

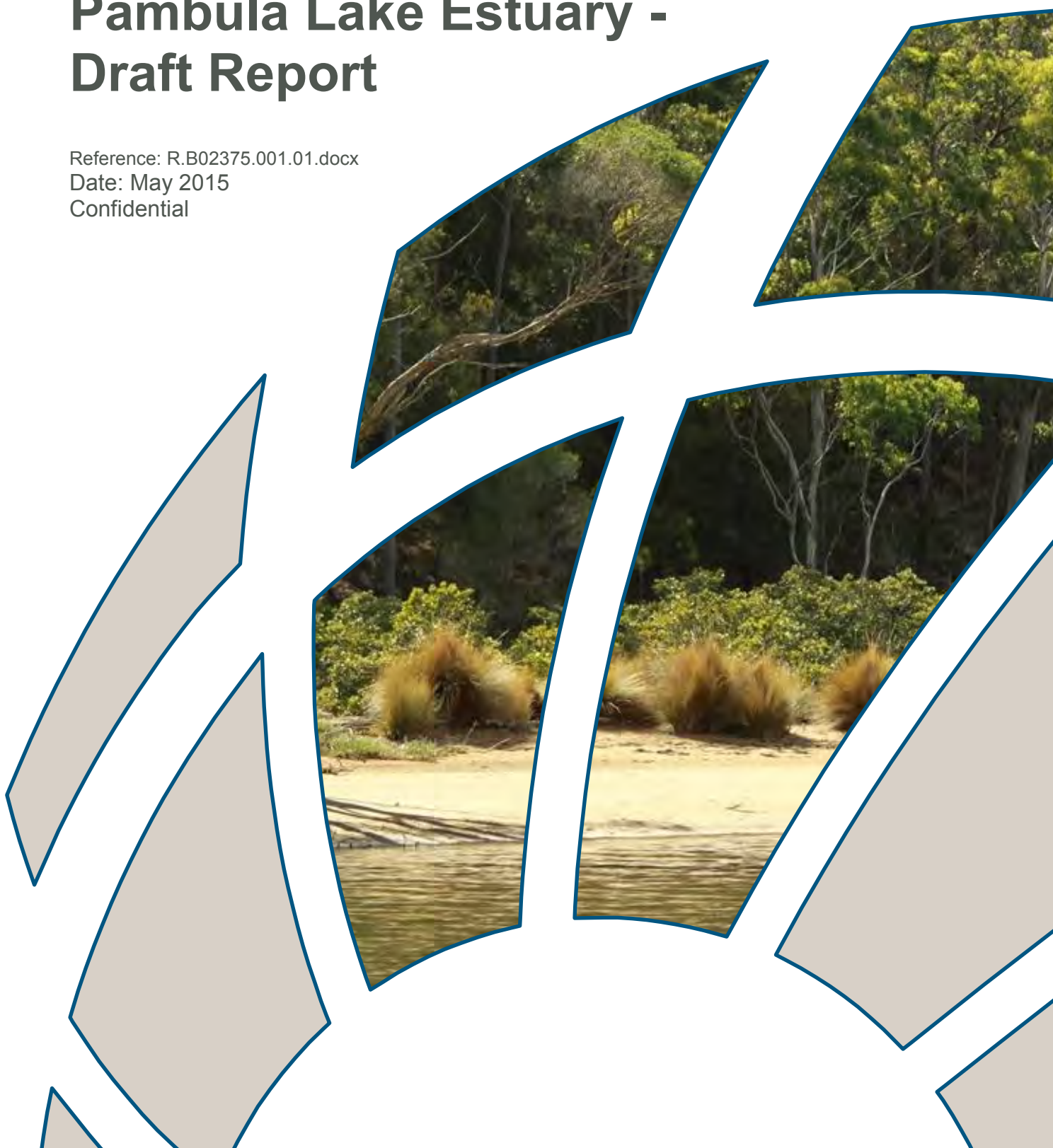


Coastal Zone Management Plan for Pambula Lake Estuary - Draft Report

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Executive Summary

Executive Summary

The Pambula Lake estuary is an estuary of very high scenic amenity. In a variety of settings the estuary displays a high level of 'naturalness' and beauty, with limited areas of disturbance and obvious degradation. This is despite the variety of recreational and commercial uses it supports.

The estuary maintains very high water quality which in turn supports its ecological systems which are also in good condition. Both of these key values are outcomes of the relatively undeveloped nature of its catchments (approximately 82% forested) that display limited hydrologic change and minimal increases in diffuse nutrient loads above what pre-European settlement conditions would be expected to provide.

These values of the estuary are further supported by its permanently open entrance, which despite periodic shoaling still supports rapid oceanic flushing of the majority of the estuary. The high rate of oceanic flushing provides for consistently high water quality that is resilient to poor water episodes in comparison to other estuaries, i.e. the water quality within the estuary recovers quickly after adverse water quality events such as experienced after floods. The consistent nature of water quality within the estuary supports a substantial and successful oyster aquaculture industry.

The estuary has a long history of use, with the catchment being originally populated by the Thaua Aboriginal people of the Yuin nation. Shell middens in the region have been dated back over 3000 years indicating a long association of Aboriginal peoples with the region. Significant and unique Aboriginal cultural heritage artefacts and sites remain in the catchment of the Pambula Lake thus representing a further value of the estuary. European settlement of the area occurred in the 1830's and this gave rise to a variety of industries that have subsequently flourished and then faded in-line with demand for various commodities and the costs and logistics of transporting commodities from the area to other regions.

Presently the catchment of the estuary supports the three main urban centres of Pambula, Pambula Beach and Pambula South. The remainder of the cleared catchment is comprised of agricultural (grazing) lands, and rural residential lands. The estuary supports a wide variety of typical estuarine recreational uses including both active uses, e.g. fishing, boating (including water-skiing), bushwalking, swimming, and a variety of passive recreation uses, e.g. view appreciation and picnicking amongst others. Commercially, oyster aquaculture is the primary commercial use of the estuary. Pambula Lake also supports commercial fishing in defined areas and part of the estuary is a defined Recreational Fishing Haven. Some other limited waterway focused commercial uses such as boat engineering facilities also exist in the estuary. The estuary has capacity to support a number of other commercial uses relating to nature and cultural heritage tourism.

The Pambula Lake estuary has many values including those described above, e.g. very good water quality, relatively intact catchments, high ecological values, high visual amenity, unique cultural heritage values and ability to support commercial and recreational pursuits, amongst others. These values are threatened by the modifying actions of direct human use and other broad scale drivers of change such as climate change. These pressures to estuarine values were assessed and most were identified to present long term risks to estuarine condition, indicating that a key focus of a future plan of management for the estuary was to identify, preserve and where possible improve current estuarine health, which for the most part is considered to be in good or even very good condition.

Utilising information from precursor studies, such as the Data Compilation and Estuary Processes Studies (EPS), studies completed since the EPS along with input from the Pambula Estuary and Coastal Group,

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State agencies and other stakeholders, the values and threats to the estuary were reviewed and analysed using a defined 'risk based' approach. This has allowed for the development of a prioritised list of potential management strategies and actions for the estuary. These management strategies and actions fundamentally aim to improve, protect and maintain the environmental and community uses and values of Pambula Lake estuary and catchment. This information is captured within this Coastal Zone Management Plan (CZMP) and is summarised in Table 1 which presents the 28 actions identified within 10 key strategy areas. The table includes a summary of key aspects of the various actions.

Table 1 Summary of Identified Actions

No#	Actions	Priority	Supporting Parties	Indicative Costs for Council
B1	Work with relevant agencies and the Far South Coast Coastal Weeds Project to control and manage weeds around the foreshore and in bushland areas surrounding the estuary.	High	DPI Agriculture and Private landowners	Current budgets maintained
C5	Work with private land holders and other relevant bodies to continue fencing of riparian areas in priority areas and encourage appropriate revegetation as opportunities and funding arise.	High	SELLS, DPI F&A and OEH (NPWS)	Determined on case by case basis, support as funds permit
D2	Undertake education programs for Council staff (and possibly key local developers and contractors) involved in Erosion and Sediment Control (E&SC), and Soil and Water Management to increase awareness of the impact poor soil controls can have on estuarine and wider catchment health.	High	-	Undertaken within existing budgets. External expert training up to \$10K
D3	In conjunction with DPI and SELLS, work with local farmers within the catchment to minimise pollution from agricultural runoff through education programs and support for appropriate on-ground management works, such as riparian revegetation and fencing to control stock access.	High	DPI Agriculture and SELLS	N.D, support as funds permit
D5	Continue existing and support new community engagement and education initiatives such as 'Love our lakes' (LoL), and 'clean up days', that serve to increase awareness on estuarine condition and management issues. Support may include financial support, logistical support, expertise support (particularly in relation to information sharing on topics of interest), amongst other things.	High	SELLS and Pambula Lake Oyster Growers (PLOG)	Grant funding for LoL ceases mid-2015. Funds to support clean up days determined on case-by-case basis
E1	Assist NPWS and Eden Local Aboriginal Land Council in the research and monitoring of Aboriginal cultural sites, and implementation of protection works as required.	High	OEH (NPWS), Eden Local Aboriginal Land Council	Undertaken within existing budgets.
E2	Council to work with relevant agencies and Eden Local Aboriginal Land Council to support long term protection of middens through appropriate heritage protection	High	OEH (NPWS) Eden Local Aboriginal Land Council	Undertaken within existing budgets.
H2	Continue to support existing Council initiatives that aim to manage risks to estuarine water quality arising from sewer pump stations overflow, as well as the siting, regulation and management of on-site sewage systems.	High	NSW Health	N.D. for sewer pump station overflow. Ongoing monitoring of OSMS undertaken within existing budgets

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No#	Actions	Priority	Supporting Parties	Indicative Costs for Council
H3	Undertake rapid catchment appraisal for Pambula Lake catchment based on SRCMA Roads and Track Survey Summary and Volume 2 of the NSW EPA Managing Urban Stormwater – Soils and Construction Guide (2008). This should include consideration of drainage structures, suitable road base materials, minimum grading requirements, design adequacy and compliance. The appraisal will assist in the establishment of road and track management priorities including those relating to permanent sealing.	High	Forests Corporation of NSW, Crown Lands, energy / tele-communication companies, OEH (NPWS) and private landowners	Moderate costs ~20K
H6	Regular inspections/compliance checking of boat work areas particularly regulating management of boat antifoulants and other chemicals in the environment (particularly stormwater runoff) that may contribute to water and metal contamination.	High	DPI F&A	Undertaken within existing budgets.
J1	Support implementation and periodic review of the Pambula Lake Oyster Growers EMS.	High	PLOG and DPI F&A	Specific support costs N.D.
C1	Undertake bank restoration and rehabilitation works in priority areas as highlighted in the Estuary Processes Study (and Pambula Catchment Rehabilitation Plan). Council and SELLS to undertake works on public and private lands as funding and resources permit	Med.	SELLS, private landowners	Determined on case by case basis, support as funds permit
C3	Monitor riparian vegetation extent / coverage and bank erosion levels by completing a 10 yearly review of extent and condition.	Med.	OEH/NPWS and SELLS	Riparian Vegetation Extent ~\$10K, Riparian Condition Assessment ~\$15K and Bank Erosion Assessment ~\$10K
C4	Rationalise pedestrian and/or vehicle tracks in public lands within the riparian zones and other areas of sensitive vegetation that impact on these estuarine values.	Med.	OEH/NPWS and SELLS	N.D. support as funds permit
D1	Provide specific information on the importance of riparian land and bank management (and options for management) to new private landowners when land ownership changes occur in relevant areas of the estuary. Similarly, provide information and support to existing private land owners to encourage ongoing best practice riparian and bank management.	Med.	SELLS and DPI F&A	Low <5K/yr
D4	Continue to provide information and support to private landholders to manage and improve native vegetation on their properties through Council, other Agencies and the Far South Coast Conservation Management Network.	Med.	SELLS	Current budgets maintained
F1	Work with OEH to undertake future hydrosurveys and analysis of water levels in response to significant community concerns to changed entrance conditions	Med.	OEH and RMS	No cost if State funded, \$10K-\$30K if funded externally
G2	Work with DPI F&A to complete mapping of the distribution / extent of mangrove, saltmarsh and seagrass using available information on a recurrent i.e. (5 to 10 year basis) or as required for other purposes.	Med.	DPI F&A and OEH	Underwater seagrass extent mapping \$15K-25K. No costs for aerial photography if supplied by State

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No#	Actions	Priority	Supporting Parties	Indicative Costs for Council
H1	Develop and implement a Stormwater Management Plan that quantifies loadings of stormwater pollutant discharges from agricultural and urban areas to the estuary. Utilise the Stormwater Management Plan as the basis for determining priority areas requiring stormwater quality mitigation.	Med.	DPI Agriculture and SELLS	Moderate cost \$40-60K
H5	Implement ecosystem health monitoring that includes biotic indicators in addition to water quality. Report findings (make data available) regularly to community and stakeholders.	Med.	PLOG and OEH	Monitoring costs described in other actions. Costs to prepare and distribute estuary report card may be of the order of \$20K per event
H7	Review/audit the Oaklands Reuse Scheme to ensure that scheme operation and management meets all approval and regulatory requirements and that reviews are clear and publically available.	Med.	SELLS, EPA and Oaklands Property Manager	No immediate costs identified.
I1	Review with recreational fishers the need for any additional facilities to minimise impacts of fishing on estuary, e.g. for waste management, cleaning tables, etc	Med.	Pambula Fishing Club	N.D.
I5	Support development or creation of low-impact nature-based activity opportunities (and associated infrastructure) within the catchment and waterways of Pambula Lake that increases the participant's awareness of the high social and environmental values of the area, for example the 'Bundian Way Initiative' amongst others.	Med.	Eden Local Area Aboriginal Land Council, OEH/NPWS and DPI F&A	N.D
A1	Assist DPI F&A in the monitoring and management of potential outbreaks of <i>Caulerpa</i> (e.g. support for overall program in terms of signage and education) and ongoing control of pest species, as appropriate.	Low	DPI F&A and Pambula Fishing Club	Low <5K/yr
C2	Council to identify priority privately owned land parcels for potential acquisition by Council, philanthropic parties, OEH and/or other related schemes such as the Coastal Lands Protection Scheme as a means of protecting and enhancing key estuarine values such as bank riparian condition, key habitat and/or improved public access use.	Low	NSW Government (Planning and Environment)	Low cost to identify suitable lands ~\$10K. Acquisition costs may be high
C6	Ensure all new seawalls being built or old ones being upgraded are built in accordance with environmentally friendly seawall guidelines	Low	NSW T&I Crown Lands Division	Costs borne by applicant
G1	Incorporate adequate buffers around key wetland areas to ensure vegetation can migrate with SLR and provide additional protection. Establish suitable means for dedicating buffers to this landuse, e.g. lease, purchase or voluntary contribution, etc	Low	NSW Planning and Environment	Planning component can be absorbed with existing budgets.
G3	Utilise available information on heavy metal testing to understand and lessen impacts of activities within estuary.	Low	Pambula Lake Oyster Growers, DPI F&A, EPA	Undertaken within existing budgets, no cost for accessing 3 rd party data. Costs for new data or supporting other programs N.D.

N.D. Not Determined; **A** - Assist in the management of aquatic weeds and pests; **B** - Minimise spread of terrestrial weeds; **C** - Actively manage riparian vegetation extent and condition and improve bank stability; **D** - Develop and implement a variety of educational

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capacity building initiatives to increase knowledge of protecting and improving estuary health; **E** - Protect and conserve Aboriginal cultural heritage sites around the foreshore; **F** - Monitor and assess changes in entrance processes and dynamics; **G** - Protect, rehabilitate and enhance estuarine vegetation including seagrass, saltmarsh and mangroves; **H** - Protect and enhance estuarine water quality; **I** - Improve recreational opportunities and amenity; and **J** - Support Oyster Aquaculture Operations.

The CZMP will be primarily implemented by Council, however, others may also be responsible for the implementation of some actions (e.g. as a supporting partner with Council). The community has a keen interest in the future management of Pambula Lake, and therefore their values and concerns have been considered and addressed as far as reasonable during preparation of this document.

The CZMP also integrates an ecological health monitoring program which aims to capture cost effectively data which provides information about the condition of the estuary. This information when compiled and reviewed over the long-term can identify changes in condition, which can be used as a starting point to understand what the pressures and drivers are that caused the decline in condition. Subsequent iterations of the CZMP can then look to address the pressures or drivers within future management strategies and associated actions.

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1 Introduction and Strategic Context

1.1 Why Develop a Coastal Zone Management Plan?

The coastal zone of NSW represents a priceless natural resource that is immensely valuable from an ecological, social and economic perspective. In addition to the open coast beaches and headlands, the NSW coastal zone contains over 184 recognised estuaries that vary in size from small coastal creeks and lagoons to large lakes and rivers. Estuaries contain diverse ecosystems that form the foundation of the coastal food chain. They provide important habitats for a variety of marine and terrestrial plants and animals. These natural systems also provide important recreational and scenic centres for many coastal communities. Pambula Lake estuary, the subject of this study, is a vital component of the local landscape from a human-interaction (active and passive recreational use), human use (commercial use) and simply as a natural resource (flora, fauna and community values).

Under the *NSW Coastal Protection Act 1979*, a Coastal Zone Management Plan may be prepared for an estuary to address risks to estuary health through management actions to maintain, improve or protect estuary values. Therefore, Bega Valley Shire Council (Council) with assistance from the NSW Office of Environment and Heritage (OEH) resolved to prepare the Pambula Lake Coastal Zone Management Plan (CZMP).

Once certified, the CZMP shall be used to inform other strategic documents that aim to manage and rationalise human activities and development within the catchments, such as Regional Strategies, Local Environmental Plans (LEPs) and Development Control Plans (DCPs). The CZMP will need to be considered when assessing new developments in accordance with Section 79C of the *Environmental Planning and Assessment Act, 1979*.

Over the past couple of years the NSW Government has introduced various reforms to coastal management, including the release of the *NSW Sea Level Rise Policy Statement* (now retracted), reforms to the *Coastal Protection Act 1979* (and other Acts) and new *Guidelines for Preparation of Coastal Zone Management Plans* (OEH, 2013, 2010). The Pambula Lake CZMP satisfies the intent and objectives of these new reforms, as well as the fundamental management principles espoused in the *NSW Coastal Policy 1997* and the previous *Estuary Management Policy 1992*. It is noted that under the recent reforms, including the gazettal process, the final document will be officially called a “Coastal Zone Management Plan” (CZMP) for Pambula Lake, and is largely the same as previous Estuary Management Plans developed for similar waterways.

This document, builds upon the information provided in the preceding studies, such as the Pambula Lake Estuary Processes Study (Cardno, 2012) to provide a prioritised list of potential management options for the estuary, based on input from Council, State agencies, the community and other stakeholders. The management options, strategies and actions presented in this document fundamentally aim to improve, protect or maintain the environmental and community uses and values of Pambula Lake.

Implementation of the CZMP will essentially be facilitated by Council. Other stakeholders including the State agencies and the general community may also be responsible for the implementation of some actions (indirectly or directly). The community has a keen interest in the future management

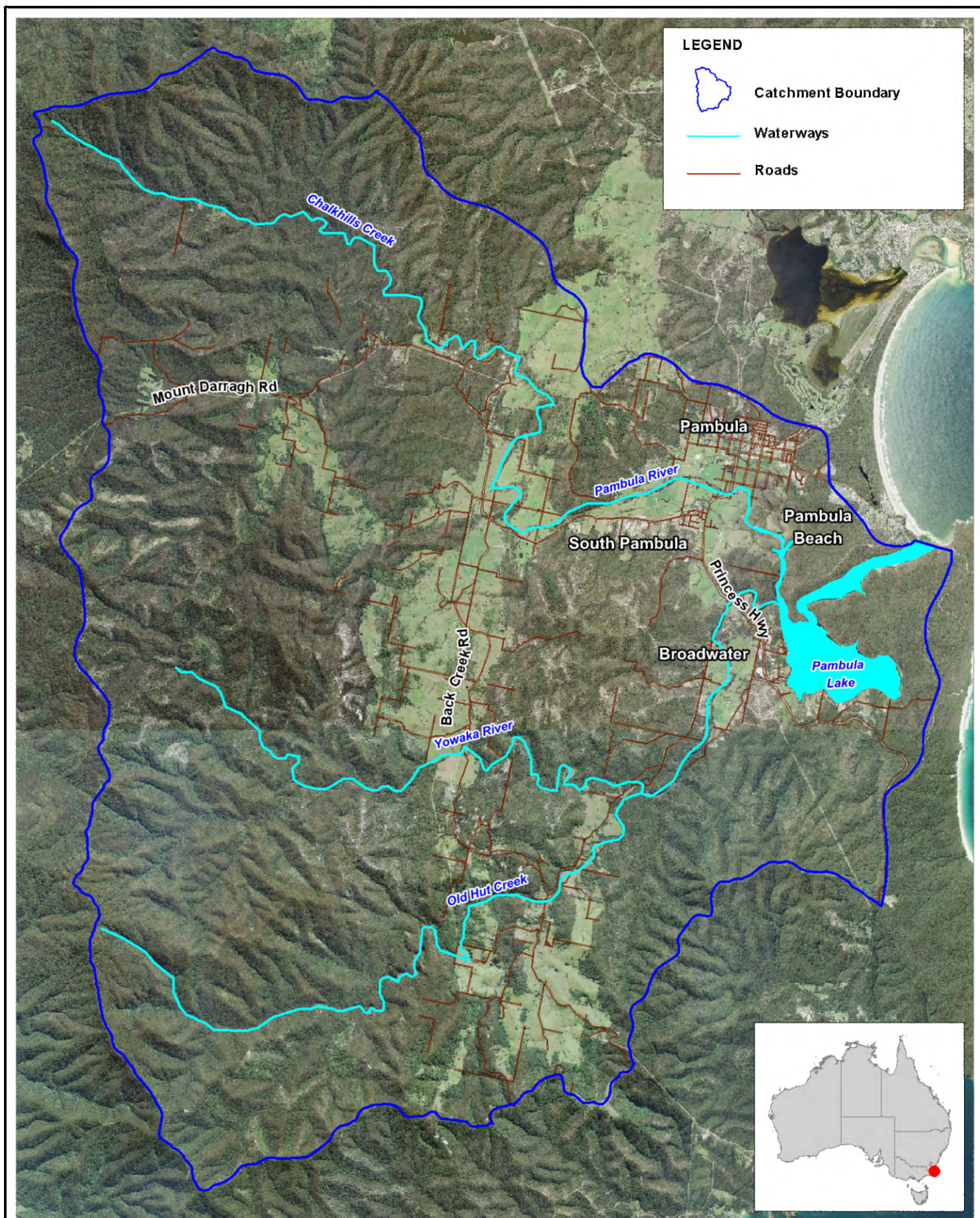
Introduction and Strategic Context

of Pambula Lake, and therefore their values and concerns have been considered and addressed as far as reasonable during preparation of this document.

The document provides a mechanism for focusing limited funds towards best and highest value works, actions and initiatives that will ultimately result in improved and sustainable opportunities for use of the Lake by both the environment and the community.

1.2 Area Covered by the Coastal Zone Management Plan

The planning process to which this study applies covers the waterway, foreshores and adjacent lands to Pambula Lake, the entrance area and tidal waterways (i.e. Pambula River and Yowaka River). In addition, the study area will extend as far into the catchment and out to sea as is necessary to describe all the processes of significance to the condition and health of the estuary. The study area is represented in Figure 1-1.



Title:
Study Area for Pambula Lake

Figure:

1-1

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Introduction and Strategic Context

1.3 Legislative and Strategic Planning Context of the CZMP

1.3.1 NSW Estuary Management Process

Up until recently, the Estuary Management Process in NSW was guided by the Estuary Management Policy (1992) and accompanying Estuary Management Manual (1992). This was replaced in 2011 by the NSW Government's Guidelines for Preparing Coastal Zone Management Plans (OEH, 2013) ('the CZMP Guidelines'). There have also been changes to various legislation and other State policies that supports the recent coastal reform initiatives, including the release of the Sea Level Rise Policy Statement (2009) (now retracted).

Under the new CZMP Guidelines, estuary management is required to focus on addressing risks to the health of estuaries through practical management actions. Estuary health has become a focus because this is not explicitly investigated or managed through other council or state planning processes.

As outlined in the CZMP Guidelines, a CZMP that addresses coastal ecosystem health management should include the following, which may be commenced in stages:

- A description of the health status of the estuary, the pressures affecting the estuary health status and their relative magnitude, and projected climate change impacts upon estuary health including consideration of potential sea level rise, which may be documented in an Estuary Processes Study;
- Identify the management objectives based on conservation of environmental and community values. Prioritise the issues or threats to those values that require treatment;
- Preparation of management options to respond to the identified pressures or threats to estuary health and values, which should include an understanding of the existing planning and legislative framework for the CZMP;
- Assessment of the costs and benefits of the management options, including community acceptability, to select preferred management actions;
- Prepare an implementation schedule for the preferred management actions, which indicates the timeframe (or trigger), responsibilities and performance measures for implementation as well as potential sources of funding;
- Present the plan to Council for adoption, then to the Minister for Certification, after which it may be gazetted by Council; and
- Monitor and review the plan on a regular basis (5-10 years).

Step 1 has been completed for Pambula Lake (refer Cardno, 2012), although aspects of estuary health have been reviewed in the preparation of the CZMP. This document addresses the remaining steps from the above list. Progress through this process has been co-ordinated by the Pambula Estuary and Catchment Group (PECG), which has representatives from Bega Valley Shire Council as well as key state agencies and other stakeholders.

A key doctrine of the CZMP Guidelines is the adoption of a risk-based approach to the management of estuary health. The Risk Management Principles and Guidelines (Australian

Introduction and Strategic Context

Standard ISO 31000:2009) have therefore been applied to the development of this document, fulfilling this requirement. The risk-based approach has several key advantages for the management of estuaries, primarily it ensures that management efforts are directed towards those areas or issues that pose the greatest risk to estuary health and sustainability.

1.4 Meeting the Coastal Management Principles

Tables demonstrating this plans compliance with the coastal management principles and other legislative requirements have been included in Appendix F.

1.4.1 State and Commonwealth Legislation and Policies

There are a number of State Parliamentary Acts, Policies and guideline documents that are relevant to the management of the Pambula Lake, including:

- Environmental Planning and Assessment Act 1979;
- State Environmental Planning Policy (SEPP) No. 71 – Coastal Protection;
- SEPP No. 14 – Coastal Wetlands;
- SEPP (Infrastructure) 2007;
- Coastal Protection Act 1979;
- NSW Sea Level Rise Policy Statement 2009;
- Threatened Species Conservation Act 1995;
- National Parks and Wildlife Act 1974;
- Fisheries Management Act 1994;
- Local Government Act 1993;
- Crown Lands Act 1989;
- Water Management Act 2000;
- Protection of the Environment Operations Act 1997;
- Catchment Management Act, 2003;
- Natural Resource Management Act, 2003;
- Environment Protection and Biodiversity Conservation Act 1999;
- The NSW Coastal Policy 1997; and
- The former Estuary Management Manual 1992.

1.4.2 Regional and Local Environmental Planning Instruments

The South Coast Regional Strategy (SCRS) was developed by the NSW Department of Planning (DP) as a long-term land use plan for the region. The Strategy covers the Eurobodalla, Bega and Shoalhaven LGAs. It contains policies and actions designed to cater for the region's projected

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housing and employment growth over the period to 2031 and outlines how and where future development should occur. Significant growth is not expected to occur in the study area.

The Bega Valley Local Environmental Plan (LEP) 2013 was prepared under the direction of the State Government to all local councils, as per the *Standard Instrument (Local Environmental Plans) Order 2006* ('the Standard Instrument').

The Standard Instrument Order provides for set land use zonings and definitions of permissible uses that must be used by all NSW councils in preparing their revised LEPs. In general, the new zonings given to the land parcels in the Bega Valley LEP aim to be as closely aligned as possible with the existing land use zonings and definitions.

Bega Valley Development Control Plan (DCP) 2013 was developed to provide a document that is streamlined with the new LEP format. This has involved the compilation of many individual DCPs into a single document. In general, the new DCP format provides development controls for land use types (e.g. commercial and industrial development), general development and specific areas (e.g. Wonboyn, Arthur Kane Drive). Future iterations of the DCP may integrate aspects of estuary management as appropriate.

The CZMP will simultaneously inform and be informed by these documents over time. As these documents are all 'live', i.e. living documents subject to periodic review and update, the information included within them will necessary be adapted over time to reflect relevant changes and updates. The hierarchy of these documents for use in planning is dictated under various legislation.

1.5 Community Consultation

The development of a CZMP requires the involvement of the community, including state agencies, stakeholders groups and directly and indirectly affected residents across the Bega Valley Shire LGA and greater region that utilise the coastline in many different ways. Community involvement is crucial to the preparation of a plan that is considered acceptable, within financial and technical constraints. A careful and comprehensive consultation process has been conducted to ensure community values and priorities have been incorporated into preparing and selecting the management strategies and actions that will form the Pambula Lake CZMP. The following consultation activities have been conducted:

- During the Data Compilation Study (ngh Environmental, 2008) a meeting with the Pambula Estuary and Catchment Group (PECG) was carried out along with further individual contact with stakeholders and community members via a number of means.
- The Pambula Lake Estuary Processes Study (Cardno, 2012) reports that a community meeting was undertaken to discuss estuarine values. A summary table of estuarine values is included in the study report.
- For the first stage of the preparation of the CZMP, an initial meeting with the PECG was held on 26th March 2013, where the study methodology was identified and discussed. Prior to this meeting a questionnaire was distributed to contacts provided by Council (on or around 13th March 2013). Persons provided the questionnaire were invited to attend a "drop-in session" (on 26th March) after the initiation meeting to ask questions of the study team. The questionnaires

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were developed to capture values and threats for Pambula Lake. Further follow up via phone calls to stakeholders were completed to elicit specifically relevant information for the study.

- The next stage of consultation for the CZMP involved a one day workshop held on 20th February 2014 to analyse and evaluate the risk level of threats to lake condition and values. The meeting was attended by representatives of Council, the PECO and various state agencies. The workshop involved confirming the values and threats identified for Pambula Lake. A threat risk assessment was then conducted, in which threats to Pambula Lake were confirmed by attendees, then analysed in terms of frequency and consequence. Due to lower than anticipated attendance, the workshop material was provided electronically to a handful of suitable persons that could not attend the initial workshop. Their input was considered along with those that attended the workshop.
- Shortlisted management options were presented to the PECO, Council and representatives of state agencies on the 16th December 2014. Attendees were talked through the outcomes of the risk assessment workshop (described in previous dot point), and then presented the shortlisted options being considered for the future management of the Pambula Lake estuary. Attendees were provided the opportunity to discuss the options and were provided with a feedback form to record any comments on option wording and priority.
- The draft CZMP will be presented to the PECO, community and agency representatives during the exhibition period of the draft CZMP. The presentation will provide an overview of the draft plan and the selected management actions. Meeting attendees and the general public will be provided the opportunity to comment on the draft report. Formal comment on the draft report will be by way of written submission to Council. Relevant findings of this review and comment process will be incorporated into the final version of the CZMP.

Through ongoing consultation with the community, it is anticipated that the recommended actions for managing threats to Pambula Lake will be better understood and therefore accepted by community. This is particularly important where difficult decisions or trade-offs form necessary actions. Conversely, there will be areas for which little to no action may be needed at the present time, and again, community have and will be involved in determining the level and type of action required to manage the threats to Pambula Lake.

1.6 Relationship to Key Council Documents

1.6.1 Community Strategic Plan: Bega Valley 2030

The management actions contained within this CZMP will, once implemented, contribute to meeting vision of the Community Strategic Plan: Bega Valley 2030 (CSP) which is stated as,

"The Bega Valley is a community that works together achieving a balance between quality of life, enterprising business, sustainable development and conservation of the environment."

The vision is supported by themes, which are articulated into a number of Directions / Stated Outcomes. Implementation of the



Introduction and Strategic Context

Pambula Lake CZMP will contribute to achieving many of these directions, themes and ultimately the vision. The CSP is also supported by the Bega Valley Delivery Plan 2012 to 2017, Bega Valley Operational Plan (annual), and the Bega Valley Resourcing Strategy.

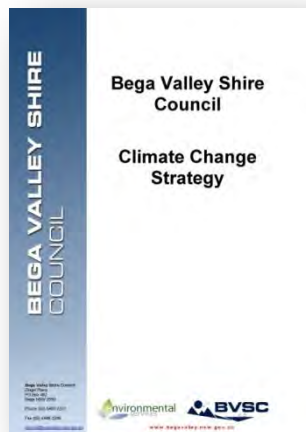
1.6.2 Climate Change Policy 2013 and Climate Change Strategy 2014

Climate Change Policy

Council will address the matter of 'Climate Change' in a systematic manner by, 'Recognising the leadership role of Local Government to help reduce greenhouse gas emissions and effectively managing climate change impacts at a local level. This is specifically related to its statutory responsibilities in land use and environmental planning, environmental protection and natural resource management'.

Council's Climate Change Strategy (described below) outlines actions to be undertaken in response to the potential impacts of climate change on all aspects of Council's activities and operations. These actions will also be based upon the legal requirements, relevant government guidelines, the unique role of local government and advice from Council's insurer.

Climate Change Strategy



Council's Climate Change Strategy supports its Climate Change Policy and actions included in other key documents such as the CSP. Council's position in respect of climate change is as follows.

"Bega Valley Shire Council recognises that climate change could impact on the social, economic and environmental values of the shire. Specific climate change projections for our Shire include: increasing temperatures; decreasing annual rainfall; more frequent extreme weather events such as drought, floods & heatwaves; rising sea levels and increased and bushfire frequency. Early mitigation and adaptive actions are required to maintain the unique values of our shire as well as to protect those sectors of the community and infrastructure most vulnerable to the effects of climate change."

The Strategy has four main elements of its approach which will integrate into many of Council's key planning and implementation documents over time, these include:

- (1) Leadership and working with the community;
- (2) Mitigation and transition;
- (3) Risk and adaptation; and
- (4) Opportunity.

These key areas are broken down into a number of strategic objectives, which are then further broken down into a number of supporting actions.

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These actions are identified and where possibly addressed in this CZMP and other Council planning documents, such as the Comprehensive Local Environment Plan, Coastal Processes and Hazard Definition Study, Asset Management plans, Emergency Management Plans, amongst others.

1.7 Structure of this Document

The information presented in this report ostensibly relates to the future community and environmental uses of Pambula Lake. Each chapter contributes to the final key outcome, which is a prioritised list of recommended options for detailed documentation within the following CZMP.

Chapter 2 details the history of human usage, as well as current day characteristics of the Pambula Lake estuary.

Chapter 3 outlines the major ecosystem and environmental processes of Pambula Lake including assessments of current condition (as available). Processes considered included catchment, hydrodynamic, sediment, morphological and water quality processes. These processes ultimately determine the ecosystem structure and function of Pambula Lake which is also described in this section.

Chapter 4 details the external pressures imposed on Pambula Lake and its natural values. The external pressures are mostly human induced, such as catchment development. It is the external pressures that threaten and modify the natural values associated with Pambula Lake.

Chapter 5 presents a summary of the values of Pambula Lake, as well as threats to those values.

Chapter 6 presents a risk assessment of the threats to natural values imposed by the external pressures. The exercise of identifying and prioritising threats contributes to the selection of a shortlist of options that best allow ongoing community and environmental uses of Pambula Lake.

Chapter 7 provides a comprehensive assessment of potential management options that aim to address identified threats. The options either improve the ability of the estuary to accommodate human activities (adaptation options) or to reduce the impacts of threats in modifying natural values (intervention options). Ultimately all options aim to improve, protect or maintain the existing values of Pambula Lake.

Chapter 8 provides implementation schedules which provide specific details relating to the shortlisted management options, with their priority identified. This section also includes suggestions regarding funding options, and finally, a suggested monitoring and evaluation framework for future condition monitoring of the estuary. The framework aims to capture key data related to values of the estuary, while balancing cost.

2 Human Usage of the Estuary

This section outlines human usage history and characteristics of the Pambula Lake estuary. Information presented builds upon and updates information included in the Estuary Processes Study prepared by Cardno in 2012.

2.1 Heritage

2.1.1 European Heritage

European settlement occurred in the 1830's and a variety of industries flourished and faded at different times in-line with demand for various commodities and transport options (for these commodities) to and from the region. Various artefacts of European Heritage associated with these various industries including significant buildings primarily within the townships, still remain within the Pambula Lake catchment.

Items of local and state heritage significance are identified in Schedule 5 of Council's Local Environment Plan (LEP), 2013. The listing in this schedule is an update on the listing provided in the Estuary Processes Study (Cardno, 2012) which referenced the 2002 LEP. Most of the listings provided in Schedule 5 of the current LEP are for buildings located in the townships and they are generally listed as being of local significance.

Cardno (2012) also provide listings (and map where item locations are known) of listed sites of Australian and State heritage significance as determined from a review of the State Heritage Register and Australia Heritage Database.

Of most relevance to this plan, based on their proximity to the estuary, are the listings of:

- Indigenous Site in the Australia Heritage Database¹;
- Ben Boyd National Park in the Australia Heritage Database;
- Yowaka Bridge in the State Heritage Register;
- Oaklands (Pamboola Station) in the State Heritage Register; and
- Two other local sites adjacent the Pambula River (non-tidal section).

There are a few sites, such as the Oaklands (Pamboola Station), that are adjacent the Pambula River (non-tidal sections).

Interaction with lands or structures recognised in these listed heritage sites must be considerate of the stated heritage management requirements for them.

2.1.2 Aboriginal Heritage

Cardno (2012) identifies that the Pambula Lake catchment was populated by the Thaua Aboriginal people of the Yuin nation. The Yuin people are considered to be the traditional owners of these lands and other lands extending to the north (Shoalhaven) and south (Victorian border). Shell

¹ Discussions with the Heritage Branch of the Australian Government's Department of Environment, identified that this listing was completed for the older Register of National Estate. It was indicated that further heritage assessment work was required to complete the listing, hence the current listing has no legal status associated with it.

Human Usage of the Estuary

middens in the region have been dated back over 3000 years indicating a long association of Aboriginal peoples with the region.

Within the study area, the Ben Boyd National Park is a significant site to the Aboriginal people. Historically, the Aboriginal peoples would gather here to complete certain social activities. In the current day context, an Aboriginal culture camp has been established at Haycock Point in the Ben Boyd National Park to help facilitate local Aboriginal cultural activities.



Midden on the Foreshore of Pambula Lake

Many localised artefacts representing traditional forms of use of the area remain within the Pambula Lake estuary catchment. The Aboriginal Heritage Information Management System (AHIMS) database (searched as part of the Estuary Processes Study) identified 63 known significant sites or items in the catchment, with the majority being middens. Of this number some 39 were noted to be located along the estuary foreshore or along the related tributaries. Discovery of

further Aboriginal items was considered likely given that much of the catchment is currently undisturbed.

Furthermore, the Pambula middens and complex is relatively unique owing to its intactness and the fact that it comprises a number of individual sites of significance. Sullivan *et al* (2006) suggests that the midden complex at Pambula is also of international significance from both a scientific and cultural perspective.

Currently protection for Aboriginal sites is afforded under the *National Parks and Wildlife (NPW) Act 1974* and further assessment of the significance of the Pambula sites / place may be required to support future listings on suitable heritage registers. Such a listing may assist in the implementation of tighter protections and greater ease in accessing funding for this protection and management.

2.2 Land Use

2.2.1 Actual Land Use

Land uses within the Pambula River catchment are presented in Figure 2-1. This is based on land use data obtained for the whole of NSW as at 2009. The principal land uses include conservation/forested lands (80.7%), urban (2.8%), grazing lands (14.7%) and other (1.8%) (OEH, 2010). The urban areas are comprised by three centres of Pambula, South Pambula and Pambula Beach.

The vast majority of the steep upper catchment is forested, with flatter sections of the lower catchment being used for grazing and agricultural purposes. Actual land uses adjacent the estuary includes:

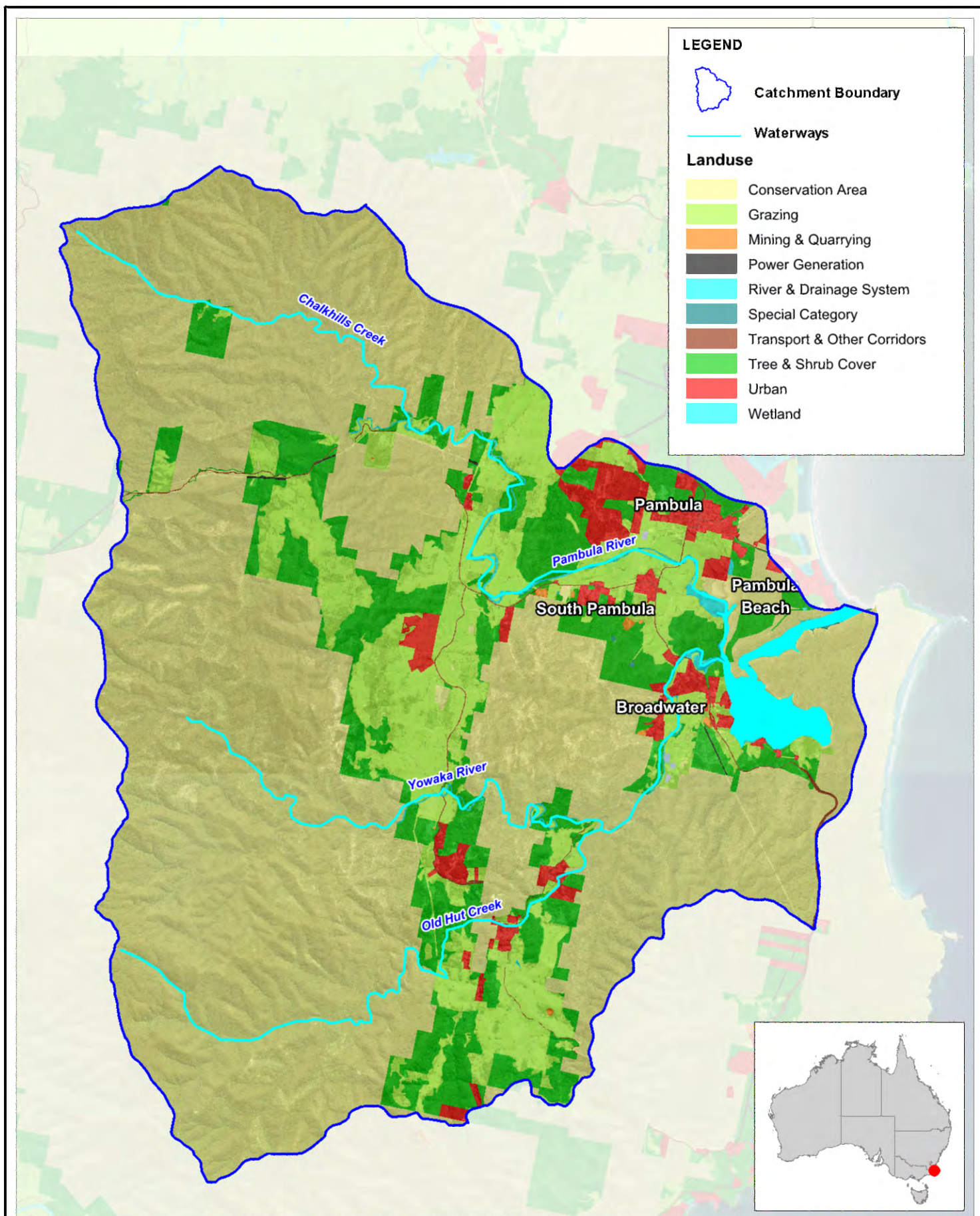
Human Usage of the Estuary

- Ben Boyd National park forming the southern and northern side of the entrance channel, main estuary basin;
- Private rural lands along the southern foreshores of the main estuary basin and sections of both the Yowaka and Pambula Rivers;
- Public lands on the western side of the main estuary basin (containing parks, fishing club, boat ramps, etc); and
- Industrial lands on the Pambula River to the west of South Pambula.

Permissible land uses for the catchment are represented in the Bega Valley LEP, 2013 and have been presented in Figure 2-2. This has been updated significantly since the previous LEP of 2002 presented in the Estuary Processes Study (Cardno, 2012). The 2013 LEP accords with the draft standard instrument LEP which is being applied by all local government authorities in NSW to increase consistency between plans². Key differences in the 2002 and 2013 LEP zonings include:

- E1 zoning (National Parks and Nature Reserves) dedicated around the majority of the entrance channel (north and south sides), continuing around to the eastern portion of the main basin, and also along sections of the Pambula River. The E1 zoning is associated with the Ben Boyd National Park;
- E2 zoning (Environmental Conservation) around the remainder of the estuary itself that is privately owned. The zone is approximately 100 m wide. The zoning extends nearly up to the tidal limits on the Yowaka and Pambula River;
- E3 zoning (Environmental Management) behind the E2 zoning in south of estuary basin;
- Greater protection of the SEPP 14 wetland (no. 375) south of Pambula. While previously primarily zoned Environment Protection (Scenic) 7 (D), sections of the wetland extended into Rural 1(A) and Industrial 4 (A) lands. With the new zoning, the wetland is now fully included in E1, E2 and E3 zones. Furthermore areas to the north which were formerly Rural 'A' (1A) have been converted to E2 or E3 zoning to provide further buffer to the SEPP 14 wetland and possibly allow for its retreat under increasing sea levels;
- Industrial lands at Pambula South have sections of increased setback to the Pambula River;
- A significant portion of Rural 'A' (1A) within the catchment has been converted to E3 zoning to recognise and allow for the existing environmental values (e.g. habitat corridors or catchment protection values) of that land to be better protected over time. It is noted that the E3 zoning still allows for agricultural activities as a permitted use;
- Two new areas of public open space (i.e. RE1 Public Recreation), have been recognised on the estuary foreshore with one at the mouth at Pambula Beach and one at the boat ramp on the western side of the main basin; and
- The waterways of the Pambula Lake estuary have been zoned W1 Natural.

² B2 (Local Centre), B4 (Mixed Use), E1 (National Parks and Nature Reserves), E2 (Environmental Conservation), E3 (Environmental Management), E4 (Environmental Living), IN1 (General Industry), IN2 (Light Industrial), R2 (Low Density Residential), R3 (Medium Density Residential), RE1 (Public Recreation), RU2 (Rural Landscape), RU3 (Forestry), RU4 (Rural Small Holdings), SP1 (Special Activities), SP2 (Infrastructure), SP3 (Tourist), W1 (Natural Waterways)



Title:
Land Use (DECCW, 2009)

Figure:

2-1

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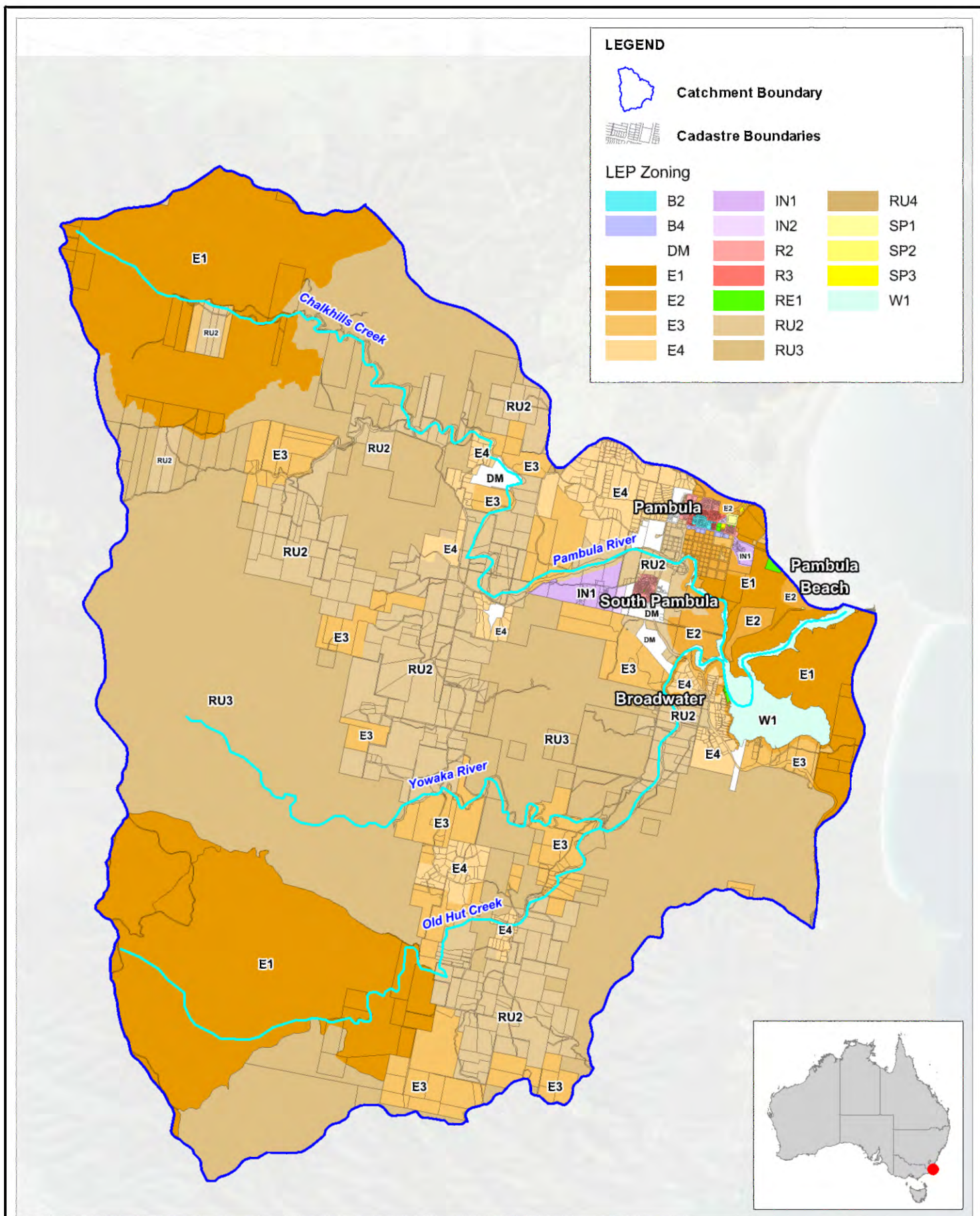
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Title:
Bega Valley LEP 2013, Land Zoning

Figure:

2-2

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2.2.2 Land Tenure

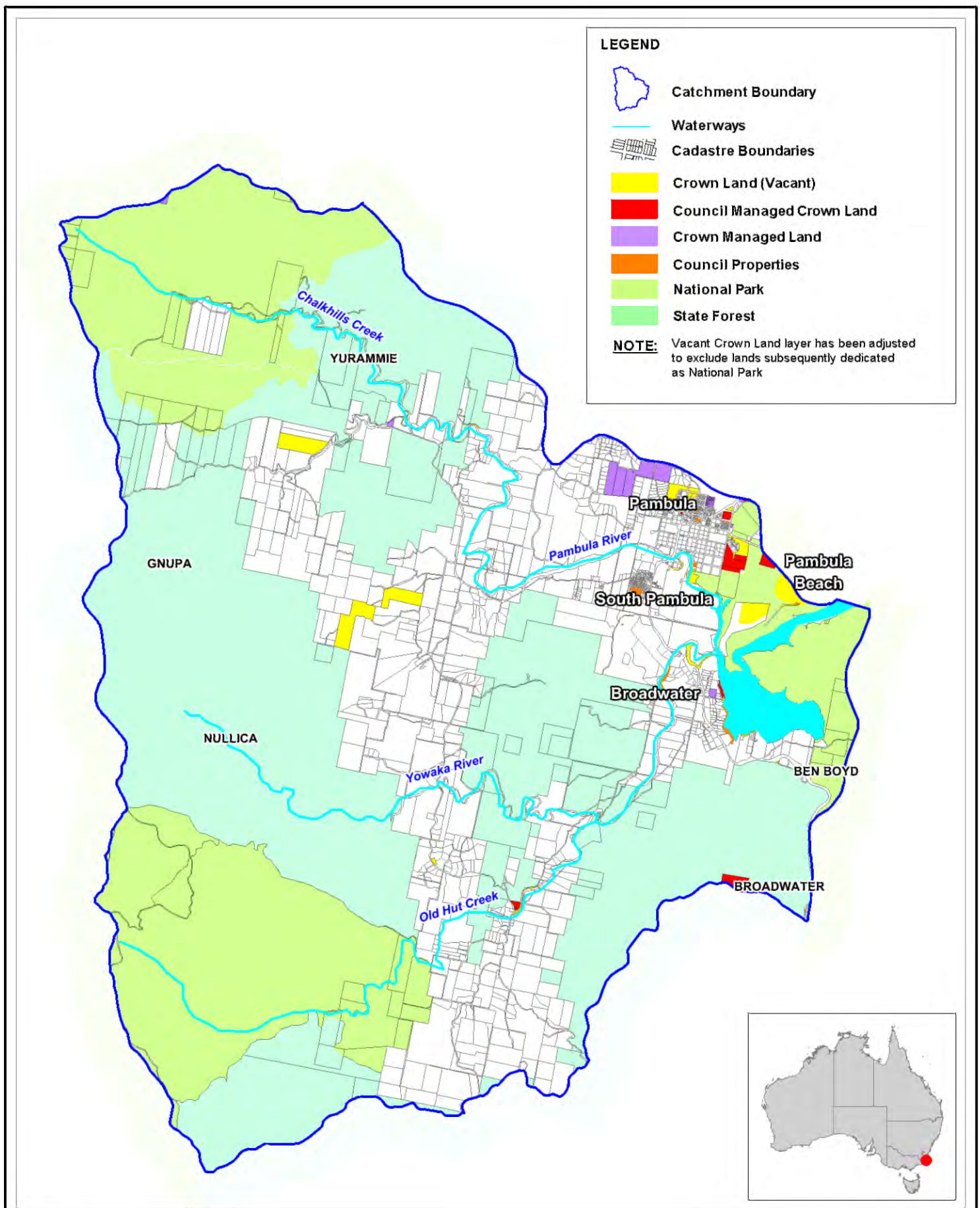
Figure 2-3 provides key land tenure arrangements for the study area, it can be seen that there are significant areas of freehold land around the townships of Pambula and South Pambula and along the lower sections of the Pambula and Yowaka Rivers. Most other areas are State Forests or National Parks.

Crown Land is land vested in the Crown and managed by the NSW Department of Primary Industries within the Land and Natural Resources Business Unit under the *Crown Lands (CL) Act* 1989. Crown lands are managed for public recreation and enjoyment, environmental conservation and heritage conservation purposes. Any land below the mean high water mark (MHW) is classed as Crown land. Within the catchment there are a number of areas of managed Crown land (by others) and Council managed Crown land. Of particular note is that the Estuary Processes Study (Cardno, 2012) identified extensive areas of vacant crown land around Pambula Beach and on the foreshores of the Pambula and Yowaka Rivers.

National Parks are dedicated under the *National Parks and Wildlife Act* 1977 (NP&W Act) and are managed by Office of Environment and Heritage (OEH). There are two National Parks falling within the bounds of the study area: Ben Boyd National Park and South East Forests National Park. These parks are managed under a plan of management which is a legal document that outlines how the area will be managed in the years ahead.

State Forests in the Pambula catchment include Nullica, Gnupa and Yurammie State Forest areas. Sections of these State Forest areas are harvested for timber by the Forestry Corporation of NSW under approved harvest plans.

Native Title is the recognition by Australian law that Indigenous people have rights and interests in their land that come from their traditional laws and customs. A review of the mapping provided by the Native Title Tribunal indicates that there are no active native title claims within the study area.



Title:
Land Tenure

Figure:

2-3

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2.3 Visual Amenity

Cardno (2012) provides an overview of the visual amenity of the waterways and foreshore areas of Pambula Lake as viewed from a watercraft. Overall, these earlier assessments and site inspections completed as part of this study indicate an estuary which has:

- Largely undisturbed foreshores, particularly in the entrance channel, Pambula River and northern and eastern margins of the Pambula Lake basin. The Ben Boyd National Park extends to the water edge and includes land on the southern and northern extents of entrance channel as well as the north-east corner of Pambula Lake;
- A mix of disturbed and undisturbed foreshores in the remaining areas (i.e. southern and western foreshores) of the Pambula Lake basin. The foreshores in these areas are disturbed with a mixture of clearing for rural residential purposes, public facilities such as boat ramps, commercial facilities such as oyster sheds, marina and slipways; and
- Extensive oyster aquaculture facilities throughout the main basin, particularly where the entrance channel joins the main basin and around the northern, eastern and southern boundaries of the lake. Leases were also present within the entrance channel, although these were seemingly not as obvious. Leases appeared to be well maintained.

The estuary provides a variety of different visual settings which adds to its scenic amenity (see Figure 2-4 and Figure 2-5), with examples including the entrance channel with its clear water, sandy beaches interspersed with incised heavily vegetated banks and rock outcrops; the main basin with its surrounding undisturbed and partially disturbed bushlands providing an idyllic rural setting; and rivers with gently sloping sand beaches merging into fringing vegetation and bushland.

Overall, the estuary is considered to be of very high scenic amenity and in a variety of settings the estuary displays a high level of 'naturalness' and beauty, with limited areas of disturbance or obvious degradation, despite the variety of recreational and commercial uses it supports.



Figure 2-4 Pambula River Foreshore (Right), Pambula River Entrance (Left)

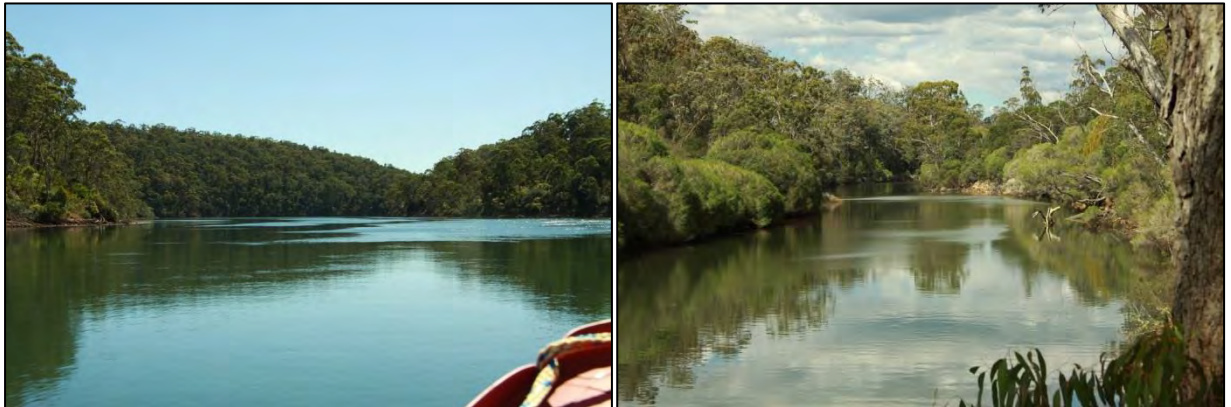


Figure 2-5 Entrance Channel (Left), Yowaka River (Right)

2.4 Recreational Use

The recreational amenity of the estuary relates to what features and values it has which makes certain types of recreation possible and enjoyable. Considerations such as access, natural features and values, manmade facilities and visual amenity (described above) are all likely to feature in considerations of its recreational amenity.

2.4.1 Access (formal and informal)

In terms of access, the estuary only has a few key points of easy land-based public access. Many areas of the estuary are effectively inaccessible to the public, as they can only be reached by walking trails through bushland, or by use of personal watercraft. Some foreshore areas on the southern and western foreshores of the main estuary basin areas are restricted access due to private ownership.

Key public access points include beach access at Pambula Beach with walking trails extending through sections of the Ben Boyd National Park (which exists on the northern side of the entrance channel), pontoon access on the western edge of the main basin (near boat ramp and public reserve) and access via the public boat ramp on the western edge of the main basin near the entrance to the Pambula River. Other accesses exist to locations along the southern side of the entrance channel through the Ben Boyd National Park although access at these locations would be associated with the use of walking trails.

Cardno (2012) identified the presence of informal walking tracks primarily on the Pambula River which presents a risk to riparian vegetation and bank stability. The informal access tracks promote foreshore access that can lead to trampling and loss of vegetation and ultimately foreshore degradation.

In addition to the existing Ben Boyd National Park trails, the Bundian Way initiative aims to create an iconic long distance walking track which commences at the Jigamy Farm. From this location it heads east to the foreshore and then south. The trail route is currently being assessed.

2.4.2 Altered features

The modified features of the estuary also provide for a range of recreational and commercial uses. Recreational uses include activities such as fishing, trail walking, sightseeing, cultural and related heritage tourism and picknicking. Key altered features include:

- A two-lane boat ramp, carpark, launching pontoon and fish cleaning table (public access) on the western edge of the main basin;
- Trails and viewing platforms within public land and the Ben Boyd National Park – trail/bushwalking, mountain-biking, horse-riding, nature observation;
- Heritage features such as middens on the foreshores (discussed further in Section 2.1.2, Page 10);
- Character buildings such as oyster facilities, oyster sheds, etc (for commercial use);
- Oyster aquaculture leases around the estuary (for commercial use);
- Broadwater Engineering ramp on the southern edge of the main basin (private for commercial use);
- Foreshore park at end of Broadwater Road associated with the boat ramp (includes tables, toilets, and other typical park infrastructure) - picknicking and other passive recreation; and
- Foreshore park at Pambula Beach (currently being redeveloped) - picknicking and other passive recreation.

2.4.3 Natural features

The Pambula Lake estuary has many natural features which lend themselves to a variety of recreational uses. Quite often it is a combination of features which makes the location suitable for certain recreational activities. Described below are some of the key recreational activities occurring within and adjacent the Pambula Lake estuary, based on its obvious natural features:

- Sandy beaches and clear ocean water (entrance channel) – swimming, snorkelling, picnicking;
- Lake locations with certain water clarity, depth and subsurface features – fishing and snorkelling; and
- Lake locations with sufficient width, wind protection and bank suitability – boating and water skiing.

The locations of these activities will be dictated by what locations are accessible for those activities to occur and where they are best suited to occur in the estuary, e.g. most swimming occurs in the entrance channel where there are clean sandy beaches with ocean like water quality. Boating as an activity usually occurs for the purposes of fishing, waterskiing, or pursuing a commercial activity.

In addition to the Ben Boyd National Park which adjoins the estuary, there exists the Panboola wetlands area which is accessed from Bullara Street in Pambula. The Panboola wetland area contains part of a SEPP 14 wetland.

2.5 Commercial Use

2.5.1 Oyster Aquaculture

As identified in Cardno (2012) Sydney Rock Oyster aquaculture is the most significant commercial use of the Pambula Lake estuary with total value of oyster sales exceeding \$1M annually.

There are 139 leases in the Pambula Lake estuary which cover some 21.17% of the lake (OEH, 2010). This is one of the highest oyster aquaculture lease coverages in the State. Trays, floating baskets and longline baskets are the main methods used for oyster aquaculture in the Pambula estuary which is appropriate for their setting over seagrass beds (Cardno, 2012).

Since 2005 the Pambula Lake estuary has been conditionally approved for direct harvest. This approval comes from site surveys and monitoring conducted by the NSW Food Authority as part of state-wide classifications of oyster growing regions. This is the lowest level of restriction applied by the NSW Food Authority and provides the highest level of operational flexibility to oyster producers in the Pambula estuary, as there are no mandatory depuration periods applied for oysters harvested prior to sale.

However, oysters are filter feeders and are therefore subject to changes in water quality which may result from catchment inputs (sediments, nutrients, sewage, chemicals, etc), or rates of oceanic exchange that may be affected by entrance conditions. Key water quality pollutants of concern for oysters include bacteria, viruses, marine biotoxins (e.g. algae) and environmental pollutants. There have been a number of examples of both short term and long term water quality related oyster issues over the past couple of decades including:

- Wallis Lake – Hepatitis A (viral) contamination of oysters which resulted in mass infection of consumers. After likely causes were investigated this resulted in significant investment in stock exclusion, erosion control measures and water quality improvement systems for urban runoff. The industry has returned.
- Bellinger and Kalang Rivers – Several years of closures, QX (parasitic) disease leading to mortality, norovirus linked to poor water quality from catchment and septic system inflows. Ongoing issue still being investigated and resolved industry in serious decline.
- The Lower Hawkesbury Estuary oyster industry has endured two devastating disease outbreaks in the last ten years, namely QX in 2005 which impacted Sydney Rock Oysters and POMS (Pacific Oyster Mortality Syndrome) which virtually wiped out all Pacific Oysters in the Lower Hawkesbury suddenly in January 2013.
- Wonboyn River – Marine algae (potentially *Prorocentrum minimum*) resulting in mass mortality of oysters in 2002. Issues have been investigated and the industry has returned.

The Pambula estuary has no history of QX disease, although may be susceptible to other water quality changes which can contaminate oysters.

The Pambula Lake Oyster Growers (PLOG) maintains a local industry based Environmental Management System (EMS) which identifies both internal and external risks to the industry. This broad assessment relates to many internal and external factors which influence the operation of the

industry. Ongoing implementation and renewal of the EMS will support the continued success of the local industry, and also provide a feedback mechanism to lake managers on emerging issues.

2.5.2 Commercial Fishing

Commercial fishing activities can occur in the entrance channel and main basin areas, the Pambula River and the Yowaka River were declared Recreational Fishing Havens in 2002 and are not subject to commercial fishing.

Commercial fishing activities are regulated under the Estuary General Fishery (EGF) which covers all commercial fishing within estuaries in NSW. The EGF is formed by legislation which governs how the estuaries are managed, including *Fisheries Management (Estuary General Share Management Plan) Regulation 2006*, *Fisheries Management Act 1994 No 38*, the *Fisheries Management (General) Regulation 2010* and *Fisheries Management (Supporting Plan) Regulation 2006*.

The Pambula Lake estuary is within Zone 7 (there are a total of 7 in NSW) which essentially includes estuaries from Ulladulla south to the Victorian Border. Commercial fishermen within Zone 7 can fish within the Pambula Lake estuary in methods for which they have been endorsed (i.e. meshing, prawning, etc). All fishing activities are subject to the rules and regulations outlined in the aforementioned legislation.

Commercial fish catches are reported to DPI Fishing and Aquaculture (DPI F&A). Data sourced from this department specifically relating to reported catch in the Pambula Lake indicate that over the past several years there have been between 6 and 8 commercial fishermen operating within the lake.

When fewer than 6 operators have recorded catches, privacy legislation prevents DPI F&A from releasing actual catch data for those years, and these represents gaps in Figure 2-6.

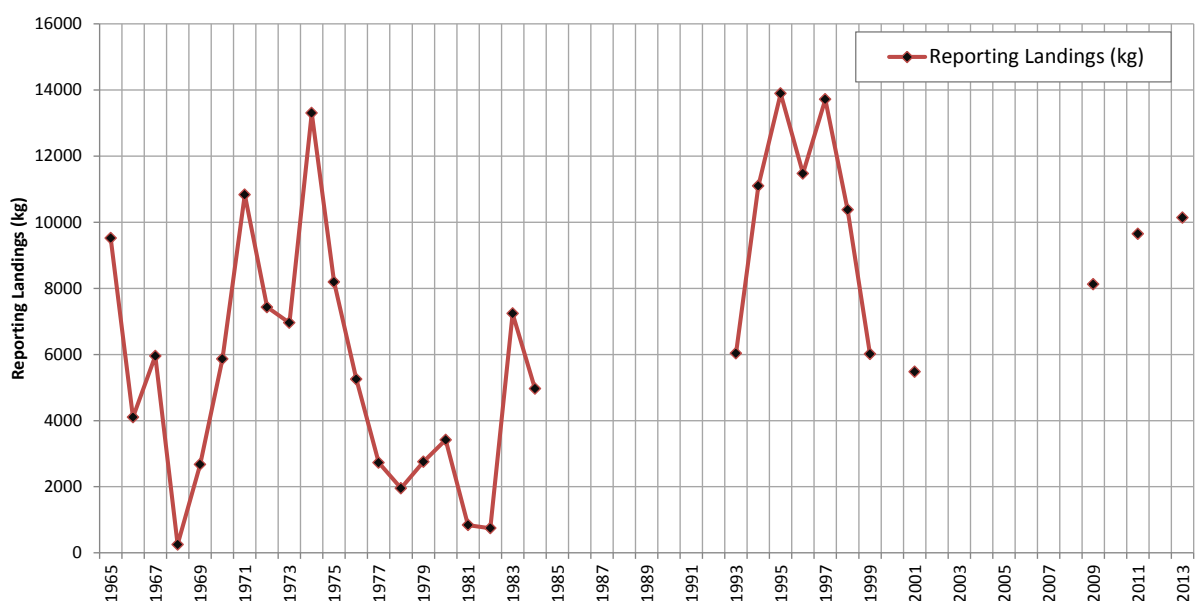


Figure 2-6 Reported Commercial Fish Catch Data Pambula Lake

The fish catch data also excludes any cultural fishing catch. DPI F&A have indicated that in the years 2009/10 to 2013/14, 60 species of fish have been reported retained and for those year the primary species harvested are luderick (30% of landings) , estuary cockles, silver trevally, yellowfin bream, and sea mullet.

Discussions with DPI F&A (Proctor, M. pers comm, 2014) indicate that:

- Commercial fishing activities in the Pambula Lake have generally been without issue. Complaints or concerns can readily be provided anonymously to DPI F&A by Fishers Watch or by direct contact, but there have been very few recent complaints received; and
- Modifications to the legislation governing commercial fishing activities would be required to change commercial fishing activities in this estuary, this would necessarily require substantial data and research to support any proposed changes.

2.5.3 Tourism

The Sapphire Coast (Bermagui to the Victorian/New South Wales border) is an increasingly popular seaside getaway. Likely tourist attractors associated with the Pambula Lake catchment include sections of the Ben Boyd National Park (and associated trails), local beaches including some near the estuary mouth and the Panboola Wetlands. Various forms of nature based recreation in addition to those undertaken in the catchment (i.e. bush walking and bird watching) include swimming, kayaking, fishing and boating on Pambula Lake (Sapphire Coast, 2014).

Tourism in the Sapphire Coast is an important local industry that is gaining in popularity. It tends to attract mostly families seeking holiday experiences, with many of the experiences being sought including nature based experiences such as swimming at beaches, fishing and simply experiencing the undeveloped nature of the region. The Pambula Lake catchment and estuary area are well aligned with the motivations and expectations of tourists as it provides a variety of nature based tourism opportunities in a relatively undisturbed setting.

2.5.4 Water Extraction

Water extraction occurs from the Pambula and Yowaka Rivers for the purposes of irrigation, domestic and stock watering use. There is also aquifer extraction permitted in the catchment. Most of the extraction from the Pambula and Yowaka Rivers will be upstream of the tidal limit, although it is possible for extraction to occur occasionally from the estuarine tidal pool (a location in the river which while still being tidal is not always subject to elevated salinity).

The extraction within these rivers is regulated by the Water Sharing Plan (WSP) for the Towamba River Unregulated and Alluvial Water Sources Order 2010, under the NSW Water Management Act, 2000. Within this WSP the Pambula Lakes Tributaries Water Source is included with other nearby systems in the Pambula River Extraction Management Unit.

A review of a recent Report Card for the Pambula Lake Tributaries Water Source (NoW, 2010) identifies the following key points:

- Total entitlement – 907 ML/year (surface water entitlement 787 ML/year and alluvial aquifer entitlement 120 ML/year);

- Number of existing licences and purpose – irrigation (23 licences and 769 ML/year), domestic and stock watering use (46 Licences and 99 ML/year) and aquifer access (5 licences for 39 ML/year);
- Peak Daily Demand - 7.6 ML/day;
- Water source Low Flow Index - 8.4 ML/day;
- The ratio of Peak Daily Demand to the Low Flow Index is 89% providing the water source with a “high” hydrologic stress rating;
- The water source has also been provided a “High” rating for Relative Instream Value (based on environmental attributes) and the Risk to Instream Value (from extraction) is also rated as “High”;
- The relative community dependence on extraction is rated as “Medium” (relative to other water sources); and
- Estuary sensitivity to freshwater inflows is rated at “Medium” on the basis that the Pambula Lake estuary is moderately sensitive to both low freshwater inflows and high freshwater flows.

The development of the WSPs has, or is occurring across the whole of NSW under an agreed methodology to provide consistency of approaches between catchments/water sources. The process of developing the WSP allows for public exhibition of the draft plan and call for public submissions. The WSP includes performance indicators against which the performance of the plan will be monitored to determine if it is meeting its objectives.

3 Lake Processes and Condition

As outlined in the *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013), in order to identify the existing and potential pressures upon estuary health and values, the relationship between the following aspects need to be identified:

- Water quality and sediment quality;
- Flow conditions (including catchment inflows and hydrodynamics);
- Sediment transport (including sedimentation and erosion); and
- Ecology (including aquatic and terrestrial habitats and species that utilise the estuaries).

The following summary of processes and condition of the Pambula Lake estuary are derived from the Pambula Lake Estuary Processes Study (Cardno, 2012), State of the Catchments report (OEH, 2010) and subsequent studies such as the Pambula Catchment Rehabilitation Plan (SRCMA, 2012) and the Pambula Lake Environmental Monitoring reports (Elgin Associates, 2013). These documents provide detailed assessments of the physical, chemical and biological processes occurring within the estuary, and the natural values associated with it.

3.1 Catchment Processes

Catchment processes are a key driver of the function and health of the Pambula Lake estuary. Cardno (2012) provide a description of relevant catchment processes for the estuary, which were considered to include climate, catchment topography, soils, geology and catchment hydrology.

3.1.1 Climate

Local Climate Descriptors

Climate is a dominant factor in the behaviour of the catchment and ocean influences on the characteristics of Pambula Lake. The local seasonal and annual climate is a factor of its geographical location on the far south coast of NSW and the topography of the catchment. Longer term factors such as El Nino – Southern Oscillation and global climate change are likely to affect historic norms of seasonal and annual weather patterns into the future.

In terms of rainfall, the Pambula catchment receives relatively low rainfall compared to the other coastal centres along the NSW Coast. Cardno (2012) reports that the Pambula Post Office receives an average of 850 mm of rainfall annually (based on data extending from 1909 to 2011). The wettest period of the year occurs from January through to March, and the driest period occurs from July through to September. The lower rainfall is matched with lower pan evaporation rates, which are noted to be among the lowest on the NSW coast (approximately 1,200 mm /year).

Local temperatures reflect its southerly position in the state where the locality is noted to have a warm summer and cold winter (BOM, 2014). Temperatures on the coast however, are likely to be moderated by the adjacent ocean water mass. Further inland, average temperatures are observed to decrease significantly. Interestingly, average solar exposure at the locality is in the same band (i.e. 15 to 18 MJ/m²) as the majority of the coast of the NSW (BOM, 2014).

Local wind pattern recordings indicate seasonal changes with predominantly north east winds during summer and westerly winds during winter.

3.1.2 Catchment Topography, Soils and Geology

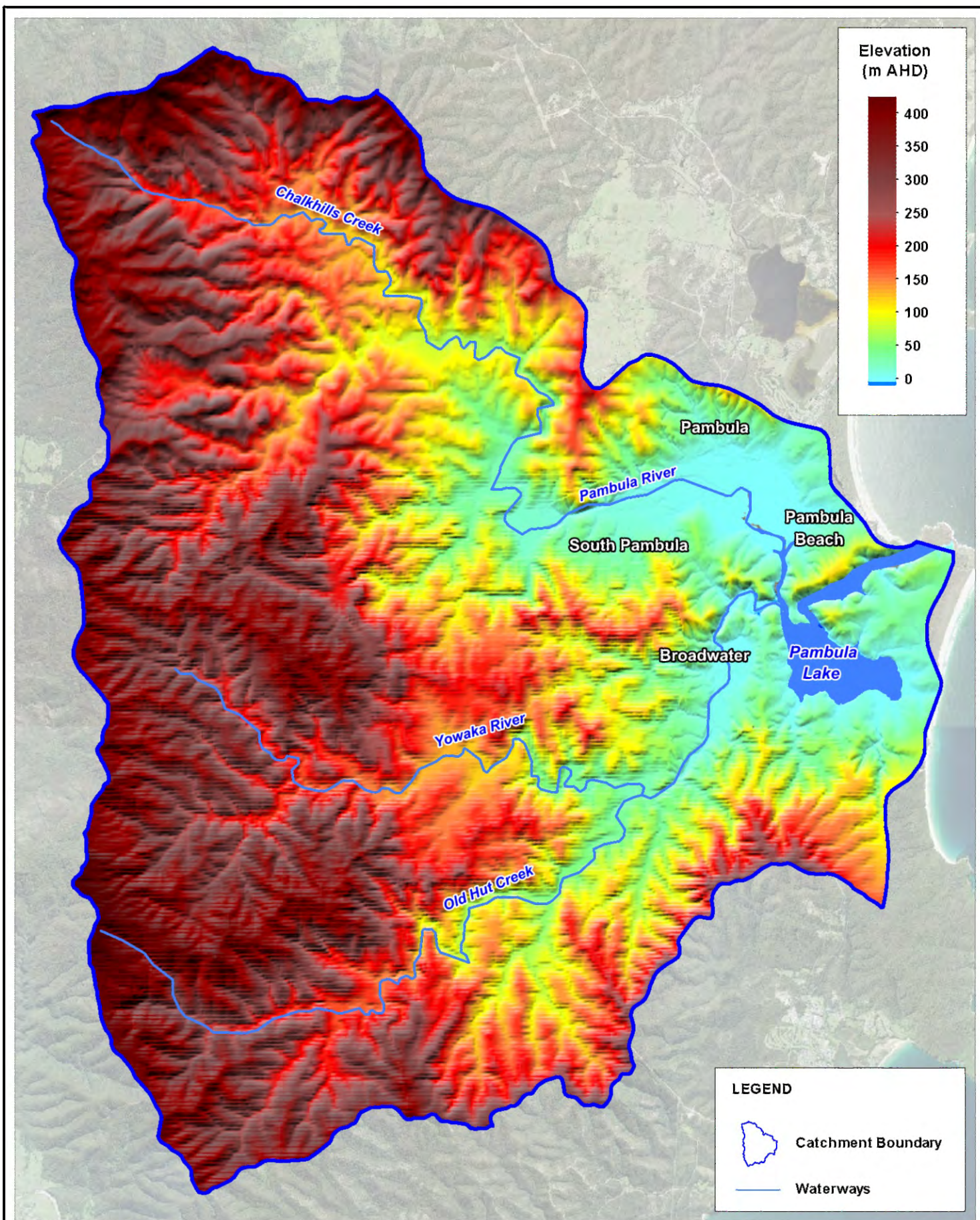
Topography

The total catchment area of Pambula Lake is 301 km² with estuarine waterways occupying an area of 4.7 km² (OEH, 2010). More than 90% of the total area represents the sub-catchments of the Yowaka River (138 km², 46% of total catchment) and Pambula River (146 km², 49% of total catchment). The remaining catchment area is represented by the Jigamy and Harts Creek catchments which are small coastal catchments that drain into Pambula Lake. They have a combined total catchment area of 17 km² (SRCMA, 2012). Figure 3-1 provides details of catchment topography.

The headwaters of the Yowaka and Pambula Rivers rise in the steep slopes of densely forested foothills of the Great Divide to the east of Wyndham. Several tributaries drain both the Pambula and Yowaka Rivers through rugged heavily forested terrain. Closer to Pambula Lake the steep terrain transitions to gently undulating country where the river valleys widen to form floodplains, with the floodplain on the Pambula River system being the most significant.

Lake Bathymetry

Cardno (2012) identify that the most of the estuary bed is between 0 and -5 m AHD, and that the average depth within the estuary is approximately -2.5m m AHD based upon hydrosurvey completed by OEH in 2003. The maximum depth of the estuary was reported to be -14 m AHD at Shark Hole (near Peach Tree Point) as shown in Figure 3-2. It can also be seen from the lake bathymetric model that Pambula and Yowaka Rivers connect with the main basin across a broad area which is relatively shallow with a main flow path existing between Mangrove Island and Tea Tree Point.



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Digital Elevation Model

Figure:
3-1

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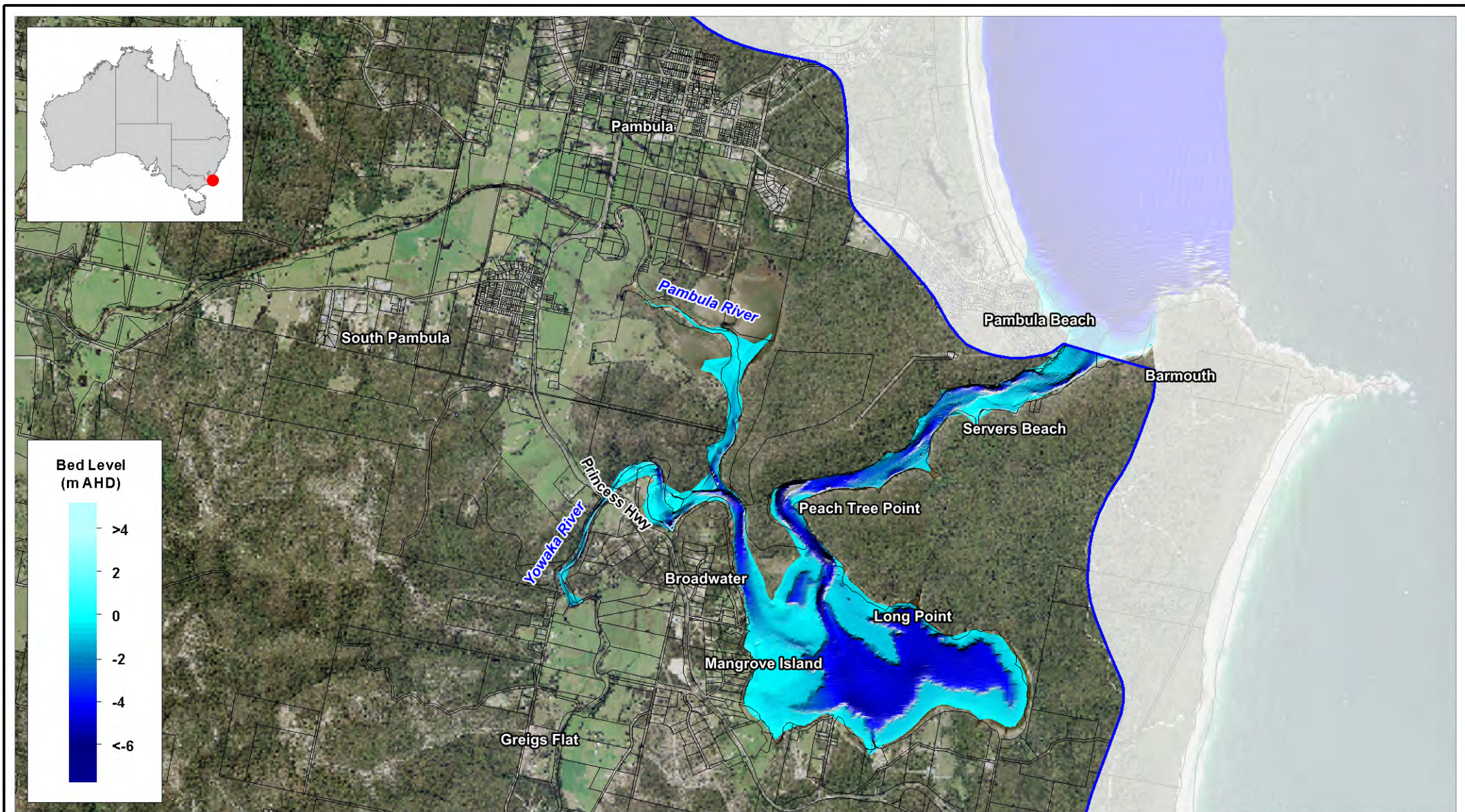
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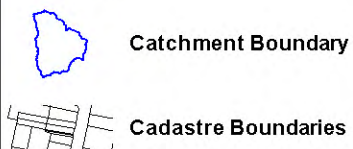
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Geology

Geologically there are a number of lithographic units found around the Pambula Lake estuary. Of interest is there are no marked geological differences in the bedrock of the two catchments, except that the Pambula River catchment contains greater area of Tertiary aged valley fill (Cardno 2012, after Thoms and Bergs, 1994). The Pambula and Yowaka Rivers, main basin and entrance channel are all situated in Devonian aged bedrock.

Soils

Cardno (2012) identify some eighteen soil landscapes in the Pambula Lake catchment with nine bounding the estuary itself. These nine soil types are described as being generally non-cohesive with moderate and high erosion potential. This indicates that disturbance of these soil types has potential to increase their erosion. Actual rates of erosion would be determined by a number of site specific factors. Acid sulphate soils have been identified around the estuary with the Pambula wetlands and eastern side of the main basin presenting high risk locations. The remainder of the estuary is surrounded by areas classified as low risk.

Catchment Hydrology

Catchment hydrology primarily relates to the way in which water runs off a catchment and into a receiving waterway after a rainfall event. While small events may not have a noticeable hydrological effect, large rainfall events can result in catchment flooding. Catchment hydrology is also a key determinant in the export (i.e. quantity and rate) of nutrient and sediment into receiving waterways.

Each catchment has a unique hydrologic response to rainfall depending on the catchment topography, i.e. catchment area, slopes and channel gradients and factors that govern runoff volumes and rates, i.e. loss and infiltration characteristics, catchment imperviousness and roughness, attenuation in storages and channel physical form and roughness. For the Pambula River, it is reported to have a forest area coverage of 82% (OEH, 2010), with the remainder being formed of cleared agricultural lands and urban areas.

The Pambula catchment is less disturbed than the majority of estuary catchments in NSW (in the lowest 15th to 20th percentile of all estuaries in the state). It is worthwhile noting that around 30% of estuaries in NSW have disturbance levels greater than 50%.

In terms of catchment runoff / stream flows OEH (2010) provides an average base flow of nearly 9,000 ML/y and a total stream flow of 50,520 ML/y. Hydrologic changes and associated pressures are discussed in Section 4.1.2 (Page 58).

Catchment Inputs

Nutrient and sediment export (referred to as catchment inputs, or diffuse catchment loadings) are primarily a function of catchment hydrology and landuse. Catchment inputs are significantly affected by changes in imperviousness (which affects hydrology) and the presence of sediment, nutrient, gross pollutants, hydrocarbons, pathogenic materials on ground (which are defined by landuse). The Pambula Lake catchment contains no significant point sources, such as sewage treatment plants.

OEH (2010) includes estimates of actual diffuse catchment inputs to Pambula Lake as:

- TSS – 693 T/yr;
- TP – 3.13 T/yr; and
- TN – 37.0 T/yr.

The degree to which these inputs act as a pressure on estuarine condition relates to how much these loadings have changed over time, whether they are concentrated in certain areas (i.e. 'hotspots'), the degree to which they mix and reside within the estuary or exchange with the ocean (i.e. what is the resultant water quality), and what if any, adverse effects are observed. Diffuse loading changes and associated pressures are discussed in Section 4.1.3 (Page 58).

3.2 Hydrodynamic Processes

Hydrodynamics (or water movement) in estuaries is driven primarily by a combination of catchment derived inputs and oceanic exchange. During periods of dry weather when stable catchment inflows are observed, estuarine hydrodynamics is typically dominated by oceanic exchange which is driven by oceanic tidal processes. During periods of wet weather, estuarine hydrodynamics can be dominated by catchment inflows (depending on the magnitude of the flow event), however, these events are typically infrequent and of short duration. This section details aspects of hydraulic processes relevant within the Pambula Lake estuary.

Tidal Processes

There are many factors in addition to tides which contribute to observed oceanic water levels, e.g. local wind and wave effects. Cardno (2012) provides an overview of these phenomena, their timeframes and likely effects on near entrance and upper estuary water levels. Of the processes most significant in influencing water levels within the estuary tides were assessed as the most significant.

Ocean tides propagate into the Pambula Lake estuary through a relatively long narrow entrance channel which is subject to some shoaling along its length; however, the entrance remains permanently open to the ocean.

Entrance shoaling results in attenuation of the tidal range within the estuary. The degree of attenuation is regarded as minor and is attributed to the long, narrow bedrock controlled inlet channel that is only partly infilled with marine derived quartzose sand (Cardno, 2012).

To illustrate the degree of tidal attenuation within the estuary Table 3-2 presents various tidal plane measures at a location near the confluence of the Yowaka and Pambula Rivers (approximately 10km upstream from the entrance) and in the ocean (at Eden) which for all intents and purposes will be the same as outside the entrance of the Pambula River.

Table 3-1 Tidal Plane Characteristics of the Pambula Lake estuary (Cardno, 2012)

Tidal Plane	Pambula Lake estuary	Ocean (at Eden)
Higher High Water (Spring Solstice)	0.75 m AHD	0.83 m AHD
Mean High Water Springs	0.42 m AHD	0.43 m AHD
Mean High Water	0.32 m AHD	0.32 m AHD
Mean Sea Level	-0.06 m AHD	0.00 m AHD
Mean Low Water	-0.44 m AHD	-0.60 m AHD
Mean Low Water Springs	-0.54 m AHD	-0.71 m AHD
Indian Springs Low Water	-0.78 m AHD	-0.99 m AHD

The tidal plane data indicates that the higher tides, e.g. the HHW (SS) is attenuated by 0.12m 10km upstream from the estuary entrance, while the lower tides are attenuated by 0.16 m (MLW), 0.17m (MLWS) and 0.21m (ISLW). The larger attenuation effect present within the low tides is likely due to the increased frictional effect of the entrance channel and shoals during these low tide events effectively holding water back within the estuary during tidal cycles.

Cardno (2012) identify that tidal processes are the dominant influence on water currents within the estuary, amongst several other phenomena including wind driven currents and catchment inflows. Catchment inflows (of sufficient magnitude) can, however, dominate tidal processes and hence currents within the estuary.

Tidal Exchange and Flushing

During each tidal cycle ocean waters are exchanged with the Pambula Lake estuary. Tidal processes push ocean water into the estuary thereby forcing tidal mixing and exchange. The efficiency of these processes varies throughout the estuary in line with the degree to which the tides can propagate through the estuary (refer tidal plane information in Table 3-2). Tidal energy is dissipated with travel along estuaries from the mouth as a result of friction (mainly flow contact with the estuary bed) and other hydraulic losses (channel constrictions, channel curvature, physical structures, etc).

Cardno (2012) calculated estuarine flushing times³ under base flow conditions (i.e. typical catchment inflows) for the Pambula estuary as:

- Entrance channel, 0-2 days (spring tides), 2-4 days (neap tides);
- Main basin, 4-8 days (spring tides), 6-14 days (neap tides); and

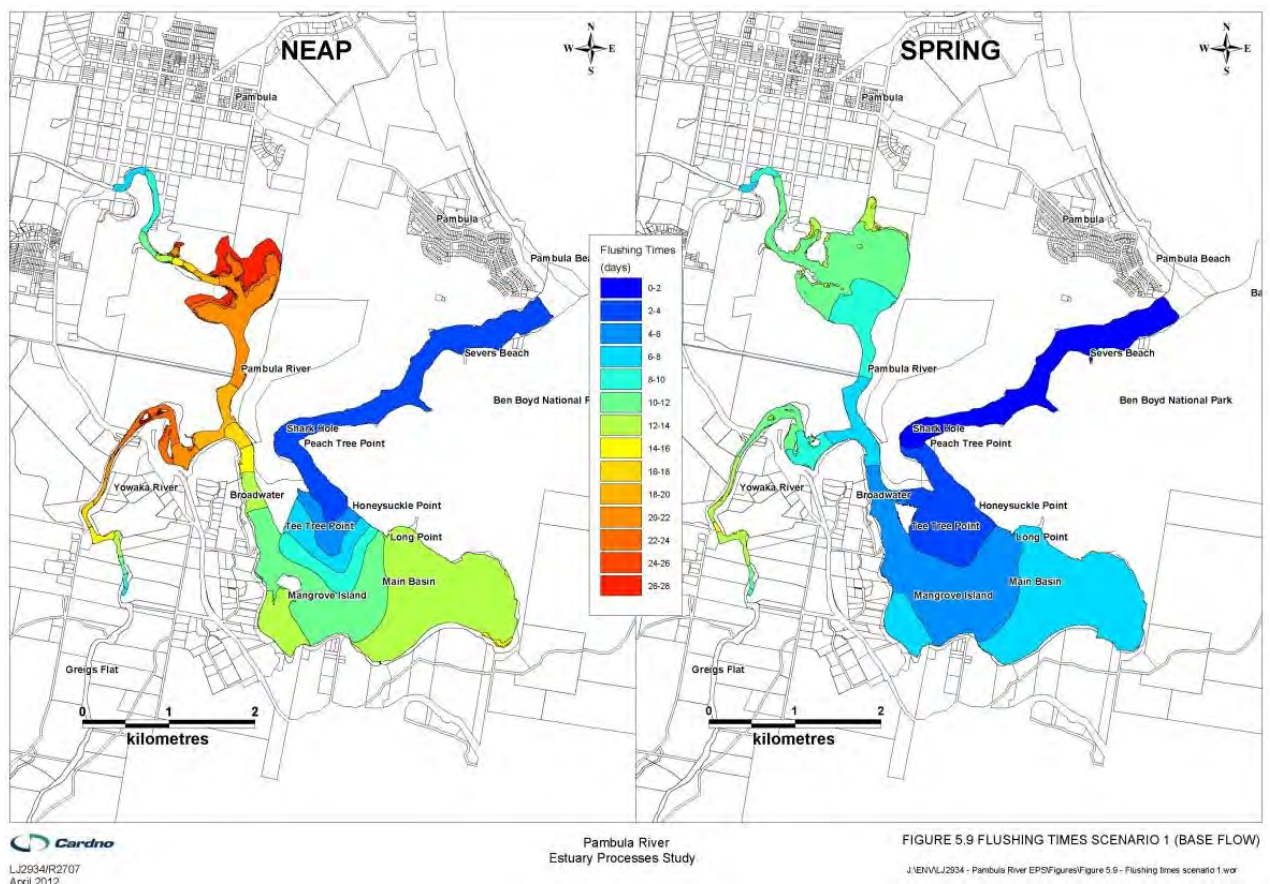
³ The flushing time definition applied in its calculation was the time it takes for a substance in the estuary to reduce to around 37% (1/e) of its original concentration

- Upper reaches, 8-14 days (spring tides), 18-28 days (neap tides).

Flushing times for the majority of the Pambula Lake estuary are approximately four days. This is a short flushing time (i.e. the estuary is well flushed by the ocean) that places the Pambula Lake estuary in the lowest quartile of all NSW estuaries in this regard. The high rates of oceanic flushing assist in moderating water quality that supports its extensive oyster industry.

It is also observed that spring tides result in greater oceanic exchange and reduced flushing times compared to neap tides. A graphical depiction of flushing times within the estuary under spring and neap tides is provided in Figure 3-3.

This figure identifies that the southerly and easternmost portions of the main basin (broadwater) have slightly reduced flushing times on account of the main flows from the entrance channel winding around Tea Tree Point into the Pambula River and not passing through the entire basin area. This presents opportunities in this part of the basin for lower velocities to exist which may promote settlement of suspended materials. These model findings are supported by sediment facies analyses completed in the Pambula estuary which identified large quantities of clay in sediments along the eastern side of Long Point, indicative of a low energy environment promoting settlement and deposition (Thoms and Bergs, 1994). Further details are provided in Section 3.3 (Page 32).



Cardno (2012) also identify flushing times of the estuary during periods of enhanced catchment flows. During these events catchment inflows begin to dominate flushing processes and have the influence of reducing flushing times throughout the estuary, particularly in the upper reaches of the estuary.

3.3 Sediment and Morphology Processes

3.3.1 Estuarine

Estuarine Processes

As described in Cardno (2012), the Pambula Lake estuary is classified as a wave-dominated, drowned river-valley estuary with an open entrance. Wave dominated estuaries are characterised by a coastal bedrock embayment (i.e. the river valley) that is partially infilled by sediment derived from its catchment and marine sources. These types of estuaries evolve by infilling over time, as such wave dominated estuaries are considered to be very efficient in retaining catchment derived materials, e.g. sediments.

Assessment of sediment facies zones within the Pambula estuary identify that it is geologically mature, displaying significant valley infilling and is dominated by sediments derived from its terrestrial catchments. Over time with continued infilling, wave dominated estuaries, such as the Pambula estuary, have the potential to evolve into a wave-dominated delta style estuary, but this requires the main basin to completely infill with sediments which may take several centuries or millennia.

Sediment facies zones of south coast NSW estuaries characteristically have three distinct zones (Cardno, 2012) including:

- Zone A – extending from the estuary mouth and is comprised of barrier and tidal inlet sedimentary environments;
- Zone B – located in the central basin portion of the estuary and possesses sedimentary units reflecting low energy depositional conditions; and
- Zone C – landward of the central basin and is composed of fluvial sediment, reflecting tidally influenced fluvial processes.

The distribution of these sediment facies zones within the estuary was assessed by Thoms and Bergs (1994) and is represented in Figure 3-4. This image depicts the three zones covering the entrance channel (Zone A), the main basin or Broadwater (Zone B) and areas landward of the main basin including the Pambula and Yowaka River (Zone C). It is noted that parts of the floodplain of the Pambula River have been included in this zone.

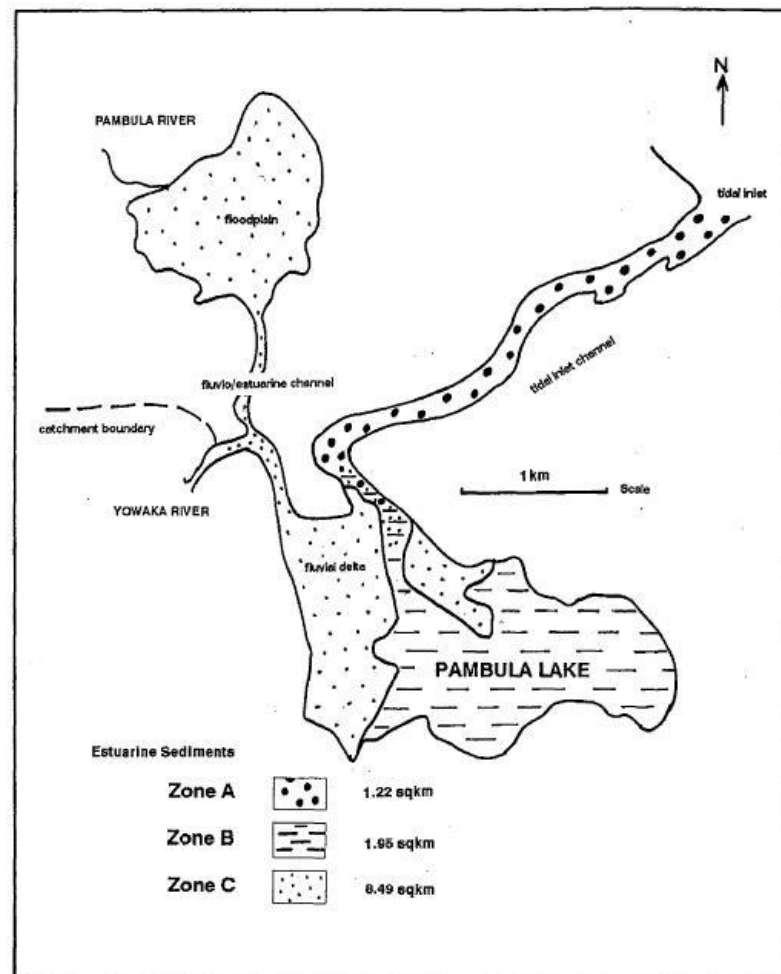


Figure 3-4 Functional zones in the Pambula estuary (Thoms and Bergs 1994)

Thoms and Bergs (1994) identified that:

- Zone A is 1.22 km² and sediments are dominated by quartzose sands (i.e. marine sands).
- Zone B is 1.95 km² and sediments are dominated by fine sand (some marine derived), silt and clay. The silt and clay fractions dominate the central basin region along with large quantities of organic material and carbonate detritus. The relative composition of these varies depending on location in this zone. The Pambula River is believed to supply approximately 65% of sediment to this basin, with the Yowaka River supplying around 30% of the sediment.
- Zone C is 8.49 km² (including extensive floodplain areas) and is dominated by granules and very coarse to coarse sands. Sediments in this zone are fluvial (i.e. catchment derived), i.e. the river and floodplain zones provide a suitable environment for the deposition of the catchment derived materials. As they are sandy, non-cohesive sediments they may be readily remobilised and transported further downstream during certain flow events. The tidal limit in this zone is suggested to have migrated downstream by 1.5km since the early 1900's due to increased sedimentation in the main Pambula River channel. The Yowaka River does not contain

significant floodplain deposits (cf Pambula River) indicating that it has a low overall sediment yield or sediment from this source is not transported in the central basin but transported directly off-shore.

The assessments indicate the need to manage land use and erosion (including bank stability) within the Pambula River catchment as a priority in comparison to Yowaka, given it appears to be the dominant source of sediments in the central basin.

Estuarine Condition

Cardno (2012) completed an estuarine bank stability assessment within the estuarine entrance channel, main basin and initial sections of both the Pambula and Yowaka Rivers (noting the assessments did not extend to the tidal limits).

Similarly to the upstream catchment areas, which were the focus of the Pambula River Catchment Rehabilitation Plan, a change in catchment hydrology has the ability to affect channel and bank stability within an estuary. Furthermore, when combined with channel modifications, riparian clearing, livestock access and human usage influences (e.g. boating), these can further impact on channel and bank stability.

To assess the condition of estuarine banks within the estuary, Cardno (2012) completed consultation with the PCEG to identify and understand perceived issues, as well conducting detailed site inspections throughout the estuary to identify bank conditions.

Key findings of this work were that the majority of banks in the Pambula Lake estuary were largely unmodified and generally stable. Some localised issues were observed, however, these were either no longer actively eroding, or were likely to be eroding at a slow rate. The assessments identified that generally the estuary was characterised by steep lower banks with unconsolidated bank materials which were mostly stable, with upper banks being mostly well vegetated with limited access. In terms of actual erosion issues, minor erosion issues were associated with localised access points, boat wash and / or minor destabilisation of the banks as a result of tidal and flood flows.

Locations of assessed erosion are provided in Figure 3-5 and are denoted by the red lines. It should be noted that the Foreshore Unit Q (on the far east of the main basin) is not a location of erosion despite also being mapped in the same colour.

Lake Processes and Condition

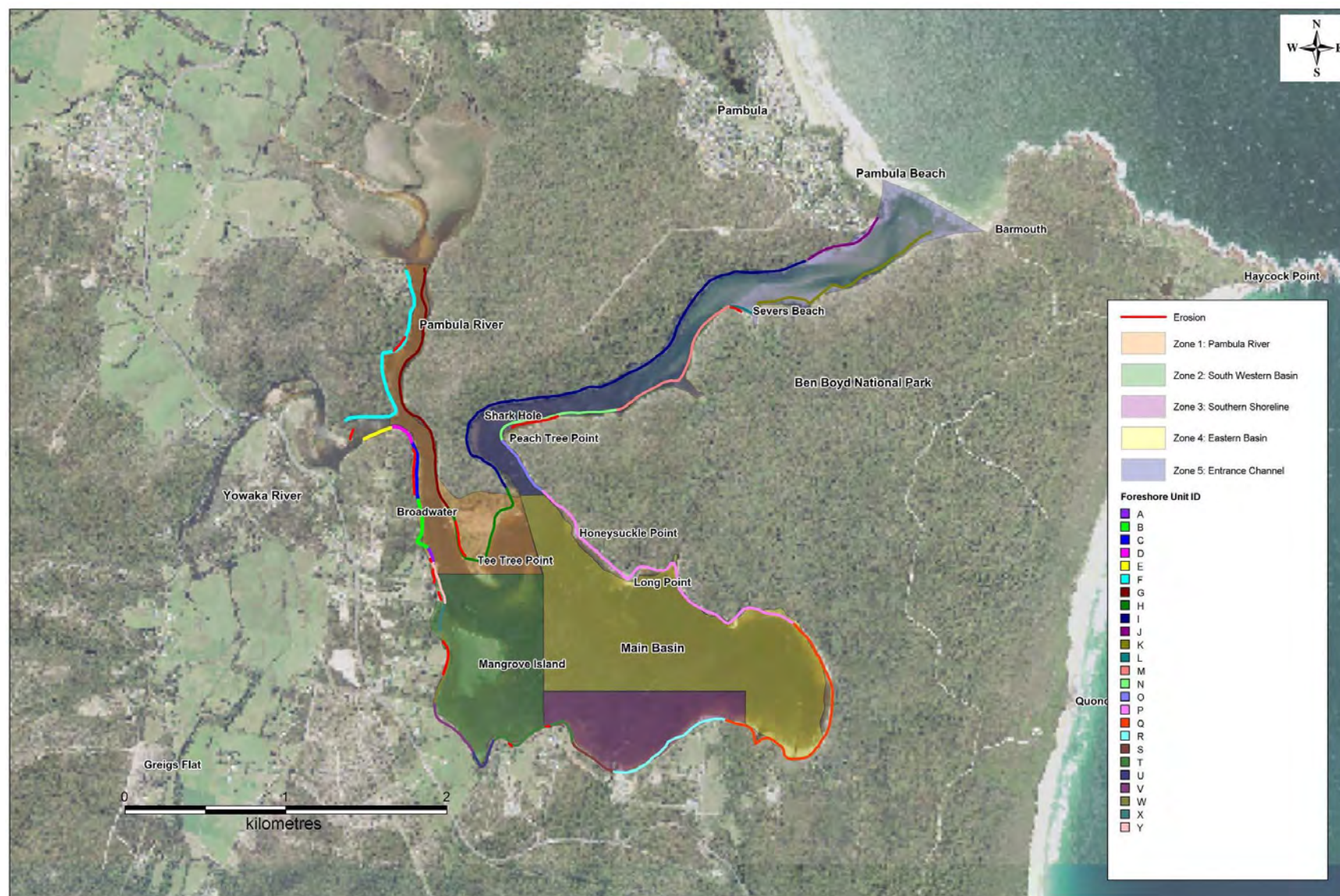


Figure 3-5 Bank Condition Assessment Findings (Cardno, 2012)

3.3.2 Fluvial

Fluvial Processes

The Pambula Catchment Rehabilitation Plan (SRCMA, 2012) was prepared in recognition of the impacts that catchment activities were having on Pambula Lake. It was prepared to identify priority reaches and actions to address these issues and ensure that future investments are strategically targeted to achieve wide-scale and long-term improvements in the condition of major streams and ultimately Pambula Lake.

SRCMA (2012) identifies that the Pambula Lake catchment was historically subject to a number of key changes including clearing for timber, clearing of riparian vegetation for grazing, mining (primarily Yowaka catchment), rubble extraction on the Pambula River and also gravel extraction on the Yowaka River. These changes, particularly the earlier catchment landuse changes were understood to have changed catchment hydrology with resultant waterway hydraulic and morphologic responses. The outcomes have included channel straightening, increased sedimentation and water quality impacts. Sections of the Pambula River are even documented to have changed course in response to flood events.

While these key modifying events occurred in the past, SRCMA (2012) identify that most reaches have adapted to new states, are relatively stable and in phases of recovery, but threatening processes still exist. These include movements of excess sediments on stream beds, agricultural/urban land use, weeds and sediment loads from road and forestry activities.

Fluvial Condition

To assess current condition and priorities for rehabilitation, SRCMA (2012) have applied a River Styles assessment to the catchment which has been supplemented with biophysical condition, recovery potential, and socio-economic values to assist in establishing priorities. As noted in Cardno (2012) the River Styles approach is not normally applied to tidal lakes or inlets.

Provided in Figure 3-6 is an excerpt from the Pambula Catchment Rehabilitation Plan which identifies the geomorphic condition of major streams in the catchment.

The geomorphic condition methodology used was based on a reaches ability to adjust within current flow and sediment characteristics. The method included assessment of channel attributes, river planform and bed character. Poor condition reaches are sensitive to change and tend to propagate degradation throughout a catchment with significant off-site impacts. Good condition reaches are less sensitive or more resilient to the effects of change.

In relation to the estuary (see Figure 3-6) the entrance channel, basin, and lower reaches of the Pambula and Yowaka were assessed as moderate condition with the upper sections of the rivers to their tidal limits being assessed to be in poor geomorphic condition. The presence of poor condition reaches in the catchment suggests that if not addressed these impacts may propagate and ultimately impact further on the largely moderate condition reaches of the estuary.

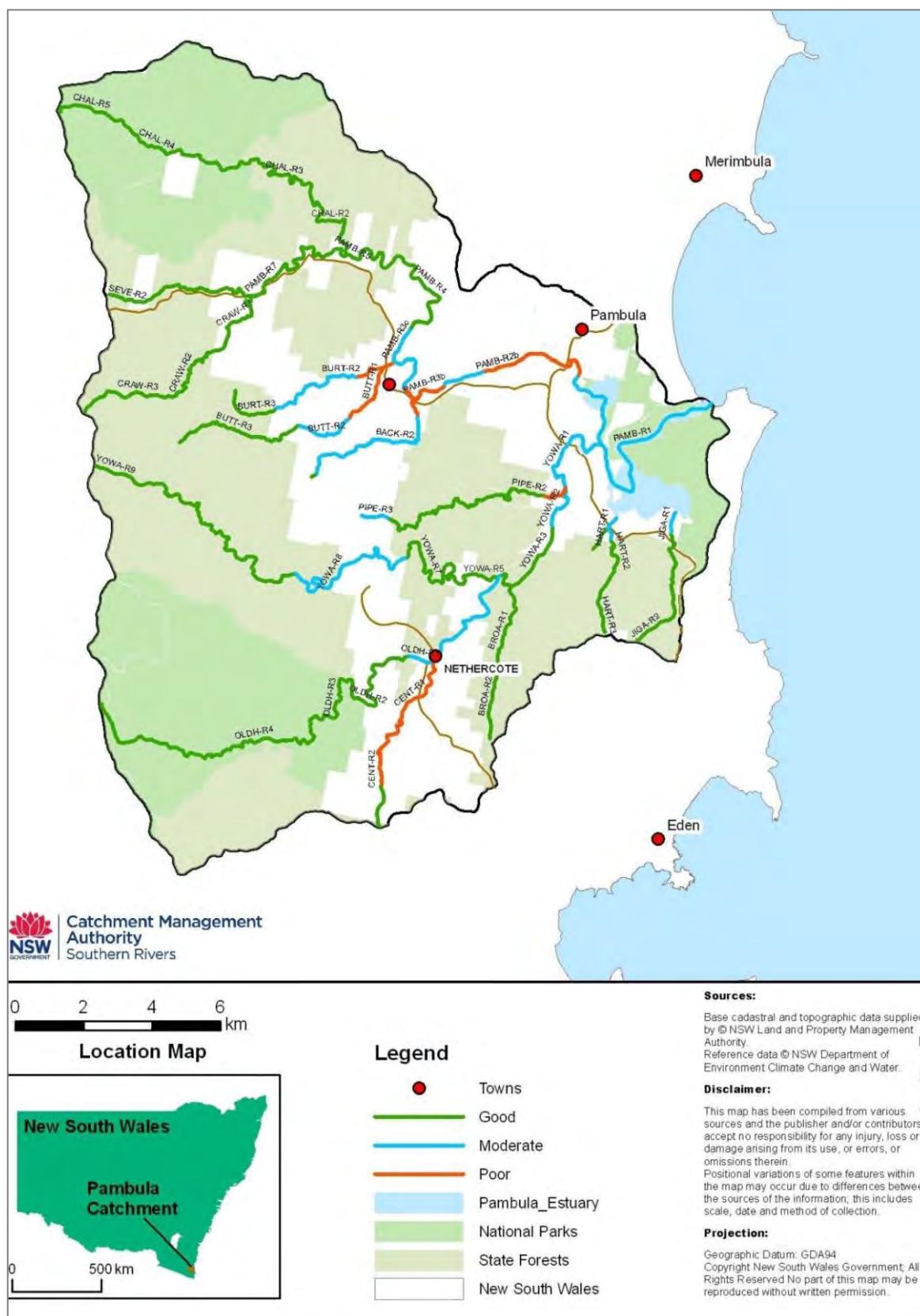


Figure 3-6 Geomorphic condition of major streams in the Pambula River Catchment (SRCMA, 2012)

3.3.3 Coastal Estuary Interface (Entrance)

Key Processes

The lower reaches of the estuary are typically in a form of dynamic equilibrium between the controlling forces of the tidal and fluvial activity of the river and the littoral processes of the adjacent beaches. As such, the configuration of the river, entrance channel and adjacent coastline is continually changing under the natural variability of the prevailing conditions. As these changes occur, the associated hydraulic, water quality, sedimentation and erosion characteristics of the estuary also change in response.

Figure 3-7 provides a schematic flow chart of the state of estuarine entrances. These patterns are most applicable to wave-dominated inter-barrier type estuaries, but are likely to be applicable to the Pambula Lake estuary as well (noting it is a wave-dominated, drowned river valley estuary). Cardno (2012) identifies that the entrance displays tidally formed sand waves on the upper surface of the flood-tide delta, which extends approximately 1.5km up the tidal inlet channel, indicating an upstream transport of sand by wave action and tidal currents in this location. Furthermore, it was identified through a review of aerial photography and anecdotal evidence from community members that the entrance is morphologically dynamic (i.e. subject to change), and that the entrance channel can become constricted due to progradation of the flood-tide delta.

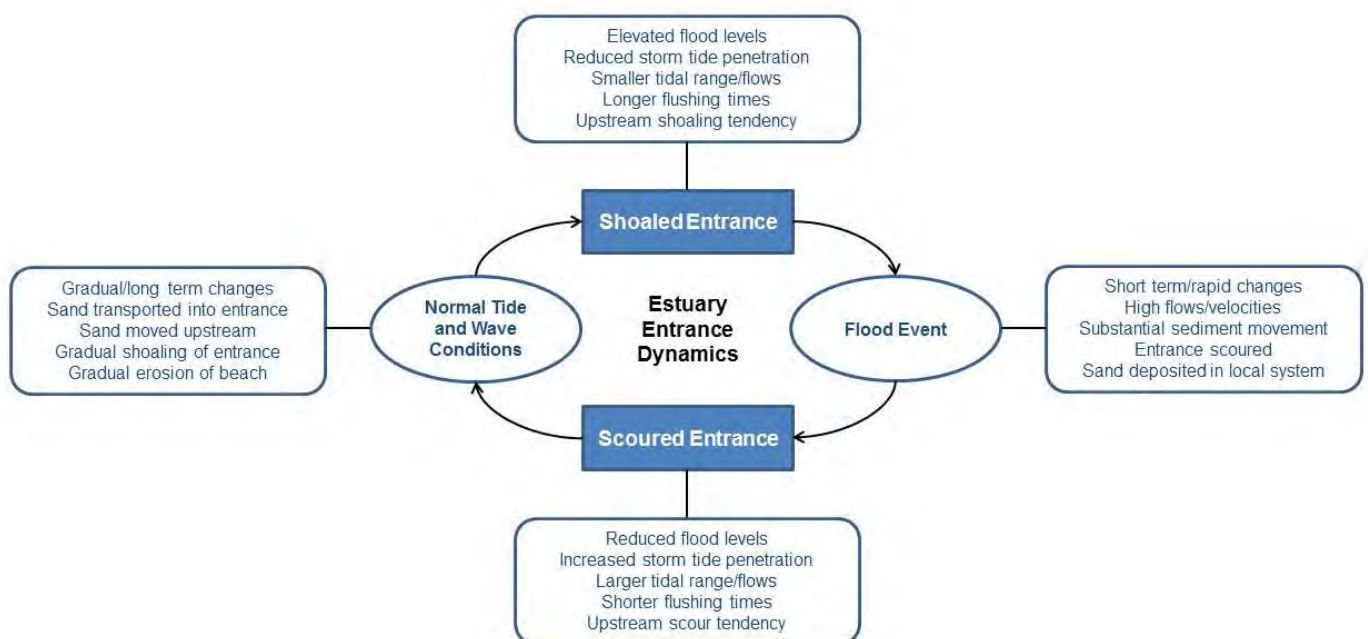


Figure 3-7 Schematic Flow Chart Showing Cycle of Entrance Conditions

Condition

To quantify the potential effect of a potentially changing entrance on tidal planes and exchange, and hence associated effect on resultant water quality and ecological processes, Cardno (2012)

completed a tidal harmonic analysis of around 20 years of hourly water level data available for the Pambula Lake estuary (covering 1991 to 2010).

The assessment identified that there had been a long term reduction in the Mean High Water Spring (MHWS) and a long term increase in the Mean Low Water Spring (MLWS) tidal planes. The combined effect over the period equated to an average of 4.3 mm/year reduction in these tidal planes. The identified cause of the tidal plane reduction was the ingress of marine sands into the entrance channel resulting in a net accretion of the marine tidal delta, with the likely effect of reducing estuarine flushing capacity over this time. These findings accord with observations of made by local fisherman and oyster growers who considered that the main entrance channel had become gradually shallower over the past decade or so (Cardno, 2012). MHL in 2012 also a similar tidal plane analysis which generally supported the findings of the earlier Estuary Processes Study.

At this stage, the reduced tidal exchange (increased flushing time) being experienced within the Pambula estuary has not been identified to have resulted in any significant reductions in water quality (refer to Section 3.5, Page 53). However, given the very extensive use of oyster aquaculture in the Pambula Lake estuary, maintenance of high water quality by its historically short flushing times may become critical should further significant declines in estuarine flushing occur. Hence, observing changes in entrance conditions and tidal planes over time may be an important consideration for the future management of the estuary.

Catchment Inflow Effects on Condition

As depicted in Figure 3-7 entrance dynamics are likely to shift between phases of normal and flood affected. For floods to affect the estuary entrance, they need to be of sufficient magnitude to generate flow velocities that can mobilise sand and scour the entrance. Assessments completed by Cardno (2012) using a calibrated hydrodynamic model suggest that smaller more frequent flood events, such as the 1 year ARI event, mostly result in scour in the upper reaches of the estuary. Larger events, such as the 10 year ARI event or greater, however, are likely to result in significant entrance scour (where velocities exceed 1 m/s).

Data presented in Cardno (2012) indicates:

- There were up to five separate events over the period from 1968 to 2010 that were equivalent or greater to a 10 year ARI event;
- The last significant flood event occurred in 2000 with flows just reaching the 10 year ARI level, with the previous 10 year ARI flood (or greater) occurring in 1992; and
- The period from 1988 to 1992 provided many floods within the Pambula River catchment with at least six floods greater than a 1 year ARI, 3 of which were greater than a 5 year ARI and 2 of which were greater than a 10 year ARI, with the 1992 flood being a very significant flood (ARI unknown). Hence the estuary may have been significantly scoured during this period, and it has been in a phase of infilling since.

These observations suggest that the potentially broader climatic cycles (such as ENSO IPO) may play a contributing factor in the entrance channel accretion observed over the period of 1991 to 2010.

3.4 Ecological Processes and Condition

The Pambula estuary contains four broad functional zones (Nichol 1991; Roy et al. 2001):

- Marine flood-tidal delta;
- Central mud basin;
- Fluvial delta; and
- Riverine channel/alluvial plain.

Each of these zones corresponds to mappable sedimentary environments (refer Figure 3-4) that have characteristic water quality, nutrient cycling/primary productivity signatures and ecosystems (Roy et al. 2001). The Roy et al. (2001) classification scheme has been adopted here to describe ecosystem condition, values and pressures operating in different parts of the estuary.

3.4.1 Important Ecological Components and their Condition

The Pambula estuary supports a wide range of habitats, communities and species (i.e. ecological components), which provide a range of values from environmental, social and economic perspectives.

Table 3-2 is a list of ecological components that are considered to be especially important in terms of supporting:

- Features of high conservation significance (i.e. threatened species and conservation areas); and
- Important ecosystem services (i.e. the benefits that people receive from ecosystems);

The following briefly describes each ecological component. Figure 3-8 is a conceptual model illustrating known and likely interactions between key ecological assets and drivers.

Table 3-2 Important ecological components in the Pambula estuary

Component	Zones represented	Key values supported
Seagrass meadows	<ul style="list-style-type: none"> Entrance (limited) Central basin (fringing) Fluvial delta (extensive) Riverine channel/alluvial plain (limited) 	<p>Conservation Values:</p> <ul style="list-style-type: none"> Present in nationally significant wetland listed in DIWA (<i>Pambula Estuarine Wetlands – NSW122</i>) Present in SEPP14 wetland <p>Ecosystem Services:</p> <ul style="list-style-type: none"> High value fisheries habitat Bed stabilisation Water quality regulation
Floodplain wetlands	<ul style="list-style-type: none"> Central basin (limited) Fluvial delta (limited) Riverine channel/alluvial plain (Pambula River – extensive) 	<p>Conservation Values:</p> <ul style="list-style-type: none"> Nationally significant wetland listed in DIWA (<i>Pambula Estuarine Wetlands – NSW122</i>) EEC (Coastal saltmarsh) SEPP14 wetland <p>Ecosystem Services:</p> <ul style="list-style-type: none"> Fisheries production (high quality habitat) High value waterbird habitat Water quality regulation Foreshore protection
Riparian vegetation	<ul style="list-style-type: none"> All zones 	<p>Conservation Values:</p> <ul style="list-style-type: none"> National Park <p>Ecosystem Services:</p> <ul style="list-style-type: none"> Foreshore protection Water quality regulation (limited) High value waterbird habitat
Soft-sediment habitats and benthic micro-flora and fauna communities	<ul style="list-style-type: none"> All zones 	<p>Ecosystem Services:</p> <ul style="list-style-type: none"> Fisheries production Waterbird food resources (see Waterbird communities below) Water quality regulation
Suitable water quality for oyster production	<ul style="list-style-type: none"> Central basin Marine flood / tide delta 	<p>Ecosystem Services:</p> <ul style="list-style-type: none"> Food production Water quality regulation
Fish communities	<ul style="list-style-type: none"> All zones 	<p>Ecosystem Services:</p> <ul style="list-style-type: none"> Fisheries production
Waterbird communities	<ul style="list-style-type: none"> All zones, particularly riverine channel/alluvial plain 	<p>Conservation Values:</p> <ul style="list-style-type: none"> Threatened and migratory species

Lake Processes and Condition

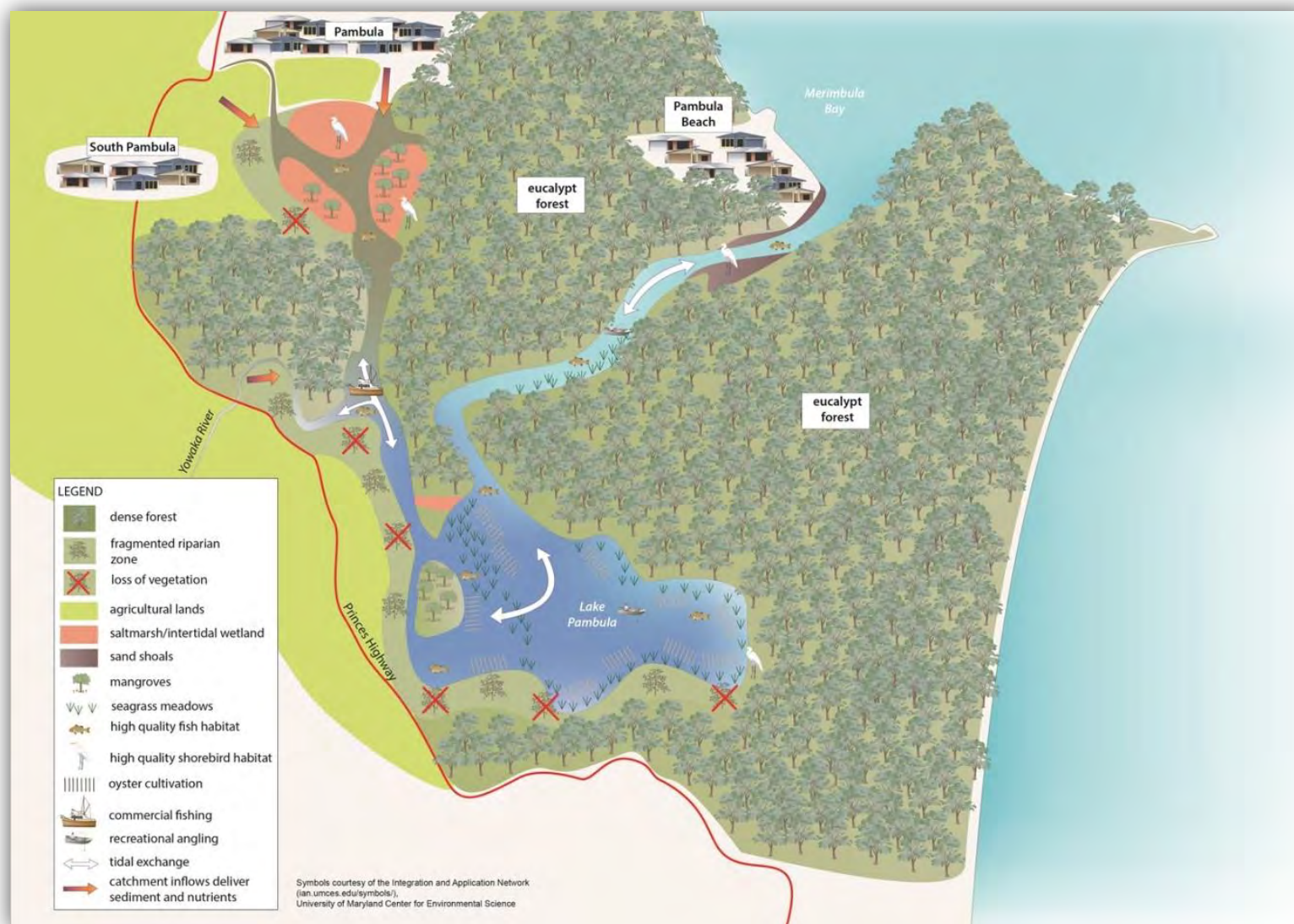


Figure 3-8 Conceptual model showing interactions between assets and drivers

3.4.2 Seagrass Meadows

Description and Drivers

Seagrass meadows are present in all zones. In the entrance channel seagrass is restricted to quiescent, shallow areas, and is comprised of mixed beds of *Posidonia* and *Zostera*. The central mud basin had a broad fringe of *Posidonia*, with *Zostera* present in shallow waters. Broad *Posidonia*, *Zostera* and *Halophila* meadows were present on the fluvial delta, whereas only small patches of *Zostera* were mapped in the riverine channel/alluvial plain.

Condition

The estuary experiences excellent water conditions (low turbidity and nutrients; Roper et al. 2011), and seagrass meadows were reported to be in 'good' condition (Roper et al. 2011; Cardno 2012). Changes to seagrass meadows occur in response to major changes in environmental characteristics, and therefore changes to seagrass meadow extent represent a robust condition indicator.

Several workers have mapped seagrass meadow extent in Pambula estuary, and results from these studies are presented in Figure 3-9. Notwithstanding differences in mapping error, it is apparent that seagrass meadow extent varies over time, expanding and contracting in response to processes described above (see for example Figure 3-10). It is however not clear whether there has been a long-term decline in seagrass meadow extent, and no studies to date have specifically determined the relative importance of different processes in regulating seagrass meadow extent in Pambula estuary.

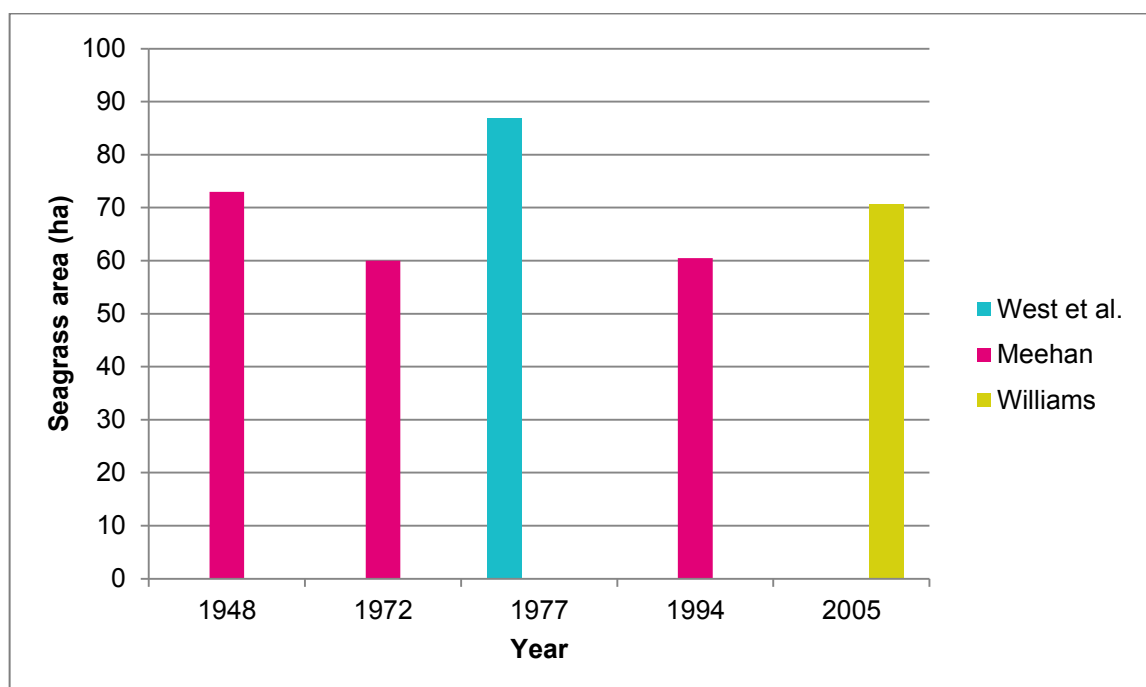


Figure 3-9 Extent of seagrass mapped in Pambula estuary over time (Sources: West et al. 1985; Meehan 1997; Williams 2006)



Figure 3-10 Changes to seagrass meadows in the Pambula estuary entrance channel, 10/4/2005 (above) and 22/3/2013 (below) (Google Earth imagery)

3.4.3 Floodplain Estuarine Wetlands

Description and Drivers

The floodplain wetlands of the Pambula estuary are comprised of a suite of vegetation types including mangrove forest, saltmarsh, *Melaleuca* and *Casuarina* forest. The largest area of estuarine wetlands occur in the upper reaches of the riverine channel/alluvial plain; the Pambula Estuarine Wetlands. The Pambula Estuarine Wetlands has high conservation values, supporting a diverse range of wetlands types and threatened ecological communities including coastal saltmarsh and freshwater wetlands. In recognition of these values, the wetland is listed on the Directory of Important Wetlands in Australia (DIWA) as a wetland of national importance, and is also a SEPP 14 wetland.

Large areas of saltmarsh occur on the fluvial delta, and an extensive area of mangrove forest (with saltmarsh) is present in the western sector of the central mud basin. Small areas of saltmarsh and mangroves occur in places elsewhere along the central basin, and at the upstream section of the entrance channel.

The health, distribution and structure of estuarine wetland habitats would be controlled by complex interactions between tidal and fluvial processes, which together control water levels, flushing, substrate stability, sediment types, salinity and a range of biogeochemical processes and biological interactions. Community structure can vary markedly at a variety of timescales in response to changes in these processes. The incursion of mangroves into saltmarsh habitat is considered the cause of saltmarsh loss in many estuaries (Saintilan and Williams 1999; Wilton 2002).

Condition

Temporal changes in mangrove and saltmarsh extent has been quantified at Pambula (and nearby Merimbula) estuary between 1948 and 1994 (Meehan 1997; Figure 3-11). There was an 83% increase in mangrove area during this period, but a 40% decline in saltmarsh area between 1948 and 1994. Similar trends were observed at nearby Merimbula Lake. The estuary switched from a saltmarsh dominated system to a mangrove dominated system within a period of 46 years. A notable finding was that the overall total area of estuarine vegetation (mangrove + saltmarsh) showed very little change (72 ha in 1948 c.f. 70.3 ha in 1994), which indicates that mangroves had replaced saltmarsh communities. Mangrove and saltmarsh extent has been mapped in the 1980s (West *et al.* 1985) and 2006 (Williams 2006). The two studies used different mapping approaches, and therefore results are not directly comparable.

The State of the Catchments report (Roper *et al.* 2011) for Pambula estuary classified saltmarsh as being in 'fair' condition and mangroves as 'good' condition. The findings of Meehan (1997) support this conclusion.

Weed invasion and historical disturbance (clearing, draining, grazing) have adversely affected wetland condition, structure and extent in places, particularly in the Pambula Estuarine Wetlands. Extensive rehabilitation work has been carried in the Pambula Estuarine Wetlands in order to reinstate flows and restore vegetation.

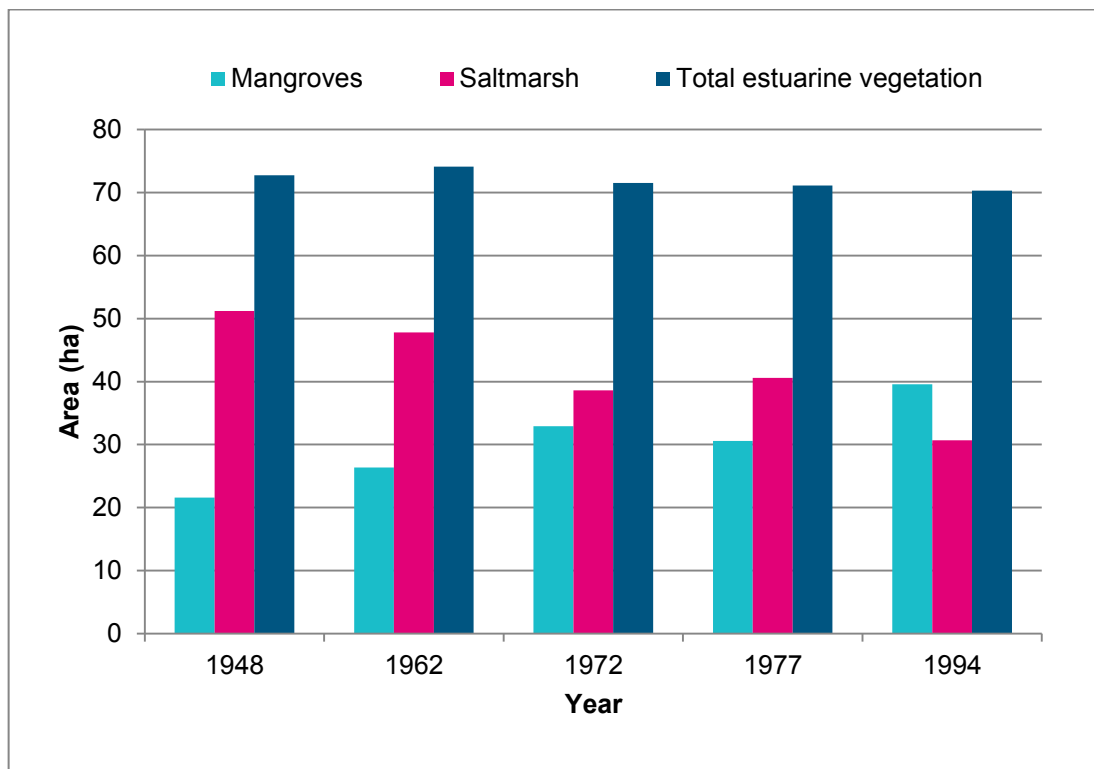


Figure 3-11 Changes in the extent of mangrove and saltmarsh between 1948 and 1994 at Pambula estuary (Source: Meehan 1997)

3.4.4 Terrestrial Riparian Vegetation

Description and Drivers

The estuary is surrounded by large tracts of largely undisturbed forest. Most of the land surrounding the entrance channel and eastern section of the central mud basin is located within Ben Boyd National Park, and is largely in-tact. The exception to this is the village of Pambula Beach at the mouth of Pambula River. The catchment areas directly adjoining the other sections of the central basin, fluvial delta and downstream sections of the riverine channel/alluvial plain contain a mosaic of Eucalypt forest and patches of clearing, but the foreshore vegetation is present for most of its length. The catchment areas directly adjacent to Pambula Estuarine Wetlands in the upstream reaches of the riverine channel/alluvial plain are largely cleared.

Hydrological processes, soil types, fire regimes and biological interactions (competition) would ultimately control patterns in riparian vegetation community structure. Disruptions to these processes could result in changes to community structure.

Terrestrial riparian vegetation provides a range of ecosystem services, including foreshore protection, water quality regulation and a buffer between development and the estuary. Riparian vegetation support a range of biodiversity/conservation values, most notably habitat and movement corridors for terrestrial fauna (including threatened species such as the yellow-bellied glider *Petaurus australis*, glossy black cockatoo *Calyptrorhynchus lathami* and masked owl *Tyto novaehollandiae*). Large sections of the eastern and southern foreshore of Pambula estuary are located in Ben Boyd National Park.

Condition

Weed invasion, historical disturbance (clearing, grazing), current-day agriculture, urbanisation and foreshore erosion would represent key pressures to vegetation communities. There is limited information describing the effect of these pressures on riparian vegetation community condition in the estuary.

SRCMA (2012) mapped riparian vegetation condition in the Pambula River catchment, and results are presented in Figure 3-12. Most of the riparian vegetation along the estuary was mapped as being in good condition. However, the upper estuary and tributary streams were mapped as degraded to Good/Average, due to catchment clearing as described above. Particular areas of note that should be a priority for riparian rehabilitation include (in relation to the estuary) upper tidal sections of the Pambula and Yowaka River (identified as degraded).

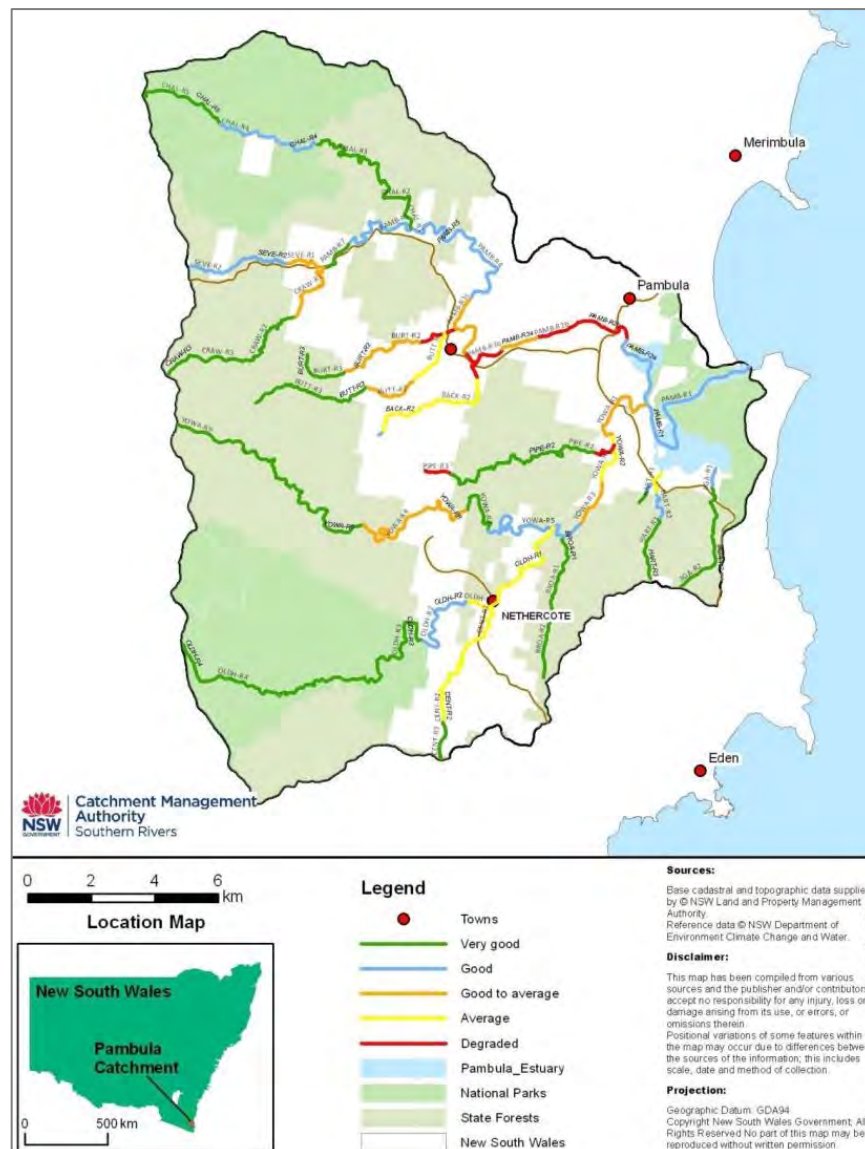


Figure 3-12 Riparian vegetation condition of major stream in the Pambula River Catchment (SRCMA, 2012)

3.4.5 Soft-Sediment Habitats and their Benthic Fauna Communities

Description and Drivers

Soft sediment habitats are the largest habitat type in the estuary. The environmental characteristics of these habitats vary among zones, reflecting dominant hydrodynamic and morphological processes in the estuary. Thoms and Bergs (1994) mapped sediment facies in the estuary and found that:

- The entrance channel is dominated by marine sands and contains beaches near the mouth, shoals in the lower reach, and subtidal sand channel environments. Marine sands comprised 10.5% of the estuary (i.e. marine flood-tidal delta zone);
- The fluvial delta and riverine channel/alluvial plain contain sand shoals and channels comprised of coarse terrigenous sands. Fluvial granules and coarse/very coarse sand comprised 72.8% of the estuary (i.e. fluvial delta and floodplain zones); and
- The central mud basin contains large mud banks and subtidal lagoonal muds, with isolated sand beach pockets in places. Fine sands/silt/clay comprised 16.7% of the estuary (i.e. central mud basin zone).

There is no information to assess the characteristics of benthic fauna communities in the estuary.

Condition

Given the excellent water quality conditions of the estuary, it is not expected that there has been a fundamental shift in the state of these communities.

3.4.6 Fish Communities

Description and Drivers

There have been few empirical surveys of fish communities in the estuary. West and Jones (2001) undertook a fish survey (using standardised seine net hauls) in February and July 1998 throughout a number of southern NSW estuaries, including Pambula estuary. A total of 23 species from 15 families were recorded in the estuary. The most abundant species was luderick *Girella tricuspidata* and glassy perchlet *Ambassis jacksoniensis* overall. Eight species of direct fisheries significance were recorded.

The structure and condition of estuarine fish communities is controlled by processes operating across multiple scales (Harrison and Whitfield 2006; Breine 2009; Vilar et al. 2013). The large surface area, permanently open entrance, high diversity and large extent of high quality fish habitats and limited catchment development are likely to be especially important in maintaining rich and abundant fish communities. The estuary is also extensively fished (commercial netting and recreational line fishing), which is expected to effect the abundance of target species.

Condition

Table 3-3 provides fish community condition metrics for Pambula estuary based on the findings of Roper et al. (2011). Overall, Pambula estuary was rated as good, with a condition score of 4 out of 5. By comparison, the average index score for south coast estuaries was 3.26 ($n = 31$ estuaries),

and Pambula estuary had the fifth highest index score in the south coast region. Consistent with other estuary health metrics, these results indicate that Pambula estuary was in good condition.

Table 3-3 Fish condition metrics for Pambula estuary (Roper et al. 2011)

Indicator Type	Indicator	Expected stress response	Pambula Condition Rating (1 lowest, 5 highest)
Species diversity and composition	Species richness	Reduced	5
	Protected sp.	Absent	5
	Introduced sp.	Present	3
	Species occurrence	Reduced	5
Species abundance	Sp. relative abundance	Reduced	3
	Most abundant sp.	Reduced	3
Nursery function	No. estuarine resident taxa	Reduced	3
	No. estuarine dependent marine taxa	Reduced	3
	Rel. abundance of estuarine resident taxa	Very low or high	5
	Re. abundance of estuarine dependent taxa	Very low or high	3
Trophic integrity	No. benthic invert. feeding taxa	Reduced	5
	No. piscivorous taxa	Reduced	5
	Rel. abundance of benthic invert feeders	Reduced	5
	Rel. abundance of piscivore taxa	Reduced	3
Total	Estuarine fish community index score	Low	56/70
	Index rating	Poor	Good
	Index score	Low	4

*1 = poor, 5 = excellent

3.4.7 Waterbird Communities

Description and Drivers

There is very little information on the waterbird communities of Pambula estuary (Cardno 2012). The Panboola Plan of Management (Ironout VCA, 2006) lists 25 waterbird species in the Panboola wetlands, which forms part of the Pambula Estuary Wetland in the riverine channel/alluvial plain zone. This wetland also includes both estuarine and freshwater environments (including billabongs), and is likely to be a locally important waterbird habitat in the Pambula River catchment.

Cardno (2012) provided a 'species list' for the South East Coastal Plains Sub-region which included four endangered species and two vulnerable bird species within mangrove and/or saltmarsh habitat. It is possible that this species list is based on a search of the Environment and Heritage on-line database. A search of this database (It is expected that the estuary would provide a range of

Lake Processes and Condition

functional values for waterbirds, including breeding areas, and feeding and roost sites. Intertidal flats are relatively small which probably limits the values of the estuary as a feeding habitat for species that rely on this habitat. The saltmarsh and other wetland areas in fluvial delta and riverine channel/alluvial plain are expected to provide feeding and breeding habitats for a wide range of waterbird species.

The main processes that would be important in controlling waterbird abundance and community structure will vary among species groups. The population size of many migratory waders is thought to be declining in response to habitat loss in the north Asian breeding grounds. At local spatial scales, important controls on abundance are likely to include feeding and roost habitat availability (which is partly a function of tidal water levels), and availability of prey resources.

Condition

There is no available information regarding the 'condition' of waterbird populations and communities within the estuary, or even the CMA. This is considered to be an information gap.

Table 3-4) identifies these species and an additional four threatened migratory waders and other waterbirds as known or expected to occur in the South East Coastal Plains Sub-region within 'mangrove swamps' or saltmarsh.

It is expected that the estuary would provide a range of functional values for waterbirds, including breeding areas, and feeding and roost sites. Intertidal flats are relatively small which probably limits the values of the estuary as a feeding habitat for species that rely on this habitat. The saltmarsh and other wetland areas in fluvial delta and riverine channel/alluvial plain are expected to provide feeding and breeding habitats for a wide range of waterbird species.

The main processes that would be important in controlling waterbird abundance and community structure will vary among species groups. The population size of many migratory waders is thought to be declining in response to habitat loss in the north Asian breeding grounds. At local spatial scales, important controls on abundance are likely to include feeding and roost habitat availability (which is partly a function of tidal water levels), and availability of prey resources.

Condition

There is no available information regarding the 'condition' of waterbird populations and communities within the estuary, or even the CMA. This is considered to be an information gap.

Table 3-4 Threatened waterbirds known or predicted to occur in the South East Coastal Plains Sub-region (Office of Environment and Heritage 2014a on-line database)

Common name	Species name	Habitat**	TSC Act	EPBC Act	Regional distribution**
Beach stone-curlew	<i>Esacus magnirostris</i>	Intertidal flats, rocky shores, mangroves	Critically Endangered	Marine	Vagrants only in SE NSW, most abundant in northern Australia*
Orange-bellied parrot	<i>Neophema chrysogaster</i>	Bays, lagoons, saltmarsh	Critically Endangered	Critically Endangered, Marine	Vagrants only in SE NSW*
Pied oystercatcher	<i>Haematopus longirostris</i>	Intertidal flats, rocky shores	Endangered	Not listed	Australian coastline, most common in

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Common name	Species name	Habitat**	TSC Act	EPBC Act	Regional distribution**
					Victoria and Tasmania. Occasionally observed I NSW.
Little tern	<i>Sternula albifrons</i>	Sandy beaches	Endangered	Marine, Migratory	Northern, eastern and south-east Australia
Australasian bittern	<i>Botaurus poiciloptilus</i>	Floodplain wetlands (freshwater)	Endangered	Endangered	SE Australia.
Sanderling	<i>Calidris alba</i>	Sandy beaches, intertidal flats, rocky shores	Vulnerable	Marine, Migratory	Rarely recorded south of Shoalhaven. Unlikely to be key habitat
Black bittern	<i>Ixobrychus flavicollis</i>	Vegetated wetlands - flooded grassland, forest, mangroves	Vulnerable	Not listed	Rarely recorded south of Shoalhaven. Unlikely to be key habitat
White-fronted Chat	<i>Epthianura albifrons</i>	Open vegetated wetlands - flooded grassland, saltmarsh	Vulnerable	Not listed	Throughout southern Australia
Black-tailed godwit	<i>Limosa limosa</i>	Sandy beaches, intertidal flats, mudbars	Vulnerable	Marine, Migratory	Occasional records throughout NSW.

*OEH predicts occurrence of species in region based on habitats and regional distribution

**Based on species profiles in SPRAT (DoE 2014) and NSW Threatened Species Profiles (NSW OEH 2014)

3.4.8 Summary

Table 3-5 is a summary of trends in condition indicators for each of the important ecological components identified for the estuary.

Table 3-5 Important ecological components and trends in condition indicators

Component	OEH Condition Rating*	Trend in indicators
Seagrass meadows	(note data >3 years old)	↔ variable extent over time, no clear trend No available data on changes to seagrass depth range
Floodplain wetlands	Mangroves	↑ in extent based on Meehan (1997) Condition likely to be 'Good'
	Saltmarsh	↓ in extent based on Meehan (1997)
Riparian vegetation	N/A	↓ in extent since 1977 based on NSW Govt (unpublished data) Likely to ↔ in National Park

Lake Processes and Condition

Component	OEH Condition Rating*	Trend in indicators
		Condition likely to be 'Good'
Soft-sediment habitats and benthic fauna communities	N/A	? too few data to assess trend
Suitable water quality for oyster production	N/A	Condition likely to be 'Good'
Fish communities	(note data >3 years old)	? too few data to assess temporal trend
Waterbird communities	N/A	? too few data to assess temporal trends

* Source: Roper et al. (2011), where: good (green), fair (orange), baseline only (grey)

3.5 Water Quality and Ecosystem Health

3.5.1 Environmental Values and Water Quality Objectives

Water quality is an essential part of estuarine function and health. Measuring water quality is a useful way to track the condition of a system over time and used in combination with various biological indicators can be a powerful tool for system managers.

Water Quality Objectives (WQOs) are established to protect Environmental Values (EVs) particular to a waterbody. EVs are assigned by the community and stakeholders who utilise and manage the waterbody and generally represent aspirational goals for the current and future condition of that waterbody. EV's for Pambula Lake⁴ have been set by the OEH. Supporting the EVs are the WQOs. WQOs have been established by the OEH and they are the default trigger values for estuaries of this type as currently included in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC, 2000). These default trigger values are recommended for use where no locally specific guideline values exist (refer to lowland river and estuarine limits included in Tables 3.3.2 and 3.3.3, chapter 3, ANZECC 2000). Additional quantitative and qualitative WQOs exist for visual amenity, secondary contact recreation and primary contact recreation and aquatic foods.

Since this time, the OEH have developed draft Statewide trigger values for chlorophyll-a and turbidity to support its Monitoring, Evaluation and Reporting (MER) program. These trigger values are more specific to the estuaries of NSW (rather than all of Australia) and are included in the OEH (2013) sampling and analysis protocols which provides these trigger values.

3.5.2 Historical Water Quality

Provided below is a review of historical water quality data obtained from a variety of sources that assist in understanding water quality processes and issue areas in the estuary. Generally, the condition of water quality in Pambula Lake is determined by comparing recorded datasets at locations (medians) against the relevant WQOs.

Physico-Chemical Indicators

Cardno (2012) provides a description of available historical water quality data (i.e. comparison of median data results at monitoring locations against default trigger values) that identifies exceedences of guidelines values at the tidal limit of the Pambula River (for total nitrogen, enterococci [primary recreation], faecal coliforms, ortho-phosphorus and ammonia), Pambula Wetlands (for ammonia, total nitrogen, total phosphorus, enterococci [primary recreation] and chlorophyll-a) as well as the lower Pambula and Yowaka River for ammonia. It is noted that the historical data provides limited representation of conditions within the Pambula Lake itself with most monitoring focusing on the tributaries.

In this regard, Council and OEH engaged Elgin Associates to undertake environmental monitoring within Pambula Lake itself. To date twelve (quarterly) surveys have been undertaken from October 2010, through to July 2013. The program involved quarterly monitoring of surface water quality

⁴ Pambula Lake estuary is included as an estuary in the Towamba and Genoa Rivers region.

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and depth profiling across the basin of the lake using protocols consistent with the state-wide Monitoring Evaluation and Reporting (MER) program. Currently the program records primarily microalgal abundance as phytoplankton (determined by chlorophyll-a) and also water clarity as turbidity. Key findings of these water quality surveys include:

- Chlorophyll-a – displays a cyclical effect with highest readings occurring in summer and lowest in winter. Summer concentrations typically exceed OEH guideline values, although the 80th percentile value of all data is lower than the OEH guideline value.
- Turbidity – during ambient conditions turbidity is well below the OEH guideline value. During non-ambient conditions (i.e. catchment flow events) inflows of freshwater and sediment into the central lake result in elevated turbidity and changes in water colour. However, the 80th percentile value of all data remains lower than the OEH guideline value.
- Nitrogen Compounds – Total nitrogen (TN) results were mostly below the ANZECC limit apart from during significant catchment flow events which elevate TN levels. The majority of nitrogen was found to be in organic forms. Nitrogen oxide (NOx) concentrations and ammonia concentrations were found to exceed ANZECC trigger values on approximately half of all sampling occasions. The levels and timing of the exceedence were not identified.
- Phosphorus Compounds – Total Phosphorus (TP) results were consistently below the ANZECC limit, even during significant catchment flow events. Mean ortho-phosphorus concentrations exceeded the ANZECC guidelines on approximately half of all sampling occasions.

Algae

Previous studies indicate that chlorophyll-a levels were generally below guideline values. The highest chlorophyll-a concentrations were evident in the upper reaches of the estuary where the highest nutrient levels and longest residence times were observed. The Oyster Monitoring Program Reports Parts 1, 2 and 3 (Oyster Information Portal, 2014) identified that the proportion of harmless algae (typically diatoms) was always much larger than the level of harmful algae (typically dinoflagellates) in the Pambula Lake.

Bacteria

Monitoring sites in the Pambula River (i.e. above and at the tidal limit) and at the Pambula wetlands site were identified as exceeding primary contact recreation guidelines for enterococci and/or faecal coliforms. The presence of (thermo-tolerant) faecal coliforms and enterococci may indicate human faecal contamination, however these bacteria can be found in the intestines of other warm blooded animals and birds and thereby represent contamination from other sources. The exceedences in the Pambula River may represent the effects of high catchment discharges to this section of the river.

Water Quality Profiles

Water profiling was reported by Cardno (2012) and also by Elgin Associates (2012). The profiling activities identified that dissolved oxygen (DO) conditions were generally very good throughout the water column and did not markedly decline with increasing depth, indicating a well-mixed water body. However, differences between the surface and benthic zone water quality do occasionally occur. During periods of higher freshwater inflows differences were observed for DO, electrical

conductivity and temperature, suggesting a distinct 'salt wedge' was present in the estuary. Other findings of the profiling activities were that the photic depth (i.e. depth to which there is sufficient light penetration to permit photosynthesis), is greater than the depth of the lake. This indicates that both benthic and pelagic algae may contribute to primary production in the lake.

High Flow Response

As outlined in the preceding discussions, the estuarine conditions change from ambient conditions during periods of high catchment flows, previous monitoring activities have identified that these events can result in the following differences in physico-chemical properties, in addition to the profile differences described above: elevated turbidity and nutrients; and reduced dissolved oxygen, conductivity and pH.

3.5.3 Summary

In consideration of all available datasets it is apparent that the Pambula Lake estuary maintains a very high standard of water quality during ambient (i.e. normal) conditions. Monitoring completed within Pambula Lake, Pambula River and Yowaka River identified only minor and periodic exceedences of the ANZECC default trigger values for nitrogen oxides, ammonia and ortho-phosphorus. No specific reasons or drivers for the exceedences have been identified in the supporting literature, but may be related to reduced tidal flushing times in the upper reaches of the tributaries.

Work completed by Elgin Associates (2012) identified that the 80th percentile values for turbidity and chlorophyll-a derived from all transects completed during the twelve quarterly surveys are below the current Statewide MER trigger values, and the identified lower values could be adopted as new site specific trigger values.

Monitoring sites upstream and downstream of the Oaklands site in the Pambula River are above or at the tidal limit of Pambula River, respectively. Monitoring data identified exceedences of total nitrogen, enterococci (primary recreation); faecal coliforms (primary recreation), ortho-phosphorus and ammonia. While the magnitude of the exceedences was not large they were out-of-step with the high quality water observed elsewhere in the estuary.

Pambula Lake also displays a fairly typical response (for its estuary type and size) to large catchment inflow events which are characterised by sometimes significant changes and reductions in estuarine water quality. These reductions and differences are obvious across the estuary and also through the water column where the estuary has been noted to form a salt wedge during periods of high freshwater inflow. It is suggested that these effects are likely to be short-lived, i.e. for a period of days to weeks, and not months as may be observed in deeper and closed waterbodies. Mixing processes in Pambula Lake, driven by tidal flushing and wind, are considered to be effective in maintaining a well-mixed waterbody.

The State of the Catchments (SOC) 2010 report (DECCW 2011) provides summary water quality condition ratings for Pambula Lake. These results are based on Monitoring Evaluation and Reporting (MER) data collected up to 2009 and these are included in Table 3-6.

Table 3-6 Water quality components and trends in condition indicators (DECCW, 2011)

Component	OEH Condition Rating*	Trend in indicators
Chlorophyll –a	4 (Good) (note data >3 years old)	Unknown
Macroalgae	No data	No data
Turbidity	5 (Excellent)	Unknown

4 External Pressures

This section considers the actual and potential impacts of external pressures applied to the Pambula Lake estuary. Key pressures are related to human usage of the estuary, and other pressures such as climate change.

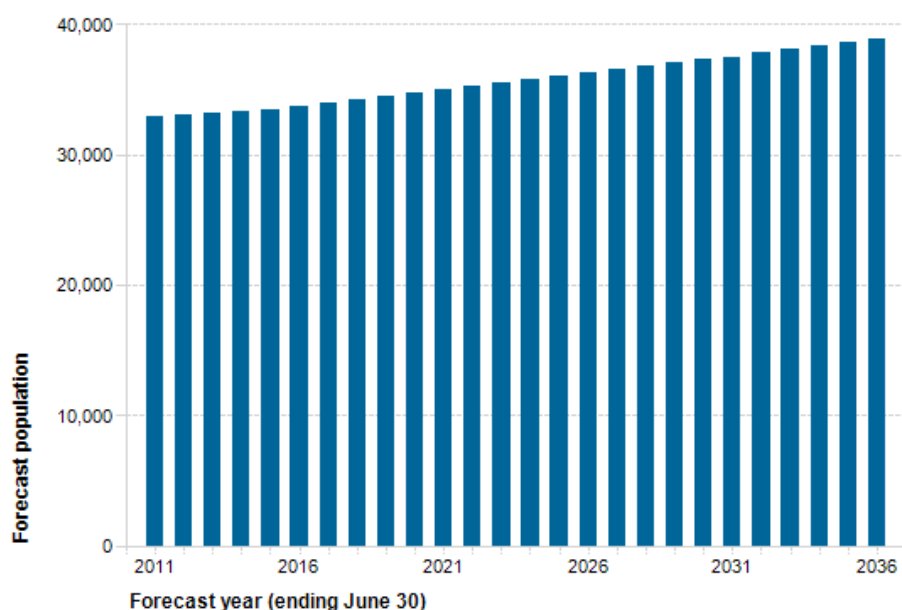
4.1 Catchment Use

Changes in catchment use (if unmanaged) can result in a myriad of related changes to catchment and estuarine processes which have the potential to impact on estuarine values. Catchment uses vary over time in response to a variety of factors including population growth (and associated expansion in urban and rural holdings), changes in industries that impact on the catchment such as forestry, agriculture, etc. Estuarine pressures associated with these changes are described below.

4.1.1 Population Growth

Population growth is a key driver for many of the pressures acting on the estuary. Population growth can drive increased catchment development which if unmanaged can change catchment hydrology, waterway morphology and nutrient and sediment inputs to the estuary. Furthermore, increased housing stock and population places additional demands on water supply and wastewater disposal networks. It also increases food requirements (e.g. increased grazing, horticulture, fishing pressure, etc) amongst many other impacts.

As shown in Figure 4-1, the Bega Valley Shire is forecast to experience a 17.7% increase in population size in the next 25 years (2014 to 2036), which is considered as modest on a state-wide scale.



Population and household forecasts, 2011 to 2036, prepared by .id, May 2013.



Figure 4-1 Forecast population for Bega Valley Shire (Source: ID 2013)

External Pressures

In relation to how this population growth will be catered for within the various catchments of the Bega Valley Shire, guidance is provided within the South Coast Regional Strategy 2006-31 which is a peak reference for Local Government Authorities in respect of growth planning. In light of the values of the south coast region (particularly its environmental values), the strategy indicates a focus on promoting appropriate activity (i.e. commercial and industrial) in existing town centres. It also encourages further densification of existing urban centres, as well as the prioritisation and management of future urban release lands to ensure that new development occurs in and around existing well serviced centres and towns. Council has recently adopted a new LEP and DCP (2013) which considers recommendations of the South Coast Regional Strategy 2006-31.

4.1.2 Hydrology

Due to the effects of catchment disturbance, (i.e., clearing, urbanisation, etc), catchment hydrology has changed since pre-European times. This is typified by reduced base-flows, increased total flow volumes and rates, and increased flow frequency (i.e. smaller rainfall events leading to more frequent flow responses in waterways). These effects can be significantly enhanced in urban areas due to the vastly modified nature of these catchments when compared to natural catchments.

OEH (2010) provides predicted changes in total catchment flows (base and surface flow combined) since pre-European times. The estimated percentage change in total flow is approximately 10% (increase) for the Pambula catchment. This is low on a state-wide basis as only about a third of estuaries have been predicted to have a lower change in total stream flows. Most of these estuaries reside in catchments with limited or no catchment modification.

Presently land use change impacts on hydrology are likely to be minor but have the potential to be impacted through continued modifications to catchment landuse, particularly conversion of forested lands to alternative uses, and increases in the imperviousness of catchments particular in urban areas (without suitable compensation). This conclusion does not reduce the potential for localised impacts of hydrologic changes to impact on estuarine condition, such as localised stream erosion resulting from increasing flow volumes, frequency and rate.

4.1.3 Diffuse Loads

Relative Changes in Pambula Catchment Diffuse Loadings

OEH (2010) provides predicted changes in diffuse catchment inputs (including total suspended solids, and total nutrients) since pre-European.

Consistent with the minor predicted changes in hydrology (see Section 4.1.2) the Pambula estuary is predicted to have experienced increases of 17% in TSS, 79% in TP and 30% in TN compared to pre-European times. These levels of increase are relatively low in comparison to those observed in other estuaries in NSW, and consistent with its low levels of catchment disturbance and urbanisation.

Information presented in the review of historical water quality (see Section 3.5.2, Page 53) identify that the estuary has excellent water quality consistent with limited diffuse loading inputs and high rates of oceanic exchange.

Areal Loading Distribution

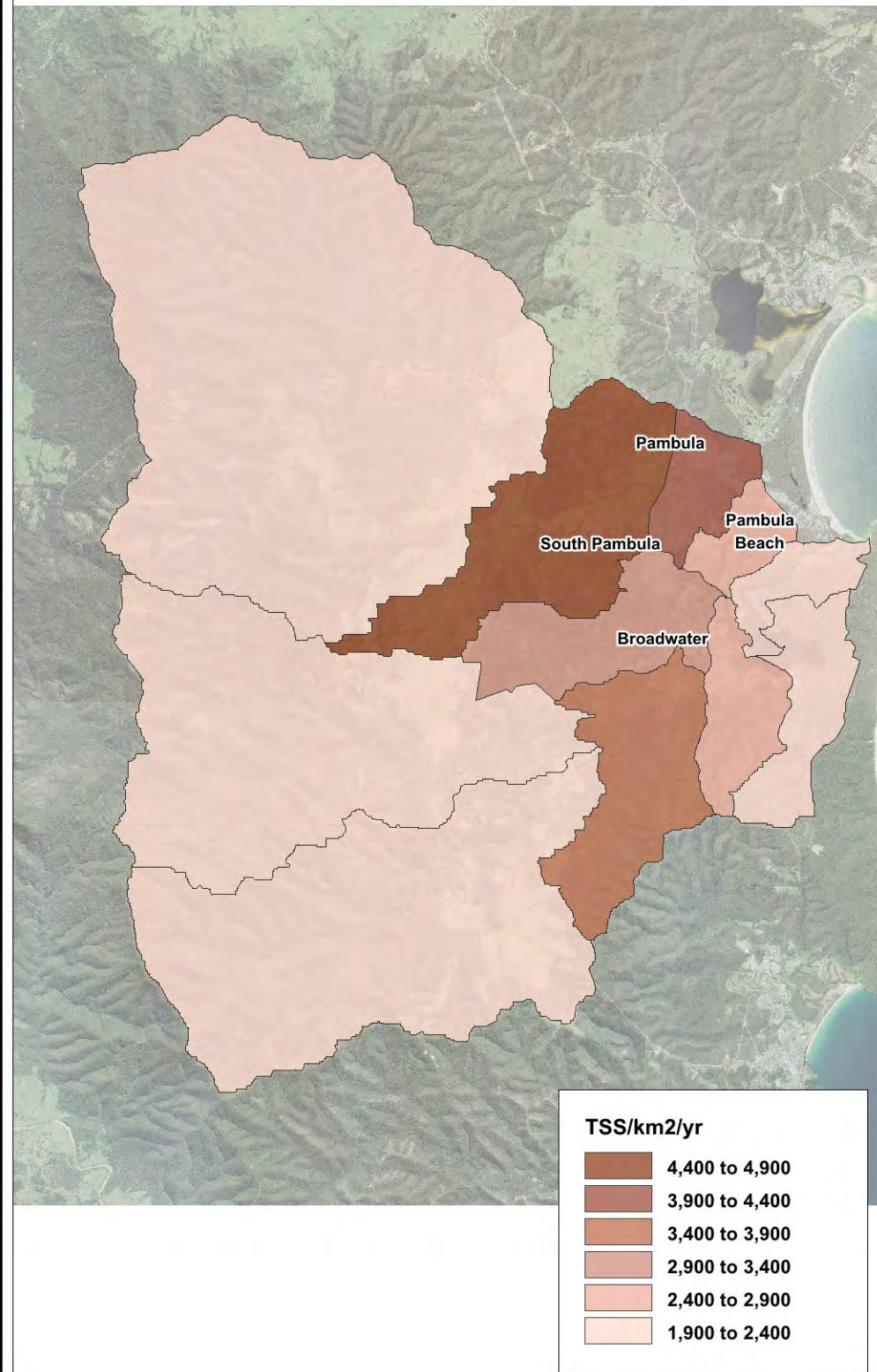
The Coastal Eutrophication Risk Assessment Tool (CERAT) has been used to generate areal loadings for the Pambula Lake estuary. Considering diffuse loadings as areal loadings is a useful way of identifying catchments which are considered to deliver higher loads, the method requires dividing the predicted annual loading from sub-catchments by its catchment area, thus eliminating bias caused by larger or smaller catchments.

The CERAT program estimates pollutant loadings based primarily on landuse classifications, thus catchments with landuses known to contribute higher quantities of sediment and nutrients (e.g. urban, industrial lands, etc) will typically be identified as the highest contributing sub-catchments to the estuary.

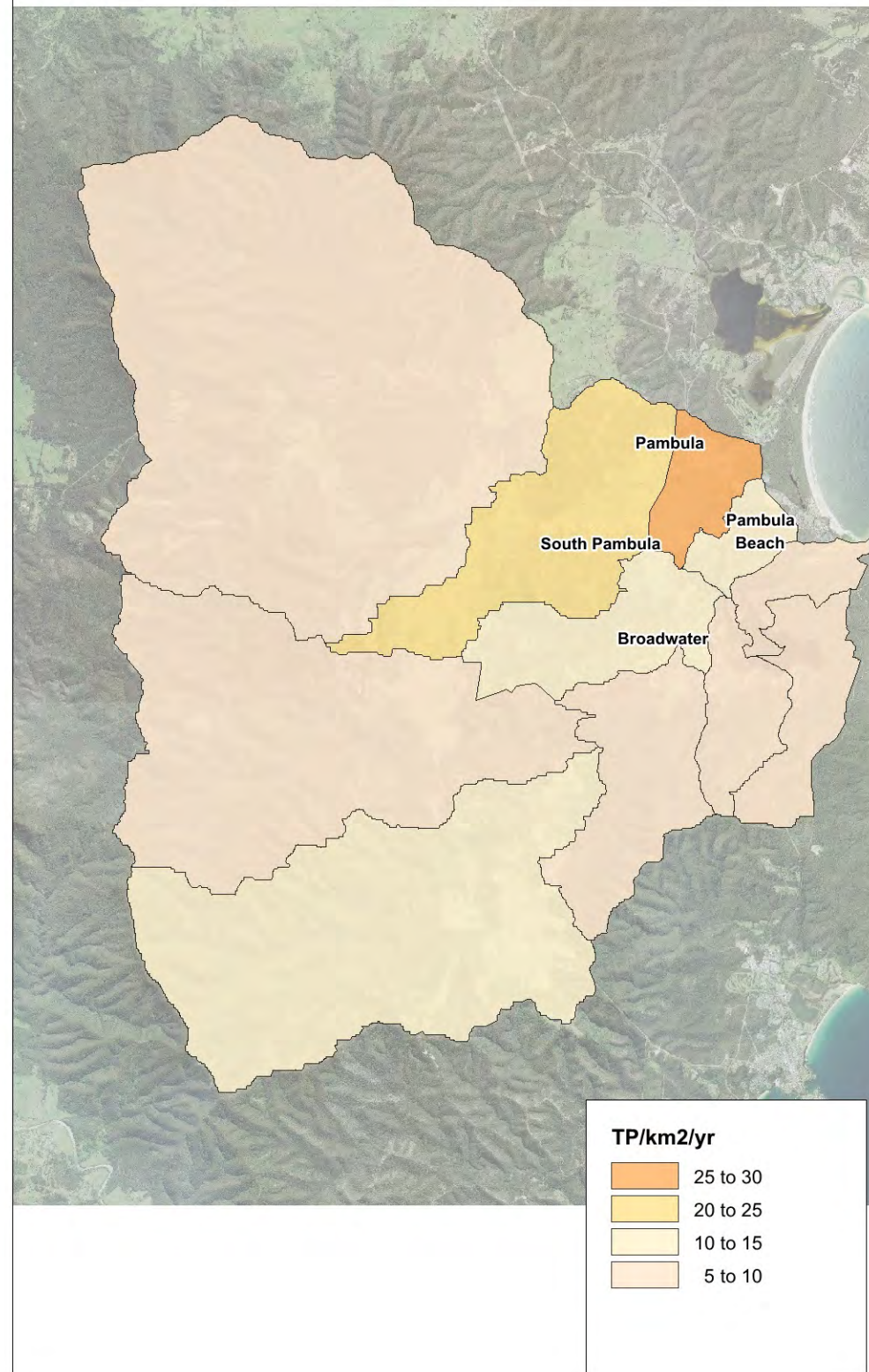
The actual loadings from these catchments will depend on local level factors such as the presence of on-site systems to detain and improve stormwater quality, and downstream areas that may filter stormwater runoff, such as the Panboola wetlands are likely to do for runoff from the Pambula township. As no local level studies exist that quantify the loadings and aspects for improvement, investigations into these 'higher load' catchments (as denoted by the intensity of the shading) would be a useful starting point for the detailed investigations. Ultimately intervention in the drainage system may be possible to improve the level of stormwater treatment prior to its entry into waterways of the estuary, or the estuary itself.

In addition to these retrofit style assessments and activities, Council's planning, assessment and management for new development within the catchment is paramount to ensure that new development does not create new quantity or quality impacts within the catchment and estuary.

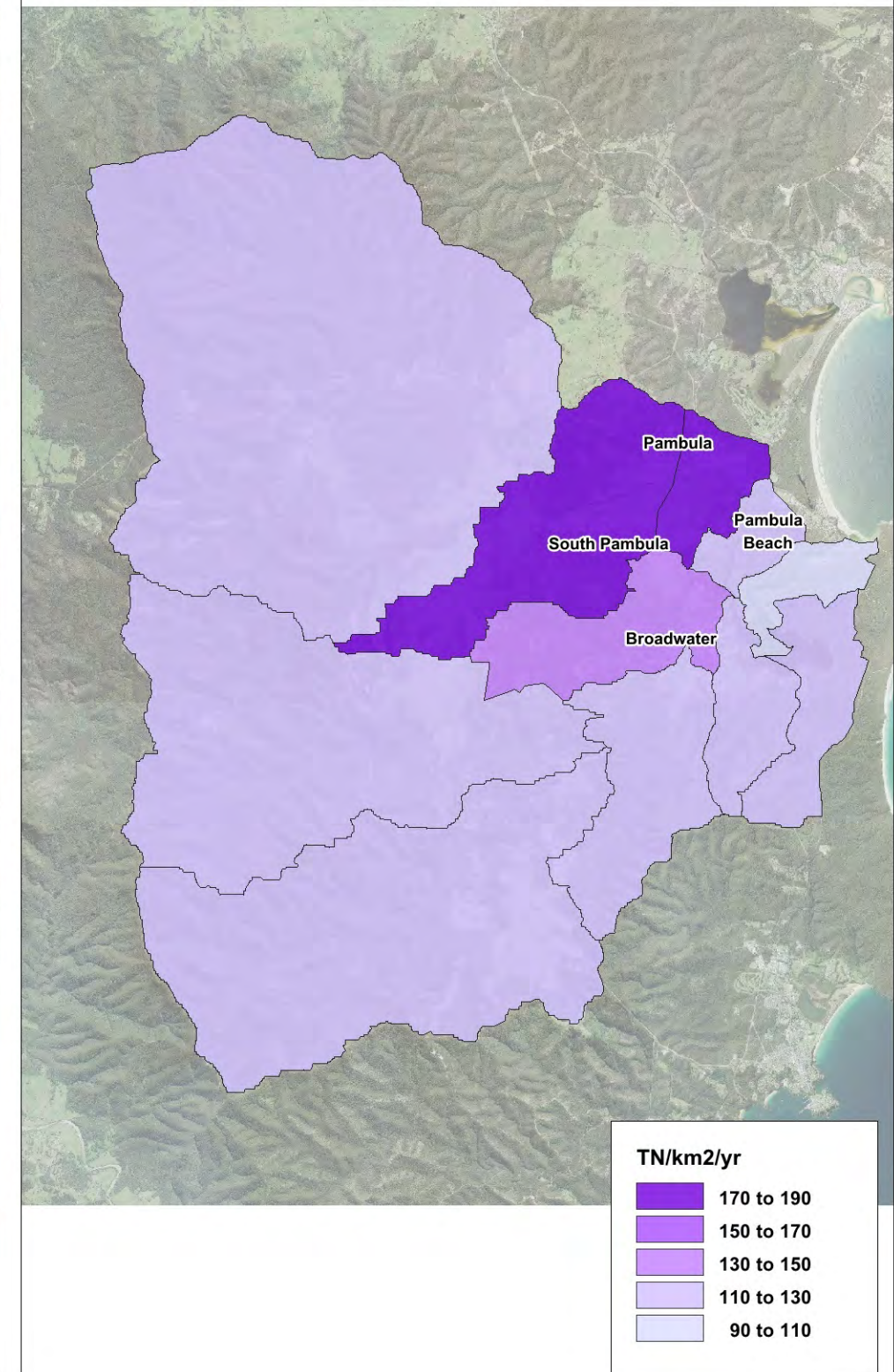
TSS Areal Loadings



TP Areal Loadings



TN Areal Loadings



NOTE: Sub-catchments boundaries are indicative and do not exactly match those from CERAT

Title:
**Predicted Areal Loadings of Nutrients and Sediments
(data CERAT, 2014)**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



0 3 6km
Approx. Scale

Figure
4-2

Rev:
A



Filepath : I:\B20189_I_Breakfast Creek_Blacktown\DRG\WQU_007_130628 Pollutant_Future.wor

External Pressures

Unsealed Roads and Tracks

Unsealed roads and tracks have been identified a source of diffuse water quality pollution within the Pambula Lake estuary.

Local level effects are evident with higher sediment loads being generated from these surfaces during rainfall events. Input from PEEG members and stakeholders indicate that catchment landuses including unsealed roads and forestry trails can contribute this sediment to the estuary.

SRCMA (2013) estimate that there is around 390 km of unsealed roads and 60 km of sealed road in the Pambula Lake estuary catchment. A survey (visual assessment) of around 90% of all unsealed roads was completed in March 2012. Table 4-1 includes survey findings for 110 sites in public and private ownership which were unsealed roads that crossed or were adjacent to waterways. Table 4-2 provides details of this ownership by sub-catchment.

Table 4-1 Draft Roads and Tracks Survey (SRCMA, 2013)

Site Score by Sub Catchment						
Score #	1-3	4	5	6-7	8-10	Total
Pambula	5	6	10	10	4	35
Yowaka	4	19	14	24	6	67
Lake	1	3	1	3	-	8
Total	10	28	25	37	10	110
%	9	25	23	34	9	100
# Score 1 represents very low sediment retention and 10 very high sediment retention. Typical roads and track with scores of: 1-3 have serious design flaws and / or very poor maintenance 4 have moderate design flaws and / or moderate maintenance 5 have moderate design flaws and / or moderate maintenance 6 -7 have few design flaws or / or good maintenance 8-10 have very few design flaws and / or very good maintenance						

Table 4-2 Owners by Subcatchment (SRCMA, 2013)

Owners by Sub Catchment									
Sub catchment	Private Property	Bega Valley Shire Council	Forest NSW	Crown Land	National park	Roads and Maritime Services	Essential Energy*	Telco	Total
Pambula	13	7	7	4	2	1	2		36
Yowaka	29	16	15		1	1		2	64
Lake	4	2			1	1			8
Total	46	25	22	4	4	3	2	2	108
%	42	23	20	4	4	3	2	2	

*Sample Only

External Pressures

Key findings of the survey were that the main influences on sediment generation were road / track length, slope, width, effectiveness of drainage structures and spacing, usage, age of track, frequency and level of maintenance. The survey suggests poor road / track design is the key issue leading to sediment generation followed by inadequate maintenance.

Comments from PEEG members and other stakeholders suggest that the soil types being used to form some of the unsealed roads can generate significant quantities of fine sediments which are evident in the waters of the Pambula Lake for a number of days subsequent to the runoff event. Fine sediments have been identified in the Pambula Lake Oyster Growers Environmental Management System as a medium level risk to their operations.

While the extent of the issue has been explored in the Roads and Track survey, the magnitude of the effect (i.e. extent of this pressure) has not been quantified in comparison to other sources (i.e. total loadings, and characteristics of the materials).

Studies from other areas have shown that sediment and nutrient levels from roads can be very high; information presented in Duncan (1999) indicates that based on a survey of many different stormwater investigations into road runoff quality that sediment levels can vary from a mean of 9 mg/L up to 14,500 mg/L. Total nitrogen levels can vary from a mean of 0.95 mg/L to 7.69 mg/L and total phosphorus levels can vary from 0.05 mg/L to 1.5 mg/L. These variations are very large on account of their being a wide sample set being tested under variable rainfall conditions, but do serve to provide an indication of the magnitude of the effect which can occur.

4.1.4 Riparian clearing, cattle grazing and illegal access

Riparian clearing, cattle grazing and informal (or illegal) accesses can all serve to destabilise banks (by removal of vegetation) and prime them for the generation of sediments during use, or in particular during infrequent flood flow events. The relative magnitude of sediment generated from banks relative to instream working of sediments and those contributed from the broader catchment (including unsealed roads and tracks, etc.) has not yet been quantified, but would be an issue for Pambula in some areas where management intervention would provide environmental benefit.

SRMA (2012) mapped riparian vegetation condition in the Pambula River catchment, and results are presented in Figure 3-12. Most of the riparian vegetation along the estuary was mapped as being in good condition. However, the upper estuary and tributary streams were mapped as degraded due to catchment clearing. There are occasions of cattle access as well as informal access also noted in this location.

4.1.5 Point Loads

There exist several potential point load sources to the estuary. These are outlined as follows with a description of the pressure that they may apply to the estuary:

Merimbula Sewage Treatment Plant

The Merimbula STP takes sewage from Pambula, Pambula South and Pambula Beach as well as urban centres in the Merimbula catchment. Council has been progressing assessment of discharge options for this STP from around 2004, it is not believed that the current discharge arrangements have an impact on the condition of the Pambula River estuary as it has generally

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excellent water quality and limited issues phytoplankton. Since this time a number of alternative effluent disposal arrangements have been implemented while others are still be developed and assessed. In addition to land based reuse (described below) a preferred option for the disposal of the bulk of the treated effluent from the STP is to dispose of it via an ocean outfall. Due to the scale of the project and its potential for impacts, an Environmental Impact Statement (EIS) will be required (and is currently being progressed by Council). The EIS will detail within it water quality impacts resulting from the proposal.

Oaklands Reuse Site

The Oaklands Farm reuse site is used to irrigate reclaimed water from the Merimbula STP. The Oaklands Farm site is used in addition to the Pambula Merimbula Golf Course site (out of catchment) for irrigation of reclaimed water. Limited irrigation reuse at the Oaklands Farm site commenced in February 2013 and has potential (in conjunction with the Golf Course) to reuse approximately 25-50% of the annual discharge from the Merimbula STP once fully established across the full 40 hectare irrigable area. Based on 2030 population projections, it is expected that the reuse potential of both sites is around 33% per average rainfall year.

Key potential pressures arising from these reuse schemes are associated with the correct application of reclaimed water on the respective sites, so as to minimise opportunity for any overland runoff or baseflow discharge to nearby waterways. The introduction of the reclaimed water to the Pambula Lake estuary (noting that the Oaklands site is adjacent to the estuary) raises the risk of nutrient enrichment within the estuary. Currently the scheme is managed with a range of measures and procedures outlined in the Operational Environmental Management Plan (OEMP) which outlines requirements for use of setback buffers (i.e. 40 m exclusion zone for irrigation adjacent the estuary) and moisture monitors that indicate when irrigation is acceptable, amongst other controls. The scheme is administered by Council and is to be audited by the NSW Environmental Protection Authority (EPA).

On-site Sewage Management (OSM)

Council has implemented through its planning frameworks clear methodologies which identify based on the locality of OSMs in the catchment, their risk of causing environmental harm. OSMs are assigned into either Critical, High or Low risk categories. The OSM category defines the maximum operational approval that Council will grant to them, currently critical risk sites are approved annual licences to operate, high risk sites receive a 3 year approval and finally low risk sites receive a 5 year operational approval. Low risk sites can be self-certified (i.e. certified by owner) after an initial Council inspection and Council's satisfaction that the landowner understands the system operation and minimum performance standards.

The risk category also then defines the inspection cycle which Council applies to the OSMs. Critical risk OSMs are inspected annually, high risk OSMs are inspected once in three years with low risk sites to be inspected once within 2 approval cycles, i.e. once in ten years.

In the Pambula catchment there are currently 632 OSM's (Madigan D., pers. Comm, 2014). Of these 20 systems are Critical Risk (3.2%) and 106 systems (16.8%) are high risk with the remainder falling into the low risk category. Of the critical risk systems 19 out of the 20 were inspected within identified timeframes. Approximately 45% (or 48/106) of the high risk systems

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were inspected within the identified timeframes and 30% of low risk systems were inspected within the identified timeframes. OSM owners will be issued correction notices by Council for deficient systems. Since 2001 when the procedure was introduced, Council has issued 1 notice for a critical risk OSM, 5 notices for high risk OSMs and 6 notices for low risk OSMs.

There is no current indication that the operations of OSMs within the catchment are causing water quality issues within the estuary. Continued application of Council's approval and inspection systems for OSMs will reduce ongoing risk and is considered to be providing adequate management of this issue. Additionally feedback through regular oyster industry monitoring of water quality within the estuary may assist in identifying any current pressures upon water quality within the estuary.

Reticulated Stormwater Networks

The major townships all have reticulated stormwater networks established for the purposes of draining stormwater flows (from rain events) away from the townships. The Estuary Processes Study (Cardno, 2012) identifies the locations of these stormwater outlets within the catchment. The study also indicates that no stormwater outlets appear to drain direct to the estuary, but that several outlets drain into small tributaries of the estuary or into natural drainage channels that discharge to the estuary. Other key findings of the Estuary Processes Study include:

- The presence of 14 stormwater outlets along Bullara St (Pambula) being treated by 5 sediment traps.
- The presence of 14 outlet pipes onto Pambula Beach from the Pambula Beach township, some of these discharge to the estuary mouth which may see stormwater discharges introduced to the estuary on flood tides.
- The presence of stormwater flow impacts on roads and gullies at locations around Pambula Beach.
- The presence of stormwater outlets into a SEPP 14 wetland introducing untreated stormwater from Pambula Beach to these wetlands.

Presently, no local scale studies exist that quantify pollutant loadings from the individual urban stormwater sub-catchments and the potential impacts of these discharges based on the likely ability of the receiving environment to assimilate the pollutant loadings. Such an investigation would identify options, priorities and costs for necessary stormwater quality improvements in these areas. Generally improvements are a mixture of either soft (e.g. education, signage, etc.) or hard solutions (e.g. gross pollutant traps, constructed wetlands, etc.).

Reticulated Sewerage Networks

Parts of the Pambula Lake catchment are within the Merimbula STP catchment including the townships of Pambula Beach, South Pambula and Pambula. Data provided by Council indicates there are a total of eight sewage pumping stations (SPS) and numerous sewer lines within the catchment (refer Figure 4-3).

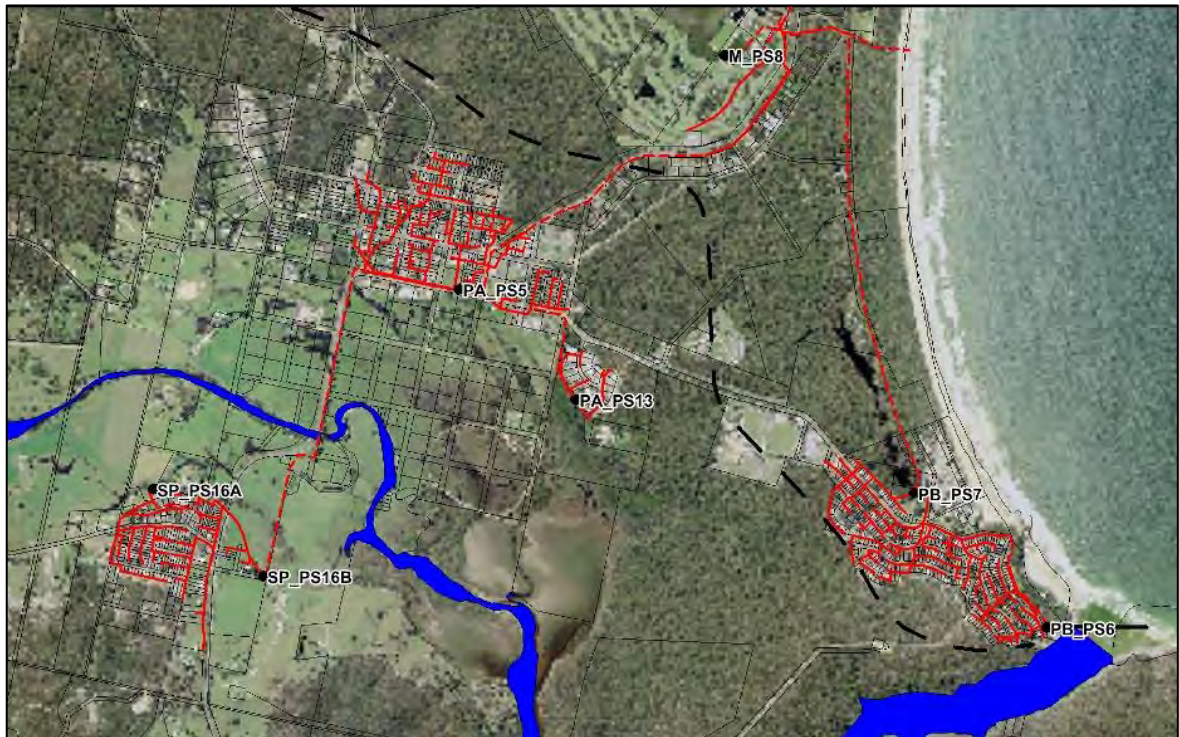


Figure 4-3 Reticulated Sewerage Network and Pump Stations

The Sewer Overflow Investigations Report (MWH, 2007) for the Merimbula STP and sewerage network reviewed the existing infrastructure (e.g., pipes, pump stations, etc.) and the likelihood and potential impact of an overflow event occurring from them. A risk assessment was used to integrate the likelihood and impact scales, and the results were then ranked and used to identify management priorities and actions.

The risk classification completed as part of the study identified risk for groups of pumping station catchments (rather than defining risk for each individual pumping station catchment). Pambula and Pambula Beach sewer catchments were classified for risk by MWH as (refer also to Figure 4-3):

- High risk: Sewage Pumping Station (SPS) 7 (i.e. the properties and sewer lines draining to SPS 7 and SPS 6);
- Moderate risk: SPS16B (i.e. the properties and sewer lines draining to SPS 16B and SPS 16A); and
- Low risk: MSTP (the properties and sewer lines draining to SPS 5, SPS13 and MSTP).

In terms of individual SPS catchment risk classification (likelihood and consequence of sewer overflows in relation to Pambula estuary water quality) likely risk categories may be (noting that these were not individually assessed in the Sewer Overflow Investigation study):

- High risk: SPS6 and SPS16B catchments;
- Moderate risk: SPS16A catchments; and

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- Low risk: SPS 5 and SPS13 catchments.

The individual catchments of SPS7 and MSTP lie outside of the Pambula estuary catchment.

Management of the risk of overflows from higher risk SPS are the priority and should be captured through Council's key planning documents such as the Integrated Water Cycle Management Plan and Sewerage Systems Asset Management Plan, noting that there many priorities for infrastructure expenditure across the Shire.

There are no current plans to sewer areas within the Pambula Lake catchment which are not currently sewered.

Regulated Operations

Pambula District Hospital

The NSW EPA regulates the operations of the Pambula District Hospital (un-licenced operation). This operation contributes waste products (including wastewater) to licenced discharge points (these may include town sewerage, or to receiving waters).

Forestry

The Forestry Corporation of NSW has a licence under the *Protection of the Environment Operations (PoEO) Act* 1997 to perform 'logging operations' in the Eden Region. With the Pambula Lake catchment the Yurammie, Gnupa and Nullica State Forests exist, areas of these forests are subject to forestry under this licence. An Ecologically Sustainable Forest Management Plan exists for the Eden Region operations (plan prepared by the former Forests NSW in 2005). Harvest Plan Operational Maps are prepared by the Forestry Corporation of NSW for subregions within the overall Eden Region. The Harvest Plan provide significant supporting detail on the regions, where logging is planned to occur, special management considerations for these areas, access routes amongst other matters.

SRCMA (2013) identify that Forestry Corporation of NSW are the land managers of around 20% of the unsealed roads and tracks within the Pambula Lake catchment. These areas have been identified as a source of sediment and nutrient to the estuary (SRCMA, 2013). The level of their contribution would depend on their location, design, material of construction, sediment controls and level of maintenance.

Other Premises

Council is an Appropriate Regulatory Authority (ARA) under the PoEO Act in its own right and is charged with the regulation of its own operations, as well as that of all businesses (and relevant business activities) across the Shire other than those regulated by the EPA. In respect of water, this includes Council's liquid trade waste policy and management system.

Contaminated Sites

The Estuary Processes Study (Cardno, 2012) presents a list of known contaminated sites that are included on contaminated site registers maintained by Council or by the NSW EPA. There have been no changes to the contaminated sites listed in these registers.

External Pressures

It is not possible with available information (which mainly includes water quality data, not necessarily focused on identifying particular compounds from these contaminated sites) to determine if a particular contaminated site is a pressure on estuarine health. Currently there are no indications that estuarine impacts are occurring.

4.2 Waterway Use

4.2.1 Fishing

Fishing use of the estuary, both recreational and commercial, is described in Section 2.4 and 2.5 (Page 18). Fish condition is also described in Section 3.4.6 (Page 48). The fish condition data provides a variety of metrics for assessing actual condition, including aspects such as species diversity and composition, trophic integrity, amongst others. It is possible that some lower than observed condition results are associated with fishing impacts, but to make firm associations detailed investigations would be required. Overall, the fish condition index for Pambula was rated as Good (with a 4 out of 5 score).

Further information on the potential impacts of recreational fishing was outlined in the 2000-01 survey of recreational fishing (by NSW Fisheries). The yearlong survey identified that recreational fishing participation in NSW country regions was twice as high as the rate observed in the main metropolitan areas, with the south coast recording the highest fishing participation rate in the State. Study results indicated that most recreational fishing effort is applied to estuarine waters. Overall, recreational fishers harvested a substantial number of fish and as a whole had the potential to impact aquatic resources. The recreational catch of several common estuarine species (namely flathead, bream, tailor, catfish, mullet, yellowtail kingfish and nippers) is larger than the commercial catch.

4.2.2 Water Extraction

Water extraction from the Pambula and Yowaka Rivers is described further in Section 2.5.4 (Page 22). Extraction within these rivers is regulated by the Water Sharing Plan (WSP) for the Towamba River Unregulated and Alluvial Water Sources Order 2010, under the NSW Water Management Act, 2000. Within this WSP the Pambula Lakes Tributaries Water Source is included with other nearby systems in the Pambula River Extraction Management Unit.

Allowable water extraction within these waterways has been set within the WSP. The system has a high hydrologic stress rating as the ratio of Peak Daily Demand to the Low Flow Index is 89% indicating that allowable extraction has the potential to significantly affect daily river flows. Accordingly, some extractive licences have conditions defining when pumping should cease (defined by the Water Sharing Rules for this water source).

The performance of the WSP will be periodically reviewed (5 to 10 yearly basis) against predetermined performance indicators to ascertain if it is meeting its objectives, the duration of the plan may be extended or a new plan commissioned if serious issues are identified. Five yearly independent audits of the WSP are also planned.

External Pressures

4.2.3 Watercraft Use

The Pambula Lake estuary has a 2-lane ramp located on the western shore of the main basin. This ramp is used to access the lake for skiing, estuary fishing and offshore fishing. It has been estimated that approximately one-third of all boat accesses are for each of these purposes respectively (Cooper, G, Pers. Comm., 2014). While the ramp is generally considered adequate it can get crowded at times. It has been suggested that access for off-shore fishing is quicker through the Pambula Lake ramp than the ones in the Merimbula Lake estuary on account of the higher transit speeds that are possible (Cooper, G. Pers. Comm., 2014).

Recent amendments to boat speeds in the entrance channel have been implemented by RMS to primarily limit disturbance to oyster leases. This includes a No Wash zone in the entrance channel as it meets with the main estuary basin. The No Wash zone does not extend as far as Peach Tree Point and does not provide specific protection to other portions of the entrance channel from the effects of boat wash.

In terms of boat wash impacts throughout the estuary, the Estuary Processes Study (Cardno, 2012) identified that *"boating activities are not likely having a significant impact on the waterway, although there are stretches of the foreshore bank which are thought to be subject to impacts from boat wake"*. Boat wash is implicated in bank erosion observed at:

- Pambula River right bank downstream of confluence with Yowaka River (associated with waterskiing); and
- Adjacent to public boat ramp.

These locations can be seen in Figure 3-5 (Page 35).

4.2.4 Oyster Aquaculture

There are 139 leases in the Pambula Lake estuary which cover some 21.17% of the lake area (OEH, 2010). This is one of the highest oyster aquaculture lease coverages in the State and may present a visual pressure and recreational constraint to some users of the estuary.

The Estuary Processes Study (Cardno, 2012) identifies that oyster aquaculture is predominantly completed using trays, floating baskets and longline baskets. Cardno (2012) also identifies that these methods are the preferred (best practice) techniques for oyster farming in sheltered areas over seagrass beds. Cardno (2012) as part of seagrass coverage investigations of the Pambula Lake estuary identify that, *"seagrass density and cover did not, however, appear to differ among areas where oyster growing racks were and were not located, suggesting the oyster growing apparatus does not impact upon seagrass health."*

The presence of oyster growing apparatus will affect water circulation patterns within the estuary. The apparatus acts to resist flow (by physical blockage or roughness) and has the potential to promote enhanced rates of fine sediment deposition within parts of the estuary where water velocities are sufficiently reduced, such as at around Long Point. However, the relative effect of the oyster apparatus has not been assessed using numerical models, nor have rates of sedimentation been physically measured. At this stage, basin depths appear to be sufficient to

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support the ongoing use of oyster aquaculture and there are no known reports of sedimentation causing issues.

4.2.5 Aquatic Weeds and Pests

Aquatic weeds and pests are current and potential pressures on estuarine value and condition. Principal aquatic weeds and pest pressures identified for the Pambula Lake estuary include:

- *Caulerpa* (*Caulerpa taxifolia*) – currently not present within the Pambula Lake estuary, but was recently present within Wallagoot Lake to the north (now eradicated). It is a listed Class 1 noxious species under the *Fisheries Management Act* 1994 and is currently managed under a Control Plan administered primarily by the NSW Government (primarily DPI F&A), with involvement of other agencies and local Councils.
- European Green Crab (*Carcinus maenas*) – The European Green Crab is an introduced species that is present within the Pambula Lake estuary; it has the potential to impact upon oyster aquaculture operations in the estuary. The European Green Crab is a declared Class 1 Noxious Species under the *Fisheries Management Act* 1994. Research and management directives are yet to be implemented for this species by NSW DPI F&A.
- Pacific oysters (*Crassostrea gigas*) - Pacific Oysters are an introduced species that are present within the Pambula Lake estuary, if unmanaged they have the potential to displace native oysters such as the Sydney Rock oyster which is an important aquaculture industry in NSW. Pacific Oysters are a declared a Class 2 Noxious Species under the *Fisheries Management Act* 1994 (in all NSW waters except Port Stephens). Recent legislative change aims to minimise the spread of Pacific Oysters in NSW through movement controls (Division 2A of the *Fisheries Management (Aquaculture) Regulation* 2012). It applies to the movement of oyster and cultivation equipment between NSW estuaries and applies to all aquaculture permit holders in respect of oyster growing operations.

Presently in the Pambula Lake estuary, control of Pacific Oysters is a requirement of oyster growers under the *Fisheries Management (Aquaculture) Regulation* 2012. A NSW DPI F&A officer inspects all leases (include cultivation equipment and foreshore areas) on a 1 per 3 yearly basis. Issues with Pacific Oysters are advised to the lease owner in writing with a requirement for rectification. The Pambula Lake Oyster Growers also complete an annual shoreline cleanup in Pacific Oyster hotspot areas where these oysters are destroyed.

4.3 Morphology

4.3.1 Fluvial

Figure 3-6 from the Pambula Catchment Rehabilitation Plan identifies the geomorphic condition of major streams in the catchment. This condition indicator reflects a reaches ability to adjust within current flow and sediment characteristics. In relation to the Pambula Lake estuary the entrance channel, main basin and lower reaches of the Pambula and Yowaka rivers are in moderate condition, with the upper sections of the Pambula and Yowaka rivers to their tidal limits being assessed as being in poor geomorphic condition.

External Pressures

These poor condition reaches are sensitive to change and tend to propagate degradation throughout a catchment with significant off-site impacts. Good condition reaches are less sensitive or more resilient to the effects of change. As such, the poor condition reaches identified (within the estuary, and upstream of the estuary) have the potential to propagate and ultimately impact further on the largely moderate condition reaches of the estuary.

4.3.2 Estuarine

Entrance processes and condition were earlier described in Section 3.3.3 (Page 32). The key estuarine pressure arising from changes in entrance condition (or open close status) is related to water quality within the estuary, although it can also present a pressure up recreational use of the estuary in terms of boating egress to and from the estuary.

The Estuary Processes Study (Cardno, 2012) completed a tidal harmonic analysis using approximately 20 years of hourly water level data for the Pambula Lake estuary (covering 1991 to 2010). The assessment identified that there had been a long term reduction in the Mean High Water Spring (MHWS) and a long term increase in the Mean Low Water Spring (MLWS) tidal planes. The combined effect over the period equated to an average of 4.3 mm/year reduction in these tidal planes.

The identified cause of the tidal plane reduction was the ingress of marine sands into the entrance channel resulting in a net accretion of the marine tidal delta, with the likely effect of reducing estuarine flushing capacity over this time. These findings accord with observations of made by local fisherman and oyster growers who considered that the main entrance channel had become gradually shallower over the past decade or so (Cardno, 2012).

At this stage, the reduced tidal exchange (increased flushing time) being experienced within the Pambula estuary has not been identified to have resulted in any significant reductions in water quality or associated impacts to the oyster industry. However, if entrance infilling continues, this is may have the effect of further reducing estuarine flushing resulting in longer periods of time for water quality to return to normal (i.e. low turbidity, low nutrient, low chlorophyll-a) after rainfall events triggering catchment runoff. This has implications for the oyster industry which benefits from the rapid oceanic flushing (and resultant high water quality) experienced within the Pambula Lake estuary.

Changes to entrance condition including depth and location of shoals has the potential to impact upon recreational and commercial boating activities which utilise the entrance to access the ocean. The estuary has no permanent marked access way (by leads or buoys) meaning that safe egress is judged by the boats navigator at the time of crossing. Monitoring of entrance crossing safety will be an ongoing consideration which may need to be enhanced if entrance shallowing is seen to continue.

4.4 Climate Change

Climate change effects have the potential to impact on many aspects of estuary function and condition. Key predicted changes and implications for the Pambula Lake estuary are described as follows.

4.4.1 Current Predictions

The most recent locally specific investigation into potential climate change outcomes were detailed in the CSIRO 2007 publication titled, Climate Change in the Southern Rivers Catchment. This study notes that the Southern Rivers Catchment has experienced:

- A warming of approximately 0.8°C since 1950; and
- A decline in annual rainfall of about 25-50 mm per decade since 1950.

This CSIRO study has been used to provide the scientific basis for later investigations, including:

- Climate Change Risk Assessment Adaptation Report, Echelon 2010; and
- Climate Change Strategy, BVSC, 2014.

As stated in the in the Council's Climate Change Strategy,

“Within the assessment report completed, key climate related assumptions were made that clearly indicate how the Shire’s climate and its associated impacts will affect Council and the local community moving forward. The scenarios used were based on data from the CSIRO.” (see Table 4-3)

Table 4-3 BVSC Climate Change Risk Assessment Adaptation Report in 2010 Outcomes

Issue	Scenario Expected
<i>Temperature</i>	<i>There is a risk that the average annual temperature may increase between 0.2°C and 1.8°C by 2030.</i>
<i>Hot Days</i>	<i>There is a risk that there will be between 2 and 3 additional hot days (i.e. >35°C) per year by 2030.</i>
<i>Rainfall</i>	<i>There is a risk that rainfall may be up to 13% less by 2030.</i>
<i>Wind</i>	<i>There is a risk that there will be an increase in average wind speed between -2% and 7.5% by 2030.</i>
<i>Fire Weather</i>	<i>There is a risk that the number of days annually when the Forest Fire Danger Level (FFDI) is high or extreme will be between 14 and 16 days higher by 2020.</i>
<i>Sea Level</i>	<i>There is a risk that the sea level may rise by 0.91m by 2100 with a linear rise over the intervening period.</i>
<i>Rainfall Intensity</i>	<i>There is a risk that intense rain periods (i.e. the number of 1 in 40 year 1 day rain fall events) will increase between -3% and +20%.”</i>

Over time increased international, national, regional and local knowledge in respect of anticipated climate change effects will be developed. Most recently at the international level, the Intergovernmental Panel on Climate Change (IPCC) released the Assessment Report 5 which relates to the physical science of climate change and predicts with high certainty that anthropogenic influence has resulted in the climate change we are currently experience. Further information which will assist in relating these broad findings down to national and regional levels is yet to be published. Over time, these high level scientific research findings will be integrated into relevant Council planning.

4.4.2 Climate Change Impacts on Estuarine Flushing

Cardno (2012) also assessed the potential effects of climate change on estuarine flushing time and water quality. The assessments completed utilised increased sea level along with either static or increased bed levels. Cardno (2012) acknowledged that the bathymetric response of the estuary to sea level rise was unknown. Hence, the outcomes predicted need to be considered with this uncertainty in mind.

Their findings identified that general oceanic flushing times (under typical base flow conditions) were predicted to shorten when sea levels increased without a matching increase in bed levels, this is on account of improved efficiency of oceanic exchange through the entrance channel, while flushing times remained somewhat similar when sea level rises were matched by similar increases in bed levels.

4.4.3 Climate Change Impacts on Entrance Morphology

A thorough review of coastal processes is underway as part of the Bega Valley Shire Coastal Processes and Hazards Definition Study (currently in draft form). This report includes a discussion on coastal entrance responses to changing sea levels.

This report identifies that the effects of sea level rise on coastal entrances is not yet fully understood. Hence, the following discussion identifies outcomes that are considered likely.

Sea level rises are expected to impact the balance of entrance sand supply and loss. As discussed in Section 3.3.3 (Page 38) entrances cycle through periods of accretion and scour, and are in a form of dynamic equilibrium. It is expected that increasing water levels will alter the hydrodynamic conditions that exist in coastal estuaries triggering a morphologic response that aims to keep the system in balance. Entrances are expected to adjust to sea level rise dynamically, with the exact response being governed by the existing entrance geometry and its unique environmental setting. Generally, it is expected that sea level rise will result in the growth of the marine deltas, with sediment sourced from erosion the adjacent beach systems.

If sea level rises are experienced, it is expected that the Pambula River system will have a high sediment demand, as it has a large entrance system relative to the beach system that supplies it with sediment (i.e. sand). Hence, the adjacent shoreline to the Pambula River entrance is sensitive to the effects of entrance sedimentation indicating that it may need to erode significantly to provide sufficient sediment to the marine delta in response to sea level rise.

Further understanding of the responses of estuarine entrances to sea level rises will become available in the future as future research findings become available.

4.4.4 Climate Change Impacts on Ecology

The Estuary Processes Study (Cardno, 2012) identifies a range of potential ecological impacts to the Pambula Lake estuary including:

- Changes in rainfall affecting the balance of freshwater and marine flows and associated nutrient cycling in the estuary;

External Pressures

- Changes in water depth within the estuary potentially affecting light penetration and its ability to support seagrass in certain areas. As seagrasses can colonise new areas as conditions permit, it is expected that there would be changes in the distribution of seagrasses in the estuary; and
- Changes (increases) in sea level leading to increased duration of inundation of existing intertidal areas and possible expansion of intertidal species into new intertidal areas (depending on the suitability of those areas for supporting these species).

Cardno (2012) identify sea level rise as the most significant and far-reaching impact on the estuary. In this regard they have produced a map showing the likely future intertidal areas at 2050 and 2100 as shown in Figure 4-4. It can be seen that particularly in the 2100 timeframe that the intertidal areas have the potential to be significantly larger than they are at the present day. Long term considerations for Council and other land managers include consideration of the need for long term policies and approaches to allow for intertidal vegetation, such as saltmarsh to colonise into these identified future areas. Incompatible land uses that either impedes or reduces the effectiveness of this transition, particularly development involving land filling and land uses involving grazing amongst others should be limited.

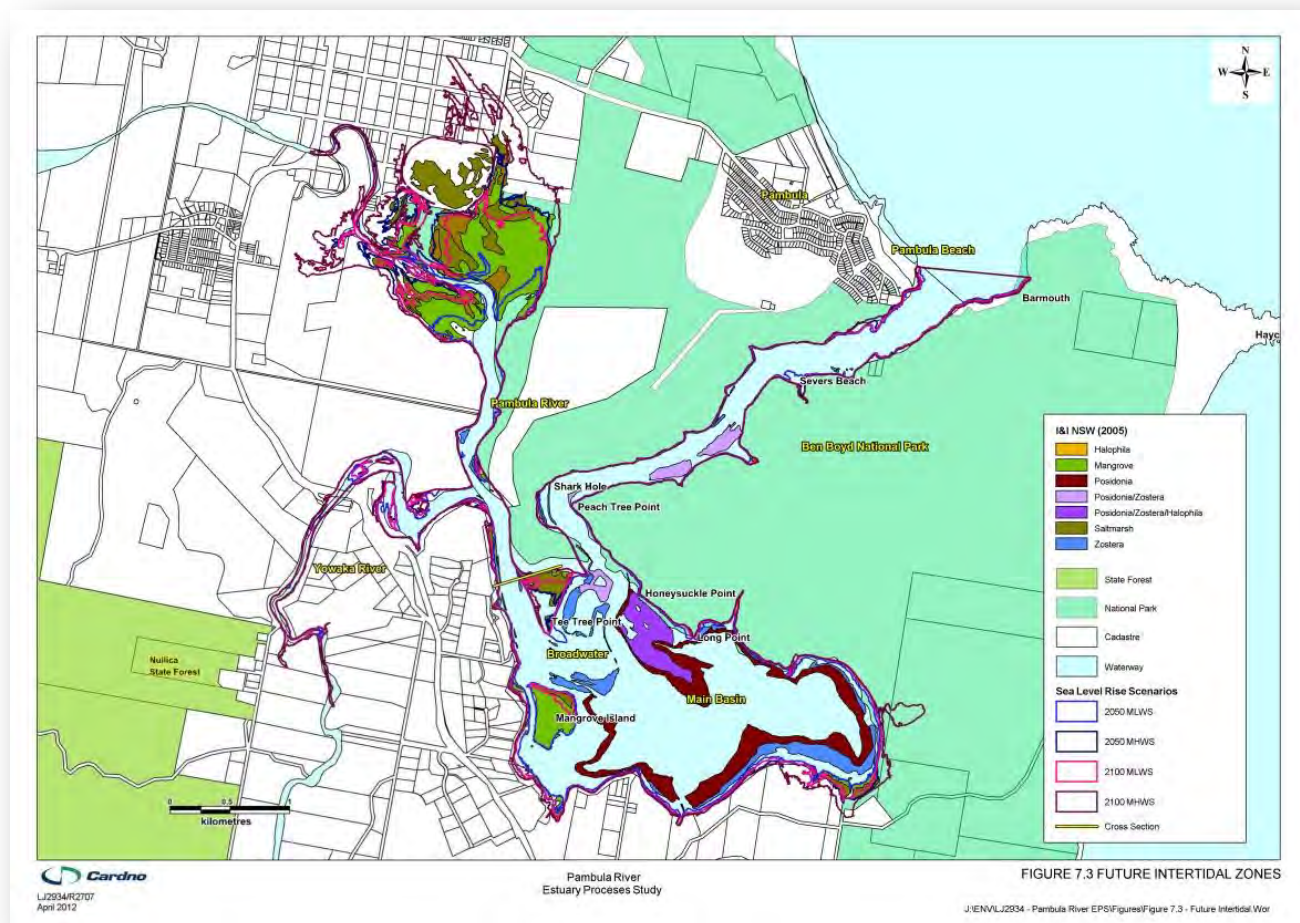


Figure 4-4 Future Intertidal Area (Cardno, 2012)

External Pressures

4.4.5 Climate Change Impacts on Catchment Hydrology and Hydraulics

There may be a variety of related impacts that may result from climate change impacts on rainfall (both long term averages) and also rainfall intensity. Changes to rainfall intensity in particular could have an influence on catchment hydrology and hydraulic responses, particularly in relation to estimation of design flood floods, and their associate flood inundation levels. This is an evolving area of research and development.

4.5 Summary of External Pressures

Table 3-6 presents a summary of the pressure indicator scores for Pambula Lake estuary from the State of Environment report (Roper *et al.* 2011). The estuary was classified as having an overall score of Very Good in relation to pressure indicators.

Most individual pressure indicators were classified as Good or Very Good, except the “Disturbed Habitat” indicator which was classified as Fair. The “Disturbed Habitat” indicator is based on a number of metrics including area of aquaculture leases, foreshore structures, riparian vegetation extent, fishing pressure and *Caulerpa taxifolia* extent. As noted earlier, Pambula estuary has:

- Extensive areas of oysters leases within the central basin;
- A fragmented riparian zone in the central basin and riverine channel/alluvial plain zone; and
- Is open to recreational and commercial fishing (in parts).

Together these would contribute to the Fair rating for the Disturbed Habitat indicator.

Table 4-4 Existing pressure rating for Pambula estuary (Roper *et al.* 2011), and potential future pressures

Pressure Indicator	Existing	Rating
Cleared land	Good	Likely increase outside National Park
Population	Good	BVS population forecast: 16.6% increase between 2014 to 2036 (Figure 4-1)
Sediment input	Good	Major change unlikely, but can be affected by operations that disturb the catchment, such as poorly managed urban development, road management, rural land management and forestry management
Nutrient input	Good	As above for sediment input, but with potentially the added pressure relating to treated sewage input from local reuse schemes and regional solutions (depending on options selected)
Freshwater flow	Very Good	Major change unlikely
Disturbed habitat	Fair	Major change unlikely
Tidal flow	Very Good	Major change unlikely

External Pressures

Pressure Indicator	Existing	Rating
Fishing	Very Good	Major change unlikely
Overall index score	4.3/5 (Very Good)	Major change unlikely
Climate change (future pressure)	Not Assessed	Sea level rise likely to affect wetland vegetation distribution. Insufficient information to assess direction of change.

5 Estuarine Values and Threats

The section outlines estuarine values and threats which are then used in a risk-based threat assessment (described in Section 6, Page 79). Estuarine values typically represent a social, cultural or environmental attribute of the estuary, while threats represent actions or processes that change or modify these attributes of estuary condition. Threats may be actively occurring, or have the potential to occur in the future.

5.1 Values

Values for the Pambula Lake estuary were identified previously as part of the Data Compilation Study (ngh Environmental, 2008). The Data Compilation Study obtained community values during a key stakeholder workshop and these were subsequently used as a starting point for refinement as part of this Coastal Zone Management Plan.

At the commencement of the CZMP process, stakeholder surveys were issued to a Council maintained list of stakeholders. During this period recipients (as well as the general public) were invited to attend an open day on 26th March 2013.

Only several stakeholder surveys were returned as part of this process. Findings from these returned surveys and the initial work completed as part of the Data Compilation Study were used to identify key estuarine values for the community (in no order), as follows:

- (1) Ability to support commerce and business enterprises;
- (2) Ecological health and diversity within the catchment, wetlands and foreshore, especially threatened species;
- (3) Aboriginal and non-indigenous heritage;
- (4) Ecological health and diversity within the waterway, especially threatened species;
- (5) Stable banks and foreshores;
- (6) Adequate water quality to support environment, economy and amenity;
- (7) Habitat for aquatic species, especially seagrass;
- (8) Habitat for terrestrial and wetland species, especially in the riparian zone;
- (9) Passive, visual amenity;
- (10) Ability to support a range of recreational pursuits;
- (11) Vessel navigability – entrance; and
- (12) Vessel navigability – lake and rivers.

The list includes values derived from scientific and other technical assessments of the estuary as determined by the study team. These values were presented to attendees of the Risk Assessment Workshop (held 20th February 2014) and no additional values were added.

5.2 Threats

Community issues with Pambula Lake were identified previously as part of the Data Compilation Study (NGH Environmental, 2008). The Data Compilation Study obtained community issues during a key stakeholder workshop and these were subsequently used as a starting point for refinement as part of this CZMP.

At the commencement of the CZMP process, stakeholder surveys were issued to a Council maintained list of stakeholders. During this period recipients (as well as the general public) were invited to attend an open day on 26th March 2013.

Only several stakeholder surveys were returned as part of this process. Findings from these returned surveys and the initial work completed as part of the Data Compilation Study was used to refine threats. At the Risk Assessment Workshop (held 20th February 2014), BMT WBM presented and described these threats to attendees. Upon review and discussion, modifications were made to 'catchment clearing / development' to recognise the threat of bushfire management, additionally 'cattle grazing' was revised to 'stock grazing' and 'poor knowledge of environment and interactions' was expanded to 'poor knowledge and awareness of environment and interactions'.

Two additional threats were added in relation to lack of implementation funding for CZMP, and also the impacts of change in responsibility and governance arrangements for implementation of the CZMP. The refined threat listing is provided below:

- A. Unsealed roads in catchment – unsealed roads have been identified within the catchment. Runoff from the roads contributes sediments to the waterways and estuaries, impacting water quality.
- B. Sea level rise – may present a wide range of threats to estuarine values relating to habitat extents, middens, waterway hydraulics and estuarine water quality.
- C. Boat wash / boating generally – threats to bank stability and middens within the estuary. Disturbance of oyster leases may also occur.
- D. Clearing of riparian vegetation – threats to bank stability, habitats and aesthetics.
- E. Aquatic weeds and pests – threats to overall estuarine amenity and existing recreational and commercial uses.
- F. Aquaculture use – potential water quality impacts associated with accumulated organic sediments, bed shading and modifications of hydro-dynamics (currents).
- G. Oaklands reuse scheme discharge – threats to estuarine water quality and oyster aquaculture.
- H. Catchment clearing (including bushfire management) and development – threats to catchment runoff quality and hydrology impacting on estuarine water quality, and structural stability of streams.
- I. Stormwater and sewage discharges – threat to surface water quality, potential impacting on oyster aquaculture.

- J. On-site sewage leachate - threat to surface and groundwater quality, potential impacting on oyster aquaculture.
- K. Terrestrial weeds and pests (including ferals) – threat to terrestrial habitats and fauna adjoining estuary.
- L. Stock grazing – threat to riparian habitats and stream bank stability. Can contribute sediments and biological contaminants directly to waterway.
- M. Commercial fishing – potential threat to fish stocks which may affect perceived recreational fishery value of Pambula Lake.
- N. Recreational fishing – potential threat to fish stocks in general, relates mostly to potential overfishing pressure.
- O. Coastal and entrance processes – threat related to entrance condition, while Pambula Lake is defined as a drowned river valley with a permanently open entrance, there are concerns that the entrance is gradually “filling in” which will have implications for tidal hydraulics and may affect lake water quality over longer periods of time.
- P. Industrial / commercial development runoff (including plastics) – potential threat to surface water quality runoff from these areas, with associated effects on estuarine water quality and sediments.
- Q. Poor knowledge/ awareness of environment and interactions – threat related to lack of education regarding estuarine values (and what these support) and how they may be impacted by inappropriate actions (i.e. uses) within the catchment and estuary.
- R. Informal access around foreshore – threat relates to unapproved foreshore developments and accesses to the foreshore.
- S. Lack of implementation funding – this threat applies to all values, and relates to the potential lack of investment funds to support appropriate estuary management priorities.
- T. Change of Responsibility / Government – this threat applies to all values and relates to the change of regulatory responsibility between governments and government agencies, leading to changes in natural resource management priorities and associated funding models.

5.3 Background Material for Risk Assessment Workshop

Relevant background and preparatory material for the risk assessment workshop was prepared and distributed in advance of the Risk Assessment Workshop (described in Section 6, Page 79). The background material is included in Appendix A and includes details of the conduct and aims of the risk assessment workshop, as well as relevant summary material on estuary condition, estuary values and threats to these values.

6 Risk Based Threat Assessment

This section outlines the application and outcomes of a risk based threat assessment for the Pambula Lake estuary.

6.1 Risk Based Threat Assessment

The use of a risk-based approach for managing threats to estuary health is a requirement of the guidelines for preparing CZMPs, and accords with current international best practice for natural resource management. The key parts of the process include:

- Establishing the context;
- Identifying the threats;
- Analysing the threats;
- Evaluating the threats; and
- Managing the threats.

Further details of this process are described in Appendix B.

6.1.1 Outcomes of the Risk Based Threat Assessment Workshop

The risk assessment workshop was held on the 20th February 2014 at the Pambula Fishing Club. At the workshop the following activities were undertaken:

- Introductions;
- Purpose and Structure of the Workshop;
- Overview of Estuary Health / Condition;
- Overview of Estuary Values;
- Overview of Threats – including presentation and general discussion of threat types and explanation of issues;
- Explanation of the Risk Assessment Process;
- Risk Assessment Workshop; and
- Feedback on actions and plans already being implemented to manage estuary condition.

6.1.2 Threat-Value Matrix

In addition to the background preparatory material provided in Appendix A, a risk assessment matrix was distributed to attendees. The matrix identifies the values and threats developed for the Pambula Lake estuary and linkages between them. This matrix is included in Appendix C.

For example 'stable banks and foreshores' (value) has no clear linkage with 'on-site sewage leachate' (threat), however, 'stable banks and foreshores' has a clear linkage with 'clearing of

riparian vegetation'. In this fashion linkages between values and threats were established using the matrix.

Furthermore, the linkages were assigned primary and secondary categorisation on the basis that on occasions, addressing the primary threat-value link also then addresses secondary threat-value links. The risk assessment process focused on assessing the risk of the primary threat-value links.

Attendees were then provided and asked to consider the information included in Table B-1 (Frequency Scale for Threat Assessment), Table B-2 (Consequence Scale for Threat Assessment) and Table B-3 (Threat Risk Assessment Matrix) as part of the assessment of the threat-value link in the matrix. Subsequently attendees ranked the threat-value links using colour coded dots. These were compiled after the workshop and analysed at a later time.

Due to relatively low attendance at the meeting, all material (e.g. background document and threat-value matrix) were compiled and issued to relevant recipients that were unable to make the meeting (via electronic means, supported with phone-calls). This increased the sample size sufficiently for the purposes of the plan.

6.1.3 Workshop Outcomes

The combined risk scores were calculated from all completed responses and are included in Table 6-1. Scores were calculated to avoid bias by partially completed assessment forms noting that some individuals ranked every single combination of threat and value, and others did not.

Scores rated from ZERO to FOUR where FOUR is the highest possible risk, and would be considered Extreme (i.e. **0 to 1.5 = Low**, **1.5 to 2.5 = Medium**, **2.5 to 3.5 = High** and **>3.5 = Extreme**).

The information derived through this process is utilised in the next stage of assessing the merit of various management options.

Risk Based Threat Assessment

Table 6-1 Threat Based Risk Assessment Outcomes

Values → Threats ↓	1. Adequate WQ to support env, econ and amenity	2. Aboriginal and non-indigenous heritage	3. Habitat for terrestrial and wetland species, esp in the riparian zone	4. Habitat for aquatic species, especially seagrass	5. Stable banks and foreshores	6. Ability to support commerce and business enterprises	7. Ability to support a range of recreational pursuits	8. Passive, visual amenity	9. Ecological health and diversity within the waterway, esp threatened species	10. Ecological health and diversity within the catchment, wetlands and foreshore, esp threatened species	11. Vessel navigability - entrance	12. Vessel navigability - lake and rivers
A. Unsealed roads in catchment	3.1	1.0	2.0	2.4	1.5	1.9	2.0	2.0	2.8	2.3	1.0	1.8
B. Sea level rise	1.7	3.3	2.4	2.2	2.7	2.2	1.0	1.5	1.6	2.3	2.0	1.0
C. Boat wash / boating generally	2.0	2.6	1.8	2.6	2.5	1.7	1.3	2.3	1.3	1.5	1.0	1.7
D. Clearing of riparian vegetation	2.7	3.0	3.3	2.2	3.5	2.2	2.3	2.5	3.0	3.1	1.3	2.0
E. Aquatic weeds and pests	3.3	2.5	3.0	3.2	2.3	3.3	2.7	2.3	3.4	3.7#	1.0	1.3
F. Aquaculture use	1.6	1.5	1.3	2.3	2.0	3.0	2.1	2.5	2.4	2.0	1.0	1.8
G. Oaklands reuse scheme discharge	2.3	1.0	2.0	2.0	1.0	3.0	2.0	1.5	2.2	3.0	1.0	2.0
H. Catchment clearing (inc Bushire mgt) / development	2.9	2.5	3.0	2.8	1.5	2.8	1.5	3.0	2.7	3.1	1.5	1.8
I. Stormwater and sewage discharges	3.0	1.5	2.0	2.0	1.5	3.3	3.0	2.0	2.7	3.0	1.0	2.0
J. On-site sewage leachate	3.2	1.0	2.5	2.0	1.0	3.3	2.8	2.0	2.5	3.0	1.0	2.0
K. Terrestrial weeds and pests, ferals	2.0	1.5	2.5	2.3	2.5	2.0	1.5	2.8	2.5	2.9	1.0	1.0
L. Stock grazing	2.5	1.8	3.0	1.5	3.2	3.0	2.0	3.0	2.8	3.0	1.0	1.5
M. Commercial fishing	1.0	1.0	1.0	2.0	1.0	2.3	2.3	1.0	2.6	1.7	1.0	1.3
N. Recreational fishing	1.0	1.5	1.0	2.5	1.5	2.0	2.0	2.0	2.6	2.0	1.0	1.5
O. Coastal and entrance processes	2.0	2.0	2.0	1.5	1.0	2.0	2.0	2.5	2.5	2.5	2.9	1.5
P. Industrial/comm development runoff (including plastics)	2.9	1.0	2.3	2.0	2.0	2.8	2.0	2.0	2.5	2.8	1.0	2.0
Q. Poor knowledge/	3.3	3.3	2.8	3.1	2.6	2.5	2.5	2.5	2.7	2.7	2.1	1.0

Risk Based Threat Assessment

Values → Threats ↓	1. Adequate WQ to support env, econ and amenity	2. Aboriginal and non-indigenous heritage	3. Habitat for terrestrial and wetland species, esp in the riparian zone	4. Habitat for aquatic species, especially seagrass	5. Stable banks and foreshores	6. Ability to support commerce and business enterprises	7. Ability to support a range of recreational pursuits	8. Passive, visual amenity	9. Ecological health and diversity within the waterway, esp threatened species	10. Ecological health and diversity within the catchment, wetlands and foreshore, esp threatened species	11. Vessel navigability - entrance	12. Vessel navigability – lake and rivers
awareness of environment and interactions												
R. Informal access around foreshore	2.3	3.2	2.3	1.5	2.0	2.0	1.5	3.0	2.3	2.5	1.0	1.5
S/ Lack of implementation funding	2.8											
T. Change of Responsibility / Government	2.8											

Note #: This result is an outcome of only two responses which rated this combination, it is not clear that this represents a credible threat / value combination.

7 Assessment of Potential Management Options

7.1 Long List of Management Options

An initial 'long-list' of possible Management Options was developed, to protect the identified values and to manage the identified threats. The source of these options included:

- Suggested items for management from the Estuary Processes Study;
- Community input through the questionnaire and workshop processes;
- Suggestions from agency representatives and other stakeholders from the questionnaire and workshop processes;
- Best practice approaches used elsewhere; and
- Tailored strategies developed by the study team.

The long list contained around 50 potential management options.

The possible management options identified utilised a variety of implementation mechanisms that can act at different levels, or can target different aspects of the problem. Types of management options considered include:

- Planning controls and policies;
- Economic incentives and cost sharing arrangements;
- Regulation and compliance;
- On-ground works and rehabilitation;
- Investigation;
- Monitoring;
- Research; and
- Education and public relations.

It is not practical, nor affordable for Council to implement all of these options, and therefore a methodology for prioritising options was developed that considers a variety of relevant "success" factors.

7.2 Evaluation of Management Options

7.2.1 Initial Evaluation by Study Team

Options were initially assessed by the study team to evaluate the relative merits of the options. Options that scored the highest in the assessment were included in an initial short-list to be presented to the PECG, Council and agency stakeholders for comment and consideration (described further in Section 7.2.2, Page 86).

Options that did not get short-listed (or were eliminated for other reasons) may still potentially have merit at some point in the future and therefore have been included in Appendix D of this document for reference purposes.

The options assessment was completed using a multi-criteria assessment tool. The tool was developed to evaluate the positive and negative costs and benefits of various options and has been applied successfully in many similar projects. These costs and benefits consider more than the technical merits of the options, by including aspects such as the degree of the threats addressed, implementation cost (capital and on-going), timeframe, community acceptance, ease of implementation and effectiveness (in terms of the management intent of the value that the option addresses).

The assessment tool is based on a “traffic light” colour system for a range of variables, to clearly display if an aspect of an option should be cause to “stop” and reconsider, “slow” to proceed with caution or “go” with few trade-offs expected (refer Table 7-1). The assessment has been conducted for each option to assist in the selection of a short-list of management options.

Each option receives a score based on this traffic light assessment. These scores are adjusted slightly (for all options) to reflect a weighting preference as some of the criteria outlined in Table 7-1 were considered by Council and the study team to be more locally significant than others. The scoring system is as follow:

- Green coloured traffic lights = 3 points;
- Orange = 2 points; and
- Red = 1 point.

Weightings are also applied to the scoring as follows (refer headings in Table 7-1).

- Risk of Threat being addressed– 20%;
- Risk Reduction Potential of option– 20%;
- Timeframe of option – 10%;
- Cost of option – 20%;
- Practicality of option – 10%; and
- Community Support for option – 20%.

Despite the weighting all options can only receive a maximum score of 18.

Certain cut-offs were applied by the study team based on the scores received for options. These cut-off points defined the high, medium and low priority.

Assessment of Potential Management Options

Table 7-1 Fine Filter (Traffic Light Assessment) Criteria

	Does it address high level threat?	Effectiveness / Risk Reduction Potential (RRP)	Time frame	Cost	Practicality / Legal	Community Support
STOP & reassess	No – addresses low level threat only	Option does not provide an effective and long term solution. Risk reduction potential is relatively low	LONG Term (> 5-10yrs before tasks can commence). Requires prior commitment of funds, resources or other tasks to be completed first	High (\$300K to millions)	LOW: Will require approval to implement and significant community engagement. There is a residual risk that approval will not be able to be obtained for the proposed works/strategy. Works may also require significant resources that are presently unavailable	LOW: Unlikely to be acceptable to community and politically unpalatable. Extensive community education, endorsement by Minister(s) and Council required.
SLOW	No- addresses medium level threat	Option is considered worthwhile, but does not necessarily help with long term sustainability and lagoon health.	MEDIUM Term (> 2 – 5yrs before tasks can commence). Requires prior commitment of funds, resources or other tasks to be completed first	Medium (e.g. \$30,000 - \$300,000)	MEDIUM: May require approvals to be implemented, but works are generally supported. Generally these approvals would likely to be granted assuming requirements are met. May require some resources that would require redistribution of existing tasks and duties by officers.	MEDIUM: Would be palatable to some, not to others (50/50 response). Briefing by Councillors, GM and community education required
GO	Yes – addresses extreme or high level threat	Option provides an effective long term solution	SHORT Term (tasks can commence within approximately 2 years). Generally can be completed without too many barriers	Low (< \$30,000)	HIGH: No or minimal approvals or other impediments required to implement. No significant additional resources required (can be done as part of normal duties)	HIGH: Is very politically palatable, acceptable to community. Minimal education required

7.2.2 Preliminary Short List of Options

The shortlisted options were presented to the PEEG, Council and agency stakeholders for comment and consideration on the 16th December 2014. Meeting attendees were provided with a background information booklet which described the process leading to the selection of short-listed options and a feedback form on which they could provide comments on the wording and priority of options. Additionally notes on whether certain options should be removed, or new options added could be provided for consideration.

The outcomes of this process are detailed in Appendix E.

7.2.3 Draft List of Options

Provided below are lists of the key strategy areas, and actions within these key strategy areas are included in Table 8-1 in Section 8 (they are not repeated below for the purposes of brevity). These strategies and action represent the short-list of management options proposed for the future management of the Pambula Lake estuary.

Strategy Areas

- A - Assist in the management of aquatic weeds and pests
- B - Minimise spread of terrestrial weeds
- C - Actively manage riparian vegetation extent and condition and improve bank stability
- D - Develop and implement a variety of educational capacity building initiatives to increase knowledge of protecting and improving estuary health
- E - Protect and conserve Aboriginal cultural heritage sites around the foreshore
- F - Monitor and assess changes in entrance processes and dynamics
- G - Protect, rehabilitate and enhance estuarine vegetation including seagrass, saltmarsh and mangroves
- H - Protect and enhance estuarine water quality
- I - Improve recreational opportunities and amenity
- J - Support Oyster Aquaculture within the estuary.

Details of the Actions and Priorities:

Actions within these key strategy areas and their relative priority are included in Table 8-1 in Section 8 (over page).

8 Implementation Schedules

Implementation schedules have been developed for the shortlisted actions and are included in Sections 8.1 to 8.10. Management actions are grouped according to their overarching management strategy and are presented in Table 8-1 below.

Actions that require implementation over the next 5-10 years (i.e. until the Plan's next review) have been provided in the implementation tables below (a total of 28 management actions in 10 strategy groupings), including applicable location(s), the timing / triggers, responsibilities, estimated costs / resources required and cross referencing to other related actions.

Potential funding programs or sources for each of the management options are outlined in Section 3.5 (Page 150). Alternative funding mechanisms should also be investigated as a means of sourcing the necessary investment for implementation. Early triggers should be used to commence a process of securing finances for implementation of specific measures so that existing values and assets do not become compromised by future funding challenges.

As part of the actions to be undertaken, a suggested monitoring and evaluation framework for future condition monitoring of the estuary has been provided in Section 8.12 (Page 152). The framework aims to capture key data related to values of the estuary, while balancing cost and provide useful ongoing information to estuary managers, stakeholders and the broader community.

Table 8-1 Summary of Identified Actions

No#	Actions	Priority	Supporting Parties	Indicative Costs for Council
B1	Work with relevant agencies and the Far South Coast Coastal Weeds Project to control and manage weeds around the foreshore and in bushland areas surrounding the estuary.	High	DPI Agriculture and Private landowners	Current budgets maintained
C5	Work with private land holders and other relevant bodies to continue fencing of riparian areas in priority areas and encourage appropriate revegetation as opportunities and funding arise.	High	SELLS, DPI F&A and OEH (NPWS)	Determined on case by case basis, support as funds permit
D2	Undertake education programs for Council staff (and possibly key local developers and contractors) involved in Erosion and Sediment Control (E&SC), and Soil and Water Management to increase awareness of the impact poor soil controls can have on estuarine and wider catchment health.	High	-	Undertaken within existing budgets. External expert training up to \$10K
D3	In conjunction with DPI and SELLS, work with local farmers within the catchment to minimise pollution from agricultural runoff through education programs and support for appropriate on-ground management works, such as riparian revegetation and fencing to control stock access.	High	DPI Agriculture and SELLS	N.D, support as funds permit
D5	Continue existing and support new community engagement and education initiatives such as 'Love our lakes' (LoL), and 'clean up days', that serve to increase awareness on estuarine condition and management issues. Support may include financial support, logistical support, expertise support (particularly in relation to information sharing on topics of interest), amongst other things.	High	SELLS and Pambula Lake Oyster Growers (PLOG)	Grant funding for LoL ceases mid-2015. Funds to support clean up days determined on case-by-case basis

No#	Actions	Priority	Supporting Parties	Indicative Costs for Council
E1	Assist NPWS and Eden Local Aboriginal Land Council in the research and monitoring of Aboriginal cultural sites, and implementation of protection works as required.	High	OEH (NPWS), Eden Local Aboriginal Land Council	Undertaken within existing budgets.
E2	Council to work with relevant agencies and Eden Local Aboriginal Land Council to support long term protection of middens through appropriate heritage protection	High	OEH (NPWS) Eden Local Aboriginal Land Council	Undertaken within existing budgets.
H2	Continue to support existing Council initiatives that aim to manage risks to estuarine water quality arising from sewer pump stations overflow, as well as the siting, regulation and management of on-site sewage systems.	High	NSW Health	N.D. for sewer pump station overflow. Ongoing monitoring of OSMS undertaken within existing budgets
H3	Undertake rapid catchment appraisal for Pambula Lake catchment based on SRCMA Roads and Track Survey Summary and Volume 2 of the NSW EPA Managing Urban Stormwater – Soils and Construction Guide (2008). This should include consideration of drainage structures, suitable road base materials, minimum grading requirements, design adequacy and compliance. The appraisal will assist in the establishment of road and track management priorities including those relating to permanent sealing.	High	Forests Corporation of NSW, Crown Lands, energy / tele-communication companies, OEH (NPWS) and private landowners	Moderate costs ~20K
H6	Regular inspections/compliance checking of boat work areas particularly regulating management of boat antifoulants and other chemicals in the environment (particularly stormwater runoff) that may contribute to water and metal contamination.	High	DPI F&A	Undertaken within existing budgets.
J1	Support implementation and periodic review of the Pambula Lake Oyster Growers EMS.	High	PLOG and DPI F&A	Specific support costs N.D.
C1	Undertake bank restoration and rehabilitation works in priority areas as highlighted in the Estuary Processes Study (and Pambula Catchment Rehabilitation Plan). Council and SELLS to undertake works on public and private lands as funding and resources permit	Med.	SELLS, private landowners	Determined on case by case basis, support as funds permit
C3	Monitor riparian vegetation extent / coverage and bank erosion levels by completing a 10 yearly review of extent and condition.	Med.	OEH/NPWS and SELLS	Riparian Vegetation Extent ~\$10K, Riparian Condition Assessment ~\$15K and Bank Erosion Assessment ~\$10K
C4	Rationalise pedestrian and/or vehicle tracks in public lands within the riparian zones and other areas of sensitive vegetation that impact on these estuarine values.	Med.	OEH/NPWS and SELLS	N.D. support as funds permit
D1	Provide specific information on the importance of riparian land and bank management (and options for management) to new private landowners when land ownership changes occur in relevant areas of the estuary. Similarly, provide information and support to existing private land owners to encourage ongoing best practice riparian and bank management.	Med.	SELLS and DPI F&A	Low <5K/yr

Implementation Schedules

No#	Actions	Priority	Supporting Parties	Indicative Costs for Council
D4	Continue to provide information and support to private landholders to manage and improve native vegetation on their properties through Council, other Agencies and the Far South Coast Conservation Management Network.	Med.	SELLS	Current budgets maintained
F1	Work with OEH to undertake future hydrosurveys and analysis of water levels in response to significant community concerns to changed entrance conditions	Med.	OEH and RMS	No cost if State funded, \$10K-\$30K if funded externally
G2	Work with DPI F&A to complete mapping of the distribution / extent of mangrove, saltmarsh and seagrass using available information on a recurrent i.e. (5 to 10 year basis) or as required for other purposes.	Med.	DPI F&A and OEH	Underwater seagrass extent mapping \$15K-25K. No costs for aerial photography if supplied by State
H1	Develop and implement a Stormwater Management Plan that quantifies loadings of stormwater pollutant discharges from agricultural and urban areas to the estuary. Utilise the Stormwater Management Plan as the basis for determining priority areas requiring stormwater quality mitigation.	Med.	DPI Agriculture and SELLS	Moderate cost \$40-60K
H5	Implement ecosystem health monitoring that includes biotic indicators in addition to water quality. Report findings (make data available) regularly to community and stakeholders.	Med.	PLOG and OEH	Monitoring costs described in other actions. Costs to prepare and distribute estuary report card may be of the order of \$20K per event
H7	Review/audit the Oaklands Reuse Scheme to ensure that scheme operation and management meets all approval and regulatory requirements and that reviews are clear and publically available.	Med.	SELLS, EPA and Oaklands Property Manager	No immediate costs identified.
I1	Review with recreational fishers the need for any additional facilities to minimise impacts of fishing on estuary, e.g. for waste management, cleaning tables, etc	Med.	Pambula Fishing Club	N.D.
I5	Support development or creation of low-impact nature-based activity opportunities (and associated infrastructure) within the catchment and waterways of Pambula Lake that increases the participant's awareness of the high social and environmental values of the area, for example the 'Bundian Way Initiative' amongst others.	Med.	Eden Local Area Aboriginal Land Council, OEH/NPWS and DPI F&A	N.D
A1	Assist DPI F&A in the monitoring and management of potential outbreaks of Caulerpa (e.g. support for overall program in terms of signage and education) and ongoing control of pest species, as appropriate.	Low	DPI F&A and Pambula Fishing Club	Low <5K/yr
C2	Council to identify priority privately owned land parcels for potential acquisition by Council, philanthropic parties, OEH and/or other related schemes such as the Coastal Lands Protection Scheme as a means of protecting and enhancing key estuarine values such as bank riparian condition, key habitat and/or improved public access use.	Low	NSW Government (Planning and Environment)	Low cost to identify suitable lands ~\$10K. Acquisition costs may be high
C6	Ensure all new seawalls being built or old ones being upgraded are built in accordance with environmentally friendly seawall guidelines	Low	NSW T&I Crown Lands Division	Costs borne by applicant

No#	Actions	Priority	Supporting Parties	Indicative Costs for Council
G1	Incorporate adequate buffers around key wetland areas to ensure vegetation can migrate with SLR and provide additional protection. Establish suitable means for dedicating buffers to this landuse, e.g. lease, purchase or voluntary contribution, etc	Low	NSW Planning and Environment	Planning component can be absorbed with existing budgets.
G3	Utilise available information on heavy metal testing to understand and lessen impacts of activities within estuary.	Low	Pambula Lake Oyster Growers, DPI F&A, EPA	Undertaken within existing budgets, no cost for accessing 3 rd party data. Costs for new data or supporting other programs N.D.

N.D. Not Determined; **A** - Assist in the management of aquatic weeds and pests; **B** - Minimise spread of terrestrial weeds; **C** - Actively manage riparian vegetation extent and condition and improve bank stability; **D** - Develop and implement a variety of educational capacity building initiatives to increase knowledge of protecting and improving estuary health; **E** - Protect and conserve Aboriginal cultural heritage sites around the foreshore; **F** - Monitor and assess changes in entrance processes and dynamics; **G** - Protect, rehabilitate and enhance estuarine vegetation including seagrass, saltmarsh and mangroves; **H** - Protect and enhance estuarine water quality; **I** - Improve recreational opportunities and amenity; and **J** - Support Oyster Aquaculture Operations.

8.1 Assist in the management of aquatic weeds and pests

8.1.1 Action A1

Assist DPI F&A in the monitoring and management of potential outbreaks of *Caulerpa* (e.g. support for overall program in terms of signage and education) and other environmental pests as appropriate.

Priority:

LOW

Aim:

Prevent infestation of the estuary by serious environmental pests that are not currently present, and manage existing environmental pests to maintain existing estuarine values and uses.

Location:

Whole of estuary, particularly the Pambula boat ramp.

Timeframe:

Long term and ongoing

Key Responsibility:

BVSC

Other Partners:

DPI F&A, Pambula Fishing Club

Indicative Cost:

Costs for ongoing support are low (<\$5K/year) on the basis that most of the activities are related to education and awareness. Actions related to field surveys (i.e. diving activities that may also observed for presence of *Caulerpa*) are costed in other actions.

Performance Measures:

- Local population is educated and aware of the risks of *Caulerpa* spread with the commercial and recreational users of the Lake (particularly boat users);
- Locals acting as Fishcare volunteers;
- Publicity and use of the Aquatic Pest Sighting Program; and
- Lake bed surveys for the presence of *Caulerpa* are supported through appropriate mechanisms.

Suggested Actions:

Education and Awareness

The NSW Control Plan (which is implemented primarily by DPI F&A, with support of other state and local government authorities) outlines a variety of communication and awareness programs that have been used previously (refer to Table 3 of the Control Plan). It is suggested that a selection of

cost-effective resources and approaches be utilised within the Pambula Lake. As there is no current outbreak, the focus of the education and awareness initiative is on prevention (i.e. vector management to limit opportunities for its introduction to the estuary) and early identification. The use of material which allows readers to use correct techniques for boat washing and to correctly identify *Caulerpa* is likely to be effective in this regard. The NSW Control plan identifies that, “*many of the patches detected to date in NSW have been reported by fishers and other members of the general public who have accidentally come across the weed.*”



Example of *Caulerpa* Signage
(DPI, 2015)

Fishcare volunteers may be able to assist in the education and awareness initiatives by speaking with other lake users about *Caulerpa*, provision of information brochures, and the need for users to be aware of its potential presence while using the lake and how to report a sighting (e.g. use of the Aquatic Pest Sightings form (on-line) or call a hotline (02 4916 3877) or emailing to aquatic.pests@industry.nsw.gov.au).

Field Based Investigation

While education and awareness are powerful tools in prevention of *Caulerpa* spread, early identification might be aided by field based surveys which could include diving to investigate lake bed conditions. Periodic lake bed surveys occur through other programs, such as the monitoring of seagrass coverage by the Estuarine and Coastal Lakes MER. Council can also initiate its own monitoring of lake bed conditions, as required under other Actions of the plan (specifically **Action G2**, and also **Action H5**).

Comments:

To assist in limiting the local spread of *Caulerpa*, Wallagoot Lake had a Section 8 commercial fishing closures applied (i.e. to ban the use of nets), but this closure has been recently lifted based on evidence that *Caulerpa* had been successfully removed from this estuary as a result of control program implemented.

Background Information:

The Control Plan for *Caulerpa* has a number of key goals, some of which are relevant to this estuary (in its current state without a *Caulerpa* outbreak) including:

- Preventing the further spread of *Caulerpa* within and between NSW estuaries;
- Continue to educate community members of the impact of *Caulerpa* and the community's role in management strategies to prevent the alga's spread and counteract its impacts; and
- To coordinate education programs and management of *Caulerpa* collaboratively with relevant local and State government agencies.

The control plan divides action into vector management; compliance; education and community involvement; control and treatment in high priority areas; survey and monitoring; and research.

Further information on aquatic pests is provided in Section 4.2.5 (Page 69) of the report.

See Also:

- **Action I1**, regarding coordinating with the Pambula Fishing Club with respect to lake facilities. This meeting could also be used to distribute brochures produced by DPI F&A regarding Caulerpa and its control. The DPI F&A officer can provide an update to attendees on the success of Caulerpa management across the State and need for continued vigilance to ensure that it does not get imported into Pambula Lake.
- **Action G2** focuses on the collection of seagrass coverage data within the estuary.
- **Action H5** focuses on the use of seagrass coverage data in the identification of estuary health and health trends.

8.2 Minimise Spread of Terrestrial Weeds

8.2.1 Action B1

Work with relevant agencies and the Far South Coast Coastal Weeds Project to control and manage weeds around the foreshore and in bushland areas surrounding the estuary.

Priority:

HIGH

Aim:

Prevent infestation of the foreshore and surrounding bushlands of the estuary by environmental weeds that are not currently present, and manage existing environmental weeds to maintain existing estuarine values and uses.

Location:

Estuary foreshores and surrounding bushlands.

Timeframe:

Continue to implement. Priority reflects need for long-term and well-resourced approach to management of weeds.

Key Responsibility:

BVSC

Other Partners:

DPI Agriculture, Private landowners, NPWS

Indicative Cost:

Current budget utilised should be maintained for ongoing weed management.

Performance Measure:

Relevant weed management programs such as Council's Weed Action Program and the Far South Coast Coastal Weeds Project are maintained and supported as appropriate.

Suggested Actions:

The Pambula Catchment Rehabilitation Plan has determined the levels of riparian weed threat (i.e. threat of weed establishment) as part of its site assessments and this is reproduced in Figure 8-1. It is noted that the lower sections of the Pambula and Yowaka Rivers are both under Moderate to High weed threat and as such should be included as priority areas inspected by Council under its Weed Action Program.



African Daisy and Polygala at back of Broadwater (Source Council)

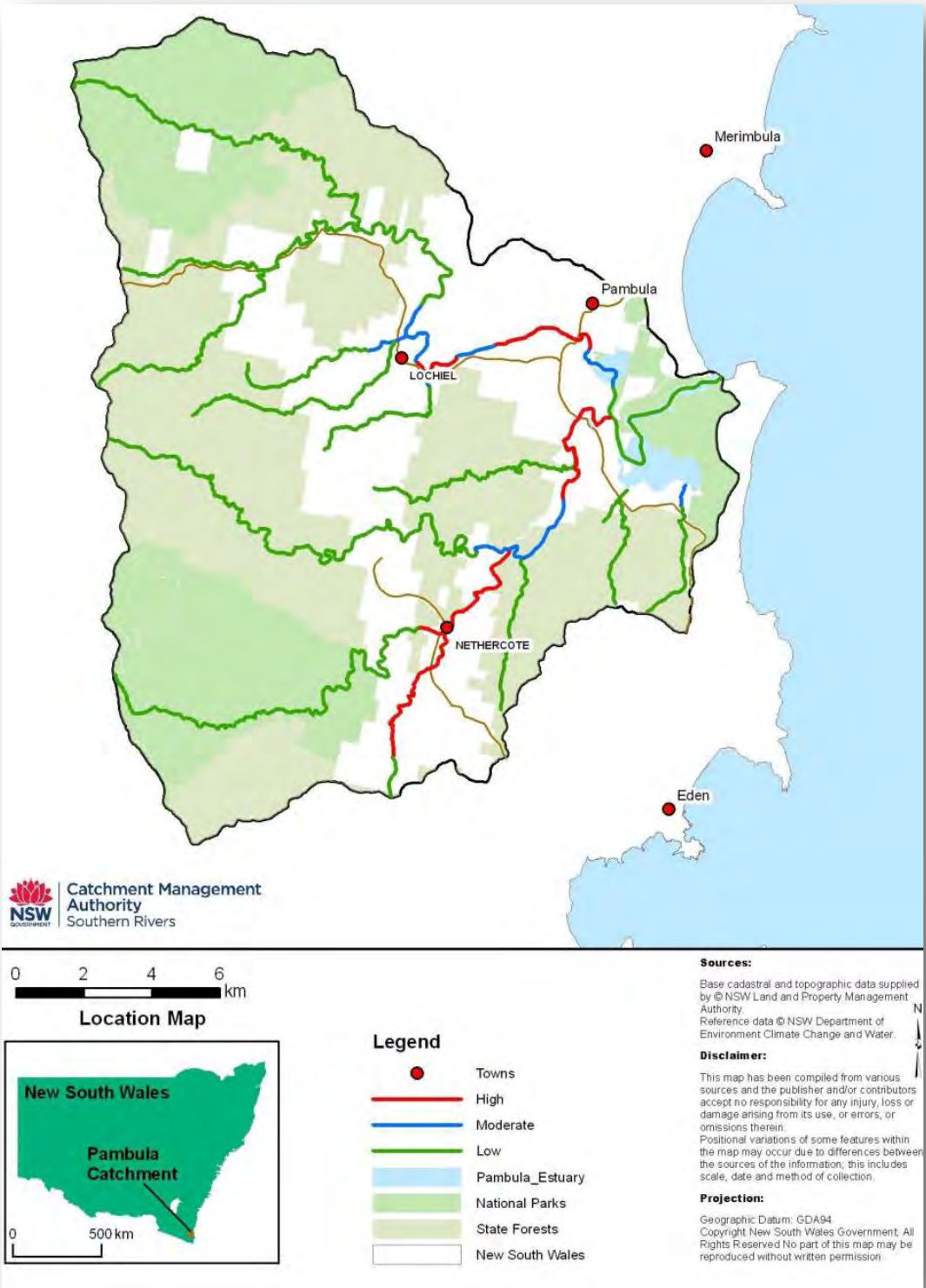


Figure 8-1 Reaches under significant riparian weed threat in the Pambula River catchment

To assist agriculturalists, those living in the urban areas of the catchment and along the coastal fringe, Council in consultation with the DPI should continue to employ extensive education and awareness programs with community activities and field days along with development of information displays and flyers to suit the needs of the community in managing noxious, environmental and coastal weeds in the local government area.

Comments:

None.

Background Information:



Serrated Tussock in Catchment (Source Council)

BVSC, DPI Agriculture and private landowners all have responsibilities related to weed management. In general, DPI Agriculture focuses on critical weed issues, research, policy, planning and education / awareness programs. Council is responsible for education and awareness of community in its Local Government Area, implementing weed management programs, managing declared weeds (removal on Council lands and enforcement on private lands), reporting on activities and coordinating with other agencies. Generally, the actions of Council are outlined in their Weed Action Program (available on Council's website). Landowners are responsible for

management of declared noxious weeds on their lands.

The Coastal Weeds Project is linked to other programs which extend beyond weed management to include dune rehabilitation, native vegetation restoration, riparian and estuary restoration, protection of endangered species. The program involves the community via extensive education and awareness programs.

See Also:

Weeds Attack – resource through DPI for schools <http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/schools>

Brochure through the CRC for weed management

http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0005/350429/crc-Managing-garden-weeds-planning-tactics.pdf

Information available on Councils website

http://www.begavalley.nsw.gov.au/cp_themes/default/page.asp?p=DOC-GPQ-71-65-36

8.3 Actively manage riparian vegetation extent and condition and improve bank stability

8.3.1 Action C1

Undertake bank restoration and rehabilitation works in priority areas as highlighted in the Estuary Processes Study (and Pambula Catchment Rehabilitation Plan). Council and SELLS to undertake works on public and private lands as funding and resources permit.

Priority:

MEDIUM

Aim:

Improving the condition of banks in priority areas by implementation of appropriate rehabilitation and protective measures.

Location:

The location of bank erosion (and geomorphic condition) is provided in Figure 3-5 and Figure 3-6 within the report, while locations for priorities for action are outlined in Figure 8-2, and Figure 8-3 below.

Timeframe:

Implement actions within 2 to 5 years (and longer as required) of Plan adoption. Actions can be implemented earlier based on need and availability of resources.

Key Responsibility:

BVSC

Other Partners:

SELLS, private landowners

Indicative Cost:

Revegetation costs will need to be determined on a site by site basis. Costs may include a component of bank restoration works (e.g. earthworks) and revegetation costs.

Open land revegetation costs are of the order of \$2,700 per hectare (based on trees at 6m centres planted, mulched and guarded).

Performance Measure:

Bank restoration works undertaken in identified priority areas.

Suggested Actions:

Priorities areas have been identified in the Pambula Catchment Rehabilitation Plan which mostly focuses on the upstream catchment areas, but does also include tidal waterways. Similarly, bank



Example of Bank Erosion in Pambula Estuary (SRCMA, 2012)

Implementation Schedules

erosion areas and likely causes were noted within the Estuary Processes Study which focused on tidal waterways (although the study excludes sections of the upper estuary in the Yowaka and Pambula Rivers). It is recognised that rehabilitation in upstream freshwater areas will ultimately improve conditions in the estuarine areas due to the connectedness of these systems.

The Catchment Rehabilitation Plan identifies that “*based on the stream recovery principle, reaches with ‘conservation, rapid recovery potential and strategic’ status have been given the highest priority for investment.*” Within the estuary this includes (refer Figure 8-2):

- The upper sections of the Pambula and Yowaka Rivers (strategic⁵); and
- Sections of the Harts and Jigamy Creeks which have been identified with rapid and or conservation ratings.

When these priorities are overlaid with socio-economic values as identified in the Catchment Rehabilitation Plan (refer Figure 8-3), the Harts and Jigamy Creeks have lower socio-economic values, thus indicating that improving the conditions of banks in the upper tidal sections of the Pambula and Yowaka Rivers are the highest priority.

Additionally, the Estuary Processes Study has identified using visual assessment locations of erosion as provided in Figure 3-5 (earlier in the report) although no priority rankings were associated with these findings. Bank erosion issues were associated with:

- Boat wash;
- Areas of erosion along the entrance channel associated with larger scale coastal and fluvial processes that have resulted in differing patterns of sand shoal formation and wave penetration in the estuary;
- Cattle access to the waterways; and
- Informal access paths to the waterways.

Other actions outlined within the CZMP seek to address the root causes of this erosion (refer to ‘See Also’ section). The Estuary Processes Study identifies that a variety of bank erosion control measures that could be applied depending on the nature of the erosion.

Prior to bank erosion works being implemented, the proponents of the activity will be required to consult with a range of agencies including OEH/NPWS for any approvals that may be required for foreshore works, particularly in respect of avoiding accidental damage to heritage items that may be present.

Comments:

Further information on erosion control approaches may be sourced through:

- A Rehabilitation Manual for Australian Streams, Volumes 1 and 2 (CRCCH, 2000)
- The Australian River Restoration Centre, <http://arrc.com.au/resources/stream-bank-erosion-and-flood-management/>.

⁵ Strategic sites have the potential to impact on other reaches and off-stream environments if not addressed.

Background Information:

Condition is discussed in Section 3.3 (Page 32);

Pressures are discussed in Section 4.3 (Page 69).

See Also:

- Aboriginal cultural and heritage site monitoring is outlined in **Action E1**, determining causes and long term solutions for erosion at some of these sites e.g., Severs Beach may be complex;
- Cattle access to the waterways is addressed in **Action C5**;
- Informal access paths to the waterways are addressed in **Action C4**; and
- Any proposed seawall construction to address erosion should consider recommendations of **Action C6**.

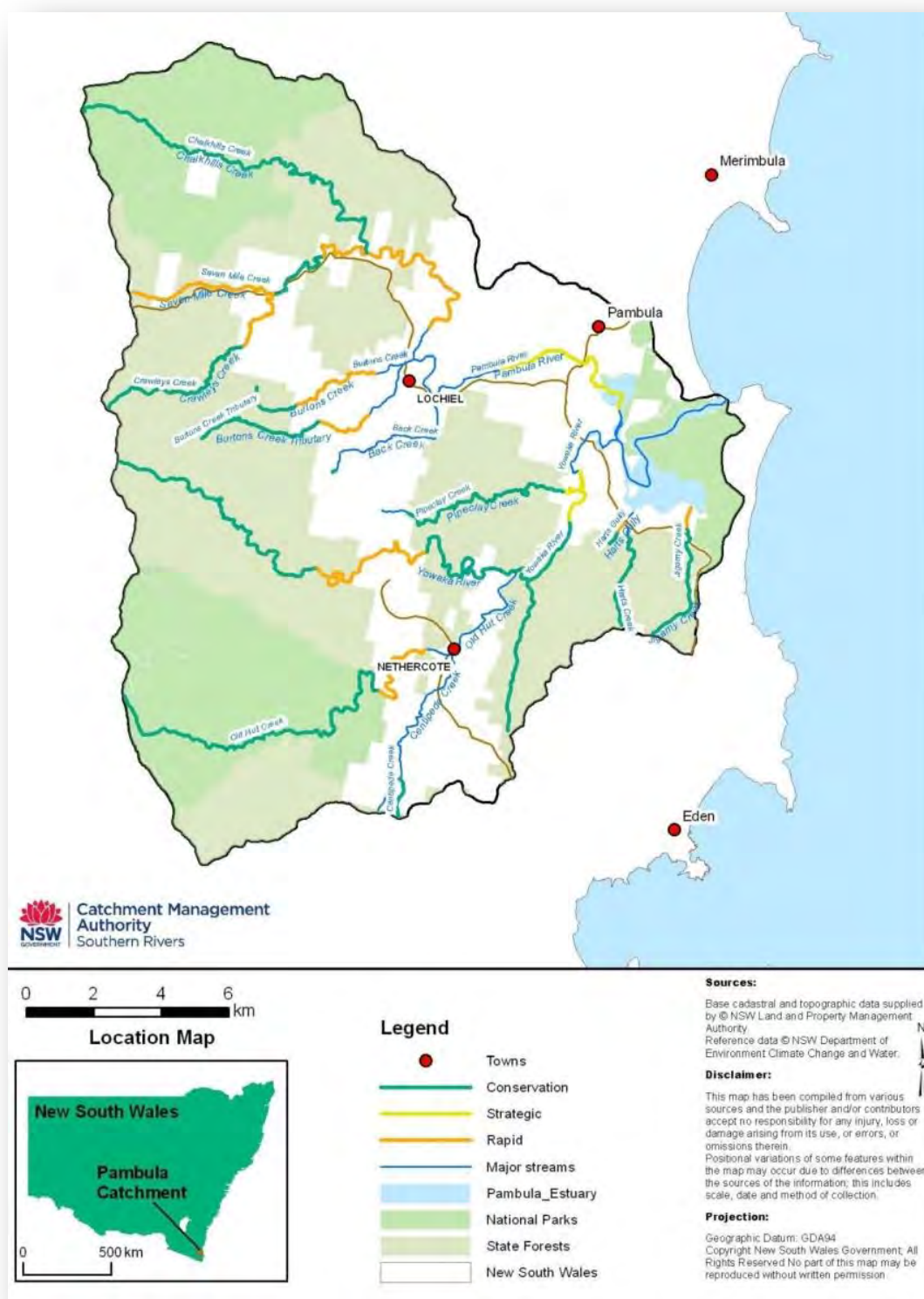


Figure 8-2 Priority reaches based on recovery potential (SRCMA, 2012)



Figure 8-3 Priority reaches based on combined socio-economic value (SRCMA, 2012)

8.3.2 Action C2

Council to identify priority privately owned land parcels for potential acquisition by Council, philanthropic parties, OEH and/or other related schemes such as the Coastal Lands Protection Scheme as a means of protecting and enhancing key estuarine values such as bank riparian condition, key habitat and/or improved public access use.

Priority:

LOW

Aim:

Facilitate purchase of select lands to protect and enhance key estuarine values where practical to do so.

Location:

Foreshores and catchment of Pambula Lake estuary.

Timeframe:

Long term i.e. > 5 years, but can be implemented as opportunities arise.

Key Responsibility:

BVSC

Other Partners:

NSW Government (Planning and Environment) as the administrators of the Coastal Lands Protection Scheme, OEH (and NPWS) and philanthropic donors amongst others.

Indicative Cost:

- Relatively low cost to Council to complete planning exercise to identify potentially key lands for acquisition, i.e. <\$10K and these costs may be able to be absorbed into existing budgets.
- Potentially large purchase cost, although costs may be borne by others with Council (or others) acting as future land managers.

Performance Measure:

Priority sites for potential land purchase are determined.

Suggested Actions:

It is recommended that Council complete an investigation of foreshore lands, and other lands in the immediate catchment of the estuary with a view of completing an internal prioritisation and listing of preferred acquisition sites. These can later be used by Council and /or provided in confidence to third party organisations and others who may have an interest in land acquisition for the purposes of preservation.

Key criteria that may be considered in the identification of potential sites could include:

- Ownership of the land, the focus would be on existing freehold land parcels, most likely unencumbered with actively used housing or related assets to keep acquisition cost low.

Implementation Schedules

- Proximity to the estuary and linkage to other key habitat or National Parks. Land parcels adjoining the estuary will have banks and associated riparian vegetation making these priority sites for acquisition.
- Presence of key habitat. These may include locations of large patches of saltmarsh, lands containing threatened flora or habitat for threatened fauna, land forming parts of habitat corridors.
- Likely environmental benefits gained from alternative management. This may include reduced weeds or opportunity for weed invasion, improved bank or riparian vegetation condition and extent, protection and rehabilitation of key habitat, reduced sediment input to the estuary, etc.
- Likely social benefit gained from the land acquisition, e.g. protection of cultural sites, improved access, increased visual amenity, improved ability for recreation, etc.
- Likely purchase cost, and cost of rehabilitation (if required) and ongoing maintenance.

Together these criteria could be used to identify and define priorities for potential acquisition. Subsequently, third parties can be invited to view or comment on priority sites based on their potential interest and criteria for selective land purchases of this nature.

Comments:

It is possible that local (and regional) philanthropists may have an interest in land purchases of this nature for the purposes of protecting key values, such as important cultural sites, saltmarsh or threatened habitat and shouldn't be discounted from consideration.

Background Information:

Information on Coastal Protection from OEH may be accessed here

<http://www.planning.nsw.gov.au/PlansforAction/Coastalprotection/tabid/166/language/en-AU/Default.aspx>

See Also:

NA

8.3.3 Action C3

Monitor riparian vegetation extent / coverage and bank erosion levels by completing a 10 yearly review of extent and condition.

Priority:

MEDIUM

Aim:

Add to the environmental knowledge base of the estuary to assist in identifying issue areas, and trends in condition over time.

Location:

Entire estuary foreshore (for bank erosion) and extending back at least 100m from the water edge for riparian extent and condition.

Timeframe:

A riparian extent survey was last completed in 1998 and a further assessment should be completed in the next 2 to 5 years.

Bank erosion was mapped in 2012 as part of the Estuary Processes Study across most of the estuary (although sections were excluded on the upper reaches to the tidal limits of the Yowaka and Pambula Rivers). Similarly, the Catchment Rehabilitation Plan completed a multi-factor river styles assessment (e.g. geomorphic condition) in 2012. Hence, the timing for a future bank erosion survey would be around 2022.

Key Responsibility:

BVSC

Other Partners:

OEH and SELLS for field support.

Indicative Cost:

- **Riparian Vegetation Extent Assessment.** Indicatively this will cost approximately \$10K to complete, based on the use of aerial photography that has been supplied by others at no cost. Note that ground-truthing would be undertaken as part of the Riparian Condition Assessment (described below). The methods outlined in the following document should be followed: 'Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols' (OEH, 2013), refer to Section 8.1 'MER Program mapping'. This includes methodologies for both GIS based aerial photo interpretation of vegetation areas, and supporting field based confirmation of desktop mapping procedures.
- **Riparian Condition and Bank Erosion Assessment.** This would involve field-based assessments of riparian vegetation condition, bank erosion and ground-truthing of mapping undertaken for the concurrent Riparian Vegetation Extent Assessment. The foreshore of the estuary would be rapidly inspected to determine vegetation and bank condition and notable pressures (e.g. cattle access, boat wake, pedestrian traffic etc.). The approximate cost would be \$20K per episode, which includes reporting.

Performance Measures:

- Completion of a Riparian Vegetation Extent Survey every 5 to 10 years with the next in 2 to 5 years.
- Completion of Riparian Condition Assessments every five years, this would be completed concurrently with the Riparian Extent survey.
- Completion of a Bank Erosion survey in around 2022.
- Information from the surveys is used to assess trends in estuary health and inform related agencies of findings.

Suggested Actions:

Riparian Vegetation Extent Assessment

The riparian zone (taken to extend up to 100m from the highest astronomical tide) of the estuary will contain a mixture of marine and terrestrial plant species depending on elevation and regularity of inundation. Monitoring as part of this action aims to investigate the extent and condition of all vegetation within the riparian zone, which also includes mangroves and saltmarsh.



Example of Riparian Vegetation on Pambula Lake estuary foreshore

To assess extent, it is recommended that use is made of suitable resolution ortho-rectified aerial photography. This information is commonly viewed and utilised using Geographical Information Systems (GIS) on desktop computers. Determination of the extent of the estuary will require delineation of the water edge and 100m buffer lines. Within these buffered zones around the estuary, digitisation of vegetation boundaries will be required to allow for calculation of the percentage of vegetation coverage within these zones. Methods for mapping saltmarsh and mangroves are outlined within the publication 'Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols' (OEH, 2013). This methodology could also be applied to map vegetation in non-tidally influenced riparian areas.

Saltmarsh and Mangrove Coverage

Determination of the areas of saltmarsh and mangrove (i.e. what makes up the riparian zone) will be addressed through **Action G2** and **Action H5**.

Riparian Condition Assessments

Vegetation community structure and condition should be recorded using standardised (repeatable) rapid assessment methods. Indicators should include level of vegetation fragmentation, presence of weeds (and types and extent), disease, presence and extent of erosion or other forms of disturbance (gross pollutants, grazing, formal and informal walking tracks, extraction, filling, clearing). Photographic records should be taken from a fixed location to allow repeated surveys, with photos taken facing each of the cardinal points. The condition assessments will build a catalogue of information which can be used to assess broad trends in riparian condition.

Bank Erosion Assessments

The survey should be conducted with observations referenced with global Positioning System (GPS) tools. This will allow information to be translated into GIS for later use by Council and others. Details that could be recorded during the bank surveys include:

- Height of bank and depth of bed at point of erosion (estimated slope);
- Possible erosion mechanisms at identified locations;

- Predominant soil type at locations of erosion;
- Presence of riparian vegetation at locations of erosion (ground cover, tree cover);
- Presence and longevity of any prior bank erosion control measures;
- Presence of cattle ingress to the banks or creek itself;
- Presence of serious invasive weeds; and
- Presence of informal tracks on the foreshore.

Generally the condition of banks within the Pambula River estuary are good with most banks being stable, hence the survey should be able to be completed relatively rapidly.

Comments:

NA

Background Information:

Aerial photography is flown every few years by OEH's Coastal Section. This data may be made available (free of charge) to Council and other state agencies that are in the process of completing work relevant to OEH, e.g. updating seagrass mapping. Alternatively, if the data is sourced separately indicative costs for the collection of the mapping data may be around \$10K to \$15K depending on estuary size.

See Also:

Action G2 (Page 127) and **Action H5** (Page 138).

8.3.4 Action C4

Rationalise pedestrian and/or vehicle tracks in public lands within the riparian zones and other areas of sensitive vegetation that impact on these estuarine values.

Priority:

MEDIUM

Aim:

Improve estuarine bank condition and foreshore vegetation extent through removal of unneeded disturbance points.

Location:

The Estuary Processes Study has identified a number of informal walking and vehicle tracks on the foreshore of the Pambula River.

Timeframe:

Survey and remediation works should occur in the next 2 to 5 years within available budgets.

Key Responsibility:

BVSC and other primary land managers where tracks are present (focus on public lands).

Other Partners:

OEH/NPWS, SELLS

Indicative Cost:

Costs unknown and will relate to the number and extent of effort required to remediate the tracks and foreshores.

Performance Measure:

- Completion of a survey to identify location of informal tracks.
- Assessment and costings for remediation of identified tracks.
- Coordination with land managers where Council is not the land manager of the track requiring remediation.

Suggested Actions:

Complete a survey of informal tracks in public lands that are not formal access points and are leading to trampling and foreshore degradation. The initial focus will be the Pambula River and locations where other foreshore degradation is known to have occurred as a result of informal access.

The site survey will complete a rapid assessment of remediation options for each site, which may include requirements for signage and track closure, replanting and bank repair works. Ownership of sites can be determined from GPS coordinates obtained on site and compared to cadastral information maintained by Council. Those sites not on land maintained by Council should be referred to the appropriate land managers.

Costs for closure, rehabilitation and repair will be estimated from the site reports.

Comments:

Further information on banks and foreshore revegetation may be sourced through:

- A Rehabilitation Manual for Australian Streams, Volumes 1 and 2 (CRCCH, 2000)
- The Australian River Restoration Centre, <http://arcc.com.au/resources/stream-bank-erosion-and-flood-management/>.

Background Information:

Condition aspects are outlined in Section 2.4.1 (Page 18)

Pressure aspects are discussed in Section 4.1.4 (page 62).

See Also:

Action I1 (page 145) which assesses fishing in the estuary, and key foreshore fishing locations which may be causing foreshore degradation such as that occurring presently near the Yowaka Bridge.

8.3.5 Action C5

Work with private land holders and other relevant bodies to continue fencing of riparian areas in priority areas and encourage appropriate revegetation as opportunities and funding arise.

Priority:

HIGH

Aim:

Exclude cattle from the estuarine banks and foreshores to promote bank stabilisation and revegetation.

Location:

Priority areas for riparian fencing include:

- Areas where cattle currently access the banks and waters of the estuary and cause degradation. Fencing off creek areas may necessitate additional works to supply water from the creek to watering troughs within the boundary of the new fencing.
- Areas for bank restoration that coincide with priorities identified in the Pambula Catchment Rehabilitation Plan and Estuary Processes Study. These priorities are further discussed in **Action C1** (Page 97).



Example of Stock Exclusion Fencing (Source Council)

Timeframe:

Commence within a couple of years of plan approval, subject to identifying suitable sites.

Key Responsibility:

BVSC

Other Partners:

SELLS, DPI F&A, OEH (NPWS)

Indicative Cost:

Costs would be determined on a site by site basis. Fencing may cost of the order of \$10 to \$20 per metre (installed) depending on fence type and terrain. Offstream water troughs (and pumps) may cost of the order of \$2000 to install. Revegetation costs are described further in **Action C1** (Page 97).

Performance Measures:

- Private landowners are engaged in discussions regarding benefits of creek fencing to exclude cattle.
- Creek fencing and revegetation in priority areas.

Suggested Actions:

- Confirm priority sites and establish contact with private landowners.
- Locate fencing above defined flood lines where possible. Flood lines should be able to be provided by Council upon request. Locating fences above defined flood extents will assist in protecting fences against flood damage from lower order frequent flood events. The highest practical flood line should be adopted to increase the likely life of fences.
- It is recommended to consult with the SELLS in respect of vegetation selection in the bank areas to be rehabilitated. Plant species should be selected to maximise rehabilitation outcomes and consider potential effects of flood flows and potential to attract feral animals.
- OEH (NPWS) should be consulted in respect of riparian works which may disturb soils including fencing activities to ensure that these activities are not in located on known or potential middens or other cultural artefacts of conservation value.
- Confirm availability for funding for any fencing activities that may be undertaken.

Comments:

Water extraction from the creek must be consistent with the requirements of the Water Sharing Plan (WSP) for the Towamba River Unregulated and Alluvial Water Sources Order 2010 (refer section 2.5.4 (Page 22)).

Background Information:

- Terrestrial riparian vegetation is discussed in Section 3.4.4 (Page 46)
- Pressure information provided in Section 4.1.4 (Page 62).

See Also:

A resource page (with multiple information sources) for rural residential lands with banks and riparian vegetation is provided here:

http://www.ruralresidentialliving.com.au/printer_friendly/printer11.pdf

8.3.6 Action C6

Ensure all new seawalls being built or old ones being upgraded are built in accordance with environmentally friendly seawall guidelines.

Priority:

LOW

Aim:

Ensure foreshore assets such as seawalls contribute to the environmental values of the estuary.

Location:

Whole of estuary.

Timeframe:

Ongoing, matter of seawalls may arise periodically, but could be expected to occur with greater frequency into the future in line with sea level rises.

Key Responsibility:

BVSC

Other Partners:

NSW Trade & Investment Crown Lands Division (generally applicable for works below the Mean High Water mark) and OEH (advisory) and other agencies that may require consultation depending on the scope and nature of the works, such as DPI Fisheries and Aquaculture.

Indicative Cost:

Generally cost is borne by the applicant in developing designs consistent with the recommended guidelines.

Performance Measure:

Seawalls designed and built in a manner consistent with the Environmentally Friendly Seawalls guidelines.

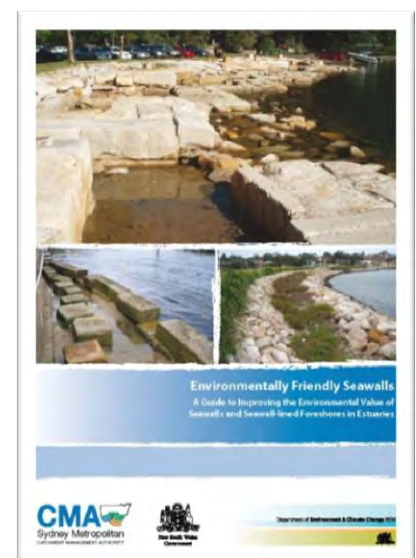
Suggested Actions:

Council to review development approval processes relating to foreshore and intertidal zone structures (including sea walls, ramps, etc) to ensure that relevant conditions will be applied to applicable developments, and that referral processes with external agencies are clear and appropriate to the process. The Crown would also have to endorse the application as the owner of land below mean high water mark.

It is recommended that seawalls comply with the design requirements of the 'Environmentally Friendly Seawalls' publication by the former Sydney Metropolitan CMA and Department of Environment and Climate Change NSW in June 2009 (ISBN 978 1 74232 254 4). The OEH will be able to supply a copy of the publication upon request. These guidelines are regarded as current best practice guidelines.

The action does not exclude the need for seawall designs to consider coastal processes, structural and other engineering considerations to ensure longevity, limited off-site impact and safety. In this regard design advice may be found in:

- Australian Standard AS 4997-2005 'Guidelines for the Design of Maritime Structures'. The objective of this standard is to provide designers and regulatory authorities of structures located in the marine environment (including estuaries) a set of guidelines and recommendations for the design, preservation and practical applications of such structures.



Environmentally Friendly
Seawall Guideline

- Further advice was published by the NSW Government in 2005, and is titled 'Engineering Standards and Guidelines for Maritime Structures', and is currently located at <http://www.rms.nsw.gov.au/documents/maritime/property-planning/development/engineering-guidelines.pdf>.

Comments:

NA

Background Information:

NA

See Also:

Bank erosion issues and priorities are outlined in **Action C1** (Page 97). In some instances hard engineering solutions may be required.

8.4 Develop and implement a variety of educational capacity building initiatives to increase knowledge of protecting and improving estuary health

8.4.1 Action D1

Provide specific information on the importance of riparian land and bank management (and options for management) to new private landowners when land ownership changes occur in relevant areas of the estuary. Similarly, provide information/support to existing private land owners to encourage ongoing best practice riparian and bank management.

Priority:

MEDIUM

Aim:

Ensure landowners who are responsible for foreshore areas adjoining the estuary are aware of the values of riparian vegetation and stable banks to the overall values and function of the estuary and have resources available to them to manage these areas appropriately.

Location:

Landowners within the catchment of the Pambula Lake estuary (and entire catchment if deemed appropriate).

Timeframe:

Should be commenced two to five years after Plan adoption, but may be commenced sooner as required.

Key Responsibility:

BVSC

Other Partners:

SELLS, DPI F&A

Indicative Cost:

- Minimal cost to prepare information as it should be possible to base it on similar examples included in Appendix G.
- Cost of production and distribution of material should be less than \$5K (depending on size of information booklet/brochure produced and cost of printing).

Performance Measure:

- Production of an easy to read yet informative brochure or information booklet. If possible, the information should provide information that may reduce barriers to implementation where these are known, e.g. e.g. lack of support, lack of information, lack of funds, etc.
- Information brochure or booklet available to new and existing owners (owning the subject lands) regarding the importance of riparian land and bank management.

- Information is available on Council's and other affiliated group websites.

Suggested Actions:

It is recommended that Council develop an easy to read yet informative brochure or booklet for distribution to landowners in possession of land containing banks and riparian lands (within the estuary and or entire catchment as required by Council). This information should be provided to existing owners, and new owners on land purchase.

The information brochure is to outline how bank stability and riparian vegetation are key estuarine values and the many functions they provide in managing water quality, controlling erosion and sedimentation and maintaining amenity. The principles of sound bank and riparian management should be outlined with options for further information and support being provided. The information package will outline key steps for landowners to follow for initiating works on banks or foreshores, that provides consideration of potential European or Aboriginal cultural heritage artefacts or sites, as well requirements for any formal permits or approvals to complete bank works.

If there are known local barriers to bank and riparian management, these should be considered and addressed where possible in the information supplied on the basis that this may help address individual's concern and promote them to take action. Common barriers are things like lack of support, information or funds. Periodic open days may be coordinated by Council to support this initiative and individuals understanding of sound bank and riparian management. The field days serve many purposes including information sharing, networking and capacity building.

Comments:

NA

Background Information:

Bank condition is discussed in Section 3.3 (page 32), while further information on riparian vegetation is provided in Section 3.4.4 (Page 46).

Morphological pressures are discussed in Section 4.3 (Page 69) and riparian vegetation pressures are outlined in Section 4.1.4 (Page 62).

See Also:

Action C5 (Page 108) is focused on Council working with private land holders and other relevant bodies to fence riparian areas and encourage riparian revegetation.

Further information is included in Appendix G.

Other related actions include:

- **Action C1** (Page 97) focuses on priority sites for bank restoration and rehabilitation works.
- **Action C3** (Page 103) collates information on riparian vegetation extent and condition and bank condition.

8.4.2 Action D2

Undertake education programs for Council staff (and possibly key local developers and contractors) involved in Erosion and Sediment Control (E&SC), and Soil and Water Management to increase awareness of the impact poor soil controls can have on estuarine and wider catchment health.

Priority:

High

Aim:

Improve knowledge and capacity of Council staff to better manage soil and water resources to limit erosion and sedimentation impacts to the estuary.

Location:

NA

Timeframe:

Within the first couple of years of Plan adoption.

Key Responsibility:

BVSC

Other Partners:

Possible others involved in Erosion and Sediment Control, e.g. key local developers.

Indicative Cost:

Many of the costs can be absorbed within existing council budgets, as the activities relate to the delivery or core Council services, however, costs for external support (if required) may be of the order of \$1500 day/person.

Performance Measure:

Implementation of a multi-divisional, cross-sectional education program covering aspects of best practice erosion and sediment control applicable to the region, its uses, values and Council's obligations.

Suggested Actions:

It is recommended that Council implement an educational program for relevant staff involved in Soil and Water Management (also called Erosion and Sediment Control (E&SC)).

Council has recently adopted new Policies and Strategies for Soil and Water Management and the reasoning behind, and implications of, these documents should be communicated to Council staff, including relevant senior managers, other middle managers and non-managers in different Council



Example of Sediment Fence on a Construction Site

divisions (i.e. Transport and Utilities, Planning and Environment, Strategy and Business Services, etc).

The nature of soil and water management necessitate that good management commences at the design and assessment stage of projects (i.e. adequate planning for E&SC) and that actions are implemented during the construction stage and maintained during the operational phase of the asset. As such many Council staff will have involvement in a development from its conception to its completion.

It is suggested that the education program cover using a variety of internal presentation, workshops and in the field site visits and demonstrations:

- Council's legal and social responsibilities in respect to Soil and Water Management and why it is important in the Pambula Lake estuary;
- Overview of what good and bad Soil and Water Management looks like, including local case studies if available;
- Council policies and strategies in this regard;
- The roles and functions of different Council staff in Soil and Water Management, including (but not limited to) development assessment, on ground activities, inspection, enforcement and on-going maintenance; and
- Workshop on what works and does not work within Council, i.e., where does the communication and skill gaps lie and what could be improved?
- Focused capacity building with differing sections of Council to improve knowledge, skills and resources in respect of Soil and Water Management.

It is likely that much of the education work can be delivered through existing Council resources, although there may be benefit in inviting external recognised practitioners in regards to reviewing Council's overall operations and providing targeted education, learning and capacity building to staff.

Comments:

NA

Background Information:

Water quality condition information provided in Section 3.5. (Page 53).

Water quality pressure information provided in Section 4.1.3. (Page 58).

See Also:

Paper by Prue Tucker, Building staff capacity: the key to erosion and sediment control, Great Lakes Council, NSW Coastal Conference, 2011.

<http://www.coastalconference.com/2011/papers2011/Prue%20Tucker%20Full%20Paper.pdf>

8.4.3 Action D3

In conjunction with DPI and LSS, work with local farmers within the catchment to minimise pollution from agricultural runoff through education programs and support for appropriate on-ground management works, such as riparian revegetation and fencing to control stock access.

Priority:

HIGH

Aim:

Improve knowledge and capacity of local farmers to minimise pollution events from their land that may impact the estuary.

Location:

Rural and agricultural areas of the Pambula Lake estuary catchment.

Timeframe:

This action should be commenced in the short term, i.e. within a couple of years of plan adoption.

Key Responsibility:

BVSC

Other Partners:

DPI Agriculture, SELLS and local farmers

Indicative Cost:

Council's contribution is undefined, but may include the provision of staff resources to assist project partners in coordinating and executing education and support activities.

Performance Measure:

- Coordinate and host education programs that focus on appropriate on-ground management works within the catchment that minimise pollution from agricultural runoff.
- Develop or link with existing support mechanisms for farmers to continue to implement change subsequent to the information sessions.

Suggested Actions:

It is recommended to engage with farmers in the catchment with a view to managing farm based pollution to the estuary, particularly that which may occur via runoff.

The aim is to get farmers to adopt best practice farming techniques that manages water quantity and quality discharges from their site to the waterways of the Pambula Lake estuary. This may include a variety of activities including bank fencing to keep cattle out of creeks and wetland areas and protect riparian vegetation, adoption of increased buffer widths and revegetation to creeks to facilitate improved riparian function (which can include filtering of runoff).



Rehabilitation Zone adjacent Pambula Broadwater (source Council)

There may also be a number of other farming techniques and practices that could be modified to improve outcomes, such as improved pasture and ground cover management, optimal pasture utilisation to improve land condition, avoidance of poor quality lands, appropriate use of pesticides and insecticides, use of modified paddock layouts and walkways for cattle to reduce risk of environmental damage, etc.

Information on any ongoing support options and funding for particular activities should be identified to assist farmers in making changes.

Comments:

NA

Background Information:

NA

From web

Water quality condition information provided in Section 3.5. (Page 53).

Water quality pressure information provided in Section 4.1.3. (Page 58).

See Also:

NA

8.4.4 Action D4

Continue to provide information and support to private landholders to manage and improve native vegetation on their properties through Council, other Agencies and the Far South Coast Conservation Management Network.

Priority:

MEDIUM

Aim:

Ensure landholders who manage native vegetation are aware of its values and its role in estuarine function, and have resources available to them to manage these areas appropriately.

Location:

Catchment of the Pambula Lake estuary.

Timeframe:

Ongoing activity. Priority reflects need to keep activity at current levels without necessarily increasing or decreasing activity and funding in this regard.

Key Responsibility:

BVSC and SELLS

Other Partners:

Private landowners

Indicative Cost:

Funding should match existing Council expenditure.

Performance Measure:

Ongoing support (financial and other) of the Far South Coast Conservation Management Network

Suggested Actions:

Continue to engage with private landowners via the Far South Coast Conservation Management Network which maintains a dedicated website, local coordinator and community network.

Past initiatives have included Microhabitat field day; Grassy ecosystems walk and talk; Plant propagation; Panboola bird walk; Seed collection; Seed propagation; Fire Day; Local Link days; A walk in the grass; and Vegetation corridors. All of these activities relate to interest areas of the members of the group and in different ways relate to the key aim of this Action which is to manage and improve native vegetation communities on private lands.

Comments:

NA

Background Information:

NA

See Also:

NA

8.4.5 Action D5

Continue existing and support new community engagement and education initiatives such as 'Love our Lakes', and clean up days that serve to increase awareness on estuarine condition and management issues. Support may include financial support, logistical support, expertise support (particularly in relation to information sharing on topics of interest), amongst other things.

Priority:

HIGH

Aim:

Support suitable community engagement and educational initiatives that raise awareness of estuarine values, condition and management issues.

Location:

As appropriate to the activity.

Timeframe:

Ongoing activity that could be further supported.

Key Responsibility:

BVSC

Other Partners:

SELLS and Pambula Lake Oyster Growers (PLOG)

Indicative Cost:

- Existing funding of Love our Lakes coordinator is due to cease in mid-2015. Additional funds to be sought through other programs to fund the same or similar position in the future.
- Additional funding (determined on a case by case basis) to support clean up days.



Performance Measure:

- Run community engagement programs.
- Coordinate and execute an annual clean-up day in select areas of the estuary that involves an educational element.

Suggested Actions:

It is suggested that Council maintain community engagement programs similar to the Love our Lake program. The program is intended to increase community awareness of the values of our estuaries and encourage community and industry participation in conservation, rehabilitation and education initiatives.

With respect to the clean-up days, these have typically been coordinated by the PLOG with a focus on, cleaning up rubbish and debris, removal of old infrastructure and destroying Pacific Oysters on the shoreline. While the focus of the day could remain the same, it is suggested that it could integrate an education element where people attending the event can learn about the estuary, its history, how it works, and so on. In this regard, local industry champions, researchers, historians etc may be invited to provide short and informative sessions about the estuary to interested parties.

To ensure success of the broadened event, the selection of an appropriate day, time and location will assist in attracting families. This could be further improved by having kid friendly activities or talks about the estuary. The event should be advertised well in advance and make mention of the clean-up day and other activities and talks that will be available for people to take advantage of.

Comments:

NA

Background Information:

Love Our Lakes is an initiative of BVSC, OEH and SELLS, in collaboration with the Merimbula and Pambula Oyster Growers. The Love Our Lakes program will see BVSC and SELLS partnering with a range of community, industry, government agencies and stakeholders groups from across the Shire, to ensure the many important values of our estuaries are protected.

8.5 Protect and conserve Aboriginal cultural heritage sites around the foreshore

8.5.1 Action E1

Assist NPWS and Eden Local Aboriginal Land Council in the research and monitoring of Aboriginal cultural sites, and implementation of protection works as required.

Priority:

HIGH

Aim:

Monitor and maintain known Aboriginal cultural sites while determining through research the broader heritage significance of these features to the region, state and country.

Location:

Estuary foreshore and catchment if deemed to be relevant to the assessment of complexes of Aboriginal cultural sites.



Severs Beach Midden and Protection Works

Timeframe:

Monitoring activities are ongoing (this was occurring prior to the adoption of the CZMP). Research activities should commence in the first couple of years after plan adoption.

Key Responsibility:

BVSC

Other Partners:

OEH (NPWS), Eden Local Aboriginal Land Council, and other public and private landowners

Indicative Cost:

Cost for research should relate to the requirements of **Action E2** (Page 121) as to what level of research may be required to support their long term protection through additional heritage protection listing. An indicative price range may be in the order of \$15 to \$30K, although may be less if suitably experienced university resources are utilised.

Performance Measure:

Council will work with NPWS where appropriate to complete:

- Scheduled monitoring of cultural sites with records maintained for future reference and analysis.
- Research into the value of the Pambula midden complex to support higher level heritage protection listing.
- Protection works implemented in consultation with relevant parties.

Suggested Actions:

Monitoring of cultural sites to continue on a scheduled basis with key details being recorded for later reference and analysis (this should include photographic evidence).

Further access to funding resources for maintenance and protective works may be possible if particular sites, or the entire complex is provided with an appropriate heritage protection listing. Having significant sites located in the estuary, is also likely to add to its tourism appeal provided that this tourism can occur in a way which is consistent with the management of the sites and area.

At the NSW state level listing as a Declared Aboriginal Place could be considered, while at the national level listing on the National Heritage List under the *Environmental Protection and Biodiversity Conservation Act*, 1999, or the *Aboriginal and Torres Strait Island Heritage Protection Act*, 1984 may be of value subject to further investigation.

Protective works may relate to a variety of actual or potential impacts to the sites including human damage (e.g. trampling, removal), as well as those relating to coastal (e.g. erosion) and catchment (e.g. flooding) processes depending on their location. The desire to implement protective works (and the approaches to be applied in this regard) should be determined with the relevant parties as soon as issues are identified.

It should be noted that some impacts may be severe and complex to determine, as well as expensive to protect against, such as the foreshore erosion observed at Sever's Beach. Where protection is impractical, alternatives may need to be considered (e.g. relocation or capping) if this is culturally acceptable. The ongoing impact of Sea Level Rise on the many foreshore artefacts in the Pambula Lake estuary may require the long term development of a strategy for their protection.

Background Information:

An overview of Aboriginal heritage is provided in Section 2.1.2 (Page 10). A variety of relevant pressures are discussed in Section 4 (Page 57).

See Also:

Further information on national and state level protection options is available on the Australia Government (DoE) website, as <http://www.environment.gov.au/topics/heritage/laws-and-notice/indigenous-heritage-laws>.

8.5.2 Action E2

Council to work with relevant agencies and Eden Local Aboriginal Land Council to support long term protection of middens through appropriate heritage protection.

Priority:

HIGH

Aim:

Protect (as appropriate) Aboriginal cultural and heritage sites with appropriate heritage listing.

Location:

Pambula Lake estuary Aboriginal Cultural and Heritage Sites (e.g. middens).

Timeframe:

Research activities should commence in the first couple of years after plan adoption.

Nomination for suitable heritage listing should occur once research has been completed and it is clear which nomination would provide the most protection to sites, as well as the potential to source funds as required for their ongoing protection.

Key Responsibility:

BVSC)

Other Partners:

OEH (NPWS), Eden Local Aboriginal Land Council, and other public and private landowners.

Indicative Cost:

Costs for completion of listing nomination are not considered to be high once targeted research has been completed (see **Action E1**) (Page 120).

Performance Measure:

- Review of available heritage protection options (in addition to what is currently afforded to the sites).
- As appropriate, nominate for additional heritage protection as that best benefits the sites/complex of the Pambula Lake estuary.

Suggested Actions:

Complete a review of available heritage protection options for the Pambula Aboriginal cultural and heritage sites. At the NSW state level, listing as a Declared Aboriginal Place could be considered, while at the national level listing on the National Heritage List under the *Environmental Protection and Biodiversity Conservation Act*, 1999, or the *Aboriginal and Torres Strait Island Heritage Protection Act*, 1984 may be of value subject to further investigation.

Once a preferred approach has been determined, a submission for nomination for additional heritage protection should be prepared.

Comments:

Further access to funding resources for maintenance and protective works may be possible if particular sites, or the entire complex is provided with an appropriate heritage protection listing. Having significant sites located in the estuary, is also likely to add to its tourism appeal provided that this tourism can occur in a way which is consistent with the management of the sites and area.

Background Information:

Further information on national and state level protection options is available on the Australia Government (DoE) website, as <http://www.environment.gov.au/topics/heritage/laws-and-notices/indigenous-heritage-laws>.

See Also:

Action I5 (Page 146) regarding cultural heritage tourism.

8.6 Monitor and assess changes in entrance processes and dynamics

8.6.1 Action F1

Work with OEH to undertake future hydrosurveys and analysis of water levels in response to significant community concern to changed entrance conditions.

Priority:

MEDIUM

Aim:

Undertake necessary hydrosurvey to identify areas and volumes of sand accretion to enable a more complete understanding of changes and potential remedial options.

Location:

Primarily the estuary mouth and entrance channel within the active coastal zone. Periodic whole of estuary surveys are conducted by the OEH, typically on an as-needs basis.

Timeframe:

As required in response to the frequency and severity of issues, noting that many estuaries in NSW suffer from periodic entrance shoaling.

Key Responsibility:

BVSC

Other Partners:

OEH and RMS

Indicative Cost:

Due to the cost involved in the collection of these data, hydrosurveys would be undertaken on an as-needs basis, usually preceded by a review of relevant tidal data and confirmation with relevant agencies.

If warranted, OEH may be able to complete the hydrosurvey at no cost to Council (subject to confirmation). Once approved, the estuary is added to a State list and depending on how it fits in with State priorities; it will be completed at some point in the future. Alternatively, external consultants can be appointed by Council to complete the hydrosurvey, but this cost will be borne by Council and depending on the aerial extent may be of the order of \$10K to \$30K to capture.

Performance Measure:

- Initial review of recorded tidal water level data from the Pambula estuary, and confirmation with relevant agencies of local conditions.
- Completion of hydrosurvey for valid requests within several months of initial request (length depends on State wide priorities at that time).

Suggested Actions:

Council liaise with OEH and RMS in regards to concerns being conveyed to Council regarding the condition of the estuary mouth and entrance channel.

Council to maintain a record of complaints regarding entrance conditions and water quality. This can be utilised in a review of changing shoaling conditions on that basis that as conditions worsen (i.e. shoaling increases) an increase in concern would be noted from a variety of parties.

Comments:

NA

Background Information:

Further information provided in Section 3.2 (Page 29).

Pressure information provided in Section 4.3.2 (Page 70) and Sections 4.4.2/4.4.3 (Page 72).

See Also:

NA

8.7 Protect, rehabilitate and enhance estuarine vegetation including seagrass, saltmarsh and mangroves

8.7.1 Action G1

Incorporate adequate buffers around key wetland areas to ensure vegetation can migrate with Sea Level Rise and provide additional protection. Establish suitable means for dedicating buffers to this landuse, e.g. lease, purchase or voluntary contribution, etc.

Priority:

LOW

Aim:

Establish a planning based approach that facilitates the long-term migration of estuarine vegetation in response to increasing sea levels.

Location:

The focus of this action is on lands surrounding the estuary predicted to be inundated with increasing sea levels and that can support migration of estuarine vegetation e.g. saltmarsh and mangrove areas. Additionally this to, the subject lands must be privately owned and/or have a zoning which may prevent the long term migration of this vegetation.

Timeframe:

This is a long term action which can be implemented several years after plan adoption, but can be commenced sooner as resources and requirements dictate. The action should however be implemented prior to any major updates to the Local Environment Plan and supporting zoning mapping.

Key Responsibility:

BVSC

Other Partners:

NSW Planning and Environment (as required), private landowners.

Indicative Cost:

The cost for identifying land areas (and individual land parcels) which should be targeted for future rezoning is low and can be readily absorbed into everyday Council activities.

The additional costs for rezoning of select areas arising out of this action are low and would be considered to form part of ongoing Council responsibilities to maintain it's Local Environment Plan (i.e. there were significant zoning changes between the 2002 and 2013 Local Environment Plan).

The cost for establishing buffers is undetermined with some areas residing in public ownership and others in private ownership. Costs for establishment of buffers on public lands is likely to be



Panboola adjacent the Pambula Lake contains estuarine vegetation

negligible as this function may already be being achieved, however, where land is in private ownership then it may be necessary to establish a formal mechanism to limit any potential development (particularly that involving filling) or inconsistent use (e.g. grazing) and to allow access for land maintenance activities. The costs of establishing these formal mechanisms (e.g. a lease, purchase or voluntary contribution) are unknown.

Performance Measure:

Identification and preservation of lands using appropriate mechanisms that allow for the long term migration of key estuarine vegetation communities under sea level rise scenarios.

Suggested Actions:

The Estuary Processes Study provides a predicted 2050 and 2100 inundation line for MHWS. This can be interpreted as the predicted landward extent of inundation by marine waters as a result of sea level rise at this time. The main area of focus of the Pambula estuary is likely to be around the Panboola wetlands, adjoining the Pambula township (refer Figure 8-4).

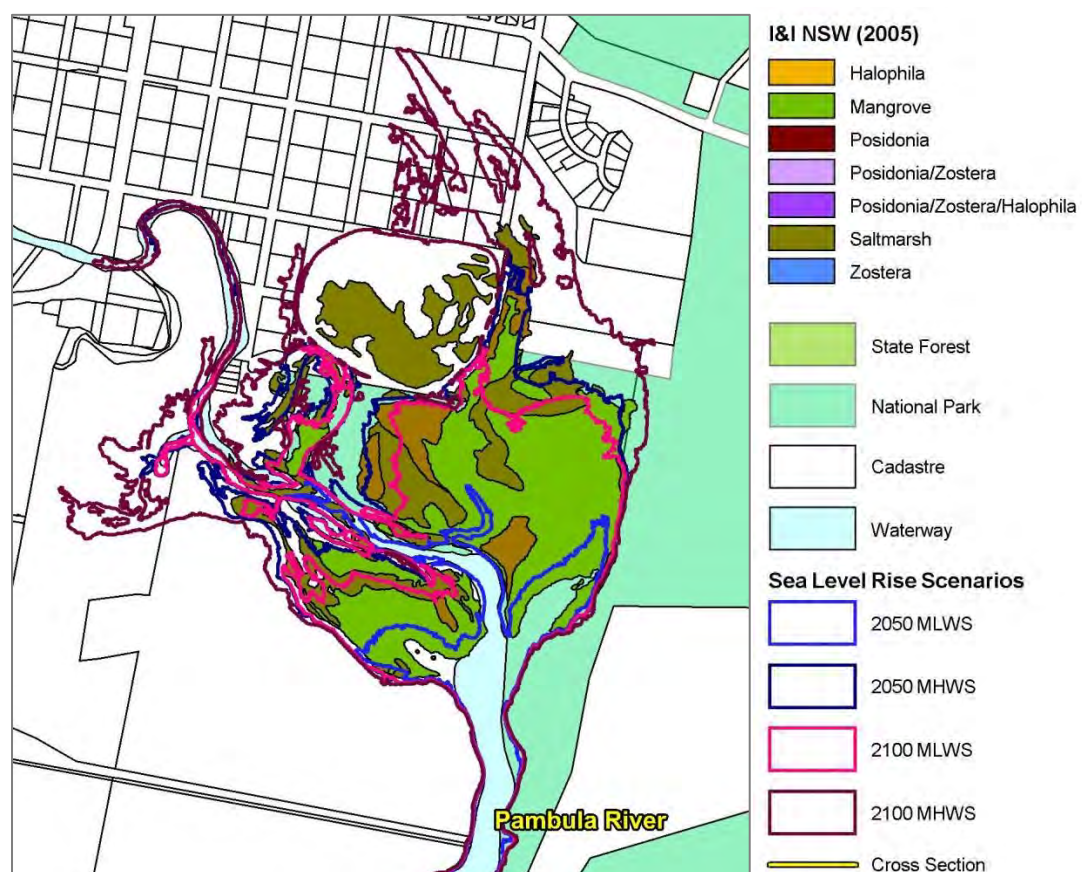


Figure 8-4 Estuarine Vegetation and Expected Inundation over Time (adapted from Cardno, 2012)

Implementation Schedules

Use of this predicted inundation line within Council's GIS system will identify the ownership and zonings of lands (both private and public) as per Council's Local Environment Plan, 2013 at both timeframes. It is noted that the 2100 inundation extent is far greater in select areas of the catchment and as such the initial use of the 2050 inundation line may be appropriate to allow staging of acquiring land buffers to allow other land uses to occur in the intervening period.



Likely Future Inundation Areas – Old Pambula Racecourse

Where lands are privately owned and not currently zoned in a way which would offer substantial protection to those lands against usage inconsistent with the long term establishment of marine vegetation, then the zoning of those lands should be identified for modification where possible. If this is not likely to be achievable, other measures should be explored to ensure protection including funding for fencing areas off and removing grazing pressure and revegetation with appropriate species.

It is recommended that formal instruments of protection be explored for those private lands to prevent inconsistent use from occurring over the intervening period. Suitable means of preserving lands under a formal management arrangement need to be determined; these may include options such as lease, purchase or voluntary contribution, or simply funding to fence buffers off and remove grazing pressure.

Comments:

NA

Background Information:

Pressure information provided in Section 4.4.4 (Page 72)

See Also:

See **Action C2** (Page 102) regarding purchase of lands for preservation.

8.7.2 Action G2

Work with DPI F&A to complete mapping of the distribution / extent of mangrove, saltmarsh and seagrass using available information on a recurrent i.e. (5 to 10 year basis) or as required for other purposes.

Priority:

MEDIUM

Aim:

Add to the environmental knowledge base of the estuary to assist in identifying issue areas, and trends in condition over time.

Location:

Estuary basin and foreshores and catchment that contain estuarine vegetation.

Timeframe:

Mapping of estuarine vegetation was last completed in 2005 as part of the Comprehensive Coastal Assessment program. It is recommended that mapping be repeated at 5-10 year intervals. As such completion of remapping using similar methods (to allow direct comparison) is recommended to occur in the next 2 to 5 years to maintain a reasonable frequency of vegetative monitoring for trend analysis.

Key Responsibility:

BVSC

Other Partners:

DPI F&A, OEH

Indicative Cost:

Depending on which actions are implemented first, mangroves and saltmarsh would be mapped as part of the Riparian Vegetation Extent Assessment (see **Action C3**, Page 103), so no additional costs would apply for these two components. In addition, seagrass would also need to be mapped (and ground-truthed), and an additional cost of \$10K would apply.

Aerial photography is flown every few years by OEH's Coastal Section. This data may be made available (free of charge) for Council and other state agencies completing work relevant to OEH, e.g. updating seagrass mapping.

If new data is required, the data may be able to be obtained by OEH if that estuary has been earmarked under the MER Program for updated vegetation mapping. Alternatively, Councils need to instigate and pay for this work separately, and indicative costs for the collection of the mapping data (e.g. for seagrass, saltmarsh, and mangrove coverage), may cost around \$10K to \$15K depending on estuary size.

Performance Measure:

- Completion of the estuarine vegetation mapping and production of suitable GIS layers to allow for comparisons to historical datasets.
- Sharing of information with OEH, and DPI F&A who maintain the NSW Estuarine Macrophytes database.

Suggested Actions:

Methods for undertaking the vegetative surveys are outlined within the publication 'Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols' (OEH, 2013), refer to Section 8.1 'MER Program mapping' (Page 91). This includes methodologies for both GIS based aerial photo interpretation of vegetation areas, and supporting field based confirmation of desktop mapping procedures.

Comments:

NA

Background Information:

Condition information provided in Sections 3.4.2, 3.4.3 and 3.4.4 (Page 43).

See Also:

A number of related actions will be able to use this data including:

- **Action H5** (page 138) which is focused on ecosystem health monitoring. The estuarine vegetation extent monitoring completed as part of this action will directly inform this related action.
- **Action C3** (Page 103) which is focused on assessment of riparian condition and extent. It may be possible that some information sharing between actions could occur, particularly the capture and use of suitable aerial photography for use in determination of vegetation extents.

8.7.3 Action G3

Utilise available information on heavy metal testing to understand and lessen impacts of activities within estuary.

Priority:

LOW

Aim:

Monitor available datasets and initiate specific investigations if issues are identified.

Location:

Estuarine waters and sediments.

Timeframe:

Ongoing as information becomes available.

Key Responsibility:

BVSC

Other Partners:

Pambula Lake Oyster Growers, DPI F&A, EPA.

Indicative Cost:

The cost to review information that is being collected by existing programs is negligible. However, if specific monitoring programs are implemented to monitor pollutant concentrations in sediments and or water (c.f. oysters) then costs may be considerable depending on the scope and duration of the program.

Performance Measure:

Develop a better understanding of potential metal (or other pollutant) contamination within the estuary by use of third party data, consultation with lake users, site investigation and support for relevant academic research as appropriate.

Suggested Actions:

There are perceived instances of metal and chemical contamination within the Pambula Lake estuary, however, there is little data available to substantiate these concerns. A useful indicator of contamination can be found by analysis of oyster meat. As filter feeders oysters are exposed to metals and other contaminants in the water and have the ability to bioaccumulate some contaminants. The risk of metal accumulation in oyster areas increases with the presence of industrial activities, agricultural activities and runoff from urban areas. While the Pambula Lake estuary has all of these activities and landuses present it is possible that due to their relatively limited extent in the catchment and the estuaries high rate of oceanic flushing that contamination levels are relatively low.

To assist in ensuring that catchment based landuses and activities do not pose a threat to the oyster industry and other species and users of the estuary, it is suggested that Council makes best use of available information collected by third parties which assists in understanding of contamination levels in the estuary (including water column and sediments). There are a variety of existing data and ongoing programs that may be accessed to provide useful information in this regard. This includes information collected by the NSW Safe Foods Authority, the Pambula Lake Oyster Growers, EPA, OEH and others (particularly universities).

Once obtained this information should be reviewed and discussed with the relevant parties to ascertain any concerning data, or data trends. It may be necessary after the review to initiate specific monitoring programs (or augment existing programs) to better define contamination in the estuary or parts of the estuary based on the data outcomes.

Ongoing discussions with relevant academics in nearby universities (e.g. Wollongong, Canberra, Wagga Wagga, etc) may identify aligned opportunities to complete testing in the Pambula Lake with this data being used to further understanding of potential contamination in the estuary. These programs may benefit from some in-kind support to get them off the ground.

Comments:

NA

Background Information:

Every three years the Food Authority carries out a shellfish heavy metal and chemical survey in shellfish harvest areas in NSW. The survey analyses shellfish for a range of heavy metals, pesticides, polychlorinated biphenyl (PCB) and polycyclic aromatic hydrocarbon (PAH) to determine whether shellfish in NSW harvest areas are within the maximum limits set out in the Food Standards Code.

Surveys undertaken over the last decade in Pambula have consistently found that shellfish have been under the required limits. A survey commenced in the reporting period and will continue

throughout 2014. Results from the samples collected during this survey will be available in early 2015.

The EPA were the previous environmental regulators of some existing high risk activities in the estuary (such as boat work facilities), they may have records of environmental testing completed as part of regulating these sites.

OEH, oyster growers and universities and other groups have in the past and may in the future complete periodic testing within the estuary as part of one-off and other longer term investigations of estuarine condition.

8.8 Protect and enhance estuarine water quality

8.8.1 Action H1

Develop and implement a Stormwater Management Plan that quantifies loadings of stormwater pollutant discharges from agricultural and urban areas to the estuary. Utilise the Stormwater Management Plan as the basis for determining priority areas requiring stormwater quality mitigation.

Priority:

MEDIUM

Aim:

Understand and manage urban and agricultural stormwater impacts upon the estuary, where possible and practical to do so.

Location:

Catchment of the estuary (to tidal limit) with a focus on urban and intensive agricultural uses likely to contribute water borne contaminants to the estuary (i.e. sediments and nutrients).

Timeframe:

2 to 5 Years

Key Responsibility:

BVSC

Other Partners:

DPI Agriculture and South East LLS in relation to rural lands management options and financial support for farmers to implement.

Indicative Cost:

Preparation of the Stormwater Management Plan for the Pambula Lake estuarine catchment with a key focus on urban areas and connected dairy/grazing lands would cost of the order \$40 to \$60K to complete depending on scope.

Future works arising out of the plan would be implemented as funds allow or to coincide with other planned developments or redevelopments. In this regard, stormwater management outcomes are most cost effectively implemented during the design phase of projects, or when planned redevelopment is occurring (i.e. relaying stormwater drainage or roads, etc). Straight retrofit can be an expensive method of implementation.

Performance Measure:

Development and use of a Stormwater Management Plan (SMP) that assesses likely rural and urban pollutant loadings to the estuary and outlines suitable management options to mitigate identified impacts.

Suggested Actions:

Appoint a suitably qualified and experienced consultant to develop the SMP if skills are unavailable within Council.

The scope of works should include:

- Review of Council policy and applicable legal requirements relating to stormwater management.
- Identification of historical water quality within the estuary and key ongoing water quality requirements considering its values and uses (particularly oysters).
- Review of available GIS data and drainage information maintained by Council, including details of existing stormwater treatment systems (including as built drawings if available).
- Consultation possibly through an appointed Project Reference Group to ascertain key areas of concern and objectives for future stormwater management.
- Completion of detailed site inspections of areas of concern and existing treatment systems.
- Development of hydrologic and pollutant export models as required to determine flow and quality aspects of catchment.
- Conceptual siting and design of treatment systems within catchments of concern (utilising modelling inputs to aid conceptual design). It should be noted that vegetative buffers and non-structural treatment options may also be considered for implementation as appropriate.
- Cost benefit analysis of stormwater treatment trains and non-structural measures.
- Prioritisation of systems with conceptual sketch designs of shortlisted sites being completed.
- Presentation to PRG and Council for confirmation.

Comments:

It is likely that Urban Stormwater Management Plans were developed for townships in the catchment in around 2000 (it was a state government requirement that these plans be prepared for townships with greater than 1000 people).

Also it is noted from the Estuary Processes Study that some existing stormwater measures have been implemented within the catchment, and that there are areas of both quality and quantity degradation present.

Background Information:

Water quality condition information provided in Section 3.5 (Page 53).

Water quality pressure information provided in Section 4.1.3 (Page 58) and 4.1.5 (Page 62).

See Also:

NA

8.8.2 Action H2

Continue to support existing Council initiatives that aim to manage risks to estuarine water quality arising from sewer pump stations overflows, as well as the siting, regulation and management of on-site sewage systems (OSMS).

Priority:

HIGH

Aim:

Support ongoing initiatives to investigate and manage water quality risks from sewer pump station overflows and discharges from OSMS.

Location:

All OSMSs in Pambula Lake catchment.

At risk catchments of sewer lines and individual sewer pumping stations as defined by previous Council investigation and judgement (refer Figure 4-3, page 65).

Timeframe:

Ongoing with implementation subject to funding availability.

Key Responsibility:

BVSC

Other Partners:

NSW Health (in relation to commercial system performance assessments).

Indicative Cost:

Costs as yet undefined in relation to addressing at risk sewer pump stations.

No additional costs associated with the ongoing implementation of the BVSC On-site Sewage Management Program which completes inspections of OSMSs at defined intervals based on their risk classification and issues approvals to operate, or issuing of notices for non-conforming systems.

Performance Measure:

For sewer pump stations with a defined risk of overflow to the estuary, requirements for mitigating this risk should be addressed in ongoing planning for sewer systems in the Bega Valley Shire. Key planning documents include the Integrated Water Cycle Management Plan (soon to be prepared) and Sewer Systems Asset Management Plan.

For inspection of OSMSs the following performance targets are suggested:

- 100% on-time inspection of critical systems.
- 50% on-time inspection of high risk systems in next 2 to 3 years, with 100% on-time inspection once the majority of low-risk systems have become self-certified.

Implementation Schedules

- 40% on-time inspection of low risk systems for next 2 to 3 years until majority of systems are self-certified, then it is expected that closer to 100% on-time inspection may be achievable.

Compliance or movement towards these targets (and reach targets in the longer term) should be checked and reported each year and included in the Estuary Health Report Card and published on Council's website.

It is expected that as self-certification comes into effect, it may be possible for Council to achieve higher targets as resources are freed up from having to inspect the nearly 500 low risk OSMSs every five year (or around 100 per year). In effect this will provide additional time for Council officers to check critical and high risk sites.

Suggested Actions:

A risk classification completed in the Sewer Overflow Investigation study (MWH, 2007) identified risk for groups of pumping station catchments (rather than defining risk for each individual pumping station catchment). Pambula and Pambula Beach sewer catchments were classified for risk by MWH as:

- High risk: Sewage Pumping Station (SPS) 7 (i.e. the properties and sewer lines draining to SPS 7 and SPS 6);
- Moderate risk: SPS16B (i.e. the properties and sewer lines draining to SPS 16B and SPS 16A); and
- Low risk: MSTP (the properties and sewer lines draining to SPS 5, SPS13 and MSTP).

In terms of individual SPS catchment risk classification (likelihood and consequence of sewer overflows in relation to Pambula estuary water quality) likely risk categories may be (noting that these were not individually assessed in the Sewer Overflow Investigation study):

- High risk: SPS6 and SPS16B catchments;
- Moderate risk: SPS16A catchments; and
- Low risk: SPS 5 and SPS13 catchments.

The individual catchments of SPS7 and MSTP lie outside of the Pambula estuary catchment.

Management of the risk of overflows from higher risk SPS are the priority and should be captured through Council's key planning documents such as the Integrated Water Cycle Management Plan and Sewerage Systems Asset Management Plan, noting that there many priorities for infrastructure expenditure across the Shire.

Comments:

Council does have the ability to approve individual OSMS designs for individual landholders on their own land that it considers will achieve the required performance objectives. However, commercial OSMS design approvals are required to be obtained from NSW Health.

Background Information:

Water quality condition information provided in Section 3.5 (Page 53).

Point source pressure information provided in Section 4.1.5 (Page 62).

See Also:

NA

8.8.3 Action H3

Undertake rapid catchment appraisal for Pambula Lake catchment based on SRCMA Roads and Track Survey Summary and Volume 2 of the NSW EPA Managing Urban Stormwater – Soils and Construction Guide (2008). This should include consideration of drainage structures, suitable road base materials, minimum grading requirements, design adequacy and compliance. The appraisal will assist in the establishment of road and track management priorities including those relating to permanent sealing.



Example of Unsealed Road in Catchment

Priority:

HIGH

Aim:

Limit the erosion and associated movement of eroded sediments into the waters and tributaries of the Pambula Lake estuary.

Location:

Catchment of Pambula Lake estuary (to tidal limit) and further afield where tracks are likely to be key contributors of sediments to the Yowaka and Pambula Rivers and other minor tributaries.

Timeframe:

Immediate and ongoing

Key Responsibility:

BVSC

Other Partners:

Forests Corporation of NSW, Crown Lands, various energy / telecommunication companies, OEH (NPWS) and private landowners. These parties have been identified as potential owners and managers of roads and tracks in the catchment.

Indicative Cost:

It is expected that the rapid catchment appraisal would cost of the order \$20K if provided to an external consultant (allowing 2 person to visit all sites over 10 days and provide a brief report), but could be integrated within an existing Council role provided sufficient capacity exists.

Performance Measure:

- Completion of a rapid catchment appraisal and establishment of road and track management priorities including those relating to permanent sealing.
- Communication of the outcomes of the appraisal with other roads managers and need for action.

Suggested Actions:

SRCMA (2013) estimate that there is around 390 km of unsealed roads and 60 km of sealed road in the Pambula Lake estuary catchment. A survey (visual assessment) of around 90% of all roads and track crossings was completed in March 2012. The Roads and Track Survey initially focused on 110 sites which were unsealed roads that crossed or were adjacent to waterways. Details of each site were recorded on a site card and given a score based on the site's ability to shed water and contain sediment. Key factors relating to the site scores (i.e. condition) were road or track length and width (i.e. effectively area), slope, usage, age and maintenance of track and levels of usage.

The rapid appraisal should focus on those sites that were found to have design and maintenance issues and were considered likely to be generating sediment laden runoff during storm events. The rapid appraisal should record further relevant site details that focus on determining the specific cause(s) of erosion at each site (i.e. roadbase material, slope, apparent maintenance, construction technique, drainage and retention features, etc). Using these issues as a guide, potential rectification options should be established, e.g. improved grading or side drainage, improved downstream retention structures, alternative road base material or sealing, etc.

The rapid appraisal should include estimates of the likely cost of the works, likely success of the works in reducing sediment loadings (i.e. longevity, performance and ability to be maintained), and other potential social benefits that may be gained by completing the works, i.e. improved or safer driving conditions as a result of better grading or sealing. BVSC can complete its own internal prioritisation of sites (for those sites where are in the management of Council) based on consideration of the costs and benefits of the works considered.

For example a current identified priority unsealed road being managed by Council is the Yowaka River Road. This road has been identified through a Council workshop as a highly visible, highly used (relatively) road that is a highly visible contributor of sediments to the Yowaka River following rainfall events.

The rapid appraisal outcomes can be distributed and discussed with the owners / managers of the roads and tracks assessed including private landowners. Ideally a works plan should be established with a timeframe for initial works and requirements for ongoing maintenance. Follow up should be planned to ensure that works have been implemented within agreed timeframes, Council Building and Environmental Health staff have the ability to issue notices under the *Protection of the Environment Operations Act*, 1997 for incomplete or poor quality works.

Additionally, where possible as part of the Development Approval, BVSC shall review consent conditions to ensure that any new driveways (for the subject development's) are appropriately designed.

Comments:

Estuary Ecosystem Health Report Cards

Results of the estuary ecosystem health assessment are provided in report cards (attached). The report card provides a grade for eutrophication indicators **chlorophyll a** and **turbidity** for each estuary zone that was sampled, and an overall zone grading. A brief explanation of the grade definitions is provided in Figure B1 below.

An **overall estuary grade** is provided based on the combined results of all sampling zones over the monitoring period. Information regarding eutrophication indicators is contained in OEH (2013).

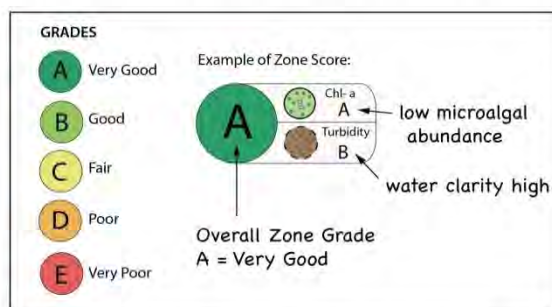


Figure B1. Key to understanding the report card grading (based on estuaries MER criteria provided in OEH (2013)).

PAMBULA LAKE ESTUARY

ECOSYSTEM HEALTH REPORT CARD 2010-13

Ecosystem health was assessed using indicators of eutrophication including microalgal abundance (as chlorophyll *a*), water clarity (as turbidity) and water column nutrients. The assessment is based on data collected from the central basin (Zones 1-3) and at the confluence of the Yowaka and Pambula Rivers (Zone 4) on a seasonal basis over the 3-year period, spring 2010 to winter 2013.

Surface water clarity was characterised by high levels of dissolved oxygen, low turbidity, low levels of nutrients and low abundance of microalgae. Water column nutrient levels were consistently below guideline limits with mean Total Nitrogen concentration of 210 µg/L and mean Total Phosphorous concentration of 14 µg/L. Information regarding the distribution, extent and condition of estuarine vegetation presented here is based on data collected in 1994 and 2002 by NSW Department of Primary Industries (DECCW 2011, Creese *et al.* 2009).

The ecosystem health assessment for the 2010-2013 period provided the estuary with an overall score of 5.0, the estuary rated as being in very good condition (Grade A+) based on the eutrophication indicators chlorophyll *a* and water clarity.

For further detailed information about Pambula Lake and Council's estuary health monitoring program, please refer to Estuary Health Monitoring Report Series Number 10.

Estuary Information (OEH 2014, NLWRA 2001)

Catchment area: 297 km² (approx. 15% cleared)

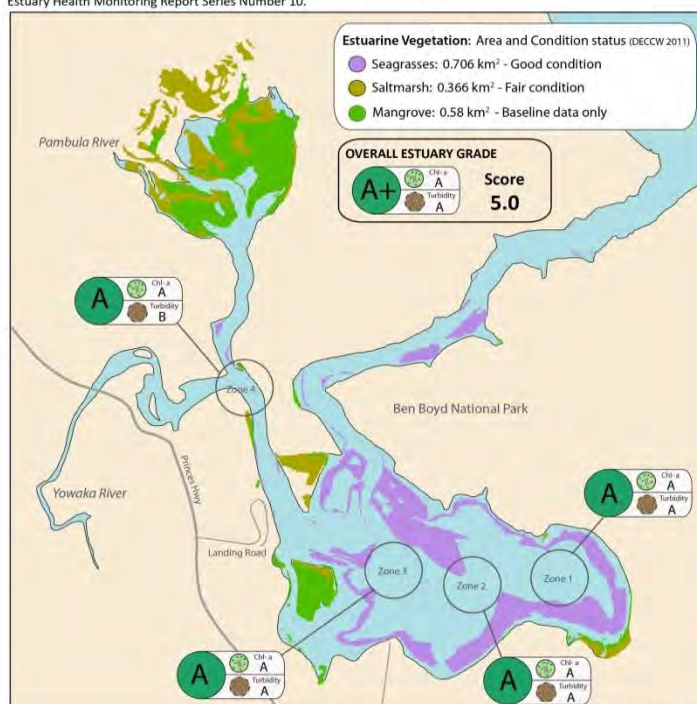
Estuary area: 4.7 km²

Estuary type: semi-mature, drowned river valley

Entrance: permanently open

Major tributaries: Pambula and Yowaka Rivers

Central basin depth range: 4 - 6 m



Example 'Technical' Report Card for Pambula Lake Estuary
(Elgin Associates, 2013)

There are a number of design manuals available for rural dirt roads and tracks, as outlined below:

- Erosion and sediment control on unsealed roads - A field guide for erosion and sediment control maintenance practices (OEH, 2012); and

- The Forestry Corporation of NSW apply the 'Forest Practices Code Parts 1-4, Forest Road and Fire Trails, 1999' and the 'Forest Soil and Water Protection, 2000' in the design and operation of forestry operations, including construction and operation of tracks to manage environmental impacts.

Background Information:

Condition information is provided in Section 3.5 (Page 53).

Pressure information is provided in Section 4.1.3 (Page 58).

See Also:

NA.

8.8.4 Action H5

Implement ecosystem health monitoring that includes biotic indicators in addition to water quality and report findings (i.e. make data available) regularly to community and stakeholders.

Priority:

MEDIUM

Aim:

Capture estuarine ecosystem health data and report key findings periodically to the community.

Location:

Tidal waters, and areas of the estuary basin, foreshore and beyond that support seagrass, salt marsh and mangrove.

Timeframe:

Timeframes are outlined below in Table 8-3.

Key Responsibility:

BVSC

Other Partners:

Oyster growers via the Australian Shellfish Quality Assurance Program and OEH via the Monitoring, Evaluation and Reporting (MER) program operating for NSW estuaries.

Indicative Cost:

Indicative costs for monitoring are outlined below in Table 8-3.

Addition costs to Council may include the preparation of an Estuary Health Report Card. The costs for the report card (preparation, printing) may be of the order of a few thousand for the first issue, but would be expected to reduce thereafter once a suitable template and method has been established for its production.

Performance Measure:

Establishment of an 'Estuarine Health Integrated Monitoring Program' (EHIMP) utilising currently collected data from other sources and data collected specifically for the program.

Preparation of periodic 'Estuary Health Report Cards', which are made publically available.

Suggested Actions:

It is recommended that an 'estuarine health integrated monitoring program' (EHIMP) be developed to identify trends in estuary condition, and therefore the effectiveness of management strategies and this plan in maintaining estuary health. The following sections describe the objectives and general approach for developing and implementing an EHIMP.

Establishment of an 'Estuarine Health Integrated Monitoring Program' (EHIMP) which aims to:

- Measure and document long-term changes in the ecosystem health of Pambula estuary;
- Provide information on ecosystem health and pressures in the Pambula estuary that can guide investment decisions; and
- Increase government, industry and community engagement and interaction with the program so as to improve its appeal, integration and focus in relation to catchment and waterway management.

The EHIMP should utilise the following key condition (and pressure) indicators as follows:

Implementation Schedules

- Water quality – including chlorophyll-a, turbidity and nutrients – essentially in the format of the current Pambula Lake Environmental Monitoring Program which has been funded by BVSC and OEH in 2012, 2013 and 2014. The format of this monitoring is consistent with the Statewide MER program administered by the OEH, and as such the two programs can be used in combination to provide data to the EHIMP program.

Table 8-2 EHIMP Water Quality Indicators

Relevant Action	Sub-action/ Component	Indicator types	Timeframes	Indicative costs
H5	-	Chlorophyll-a, turbidity and nutrients (note that other data is recorded during the surveys)	Six times from mid-November to end March), with additional 'off-season' runs being optional	The completion of six sampling runs per year costs approximately \$12K per year.

- Biology – This monitoring involves the assessment of habitat changes in seagrass, saltmarsh and mangrove and is based on analysis of remote imagery and ground-truthing of data in the field. Biological data will be collected and analysed in accordance with methods and timeframes specified elsewhere in this document, as shown in Table 8-3.

Table 8-3 EHIMP Biological Indicators

Relevant Action	Sub-action/ Component	Indicator types	Timeframes	Indicative costs
C3	Action C3 (i) Riparian Vegetation Extent Assessment	Vegetation distribution and extent (riparian, mangroves, saltmarsh) Excludes seagrass (see Action G2)	Every 5-10 years Undertaken in conjunction with Action C3 - Riparian Condition Assessments and Action G3 - Estuarine Vegetation Mapping	C3 - \$10K (if aerial photography can be accessed freely) G3 - \$15-\$25K for seagrass mapping
C3	Action C3 (ii) Riparian Condition Assessment	Vegetation community structure and condition (riparian, mangroves, saltmarsh) Excludes seagrass (see Action G2)	Every 5 years Undertaken in conjunction with Action C3 (i) and Action G2 (i)	Approximately \$15K per episode
C3	Action C3 (iii) Bank Erosion Assessment	Number and severity of erosion sites	Every 10 years	Approximately \$10-15K per episode
G2	Action G2 (i)	Seagrass,	Every 5-10 years	Approximately \$15-

Relevant Action	Sub-action/ Component	Indicator types	Timeframes	Indicative costs
	Estuarine Vegetation Mapping	saltmarsh, mangrove mapping in accordance with OEH (2013)	Undertaken in conjunction with Action C3 (i) and (ii)	\$25K for seagrass ground-truthing

Methods are outlined within the publication 'Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols' (OEH, 2013).

The Estuary Health Report Card should present the following key information:

- Estuarine overview;
- Indicators used to assess health (essentially water quality and biology);
- Indicator scoring and how to interpret results;
- Results for water quality and biological indicators for the estuary overlaid on a map. Results could potentially be divided into key functional areas of the estuary such the entrance channel (i.e. marine flood-tidal delta), broadwater (i.e. central mud basin), lower sections of the Yowaka and Pambula Rivers (fluvial delta) and up the tidal limits of the Yowaka and Pambula River (i.e. riverine channel/alluvial plain);
- Possibly also key results from the Shellfish QAP, these may include number of harvest closure days per year as a result of poor water quality;
- Results interpretation, including consideration of long term trends utilising suitable historical datasets. Where adverse trends are observed, possible drivers for the observed trends should be identified; and
- Contact details for further information.

Comments:

There are many examples of ecohealth style report cards now available, some Councils that now report on this include:

- Coffs Harbour;
- Bellingen;
- Eurobodalla;
- Tweed;
- Clarence; and
- Shoalhaven.

It should be noted that these programs are different in their formulation as some also consider freshwater water quality and biology.

Background Information:

NA

See Also:

Action C3 (Page 103) and **G2** (Page 127)

8.8.5 Action H6

Regular inspections/compliance checking of boat work areas particularly regulating management of boat antifoulants and other chemicals in the environment (particularly stormwater runoff) that may contribute to water and metal contamination.

Priority:

HIGH

Description / Aim:

Manage potentially polluting industries adjacent the estuary to limit opportunities for water quality and sediment contamination and associated ecosystem health impacts.

Location:

Boat work operations around the Pambula Lake estuary.

Timeframe:

Immediate and ongoing

Key Responsibility:

BVSC

Other Partners:

Potentially DPI F&A

Indicative Cost:

Should be integrated into existing roles of Council staff.

Performance Measure:

- Completion of yearly basic site audit of boat work areas surrounding the Pambula River estuary.
- Support for boat site operators to improve site activities to improve compliance over time.

Suggested Actions:

It is recommended that Council complete a minimum yearly inspection of boat work operations surrounding the Pambula Lake estuary. In addition to talking to the site operators about site management and any issues they may have in implementing sound management practices, Council staff should complete a basic audit of operations inspecting overall site management and opportunities for pollution events to occur.

Council should consider the development of a checklist based on information in the 'Environmental Action for Marinas, Boatsheds and Slipways' which is an information booklet published by OEH and EPA in June 2007. While the primary element of concern to the estuary is water based pollution the audit may consider other factors relevant to site operation such as waste management and noise control.

Comments:

Noticeable diebacks in seagrass and other marine biota may be a sign of potential contamination by Tributyltin or copper based treatments which were commonly applied to boat hulls to prevent accumulation of parasites. These materials are also persistent in the marine environment, particularly sediments, and if present in the water column could accumulate in oysters and other marine organisms.

Background Information:

Boat works can be a high risk activity to estuarine health due to the nature of the work and their typically close proximity to the waters of estuaries.

The sites of operation require adequate design to allow for management of water and waste that may emanate from them and in particular to ensure that this material does not enter the estuary where it may cause either acute or chronic health issues for marine biota.

At this time no substantiated information was available to identify the actual effects of boat work operations in the Pambula Lake estuary.

See Also:

Pressure information outlined in Section 4.1.5 (Page 62).

8.8.6 Action H7

Review/audit the Oaklands Reuse Scheme to ensure that scheme operation and management meets all approval and regulatory requirements and that reviews are clear and publically available.

Priority:

MEDIUM

Aim:

Ensure the Oaklands Reuse scheme operations meet regulatory requirements and are made transparent through sharing of relevant datasets.

Location:

Oaklands reuse site and surrounds.

Timeframe:

Information arising from audit and or review of scheme should be available within 2 to 3 years after Plan adoption if not prior.

Key Responsibility:

BVSC

Other Partners:

SELLS, EPA, Oaklands Property Manager.

Indicative Cost:

The NSW EPA is the nominated auditor for the Oaklands Reuse Scheme and there will be minimal costs to Council in this regard. However, costs may be incurred in updating the OEMP or implementing further controls if the audit identifies non-compliance or other issues requiring rectification.

Performance Measures:

- That a review or audit is completed of the Oaklands Reuse Scheme that overviews the performance of the scheme in respect to its operation against its licence conditions and associated operations manual as outlined in the Merimbula Sewerage System Operational Environmental Management Plan (OEMP) version 2.
- Information arising from the review or audit is made available on Council's website for public viewing.

Suggested Actions:

Oyster farmers and others in the community have expressed concern regarding the operation of the Oaklands reuse scheme. Generally these concerns appear to have resulted from differing interpretations of the OEMP, concerns about irrigation within the 40m setback to water edge, slow implementation of fencing and riparian land management in the 40 m riparian zone and a general lack of scheme performance data. Potential concerns regarding the scheme relate to potential water quality degradation (inadvertent runoff to the runoff, or baseflow infiltration) either through pathogenic contamination and nutrient enrichment which may support increased algae activity.

Based on the findings of the review or audit, the OEMP allows for the irrigation schedule to be reviewed and refined based on consideration of monitoring data such as soil condition, soil moisture, groundwater quality and other factors or concerns that may influence scheme operation.

Comments:

NA

Background Information:

There is no quantitative background information available other than that provided in the OEMP.

Water quality condition data is provided in Section 3.5 (Page 53). Pressure information is outlined within Section 4.1.5 (Page 62).

See Also:

NA

8.9 Improve recreational opportunities and amenity

8.9.1 Action I1

Review with recreational fishers the need for any additional facilities to minimise impacts of fishing on estuary, e.g. for waste management, cleaning tables, etc.

Priority:

MEDIUM

Aim:

Ensure recreational fishing activities and facilities are appropriate and do not contribute to degradation of estuarine values.

Location:

Whole of estuary.

Timeframe:

Two to Five years.

Key Responsibility:

BVSC and Pambula Fishing Club (possibly also Merimbula Fishing Club as many fishers utilise the Pambula ramp to access the ocean).

Other Partners:

RMS and DPI F&A

Indicative Cost:

Meeting cost is minimal. Cost of works yet to be determined.

Performance Measures:

- Scheduled meeting with the Fishing Clubs, e.g. annually or biannually.
- Development and implementation of agreed actions as funds and approvals are obtained.

Suggested Actions:

Contact should be made with the Fishing Clubs, RMS and DPI F&A at the appropriate time to convene a meeting to discuss fishing facilities and operations within the estuary.

Comments:

NA



Recreational Fishing at the entrance to Pambula Lake Estuary

Background Information:

Generally it is understood that facilities servicing the Pambula Lake estuary are adequate although some of the facilities are aging and some others could benefit from slight modification to improve functionality.

The current boat ramp can generally handle usage levels, but it can be very busy at times. Car-parking at ramp, fish cleaning facilities and provision of suitable and well placed waste receptacles may all be other items which can be discussed with the Fishing Clubs.



Foreshore Erosion on Yowaka River from shoreline fishing

Other aspects which may be discussed from a fisheries perspective (with discussion lead by DPI F&A and or RMS officer) are the continued need to observe boat speed regulations within the estuary on account of extensive oyster leases and cultural artefacts, compliance with fishing regulations particularly bag limits and ability to report any suspicious commercial fishing activities directly or anonymously to NSW DPI F&A. Discussions about the continued activities of DPI F&A and partners in the control of Caulerpa and the need for ongoing vigilance in Pambula Lake are required.

Another topic of discussion may include shore based fishing near the Yowaka Bridge which is leading to foreshore trampling and localised erosion.

Condition information provided in Section 2.4 (Page 18), and pressure information provided in Section 4.2 (Page 67).

See Also:

NA

8.9.2 Action I5

Support development or creation of low-impact nature-based activity opportunities (and associated infrastructure) within the catchment and waterways of Pambula Lake that increases the participant's awareness of the high social and environmental values of the area, for example the 'Bundian Way Initiative' amongst others.

Priority:

MEDIUM

Aim:

Support low-impact recreational activities that contribute to increased awareness of estuarine values.

Location:

Select areas in the catchment and foreshore of the Pambula Lake estuary.

Timeframe:

Two to five years for implementation type activities, although support e.g. information provision, assistance with grant applications, permits, etc. which is consistent with standard Council activities can be provided immediately.

Key Responsibility:

BVSC to provide support to other partners outlined below.

Other Partners:

Eden Local Area Aboriginal Land Council, OEH/NPWS and other agencies such as DPI F&A depending on the nature of the support required.

Indicative Cost:

Costs (to Council) and or resource requirements for particular activities or initiatives to be determined once solid proposals for activities/works are established.

Performance Measure:

Council to provide support consistent with Council activities and operations to develop and deliver activities and initiatives considered to be consistent with the uses and values of the estuary and the focus of this action and other related actions in this CZMP.

Suggested Actions:

A variety of initiatives have been mooted that relate to the estuary including (and not limited to):

- Establishment of walking trail from Jigamy Farm to Quondola Point/Pinnacles through Ben Boyd National Park as first leg of Bundian Way Tourist Trail from Jigamy Farm (Bundian Way Gateway) to Bilgalera (Fisheries Beach) on southern shores of Twofold Bay south of Eden.
- Upgrade of camping ground fronting Pambula Lake at Jigamy Farm, including possible installation of jetty at a future point in time.
- Establishment of Cultural Tours on Pambula Lake with guided kayaking/walks packages to Haycock Point, Quondola Point, The Pinnacles and various other destinations of interest within the Lake catchment (including 1/2 day, full day, and overnight packages).
- Use of Cultural Centre/Visitor Information Centre (and adjoining Pambula Lake and Ben Boyd National Park) as a tourist destination to learn about indigenous culture.
- Development of a Property Management Plan on Jigamy Farm (funded), including campground and lake foreshore area.

Comments:

NA

Background Information:

NA

See Also:

NA

8.10 Support Oyster Aquaculture Operations

8.10.1 Action J1

Support implementation and periodic review of the Pambula Lake Oyster Growers EMS.

Priority:

HIGH

Aim:

Maintain an awareness of the objectives and aims of the EMS and provide support to actions aligned with maintaining or improving estuarine values or are likely to have demonstrable community benefit.

Location:

Pambula Lake estuary operations

Timeframe:

Immediate and ongoing

Key Responsibility:

BVSC

Other Partners:

Pambula Lake Oyster Growers, DPI F&A

Indicative Cost:

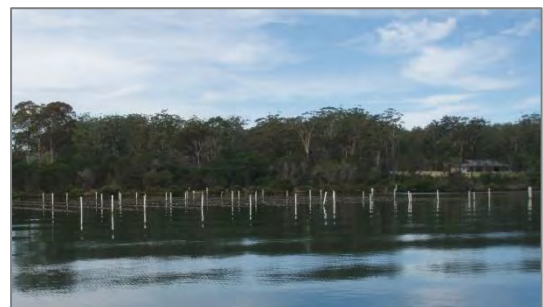
Costs for Council involvement with the PLOG is minimal and will be absorbed into existing budgets, however, costs for particular support activities has yet to be determined.

Performance Measure:

- Council to attend (with permission) at the minimum an annual meeting of the PLOG that reviews their performance of the EMS.
- Council to support activities identified within the EMS that relate to Council's charter and are deemed to have significant benefit to the environment and social fabric of the community.

Suggested Actions:

Continued liaison with the PLOG regarding their operations and issues which limit the industry from achieving better environmental outcomes. Where Council can assist the PLOG (within Council's charter) these should be considered for implementation. To maintain awareness of PLOG operations and associated operational issues, a nominated Council member should attend at the minimum annual meetings and report this information back to others in Council as appropriate.



Oyster Leases in Pambula Lake Estuary

Comments:

A key example of where this high level of integration and awareness may benefit both parties is in respect of water quality data. For instance, monitoring conducted by the oyster growers may identify a trend of poor water quality in a particular part of the estuary, which can then be picked up and further investigated by Council.

Background Information:

Condition information is provided in Section 2.5.1 (Page 20).

As a sensitive receptor within an estuary, oyster aquaculture is subject to a wide range of pressures as outlined within Sections 4.1 and 4.2 (Page 57).

See Also:

NA

8.11 Potential Funding Sources

An important reason for preparing a Coastal Zone Management Plan is the ability to attract sources of Government funding. By demonstrating that a considered and informed approach has been taken to designing actions, funding organisations can be confident that resources provided will be a good investment. This is particularly true for the NSW Government Estuary Management Grant Program, which is likely to be a key avenue for future funding.

Information on potential grants is provided in Table 8-4. This list of funding sources is not exhaustive and it will be important to track and identify emerging grants opportunistically during implementation.

Table 8-4 Examples of Potential Funding Sources

Grant Name / Key dates	Administrator	Details
Managing Coastal Wetlands Open Now	SELLS	<p>South East LLS has Australian Government biodiversity funding available to support landholders in priority areas to undertake works on coastal wetlands including salt marsh, mangroves, riparian areas, coastal floodplains, swamps, lakes and estuarine areas.</p> <p>Project works to be funded:</p> <ul style="list-style-type: none"> • Funding can be used to manage and protect coastal wetlands including: • Fencing to control stock and unauthorised recreational access • Off-stream stock watering points • Removal and control of weeds including blackberry, sharp rush, arrowhead, invasive vine species such as madeira vine, and Japanese honey suckle • Feral animal control including fox, rabbit, deer, goat and pig • Removal of barriers to flow such as removal or modification of floodgates and/or crossings • Revegetation to maintain and connect vegetation buffers, address erosion or improve habitat. <p>http://southeast.lls.nsw.gov.au/our-region/financial-assistance/managing-coastal-wetlands</p>
National Landcare Programme Annual	Australian Government	<ul style="list-style-type: none"> • The Australian Government National Landcare Programme will invest \$1 billion over the next four years to help drive sustainable agriculture as well as supporting the protection, conservation and rehabilitation of Australia's natural environment. • The National Landcare Programme merges previous funding initiatives into a single programme • Across Australia, the National Landcare Programme will support sustainable land management practices to deliver long-term benefits to communities, environment, economy and country.
Coast and Estuary	NSW Government	The primary objective of the NSW Government's Estuary Management Program is to provide support to councils to

Implementation Schedules

Grant Name / Key dates	Administrator	Details
Management Grants Program Annual	- OEH	improve the health of NSW estuaries and understand the potential risks from climate change.
The Green Army Programme Open Now	Australian Government Department of Environment	<p>The Green Army is a hands-on, practical environmental action programme that supports local environment and heritage conservation projects across Australia.</p> <p>Projects funded under the programme must have a clear environment or heritage conservation focus and offer participants valuable practical experience, while supporting a safe work environment. Projects will be guided by local community needs and contribute to Australia's national and international environmental priorities and obligations. A full list of eligible activities is provided in the Green Army Round 3 Project Guidelines</p> <p>http://www.environment.gov.au/land/green-army/publications/green-army-project-guidelines-round-3</p>
Working on Country Open Now	Australian Government Department of Environment	<p>The Working on Country programme recognises that protecting and conserving the environment is a shared responsibility and to provide sustainable employment for Indigenous people.</p> <p>It builds on Indigenous traditional knowledge to protect and manage land and sea country. This five year program will support the development and employment Indigenous rangers.</p>
Land Sector Package Annual	Australian Government Department of Sustainability, Environment, Water, Population and Communities	<p>Package includes:</p> <ul style="list-style-type: none"> • <i>The Biodiversity Fund</i> - \$946m over six years Support for Australia's land managers to reduce carbon pollution, protect biodiversity and increase productivity on their land. • <i>Indigenous Carbon Farming Fund</i> - \$22.3m over five years Provides assistance to Indigenous Australians to participate in the carbon market. • <i>Regional Planning for Natural Resource Management Climate Change Fund</i> - \$43.9m over five years Support regional NRM organisations to revise existing regional NRM plans to help identify where in the landscape biodiversity and carbon abatement activities should be undertaken.
Ian Potter Foundation / Always open	Ian Potter Foundation	<p>The Ian Potter Foundation is a private Australian philanthropic foundation which makes grants for charitable purposes in Australia in areas including the environment</p> <p>http://www.ianpotter.org.au/apply-for-a-grant</p>
Coles Junior Landcare Grants Program / Ongoing Annual - Open Now	Coles	Through the Junior Landcare Grants Program, any school or organisation that would like to involve their students in landcare projects, in conjunction with local landcare groups, can apply for grants to assist them with the cost of their projects.
Habitat action	DPI F&A	Angling clubs, individuals, community groups, local councils and organisations interested in rehabilitating fish habitats in

Grant Name / Key dates	Administrator	Details
grants Annual		freshwater and saltwater areas throughout NSW can apply for grants.
Recreational Fishing Trusts Annual	DPI F&A	The Trusts can provide funding to a wide range projects including: <ul style="list-style-type: none"> • Recreational fishing enhancement • Recreational fishing education • Fishing access and facilities • Aquatic habitat rehabilitation and protection • Research on fish and recreational fishing • Enforcement of fishing rules.
NSW Boating Now Program Annual	NSW RMS	The Better Boating Program funds recreational boating infrastructure improvements across NSW. A state-wide study of existing boating facilities and safety measures has been conducted to inform the development of Regional Boating Plans. The plans will inform projects to be funded under the new program by identifying infrastructure priorities for each region and across the state. The Study for the Far South Coast is not yet available http://www.transport.nsw.gov.au/community-engagement/nsw-regional-boating-plans

8.12 Monitoring and Evaluation

8.12.1 General Context

Aquatic ecosystems of the Pambula estuary are in good condition (Section 3.4.1, Page 40), and human pressure levels are considered to be low compared to other NSW estuaries (Section 4, Page 57). Population growth and sea level rise are the key future pressures on the estuary.

There are several environmental monitoring programs operating within the estuary, including:

- Bega Valley Shire Council's (BVSC) environmental monitoring programs, including the Pambula Lake environmental monitoring program (Elgin and Associates 2014);
- Australian Shellfish Quality Assurance Program (SQAP), which focusses on water testing in oyster growing areas, as well as trials of other oyster condition indicators trialled in Pambula and other southern NSW estuaries (Nash and Rubio 2012); and
- NSW Government Monitoring, Evaluation and Reporting (MER) Program (see Roper *et al.* 2011).

It is recommended that an 'estuarine health integrated monitoring program' (EHIMP) be developed to identify trends in estuary condition, and therefore the effectiveness of management strategies and this plan in maintaining estuary health. The following sections describe the objectives and general approach for developing and implementing an EHIMP.

8.12.2 Monitoring Objectives

The objectives of the EHIMP are to:

- To measure and document long-term changes in the ecosystem health of Pambula estuary;
- To provide information on ecosystem health and pressures in the Pambula estuary that can guide investment decisions; and
- To increase government, industry and community engagement and interaction with the program so as to improve its appeal, integration and focus in relation to catchment and waterway management.

8.12.3 Indicators

As stated above, it is intended that the EHIMP integrates with the state-wide MER Program and other ongoing programs. Table 8-5 lists indicators adopted in the state-wide MER (Roper *et al.* 2011) and Pambula Lake environmental monitoring program (EMP) (Elgin and Associates 2014).

In selecting condition and condition driver indicators for the EHIMP, principles of the SMART framework (UNDP 2009) were considered. The SMART framework is divided in to the following five criteria:

- Specific (specific to issue under consideration);
- Measurable (statistically verifiable, reproducible and show trends);
- Accessible (regularly monitored, cost effective and consistent);
- Relevant (directly address issues or agreed objectives); and
- Timely (provide early warning of potential problems).

Each of the indicator groups were assessed in accordance with the SMART criteria listed above.

Table 8-5 Pambula Estuary EIMP Indicators

Issue	Indicator	Other Programs	EHIMP
Eutrophication	Phytoplankton abundance (as chlorophyll a)	State MER, Pambula EMP	✓
	Macroalgae abundance	State MER	×
	Water clarity (as turbidity)	State MER, Pambula EMP	✓
	Nutrients, <i>in situ</i> measurements	Pambula EMP	✓
Habitat Changes – clearing, sea level rise etc.	Condition of tidal and non-tidal riparian vegetation	-	✓
	Extent of non-tidal riparian vegetation	-	✓
	Extent of seagrass meadows	State MER	✓
	Extent of mangroves	State MER	✓
	Extent of saltmarsh	State MER	✓

Issue	Indicator	Other Programs	EHIMP
Changes to trophic structure of fish assemblages – due to gross changes in ecosystem functioning, over-harvesting etc.	Species diversity and composition	State MER	×
	Species abundance	State MER	×
	Nursery function	State MER	×
	Trophic integrity	State MER	×

The recommended indicators for the EHIMP are presented in Table 8-5. These indicators meet SMART criteria presented above with respect to:

- Specific/Relevant:
 - All indicators are relevant to capturing the condition of assets most sensitive to potential future threats, namely water quality degradation, habitat clearing and sea level rise.
 - Most indicators, particularly biological indicators, may be affected by a range of processes and therefore are not necessarily specific to any particular condition driver. It is therefore important that multiple indicators are measured to identify likely drivers of changes to ecosystem health.
 - The fish assemblage based indicators are more relevant to gross changes in ecosystem functioning, which can be readily and quickly measured using other indicators. This indicator is more relevant to comparing condition among estuaries, and is not ideal for assessing health at the within-estuary scale.
- Measurable/Accessible:
 - The physio-chemical indicators can all be measured *in-situ* using a multi-probe water quality instrument. The operation of the instrument does not require specialist expertise, however it is critical that data collection be undertaken in accordance with standard methods and the instrument must be calibrated prior to undertaking measurements. Nutrient and chlorophyll measurements can be undertaken by appropriately trained environmental scientists. Therefore, physio-chemical indicators can be cost effectively measured (accessible) on a regular basis.
 - The assessment of habitat changes is based on analysis of remote imagery and ground-truthing. Specialist skills are required in this regard.
 - Sampling of fish assemblages requires specialist skills in fish sampling, taxonomy and data analysis.
- Timely:
 - All physio-chemical parameters are measured *in-situ* and can provide an early warning of potential water quality and therefore ecological issues. However, because all these

parameters can show marked variability over a range of time-scales (in response to rainfall, tidal cycles, discharges, seasonal factors), it is important that trends are considered over time, rather than as individual measurements.

8.12.4 Design and Implementation

The sites and design adopted in the Pambula Lake environmental monitoring program (EMP) (Elgin and Associates 2014) are appropriate for the measurement of water quality parameters (including chlorophyll *a*), but would benefit by increased sampling effort so more than four samples a year are taken. The current OEH guidelines for assessing ecosystem health, recommend six sampling occasions over mid-November to end March (in southern NSW). Monitoring at these times will enable more precise identification of the chlorophyll-*a* maximum. Further monitoring in winter and autumn is also encouraged funding permitting.

Habitat-based indicators should be mapped at a whole of estuary scale. Representative sampling sites within each habitat type and estuary should be established to ground-truth desk-top based mapping assessments.

MER framework is applicable across the whole estuary when considered as lower, mid and upper zones based on salinity, i.e. it is spatially scalable. The MER program provides trigger/guideline values for each of the estuary zones, which provide a basis for (i) grading each indicator; (ii) assessing trends in estuary condition relative to other estuaries in the state. It is recommended that results be presented in on-line Report Cards.

Suggested timeframes are outlined in Table 8-3 and Table 8-4.

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Appendix A Risk Assessment Workshop Background Material



PAMBULA LAKE COASTAL ZONE MANAGEMENT PLAN RISK ASSESSMENT WORKSHOP BACKGROUND MATERIAL

Definitions

Threat – An action or process that changes various elements of estuary condition. Threats may be actively occurring, or have the potential to occur in the future. In the context of this study threats negatively affect estuary condition. Examples may include sea level rise, or stormwater discharges.

Value – A social, cultural or environmental attribute of the estuary. Values are generally associated with the current condition of the estuary. Values determine how the estuary is used. Values may include aspects like high water quality, vegetated riparian zones, presence of boatramps, foreshore access, navigability, etc. The values of the estuary determine its use.

Issue – In the context of this study, issues are where an identified threat may have, or is currently having, a detrimental impact on one or more identified values of the estuary.

Risk – Risk is the measure of impact of an issue. Risk is determined by combining the likelihood (or frequency) of the threat occurring and the consequence of that threat to the value(s) affected. Risks are generally rated from low to extreme. Issues that have a higher risk would generally be the target for future management actions.

Introduction

BMT WBM is preparing a Coastal Zone Management Plan ('CZMP') for Pambula Lake. This study builds on the work completed previously as part of the Estuary Processes Study (2012) and Data Compilation Study (2008) and related studies and investigations completed by others.

The intent of the CZMP is to identify and prioritise issues affecting the long term sustainability of the estuary. This is to be done using a risk-management approach that considers threats (natural or human induced) that impact on (or potentially will impact on) the values and uses of the estuary. The threats to the estuary have largely been identified during the previous studies and through additional consultation tasks completed as part of this study.

The identification and prioritisation of the management issues will be based on a combination of the likelihood and consequence of the threats, as per standard risk assessment methods. As part of the risk assessment process, a level of risk tolerance will be defined. Issues that are considered intolerable and pose the greatest risk to the condition and associated values of Pambula Lake will become the focus of management actions, as identified in the CZMP.

The approach will also provide integration with existing Council actions and initiatives, as these are included when assessing risk priorities. Risk management is also an effective process for preparing strategies where outcomes are uncertain, such as potential future impacts of climate change.

Risk Assessment Workshop

A risk assessment workshop will be held to help identify and prioritise issues affecting Pambula Lake. The workshop is to be attended by all major stakeholders of the estuary, including those responsible for its on-going management and conservation, as well as landuse planning and developing within the catchment.

BMT WBM will facilitate the risk workshop and will lead attendees through the following key steps in the risk assessment process (described further below):

- **Risk identification:** Confirm the identified threats and values. Identify the issues relevant to Pambula Lake;
- **Risk Analysis:** Analyse the risks of the issues identified. This includes the likelihood (or frequency) of occurrence and potential consequence associated with each issue. The combination of likelihood/frequency and consequence yields an overall level of risk (extreme, high, medium, low);
- **Risk Evaluation:** Prioritise the risks for treatment. What is a tolerable level of risk?
- **Current Controls:** Provide details of existing strategies and control measures that are already mitigating the risk of the issues identified. Any risk remaining after implementation of current controls is the residual risk; and
- **Risk Treatment:** Provide ideas and suggestions for potential additional management options to reduce risks down to a tolerable level. Cost/benefits of options should be considered. Are triggers required for implementation of actions?

The information provided below aims to give a general understanding of current estuary condition, values and threats. The values and threats will be combined to provide a list of issues for management.

Attendees will firstly confirm our understanding of values of the estuary and threats it faces. These have been determined to date from reviews of previous correspondence and further consultative activities. Attendees will then participate in grading the frequency/likelihood and consequence for each identified issue to analyse its overall risk level. Agreement on tolerable and intolerable risks to the estuary will also be an important activity following the risk analysis.

Depending on time availability, the risk workshop will also review existing control measures in place to address identified issues, and to formulate new options, specifically for issues that have an intolerable level of risk. Management options considered are typically 'intervention' type options that try and reduce the occurrence of the threat (either in magnitude or extent) and/or 'adaptation' type options that try to adjust the uses of the estuary based on acceptance of modified values. The latter would be used when intervention-type options are not feasible or economically practical.

Estuary Condition, Values and Threats

As defined at the start of this document, threats are actions or processes which affect estuarine condition. The changes in estuarine condition that may be occurring now or in the future will change the values of the estuary thereby changing the uses it is capable of. While Pambula Lake remains largely unmodified, the values and uses of the estuary have still been affected by human development, which accounts for its current condition.

Estuary Condition

The status of estuary health (or condition) of Pambula Lake has been identified in a variety of available information including:

- National Land Water Resources Audit – Ecosystem Health (Heap et al. 2001);
- State of the Catchments Reports (OEH, 2010); and
- Recent Environmental Monitoring of Pambula Lake commissioned by Council (Elgin Associates, 2012).

The following information in respect of these health assessments has been obtained from Elgin Associates (2012):

The NLWRA (2001) assessed the ecosystem health of all Australian estuaries based on geomorphic characteristics, and catchment and habitat integrity. The NLWRA classification for Pambula Lake was 'largely unmodified' based on criteria including: 65-90% catchment cover is intact, gross impacts from land use are not known, catchment and floodplain hydrology are largely unmodified, extractive activities (i.e. fishing) are sustainable, impact from weeds and pest species is minimal and estuarine systems and processes are mostly intact.

A State of the Catchments (SOC) 2010 report (DECCW 2011) was published that provides the latest assessment of ecological condition/health of estuaries and coastal lakes and the pressures acting upon them in the Southern Rivers region including Pambula Lake. This assessment is based on Monitoring Evaluation and Reporting (MER) data collected up to 2009. The assessment provided Pambula Lake with an overall condition index of 4.0 (out of 5), rated as being good to very good based on the estuarine health indicators - chlorophyll a, turbidity, extent of seagrass, extent of saltmarsh and fish. Majority of the indicators were assessed as 'good', with turbidity rated as 'very good' and extent of saltmarsh assessed as 'fair'.

Specific information from the SOC report relevant to Pambula Lake is included in Table 1.

Table 1 Pambula Lake Condition, State of Catchments Reports (2010)

Overall Condition Index	Index Trend	Chlorophyll a	Macro algae	Turbidity	Seagrass	Mangrove	Saltmarsh	Fish	Confidence
4/5 *	?	4/5	A	5/5	4/5	B	3/5	4/5 *	Med.

? Unknown

A – No data

B – Baseline data only

* - Data greater than 3 years old

As can be seen in Table 1 there are many potential indicators that can be used to determine condition including a variety of ecological and water quality indicators. The SOC has developed this list of indicators based on factors including suitability of indicators to reflect estuarine condition, availability of

indicator data across estuaries of the state, ability to compare datasets against reference conditions (to provide a relative measure), costs and practicality of collecting this data amongst other things.

In interpreting the results included in Table 1 the water quality results are determined by comparison of data obtained from Pambula Lake against reference condition data (that represent conditions in equivalent "pristine" site). The ratings for seagrass and saltmarsh are determined by their change in extent between survey periods (in this case 1985 and 2006). Further explanation of the result for Saltmarsh was not available in the State of the Catchments report.

Elgin Associates (2012) provides additional insight into the health of Pambula Lake. Their work included eight (quarterly) water quality sampling campaigns undertaken from October 2010, through to July 2012. The program monitored surface water quality (including depth profiling) across the basin of Pambula Lake using protocols consistent with the state-wide MER program (which is used to derive the State of Catchments condition results). The primary aim of the program was to record microalgal abundance as phytoplankton (determined by chlorophyll-a) and also water clarity as turbidity. The monitoring identified that the 80th percentile values for turbidity and chlorophyll-a derived from all transects were below the current MER trigger values. The results indicate that these results could be adopted as new site specific trigger value, consistent with the high water quality observed in Pambula Lake.

The Estuary Processes Study (Cardno, 2012) included an assessment of historical water quality and ecological processes of Pambula Lake. Environmental Values associated with Pambula Lake include protection of aquatic ecosystems, visual amenity, secondary contact recreation, primary contact recreation, and consumption of aquatic foods (to be cooked prior to eating). Water Quality Objectives associated with these Environmental Values were generally observed to be met. Compliance was achieved at all times in Pambula Lake and Yowaka River, although there were exceedences at times for total nitrogen, enterococci (primary recreation), faecal coliforms (primary recreation), ortho-phosphorus and ammonia in the Pambula River near the tidal limit. The result indicates that the estuary maintains a high standard of water quality and Environmental Values are mostly being protected.

During wet weather events Pambula Lake responds differently as a result of catchment derived freshwater flows. Elgin Associates (2012) completed a quarterly water quality survey during April 2012 which was identified as a period of significant freshwater inflow due to substantial catchment rainfall in the preceding month and week prior to the sampling event. During this monitoring the estuary displayed high turbidity, reduced dissolved oxygen, reduced conductivity and pH. Wet weather effects are commonly observed in estuaries.

In terms of ecology, the Estuary Processes Study identified that the extent of seagrass distribution in Pambula Lake was substantially greater than that previously mapped. However, exact differences in areas were not calculated. The Processes Study did recommend that more detailed mapping be obtained to provide an accurate baseline against which future quantitative monitoring survey could be compared.

The methodologies used to develop report card gradings for the State of the Catchments report (as shown in Table 1) were not employed in the monitoring work completed by Elgin Associates (2012) and hence further interpretation of this data would be required to allow direct comparisons and identification of changes. However, the outcomes of both assessments indicate that Pambula Lake is considered to be in good to very good condition for most estuary condition indicators.

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Estuary Values

From the review of the existing studies and recent consultative activities the following sets of suggested values are provided in Table 2 and Table 3.

Table 2 Natural Values

Data Compilation Study	Consultation as part of this Study
Pristine nature (lack of pollution)	Natural bushland /riparian vegetation
Good water quality	Aquatic/marine vegetation (seagrass, etc.)
Lack of clearing, large areas still forested	Wetland fauna – fish and other aquatic fauna habitat values
Aquatic habitat	Wetland fauna – waterbird habitat (migratory or resident)
Wildlife within lake and catchment eg birdlife, rare fish	Water quality
	Presence of threatened species – flora or fauna
	Supports species at a critical life stage – (nesting, breeding, spawning habitat)

Table 3 Human Use Values

Data Compilation Study	Consultation as part of this Study
Sustainability	Aesthetic beauty / Scenic values
Aboriginal heritage within the area	Public access around lagoon
Maintaining water quality through future changes	Secondary contact recreation (kayaking, motor boating, fishing)
Recreational uses of the estuary	Primary contact recreation (swimming) – near entrance only
Aesthetics/beauty, visual amenity	Historic or indigenous cultural heritage
Livelihood, commercial benefits of the estuary and catchment	Naturalness/ quiet and undisturbed
Lifestyles	Commercial aquaculture opportunities
Navigable, permanent open entrance	Recreational Fishing environments
Varied landuse in the catchment eg agriculture, forestry, National Park	Water quality
Valuable oyster industry, internationally recognized	

It is considered that there are some prime values of the estuary that relate to its unique features including:

- A catchment which is only partially modified with large areas still forested;
- Largely intact and healthy aquatic and wetland vegetation communities;
- A permanently open entrance and entrance channel which allows rapid flushing of the estuary with marine water and during dry periods provides for high water quality within the majority of Pambula Lake; and
- Unique and highly significant Aboriginal heritage artefacts.

It is from these key values that many of the other values originate such as the suitability for the oyster industry, fishing, wildlife habitat, visual amenity and recreational pursuits.

Estuary Threats

Specific information on pressures or threats faced by Pambula Lake is available in the SOC Report 2010 (DECCW 2011). Table 4 provides a summary of the information included in this report.

Table 4 Pambula Lake Pressure, State of Catchments Reports (2010)

Condition Index	Index Trend	Cleared land	Population	Sediment input	Nutrient input	Freshwater flow	Disturbed habitat	Tidal flow	Fishing	Confidence
Low to V. Low	?	Low	Low	Low	Low	V Low	Mod.	V Low	V Low	High

This report identifies that many of the pressure indicators are very low; however, Pambula Lake received a moderate score on the indicator of disturbed habitat which includes jetties, moorings, reclamation walls and oyster lease infrastructure. Presumably this result relates to the extensive areas of oyster leases present within Pambula Lake as the other items are not overly prevalent within the system.

A variety of estuarine threats have been identified from previous literature and through recent consultative activities as detailed in Table 5.

Table 5 Pambula Lake Condition Threats

Data Compilation Study	Estuary Processes Study	Consultation as part of this Study
Sustaining viable oyster industry - dependent on good water quality	Clearing of the catchment for forestry, agricultural, rural and urban land uses	Changes to catchment inflows (quantity, i.e. extraction, increased imperviousness)
Increase public awareness of effects of catchment activities on the estuary	Loss of riparian vegetation	Outbreaks of aquatic weeds or pests
Continuing regeneration of saltmarsh	Delivery of high sediment loads from the catchment	Changes in catchment inflows (quality, i.e. delivery of high sediment loads from the catchment, particularly from unsealed gravel roads)
Estuary plan that influences planning decisions - want baseline information so can see improvements	Potential for pollution from stormwater outlets and sewer overflows	Potential pollution from Oaklands reuse scheme
Comprehensive water quality monitoring programme to monitor changes	Recreational usage of the waterway - manage banks affected by waterskiing on Pambula River	Stormwater runoff from towns
Improving water quality	Oyster aquaculture	On-site sewage systems

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Risk Assessment Workshop Background Material

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Data Compilation Study	Estuary Processes Study	Consultation as part of this Study
Sensitive development within the catchment	Possible impacts of climate change on habitats and bank conditions	Plastics in the environment
Healthy and extensive riparian corridors	Need for improved mapping of estuarine vegetation (particularly seagrasses)	Slipway runoff
Existing values of the estuary maintained	Ongoing management of weeds	Managing weeds
Improve management of access to the lake	Manage banks accessed by cattle	Informal access ways
Easily accessible rehabilitation programmes for catchment users		Feral animals
Increase community awareness of estuaries and connection with catchment	Ongoing management of foreshore protection works at Severs Beach and other locations.	Damage to middens from boat wash
Economic evaluation of benefit of good water quality, and costs associated with deterioration	Address erosion as noted at locations around estuary, e.g. adjacent marina and boat ramp	Sea level rise impacts on middens
Improve stormwater management	Observation of entrance status with respect of sand build up and boat navigation and lake water quality (tidal exchange)	Commercial fishing impacts
Good working relationship, communication and involvement between all stakeholders		
Prevent siltation of estuary, target known sediment sources		
Range of current users of lake maintained and enhanced (eg National Park, oyster growing, fishing, boating). Commercial/recreational balance achieved		
Quality, well managed facilities		
Increase compliance capability from government agencies		
Suite of catchment health indicators (report card) understood by the community		
Cultural heritage (Aboriginal and European) acknowledged and shared		
Protection of Aboriginal heritage sites		

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Workshop

Having read through the above material which provides a brief overview of current estuarine condition, values and threats, the key elements of the workshop are reiterated below:

1. Risk Identification: At this stage the study team will present the suggested threats to estuarine condition and values of the estuary. The study team has reviewed the previously identified values and threats (presented in Tables 2, 3 and 5) and condensed them to those included in Table 6.

Table 6 Pambula Lake Condition Threats

Suggested Threats	Suggested Values
Unsealed roads in catchment	Adequate WQ to support environment, economy and amenity
Sea level rise	Aboriginal and non-indigenous heritage
Boat wash / boating generally	Habitat for terrestrial and wetland species, especially in the riparian zone
Clearing of riparian vegetation	Habitat for aquatic species, especially seagrass
Aquatic weeds and pests	Stable banks and foreshores
Aquaculture use	Ability to support commerce and business enterprises
Oaklands reuse scheme discharge	Ability to support a range of recreational pursuits
Catchment clearing / development	Passive, visual amenity
Stormwater and sewage discharges	Ecological health and diversity within the waterway, especially threatened species
On-site sewage leachate	Ecological health and diversity within the catchment, wetlands and foreshore, especially threatened species
Terrestrial weeds and pests (including ferals)	Vessel navigability - entrance
Cattle grazing	Vessel navigability – lake and rivers
Commercial fishing	
Recreational fishing	
Coastal and entrance processes	
Industrial / commercial development runoff (including plastics)	
Poor knowledge of environment and interactions	
Informal access around foreshore	

A brief description of the suggested threats is provided as follows:

- Unsealed roads in catchment – unsealed roads have been identified within the catchment. Runoff from the roads contributes sediments to the waterways and estuaries, impacting water quality.
- Sea level rise – may present a wide range of threats to estuarine values relating to habitat extents, middens, waterway hydraulics and estuarine water quality.
- Boat wash / boating generally – threats to bank stability and middens within the estuary. Disturbance of oyster leases may also occur.
- Clearing of riparian vegetation – threats to bank stability, habitats and aesthetics.

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- Aquatic weeds and pests – threats to overall estuarine amenity and existing recreational and commercial uses.
- Aquaculture use – potentially water quality impacts associated with accumulated organic sediments, bed shading and modifications of hydro-dynamics (currents).
- Oaklands reuse scheme discharge – threats to estuarine water quality and oyster aquaculture.
- Catchment clearing / development – threats to catchment runoff quality and hydrology impacting on estuarine water quality, and structural stability of streams.
- Stormwater and sewage discharges – threat to surface water quality, potential impacting on oyster aquaculture.
- On-site sewage leachate – threat to surface and groundwater quality, potential impacting on oyster aquaculture.
- Terrestrial weeds and pests (including ferals) – threat to terrestrial habitats and fauna adjoining estuary.
- Cattle grazing – threat to riparian habitats and stream bank stability. Can contribute sediments and biological contaminants directly to waterway.
- Commercial fishing – potential threat to fish stocks which may affect perceived recreational fishery value of Pambula Lake.
- Recreational fishing – potential threat to fish stocks in general, relates mostly to potential overfishing pressure.
- Coastal and entrance processes – threat related to entrance condition, while Pambula Lake is defined as a drowned river valley with a permanently open entrance, there are concerns that the entrance is gradually “filling in” which will have implications for tidal hydraulics and may affect lake water quality over longer periods of time.
- Industrial / commercial development runoff (including plastics) – potential threat to surface water quality runoff from these areas, with associated effects on estuarine water quality and sediments.
- Poor knowledge of environment and interactions – threat related to lack of education regarding estuarine values (and what these support) and how they may be impacted by inappropriate actions (i.e. uses) within the catchment and estuary.
- Informal access around foreshore – threat related to installation of personal (unapproved) developments on the foreshore sometime associated with fixed structures for boating. These may have a variety of aesthetic, safety and environmental concerns associated with them.

The values and threats have been presented within a matrix. Where a threat affects a value, these “cross-overs” have been recorded as an “issue” for management.

The identified risks will have a higher or lesser degree of association between the value and threat. These can be considered in terms of primary / direct relationships, or secondary / indirect relationships. An example is posed in relation to unsealed roads in the catchment. Runoff from the unsealed roads is

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likely to have a direct effect on values associated with water quality, but have a secondary or indirect effect on values associated with supporting business and commercial activities.

The risks have already been categorised in primary / direct or secondary / indirect relationships by the study team to allow the risk assessment workshop to focus on the primary / direct effects. In relation to the above example, this would essentially mean that the CZMP will focus on managing the effects of unsealed road runoff in the catchment. Managing this primary / direct impact would address a number of secondary effects, such as economies supported by the estuaries high water quality.

2. Risk Analysis: The primary / direct issues will now be assessed and evaluated as part of a risk assessment process. Workshop attendees will consider each issue in terms of its likelihood (or frequency) of occurrence and potential consequence. The combination of likelihood/frequency and consequence will then yield an overall level of risk (extreme, high, medium and low) as presented in Table 7.

Table 7 Suggested Risk Analysis Scale

		CONSEQUENCE				
		Negligible (1)	Small but measurable (2)	Moderate (3)	Major (4)	Permanent (5)
FREQUENCY	Often / Continuous (5)	Low	High	High	Extreme	Extreme
	Occasionally (4)	Low	Medium	High	High	Extreme
	Infrequent (3)	Low	Medium	High	High	High
	Rare (2)	Low	Low	Medium	Medium	High
	Almost Never (1)	Low	Low	Medium	Medium	High

To assist in determining the consequence of the risks, a consequence scale can be used as shown in Table 8. This rating scale considers triple-bottom line effects, i.e. those that apply to society / community, environment and finance / economy. Typically the highest consequence from these separate categories is used to determine the overall consequence rating for the risk.

Table 8 Indicative Consequence Rating Scale

Consequence	Society / Community	Environment	Finance / Economy
Permanent (Catastrophic)	Widespread semi-permanent impact (~1 yr) to highly utilised community services, wellbeing, or culture of the community with no suitable alternatives. Loss of lives and/or permanent disabilities	Severe and widespread, permanent impact on multiple regionally or nationally significant ecosystem services. Recovery unlikely.	Widespread major damage or loss of property or infrastructure with total value - \$5 million +. Regional economic decline, widespread business failure and impacts on state economy.
Major	Major widespread long term (~1 month) disruption to well-utilised services, wellbeing, or culture of the community with very few alternative available. Widespread serious injuries / illnesses.	Severe and widespread semi-permanent impact on one or more regionally or nationally significant ecosystem services. Partial recovery may take many years.	Major damage or loss of property or infrastructure with total value - \$1 million. Lasting downturn of local economy with isolated business failures and major impacts on regional economy.
Moderate	Minor medium to long term (~1 week) or major short term disruption to moderately utilised services, wellbeing, or culture of the community with limited alternatives. Isolated serious injuries / illnesses and / or multiple minor injuries / illnesses	Substantial impact on one or more locally significant ecosystem services. Full recovery may take several years.	Major damage to property or infrastructure with total value - \$200,000. Significant impacts on local economy and minor impacts on regional economy.
Small but Measurable (Minor)	Small to medium short term disruption (~1 day) to moderately utilised services, wellbeing, finances, or culture of the community with some alternatives available, or more lengthy disruption of infrequently utilised services. Minor and isolated injuries and illnesses	Small, contained and reversible short term impact on isolated ecosystem services. Full recovery may take less than 1 year.	Substantial damage to properties or infrastructure with total value - \$50,000. Individually significant but isolated impacts on local economy.
Negligible (Insignificant)	Very small short term disruption (~1 hr) to services, wellbeing, finances, or culture of the community with numerous alternatives available.	Little to no environmental impact	Minor damage to properties or infrastructure with total value - \$10,000. Minor short-term impact on local.

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3. Risk Evaluation. Considering the frequency and consequence determined collectively for all risks, these will be scored. To most effectively utilise limited resources the risks will be prioritised from highest / greatest to lowest. Addressing the greatest risks as part of the CZMP is considered to make the maximum use of available limited resources.

The limit of tolerable risk will be discussed, i.e. is it acceptable to only address extreme, and high risks, or do the medium risks need to be considered as well. These considerations will depend on workshop attendee's view as to what is necessary to address and tolerable to let go of for the time being.

4. Current Controls. This portion of the workshop is important and it will be used to inform the study team and other attendees of the existing controls or actions which are being implemented by others in respect of addressing the threats facing the estuary. This session will be used to determine what existing strategies and control measures are in place (or planned for implementation) that will mitigate the risk of the issues identified. Any risk remaining after implementation of current controls is the residual risk.

5. Risk Treatment / Management Options. The study team will seek suggestions for potential additional management options to reduce risks down to a tolerable level. The session is also important as it may facilitate discussion on options which can be further researched by the study team in the option assessment phase. The wide attendance of individuals at the workshop will provide for a variety of viewpoints and approaches to be presented.

Next Step

Subsequent to the risk workshop, the study team will prepare management options relevant to the risks deemed to be necessary for treatment. The identified management options will be presented to the committee during a later workshop for further comment.

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Appendix B Risk Based Threat Assessment

B.1 Method

The 'Threat Assessment' process is adapted from the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000:2009), and is described below and presented schematically in Figure B-1.

- **Establish the Context** – the requirements and scope of a coastal zone management plan for estuaries set by NSW Legislation and Guidelines provides the context for the threat assessment and intended outcomes.
- **Identify the Threats** – the threats arise from the pressures upon lake processes that subsequently modify its values. Pressures may be historical, current, or have the potential to occur in the future, such as sea level rise. A combination of scientific assessment and community inputs assist in identifying the pressures and threats upon the estuary.
- **Analyse the Threats** – the threats to lake values are qualified in terms of the frequency with which they occur and the consequence of their occurrence. The frequency of occurrence for the threats aims to qualify the existing threats that are already occurring (see Table B-1) as well as the potential future threats such as sea level rise. The consequence relates to the impact of the threats upon the values of the lake (see Table B-2).

The frequency and consequence is then combined to determine the level or degree of the threat to the lake. The product of frequency and consequence are specified within a Threat Matrix (i.e. extreme, high, medium or low) as shown in Table B-3.

The level of threat is listed for each identified threat, which is then used to assist in the identification and prioritisation of management actions, with management options that treat the greatest increased in priority. This threat analysis is undertaken at a workshop attended by representatives of Council, state agencies and selected members of the local community. A register of the threats listed in priority order from greatest to least threat is prepared.

- **Evaluate the Threats** – in consultation with Council and other stakeholders the threat assessment and threat criteria is checked to ensure a reasonable and consistent outcome. The existing controls that may manage any of the identified threats is investigated and included in the development of management options where appropriate.
- **Manage the Threats** – the process of developing management actions is directly related to managing the threats to lake values. Management actions may be designed as:
 - Intervention actions (targeting frequency of threats) to improve or protect lake values and therefore eliminate extreme or high threats; or
 - Adaptation actions (targeting consequence of threats) to maintain, protect or improve lake values and therefore reduce extreme or high threats and incidentally eliminate medium or low threats where possible.

Section 7 (Page 83 of the main report) describes how the management actions are considered based upon the technical viability of implementation in the study area.

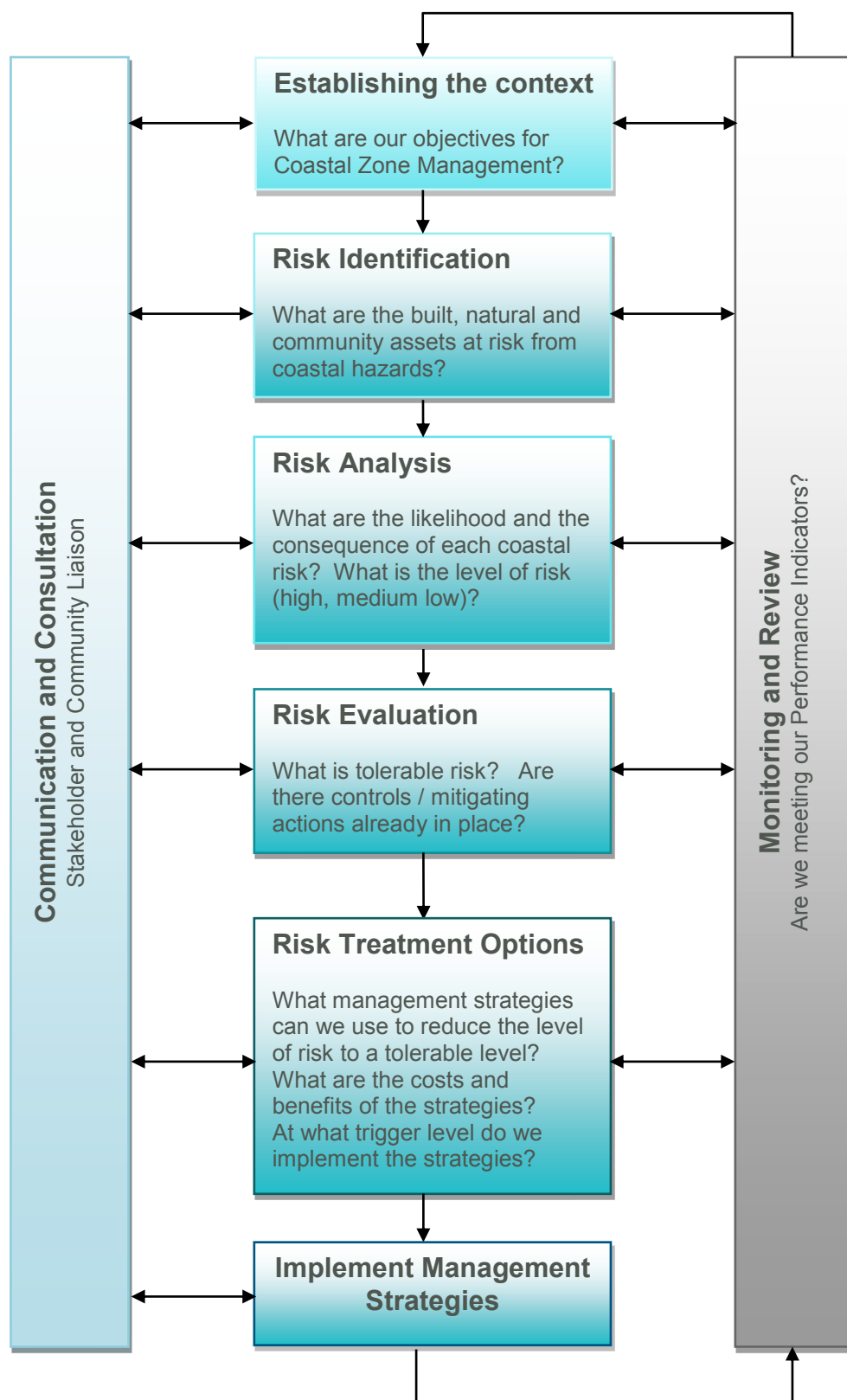


Figure B-1 Risk Management Framework (ISO 31000:2009) adapted for CZMPs

Table B-1 Frequency Scale for Threat Assessment

Scale	Frequency Descriptor
1	Almost Never
2	Rare
3	Infrequent
4	Occasionally
5	Frequently / Continuous

Table B-2 Consequence Scale for Threat assessment

Scale	Consequence
1	Changes are minor /within natural variability
2	Approaching limit of acceptable change, recovery without intervention is still possible
3	At limit of acceptable change, recovery possible with intervention
4	Beyond limit of acceptable change, recovery is possible with further intervention but will take several years
5	Permanent Loss of Value; Unacceptable change to ecological character has occurred, recovery unlikely

Table B-3 Threat Risk Assessment Matrix

		Consequence				
		Negligible (1)	Small but measurable (2)	Moderate (3)	Major (4)	Permanent (5)
Frequency	Often / Continuous (5)	low	medium	high	extreme	extreme
	Occasionally (4)	low	medium	high	high	extreme
	Infrequent (3)	low	medium	high	high	high
	Rare (2)	low	low	medium	medium	high
	Almost never (1)	low	low	medium	medium	medium

Threat-Value Matrix

Appendix C Threat-Value Matrix

Primary / Secondary	Adequate WQ to support env, econ and amenity	Aboriginal and non-indigenous heritage	Habitat for terrestrial and wetland species, esp in the riparian zone	Habitat for aquatic species, especially seagrass	Stable banks and foreshores	Ability to support commerce and business enterprises	Ability to support a range of recreational pursuits	Passive, visual amenity	Ecological health and diversity within the waterway, esp threatened species	Ecological health and diversity within the catchment, wetlands and foreshore, esp threatened species	Vessel navigability entrance	Vessel navigability – lake and rivers
Unsealed roads in catchment	P			S		S	S	P	P			S
Sea level rise		P	P		P							
Boat wash / boating generally		P	S		P							
Clearing of riparian vegetation	S		P		P			P		S		
Aquatic weeds and pests						P			P			
Aquaculture use	P						P	P	S			
Oaklands reuse scheme discharge	P								S			
Catchment clearing (inc. bushfire management) and development	P			S						P		S
Stormwater and sewage discharges	P						S		P			
On-site sewage leachate	P						S		P			
Terrestrial weeds and pests, ferals			P					S		P		
Stock grazing	S		P		P							
Commercial fishing						S	S		P			
Recreational fishing									S			
Coastal and entrance processes	P										P	
Industrial/comm development runoff (including plastics)	P			S				S	S			
Poor knowledge of environment and interactions	P	P	S	P	P				P	P		
Informal access around foreshore		S	P					S		S		
Lack of implementation funding	all	all	all	all	all	all	all	all	all	all	all	all
Change of Responsibility / Government	all	all	all	all	all	all	all	all	all	all	all	all

Options Assessment

Appendix D Options Assessment

Assist in the management of aquatic weeds and pests

	Actions	No Regrets?	Addresses Threat	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
A1	Assist NSW Fisheries in the monitoring and management of potential outbreaks of Caulerpa (eg support for overall program in terms of signage and education)		E	High	3	2	2	3	3	3	16	16.2	
A2	Utilise in-lake monitoring of seagrass (if undertaken) to identify potential presence of Caulerpa in addition to other preventative actions		E									NS	Sufficiently addressed by other actions
A3	Support PLOG to prepare a protocol for management and handling of inter-estuary oysters arriving at Pambula Lake		E									NS	Covered under other actions

Minimise spread of terrestrial weeds, pests and feral animals

	Actions	No Regrets?	Addresses Threats	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
B1	Work with relevant authorities to control and manage weeds around the foreshore	yes	K	High	3	3	3	3	3	3	18	18	

Actively manage riparian vegetation extent and condition and improve bank stability

	Actions	No Regrets?	Addresses Threats	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
C1	Undertake bank restoration and rehabilitation works in priority areas as highlighted in the Estuary Processes Study (and Pambula Catchment Rehabilitation Plan). Council and LLS to undertake works on public and private lands as funding and resource permit		D	High to Extreme	3	3	3	2	3	3	17	16.8	
C2	Consider acquisition of privately owned foreshore lands to bring them into public ownership as a method to improve and enhance riparian and wetland health as well as public access. Acquisition would occur as opportunities arise subject to sufficient internal and external funding (e.g. Coastal Lands Protection Scheme).		D	High	3	3	2	2	3	2	15	15	costs dependent on land parcel being sought
C3	Monitor riparian vegetation extent / coverage and bank erosion levels by completing a 10 yearly review of extent and condition		D	High	3	2	3	3	3	3	17	16.8	
C4	Rationalise track network around lake in public lands (particularly within riparian zones and other areas of sensitive vegetation) including rationalisation and / or rehabilitation of tracks		R, D	Medium	2	3	3	3	3	3	17	16.8	
C5	Work with private land holders and other relevant bodies to continue fencing of riparian areas and encourage revegetation as opportunities and funding arise		L, D, Q, I	High	3	3	3	3	3	3	18	18	
C6	Ensure all new seawalls being built or old ones being upgraded are built in accordance with environmentally friendly seawall guidelines		Q, D	Low	1	3	3	3	3	3	16	15.6	

Options Assessment

C7	Adopt / apply NSW office of water Guidelines for Riparian Corridors on Waterfront Land, 1st order 10m, 2nd order 20 m, 3rd order 30m 4th order and estuaries, 40 m (distances on one side only) in relevant Council planning documents, i.e. DCP to apply to both private and Council related development		D									NS	Already adopted by Council
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Develop and implement a variety of educational capacity building initiatives to increase knowledge of protecting and improving estuary health

	Actions	No. Regrets?	Addresses Threats	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
D1	Provide specific information on the importance of riparian land and bank management (and options for management) to new private landowners when land ownership changes occur in relevant areas of the estuary. Similarly, provide information/support to existing private land owners to encourage ongoing best practice riparian and bank management. Material should address identified barriers to implementation		D	High	3	2	3	3	3	3	17	16.8	
D2	Undertake an education program for Council Work staff (and possibly key local developers) involved in Erosion and Sediment Control (E&SC), and officers involved in assessment of DA's to improve their understanding of E&SC policy, procedures including on-ground works, inspections, DA review, strategic planning etc.		I, Q	High	3	3	3	3	3	3	18	18	
D3	In conjunction with DPI and LLS, work with local farmers within the catchment to minimise pollution from agricultural runoff through education programs and support for appropriate on-ground management works		I, Q	High	3	2	3	3	3	3	17	16.8	
D4	Provide information to private landholders that have key habitat and vegetation communities on their properties to describe the community, its importance to the river and options for its protection and management		H	High	3	2	3	3	3	3	17	16.8	
D5	Continue existing and support new community engagement and education initiatives such as 'Love our lakes', and 'clean up days', that serve to increase awareness on estuarine condition and management issues. Support may include financial support, logistical support, expertise support (particularly in relation to information sharing on topics of interest), amongst other things.	yes	Q	High	3	3	3	3	3	3	18	18	
D6	Support implementation of Pambula Lake Oyster Growers EMS	yes	E	High	3	3	3	3	3	3	18	18	
D7	Support employment of an Oyster Environmental Management System (EMS) implementation officer - cleanup, sustainable materials, modern techniques, etc. This position could be partially funded by Council/agencies and have multiple responsibilities		Q								NS		Covered other under actions

Options Assessment

D8	Develop educational material with recreation fishing community that identifies best practice use of estuary. Educational material may cover appropriate disposal of waste, use of quiet low emission motors, adopting safe boating speeds for estuary, consideration of wake, being licenced to fish, applying bag limits, etc. Identify also enforcement measures.		Q, C									NS	NSW Fisheries function
D9	Develop educational material for landowners (targeted to rural and urban) on how to use horticultural and agricultural products (e.g. fertilisers and pesticides) appropriately. This would cover generic aspects of use of chemicals such as appropriate storage, application times, rates and buffers, selection of appropriate products.		Q									NS	Covered other under actions

Protection and conservation of Aboriginal cultural heritage sites around the foreshore

	Actions	No Regrets?	Addresses Threats	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
E1	Assist NPWS in monitoring of cultural sites and to undertake protection works as required, e.g. for middens (working with Land Council)	yes	B, C, Q, H	High	3	3	3	3	3	3	18	18	
E2	Council to work with relevant agencies to support long term protection of middens through appropriate heritage protection	yes	B, C, Q, H	High	3	3	3	3	3	3	18	18	

Monitoring of entrance processes and dynamics

	Actions	No Regrets?	Addresses Threats	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
F1	Work with OEH to undertake future hydrosurveys and analysis of water levels in response to community concerns to changed entrance conditions		B & O	Medium	2	3	3	3	3	3	17	16.8	Tide level recorder has been confirmed as not slowly sinking

Protect, rehabilitate and enhance estuarine vegetation including seagrass, saltmarsh and mangroves

	Actions	No Regrets?	Addresses Threats	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
G1	Incorporate adequate buffers around key wetland areas to ensure vegetation can migrate with SLR and provide additional protection. Establish suitable means for dedicating buffers to this landuse, e.g. lease, purchase or voluntary contribution, etc		B	Medium	2	3	3	3	3	2	16	15.6	
G2	Work with NSW Fisheries to complete mapping of the distribution / extent of mangrove, saltmarsh and seagrass using available information on a 5 - 10 year basis		B	High	3	3	2	3	3	3	17	17.4	
G3	Utilise available information on heavy metal testing to understand and lessen impacts of activities within estuary		P, F, Q	Medium	2	3	3	2	3	3	16	15.6	

Protection and enhancement of water quality

Options Assessment

	Actions	No Regrets?	Addresses Threats	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
H1	Develop and implement a Stormwater Management Plan that quantifies loadings of stormwater pollutant discharges from agricultural and urban areas to the estuary. Utilise the Stormwater Management Plan as the basis for determining priority areas requiring stormwater quality mitigation, taking into account existing management systems. Stormwater Management Plan to identify cost and benefit of various control systems/approaches to reduce pollutant loadings. Priority for implementation should be identified. Works implemented as funds allow		I	High	● 3	● 3	● 3	● 2	● 3	● 3	17	16.8	
H2	Continue to support existing Council initiatives that aim manage risks to estuarine water quality arising from sewer pump stations overflow, as well as the siting, regulation and management of on-site sewage systems		I	High	● 3	● 3	● 3	● 3	● 3	● 3	18	18	
H3	Undertake rapid catchment appraisal for Pambula Lake catchment based on SRCMA Roads and Track Survey (Len Gazzard) summary, including consideration of suitable alternative road base materials, reduced grading, need for improved design and regulation and establishment of road sealing priorities.		A, I, Q	High	● 3	● 3	● 3	● 3	● 3	● 3	18	18	
H4	Ensure oyster leases apply relevant OISAS guidelines (Ch 7) in the management of the appearance of leases, i.e. signage, cleanliness, removal of redundant infrastructure and appropriate disposal of tarred products and old infrastructure.		F									NS	Sufficiently covered under other actions
H5	Implement ecosystem health monitoring that includes biotic indicators in addition to WQ. Report findings (make data available) regularly to community and stakeholders		Q	High	● 3	● 3	● 3	● 2	● 3	● 3	17	16.8	
H6	Regular inspections/compliance checking of boat work areas particularly regulating use of boat antifoulants and other chemicals in the environment including water and metal contamination.	yes	Q, I	High	● 3	● 3	● 3	● 3	● 3	● 3	18	18	
H7	Review / Audit the Oaklands Reuse Scheme to ensure aspects of scheme ownership and accountability, rules and bounds of application, scheme monitoring, review and auditing are clear and available for third parties to access.		G	Medium	● 2	● 3	● 3	● 3	● 3	● 3	17	16.8	The scheme does partially operate under EPA approval and licence requirements. It is reviewed and regulated by the EPA thru the Merimbula STP licence. Reuse operations themselves are regulated via legal agreements with Council so this options does remain valid. The quality and volume data of the effluent from the STP monitoring is available thru the EPA as are the annual licence returns that are submitted to the NSW EPA by BVSC.

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H8	Council to investigate, in partnership with RMS, suitable vessel waste disposal sites within the Shire (including the Pambula Lake estuary). Key considerations in site selection will include accessibility, likely demand, capital and operating costs (including options for cost recovery) and potential environmental benefits, particularly to surrounding water sensitive uses, such as swimming		E, I, Q	High	● 3	● 3	● 3	● 2	● 1	● 2	14	14.4	Pambula estuary unlikely to be the best site for the facility as it has relatively low usage for these types of vessels
H9	Incorporate climate change/SLR considerations into infrastructure asset planning/management processes that may affect estuarine condition, e.g. stormwater and sewer systems (refer to Council's Climate Change Strategy). This may require assessment of capabilities of existing infrastructure and update of design approaches in respect of effects of changing climate, i.e. changes in rainfall volumes and intensity		B									NS	Council's Climate Change Risk Assessment Adaptation Report identifies risk areas and priorities for adaptation responses. The overarching risk for Council centred on the need to develop and implement strategies to modify or relocate essential Council infrastructure (e.g. sewerage treatment infrastructure). To this end, Council is completing a Coastal Hazard Study, appropriate flood studies and ensuring Asset Management Planning incorporates these issues. The CC Policy and strategy point this direction.
H10	Review and update DCP and guidelines in respect of urban development and agricultural use (and stormwater runoff) to provide greater protection to estuary assets and represent current best practice. DCP and guidelines must address construction (E&SC) and operational stages of development.		I									NS	DCP updated sufficiently in 2013 to address these issues.
H11	Confirm appropriate means to verify and regulate the design, maintenance of forestry tracks to limit potential for erosion and sediment input to estuary. This may include provision of information such as work by SRCMA (Len Gazzard) and design guidance as required.		I, Q									NS	The CROWN is regulated by NSW EPA and Council does not have a regulatory role.
H12	Review and update LEP land zoning recommendations in catchment of estuary for consistency with management of stormwater impacts.		I									NS	Updated 2013 LEP mapping provides improved outcomes and option is not required.
H13	Council review of recommended / approved systems for on-site sewerage systems on a five yearly basis to ensure highest quality systems and management approaches are applied to protect estuarine water quality according to identified risk category		J									NS	OSM approvals are regulated by NSW Health with input from Council as required.
H14	Council to connect rural residential residences up to the sewer network where cost / benefits are high, wrt potential impacts to estuary.		I, J									NS	Council's current priorities for connection of rural areas is stated in the Sewer Asset management Plan including North Bega, Mogareeka, Bemboka, Quaama.
H15	Address implications of recent changes by Government in relation to clearing for bushfire protection i.e. 10/50 rule - APZ, relationship to CZMP.		H									NS	Tree-clearing rules required by NSW law (statutory) and are subject to change. Tree protection measures in LEP and DCP applies in urban zoned lands.

Options Assessment

H16	Consider use of an independent auditor for the Effluent Reuse Scheme, i.e. outside of Council		G									NS	The NSW EPA now fulfil this role, additionally Council is establishing an internal environmental audit function within the Environmental Services Section. This will be an independent internal function to ensure a layer of scrutiny separate to the operational area and in addition to the NSW Environmental Regulator - NSW EPA
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Recreation and amenity

	Actions	No Regrets?	Addresses Threats	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
I1	Review with recreational fishers the need for any additional facilities to minimise impacts of fishing on estuary, e.g. for waste management, cleaning tables, etc		N, Q	Medium	2	3	3	3	3	3	17	16.8	
I2	Use RMS to relocate markers in lake/channels as required as entrance and lake conditions change to advise boaters and industry		O									NS	This is a function that occurs as required by NSW RMS
I3	Complete recreational fishing survey for Pambula Lake (e.g. as done for Tuross Lake recently). Survey may be able to integrate/consider commercial catch data from DPI Fisheries		N, M, Q									NS	Fishing surveys are difficult to complete on the basis of the very large volunteer effort required to collate data. Some funds required for data analysis and statistics. Also, the mobility of fish in estuaries makes determinations of trends difficult.
I4	Update of older equipment to environmentally and socially sensitive equipment over time, i.e. low noise and emission boat motors, i.e. VELS rating, noise ratings, regular maintenance and so on		F, N									NS	Covered under other actions
I5	Support development or creation of low-impact nature-based activity opportunities (and associated infrastructure) within the catchment and waterways of Pambula Lake that increase the participant's awareness of the high social and environmental values of the area, for example the 'Bundian Way Initiative' amongst others.		Q, R	High	3	2	3	3	3	3	17	16.8	

Plan Implementation

	Actions	No Regrets?	Addresses Threats	Threat Level	Threat Score	Risk Reduction Potential	Timeframe	Cost	Practicality	Community Support	Equal Weighted Score	Weighted Score	Notes
J1	Council to work with OEH (and other agencies) to develop secure funding pipeline for estuary initiatives		S									NS	A secure funding pipeline would be good and intent of option noted but not relevant to the plan. This objective should be within the narrative of the Plan however.
J2	Council to work/meet with relevant State agencies to ensure agency responsibilities are clearly translated during a restructure of State Govt as happens periodically		T									NS	This is a continuous and ongoing function for NSW EPA and also 3x P.A. at Council's Coastal Planning and Management Committee (a \$355 Committee of Council).

Appendix E Workshop Outcomes Preliminary Management Options – 16.12.2014

Strategy	No#	Actions	Priority	Comments
Assist in the management of aquatic weeds and pests	A1	Assist DPI F&A in the monitoring and management of potential outbreaks of <i>Caulerpa</i> (e.g. support for overall program in terms of signage and education) and ongoing control of pest species, as appropriate.	Low	Wording adjusted to include mention of the need for ongoing control of other pest species as appropriate. Priority appropriate
Minimise spread of terrestrial weeds	B1	Work with relevant agencies and the Far South Coast Coastal Weeds Project to control and manage weeds around the foreshore and in bushland areas surrounding the estuary.	High	Wording adjusting to include mention of the Far South Coast Coastal Weeds Project and the need to consider weed invasion in bushland adjoining the estuary. Priority appropriate.
Actively manage riparian vegetation extent and condition and improve bank stability	C1	Undertake bank restoration and rehabilitation works in priority areas as highlighted in the Estuary Processes Study (and Pambula Catchment Rehabilitation Plan). Council and SELLS to undertake works on public and private lands as funding and resources permit	Medium	Wording appropriate. Details of action to identify the need for proponents to obtain OEH/NPWS approval for foreshore works, particularly in respect of avoiding accidental damage to heritage items that may be present. Priority appropriate.
	C2	Council to identify priority privately owned land parcels for potential acquisition by Council, philanthropic parties, OEH and/or other related schemes such as the Coastal Lands Protection Scheme as a means of protecting and enhancing key estuarine values such as bank riparian condition, key habitat and/or improved public access use.	Low	Wording adjusted based on feedback from workshop. Priority appropriate.
	C3	Monitor riparian vegetation extent / coverage and bank erosion levels by completing a 10 yearly review of extent and condition.	Medium	Wording appropriate. Priority appropriate.
	C4	Rationalise pedestrian and/or vehicle tracks in public lands within the riparian zones and other areas of sensitive vegetation that impact on these estuarine values.	Medium	Wording adjusted to make reference to vehicle tracks. Priority appropriate.

Strategy	No#	Actions	Priority	Comments
	C5	Work with private land holders and other relevant bodies to continue fencing of riparian areas in priority areas and encourage appropriate revegetation as opportunities and funding arise.	High	Wording adjusted to identify application in priority areas. The action will identify that priority areas are those that coincide with priorities identified in the Pambula Catchment Rehabilitation Plan and Estuary Processes Study. Also action to identify need for appropriate fencing location (to avoid flood damage) and revegetation plant species to maximise rehabilitation outcomes and avoid attracting feral animals. Priority appropriate.
	C6	Ensure all new seawalls being built or old ones being upgraded are built in accordance with environmentally friendly seawall guidelines	Low	Wording appropriate. Priority appropriate.
Develop and implement a variety of educational capacity building initiatives to increase knowledge of protecting and improving estuary health	D1	Provide specific information on the importance of riparian land and bank management (and options for management) to new private landowners when land ownership changes occur in relevant areas of the estuary. Similarly, provide information and support to existing private land owners to encourage ongoing best practice riparian and bank management.	Medium	Wording adjusted to remove, <i>"Material should address identified barriers to implementation"</i> , as this will be incorporated in the details of the action. Workshop feedback identified that there is existing similar material available which should be adapted and made specific to the area and would link with No# C5. The use of field days is likely to be valuable. Priority appropriate.
	D2	Undertake education programs for Council staff (and possibly key local developers and contractors) involved in Erosion and Sediment Control (E&SC), and Soil and Water Management to increase awareness of the impact poor soil controls can have on estuarine and wider catchment health.	High	Wording adjusted to improve understanding. Priority appropriate. Workshop feedback identified need for Council management and staff to be supportive of the action and enforce where necessary.
	D3	In conjunction with DPI and LSS, work with local farmers within the catchment to minimise pollution from agricultural runoff through education programs and support for appropriate on-ground management works.	High	Wording appropriate. Priority increased to High. Workshop feedback identified lack of adequate riparian buffers to filter dairy/grazing runoff to the estuary, also there is a need to keep cattle out of the creeks. Water monitoring in the estuary may be used a measure of progress in achieving outcomes.

Strategy	No#	Actions	Priority	Comments
	D4	Continue to provide information and support to private landholders to manage and improve native vegetation on their properties through Council, other Agencies and the Far South Coast Conservation Management Network.	Medium	Wording adjusted to reflect Council's current support of the Far South Coast Conservation Management Network (CMN). The CMN provides support, knowledge and resources to assist in this regard. Priority appropriate. Workshop feedback identified that Council, OEH and SELLS have roles in this regard.
	D5	Continue existing and support new community engagement and education initiatives such as 'Love our lakes', and 'clean up days', that serve to increase awareness on estuarine condition and management issues. Support may include financial support, logistical support, expertise support (particularly in relation to information sharing on topics of interest), amongst other things.	High	Wording appropriate. Priority appropriate.
	D6	Support implementation and periodic review of the Pambula Lake Oyster Growers EMS.	High	Wording appropriate Priority Appropriate. Feedback from workshop identified the need for Council to be more closely involved in EMS review and active involvement in initiatives as appropriate (noting that the EMS is an oyster industry tool).
Protect and conserve Aboriginal cultural heritage sites around the foreshore	E1	Assist NPWS and Eden Local Aboriginal Land Council in the research and monitoring of Aboriginal cultural sites, and implementation of protection works as required.	High	Wording adjusted to include option for support of research to better define the values and management requirements of Aboriginal heritage sites. Reference to Eden LALC included. Priority appropriate.
	E2	Council to work with relevant agencies and Eden Local Aboriginal Land Council to support long term protection of middens through appropriate heritage protection	High	Wording adjusted to reference to Eden LALC. Priority appropriate.
Monitor and assess changes in entrance processes and dynamics	F1	Work with OEH to undertake future hydrosurveys and analysis of water levels in response to significant community concerns to changed entrance conditions	Medium	Wording appropriate. Priority appropriate.
Protect, rehabilitate and enhance estuarine vegetation including seagrass, saltmarsh and mangroves	G1	Incorporate adequate buffers around key wetland areas to ensure vegetation can migrate with SLR and provide additional protection. Establish suitable means for dedicating buffers to this landuse, e.g. lease, purchase or voluntary contribution, etc	Low	Wording appropriate. Priority appropriate. Feedback from workshop identified need for potentially flagging areas around Panboola in details of action.

Strategy	No#	Actions	Priority	Comments
	G2	Work with DPI F&A to complete mapping of the distribution / extent of mangrove, saltmarsh and seagrass using available information on a recurrent i.e. (5 to 10 year basis) or as required for other purposes.	Medium	Wording adjusted to allow greater flexibility in the timing of the surveys. Priority appropriate.
	G3	Utilise available information on heavy metal testing to understand and lessen impacts of activities within estuary.	Low	Wording appropriate. Priority appropriate.
Protect and enhance estuarine water quality	H1	Develop and implement a Stormwater Management Plan that quantifies loadings of stormwater pollutant discharges from agricultural and urban areas to the estuary. Utilise the Stormwater Management Plan as the basis for determining priority areas requiring stormwater quality mitigation.	Medium	Wording of action shortened with the following to become part of the action <i>"Stormwater Management Plan to identify cost and benefit of various control systems / approaches to reduce pollutant loadings. Priority for implementation should be identified. Works implemented as funds allow."</i> Priority appropriate.
	H2	Continue to support existing Council initiatives that aim to manage risks to estuarine water quality arising from sewer pump stations overflow, as well as the siting, regulation and management of on-site sewage systems.	High	Wording appropriate. Priority appropriate. Feedback from workshop indicated inclusion of OSSM systems in catchment via a map may be useful. Also possible feedback linkage between oyster water quality monitoring and overall estuarine water quality.
	H3	Undertake rapid catchment appraisal for Pambula Lake catchment based on SRCMA Roads and Track Survey Summary and Volume 2 of the NSW EPA Managing Urban Stormwater – Soils and Construction Guide (2008). This should include consideration of drainage structures, suitable road base materials, minimum grading requirements, design adequacy and compliance. The appraisal will assist in the establishment of road and track management priorities including those relating to permanent sealing.	High	Wording adjusted to include drainage and broadening the definition of the management outcomes that may arise from the rapid catchment appraisal. Including reference of an appropriate standard. Priority appropriate. Workshop feedback reiterated the need to ensure private tracks are included in the appraisal.
	H5	Implement ecosystem health monitoring that includes biotic indicators in addition to water quality. Report findings (make data available) regularly to community and stakeholders.	Medium	Wording appropriate. Priority appropriate. Workshop feedback is that the generation of periodic report cards for posting on Council's website may be useful

Strategy	No#	Actions	Priority	Comments
	H6	Regular inspections/compliance checking of boat work areas particularly regulating management of boat antifoulants and other chemicals in the environment (particularly stormwater runoff) that may contribute to water and metal contamination.	High	Wording adjusted to broaden to need for overall site management, as while chemicals may be the concern, the issue may stem from poor site management practices, such as stormwater control. Priority appropriate. Feedback from workshop indicated that some support may be required to assist some operators in this regard.
	H7	Review/audit the Oaklands Reuse Scheme to ensure that scheme operation and management meets all approval and regulatory requirements and that reviews are clear and publically available.	Medium	Wording adjusted to make the action clearer. Priority appropriate. Feedback from workshop identified the need to focus on compliance with the rules associated with scheme operation
	H8	Council to investigate, in partnership with RMS, suitable vessel waste disposal sites within the Shire (including the Pambula Lake estuary). Key considerations in site selection will include accessibility, likely demand, capital and operating costs (including options for cost recovery) and potential environmental benefits, particularly to surrounding water sensitive uses, such as swimming and oyster aquaculture	Medium	Option to be removed from present plan formulation. The option is relevant for the Shire, but less relevant for the Pambula Lake estuary with relatively low usage by boats of the size required to have on board storage of wastewater.
Improve recreational opportunities and amenity	I1	Review with recreational fishers the need for any additional facilities to minimise impacts of fishing on estuary, e.g. for waste management, cleaning tables, etc	Medium	Wording appropriate. Priority appropriate. Feedback from workshop noted the potential impact of shore based fishing activities on sections of the Yowaka River, and how this situation could be improved to lessen stream bank impacts.
	I5	Support development or creation of low-impact nature-based activity opportunities (and associated infrastructure) within the catchment and waterways of Pambula Lake that increases the participant's awareness of the high social and environmental values of the area, for example the 'Bundian Way Initiative' amongst others.	Medium	Wording appropriate. Priority appropriate.

Appendix F Legislative Requirements of the CZMP

F.1 Coastal Management Legislation

Coastal management in New South Wales is guided by the *NSW Coastal Protection Act 1979* (CP Act) and amendments, NSW Coastal Policy (NSW Government, 1997), State Environment Planning Policy No. 71 – Coastal Protection, *Local Government Act 1993* and *Environmental Planning and Assessment Act 1979*. Guidance for land use planning in the coastal zone is also given by the Coastal Design Guidelines for NSW (Coastal Council of NSW, 2003).

Current requirements for the preparation of Coastal Zone Management Plans are outlined in Part 4A of the *Coastal Protection Act 1979* and the supporting Guidelines for Preparing Coastal Zone Management Plans (DECCW, 2010a) (the CZMP Guidelines – refer Section F.2).

The objectives of the *Coastal Protection Act 1979* provide for the protection of the coastal environment of the State for the benefit of both present and future generations. Specific objects of the Act, along with details of how these objects have been addressed by the Pambula Lake CZMP, are presented in Table F-1.

Table F-1 Coastal Protection Act 1979 Objectives

Specific Objectives of the CP Act	Addressed by this CZMP
(a) to protect, enhance, maintain and restore the environment of the coastal region, its associated ecosystems, ecological processes and biological diversity, and its water quality	Environmental values have been considered and actions developed for restoration and rehabilitation of important habitats.
(b) to encourage, promote and secure the orderly and balanced utilisation and conservation of the coastal region and its natural and man-made resources, having regard to the principles of ecologically sustainable development	The CZMP balances natural and anthropogenic demands on the environment and resources. Sustainability and conservation of environmental, social and economic values is paramount in the development of actions and works.
(c) to recognise and foster the significant social and economic benefits to the State that result from a sustainable coastal environment, including: (i) benefits to the environment, (ii) benefits to urban communities, fisheries, industry and recreation, (iii) benefits to culture and heritage, (iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,	All relevant values have been considered as part of the risk assessment process, with consequences related to environmental, social and economic factors. Actions within the CZMP include protection of existing environmental values such as catchment condition and water quality, and restoration of important habitat areas as well as preservation of social and the areas unique European and Aboriginal cultural and heritage values.
(d) to promote public pedestrian access to the coastal region and recognise the public's right to access	Actions within the CZMP promote the creation of additional public access and use of the coastal region and recognises the public's right to access these lands.
(e) to provide for the acquisition of land in the coastal region to promote the protection, enhancement, maintenance and restoration of the environment of the coastal region	Actions within the CZMP provide for the potential acquisition of key parcels of land within the coastal zone, and long term protection of key habitats that may migrate

Legislative Requirements of the CZMP

Specific Objectives of the CP Act	Addressed by this CZMP
	under climate change.
(f) to recognise the role of the community, as a partner with government, in resolving issues relating to the protection of the coastal environment	Community engagement is to be undertaken as part of the integrated CZMP process and their continued engagement is a focus of many of the action of the CZMP.
(g) to ensure co-ordination of the policies and activities of the Government and public authorities relating to the coastal region and to facilitate the proper integration of their management activities	The CZMP reflects and supports many of the existing programs being implemented by local and State government in the region as their continued implementation will assist in the long term protection of identified social, environmental and commercial values of the estuary by addressing key threats to condition.
(h) to encourage and promote plans and strategies for adaptation in response to coastal climate change impacts, including projected sea level rise	Council's current position with respect to sea level rise resulting from climate variability has been considered and relevant actions included within the CZMP to reflect estuary specific requirements.
(i) to promote beach amenity	The study area does not include open coastal beaches. Amenity of beaches within the bounds of the estuary is preserved under the CZMP.

Section 55C of the Coastal Protection Act 1979 lists the specific matters to be dealt with in coastal zone management plans. These matters are outlined in Table F-2, along with a description of how they have been satisfied by the Pambula Lake Coastal Zone Management Plan.

Table F-2 Coastal Protection Act 1979 Section 55C matter to be dealt with in CZMPs

Specific matters to be dealt with in CZMPs	Addressed by this CZMP
a. protecting and preserving beach environments and beach amenity,	Open ocean beaches are not a part of this CZMP.
b. 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,	NA
c. ensuring continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion,	Accretionary affects were not specifically assessed within the estuary. In respect of access, much of the foreshore of the estuary remains in public ownership (as Ben Boyd National Park), with much of the remainder residing in private ownership. Actions within the CZMP promote the creation of additional public accesses (i.e. iconic walks and cultural heritage tourism opportunities) through the National Park Lands. Other options leave the option open for purchase of lands that may be used to improve access to the foreshore.

Legislative Requirements of the CZMP

Specific matters to be dealt with in CZMPs	Addressed by this CZMP
d. where the plan relates to a part of the coastline, the management of risks arising from coastal hazards,	NA
e. where the plan relates to an estuary, the management of estuary health and any risks to the estuary arising from coastal hazards,	Coastal hazards may result in changes in entrance form and function. Actions are included in the Plan to observe entrance function, and other general indicators of estuarine condition (health) which may be expected to change if adverse entrance changes are observed (e.g. significant restriction impacting on boating and oceanic exchange).
f. the impacts from climate change on risks arising from coastal hazards and on estuary health, as appropriate,	As noted above.
g. where the plan proposes the construction of coastal protection works (other than temporary coastal protection works) that are to be funded by the council or a private landowner or both, the proposed arrangements for the adequate maintenance of the works and for managing associated impacts of such works (such as changed or increased beach erosion elsewhere or a restriction of public access to beaches or headlands).	NA

F.2 CZMP Guidelines

The CZMP Guidelines replace the former Coastline Management Manual and the Estuary Management Manual, and have been notified in the gazette as a manual suitable for management of the coastline under Section 733(5) of the *Local Government Act 1993*. Councils are afforded exemption of liability under Section 733 of the Act if works and activities are undertaken in accordance with any coastal zone management plan that has been prepared following the CZMP guidelines.

The CZMP guidelines require that coastal zone management plans should:

- Support the goals and objectives of the NSW Coastal Policy 1997;
- Address the principles for coastal management, as outlined in the guidelines; and
- Satisfy the minimum requirement for coastal zone management plans, as outlined in the guidelines.

The CZMP guidelines also require coastal zone management plans to meet the NSW Government's Sea Level Rise Policy Statement, however, this Policy Statement was repealed subsequent to the publishing of the guidelines. Notwithstanding, the *Coastal Protection Act 1979* and the Coastal Policy 1997 still require consideration of climate change, including sea level rise. Bega Valley Shire Council recognises the risk of sea level rise in its Climate Change Policy and Strategy, this Coastal Zone Management Plan takes into account Council's acceptance of likely future sea level rises.

Legislative Requirements of the CZMP**F.2.1 Meeting the NSW Coastal Policy goals and objectives**

This Pambula Lake CZMP meets the goals of the NSW Coastal Policy as outlined in Table F-3.

Table F-3 NSW Coastal Policy goals and relevance to this CZMP

Coastal Policy Goals	Addressed by this CZMP
To protect, rehabilitate and improve the natural environment	Environmental values are to be protected and important areas rehabilitated through proposed actions of the CZMP
To recognise and accommodate natural processes and climate change	The CZMP identify (where possible) natural estuarine processes and how these may be modified by sea level rise over time. Actions within the plan take into account the likely environmental changes of sea level and the timeframes at which these may occur. The priority of the actions reflects the risk of the threat.
To protect and enhance the aesthetic qualities	The aesthetic values of the Pambula Lake estuary are preserved and potentially enhanced by actions of the plan which seek to improve riparian and bank condition. Additionally the plan supports actions which result of the appropriate management of oyster leases and associated activities such as clean up days focused on the lake.
To protect and conserve cultural heritage	Cultural heritage is recognised through the environmental and social values that were identified for the estuary, these have translated into a number of actions which seek to protect and enhance cultural heritage values and the potential for cultural heritage tourism.
To promote Ecologically Sustainable Development (ESD)	The four principles of ESD have been considered in development of the CZMP. ESD is promoted through the preservation of existing environmental and social values and taking a longer-term sustainable focus for strategic planning.
To provide for ecologically sustainable human settlement	The pressures associated with human settlement in terms of catchment disturbance (loss of forests, hydrologic and water quality changes) etc are identified in the plan. The current pressures have resulted in some reductions in environmental values, and the need to observe potential future changes is reflected in actions to establish long term estuarine health monitoring programs.
To provide for appropriate public access and use	Public access and use of facilities along public foreshore lands are to be maintained and protected. Actions of the plan include discussions with key user groups to determine if access and facilities require modification or upgrade.
To provide information to enable effective management	CZMP includes monitoring of estuarine conditions to ascertain trends in condition over time. Given the timeframes of this monitoring and trend analysis, it is expected that this information will be vital in informing future iterations of this CZMP.
To provide for integrated planning and management	CZMP includes actions that relate to Council's and other agencies role in planning and management and seeks to ensure these are sufficient to protect estuarine values from identified threats.

Legislative Requirements of the CZMP

F.2.2 Addressing the coastal management principles

This Pambula Lake Coastal Zone Management Plan addresses the coastal management principles, as espoused in the CZMP guidelines, as outlined in Table F-4.

Table F-4 Coastal Management Principles Addressed by the Pambula Lake CZMP

Principle No#	Coastal Management Principles (DECCW, 2010)	Addressed by Pambula Lake CZMP	Report Section
1	Consider the objectives of the <i>Coastal Protection Act 1979</i> and the goals, objectives and principles of the NSW Coastal Policy 1997 and the <i>NSW Sea Level Rise Policy Statement (2009)</i> [#]	The preparation of this CZMP has followed the <i>Guidelines for Preparing Coastal Zone Management Plans</i> that is the manual for implementation of the objectives of the Act for CZMPs. In determining the intent for management of the lake, the NSW Coastal Policy has been considered.	See Table F-1, F-2 and F-3
2	Optimise links between plans relating to the management of the coastal zone	By using a risk-based approach, existing controls within existing plans are reviewed and incorporated into the analysis of risk, and also used as starting point for developing risk treatments (i.e. management options).	Section 1.4 and 1.6
3	Involve the community in decision-making and make coastal information publicly available.	Comprehensive community consultation has been undertaken throughout the development of this plan.	Section 1.5
4	Base decisions on the best available information and reasonable practice; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach.	An investigation of the scientific aspects of the lake was conducted. This was combined with community consultation and further investigations to identify the community values and human pressures upon the lake. The environmental and community values and threats to the lake are based upon these studies and information. The management intent has been based upon estuary values and the threat assessment has utilised this information. Both the degree of threat and values for the lake was used as the basis for preparing management actions.	Sections 2, 3, 4 and 5
5	The priority for public expenditure is public benefit; public expenditure should cost effectively achieve the best practical long-term outcomes	Cost benefit analysis for management options has recognised the public benefit as priority for management options	Section 7
6	Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risk where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions	This plan has been prepared using the ISO 31000:2009 International Standard Risk Management Principles and Guidelines. The risk based approach is an internationally recognised framework for management because it incorporates the best available information and its	Section 6

Legislative Requirements of the CZMP

Principle No#	Coastal Management Principles (DECCW, 2010)	Addressed by Pambula Lake CZMP	Report Section
	to manage high risks while long-term options are implemented	uncertainty. The adopted Risk Management Framework intrinsically requires ongoing monitoring of risks and review and tailoring of risk treatments (management options).	
7	Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions	The Risk Management approach is an internationally accepted standard that intrinsically incorporates both the known and possible frequency and consequence of a threat, thereby incorporating the uncertainty in the occurrence of risks / threats. The CZMP will include an ongoing monitoring and evaluation component, linked to an estuary health monitoring program.	Sections 6 and 7
8	Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems	Ability of a management option to provide environmental protection or benefit has formed part of cost benefit analysis of options. Ecological values have been linked to future management intent to allow high value ecosystems to be prioritised for improvement while the objective for other areas is to maintain values at their current level.	Section 3.4, Sections 6 and 7
9	Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy	The open coast and rocky headlands are not included in the study area. Public access to lake areas has been included.	NA to study area
10	Support recreational activities consistent with the goals of the NSW Coastal Policy	Recreational usage is an important component in determining the values of the lake. The management intent for the lake has considered the recreational values to a level that is appropriate with the community and environmental uses of the lake. This has facilitated the management of recreation activities in a manner that is consistent with the values of the lake in accordance with the NSW Coastal Policy.	Section 2.6, Section 6 and 7

Note that the NSW Government on 8 September 2012 repealed its Sea Level Rise Policy. However, for this study, Bega Valley Council Shire recognises the risk of sea level risk in its Climate Change Policy and Strategy.

F.2.3 Satisfying the minimum requirements for plan preparation

The minimum requirements for preparation of coastal zone management plans have been satisfied by this Pambula Lake Coastal Zone Management Plan as outlined in Table F-5.

Table F-5 CZMP minimum requirements

Minimum Requirement	Addressed by this CZMP
A description of how the relevant Coastal Management Principles have been considered in preparing the plan	Refer Table F-4 of this document
A description of the community and stakeholder consultation process, the key issues raised and how they have been considered	Refer to Section 1.5, Section 6.1 and Section 7.2.2. The process has involved understanding uses and values (via questionnaire and workshops/open days, verbal and written dialogue with stage agencies and other stakeholders). Integration of identified threats and values in a risk assessment workshop. Use of material to derive initial list of management options which have been presented and discussed with the Council, PEGC and other stakeholders.
A description of how the proposed management options were identified, the process followed to evaluate management options, and the outcomes of the process	See Section 5, 6 and 7
Proposed management actions over the CZMP's implementation period in a prioritised implementation schedule which contains: <ul style="list-style-type: none"> proposed funding arrangements for all actions, including any private sector funding actions to be implemented through other statutory plans and processes actions to be carried out by a public authority or relating to land or other assets it owns or manages, where the authority has agreed to these actions (section 55C(2) (b) of the Coastal Protection Act 1979) proposed actions to monitor and report to the community on the plan's implementation, and a review timetable 	See Section 8
Plan to be prepared using a process that includes: <ul style="list-style-type: none"> evaluating potential management options by considering social, economic and environmental factors, to identify realistic and affordable actions consulting with the local community and other relevant stakeholders. The minimum consultation requirement is to publicly exhibit a draft plan for not less than 21 days, with notice of the exhibition arrangements included in a local newspaper (section 55E of the Coastal Protection Act 1979) considering all submissions made during the consultation period. The draft plan may be amended as a result of these submissions (section 55F of the Coastal Protection Act 	Evaluation of management options is outlined in Section 7 (builds off of material in Sections 2 to 6). Consultation is outlined in Section 1.5.

Minimum Requirement	Addressed by this CZMP
1979).	
CZMPs are to achieve a reasonable balance between any potentially conflicting uses of the coastal zone	The CZMP has sought to protect key environmental, social and commercial interests associated with the Lake.

Appendix G Example Brochures – Action D1



**Department of
Primary Industries**



Living & working on a riverbank

IF YOU LIVE OR WORK ON A RIVERBANK,
YOU PLAY AN IMPORTANT ROLE IN THE
HEALTH OF OUR RIVERS AND ESTUARIES!



If you own or manage livestock, or are planning on undertaking works along the riverbank, here is some information to help you comply with the law.

Why are rivers and their banks so important?

Rivers are vital habitat for a range of species including fish, shellfish, frogs, platypus and water birds. They are also an important part of our way of life, providing water for livestock and domestic use, and supporting industries such as tourism, recreational and commercial fishing and oyster production. Rivers are under pressure from further development, increasing demand for water use, and inappropriate land management practices resulting in loss of habitat, sedimentation, erosion and other water pollution issues.

Everyone has a role to play in ensuring our rivers and estuaries continue to be healthy and productive for future generations. Here are some useful tips to help you to look after your river and to comply with current laws aimed at protecting our waterways.

Managing your riverbank – the right way

Riverbank vegetation

Native riverbank or riparian vegetation provides many benefits to fish and other species as it helps to stabilise the riverbank, reducing bank erosion and siltation; provides food for aquatic insects and fish; and helps to shade the waterway which in turn regulates water temperature. Riverbank vegetation also acts as a filter by removing pollutants such as soil, pesticides and fertilisers from overland runoff, helping to maintain good water quality.

Some useful things you can do to protect riverbank vegetation include:

- Reducing livestock access to riverbank vegetation by providing alternative paddock shade trees and watering points away from the river and introducing rotational grazing regimes.
- Protecting existing riverbank vegetation by managing livestock and vehicular access into these sensitive areas.
- Planting native trees and shrubs along the riverbank where they have been removed or damaged.
- Implementing weed control measures in consultation with your local council or Landcare group.

Your local Catchment Management Authority can also assist with advice on riverbank vegetation management and availability of funding to undertake works on your property that help to protect and restore native vegetation.

Snags

A "snag" refers to large woody debris from trees or shrubs, including whole fallen trees, large broken branches and exposed root balls that have fallen or washed into the river. Snags are very important as they provide habitat and breeding areas for fish and other species as well as helping to create different habitats within the river, such as refuge holes, and assisting in the stabilisation of the bed and banks.

Some useful things you can do to protect snags include:

- Retaining snags within the waterway.
- Seeking approval from Fisheries NSW before considering any works to remove or relocate snags.
- Advising Fisheries NSW if you observe other people removing snags from the waterway.





Photo captions:

1. Riverbank vegetation on left bank has re-established after stock exclusion.
2. No stock (left) v stock access (right) in marine vegetation. **3.** Large woody debris (snags). **4.** Vehicle damage to saltmarsh. **5.** A degraded riverbank with no vegetation. **6.** Excavator on riverbank doing bank stabilisation works. **7.** Unauthorised bank stabilisation.

Example Brochures – Action D1

Marine vegetation

Marine vegetation includes saltmarsh, mangroves and seagrass. Saltmarsh includes a wide variety of small herb like plants that can tolerate high levels of soil salinity and occasional tidal flooding. Mangroves are trees that grow in tidal waters and are the nursery areas for many commercially and recreationally important fish species. Seagrasses are flowering plants that live and reproduce entirely within seawater. They grow primarily in estuaries and sheltered embayments. All play an important role in providing habitat for a range of estuarine fish species and help stabilise the bed and riverbanks from flood and storm damage. They also act as a filter or trap for pollutants from overland flows or stormwater runoff.

Some useful things you can do to protect marine vegetation include:

- Protecting saltmarsh and mangroves by removing livestock, vehicle and human access through these sensitive areas.
- Seeking approval from your local Council or Fisheries NSW before undertaking any works or activities that could harm marine vegetation.
- Notifying Fisheries NSW if you believe someone is trying to harm marine vegetation. If your information leads to a conviction then you may be eligible for a reward of up to \$1,000.

Livestock management

Livestock grazing on the foreshore can contribute to bank erosion and loss of valuable paddock soils to the river. Livestock manure can also impact on downstream water quality and the health of others using the waterway for recreational (swimming) and commercial use (e.g. oyster production).

Recent amendments to the *Fisheries Management (General) Regulation 2010* now make it illegal for livestock of any type to graze and trample marine vegetation (including saltmarsh and mangroves) on public water land (e.g. Crown land or Council land). A maximum penalty of \$110,000 for an individual or \$220,000 for a Corporation applies.

Some useful things you can do to manage your livestock

- Install fencing to control livestock and reduce damage from grazing or trampling riverbanks and saltmarsh and mangrove areas.
- Provide paddock shade trees and livestock watering points away from the river to reduce the need for livestock to access the riverbank.
- Talk to your local Catchment Management Authority as they may be able to provide advice on funding opportunities to help you undertake fencing or native vegetation replanting to protect your riverbank.

Undertaking works on or near the riverbank

Works on or near riverbanks can have unforeseen consequences such as destabilising the bank, blocking the movement of fish, or damaging aquatic habitats. As waterways are fragile environments, both State and local governments have an interest in ensuring that any works undertaken in or around waterways are done appropriately.

EXAMPLES OF SUCH WORKS INCLUDE:

- bank stabilisation works,
- constructing jetties, pontoons, boat ramps and other waterfront infrastructure,
- constructing, repairing or modifying waterway crossings (e.g. fords, causeways, culverts, bridges),
- modifying or repairing existing, or building new weirs, floodgates or levee banks,
- removing or relocating large woody debris (snags), gravel beds, rocks or aquatic vegetation,
- harming or shading marine vegetation (including saltmarsh, mangroves, seagrass or seaweeds),
- dredging activities for navigation or for extraction of sand, gravel or other materials for private or commercial use, and,
- undertaking reclamation works by placing any sort of fill material on the bed or banks of a waterway or areas which are inundated by the highest tides.

By obtaining the required approvals, these sorts of works can be adequately assessed before they are undertaken to ensure that the river's values are protected and the works are undertaken in an environmentally sensitive manner.

The need to obtain approvals generally applies regardless of the ownership of the land. Privately owned land is not exempt.



HOW CAN I DO THE RIGHT THING?

It is your responsibility to determine what approvals are required and obtain permission from the relevant authorities for any proposed works before any riverbank work commences. The best way to do this is to talk to your local Council first before you undertake any works or contact the other State agencies listed below. These works are often assessed as 'integrated development' by your local Council and require approval from other State agencies before Council can approve the works. These agencies include:

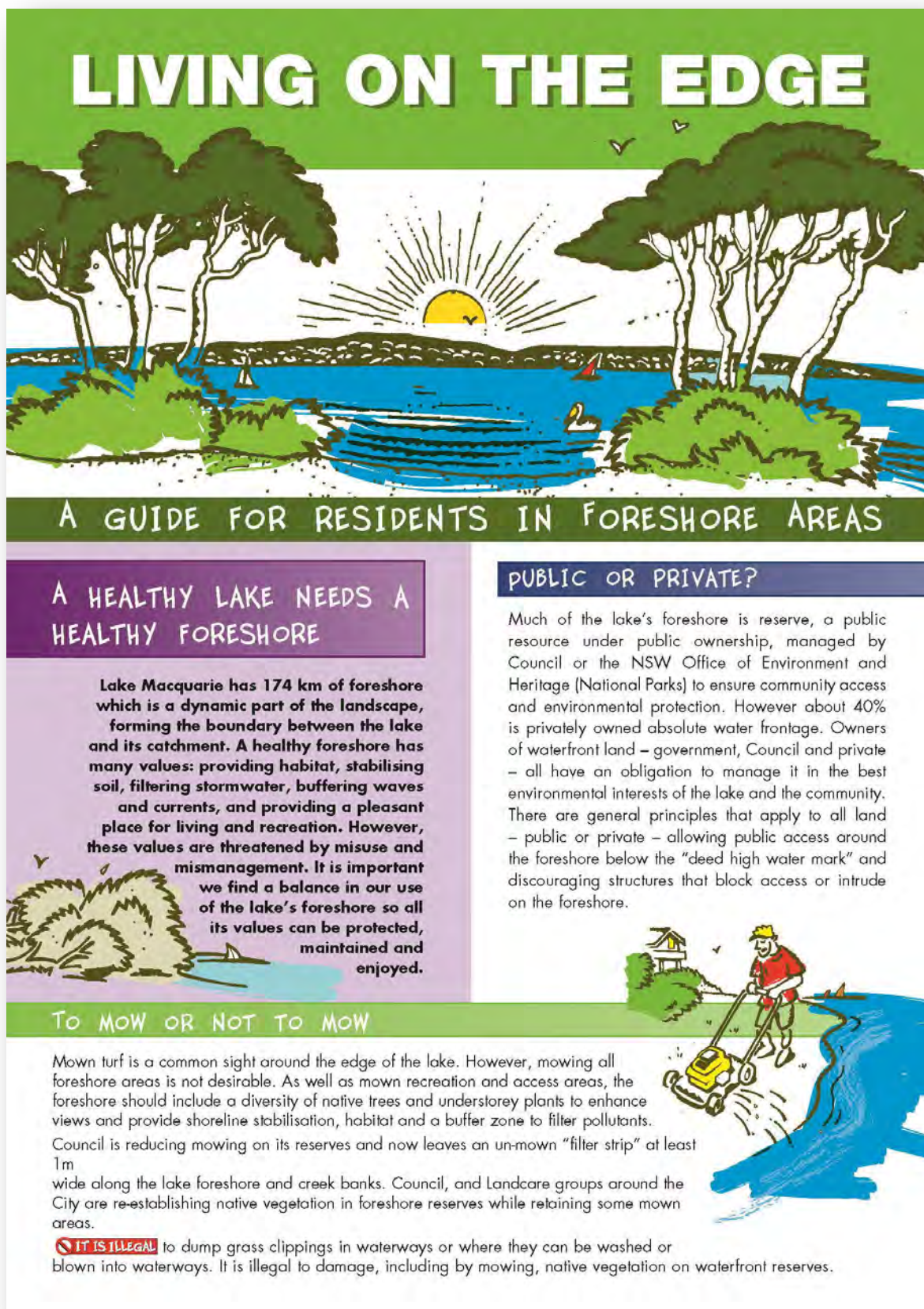
- **Department of Primary Industries 1300 550 474**
(Fisheries NSW, Crown Land Division and NSW Office of Water)
for Fisheries NSW in the first instance – for those works listed above
- **NSW Roads and Maritime Services 13 12 56**
if the works are associated with boating activities or may affect navigation
- **Your regional Catchment Management Authority (CMA)**
www.cma.nsw.gov.au
for contact details for your nearest CMA region

WHAT CAN HAPPEN IF I DON'T DO THE RIGHT THING?

Penalties of up to \$110,000 for individuals or \$220,000 for corporations can apply if works are undertaken without the necessary approvals. The above State agencies can also issue remediation orders to individuals or corporations to remediate a site where damage has occurred at their cost.



Department of
Primary Industries



Example Brochures – Action D1

COMMUNITY LAND – ARE YOU A GOOD NEIGHBOUR?

Many foreshore reserves lie between residences and the lake. Extending your 'backyard' into the reserve can impact on the sensitive foreshore environment as well as the amenity of the reserve. All members of the public have a right to access and enjoy all areas of the reserve. Please treat foreshore reserves as you would other neighbouring properties.

The following activities are not environmentally friendly or neighbourly practices:

- Planting non-native garden plants on reserves – they can become weeds and spread into natural bushland. They also change the natural character which gives Lake Macquarie its identity
- Dumping grass clippings, tree prunings or other garden waste on reserves, which can also be a source of weeds
- Building fences, barbecues, sheds and other structures and storing privately owned items and materials on reserves

Council encourages residents to help maintain and protect reserves by removing weeds and rubbish and regenerating native bushland, but advice and permission is required before you carry out any activities (see "Further Information").

The storage of privately owned items on reserves can expose their owner to legal liability should an accident or injury occur as a result of their presence.

IT IS ILLEGAL to restrict access to foreshore reserves by structures such as fences or walls, or by landscape barriers such as garden beds and hedges. Items and equipment illegally stored on reserves can be ordered by Council to be removed. Structures on private waterfront land are generally not allowed in the "Lakefront Development Area" which is typically 6 metres landward from high water.

SCOOPING THE POOP

You can take dogs onto Council reserves provided they are on a leash. There are also nearly 30 "leash free" areas, and these are clearly signposted. You cannot take your dog within 10 metres of a play area or picnic area, or into any Nature Reserves, Conservation Areas (such as Pulbah Island or Wangi Point) or National Parks. And don't forget to scoop your dog's poop!

IT IS ILLEGAL to allow your dog into protected reserves such as State Conservation Areas, or to allow them off-leash except in a designated "off-leash" area. It is illegal to allow your dog to foul waterways and public areas.

FORESHORE RESERVES – A VEHICLE-FREE ZONE

Vehicles are frequently driven on foreshore reserves to gain access to private properties or to the lake's edge. Vehicle tracks can damage or kill vegetation, compact the soil and cause erosion. There are numerous public boat ramps around the lake that provide convenient access for trailer-launched boats.

IT IS ILLEGAL to drive a vehicle on a Council reserve contrary to signs, and to cause damage by driving a vehicle on a reserve. Temporary access licences are available during building activities.

THE GREAT WALL

Many residents with absolute water frontage seek to protect their land against erosion by constructing seawalls. Seawalls are not the best option for protecting the shoreline for several reasons:

- They interrupt natural wave and tidal movement. This prevents seagrass from washing onto the shore and drying out. Instead, it accumulates and decomposes in the water, creating water quality and odour problems including the familiar "black ooze" (caused by rotted organic material). As a result, aquatic animal life is also reduced
- They result in the transfer of wave energy along the shoreline and beyond the wall, increasing erosion on neighbouring properties
- They prevent access to the foreshore by aquatic wildlife and can damage seagrass, as accumulated floating wrack (dead seagrass) causes shading of the underlying seagrass

Council and some landowners are now adopting a more natural approach to foreshore protection, using 'soft engineering' techniques of gently sloping foreshore profiles, native vegetation and natural materials. This absorbs wave energy, allows for the natural process of seagrass build-up and is more sympathetic to wildlife.

IT IS ILLEGAL to construct a seawall or modify the lake shoreline by filling or dredging without permits and approvals.

MANGROVES + SALTMARSH

Some foreshore areas support mangroves and saltmarsh. They are among the most important fish and prawn breeding and feeding habitats. Saltmarsh is now recognised as an "endangered ecological community" as so much of it has been lost to filling, draining, mowing and weeds – an estimated 25% in Lake Macquarie in the last 50 years. You can protect saltmarsh on your land by preserving gently sloping foreshores and by leaving an un-mown strip below the spring-high water level.

IT IS ILLEGAL to remove or damage mangroves in any waterway without a permit. Saltmarsh cannot be removed or damaged unless the action is part of an approved development.



Example Brochures – Action D1

BOAT LAUNCHING + STORAGE

There are around 1,500 dinghies left on the foreshore around Lake Macquarie, many either abandoned or rarely used. These can damage foreshore vegetation and restrict access to the foreshore. Do you launch your boat from foreshore areas that are not designated boat ramps? This can result in damage to the foreshore and to native plants.

Council recognises the need to provide and manage dinghy storage on the foreshore and is trialing a system of racks and designated launch areas at Valentine, Marks Point and Belmont. In the meantime:

- Store your boat on your own property
- Ensure your boat isn't blocking access to or along the foreshore
- Don't damage trees or native vegetation with chains or by shading
- Launch your boat at authorised boat ramps if possible and, if not, carry it into the water, don't drag it

IT IS ILLEGAL to cause damage or restrict access to the foreshore - which may occur as a result of boat launching and storage.

JETTIES, MOORINGS, SLIPS + RAMPS

There are over 2,000 moorings, 1,000 jetties and 300 ramps or slipways authorised for use in Lake Macquarie, as well as many unauthorised facilities. They can limit public access along the foreshore and damage seagrass, mangroves and other foreshore vegetation, so the numbers and location are managed to provide adequate structures while protecting the environment. Unauthorised facilities can be removed when they are identified, and all new facilities require permits and Council approval. Proper design and maintenance can greatly reduce their environmental impact.

IT IS ILLEGAL to construct new jetties, moorings, slips or ramps without the necessary approvals and permits. It is illegal to retain existing facilities if they have not been approved.

WANTED - DEAD AND ALIVE

Seagrass (both living and dead) is an important part of the lake foreshore. Land reclamation or 'beach' construction involving sand or other material can smother seagrass. In areas where seagrass is lost, fish also disappear, as they need seagrass beds to survive. Dead seagrass (wrack) that builds up along the foreshore beach provides important habitat for many animals and protects the shoreline from erosion. This build-up of wrack is a natural process. Council sometimes removes excess wrack in highly used foreshore reserve areas but allows it to remain elsewhere.

IT IS ILLEGAL to damage or remove live seagrass without a permit. A permit is required for the collection of more than 20 kg per day of dead seagrass.

LAKE MACQUARIE CITY COUNCIL AND LANDCARE, IN PARTNERSHIP WITH THE FEDERAL AND STATE GOVERNMENT, ARE WORKING TOWARDS A HEALTHY AND ATTRACTIVE LAKE FORESHORE, BUT ACHIEVING THIS RELIES ON YOUR COOPERATION.

LESS IMPACT



1. Natural sloping shoreline - allows dead sea grass to wash out, improving water quality
2. Small shared jetty with open mesh deck - low impact on "ribbon of life"
3. Stepping stones for footpath - less chance of water runoff and erosion
4. Trimmed trees and adjustable awnings - natural air conditioning with view maintained
5. Work less - relax more
6. Kitchen compost - improves your soil's quality
7. Low maintenance native plants for stabilisation and filtration - provides shoreline buffer
8. Building - set back from shore and in character with setting
9. Well maintained motor - electric or modern 4-stroke outboard, operated with low wake near shore

GREATER IMPACT



1. Bare shoreline - subject to erosion
2. Solid deck on jetty - affects sealife habitat
3. Fertiliser spills and chemical runoff from lawn damages water quality
4. Paved driveways - pollution-laden runoff flows to water
5. No shade trees - overworked air conditioner adds to your electric bill
6. Removal of natural vegetation - more work for you and more runoff
7. Ornamental shrubs - require chemicals and extra work
8. Poor fuel management - spills are deadly
9. Hardened seawall shoreline - eliminates "natural filter", degrades water quality and causes erosion elsewhere

Example Brochures – Action D1

DISAPPEARING TREES

Is your view really worth it? Damaging or removing native foreshore vegetation can result in the loss of a lot more than trees (not to mention the fines you could incur). Native vegetation stabilises the shoreline, provides a valuable habitat for wildlife, provides shade, acts as a windbreak, is effective in reducing glare from the water, and enhances overall views of the lake. The lake has already lost over 75% of its natural foreshore vegetation, so please help to conserve what's left.

IT IS ILLEGAL to remove any native vegetation without Council consent.

LET'S KEEP IT CLEAN

Foreshore reserves are popular areas for fishing, walking and picnicking. These activities are encouraged, however people sometimes leave bait bags, fishing tackle and other litter behind. Discarded tackle and fishing line can entangle wildlife and plastic bait bags can end up in the lake and cause death to animals such as dolphins and turtles who mistake plastic bags for jellyfish or squid.

The relative isolation of some foreshore reserves can encourage the dumping of household and industrial rubbish. Apart from being unsightly, such rubbish may destroy vegetation, encourage vermin, pose a safety risk (from broken glass, for example) or cause pollution.

IT IS ILLEGAL to litter or dump rubbish within a foreshore reserve, or anywhere else for that matter. A NSW recreational fishing licence is generally required to fish in fresh and salt water in NSW unless you are under 18.

To report damaging and ILLEGAL activities on foreshore reserves ring the Council Rangers on 4921 0333.

FURTHER INFORMATION

Lake Macquarie Streambank & Foreshore Planting Guide is available free from Council. It can also be downloaded from Council's website. The booklet provides guidelines for assessment & rehabilitation of lake foreshore and streambank areas and a list of suitable plant species with information on where and how to plant them.

Lake Macquarie Coastal Planting Guide is a valuable reference for individuals, Landcare, community, and environmental groups. It enables them to identify plant species indigenous to the Lake Macquarie coastal area, and sets out practical rehabilitation and planting hints. The guide is available

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SOME THINGS YOU CAN DO TO BE A FORESHORE FRIEND

- Leave at least a 1 metre buffer along the edge of the foreshore and waterways when mowing
- Plant local native species in your waterfront buffer and garden and avoid plants that can "escape" into bushland
- Restore a natural slope to your water frontage and ensure access around the foreshore
- Help protect and rehabilitate foreshore bushland by getting involved in Landcare
- Leave dead and fallen trees to provide wildlife habitat
- Compost your grass clippings and garden waste and keep it away from foreshore reserves
- Store all privately owned equipment and materials within your property boundary
- Launch boats only from properly constructed and authorised boat ramps and store boats within your property
- Leave dead seagrass along the foreshore beach to reduce erosion and provide habitat
- Keep vehicles off foreshore reserves to avoid environmental damage
- Remove unauthorised structures, and ensure authorised structures are designed and maintained to reduce environmental impacts



free from Council or can be downloaded from Council's website.

To obtain a copy of the guides, more copies of this brochure, or for further information on **how you can help to protect our foreshore** contact

Lake Macquarie City Council

4921 0333

or visit www.lakemac.com.au



To become involved in Landcare and for advice on native plants and vegetation contact Lake Macquarie

Landcare Resource Centre **4921 0392**

or visit lakemacquiarielandcare.org





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