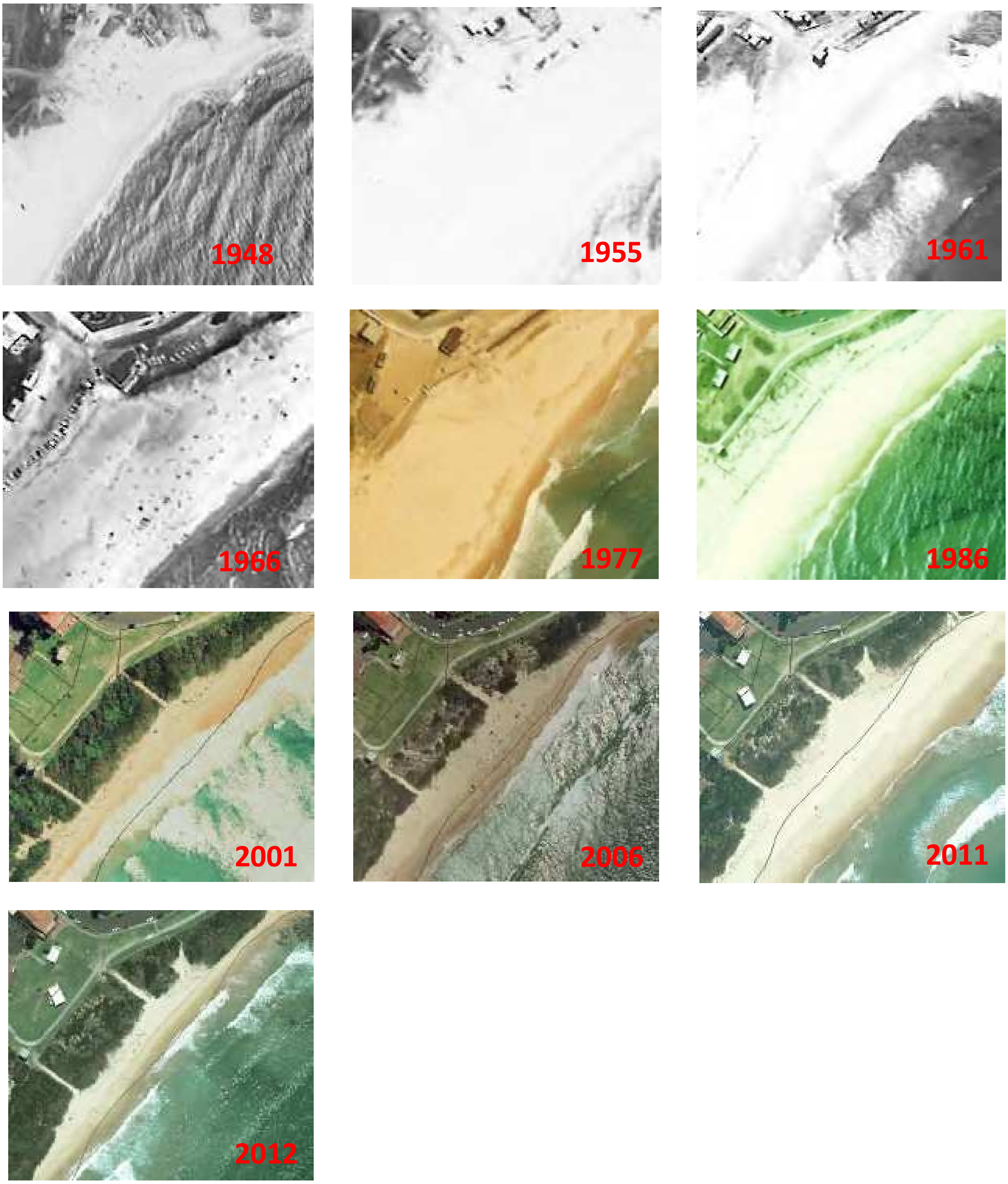
BELLAMBI



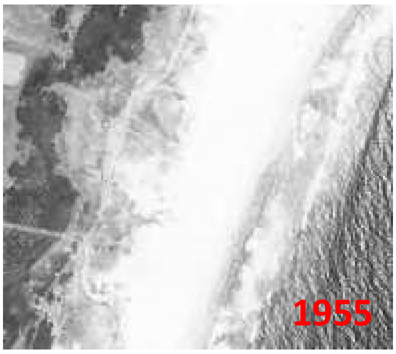
CORRIMAL



TOWRADGI

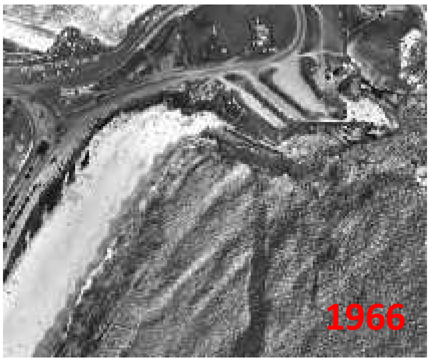


FAIRY MEADOW



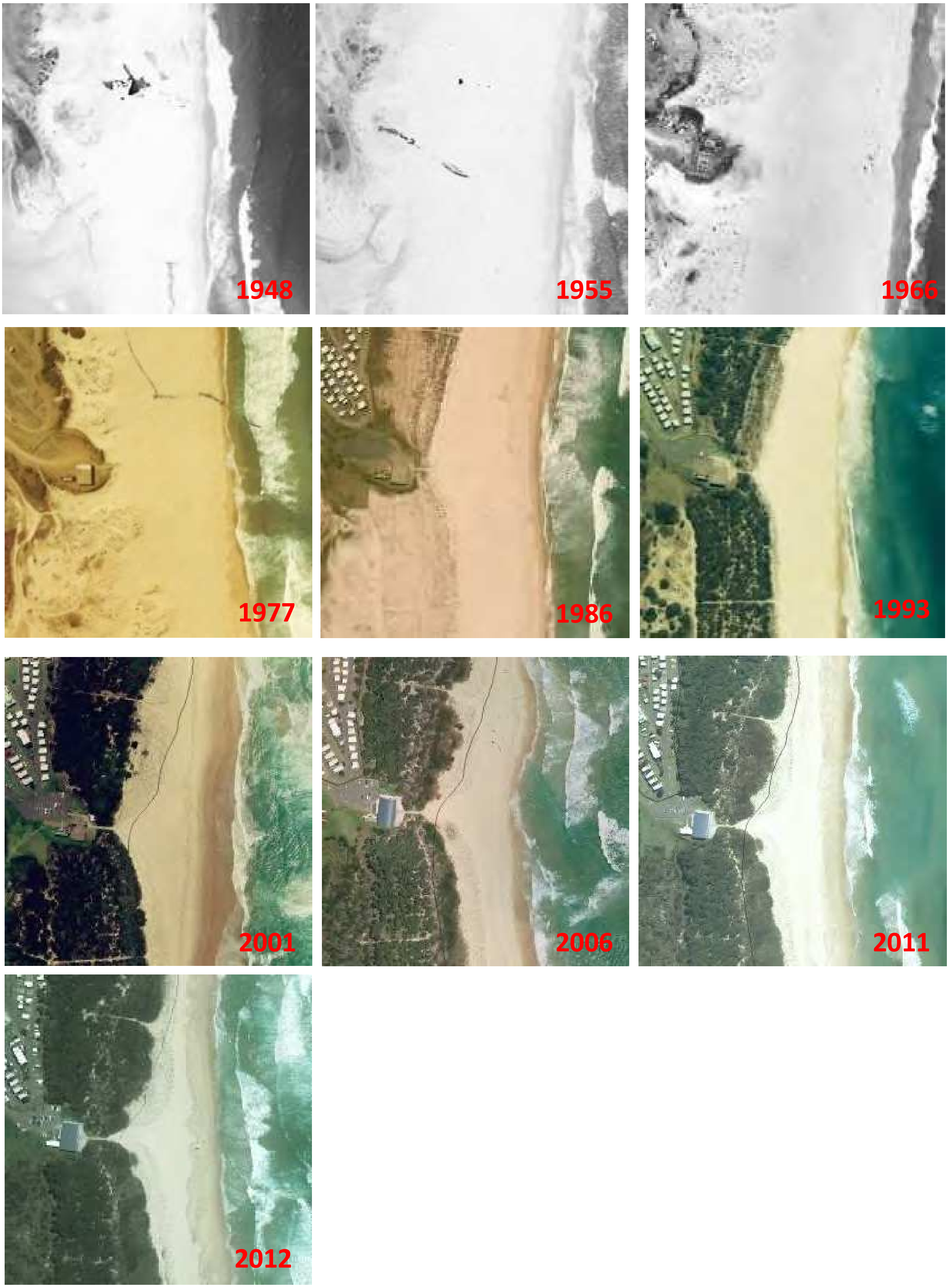
NORTH WOLLONGONG

CITY



PORT KEMBLA

WINDANG



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Appendix I – Plant species for replanting

Plant species list for dune planting

For the patrolled beach management zones, Council will consider sight line requirements when selecting suitable species for planting. Note that several patrolled beaches do not have a hind dune, and in some patrolled beach management areas, tall-growing variants of subspecies of *Acacia longifolia* have created sight line problems for lifeguard/lifesavers and can exist as a monoculture.

Incipient dune

Poa billardierei	Coastal Fescue
Ficinia nodosa	Clubrush
Spinifex sericeus	Spinifex
Calystegia soldanella	-
Carpobrotus glaucescens	Pigface
Actites megalocarpa	Coastal Sowthistle
Cynodon dactylon	Couch
Canavalia rosea	Beach Bean
Scaevola calendulacea	Scented Fanflower
Carex pumila	Strand Sedge
Dianella congesta	Coastal Flax Lily
Sporobolus virginicus	Sand Couch
Tetragonia tetragonioides	Warrigal Greens
Senecio spathulatus	-
Melanthera biflora	-

**Cakile eduntula* and **Cakile maritima* are cosmopolitan species which readily self-recruit on the incipient dune. Removal of these species may be counter-productive.

**Gazania rigens* and **Hydrocotyle bonariensis* are garden escapes which are probably too well distributed to consider eradication. The management of these species should mainly relate to areas where their growth and reproduction is inhibiting indigenous species.

Fore-dune and Crest

Acacia longifolia subsp. *sophorae*	Coastal Wattle^
Monotoca scoparia	-
Monotoca elliptica	Tree Broom-heath
Breynia oblongifolia	Coffee Bush
Leucopogon parviflorus	White-beard
Atriplex australasica	Saltbush
Rhagodia candolleana subsp. *candolleana*	Seaberry Saltbush
Pellargonium australe	Coastal Geranium
Westringia fruticosa	Coastal Rosemary
Myoporum boninense subsp. *australe*	Boobialla
Correa alba var. *alba*	White Correa
Cayratia clematidea	Slender Grape
Dichondra repens	Kidney Weed
Lomandra longifolia	Mat Rush
Hibbertia scandens	Golden Guinea Flower
Commelina cyanea	Scurvy Weed
Imperata cylindrica var. *major*	Blady Grass

^A specific management option refers to this species and should be followed where relevant.

**Coprosma repens* has self-recruited in most dune vegetation patches in the study area. Native to New Zealand, but probably a low priority species for removal.

**Cupaniopsis anacardioides* is beginning to self-recruit in hind-dune vegetation, especially Puckey's Estate. This species is being planted as an ornamental in new developments, e.g. MacCauleys, Campus East, Thirroul Beach playground and elsewhere.

Hind-dune and creek mouths

Crinum pedunculatum	Swamp- Lily
Carex appressa	-
Pittosporum revolutum	Rough-fruit Pittosporum
Homalanthus populifolius	Bleeding Heart
Banksia integrifolia subsp. *integrifolia*	Coastal Banksia
Leptospermum laevigatum	Coastal Tea-tree
Synoum glandulosum subsp. *glandulosum*	Bastard Rosewood
Clerodendrum tomentosum	Hairy Clerodendrum
Melaleuca linariifolia	Snow in Summer
Pseuderanthemum variabile	Pastel Flower
Glochidion ferdinandi var. *ferdinandi*	Smooth Cheese tree
Glochidion ferdinandi var. *pubens*	Hairy Cheese Tree
Oplismenus imbecillis	Basket Grass
Geitonoplesium cymosum	Scrambling Lily
Notelaea venosa	Native Olive
Acronychia oblongifolia	White Aspen
Acronychia wilcoxiana	Silver Aspen
Zoysia macrantha	Coastal Couch
Alphitonia excelsa	Red Ash
Poa poiformis	Coastal Tussock
Planchonella (Pouteria) australis	Black Apple
Juncus krausii subsp. *australiensis*	Sea Rush
Myrsine variabilis	Muttonwood
Casuarina glauca	Swamp Oak
Guioa semiglauca	-
Eucalyptus botryoides	Bangalay
Celtis paniculata	Native Celtis
Eucalyptus pilularis	Blackbutt

Eucalyptus robusta	Swamp Mahogany
Corymbia gummifera	Red Bloodwood
Dodonaea triquetra	Hop Bush
Desmodium brachypodum	-
Duboisia myoporoides	Poison Corkwood
Endiandra sieberi	Corkwood
Hardenbergia violacea	False Sarsparilla
Pandorea pandorana subsp. *pandorana*	Wonga Wonga Vine
Gahnia clarkei	Saw-sedge
Gahnia melanocarpa	Saw-sedge
Eustrephus latifolius	Wombat Berry
Kennedia rubicunda	Running Postman

Appendix J – Historical photographs

Prepared by Wollongong City Council

Photo 1 Stanwell Park Beach, 1907

Photo 2 Coalcliff Beach, 1940

Photo 3 Scarborough Beach, undated

Photo 4 Coledale Beach, undated

Photo 5 Austinmer Beach, 1890

Photo 6 Thirroul Beach, 1907

Photo 7 Thirroul Beach, 1907

Photo 8 Thirroul Beach, 1907


Photo 9 Thirroul Beach, 1974 (exposed pebbles, Bayley 1974)


Photo 10 Thirroul Beach, 2008 (exposed pebbles, courtesy of S Tedder, 2008)


Photo 11 Sandon Point, 1912

Photo 12 Bulli Beach, 1958

Photo 13 Bulli Beach, 1958

Photo 14 Bulli Beach, 1986 (windblown sand)

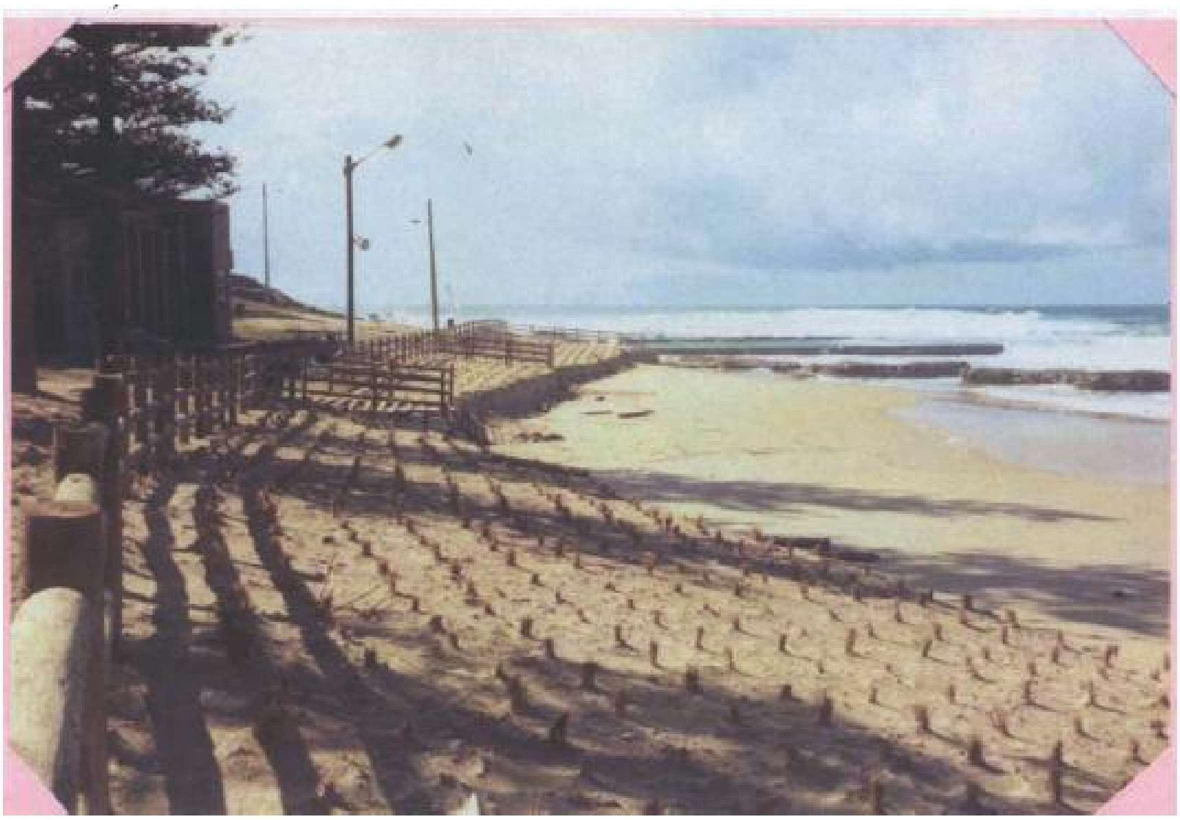

Photo 15 Bulli Beach, 1986 (dune stabilisation, courtesy of Ian Foreman, 1986)

Photo 16 Woonona Beach, 1981

Photo 17 Woonona Beach, 1984

Photo 18 Woonona Beach, 1986 (sand on road, courtesy of Ian Foreman)

Photo 19 Woonona Beach, 1986 (sand on road)

Photo 20 Woonona Beach 1986 (dune stabilisation works)

Photo 21 Woonona Beach 1986 (dune stabilisation works)

Photo 22 Woonona Beach, 1986 (dune stabilisation, courtesy of Ian Foreman, 1986)

Photo 23 Bellambi Beach, undated

Photo 24 Bellambi Beach, 1984

Photo 25 Corrimal Beach, undated

Photo 26 Fairy Meadow Beach, 1919

Photo 27 Towradgi Beach, undated

Photo 28 North Wollongong Beach, 1911

Photo 29 North Wollongong Beach, 1920's

Photo 30 North Wollongong Beach, 1986 (windblown sand, courtesy of Ian Foreman)

Photo 31 City Beach, undated

Photo 32 City Beach, undated

Photo 33 City Beach, undated

Photo 34 City Beach, 1964

Photo 35 City Beach, 1964

Photo 36 City Beach, 1964

Photo 37 City Beach, 1984

Photo 38 City Beach, 2003

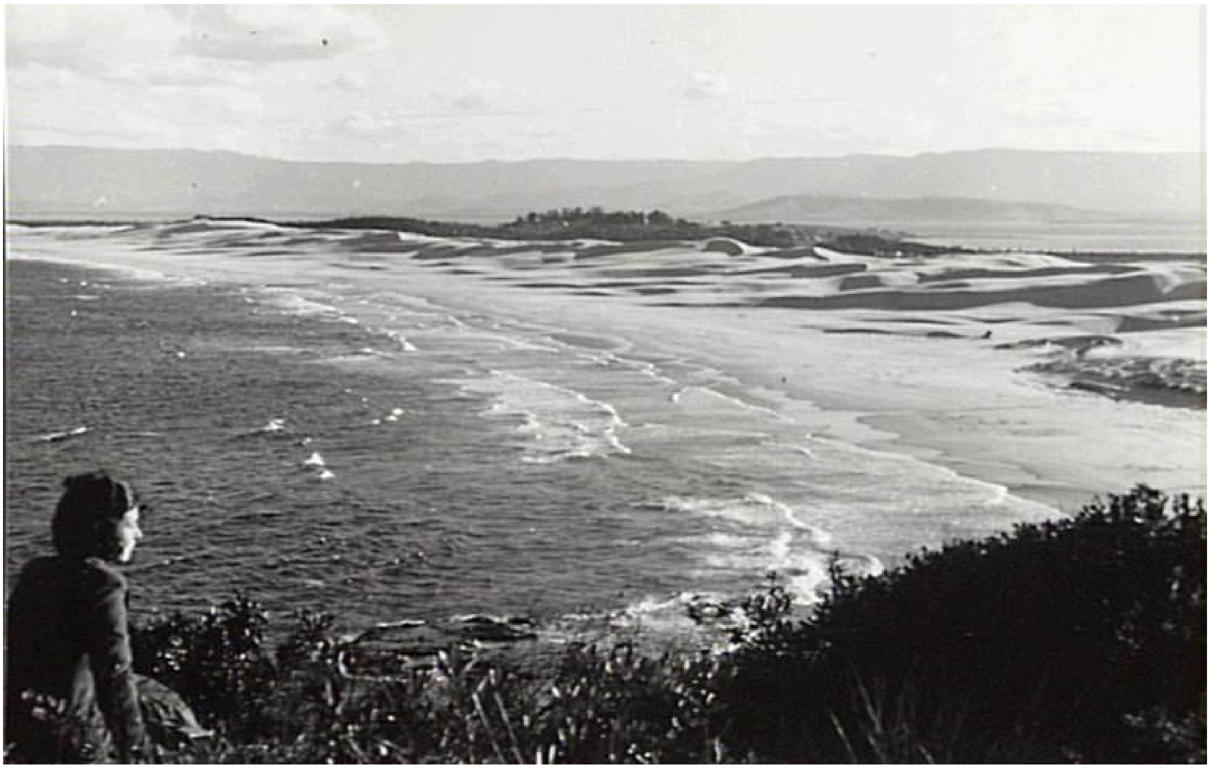

Photo 39 Port Kembla Beach, 1940

Photo 40 Port Kembla Beach, undated

Photo 41 Port Kembla Beach, undated

Photo 42 Port Kembla Beach, undated

Photo 43 Port Kembla Beach, undated

Appendix M – Dune profile cross sections

Prepared by Wollongong City Council.

Graphs are XY scatter with smooth lines.

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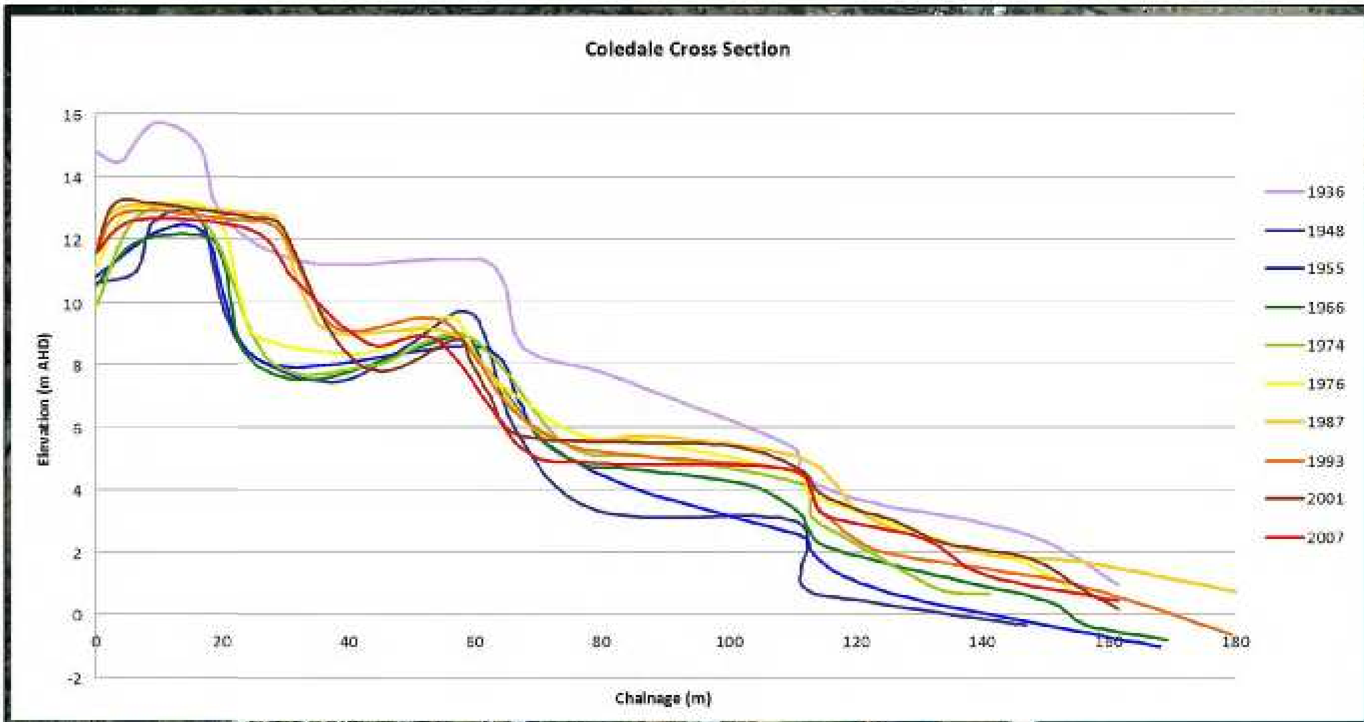


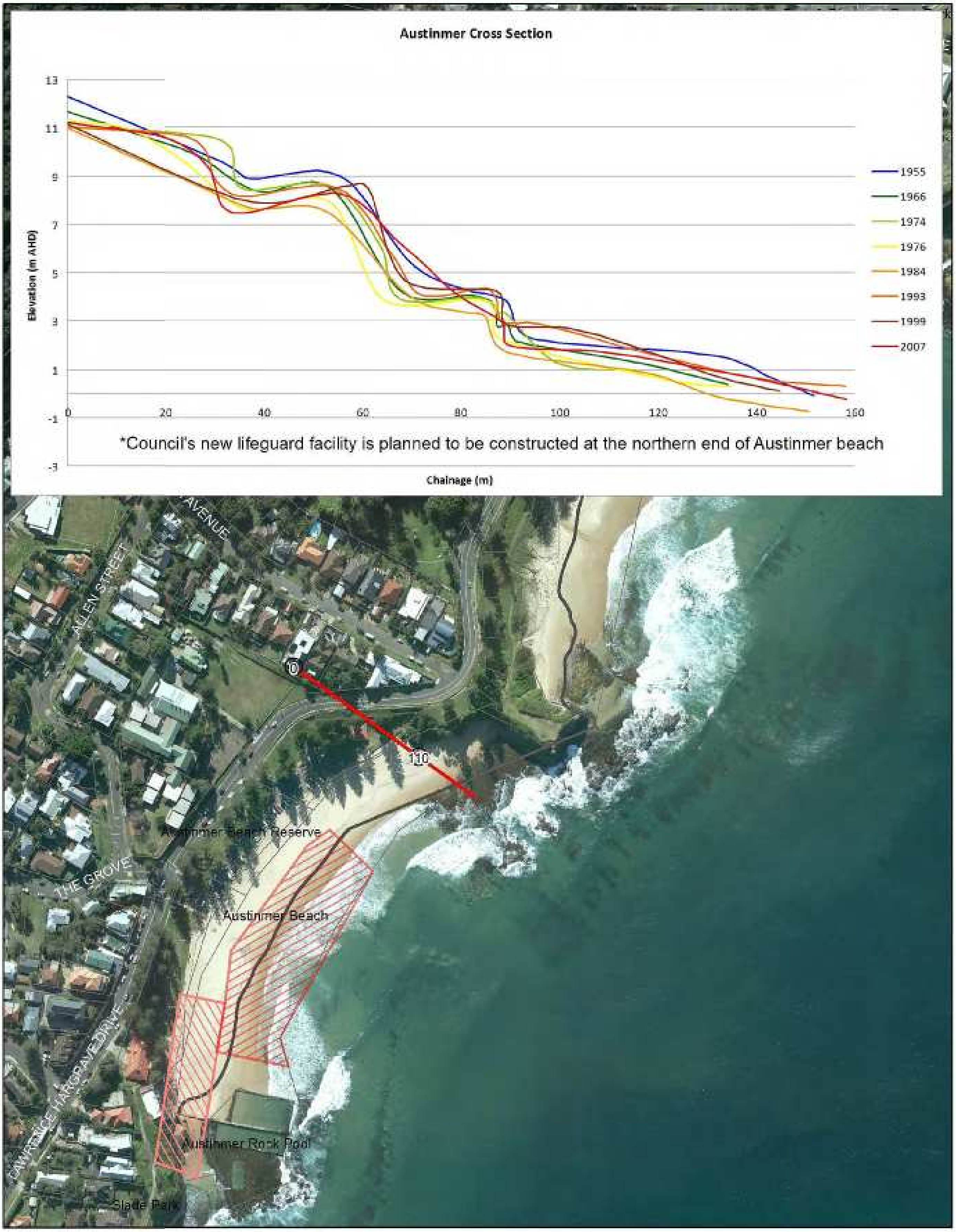
wollongong
city of innovation

Coledale

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

gie00779-09_survey01
Date: 18/09/2013
Aerial Photography: 2011
Scale 1:5,000
100 50 0 100 Meters



wollongong
city of innovation

Austinmer

- Chainage (m)
- Transect
- Primary Flag Area
- Secondary Flag Area
- Management Area

N

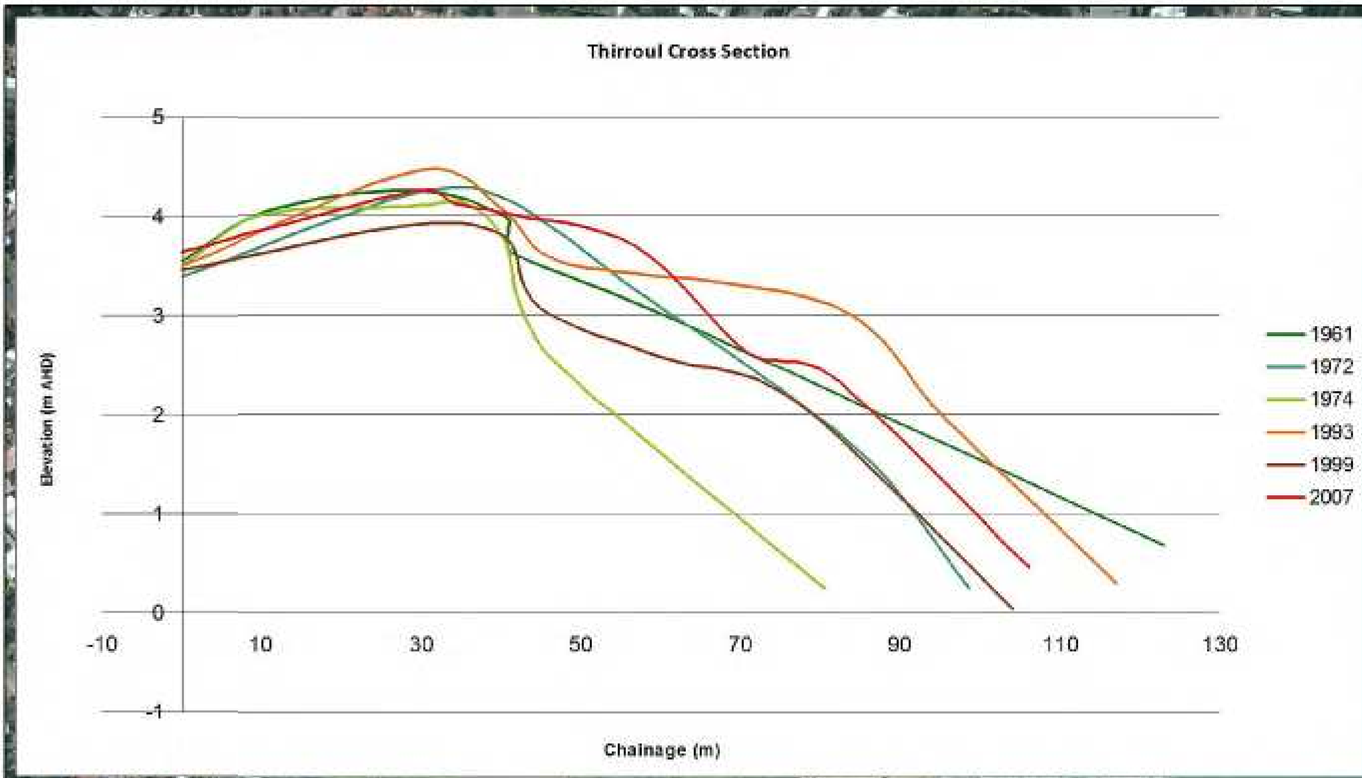
50 25 0 50 Meters

gie00779-09_survey02

Date: 18/09/2013

Aerial Photography: 2011

Scale 1:3,500



Thirroul

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

50 25 0 50 Meters

gie00779-09_survey03
Date: 18/09/2013
Aerial Photography: 2011
Scale 1:3,500

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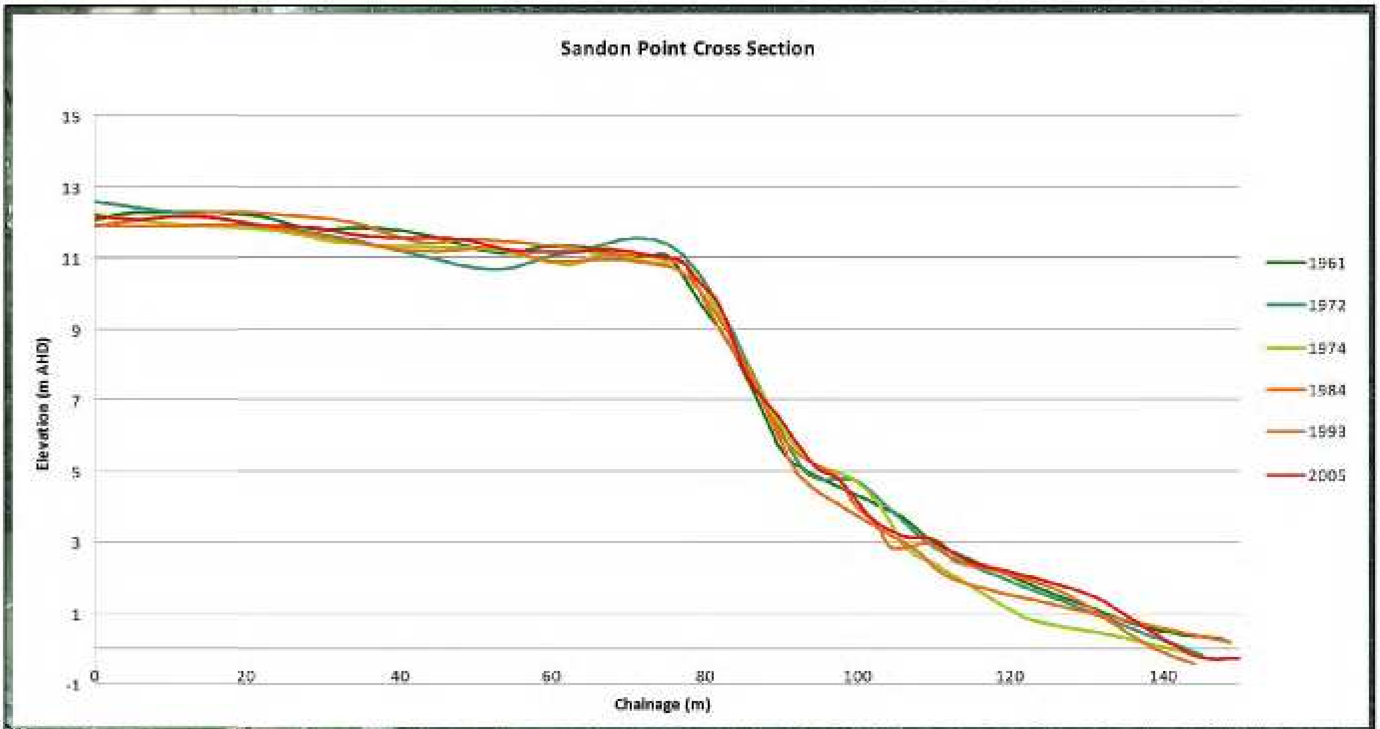

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Sandon Point

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

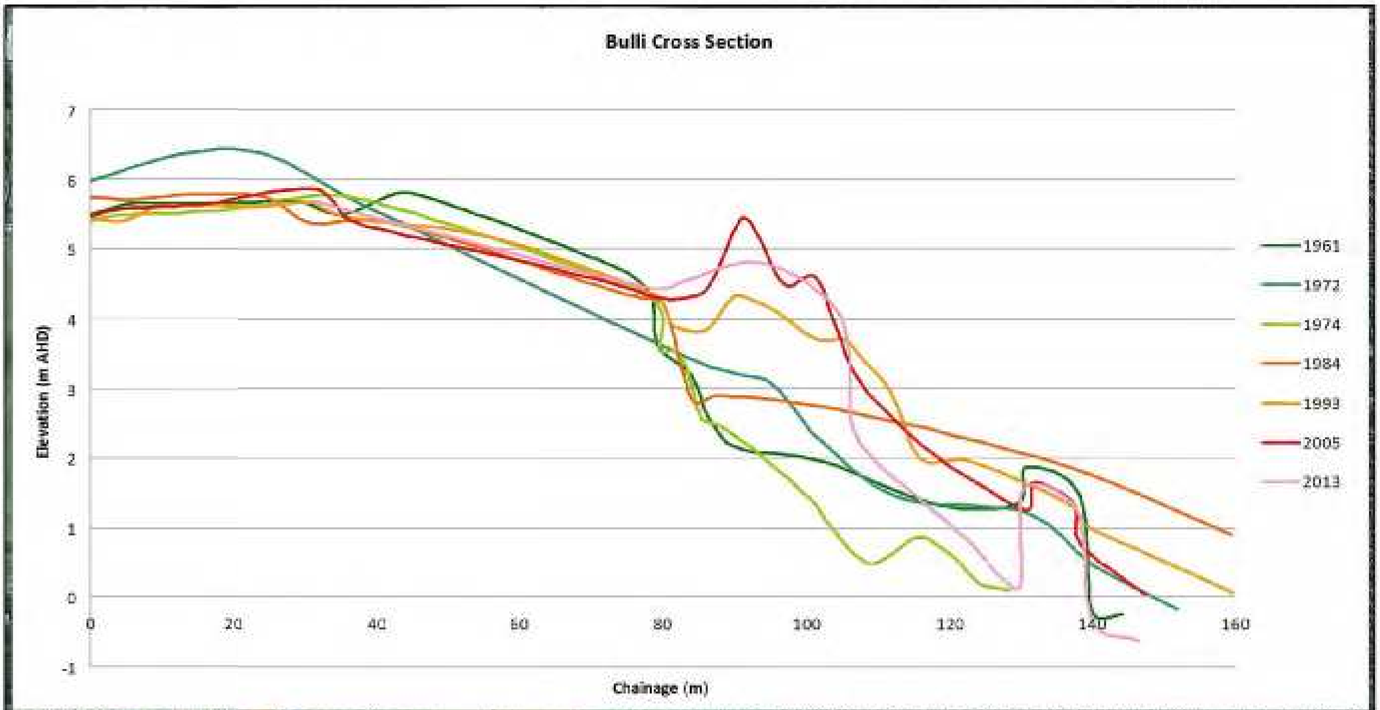
50 25 0 50 Meters

gie00779-09_survey04

Date: 18/09/2013

Aerial Photography: 2012

Scale 1:3,500



Bulli

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

50 25 0 50 Meters

gie00779-09_survey05

Date: 18/09/2013

Aerial Photography: 2012

Scale 1:3,500

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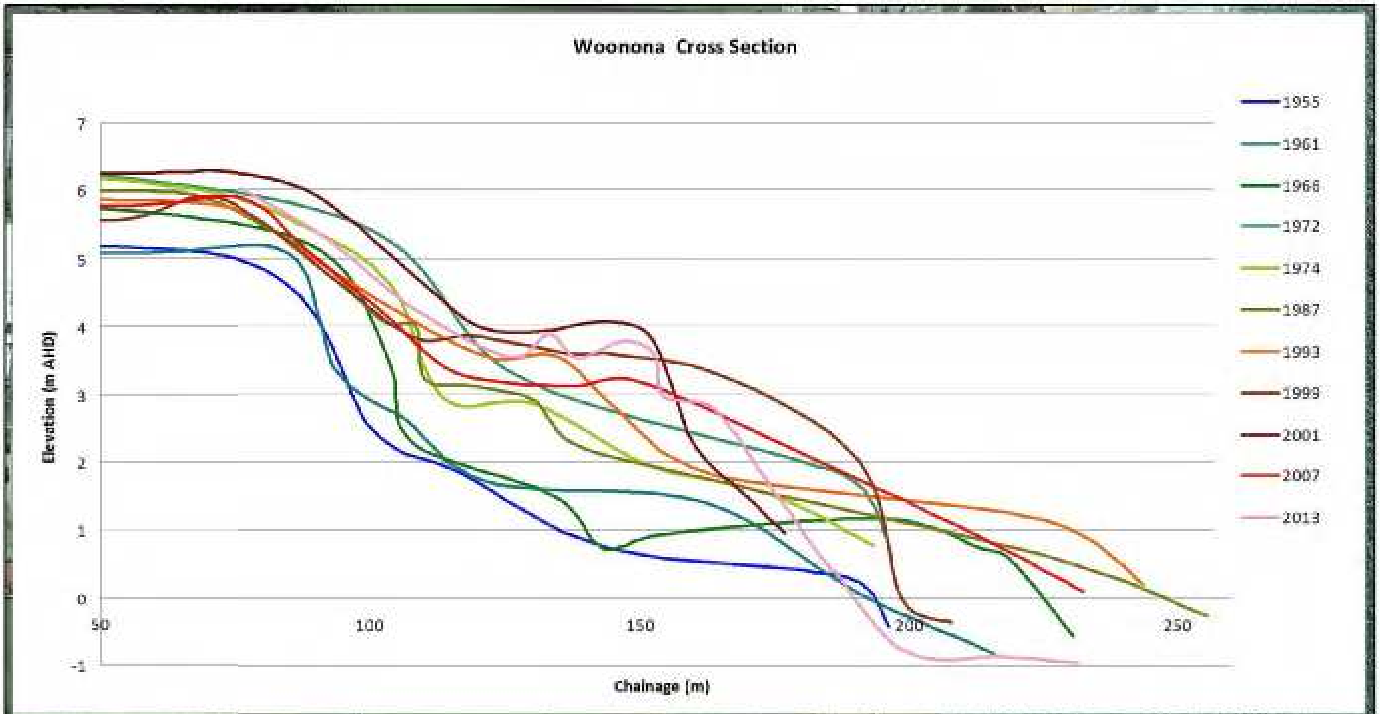

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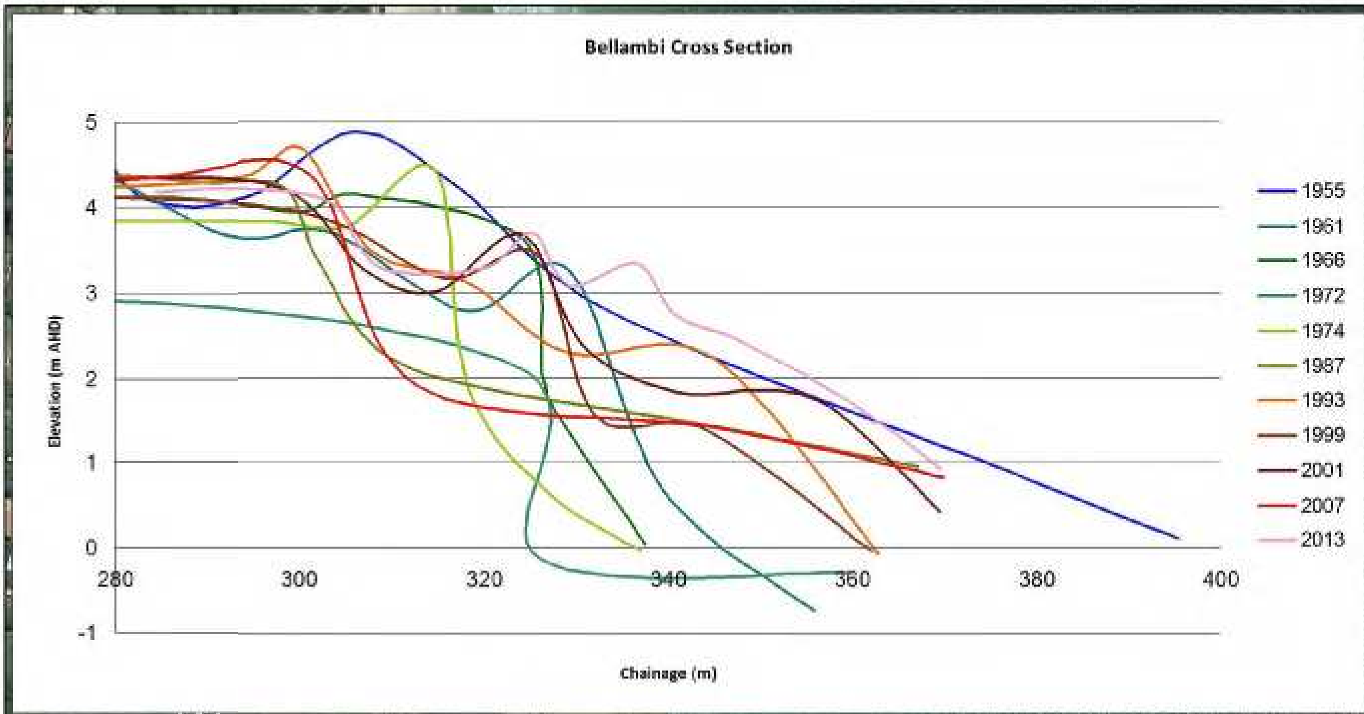
Woonona

○	Chainage (m)
—	Transect
	Primary Flag Area
	Secondary Flag Area
	Management Area

N

gie00779-09_survey06
Date: 18/09/2013
Aerial Photography: 2012
Scale 1:3,500

70 35 0 70 Meters



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Bellambi

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

gie00779-09_survey07
Date: 18/09/2013
Aerial Photography: 2012
Scale 1:3,500

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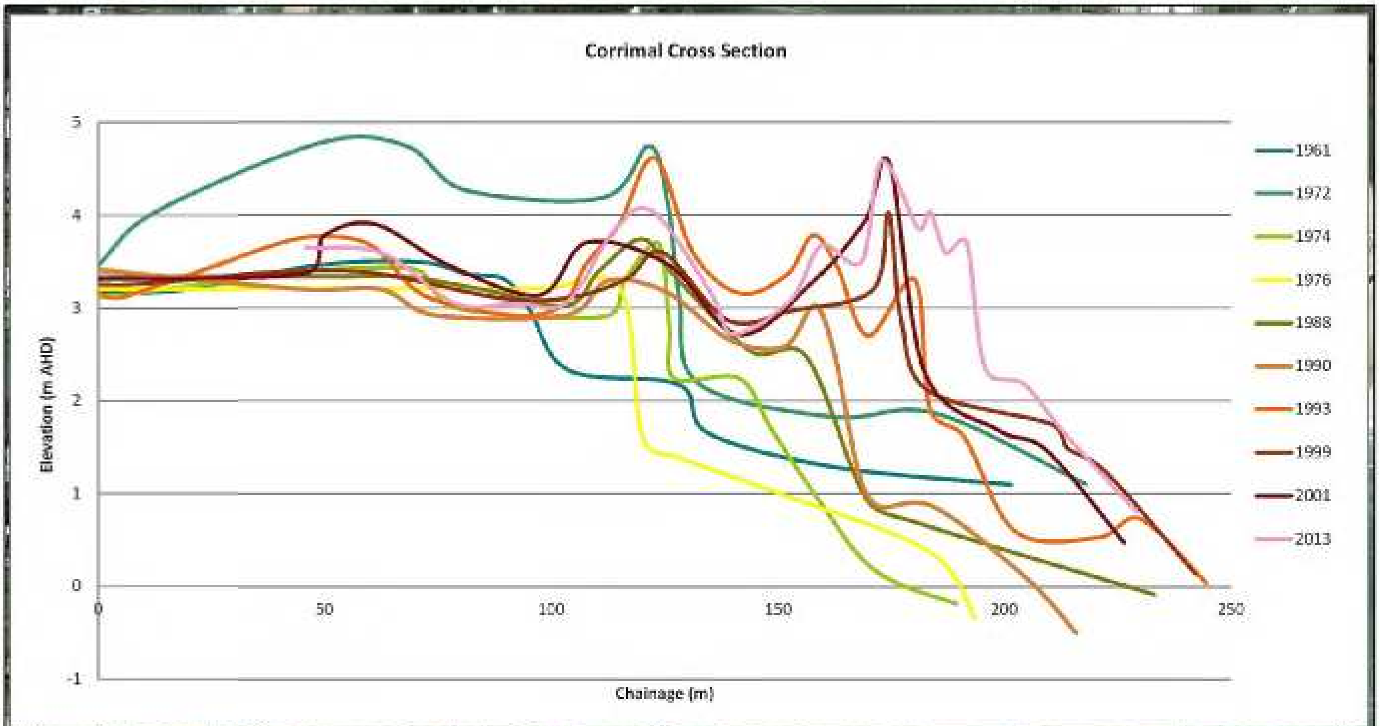

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Corrimal

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

gie00779-09_survey08
Date: 24/09/2013
Aerial Photography: 2012
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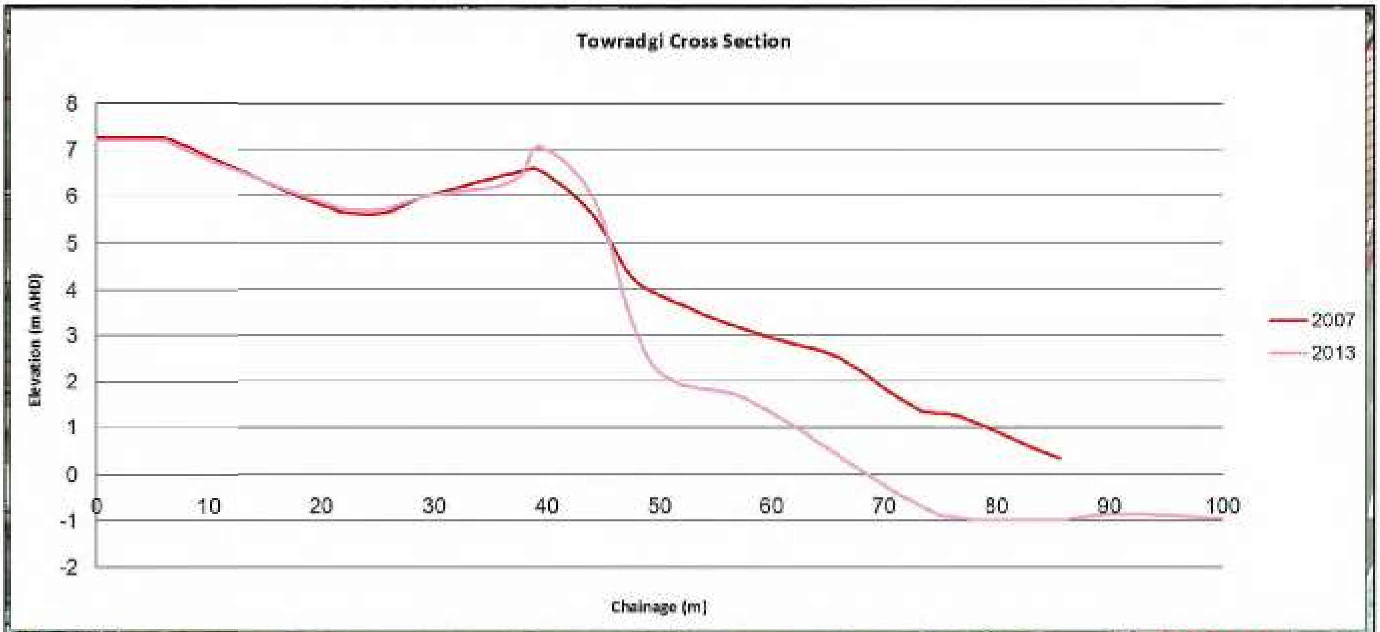

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Towradgi

○	Chainage (m)
—	Transect
	Primary Flag Area
	Secondary Flag Area
	Management Area

N

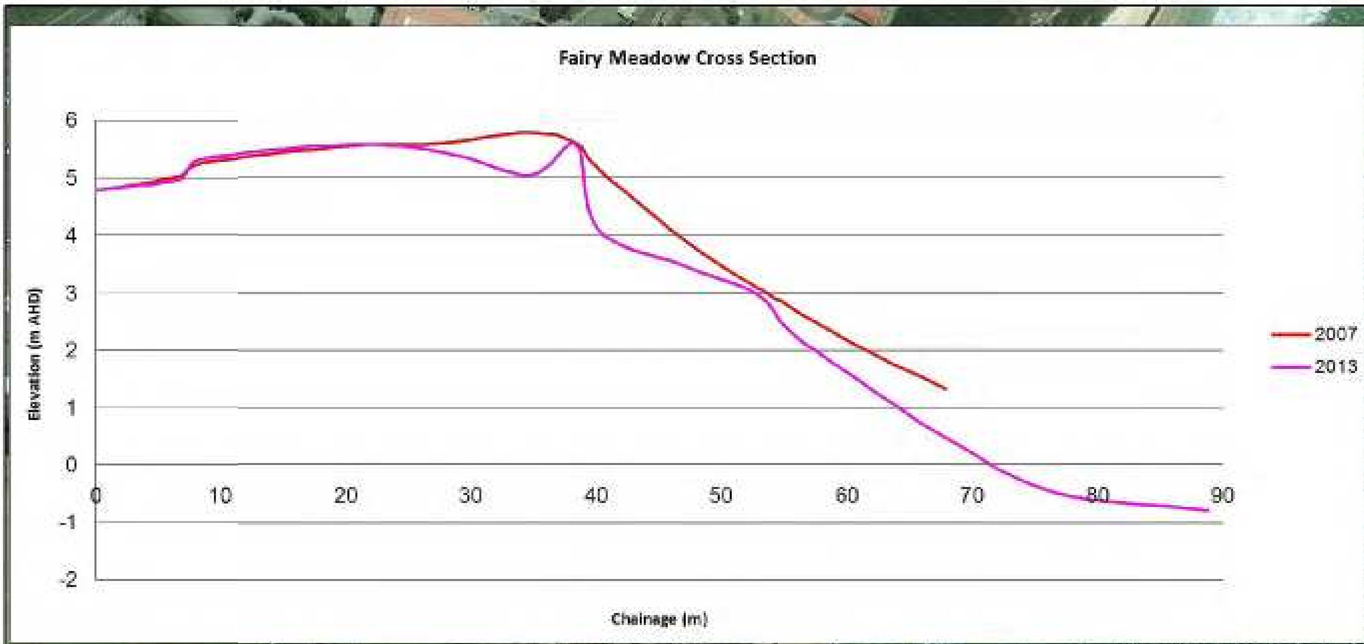
gie00779-09_survey09

Date: 18/09/2013

Aerial Photography: 2012

Scale 1:3,500

70 35 0 70 Meters



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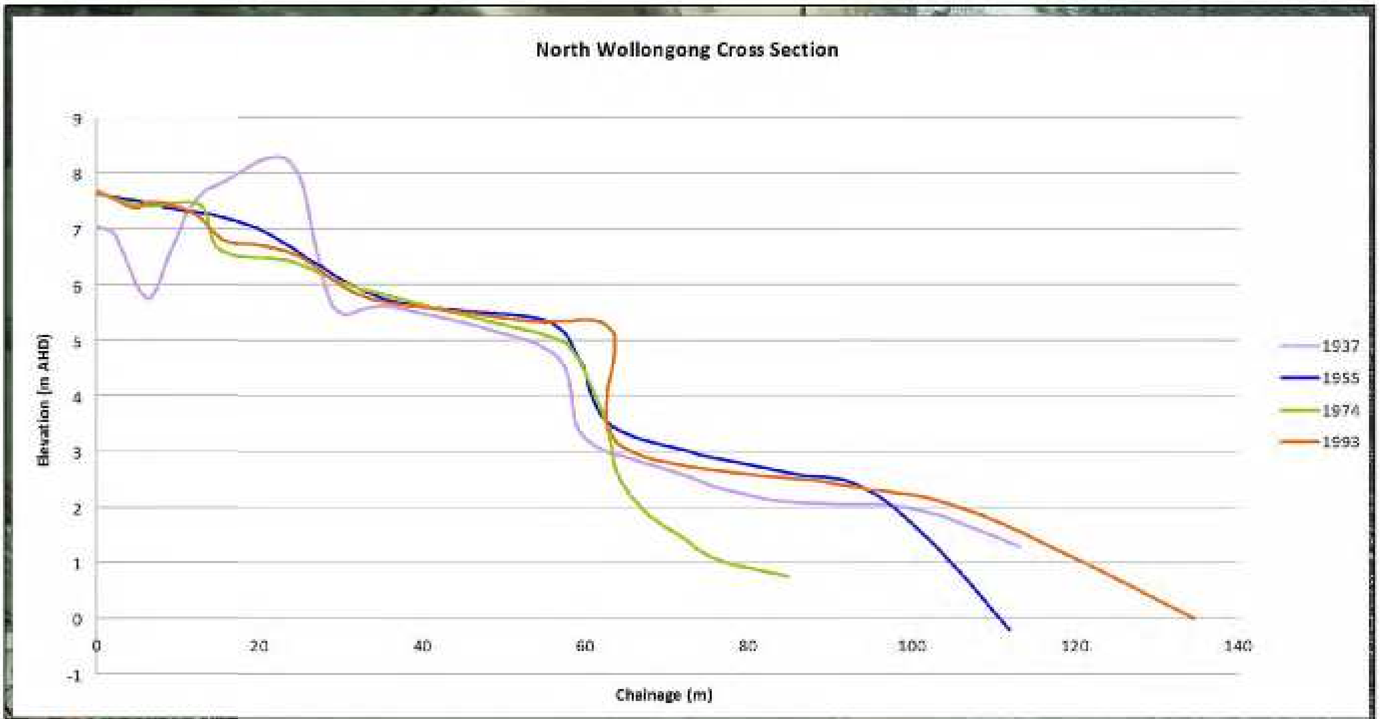
Fairy Meadow

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

gie00779-09_survey10	
Date: 18/09/2013	
Aerial Photography: 2012	
Scale	1:3,500

70 35 0 70 Meters



North Wollongong

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Legend	
○	Chainage (m)
—	Transect
	Primary Flag Area
	Secondary Flag Area
	Management Area

N

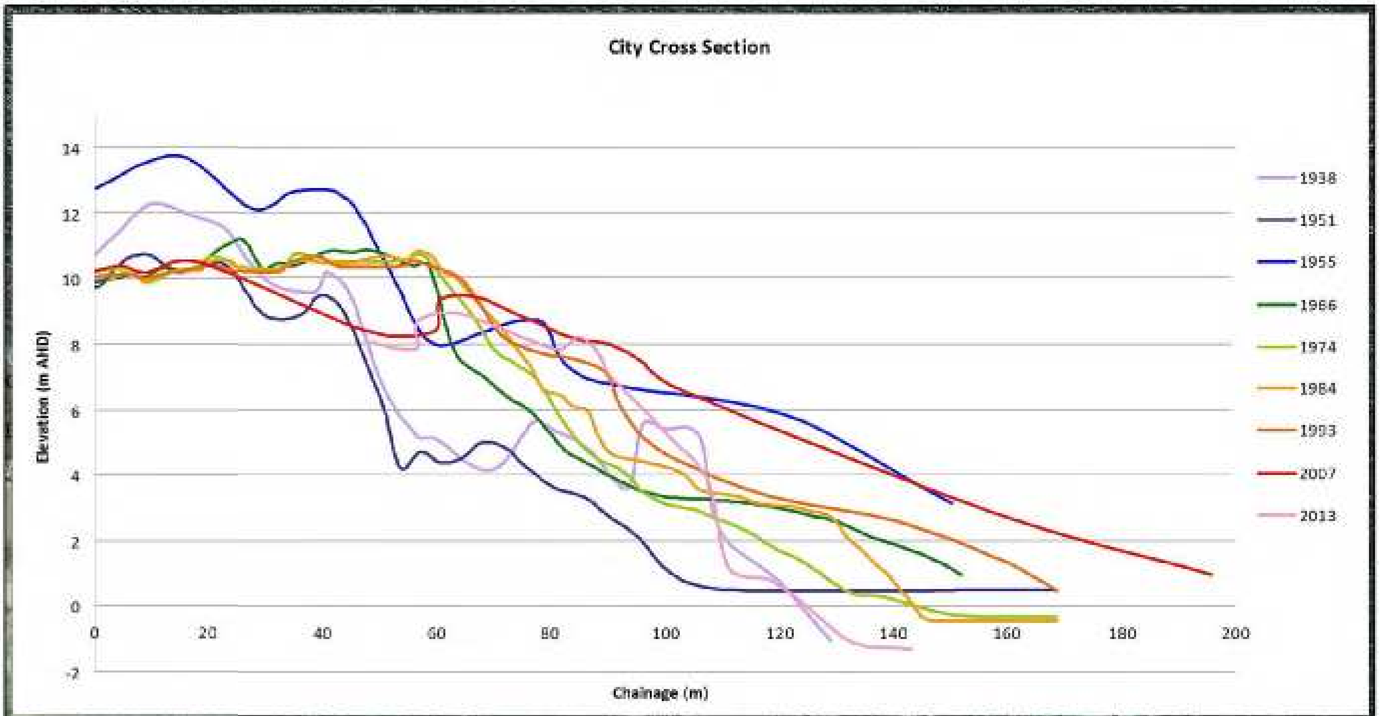
gie00779-09_survey11

Date: 18/09/2013

Aerial Photography: 2012

Scale 1:3,500

70 35 0 70 Meters



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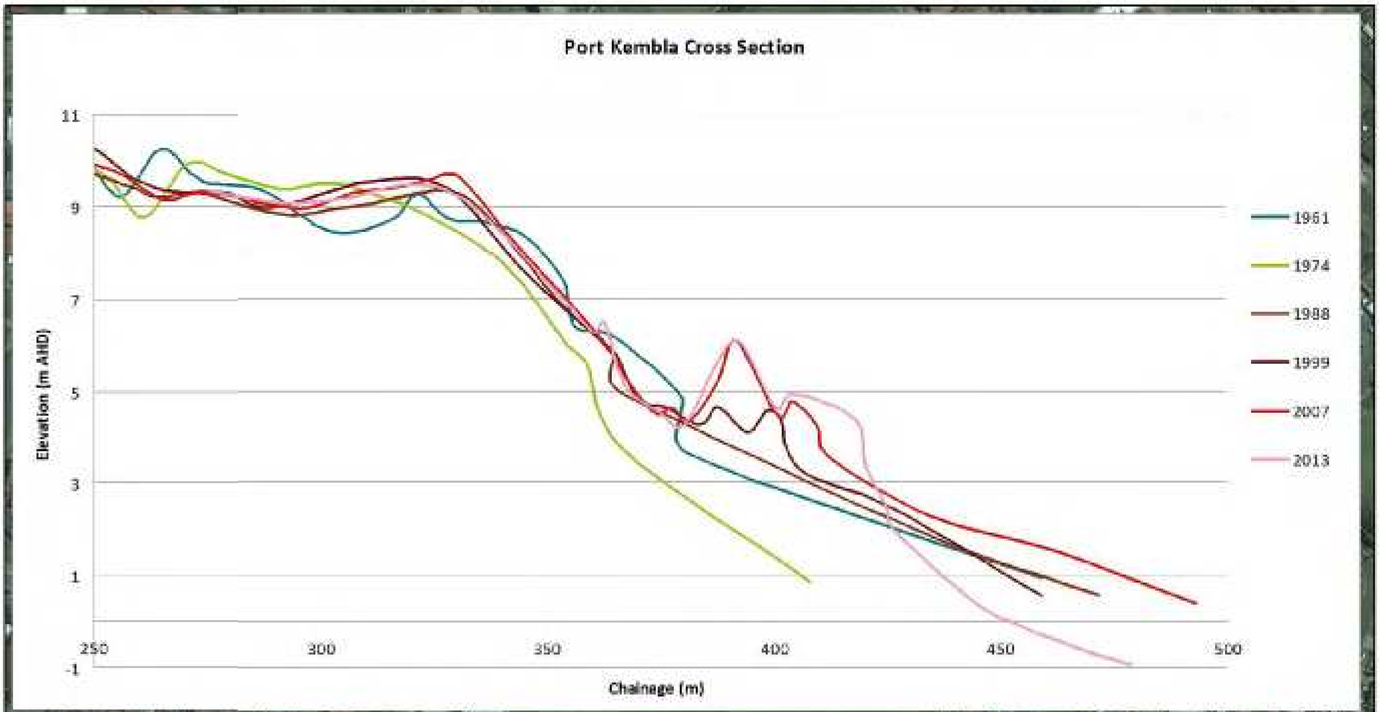
City Beach

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

gie00779-09_survey12
Date: 18/09/2013
Aerial Photography: 2012
Scale 1:3,500

70 35 0 70 Meters



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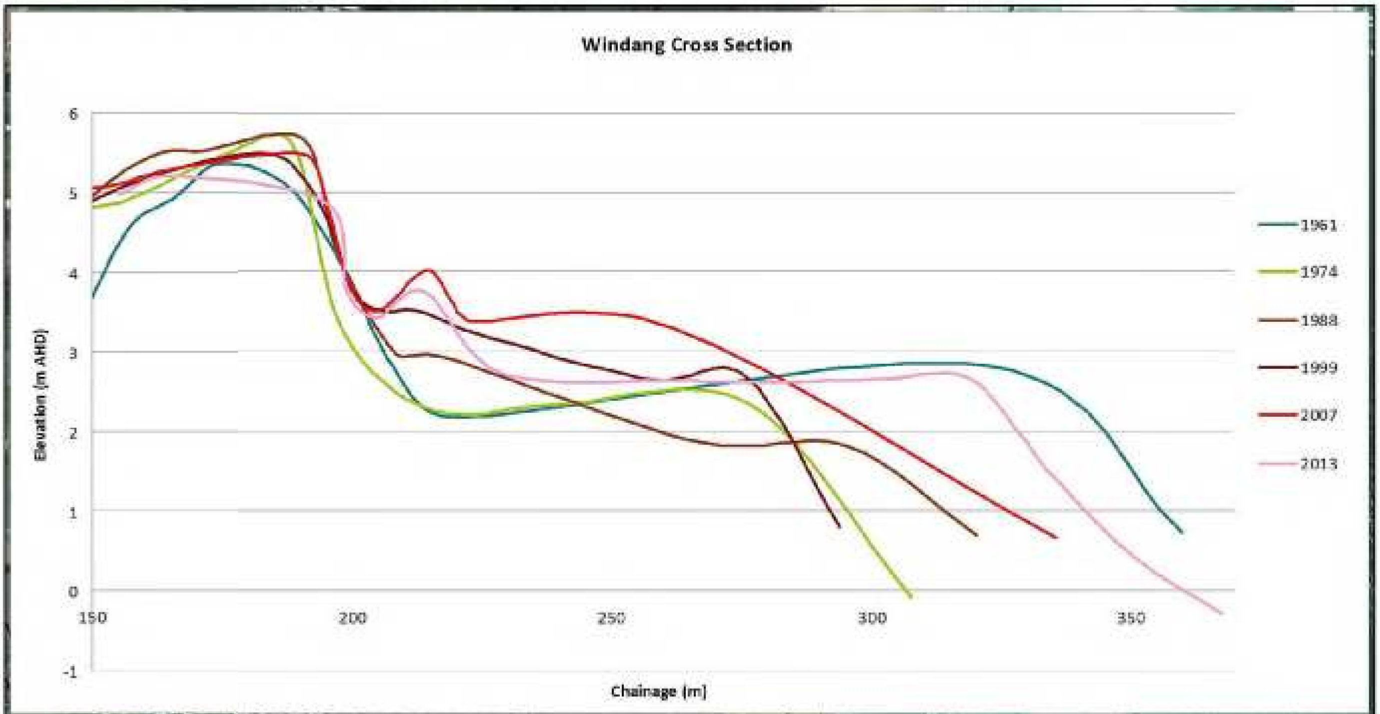
Port Kembla

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

gie00779-09_survey13
Date: 18/09/2013
Aerial Photography: 2012
Scale 1:3,500

70 35 0 70 Meters



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Windang

Chainage (m)
Transect
Primary Flag Area
Secondary Flag Area
Management Area

N

gie00779-09_survey14
Date: 18/09/2013
Aerial Photography: 2012
Scale 1:3,500

70 35 0 70 Meters

Appendix N – Structural and sight line assessment

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Bulli

Primary Flag Area
Secondary Flag Area
Management Area

N

GIS ref. gie00755-05.mxd
Printed:02/05/2013
Aerial Photography: 2012
Scale 1:3,000
40 20 0 40 Meters

Bulli Beach - site photos

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Woonona

- Primary Flag Area
- Secondary Flag Area
- Management Area

N

GIS ref. gie00755-05.mxd	
Printed:02/05/2013	
Aerial Photography: 2012	
Scale	1:3,000

40 20 0 40 Meters

Woonona Beach - site photos

Note: Sightline issues shown on the following map are from the SLSC. View of the beach from the lifeguard observation tower is also obstructed but not to as great an extent as from the SLSC.

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Bellambi

Primary Flag Area
Secondary Flag Area
Management Area

N

40 20 0 40 Meters

GIS ref. gie00755-05.mxd
Printed:02/05/2013
Aerial Photography: 2012
Scale 1:3,000

Bellambi Beach - site photos




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Corrimal

- Primary Flag Area
- Secondary Flag Area
- Management Area

N

40 20 0 40 Meters

GIS ref. gie00755-05.mxd

Printed:02/05/2013

Aerial Photography: 2012

Scale 1:3,000

Corrimal Beach - site photos




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Towradgi

Primary Flag Area
Secondary Flag Area
Management Area

N

40 20 0 40 Meters

GIS ref. gie00755-05.mxd	
Printed:02/05/2013	
Aerial Photography: 2012	
Scale 1:3,000	

Towradgi Beach - site photos

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Fairy Meadow

Primary Flag Area
Secondary Flag Area
Management Area

N

GIS ref. gie00755-05.mxd	
Printed:02/05/2013	
Aerial Photography: 2012	
Scale 1:3,000	

40 20 0 40 Meters

Fairy Meadow Beach - site photos

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City Beach

Primary Flag Area
Secondary Flag Area
Management Area

N

40 20 0 40 Meters

GIS ref. gie00755-05.mxd
Printed:02/05/2013
Aerial Photography: 2012
Scale 1:3,000

City Beach - site photos

wollongong
city of innovation

Port Kembla

- Primary Flag Area
- Secondary Flag Area
- Management Area

N

GIS ref. gie00755-05.mxd

Printed:02/05/2013

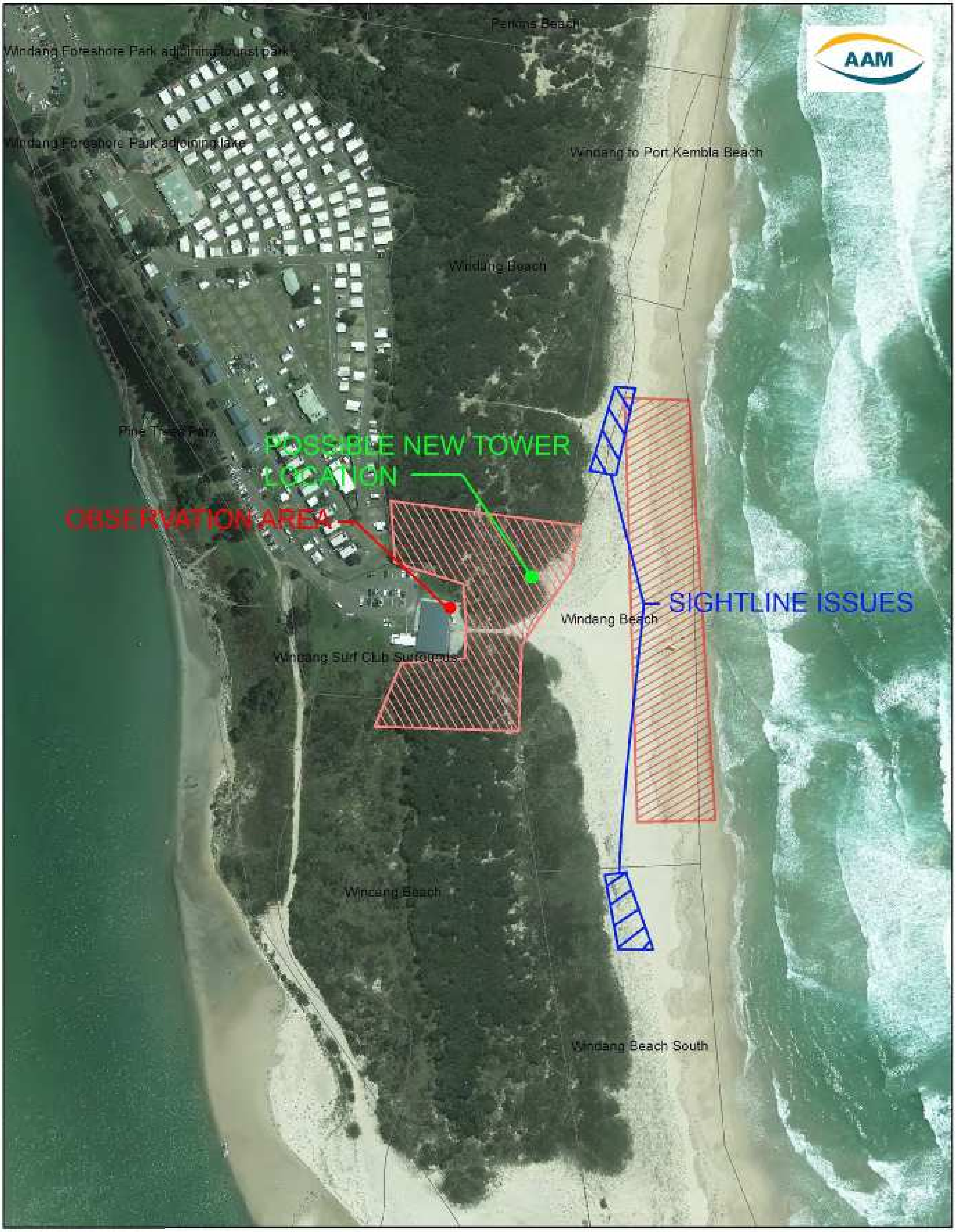
Aerial Photography: 2012

Scale 1:3,000

40 20 0 40 Meters

Port Kembla Beach - site photos

Note: Sightline issues shown on the following map are from the SLSC. The lifeguard observation tower has a clear view ofthe beach.



wollongong
city of innovation

Windang

Primary Flag Area
Secondary Flag Area
Management Area

N

GIS ref. gie00755-05.mxd	
Printed:02/05/2013	
Aerial Photography: 2012	
Scale	1:3,000

40 20 0 40 Meters

Windang Beach - site photos

Appendix O – Further details on selected management options

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Further Details on Selected Management Options

Remove trees and shrubs affecting line of sight

Description/location

Community concerns have been raised relating to the height of vegetation on the dune at Port Kembla, Corrimal, Towradgi, Fairy Meadow, Woonona and Bulli beaches that is affecting line of sight from Surf Life Saving Club (SLSC) viewing points to the shoreline of patrolled areas.

Removal of dune vegetation needs to be considered in the context of relevant legislation (see section 3 and section 7.2), the objectives of the relevant community land classification, any relevant Plan of Management for the site, and the permissible activities within the LEP zoning.

There is some justification for removing specimens of Golden Wreath Wattle **Acacia saligna*, a species which is not indigenous, and which has been found to be invasive. Golden Wreath Wattle is growing near the clubhouses of Corrimal, Towradgi, Woonona, Bulli and Fairy Meadow beaches.

A species which naturally occurs on the Hawkesbury Sandstone plateau above the Illawarra Escarpment has also been extensively planted in dune vegetation. Sydney Golden Wattle *Acacia longifolia* subsp. *longifolia* is discussed in detail in section 5 and could be considered for removal because it may exceed 4m in inappropriate locations (as is the case at Corrimal, Bulli and Woonona beaches), and it is hybridising with the indigenous Coastal Wattle *Acacia longifolia* subsp. *sophorae*, resulting in a second generation with a more upright growth habit.

Mangrove Boobialla *Myoporum acuminatum* has also been extensively planted in dune vegetation, and appears to succeed patches of senescent Coastal Wattle. This species may exceed 4m, in sheltered conditions, and generally occurs naturally in Littoral Rainforest or estuarine Swamp Oak Forest, rather than in dune scrub.

Coastal Tea-tree *Leptospermum laevigatum* occurs in dense thickets at most beaches. This species naturally recruits in the hind-dune, although at some beaches the narrow width of the dune vegetation has resulted in hind-dune succession along the landward fence line, where it will exceed 4m in height. This species naturally establishes in dense clumps, to provide a protective barrier for hind-dune vegetation. At Corrimal and Towradgi beaches, for example, this dense barrier provides shelter in the adjacent lawn area from strong sea-winds, but may also inhibit views from the clubhouse.

Bracelet Honey-myrtle *Melaleuca armillaris* is a densely growing shrub which may exceed 4m in height. Although this species occurs as a dune shrub at Kurnell and the Royal National Park, it only occurs in Wollongong dune vegetation as a planted specimen.

Therefore, there is some ecological justification for gradual removal of specimens of Golden Wreath Wattle (exotic weed), Sydney Golden Wattle (tendency to hybridise with Coastal Wattle), Mangrove Boobialla, Coastal Tea-tree and Bracelet Honey-myrtle (marginally out of habitat). However, bearing in mind the core objectives for Natural Areas, any removal should be preceded by an impact assessment and a strategic plan to ensure that there is minimal disruption to habitat, and that all gaps are replaced by suitable native species.

One tall-growing species which is a natural occurrence on dunes is Coastal Banksia *Banksia integrifolia subsp. integrifolia*. This species occurs as an emergent at most beaches, including Port Kembla, Coalcliff and Scarborough, where the club house is located above a steep batter above the beach. In most cases, this species occurs as scattered individuals, rather than in dense thickets, and views are partially restricted, rather than blocked. Decisions relating to the removal of Coastal Banksia from dune vegetation should be considered in the context of the habitat value of this species and the impacts of removal on the core objectives listed above.

Method of Management

Some trimming for height reduction has been carried out by the dune crew over the summer months. It is apparent that much of the trimmed vegetation has died back, leaving bare patches which are likely to be colonised by weed species, especially Bitou Bush. A gradual removal of tall-growing species with immediate replacement by lower-growing species may provide a more satisfactory long-term and less time-consuming solution.

Replacement plantings of low-growing species should include *Correa alba, Westringia fruticosa, Atriplex cinerea, Rhagodia candolleana, Leucopogon parviflorus a*nd *Myoporum boninense.* Refer to Appendix I for additional plant species recommended for dune planting.

One low-growing species which is a self-recruiting pioneer in some dunes and which has been extensively planted, and which has been the subject of much ill-informed criticism during the consultation process is Coastal Wattle *Acacia longifolia* subsp. *sophorae*. Coastal Wattle is discussed in more detail in section 5.4 of the report, Coastal Wattle is an ideal species for Wollongong dunes, because it is low-growing, makes nitrogen and organic matter available to successional plant species, and acts as a sand-binder by producing roots at nodes when buried.

The following should be considered when undertaking this management option:

- Care needs to be taken to minimise the risk from non-target secondary infection of adjacent native vegetation by fungi or other invasive organisms, and to avoid damage to the surrounding native trees' Critical Root Zone, as a result of compaction (especially if machinery is used).

- Removal of trees and shrubs may increase erosion and sedimentation; indirect impacts on downslope environments or adjoining wetland habitat need to be considered.

- Uncontrolled erosion from removal areas and exposed sediment and corresponding deposition into native vegetation or freshwater creeks, can cause weed problems, reduce aquatic habitat values and stifle plant growth. Dunes in the study area show signs of instability and active erosion; removal of trees and adjoining vegetation (and their root systems) may further destabilise dune integrity and the beach profile in the coastal zone.

- Removal of vegetation may result in edge effects. Edge effects may result in impacts including changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna.

- Removal of vegetation may result in the displacement of roosting migratory birds and other threatened fauna species. Dune vegetation hosts visiting threatened fauna from nearby headlands, rock platforms, wetlands and cross-continental (including migratory shorebirds) as they seek food and nesting material or take refuge.

- Removal of vegetation may result in a reduction of foraging and nesting habitat for a variety of threatened bird, reptile and mammal species (including migratory species). For example, threatened seabirds such as the Little Tern (endangered) are known to nest occasionally within and nearby dune vegetation along Windang Beach.

Additional management of noxious and invasive weed species

Description/location

This option is focused on replacement of weeds with appropriate native species.

The study area contains at least nine flora species declared as noxious weeds in the Wollongong Local Government Area (note this control area also includes the local councils of Kiama and Shellharbour), as shown in the table below.

Species Name	Common Name	Control Class	Control Requirements
Chrysanthemoides monilifera subsp. *rotundata*	Bitou Bush	4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction.
Lantana camara	Lantana	4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction, and the plant must not be sold, propagated or knowingly distributed.
Asparagus asparagoides	Bridal Creeper	4	The plant must not be sold, propagated or knowingly distributed.
Argemone mexicana	Mexican Poppy	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.
Opuntia stricta	Prickly Pear	4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction, and the plant must not be sold, propagated or knowingly distributed.
Eragrostis curvula	African Lovegrass	4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction, and the plant

Species Name	Common Name	Control Class	Control Requirements
			must not be sold, propagated or knowingly distributed.
Pennisetum setaceum	Fountain Grass	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.
Sprobolus fertilis	Giant Parramatta Grass	3	The plant must be fully and continuously suppressed and destroyed.
Rubus fruticosus sp. aggregate	Blackberry	4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction, and the plant must not be sold, propagated or knowingly distributed.

The noxious plant species recorded in the study area during flora field surveys are described in detail below.

Bitou Bush occurs at varying levels of abundance at all beaches with dune vegetation. Council has an ongoing management programme for this species, and the need to carry out gradual removal, in order to retain existing habitat for small passerine birds is recognised. At the time of the survey, numerous seedlings were recorded, especially in bare patches and along tracks. Planting of appropriate native species in gaps and manual removal of seedlings is an appropriate, albeit labour intensive management strategy.

Lantana also occurs at all beaches with dune vegetation, although not as frequently as Bitou Bush. Seedlings of Lantana were also scarce. Manual removal of Lantana clumps and replanting with appropriate species is recommended for management where scattered clumps occur within the dune vegetation, e.g. Bulli Beach.

Bridal Creeper and other Asparagus species occur at all beaches, whether in the dune vegetation or in adjacent forest, woodland or scrub. It is likely that the most common seed vectors are frugivorous birds. This species is difficult to manage, because the entire root clump needs to be removed. It is apparent that Asparagus species will become more invasive in dune vegetation, if no management practices are implemented. It should also be recognised that complete removal of Asparagus species may be impossible; therefore, planning for management of this species should follow a similar process as Bitou Bush and Lantana management, with an annual management component for this plant group.

Mexican Poppy is not common, and was not recorded at any beach north of City Beach. No individuals were recorded in the study area of any beach, although scattered individuals were observed in adjacent areas, especially at Port Kembla. Manual removal of individuals prior to seed set, or spot spraying would be appropriate management practices.

Blackberry was not recorded within any dune vegetation in the study area, although small, scattered clumps were observed in some areas of dense vegetation, particularly on batters above creeks, e.g. Bellambi Creek, upstream of the bridge. It was noted that some Blackberry clumps have recently been spot-sprayed.

Several noxious grass species were recorded in dune vegetation, especially between Corrimal and Fairy Meadow and Port Kembla. No large patches of any species were recorded in the study area, and most infestations are sufficiently small for control either by spot spraying or manual removal.

The most commonly occurring species are African Lovegrass **Eragrostis curvula* and Giant Parramatta Grass **Sporobolus fertilis*. It was noted that the native species, *Sporobolus virginicus* was more common and wide-spread than the introduced Giant Parramatta Grass. Staff carrying out management of Giant Parramatta Grass should be familiar with taxonomic differences between the two species. Ideally, spot spraying should be carried out during flowering, when identification is easier.

A cultivar of Fountain Grass **Pennisetum setaceum* has been planted along the walkway at City Beach. It is not known whether this cultivar produces viable seed and no seedlings were observed during the survey. Nevertheless, cultivars of **Pennisetum setaceum* are an inappropriate selection for areas adjacent to patches of native vegetation.

Management

Bitou Bush and Lantana are noxious species which are regularly maintained by Council's dune crew. Asparagus species are probably becoming more invasive in coastal vegetation and there will be a need to carry out targeted removal. Windang, Port Kembla, Bulli, Woonona, Bellambi, Corrimal and Towradgi are beaches where management practices should not be delayed. Plants should be removed prior to flowering, and if removed manually, care should be taken to dig out and remove all tubers.

Follow-up management is essential, in order to remove or re-spray regrowth and seedlings and to plant suitable native species.

There are extensive infestations of environmental weeds throughout the study area that will require regular management; recorded species included Turkey Rhubarb **Acetosa sagittata* (most beaches, but especially Bulli, Woonona, Corrimal, Port Kembla and Windang), Green Cestrum **Cestrum parqui* (Woonona and Windang) and Mother of Millions **Bryophyllum delagoense* (Towradgi, Wollongong, Port Kembla and Windang).

Some non-native species are too well established to consider removal. In particular, Kurnell Curse **Hydrocotyle bonariensis, *Gazania rigens* and Seablight **Cakile maritima* and **Cakile edentula* may even be beneficial, because of their ability to colonise in the foredune.

The following should be considered when undertaking this management option:

- Removal of large patches of weeds may result in edge effects to adjacent native vegetation. Edge effects may result in impacts including changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Weed invasion and edge effects are already evident within the study area. The potential for the extensive weed management activities to exacerbate existing edge effects and subsequent weed invasion needs to be minimised by restricting the area of disturbance, immediate follow-up planting, monitoring and maintenance.

- There is the potential for minor, additional impacts on native vegetation in the study area through transmission of weed propagules on equipment and through disturbance of vegetation and surface soil, which may provide increased opportunities for weed recruitment.

Remove vegetation from frontal zone

Description/location

This option has been identified as more suitable for Bulli, Woonona, Corrimal, Towradgi and Fairy Meadow beaches, either because the vegetation has extended too far onto the beach, thereby reducing the beach width, (e.g. Bulli and Woonona) or because the frontal zone of the foredune has increased in height as sand is trapped within vegetation growing on the foredune.

Management method

Encroaching vegetation would best be removed manually, in order to ensure that any cuts to stems are made cleanly and appropriately (i.e. back to nodes or stem unions). Associated organic matter should be gathered after removal of live plant material, otherwise the newly exposed foredune will appear untidy and unattractive. The removed live material and organic matter should be scattered over vegetated areas further upslope.

There may be a need to reshape the foredune, especially if steep scarping has occurred. This should be carried out by light machinery.

The following should be considered when undertaking this management option:

- If cuts are not made cleanly, there may be extensive die-back from fungal infection or from salt damage.

- Storm action after the vegetation removal may result in increased erosion or scarping, as a result of reduced protection and stability.
- Removal of vegetation may result in the displacement of roosting migratory birds and other threatened fauna species. Dune vegetation hosts visiting threatened fauna from nearby headlands, rock platforms, wetlands and cross-continental (including migratory shorebirds) as they seek food and nesting material or take refuge (see Figure 1).

Figure 1: Sooty Oystercatchers seeking refuge on Sandon Point.

- Removal of vegetation may result in a reduction of foraging and nesting habitat for a variety of threatened bird, reptile and mammal species. For example, threatened seabirds such as the Little Tern are known to nest occasionally within and nearby dune vegetation along Windang Beach.

Improve beach access ways

Description/location

Most vehicular access tracks are sufficiently wide, although some overhanging branches may require seasonal trimming. Scarping appears to be a problem at several beaches, such as City, Fairy Meadow and Towradgi, in which case, there may be a steep incline from the dune down to the beach strand. Other issues related to grade, track surface and infrastructure, insufficient width for rescue and SLSC vehicles and sand build-up at edges.

Management method

The following activities may need to be undertaken as part of this option:

- Any overhanging branches should be removed back to the main leader. All cuts should be made by clean, sharp secateurs.
- Steep inclines to be managed by use of light machinery.
- Removal of sand build-up at edges by use of light machinery.
- Widening of the track, which may involve some minor vegetation clearing and moving the fence line.
- Repairing of fences/other track infrastructure.

Temporary disturbance of roosting or nesting fauna should be avoided. For example, the threatened Black Bittern, which is known from nearby locations to the various beaches, will roost in trees during the day.

Management of subspecies of *Acacia longifolia*

Description/location

At some beaches, much of the wattle growth on dunes is inappropriate in terms of growth habit and height. Beaches where subspecies of *Acacia longifolia* may have already grown to an unsatisfactory height include City, Fairy Meadow, Towradgi, Corrimal, Bellambi, Woonona and Bulli beaches. Problems may also eventuate in the next few years at Stanwell Park, Windang and Port Kembla.

Management method

Subspecies of *Acacia longifolia* in the management areas will be gradually managed to improve sight lines, reduce monocultures and increase biodiversity. These activities will include removal of dead plants, plants of excessive height and seedlings, and their replacement with appropriate low growing species.

Removal of this species should be gradual and should not involve large patches. Ideally, removal should begin from fence lines and track edges, and should always be followed by replanting of lower-growing species.

An alternative to removal of this species is to replant lower-growing species within the gaps left by senescent plants. This method would cause fewer disturbances to adjacent vegetation and would be more cost-effective. The replanted gaps should be monitored over at least the next twelve months, in order to ensure survival of the planted seedlings and to remove Wattle seedlings that have recruited from the seedbank.

The following should be considered when undertaking this management option:

- Removal of established Wattle plants will result in the removal, however temporary, of fauna habitat.

- Removal of the parent plants require follow-up, as it is likely that numbers of Wattle seeds have been buried by ants. The exposure to additional light in the cleared gaps, as well as disturbance to topsoil and organic matter may stimulate the germination of these seeds. Wattle seedlings will be able to out-compete other planted species because of their nitrogen – fixing capabilities.

Build a Tower

A relocatable lifeguard tower with minimum floor plan dimensions of 2.5m by 2.5m is suggested for use on Wollongong's beaches. Consideration needs to be made with regards to safety; design must incorporate anti-climbing measures and be lockable to prevent vandalism. Design should take into consideration the environmental aspects of the area, with consideration to changing dune profiles (tower should be relocated if/when necessary), design should be durable (structure subject to corrosive environment). Structure will require a regular maintenance schedule (repainting, etc.) to minimise effects of corrosion.

Method

After carrying out a line of sight survey and geotechnical assessment, build a small non-powered lifeguard tower. This could be similar to the current towers at Woonona and Corrimal, and the proposed tower for Windang (Figure 2i). These towers cost approximately $150,000. Design of tower needs to be easily constructed on site (lightweight sections and bolted connections only), with all welding/fabrication of steel sections undertaken in a workshop.

The current towers have the following design features:

- A floor plan of approximately 2.5m x 2.5m with floor level approximately 2-3m above ground level.
- Space to comfortably accommodate 2-3 people, a desk and seating area and an undercover deck area.
- Towers are made of aluminium with a small precast concrete pad footing shaped like skis with hooks to enable them to be dragged to a different location on the beach (Figure 2ii).

Figure 2. i) Patrol tower at Corrimal Beach ii) Precast footing showing hooks to drag the structure.

Appendix L provides an indication of suitable locations for towers to achieve line of sight. Towers should ideally be located within the dunal area landward of the immediate hazard line at the beach. However, as these towers are relocatable, they could be located seaward of the hazard line, but would then risk damage from a 1 in 100 year storm or would need to be dragged landward if such an event was forecast. The same applies for the option of relocation of the existing towers.

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Appendix P – MCA detailed results

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Management Options Assessment for Dune Management - Evaluation Matrix

Stanwell Park

		Criteria						
		A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	
								TOTAL
Maintain current management		0	0	0	0	0	0	**Rank 3**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								**Rank N/A**
	Sub Total							
Build a tower								**Rank N/A**
	Sub Total							
Relocate existing tower								**Rank N/A**
	Sub Total							
Remove trees and shrubs affecting line of sight								**Rank N/A**
	Sub Total							
Additional management of noxious and invasive weed species		0	0	0	0	2	0	**Rank 1**
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone								**Rank N/A**
	Sub Total							
Reduce dune height by re-profiling		0	0	1	-2	-3	3	**Rank**
	Sub Total	0.00	0.00	2.19	-5.00	-1.88	0.00	**-4.69**
Build seawall								**Rank N/A**
	Sub Total							
Management of subspecies of Acacia longifolia		0	0	0	0	1	1	**Rank 2**
	Sub Total	0.00	0.00	0.00	0.00	0.63	0.00	**0.63**
Improve beach access ways								**Rank N/A**
	Sub Total							

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Coalcliff

		Criteria						
		A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	
								TOTAL
Maintain current management		0	0	0	0	0	0	**Rank 3**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								**Rank N/A**
	Sub Total							
Build a tower								**Rank N/A**
	Sub Total							
Relocate existing tower								**Rank N/A**
	Sub Total							
Remove trees and shrubs affecting line of sight								**Rank N/A**
	Sub Total							
Additional management of noxious and invasive weed species		0	0	0	0	2	0	**Rank 1**
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone								**Rank N/A**
	Sub Total							
Reduce dune height by re-profiling								**Rank N/A**
	Sub Total							
Build seawall								**Rank N/A**
	Sub Total							
Management of subspecies of Acacia longifolia		0	0	0	0	1	1	**Rank 2**
	Sub Total	0.00	0.00	0.00	0.00	0.63	0.00	**0.63**
Improve beach access ways								**Rank N/A**
	Sub Total							

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Scarborough

		Criteria A	Criteria B	Criteria C	Criteria D	Criteria E	Criteria F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	TOTAL
Maintain current management		0	0	0	0	0	0	Rank 3
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								Rank N/A
	Sub Total							
Build a tower								Rank N/A
	Sub Total							
Relocate existing tower								Rank N/A
	Sub Total							
Remove trees and shrubs affecting line of sight								Rank N/A
	Sub Total							
Additional management of noxious and invasive weed species		0	0	0	0	2	1	Rank 1
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone								Rank N/A
	Sub Total							
Reduce dune height by re-profiling								Rank N/A
	Sub Total							
Build seawall								Rank N/A
	Sub Total							
Management of subspecies of Acacia longifolia		0	0	0	0	1	1	Rank 2
	Sub Total	0.00	0.00	0.00	0.00	0.63	0.00	**0.63**
Improve beach access ways								Rank N/A
	Sub Total							

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Coledale

		Criteria A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	TOTAL
Maintain current management		0	0	0	0	0	0	**Rank 3**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								**Rank N/A**
	Sub Total							
Build a tower								**Rank N/A**
	Sub Total							
Relocate existing tower								**Rank N/A**
	Sub Total							
Remove trees and shrubs affecting line of sight								**Rank N/A**
	Sub Total							
Additional management of noxious and invasive weed species		0	0	0	0	2	0	**Rank 1**
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone								**Rank N/A**
	Sub Total							
Reduce dune height by re-profiling								**Rank N/A**
	Sub Total							
Build seawall								**Rank N/A**
	Sub Total							
Management of subspecies of Acacia longifolia		0	0	0	0	1	1	**Rank 2**
	Sub Total	0.00	0.00	0.00	0.00	0.63	0.00	**0.63**
Improve beach access ways								**Rank N/A**
	Sub Total							

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Austinmer

		A	B	C	D	E	F	
		Criteria						
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	
								TOTAL
Maintain current management		0	0	0	0	0	0	**Rank 1**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								**Rank N/A**
	Sub Total							
Build a tower								**Rank N/A**
	Sub Total							
Relocate existing tower								**Rank N/A**
	Sub Total							
Remove trees and shrubs affecting line of sight								**Rank N/A**
	Sub Total							
Additional management of noxious and invasive weed species								**Rank N/A**
	Sub Total							
Remove vegetation from frontal zone								**Rank N/A**
	Sub Total							
Reduce dune height by re-profiling								**Rank N/A**
	Sub Total							
Build seawall								**Rank N/A**
	Sub Total							
Management of subspecies of Acacia longifolia								**Rank N/A**
	Sub Total							
Improve beach access ways								**Rank N/A**
	Sub Total							

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Thirroul

		Criteria						
		A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	
								TOTAL
Maintain current management		0	0	0	0	0	0	Rank 1
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								Rank N/A
	Sub Total							
Build a tower								Rank N/A
	Sub Total							
Relocate existing tower								Rank N/A
	Sub Total							
Remove trees and shrubs affecting line of sight								Rank N/A
	Sub Total							
Additional management of noxious and invasive weed species								Rank N/A
	Sub Total							
Remove vegetation from frontal zone								Rank N/A
	Sub Total							
Reduce dune height by re-profiling								Rank N/A
	Sub Total							
Build seawall								Rank N/A
	Sub Total							
Management of subspecies of Acacia longifolia								Rank N/A
	Sub Total							
Improve beach access ways								Rank N/A
	Sub Total							

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Sandon Point

		Criteria						
		A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	
								TOTAL
Maintain current management		0	0	0	0	0	0	Rank 3
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Raise level of observation area in SLSC								Rank N/A
	Sub Total							
Build a tower								Rank N/A
	Sub Total							
Relocate existing tower								Rank N/A
	Sub Total							
Remove trees and shrubs affecting line of sight								Rank N/A
	Sub Total							
Additional management of noxious and invasive weed species		0	0	0	0	2	0	Rank 1
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	1.25
Remove vegetation from frontal zone								Rank N/A
	Sub Total							
Reduce dune height by re-profiling								Rank N/A
	Sub Total							
Build seawall								Rank N/A
	Sub Total							
Management of subspecies of Acacia longifolia		0	0	0	0	1	1	Rank 2
	Sub Total	0.00	0.00	0.00	0.00	0.63	0.00	0.63
Improve beach access ways								Rank N/A
	Sub Total							

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Bulli

		Criteria						
		A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	TOTAL
Maintain current management		0	0	0	0	0	0	**Rank 11**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC		2	0	0	0	0	0	**Rank 3**
	Sub Total	6.25	0.00	0.00	0.00	0.00	0.00	**6.25**
Build a tower		3	0	0	0	-1	1	**Rank 1**
	Sub Total	9.38	0.00	0.00	0.00	-0.63	0.00	**8.75**
Relocate existing tower								**Rank N/A**
	Sub Total							
Remove trees and shrubs affecting line of sight		1	0	0	0	-1	1	**Rank 8**
	Sub Total	3.13	0.00	0.00	0.00	-0.63	0.00	**2.50**
Additional management of noxious and invasive weed species		0	0	0	0	2	2	**Rank 9**
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone		1	1	2	-3	-2	1	**Rank 10**
	Sub Total	3.13	1.56	4.38	-7.50	-1.25	0.00	**0.31**
Reduce dune height by re-profiling		2	2	2	-3	-3	3	**Rank 4**
	Sub Total	6.25	3.13	4.38	-7.50	-1.88	0.00	**4.38**
Build seawall								**Rank N/A**
	Sub Total							
Management of subspecies of Acacia longifolia		1	0	0	0	1	2	**Rank 6**
	Sub Total	3.13	0.00	0.00	0.00	0.63	0.00	**3.75**
Improve beach access ways		0	3	0	0	-1	0	**Rank 5**
	Sub Total	0.00	4.69	0.00	0.00	-0.63	0.00	**4.06**
Raise level of observation area in SLSC and remove vegetation from frontal zone		2	1	2	-3	-2	1	**Rank 7**
	Sub Total	6.25	1.56	4.38	-7.50	-1.25	0.00	**3.44**
Build a tower and remove vegetation from frontal zone		3	1	2	-3	-2	1	**Rank 2**
	Sub Total	9.38	1.56	4.38	-7.50	-1.25	0.00	**6.56**

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Woonona

		Criteria A	B	C	D	E	F	TOTAL
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	
Maintain current management		0	0	0	0	0	0	Rank 11
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Raise level of observation area in SLSC		2	0	0	0	0	0	Rank 4
	Sub Total	6.25	0.00	0.00	0.00	0.00	0.00	6.25
Build a tower								Rank N/A
	Sub Total							
Relocate existing tower		3	0	0	0	-1	1	Rank 2
	Sub Total	9.38	0.00	0.00	0.00	-0.63	0.00	8.75
Remove trees and shrubs affecting line of sight		2	0	0	0	-2	2	Rank 7
	Sub Total	6.25	0.00	0.00	0.00	-1.25	0.00	5.00
Additional management of noxious and invasive weed species		0	0	0	0	2	0	Rank 10
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	1.25
Remove vegetation from frontal zone		1	1	2	-1	-2	2	Rank 5
	Sub Total	3.13	1.56	4.38	-2.50	-1.25	0.00	5.31
Reduce dune height by re-profiling		2	1	2	-2	-3	3	Rank 5
	Sub Total	6.25	1.56	4.38	-5.00	-1.88	0.00	5.31
Build seawall		3	1	-3	-3	-3	3	Rank
	Sub Total	9.38	1.56	-6.56	-7.50	-1.88	0.00	-5.00
Management of subspecies of Acacia longifolia		1	0	0	0	1	1	Rank 9
	Sub Total	3.13	0.00	0.00	0.00	0.63	0.00	3.75
Improve beach access ways		0	3	0	0	-1	0	Rank 8
	Sub Total	0.00	4.69	0.00	0.00	-0.63	0.00	4.06
Raise level of observation area in SLSC and remove vegetation from frontal zone		2	1	2	-1	-2	2	Rank 3
	Sub Total	6.25	1.56	4.38	-2.50	-1.25	0.00	8.44
Relocate existing tower and remove vegetation from frontal zone		3	1	2	-1	-2	2	Rank 1
	Sub Total	9.38	1.56	4.38	-2.50	-1.25	0.00	11.56

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Bellambi

		Criteria						
		A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	
								TOTAL
Maintain current management		0	0	0	0	0	0	Rank 11
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Raise level of observation area in SLSC		3	0	0	0	0	0	Rank 4
	Sub Total	9.38	0.00	0.00	0.00	0.00	0.00	9.38
Build a tower		3	0	0	0	-1	1	Rank 5
	Sub Total	9.38	0.00	0.00	0.00	-0.63	0.00	8.75
Relocate existing tower								Rank N/A
	Sub Total							
Remove trees and shrubs affecting line of sight		1	0	0	0	-2	1	Rank 9
	Sub Total	3.13	0.00	0.00	0.00	-1.25	0.00	1.88
Additional management of noxious and invasive weed species		0	0	0	0	2	0	Rank 10
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	1.25
Remove vegetation from frontal zone		1	1	1	0	-1	1	Rank 6
	Sub Total	3.13	1.56	2.19	0.00	-0.63	0.00	6.25
Reduce dune height by re-profiling		2	2	2	0	-3	3	Rank 3
	Sub Total	6.25	3.13	4.38	0.00	-1.88	0.00	11.88
Build seawall								Rank N/A
	Sub Total							
Management of subspecies of Acacia longifolia		1	0	0	0	1	2	Rank 8
	Sub Total	3.13	0.00	0.00	0.00	0.63	0.00	3.75
Improve beach access ways		0	3	0	0	-1	0	Rank 7
	Sub Total	0.00	4.69	0.00	0.00	-0.63	0.00	4.06
Build a tower and remove vegetation from frontal zone		3	1	1	0	-1	1	Rank 1
	Sub Total	9.38	1.56	2.19	0.00	-0.63	0.00	12.50
Raise level of observation area in SLSC and remove vegetation from frontal zone		3	1	1	0	-1	1	Rank 1
	Sub Total	9.38	1.56	2.19	0.00	-0.63	0.00	12.50

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Corrimal

		Criteria						
		A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	TOTAL
Maintain current management		0	0	0	0	0	0	**Rank 9**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								**Rank N/A**
	Sub Total							
Build a tower								**Rank N/A**
	Sub Total							
Relocate existing tower		3	0	0	0	-1	1	**Rank 4**
	Sub Total	9.38	0.00	0.00	0.00	-0.63	0.00	**8.75**
Remove trees and shrubs affecting line of sight		1	0	0	0	-2	2	**Rank 7**
	Sub Total	3.13	0.00	0.00	0.00	-1.25	0.00	**1.88**
Additional management of noxious and invasive weed species		0	0	0	0	2	0	**Rank 8**
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone		1	2	2	0	-2	2	**Rank 3**
	Sub Total	3.13	3.13	4.38	0.00	-1.25	0.00	**9.38**
Reduce dune height by re-profiling		2	2	2	0	-3	3	**Rank 2**
	Sub Total	6.25	3.13	4.38	0.00	-1.88	0.00	**11.88**
Build seawall								**Rank N/A**
	Sub Total							
Management of subspecies of Acacia longifolia		1	0	0	0	2	2	**Rank 5**
	Sub Total	3.13	0.00	0.00	0.00	1.25	0.00	**4.38**
Improve beach access ways		0	3	0	0	-1	0	**Rank 6**
	Sub Total	0.00	4.69	0.00	0.00	-0.63	0.00	**4.06**
Relocate existing tower and remove vegetation from frontal zone		3	2	2	0	-2	2	**Rank 1**
	Sub Total	9.38	3.13	4.38	0.00	-1.25	0.00	**15.63**

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Towradgi

		Criteria A	Criteria B	Criteria C	Criteria D	Criteria E	Criteria F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	TOTAL
Maintain current management		0	0	0	0	0	0	**Rank 9**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								**Rank N/A**
	Sub Total							
Build a tower		3	0	0	0	-1	1	**Rank 2**
	Sub Total	9.38	0.00	0.00	0.00	-0.63	0.00	**8.75**
Relocate existing tower								**Rank N/A**
	Sub Total							
Remove trees and shrubs affecting line of sight		1	0	0	0	-1	1	**Rank 7**
	Sub Total	3.13	0.00	0.00	0.00	-0.63	0.00	**2.50**
Additional management of noxious and invasive weed species		0	0	0	0	2	0	**Rank 8**
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone		1	2	2	-2	-2	2	**Rank 3**
	Sub Total	3.13	3.13	4.38	-5.00	-1.25	0.00	**4.38**
Reduce dune height by re-profiling		2	2	2	-3	-3	3	**Rank 3**
	Sub Total	6.25	3.13	4.38	-7.50	-1.88	0.00	**4.38**
Build seawall		3	2	-3	-3	-2	2	**Rank**
	Sub Total	9.38	3.13	-6.56	-7.50	-1.25	0.00	**-2.81**
Management of subspecies of Acacia longifolia		1	0	0	0	1	2	**Rank 6**
	Sub Total	3.13	0.00	0.00	0.00	0.63	0.00	**3.75**
Improve beach access ways		0	3	0	0	-1	0	**Rank 5**
	Sub Total	0.00	4.69	0.00	0.00	-0.63	0.00	**4.06**
Build a tower and remove vegetation from frontal zone		3	2	2	-2	-2	2	**Rank 1**
	Sub Total	9.38	3.13	4.38	-5.00	-1.25	0.00	**10.63**

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Fairy Meadow

		Criteria						
		A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	TOTAL
Maintain current management		0	0	0	0	0	0	Rank 11
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC		2	0	0	0	0	0	Rank 5
	Sub Total	6.25	0.00	0.00	0.00	0.00	0.00	**6.25**
Build a tower								Rank N/A
	Sub Total							
Relocate existing tower		3	0	0	0	-1	1	Rank 3
	Sub Total	9.38	0.00	0.00	0.00	-0.63	0.00	**8.75**
Remove trees and shrubs affecting line of sight		1	0	0	0	-2	2	Rank 9
	Sub Total	3.13	0.00	0.00	0.00	-1.25	0.00	**1.88**
Additional management of noxious and invasive weed species		0	0	0	0	2	0	Rank 10
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone		1	1	2	-1	-2	2	Rank 6
	Sub Total	3.13	1.56	4.38	-2.50	-1.25	0.00	**5.31**
Reduce dune height by re-profiling		2	2	2	-1	-3	3	Rank 2
	Sub Total	6.25	3.13	4.38	-2.50	-1.88	0.00	**9.38**
Build seawall		3	2	-3	-3	-2	2	Rank
	Sub Total	9.38	3.13	-6.56	-7.50	-1.25	0.00	**-2.81**
Management of subspecies of Acacia longifolia		1	0	0	0	1	2	Rank 8
	Sub Total	3.13	0.00	0.00	0.00	0.63	0.00	**3.75**
Improve beach access ways		0	3	0	0	-1	0	Rank 7
	Sub Total	0.00	4.69	0.00	0.00	-0.63	0.00	**4.06**
Raise level of observation area in SLSC and remove vegetation from frontal zone		2	1	2	-1	-2	2	Rank 4
	Sub Total	6.25	1.56	4.38	-2.50	-1.25	0.00	**8.44**
Relocate existing tower and remove vegetation from frontal zone		3	1	2	-1	-2	2	Rank 1
	Sub Total	9.38	1.56	4.38	-2.50	-1.25	0.00	**11.56**

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

North Wollongong

		Criteria						
		A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	
								TOTAL
Maintain current management		0	0	0	0	0	0	Rank 1
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								Rank N/A
	Sub Total							
Build a tower								Rank N/A
	Sub Total							
Relocate existing tower								Rank N/A
	Sub Total							
Remove trees and shrubs affecting line of sight								Rank N/A
	Sub Total							
Additional management of noxious and invasive weed species								Rank N/A
	Sub Total							
Remove vegetation from frontal zone								Rank N/A
	Sub Total							
Reduce dune height by re-profiling								Rank N/A
	Sub Total							
Build seawall								Rank N/A
	Sub Total							
Management of subspecies of Acacia longifolia								Rank N/A
	Sub Total							
Improve beach access ways								Rank N/A
	Sub Total							

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

City

		A	B	C	D	E	F	
		Criteria						
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	**TOTAL**
Maintain current management		0	0	0	0	0	0	**Rank 8**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								**Rank N/A**
	Sub Total							
Build a tower		2	0	0	0	-1	1	**Rank 2**
	Sub Total	6.25	0.00	0.00	0.00	-0.63	0.00	**5.63**
Relocate existing tower								**Rank N/A**
	Sub Total							
Remove trees and shrubs affecting line of sight								**Rank N/A**
	Sub Total							
Additional management of noxious and invasive weed species		0	0	0	0	2	0	**Rank 7**
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone		1	2	2	-3	-2	2	**Rank 6**
	Sub Total	3.13	3.13	4.38	-7.50	-1.25	0.00	**1.88**
Reduce dune height by re-profiling		2	3	2	-3	-3	3	**Rank 1**
	Sub Total	6.25	4.69	4.38	-7.50	-1.88	0.00	**5.94**
Build seawall		3	2	-3	-3	-3	2	**Rank**
	Sub Total	9.38	3.13	-6.56	-7.50	-1.88	0.00	**-3.44**
Management of subspecies of Acacia longifolia		1	0	0	0	1	2	**Rank 5**
	Sub Total	3.13	0.00	0.00	0.00	0.63	0.00	**3.75**
Improve beach access ways		0	3	0	0	-1	1	**Rank 4**
	Sub Total	0.00	4.69	0.00	0.00	-0.63	0.00	**4.06**
Build a tower and remove vegetation from frontal zone		2	2	2	-3	-2	2	**Rank 3**
	Sub Total	6.25	3.13	4.38	-7.50	-1.25	0.00	**5.00**

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Port Kembla

This assessment has assumed patrol is from Clubhouse and not tower near pool

		Criteria A	B	C	D	E	F	
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	**TOTAL**
Maintain current management		0	0	0	0	0	0	**Rank 9**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								**Rank N/A**
	Sub Total							
Build a tower		3	0	0	0	-1	1	**Rank 3**
	Sub Total	9.38	0.00	0.00	0.00	-0.63	0.00	**8.75**
Relocate existing tower								**Rank N/A**
	Sub Total							
Remove trees and shrubs affecting line of sight		1	0	0	0	-2	2	**Rank 7**
	Sub Total	3.13	0.00	0.00	0.00	-1.25	0.00	**1.88**
Additional management of noxious and invasive weed species		0	0	0	0	2	0	**Rank 8**
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone		0	1	1	0	-1	2	**Rank 6**
	Sub Total	0.00	1.56	2.19	0.00	-0.63	0.00	**3.13**
Reduce dune height by re-profiling		2	2	2	0	-3	3	**Rank 2**
	Sub Total	6.25	3.13	4.38	0.00	-1.88	0.00	**11.88**
Build seawall		3	2	-3	-3	-2	2	**Rank**
	Sub Total	9.38	3.13	-6.56	-7.50	-1.25	0.00	**-2.81**
Management of subspecies of Acacia longifolia		1	0	0	0	1	2	**Rank 5**
	Sub Total	3.13	0.00	0.00	0.00	0.63	0.00	**3.75**
Improve beach access ways		0	3	0	0	-1	1	**Rank 4**
	Sub Total	0.00	4.69	0.00	0.00	-0.63	0.00	**4.06**
Build a tower and remove vegetation from frontal zone		3	1	1	0	-1	2	**Rank 1**
	Sub Total	9.38	1.56	2.19	0.00	-0.63	0.00	**12.50**

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

Management Options Assessment for Dune Management - Evaluation Matrix

Windang

		A	B	C	D	E	F	
		Criteria						
		Sight line	Beach access	Recreational amenity	Coastal hazards impacts	Ecology	Pests and vermin	
		3.13	1.56	2.19	2.50	0.63	0.00	**TOTAL**
Maintain current management		0	0	0	0	0	0	**Rank 3**
	Sub Total	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Raise level of observation area in SLSC								**Rank N/A**
	Sub Total							
Build a tower								**Rank N/A**
	Sub Total							
Relocate existing tower								**Rank N/A**
	Sub Total							
Remove trees and shrubs affecting line of sight								**Rank N/A**
	Sub Total							
Additional management of noxious and invasive weed species		0	0	0	0	2	1	**Rank 2**
	Sub Total	0.00	0.00	0.00	0.00	1.25	0.00	**1.25**
Remove vegetation from frontal zone								**Rank N/A**
	Sub Total							
Reduce dune height by re-profiling								**Rank N/A**
	Sub Total							
Build seawall								**Rank N/A**
	Sub Total							
Management of subspecies of Acacia longifolia		1	0	0	0	1	2	**Rank 1**
	Sub Total	3.13	0.00	0.00	0.00	0.63	0.00	**3.75**
Improve beach access ways								**Rank N/A**
	Sub Total							

Note - Management Options with negative scores were discarded as they indicate actions worse than the current management actions

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Appendix Q – Wollongong coastal erosion emergency action sub plan

Prepared by BMT WBM Pty Ltd January 2012

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Wollongong Coastal Erosion Emergency Action Sub Plan

January 2012

Offices

Brisbane
Denver
Mackay
Melbourne
Newcastle
Perth
Sydney
Vancouver

Prepared For:	Wollongong City Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Title:	Wollongong Coastal Erosion Emergency Action Sub Plan
Author :	Doug Lord (Coastal Environment Pty Ltd)
Synopsis :	This Wollongong Coastal Erosion Emergency Action Sub Plan forms an Appendix to the Wollongong Coastal Zone Management Study and Plan. This sub-plan outlines actions to be performed before, during and after an erosion emergency and the roles and responsibilities for coastal erosion emergencies.

REVISION/CHECKING HISTORY

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DISTRIBUTION

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ACRONYMS

CEEAS	Coastal Erosion Emergency Action Sub-plan
CPA	Coastal Protection Act (1979)
DECCW	Department of Environment Climate Change and Water (former department, now OEH)
LEMC	Local Emergency Management Committee
LEOCON	Local Emergency Operations Controller
OEH	Office of Environment and Heritage
SERM	State Emergency and Rescue Management
SERMA	State Emergency and Rescue Management Act
WCC	Wollongong City Council

1 INTRODUCTION

1.1 Coastal Zone Management Planning

The process for managing coastal hazards and coastal risks along the New South Wales coast is through the preparation of Coastal Zone Management Plans. Through the development and subsequent implementation of these plans, the coastal hazards are identified and, as appropriate, the risks are addressed through a range of planning and protection measures. In this way the likelihood of emergencies resulting from erosion during storm events is minimised. The need for unplanned protection is reduced and the risk to life and property managed. The residual risk to properties, assets and life until such time as the key elements of the plan have been adopted or as a result of potential unforeseen outcomes or storm severity are covered by this Coastal Erosion Emergency Action Subplan (CEEAS).

The CEEAS is a required component of the preparation of a Coastal Zone Management Plan (CZMP) as set out in the NSW *Coastal Protection Act 1979* (the CPA). Section 55C(1)(b) of the CPA states a CZMP must provide for *'emergency actions carried out during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event'.* Section 4 of the CPA states that the part of a CZMP that deals with the matters specified in Section 55C(1)(b) is an emergency action sub plan (OEH 2011, page 1).

1.2 The Role of the Coastal Erosion Emergency Action Sub-plan

"The emergency action sub-plan forms an integral component of a CZMP. It outlines a council's intended response to a coastal erosion emergency and explains ways in which and where beachfront property owners can place emergency coastal protection works according to the Coastal Protection Act 1979 (CPA)" (OEH 2011, page 1).

*"Section 55C(2)(a) of the CPA requires that CZMPs **must not** include matters dealt with in any plan made under the State Emergency and Rescue Management Act 1989 (SERMA) in relation to emergency responses.*

The roles and responsibilities of government agencies, councils and other relevant organisations during severe storm events (including events that cause erosion) are detailed in the NSW State Storm Plan (SES 2007)" (OEH 2011, page 1).

1.3 Extent of the Coastal Erosion Emergency Action Sub-plan

The OEH Guide (2011) advises that *"The minimum area to be covered by an emergency action sub-plan would be either:*

- *any area defined by a direction from the Minister according to Section 55B of the CPA; or*
- *all beachfront margins where erosion is likely to threaten public and private infrastructure or assets.*

The sub-plan may also cover areas of the coastline accessed or utilised by the general public where there is an identified threat posed by erosion, e.g. walking tracks through coastal parkland."

No direction has been issued under Section 55B for the Wollongong Local Government Area (LGA) coastal zone. The extent of this CEEAS is, therefore defined as the coastal margins of the ocean beaches and headlands within the city boundaries, extending from the Royal National Park at Stanwell Park in the North to the Lake Illawarra entrance in the south (excluding the Port Kembla Harbour foreshores).

1.4 Minimum Requirements for Emergency Action Sub-plans

The CEEAS must be consistent with and not duplicate or contradict any plans prepared under the *State Emergency and Rescue Management Act 1989* (SERM Act). The relationship between these two planning frameworks is indicated in Table 1 which has been adapted from OEH, 2011 (page 14).

Table 1 Contents of CEEAS and SERM Act plans (adapted from OEH, 2011)

Emergency Action Sub Plans	SERM Act Plans
Any coastal protection works or other actions to be carried out by council when coastal erosion is imminent or occurring, or in recovering from coastal erosion.	Actions in relation to the prevention of, preparation for, response to and recovery from emergencies, excluding permanent or temporary coastal protection works.
Any additional requirements for landowner placement of emergency coastal protection works beyond those in the *Coastal Protection Act 1979* (e.g. constraints on access and the location of works) *	Actions are consistent with the NSW State Disaster Plan and the State Storm Sub Plan.

** No locations for emergency coastal protection works in accordance with the CPA 1979 have been identified in the Wollongong LGA coastal zone.*

Where landowners are eligible to place emergency coastal protection works, the CEEAS is to be prepared with direct consultation with landowners affected by the subplan. In the Wollongong LGA coastal zone at present there are no private properties identified as eligible to place emergency coastal protection works in accordance with the CPA 1979 (Part 4C). Therefore, this requirement is not currently applicable.

The minimum requirements for a Coastal Erosion Emergency Action Subplan are set out in the NSW Government Guideline (OEH, 2011) which reflects the requirements expressed in the CPA 1979. These are:

- describing intended emergency actions to be carried out during periods of beach erosion, such as coastal protection works for property or asset protection, other than matters dealt with in any plan made under the *State Emergency and Rescue Management Act 1989* relating to emergency response (sections 55C(1)(b) and (g) of the CPA *1979*)
- describing any site-specific requirements for landowner emergency coastal protection works
- describing the consultation carried out with the owners of land affected by a subplan.

2 EMERGENCY PLANNING HIERARCHY

2.1 Declared Storm Emergency

There is a clear hierarchy in planning and responsibility that applies to emergency management in NSW, including those emergencies resulting from a defined storm or disaster. In these events, the NSW State Emergency Services are designated as the lead combat agency and are in charge of the emergency response. The various roles and responsibilities are defined in the NSW Storm Plan and within the City of Wollongong Local Disaster Plan (DISPLAN). The DISPLAN states at paragraphs 114 and 115 that:

"***114*** *Subject to the requirements and provisions of the SERM Act, and under the provisions of the SES Act, for the emergencies of flood and damage control for storms, including the coordination of evacuation and welfare of affected communities, the overall control of operations in response to these emergencies is vested in the Director General of the State Emergency Service.*

115 *In both flood or storm emergencies, the DISPLAN for the District and/or any Local Area to which the emergency applies is automatically active and Police, the other Emergency Services and Functional Areas are to provide support as required by the Combat Agency Controller. The Local or District Emergency Operations Controller is then to be prepared to coordinate support if requested by the appointed Local/Division State Emergency Service Controller.*"

Therefore, the Wollongong DISPLAN informs this Coastal Erosion Emergency Action Sub-plan.

The role of Council in a storm emergency is limited to those activities that may be requested by the SES to assist with the emergency relief or to activities (including protection works) undertaken by the Council to protect assets under Council control. Where any proposed protection works require development approval, Council must only undertake such works during an emergency where the consent has been obtained in advance. Where the works are exempt (such as minor works or emergency works to protect a road or stormwater system under SEPP (Infrastructure) 2007) Council must first undertake an assessment to determine that the works will not result in a significant adverse environmental impact. Before undertaking any works, Council must also confirm that the works proposed are in accordance with the currently gazetted (or adopted) Coastal Zone Management Plan.

There are no protection works proposed for emergency management purposes under this CEEAS that require development consent.

Following the emergency, Council is involved in the remediation of damage or hazards and the reinstatement of the dunes, beaches and accessways in an appropriate and safe manner. This will include works of varying priorities and timeframes in accordance with usual Council maintenance procedures.

2.2 Coastal Erosion Emergency (not triggered by a storm)

Where the erosion emergency arises from events other than a declared storm event, then the requirement of the State Storm Plan and Wollongong DISPLAN are not activated. Such an event could arise for example from a period of high tides and large swell, resulting in substantial erosion to the back of the beach. For these conditions it is likely that the erosion resulting would be substantially less than that which would result from the design storm event (unless such an event was to occur immediately following a severe storm event).

It is not possible to determine a trigger event for such an occurrence. Therefore, the determination to invoke the this emergency sub-plan (in this case by Council) would need to be based on monitoring of the beach state. In such a case, the CEEAS would be implemented following a request from the designated Council Officer.

2.3 Assets and Development at Threat

The extent of coastal hazards within the Wollongong LGA coastal zone is defined in the Wollongong City Council Coastal Zone Study (Cardno, 2010). This study maps the landward extent of erosion hazards that may be anticipated for various planning timeframes. Specifically, the landward extent of erosion hazards at present are defined in Maps included in the Wollongong Coastal Zone Study (Cardno, 2010) at Figures 8.5 to 8.13 and form the basis for defining the extent of the erosion hazard at present.

Within the Wollongong LGA coastal zone the extent of storm erosion resulting from a severe design storm event at present is mainly restricted to the sandy beach area with little public infrastructure or private property likely to be affected. Significant encroachments of the storm erosion extent threatening existing development are limited to the following locations:

- the parking area and ramp at Austinmer Boat Harbour (Cardno, 2010 Fig 8.5);
- the seaward portion of the Tuckerman Park carpark at Austinmer North (Cardno, 2010 Fig 8.6); and
- Thirroul Beach carpark and promenade (Cardno, 2010 Fig 8.7).

At each of these locations the development likely to be impacted is protected by a seawall of unknown design. The potential encroachment of the erosion into these paved areas was calculated on the basis that the seawall at present offered no protection to beach erosion.

In addition to these specific developments there are different types of activities, development and areas that may be impacted during an erosion emergency. These include:

- stormwater and drainage outlet structures located on beaches;
- ocean baths and rock pools;
- defined beach and dune access tracks under care and control of Council; and
- the beaches and dunes.

These exist within an area of known high hazard and are either designed to accommodate the erosion events (such as the stormwater outlets and pools), or are temporarily affected by erosion, limiting their use by the community (such as beaches and accessways). In each case the opportunity to protect the asset prior to an erosion event is low and the risk to life during an event is low. Similarly, the opportunity to undertake emergency works during an event is low and the preferred approach is to identify impacts, assess and repair the asset following the event. In most instances this becomes a routine maintenance role.

The landward extent of the erosion hazard as considered in this CEEAS may increase into the future as sea level rises. The impacts on the future revisions of the CEEAS should take this into account at each plan review.

3 EMERGENCY RESPONSES

3.1 Communication

3.1.1 Storm Emergency

Where coastal erosion is anticipated as a result of a declared storm emergency, the responsibility for communicating the potential hazards defaults to the SES and the Local Emergency Operations Controller (LEOCON). Activation of the Wollongong DISPLAN would trigger this CEEAS. Council would assist in the provision of information on the current state of beaches and ocean pools as well as potential for impacts on beach access. Internally, Council staff with relevant responsibilities should be placed on standby and commence monitoring the impacts. Council employed Lifeguards and local Surf Life Saving Clubs should be contacted with a view to closure of beaches and ocean pools.

As the emergency progresses Council is required to continue monitoring these areas and updating information through the LEOCON as appropriate. Where specific hazards are resulting in damage, Council will provide this information to the LEOCON and for distribution through the media or directly to community as appropriate.

Following the emergency, Council is responsible for advising the current state of beaches and pools in the Council area (when/if they are re-opened for the public). Where residual hazards remain to be addressed, Council should take appropriate action to convey this to local communities including the use of signage and the release of media bulletins.

3.1.2 Non Storm Erosion Emergency

Where the emergency does not trigger the State Storm Plan or Wollongong DISPLAN, Council is responsible for initially monitoring the potential progress of erosion and subsequently implementing this CEEAS. The roles and responsibilities of Council in communicating the emergency to the community remain the same except that information needs to be provided by Council directly through the media rather than through the LEOCON as outlined in Section 3.1.1 above.

3.2 Landowner Initiated Actions

There are no locations in the Wollongong LGA coastal zone at which temporary emergency coastal protection works (CPA 1979, Part 4c Sand/Sandbags ECPW) are permitted. This includes properties within the immediate erosion hazard line in the LGA, such as at Thirroul Beach. Temporary emergency coastal protection works are only permitted under the CPA 1979 at locations listed in Schedule 1 of that act, none of which exist in Wollongong LGA.

Property owners, such as those at locations within the immediate erosion hazard line, are permitted to submit development applications to install permanent protection works, provided such works are consistent with the Wollongong CZMP once it is certified.

Where property owners wish to install permanent protection works (either prior to or during a coastal erosion emergency):

- they must submit a development application for the works,

- they must have a valid approval, and
- they must comply with all conditions of consent applying to that approval, before proceeding with the works.

Any illegal works placed by a property owner may result in prosecution of the person and removal of the works.

A property owner may be able to undertake minor works to minimise damage to their property and/or dwelling where such works do not require development approval and do not result in adverse impacts. The types of things permitted without consent are unlikely to provide significant protection from any coastal erosion that is occurring but may limit consequent damage, for example: Sealing of the space at the bottom of a doorway to limit water entry, repair/replacement of damaged windows, cladding or roofing, clearing of drains, pumping of ponded water, removal of objects from proximity to an escarpment (such as fences, sheds, furniture), etc.

The owner of a property has the right to undertake a wide variety of activities/maintenance in relation to their property which may or may not result from damage during a storm event and which, generally are of a minor nature. As with all activities there is a common law obligation not to cause a nuisance to neighbours or damage to adjacent properties. Generally those works resulting in structural alterations to a building (de including demolition or removal), or significant construction (such as a retaining wall or underpinning a structure) or significant earthworks (excavation or placement of fill) would require prior development/building approval.

3.3 Council Actions Prior to a Coastal Erosion Emergency

- Where the likelihood of an emergency event is identified (e.g. Storm warnings or damaging wave warnings from the SES/BOM), the local Lifeguards (employed by Council) will inform the local Surf Life Saving Clubs. The Council Lifeguards and / or the local SLSCs will then take the appropriate action in terms of closing the beaches and/or ocean pools.
- Where difficulties/damage are known to exist on beach accessways and these are likely to be exacerbated by storm erosion, then Council at their discretion may close those walkways and place appropriate signage.
- Council will commence monitoring the effects of the erosion on assets and development potentially at threat (section 5).
- As appropriate, the Council CEEAS controller will initiate the CEEAS.

3.4 Council Actions During a Coastal Erosion Emergency

The following activities would be undertaken by Council during the emergency:

- Council activities during a coastal erosion emergency will be guided by issues relating to the safety of Council staff.

- Where damage to walkways is identified and/or reported to Council, as practical Council will take appropriate action to close off the accessways and/or advise the local community of the hazards at the first opportunity.
- Where damage to assets is identified through monitoring (Section 5), Council will assess the damage and any opportunities for limiting further damage that may be appropriate during the event.
- Where repairs are permissible (as outlined in Section 2.1) and may be readily and safely undertaken, this will be done at the first opportunity.
- At the appropriate time the CEEAS controller will determine that the emergency has passed and that the remediation stages of the plan are to commence.

3.5 Council Actions Following the Cessation of a Coastal Erosion Emergency

The following activities would be undertaken by Council following the emergency, within their usual maintenance programs.

- Following the erosion emergency, Council will undertake an inspection of all beach accessways to establish any damage to the access or dangers to the public in using the access to the beach.
- Where an accessway is considered unsafe, action will be taken to close the access (top and/or bottom) and to place appropriate signage warning the access is unsafe for use.
- Council will prioritise the work required to repair and reopen any damaged or unsafe accessways in accordance with the Council maintenance works schedule.
- Where an erosion escarpment has been created at the back of the beach (height greater than 1.5m), Council will document the extent of the escarpment and at the earliest opportunity undertake a risk assessment of the likely hazard to beach users (both to persons on the beach and to persons on the dune above the scarp) from collapse of the erosion scarp.
- Where the risk is deemed unacceptable, Council will at the earliest opportunity undertake appropriate mitigation works which may include:
    - regrading the escarpment to a stable slope (following approval from Council's environment division);
    - fencing and signposting escarpments, to discourage public access (top and/or bottom) until such time as the beach recovers naturally; and
    - keeping the beach closed until such time as the risk has reduced to an acceptable level.
- At the appropriate time the Council CEEAS controller will declare the emergency has finished and the CEEAS is no longer operative.

4 RESPONSIBILITIES

Specific responsibilities under the CEEAS are tabulated in Table 2.

Council through the nominated CEEAS controller must tabulate relevant Council positions and responsibilities for implementation and execution of the CEEAS. This will require an up to date list (names and contact numbers) for relevant contacts to be maintained by Council and updated as positions or responsibilities change. This list is to be readily available within Council and communicated to each of the nominated contact persons following any update.

Table 2 Specific Responsibilities in implementation of the CEEAS

Position	Responsibilities
Local Emergency Operations Controller (LEOCON)	Execution of the Local DISPLAN, including aspects relating to coastal erosion
Council CEEAS controller	Liaison with LEOCON during storm emergency. Implementation of the CEEAS during non-storm erosion emergency
Council Recreation Services Manager	Monitoring repair of beaches and dunes. Closure of Beaches and ocean pools as appropriate. Post storm remediation.
Council Media Liaison Officer	Distribution of warnings and closures via the media.

5 PLAN REVIEW

This coastal erosion emergency management plan should be maintained as required and reviewed at intervals not exceeding 5 years from its initial adoption. Earlier review may be triggered by:

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Wollongong Coastal Erosion Emergency Action Sub Plan

January 2012

Prepared For:	Wollongong City Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Title:	Wollongong Coastal Erosion Emergency Action Sub Plan
Author :	Doug Lord (Coastal Environment Pty Ltd)
Synopsis :	This Wollongong Coastal Erosion Emergency Action Sub Plan forms an Appendix to the Wollongong Coastal Zone Management Study and Plan. This sub-plan outlines actions to be performed before, during and after an erosion emergency and the roles and responsibilities for coastal erosion emergencies.

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ACRONYMS

CEEAS	Coastal Erosion Emergency Action Sub-plan
CPA	Coastal Protection Act (1979)
DECCW	Department of Environment Climate Change and Water (former department, now OEH)
LEMC	Local Emergency Management Committee
LEOCON	Local Emergency Operations Controller
OEH	Office of Environment and Heritage
SERM	State Emergency and Rescue Management
SERMA	State Emergency and Rescue Management Act
WCC	Wollongong City Council

1 INTRODUCTION

1.1 Coastal Zone Management Planning

The process for managing coastal hazards and coastal risks along the New South Wales coast is through the preparation of Coastal Zone Management Plans. Through the development and subsequent implementation of these plans, the coastal hazards are identified and, as appropriate, the risks are addressed through a range of planning and protection measures. In this way the likelihood of emergencies resulting from erosion during storm events is minimised. The need for unplanned protection is reduced and the risk to life and property managed. The residual risk to properties, assets and life until such time as the key elements of the plan have been adopted or as a result of potential unforeseen outcomes or storm severity are covered by this Coastal Erosion Emergency Action Subplan (CEEAS).

The CEEAS is a required component of the preparation of a Coastal Zone Management Plan (CZMP) as set out in the NSW *Coastal Protection Act 1979* (the CPA). Section 55C(1)(b) of the CPA states a CZMP must provide for *'emergency actions carried out during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event'.* Section 4 of the CPA states that the part of a CZMP that deals with the matters specified in Section 55C(1)(b) is an emergency action sub plan (OEH 2011, page 1).

1.2 The Role of the Coastal Erosion Emergency Action Sub-plan

"The emergency action sub-plan forms an integral component of a CZMP. It outlines a council's intended response to a coastal erosion emergency and explains ways in which and where beachfront property owners can place emergency coastal protection works according to the Coastal Protection Act 1979 (CPA)" (OEH 2011, page 1).

"Section 55C(2)(a) of the CPA requires that CZMPs ***must not*** *include matters dealt with in any plan made under the State Emergency and Rescue Management Act 1989 (SERMA) in relation to emergency responses.*

The roles and responsibilities of government agencies, councils and other relevant organisations during severe storm events (including events that cause erosion) are detailed in the NSW State Storm Plan (SES 2007)" (OEH 2011, page 1).

1.3 Extent of the Coastal Erosion Emergency Action Sub-plan

The OEH Guide (2011) advises that *"The minimum area to be covered by an emergency action sub-plan would be either:*

- *any area defined by a direction from the Minister according to Section 55B of the CPA; or*
- *all beachfront margins where erosion is likely to threaten public and private infrastructure or assets.*

The sub-plan may also cover areas of the coastline accessed or utilised by the general public where there is an identified threat posed by erosion, e.g. walking tracks through coastal parkland."

No direction has been issued under Section 55B for the Wollongong Local Government Area (LGA) coastal zone. The extent of this CEEAS is, therefore defined as the coastal margins of the ocean beaches and headlands within the city boundaries, extending from the Royal National Park at Stanwell Park in the North to the Lake Illawarra entrance in the south (excluding the Port Kembla Harbour foreshores).

1.4 Minimum Requirements for Emergency Action Sub-plans

The CEEAS must be consistent with and not duplicate or contradict any plans prepared under the *State Emergency and Rescue Management Act 1989* (SERM Act). The relationship between these two planning frameworks is indicated in Table 1 which has been adapted from OEH, 2011 (page 14).

Table 1 Contents of CEEAS and SERM Act plans (adapted from OEH, 2011)

Emergency Action Sub Plans	SERM Act Plans
Any coastal protection works or other actions to be carried out by council when coastal erosion is imminent or occurring, or in recovering from coastal erosion.	Actions in relation to the prevention of, preparation for, response to and recovery from emergencies, excluding permanent or temporary coastal protection works.
Any additional requirements for landowner placement of emergency coastal protection works beyond those in the *Coastal Protection Act 1979* (e.g. constraints on access and the location of works) *	Actions are consistent with the NSW State Disaster Plan and the State Storm Sub Plan.

** No locations for emergency coastal protection works in accordance with the CPA 1979 have been identified in the Wollongong LGA coastal zone.*

Where landowners are eligible to place emergency coastal protection works, the CEEAS is to be prepared with direct consultation with landowners affected by the subplan. In the Wollongong LGA coastal zone at present there are no private properties identified as eligible to place emergency coastal protection works in accordance with the CPA 1979 (Part 4C). Therefore, this requirement is not currently applicable.

The minimum requirements for a Coastal Erosion Emergency Action Subplan are set out in the NSW Government Guideline (OEH, 2011) which reflects the requirements expressed in the CPA 1979. These are:

- describing intended emergency actions to be carried out during periods of beach erosion, such as coastal protection works for property or asset protection, other than matters dealt with in any plan made under the *State Emergency and Rescue Management Act 1989* relating to emergency response (sections 55C(1)(b) and (g) of the CPA *1979*)
- describing any site-specific requirements for landowner emergency coastal protection works
- describing the consultation carried out with the owners of land affected by a subplan.

2 EMERGENCY PLANNING HIERARCHY

2.1 Declared Storm Emergency

There is a clear hierarchy in planning and responsibility that applies to emergency management in NSW, including those emergencies resulting from a defined storm or disaster. In these events, the NSW State Emergency Services are designated as the lead combat agency and are in charge of the emergency response. The various roles and responsibilities are defined in the NSW Storm Plan and within the City of Wollongong Local Disaster Plan (DISPLAN). The DISPLAN states at paragraphs 114 and 115 that:

"***114*** *Subject to the requirements and provisions of the SERM Act, and under the provisions of the SES Act, for the emergencies of flood and damage control for storms, including the coordination of evacuation and welfare of affected communities, the overall control of operations in response to these emergencies is vested in the Director General of the State Emergency Service.*

115 *In both flood or storm emergencies, the DISPLAN for the District and/or any Local Area to which the emergency applies is automatically active and Police, the other Emergency Services and Functional Areas are to provide support as required by the Combat Agency Controller. The Local or District Emergency Operations Controller is then to be prepared to coordinate support if requested by the appointed Local/Division State Emergency Service Controller.*"

Therefore, the Wollongong DISPLAN informs this Coastal Erosion Emergency Action Sub-plan.

The role of Council in a storm emergency is limited to those activities that may be requested by the SES to assist with the emergency relief or to activities (including protection works) undertaken by the Council to protect assets under Council control. Where any proposed protection works require development approval, Council must only undertake such works during an emergency where the consent has been obtained in advance. Where the works are exempt (such as minor works or emergency works to protect a road or stormwater system under SEPP (Infrastructure) 2007) Council must first undertake an assessment to determine that the works will not result in a significant adverse environmental impact. Before undertaking any works, Council must also confirm that the works proposed are in accordance with the currently gazetted (or adopted) Coastal Zone Management Plan.

There are no protection works proposed for emergency management purposes under this CEEAS that require development consent.

Following the emergency, Council is involved in the remediation of damage or hazards and the reinstatement of the dunes, beaches and accessways in an appropriate and safe manner. This will include works of varying priorities and timeframes in accordance with usual Council maintenance procedures.

2.2 Coastal Erosion Emergency (not triggered by a storm)

Where the erosion emergency arises from events other than a declared storm event, then the requirement of the State Storm Plan and Wollongong DISPLAN are not activated. Such an event could arise for example from a period of high tides and large swell, resulting in substantial erosion to the back of the beach. For these conditions it is likely that the erosion resulting would be substantially less than that which would result from the design storm event (unless such an event was to occur immediately following a severe storm event).

It is not possible to determine a trigger event for such an occurrence. Therefore, the determination to invoke the this emergency sub-plan (in this case by Council) would need to be based on monitoring of the beach state. In such a case, the CEEAS would be implemented following a request from the designated Council Officer.

2.3 Assets and Development at Threat

The extent of coastal hazards within the Wollongong LGA coastal zone is defined in the Wollongong City Council Coastal Zone Study (Cardno, 2010). This study maps the landward extent of erosion hazards that may be anticipated for various planning timeframes. Specifically, the landward extent of erosion hazards at present are defined in Maps included in the Wollongong Coastal Zone Study (Cardno, 2010) at Figures 8.5 to 8.13 and form the basis for defining the extent of the erosion hazard at present.

Within the Wollongong LGA coastal zone the extent of storm erosion resulting from a severe design storm event at present is mainly restricted to the sandy beach area with little public infrastructure or private property likely to be affected. Significant encroachments of the storm erosion extent threatening existing development are limited to the following locations:

- the parking area and ramp at Austinmer Boat Harbour (Cardno, 2010 Fig 8.5);
- the seaward portion of the Tuckerman Park carpark at Austinmer North (Cardno, 2010 Fig 8.6); and
- Thirroul Beach carpark and promenade (Cardno, 2010 Fig 8.7).

At each of these locations the development likely to be impacted is protected by a seawall of unknown design. The potential encroachment of the erosion into these paved areas was calculated on the basis that the seawall at present offered no protection to beach erosion.

In addition to these specific developments there are different types of activities, development and areas that may be impacted during an erosion emergency. These include:

- stormwater and drainage outlet structures located on beaches;
- ocean baths and rock pools;
- defined beach and dune access tracks under care and control of Council; and
- the beaches and dunes.

These exist within an area of known high hazard and are either designed to accommodate the erosion events (such as the stormwater outlets and pools), or are temporarily affected by erosion, limiting their use by the community (such as beaches and accessways). In each case the opportunity to protect the asset prior to an erosion event is low and the risk to life during an event is low. Similarly, the opportunity to undertake emergency works during an event is low and the preferred approach is to identify impacts, assess and repair the asset following the event. In most instances this becomes a routine maintenance role.

The landward extent of the erosion hazard as considered in this CEEAS may increase into the future as sea level rises. The impacts on the future revisions of the CEEAS should take this into account at each plan review.

3 EMERGENCY RESPONSES

3.1 Communication

3.1.1 Storm Emergency

Where coastal erosion is anticipated as a result of a declared storm emergency, the responsibility for communicating the potential hazards defaults to the SES and the Local Emergency Operations Controller (LEOCON). Activation of the Wollongong DISPLAN would trigger this CEEAS. Council would assist in the provision of information on the current state of beaches and ocean pools as well as potential for impacts on beach access. Internally, Council staff with relevant responsibilities should be placed on standby and commence monitoring the impacts. Council employed Lifeguards and local Surf Life Saving Clubs should be contacted with a view to closure of beaches and ocean pools.

As the emergency progresses Council is required to continue monitoring these areas and updating information through the LEOCON as appropriate. Where specific hazards are resulting in damage, Council will provide this information to the LEOCON and for distribution through the media or directly to community as appropriate.

Following the emergency, Council is responsible for advising the current state of beaches and pools in the Council area (when/if they are re-opened for the public). Where residual hazards remain to be addressed, Council should take appropriate action to convey this to local communities including the use of signage and the release of media bulletins.

3.1.2 Non Storm Erosion Emergency

Where the emergency does not trigger the State Storm Plan or Wollongong DISPLAN, Council is responsible for initially monitoring the potential progress of erosion and subsequently implementing this CEEAS. The roles and responsibilities of Council in communicating the emergency to the community remain the same except that information needs to be provided by Council directly through the media rather than through the LEOCON as outlined in Section 3.1.1 above.

3.2 Landowner Initiated Actions

There are no locations in the Wollongong LGA coastal zone at which temporary emergency coastal protection works (CPA 1979, Part 4c Sand/Sandbags ECPW) are permitted. This includes properties within the immediate erosion hazard line in the LGA, such as at Thirroul Beach. Temporary emergency coastal protection works are only permitted under the CPA 1979 at locations listed in Schedule 1 of that act, none of which exist in Wollongong LGA.

Property owners, such as those at locations within the immediate erosion hazard line, are permitted to submit development applications to install permanent protection works, provided such works are consistent with the Wollongong CZMP once it is certified.

Where property owners wish to install permanent protection works (either prior to or during a coastal erosion emergency):

- they must submit a development application for the works,

- they must have a valid approval, and
- they must comply with all conditions of consent applying to that approval, before proceeding with the works.

Any illegal works placed by a property owner may result in prosecution of the person and removal of the works.

A property owner may be able to undertake minor works to minimise damage to their property and/or dwelling where such works do not require development approval and do not result in adverse impacts. The types of things permitted without consent are unlikely to provide significant protection from any coastal erosion that is occurring but may limit consequent damage, for example: Sealing of the space at the bottom of a doorway to limit water entry, repair/replacement of damaged windows, cladding or roofing, clearing of drains, pumping of ponded water, removal of objects from proximity to an escarpment (such as fences, sheds, furniture), etc.

The owner of a property has the right to undertake a wide variety of activities/maintenance in relation to their property which may or may not result from damage during a storm event and which, generally are of a minor nature. As with all activities there is a common law obligation not to cause a nuisance to neighbours or damage to adjacent properties. Generally those works resulting in structural alterations to a building (de including demolition or removal), or significant construction (such as a retaining wall or underpinning a structure) or significant earthworks (excavation or placement of fill) would require prior development/building approval.

3.3 Council Actions Prior to a Coastal Erosion Emergency

- Where the likelihood of an emergency event is identified (e.g. Storm warnings or damaging wave warnings from the SES/BOM), the local Lifeguards (employed by Council) will inform the local Surf Life Saving Clubs. The Council Lifeguards and / or the local SLSCs will then take the appropriate action in terms of closing the beaches and/or ocean pools.
- Where difficulties/damage are known to exist on beach accessways and these are likely to be exacerbated by storm erosion, then Council at their discretion may close those walkways and place appropriate signage.
- Council will commence monitoring the effects of the erosion on assets and development potentially at threat (section 5).
- As appropriate, the Council CEEAS controller will initiate the CEEAS.

3.4 Council Actions During a Coastal Erosion Emergency

The following activities would be undertaken by Council during the emergency:

- Council activities during a coastal erosion emergency will be guided by issues relating to the safety of Council staff.

- Where damage to walkways is identified and/or reported to Council, as practical Council will take appropriate action to close off the accessways and/or advise the local community of the hazards at the first opportunity.
- Where damage to assets is identified through monitoring (Section 5), Council will assess the damage and any opportunities for limiting further damage that may be appropriate during the event.
- Where repairs are permissible (as outlined in Section 2.1) and may be readily and safely undertaken, this will be done at the first opportunity.
- At the appropriate time the CEEAS controller will determine that the emergency has passed and that the remediation stages of the plan are to commence.

3.5 Council Actions Following the Cessation of a Coastal Erosion Emergency

The following activities would be undertaken by Council following the emergency, within their usual maintenance programs.

- Following the erosion emergency, Council will undertake an inspection of all beach accessways to establish any damage to the access or dangers to the public in using the access to the beach.
- Where an accessway is considered unsafe, action will be taken to close the access (top and/or bottom) and to place appropriate signage warning the access is unsafe for use.
- Council will prioritise the work required to repair and reopen any damaged or unsafe accessways in accordance with the Council maintenance works schedule.
- Where an erosion escarpment has been created at the back of the beach (height greater than 1.5m), Council will document the extent of the escarpment and at the earliest opportunity undertake a risk assessment of the likely hazard to beach users (both to persons on the beach and to persons on the dune above the scarp) from collapse of the erosion scarp.
- Where the risk is deemed unacceptable, Council will at the earliest opportunity undertake appropriate mitigation works which may include:
  - regrading the escarpment to a stable slope (following approval from Council's environment division);
  - fencing and signposting escarpments, to discourage public access (top and/or bottom) until such time as the beach recovers naturally; and
  - keeping the beach closed until such time as the risk has reduced to an acceptable level.
- At the appropriate time the Council CEEAS controller will declare the emergency has finished and the CEEAS is no longer operative.

4 RESPONSIBILITIES

Specific responsibilities under the CEEAS are tabulated in Table 2.

Council through the nominated CEEAS controller must tabulate relevant Council positions and responsibilities for implementation and execution of the CEEAS. This will require an up to date list (names and contact numbers) for relevant contacts to be maintained by Council and updated as positions or responsibilities change. This list is to be readily available within Council and communicated to each of the nominated contact persons following any update.

Table 2 Specific Responsibilities in implementation of the CEEAS

Position	Responsibilities
Local Emergency Operations Controller (LEOCON)	Execution of the Local DISPLAN, including aspects relating to coastal erosion
Council CEEAS controller	Liaison with LEOCON during storm emergency. Implementation of the CEEAS during non-storm erosion emergency
Council Recreation Services Manager	Monitoring repair of beaches and dunes. Closure of Beaches and ocean pools as appropriate. Post storm remediation.
Council Media Liaison Officer	Distribution of warnings and closures via the media.

5 PLAN REVIEW

This coastal erosion emergency management plan should be maintained as required and reviewed at intervals not exceeding 5 years from its initial adoption. Earlier review may be triggered by:

- occurrence of a coastal erosion emergency that exceeds the defined hazard extent as outlined in the Wollongong City Council Coastal Zone Study (Cardno, 2010) to redefine the extent of the area covered by the Plan;
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