



Shellharbour City Council

Business Paper

23 July 2019

Attachment 1 to Item 11.3.5
Draft Lake Illawarra Coastal Management
Program

**Draft Lake Illawarra Coastal
Management Program – Draft Report**

Lake Illawarra Coastal Management Program

Draft Report

June 2019





Clarity from complexity

Lake Illawarra Coastal Management Program (2019-2029)

Prepared for: Wollongong City Council and Shellharbour City Council

Prepared by: BMT Eastern Australia Pty Ltd

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Document Control Sheet

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<p>Synopsis: This Coastal Management Program outlines implementation details for recommended actions for managing Lake Illawarra over current and future timeframes.</p>		

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Acknowledgement to Country

Wollongong City and Shellharbour City Councils would like to show their respect and acknowledge the traditional owners of the Land, of Elders past and present, and extend that respect to other Aboriginal and Torres Strait Islander people.

Acknowledgement

The preparation of this CMP was overseen by a project management team consisting of Kristy Blackburn (WCC & SCC) Philomena Gangaiya (WCC), Tuesday Heather (SCC) and Danny Wiecek (OEH).

Glossary of Terms

Glossary of Terms

Bacteriological	The science and study of bacteria (single-celled microorganisms which can live as independent organisms or, dependently, as parasites).
Biodiversity	The variety of wildlife (both plants and animals) and habitats.
Brackish water	Water with higher salinity than fresh water and lower than seawater.
Breakwater(s)	A man-made structure built offshore to protect coastal areas such as harbours, anchorage etc. from offshore waves.
Climate change	The long-term change (decades or longer) in pattern of weather, and related changes in oceans, sea level, land surfaces and ice sheets.
Contaminant	Substances or groups of substances that are toxic, likely to bio-accumulate and/or give cause for concern.
Dredging	An underwater excavation activity intended to remove sediments and debris. Often used to keep navigable pathways within waterways.
Ebb tide delta	Deposit of marine sediment (usually sand) at the seaward outlet of a tidal creek by ebbing (outgoing) tidal currents.
Ecosystem	A community of living organisms and the surrounding nonliving environment interacting as a system.
Entrance management	Includes artificial opening of entrances, managing the configuration, height or location of the beach to enable entrance opening at a level lower than the natural range.
Entrance training	Deployment of man-made structures designed to constrain river discharges to a desired location.
Erosion	The removal of land by natural forces such as waves, tidal currents and / or littoral currents.
Estuarine macrophytes	Vegetation that can grow emergent, submerged or floating within the water of estuarine environments e.g. saltmarsh, mangroves and seagrass.
Estuary	The section of a river affected by tidal activity where fresh water from the river mixes with salt water from the ocean.
Flood tide delta	Deposit of marine sediment (usually sand) within a coastal embayment that has formed at the landward side of a tidal inlet by rising (or flood) tidal currents.
Foreshore	The section of the shore between the low and high tidal limits.
Geomorphology	A branch of physical geography encompassing the formation of the earth's surface, distribution of land, water etc.
Groundwater	Water that is located beneath the earth's surface accumulated from rain, rivers and marine water that penetrates the ground through soils and rocks where it is then stored.
Inundation (estuarine)	Rising waters caused by a combination of catchment flood waters (from rainfall) and oceanic waters (from tides and high sea levels that occur during storms).
Littoral current	A current flowing parallel to and near the shore, usually generated by breaking waves at the shoreline. Also known as longshore currents.
Littoral transport	Transportation of non-cohesive sediments (usually sand) along the shore by littoral or longshore currents. Also termed longshore sediment transport.

Glossary of Terms

Marine debris	Solid man-made material which is disposed of directly or indirectly into the marine environment.
Marine pest	Introduced (or non-native) plant, animal and other kingdoms that have (or could have) a detrimental impact on the marine environment.
Midden	Aboriginal place of significance where debris from eating shellfish and other food has accumulated over time. Often found on headlands, beaches and dunes, around estuaries, swamps and along the banks of rivers, creeks and lakes.
Ocean waves	Waves occurring in the ocean that have been generated from wind blowing over the ocean surface over long distances (known as the fetch). Swell or incident waves on the coast typically have a wave period of 8 to 10 seconds, with large storm waves having periods of 12 seconds or greater.
Physico-chemical	Relating to physics and chemistry, or physical chemistry
Physiochemical	Of or pertaining to both physiology and chemistry, or physiological chemistry.
Wind waves	While most waves are generated by wind, the term “wind waves” is associated with small, short period (3-5 second) waves that are generated locally within a small fetch. Wind waves can be generated on smaller water bodies such as lakes, lagoons, or tidal inlets.
Riparian vegetation	Vegetation located along the banks of a body of water, usually rivers.
Scour	Localised loss of soil often present around a foundation element.
Sea level rise	A long-term increase in mean sea level, usually associated with climate change and increase in temperature in particular.
Sedimentation	The settling of particles (e.g. sand or mud) out of the water column onto the bed of a waterbody.
Sediment cores	A cylindrical sample of soil for tests and examination. Sediment cores are retrieved by sampling soil deposits using a long narrow metal tube.
Siltation	The process by which water becomes dirty and/or polluted as a result of fine mineral particles being suspended in the water.
Stakeholders	Persons or organisations with an interest or concern in a given matter.
Surface water	Natural water sources found on the earth’s surface such as rivers, wetlands, oceans and lakes.
Terrestrial pests	Introduced (or non-native) plant, animal and other kingdoms that have (or could have) a detrimental impact on the terrestrial environment.
Tidal currents	Currents caused by the incoming (flood) or outgoing (ebb) tide (see Tide). Tidal currents are typically the main current within estuaries, particularly in the entrance area where tidal currents transport marine sediments (sand).
Tide	The periodic rise and fall of the water of oceans, seas, bays, etc., caused mainly by the gravitational interactions between the Earth, Moon and Sun.
Tributary	A stream or river that flows into a larger stream or lake.
Wetland	Areas of land that are partly saturated by water, including marshes, swamps etc.

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1 Introduction and Strategic Context

1.1 Purpose of the Lake Illawarra Coastal Management Program

Wollongong City and Shellharbour City Councils (WCC and SCC) with the assistance of the NSW Office of Environment and Heritage (OEH), resolved to prepare this Lake Illawarra Coastal Management Program (CMP), to provide the strategic direction and specific actions to address the threats to the Lake and to maintain the ecological, social and economic values of the Lake. The Lake Illawarra CMP shall thereby achieve ecological sustainability for Lake Illawarra over the long term.

The Lake Illawarra CMP has been prepared in accordance with the mandatory requirements for CMPs specified in the *Coastal Management Act 2016* (the CM Act) and accompanying NSW Coastal Management Manual (OEH, 2018).

This CMP outlines the strategic aims for managing the Lake and gives effect to specific actions to mitigate the threats and issues identified for the Lake that are to be implemented over the next 5 to 10 years. Clear details for how actions will be implemented, funded, monitored, and reviewed are given in this CMP. The CMP is an operational document for this community to take action to manage, preserve, improve, promote and rehabilitate our Lake.

1.2 Introduction to Lake Illawarra

Lake Illawarra (the Lake) is a large estuary system located approximately 80km south of Sydney and 10km south of Wollongong, shown in Figure 1-1 and Figure 1-2. The Lake catchment covers an approximate area of 240 km², with a lake surface area of around 35 km² and an average depth of 2.1 m (OEH, 2012). The Lake is a highly modified wave dominated barrier estuary with a shallow flat bottomed bed.

The Lake and its catchment span both the Wollongong and Shellharbour Local Government Areas (LGAs) (refer to Figure 1-1). Predominantly the Lake is co-managed by Wollongong City Council (WCC) and Shellharbour City Council (SCC), with support from State agencies such as the Office of Environment and Heritage (OEH), and Department of Industry – Lands and Water (Crown Lands) (herein referred to as “DOI – Crown Lands”). Most notably, DOI – Crown Lands now manages the Lake Illawarra entrance management works.

The Lake is a highly valued natural resource within the Illawarra region, and is immensely valuable from an ecological, social and economic perspective. Lake Illawarra is considered one of the more complex estuary systems on the NSW south coast in terms of balancing the existing modified environment with the community’s aspirations for use and enjoyment of the Lake, past and present industrial uses in the catchment, and increasing residential development pressures. Management of the Lake across the two councils and various agencies further increases the political, financial, resourcing, social and other challenges of managing this important Lake.

In its previously natural condition, the entrance was typically narrow, shoaled and intermittently closed, opening in response to elevated water levels following rainfall events. Between 2000 and 2007, in conjunction with channel dredging, the entrance breakwaters were constructed to keep the Lake continuously open to the ocean. The entrance breakwaters have resulted in major geomorphic, hydrodynamic and ecological changes to the Lake. Lake Illawarra supports numerous protected

Introduction and Strategic Context

species and endangered ecological communities, including a number of migratory species. The gently sloping foreshores provide habitat for extensive areas of coastal saltmarsh, while the shallow subtidal areas support extensive seagrass.

The Lake is also highly valued and heavily utilised by the community, particularly for recreation such as fishing, sailboarding, boating, swimming, kayaking, and picnics, cycling and walking along the foreshores. Economically, the Lake supports tourism industries relating to its recreational opportunities. There is a significant general commercial fishing effort in Lake Illawarra with the overall catch dominated by sea mullet, blue swimmer crab, dusky flathead and school prawns.

The Lake contains areas of cultural significance from both the long history of Aboriginal use of the estuary, and non-indigenous development and use of the Lake over the last 100 years. The Lake provided more than just a food source for the Aboriginal people of the Illawarra region. The Traditional occupants of the land of the Illawarra region, the Yuin people not only utilised the natural environment for survival and protection, but also had a spiritual connection to the Lake and the surrounding land. The significance of this site to the Yuin people stretches for thousands of years into the past, and its importance to the Aboriginal community continues today.

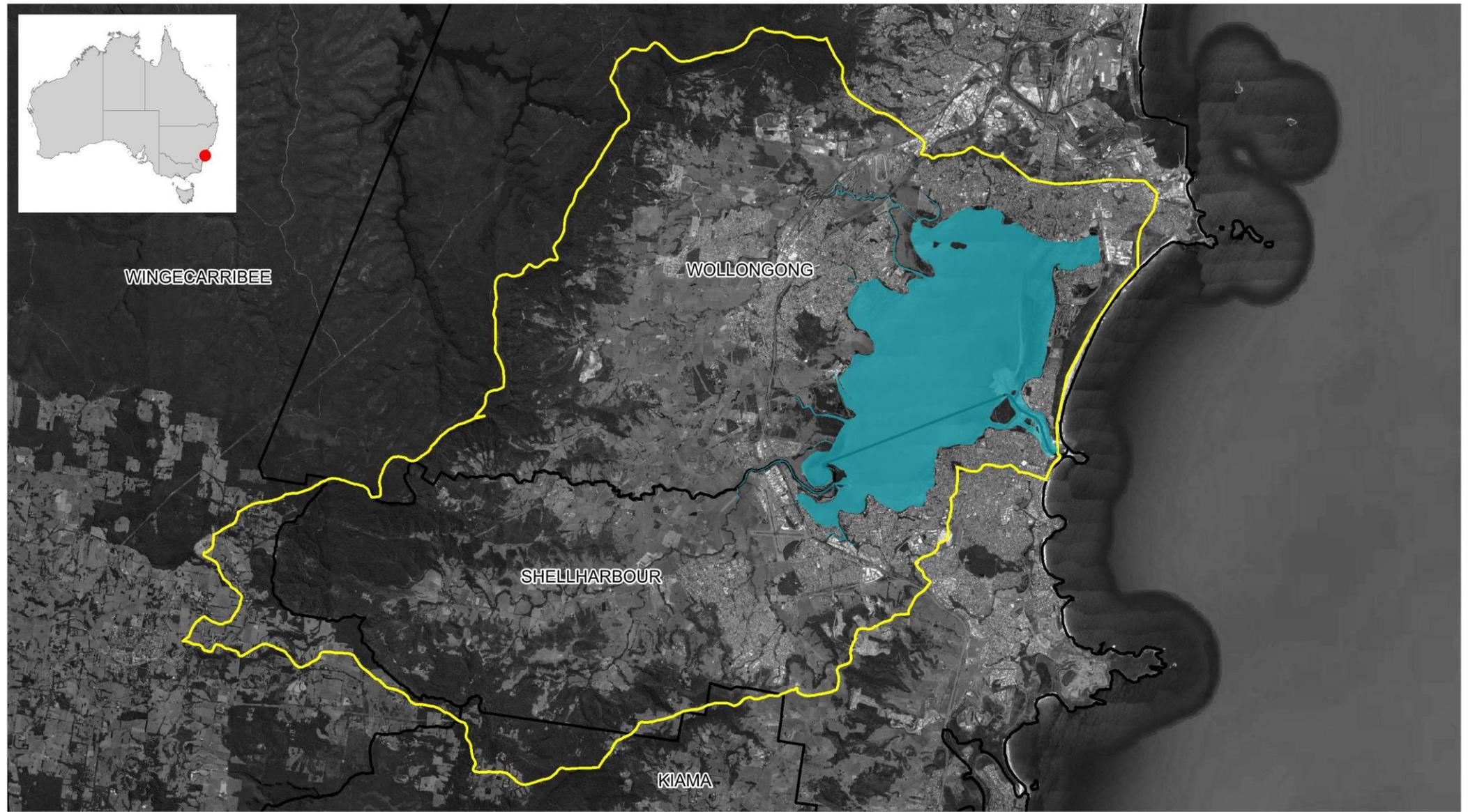
The pressures on the natural resources of Lake Illawarra are significant and include both natural coastal hazards as well as those brought about by human use of the foreshore and catchment. Population growth and growing residential development needs, tourism and recreational activities as well as climate change impacts all place pressure on the Lake.

1.3 Area Covered by this CMP

This CMP covers the entire Lake Illawarra estuary and catchment as it affects the estuary. That is, as shown in Figure 1-1, the CMP covers:

- up to the upstream tidal limits of the tributaries to the Lake (namely Macquarie Rivulet, Mullet, Brooks, Duck and Horsley Creeks);
- downstream to the entrance channel (including the entrance training works and extending out to the ebb tide delta);
- all foreshore (and backshore) areas of the Lake, and
- considers the influence of the wider catchment area of the Lake insofar as activities pose a high threat to the estuary system (see Figure 1-1 and Figure 1-2). The CMP applies only to the Lake Illawarra catchment area that forms part of both the Shellharbour and Wollongong LGAs.

This Lake Illawarra CMP encompasses all four coastal management areas defined in the CM Act, as outlined further in Section 1.5.2.



LEGEND

-  LGA Boundary
-  Lake Illawarra Catchment
-  Tidal limit

Title:

**Locality Map
Lake Illawarra CMP Study and Catchment Areas**

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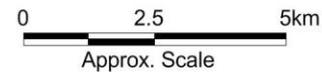


Figure:

1-1

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Title:
Lake Illawarra and Waterways

Figure:
1-2

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Introduction and Strategic Context

1.4 Who is the CMP for?

While the estuary and its catchment are partitioned into two separate LGAs, the natural processes occurring within the estuary, their associated values, threats and opportunities are largely cross-jurisdictional. The estuary and its catchment are a holistic system and need to be managed as such by all stakeholders responsible for the Lake, and its catchment insofar as it affects the Lake. The CMP is a guiding document for those involved in managing the Lake, and who are variously responsible for implementing the actions in this CMP for the benefit of the community and the environment.

The majority of the actions are the responsibility of WCC and SCC. For WCC and SCC, issues and associated management responses are likely to be similar across both LGAs, meaning that there are significant advantages to managing the estuary in a coordinated and integrated manner. Pooled funds and resources are also likely to be more efficiently used, without the need for duplication. Both councils agreed to collaborate in preparing this CMP with support from OEH, and this CMP aims to provide the judicious management of the Lake and its surrounds into the future.

OEH is also a key stakeholder, having contributed financial and technical support to developing this CMP, and can assist with funding many CMP actions through the NSW Coastal Management Program.

DOI – Crown Lands who, on behalf of the Ministerial Corporation, manage the Lake waterbody, land on foreshore and some associated infrastructure, are responsible for some actions within the plan.

A range of other stakeholders have responsibilities in this plan, ranging from directly implementing actions, to providing financial, technical or other support to this CMP, including: the NSW Marine Estate Management Authority (MEMA), the NSW Department of Primary Industries Fisheries (DPI Fisheries), Department of Planning and Environment (DPE), Roads and Maritime Services (RMS), NSW National Parks and Wildlife Service (NPWS), Sydney Water Corporation, Illawarra Local Aboriginal Land Council (ILALC), as well as developers, tourism operators, recreational fishers, residents, visitors and the general public.

1.4.1 Land Tenure and Ownership

Prior to July 2014, the Lake Illawarra Authority (LIA) had primary responsibility for managing the Lake, including most of its assets, and sections of foreshore and public lands in conjunction with W and SCC. Through joint funding arrangements from the State Government and Councils, the LIA delivered significant asset improvements to all foreshore lands around the Lake.

When the LIA was disbanded, LIA land and assets were transferred back to the State Government and to local Councils. Figure 1-3 provides information on which public lands and assets each Agency is responsible for. The remainder of the Lake foreshore is privately owned and managed. The entrance islands are either managed by WCC or SCC, and Hooka and Gooseberry are managed by NPWS. The change in ownership and management arrangements, from one overarching management body to several, means that a well-considered and supported CMP is vital to achieve effective and coordinated management responses for the Lake. Management Strategy 4.2 “Improve Planning and Management Arrangements for the Lake” outlines several actions which aim to achieve such coordination.

Introduction and Strategic Context

This CMP has considered the obligations under the Native Title Act 1993 and Aboriginal Land Rights Act 1983 and proposed management actions will be undertaken accordingly. The entire CMP study area is included in the Native Title Claim (NC2017/003 South Coast People, registered 31/1/2018). No determinations regarding this Claim have been made to date.

It is noted that relevant authorisations and appropriate tenure arrangements may need to be obtained for actions on public land under the Crown Land Management Act 2016 which commenced 1 July 2018.

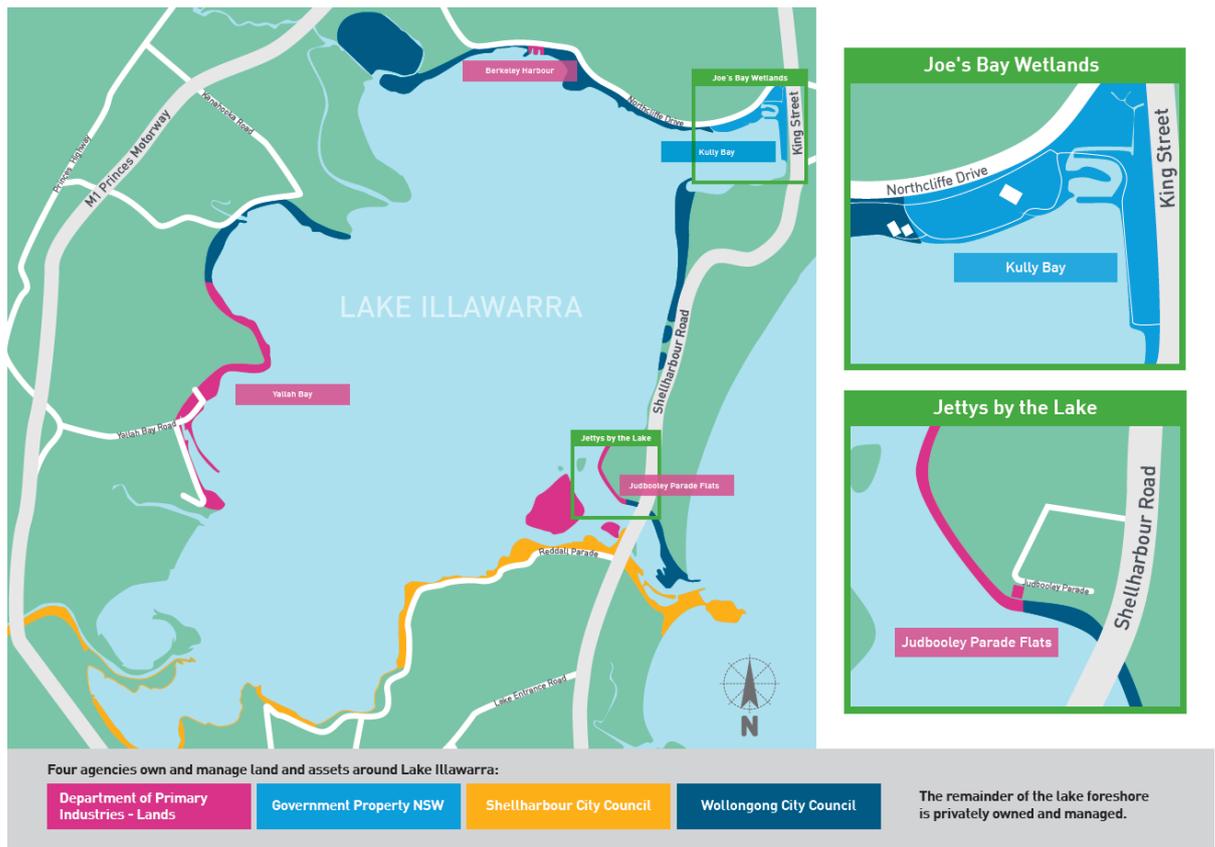


Figure 1-3 Management responsibility of Public lands and assets

1.5 Coastal Strategy Statement and Objectives

This CMP sets the long-term strategy for the coordinated management of Lake Illawarra. In particular, the CMP aims to:

- protect and enhance the natural processes and environmental values of Lake Illawarra including natural character, scenic value, biological diversity and ecosystem integrity and resilience,
- support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety,
- encourage and promote plans and strategies to improve the resilience of the Lake to the impacts of an uncertain climate future including impacts of climate change,

Introduction and Strategic Context

- ensure co-ordination of the policies and activities of WCC and SCC and public authorities relating to Lake Illawarra and to facilitate integration, and
- support public participation and greater public awareness, education and understanding of Lake processes and management actions.

1.5.1 Objectives

In accordance with the CM Act, this CMP shall give effect to the management objectives for the four coastal management areas that exist within Lake Illawarra and its catchment. The coastal zone is defined in the CM Act as comprising four coastal management areas. The CM Act provides the definition and objectives for each of the management areas. *The State Environmental Planning Policy (Coastal Management) 2018 (CM SEPP)* provides development controls for each of the management areas, and statewide mapping of the areas. The four coastal management areas as defined by the CM Act are, in order of priority:

- coastal wetlands and littoral rainforest area;
- coastal vulnerability area;
- coastal environment area; and
- coastal use area.

These new definitions of coastal zones have been adopted by the NSW Government to enable targeted management of the diverse environments occurring throughout the coast. The overall aim of this approach is to balance social, economic and environmental interests by promoting a coordinated approach to coastal management (DPE, 2016).

Through the implementation of the actions in this CMP, it is intended that threats to Lake Illawarra will be eliminated, reduced, mitigated or otherwise managed to a tolerable level; and that the values of the Lake will be preserved and enhanced. It is expected that the management objectives identified in the CM Act for the coastal management areas will be achieved by addressing the threats and values identified for Lake Illawarra. The values and threats identified for Lake Illawarra are detailed in Sections 2.3 and 2.4 respectively.

The CM Act states under Part 1, Section 3 “*the objects of this Act are to manage the coastal environment of New South Wales in a manner consistent with the principles of ecologically sustainable development for the social, cultural and economic well-being of the people of the State*”. It also sets out 13 objects of the CM Act that must be considered and promoted when preparing a CMP. The 13 objects of the CM Act and the location where they have been incorporated in this report are outlined in Table 1-1.

Introduction and Strategic Context

Table 1-1 Objects of the CM Act and their Consideration within this Report

CM Act Part 1	Objects of the CM Act	Action section in this CMP
Section 3a	to protect and enhance natural coastal processes and coastal environmental values including natural character, scenic value, biological diversity and ecosystem integrity and resilience.	4
Section 3b	to support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety.	4.2, 4.5
Section 3c	to acknowledge Aboriginal peoples' spiritual, social, customary and economic use of the coastal zone.	4.6
Section 3d	to recognise the coastal zone as a vital economic zone and to support sustainable coastal economies.	4
Section 3e	to facilitate ecologically sustainable development in the coastal zone and promote sustainable land use planning decision-making.	4.2, 4.8
Section 3f	to mitigate current and future risks from coastal hazards, taking into account the effects of climate change.	4.3, 4.7, 4.8
Section 3g	to recognise that the local and regional scale effects of coastal processes, and the inherently ambulatory and dynamic nature of the shoreline, may result in the loss of coastal land to the sea (including estuaries and other arms of the sea), and to manage coastal use and development accordingly.	4.3, 4.7, 4.8
Section 3h	to promote integrated and co-ordinated coastal planning, management and reporting.	4
Section 3i	to encourage and promote plans and strategies to improve the resilience of coastal assets to the impacts of an uncertain climate future including impacts of extreme storm events.	4.8
Section 3j	to ensure co-ordination of the policies and activities of government and public authorities relating to the coastal zone and to facilitate the proper integration of their management activities.	4.2
Section 3k	to support public participation in coastal management and planning and greater public awareness, education and understanding of coastal processes and management actions.	4
Section 3l	to facilitate the identification of land in the coastal zone for acquisition by public or local authorities in order to promote the protection, enhancement, maintenance and restoration of the environment of the coastal zone.	4.5, 4.8
Section 3m	to support the objects of the <i>Marine Estate Management Act 2014</i> .	4

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1.5.2 Coastal Management Areas in the CMP Area

This Lake Illawarra CMP encompasses all four coastal management areas defined in the CM Act. Mapping of the coastal wetlands and littoral rainforest area; coastal environment area and coastal use area has been completed by DPE (2017) as reproduced in Figure 1-4. Detailed description and the management objectives for each coastal management area as taken from the CM Act are provided in Appendix A. It should be noted that development for the purpose of environmental works, undertaken by or on behalf of public authorities, on land identified as “coastal wetlands” or “littoral rainforest” within the Coastal Wetlands and Littoral Rainforests Area Map may be carried out without further development consent if they are consistent with this CMP.

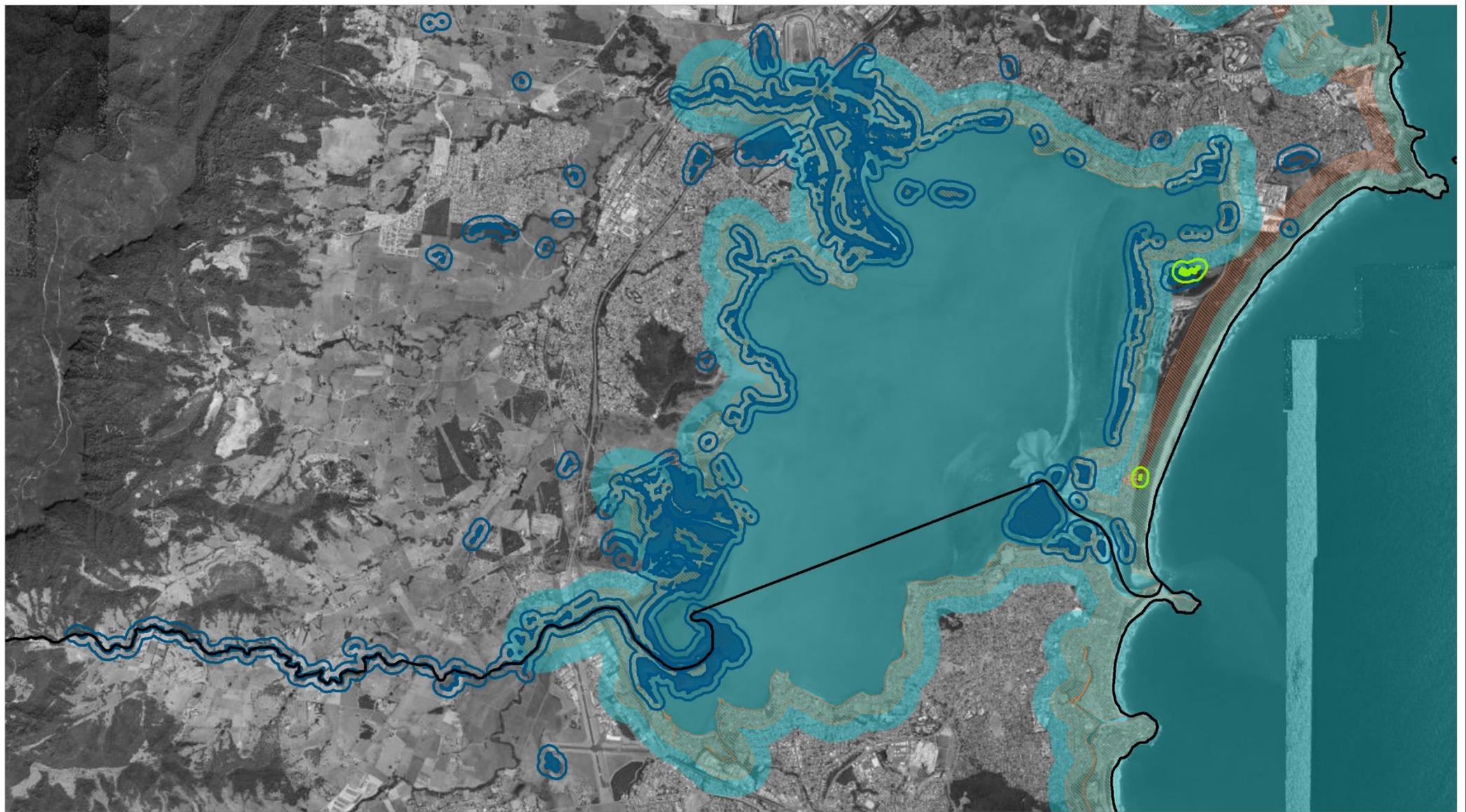
1.5.2.1 Coastal Vulnerability Area

While DPE (2017) does not currently provide mapping of the coastal vulnerability area in NSW including for Lake Illawarra, it is recognised that Lake Illawarra is subject to coastal hazards and that the scope of this CMP also covers managing coastal vulnerability. Lake Illawarra is subject to coastal hazards including foreshore erosion, inundation due to catchment rainfall and/or elevated ocean water levels, and ongoing changes in mean and tidal water levels due to entrance opening and sea level rise (also termed tidal inundation).

Inundation relating to catchment rainfall coincident with storm event elevated ocean water levels is already managed through the NSW floodplain risk management framework, and is therefore not repeated by this CMP. Existing actions in place to manage flooding include the preparation of Flood Studies and Floodplain Risk Management Plans for the Lake (refer Section 1.9) and major tributaries, and clauses in the Local Environmental Plans (LEPs) and planning provisions in the Development Control Plans (DCPs) of Shellharbour and Wollongong LGAs.

While it is not the intent of this CMP to pursue a planning proposal to adopt a coastal vulnerability area at this time, it is noted that suitable mapping is presently available to do so. This mapping will be used to inform land use planning for the Lake. Cardno (2010, 2012) modelled coastal inundation due to storm event elevated ocean water levels without catchment rainfall at present and at 2050 and 2100 including sea level rise. The inundation mapping provided by Cardno (2012) represents the water level during periodic ocean storm events, which is then applied around the foreshore using a simple water height approximation (or ‘bath tub’) approach. The Cardno (2012) modelling is discussed and mapping provided in Appendix Section A.1.2.

The University of Wollongong has completed mapping of the tidal inundation hazard in Lake Illawarra that is projected to occur due to both the increasing tidal range in the Lake since permanent opening of the entrance, and sea level rise. Kumbier et al (2019) investigated the mean high water spring (MHWS) and high high water solstice spring (HHWSS) tidal water levels at present, 2040, 2070 and 2100. Discussion and model output from the tidal inundation assessment by Kumbier et al (2019) is provided in the *Lake Illawarra Information Synthesis Report* (BMT, 2019a). The tidal inundation modelling was used to assess the risks from tidal inundation and then incorporate risk assessment findings into the threat assessment that supports this CMP, and to develop and augment management actions in this CMP to treat inundation risks. Further details regarding the tidal inundation risk assessment are contained in Appendix C of the *Community Uses, Values, Threats and Opportunities: Lake Illawarra Report* (BMT, 2019b).



LEGEND

- Littoral Rainforests
- Proximity Area for Littoral Rainforests
- Coastal Wetlands
- Proximity Area for Coastal Wetlands
- Coastal Environmental Area
- Coastal Use Area
- LGA Boundary

Title:

**Coastal Management Areas for Lake Illawarra
(excluding Coastal Vulnerability)**

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

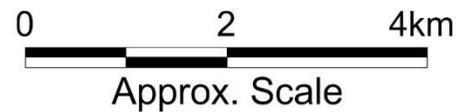


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1.6 Timeframes Covered by this CMP

This CMP has been prepared for a 10-year period from 2019 to 2029. However, the CMP considers a range of timeframes and planning horizons both in completing the risk assessment for known threats to the Lake, and in terms of the management actions to address these threats both now and into the future. For certain threats that we know are likely to change over time, the following future timeframes were considered:

- 2040-2050, where 20 years from present (i.e. 2040) is a regularly applied “short(er)” planning timeframe, and 2050 is and was a commonly applied timeframe for strategic planning purposes;
- 2070-2100+, where 50 years from present (i.e. 2070) is a regularly applied planning timeframe, 2100 is and was a commonly applied timeframe for strategic planning purposes, and consideration of timeframes beyond 2100 is also given because processes such as sea level rise will continue for many hundreds of years regardless of climate change mitigation actions.

Coastal vulnerability assessments such as storm event coastal inundation and tidal inundation were based on deterministic models with set timeframes, specifically:

- Present, 2050 and 2100 timeframes were investigated for coastal inundation modelling for storm events (ocean water levels) by Cardno (2010, 2012); and
- Present, 2040, 2070 and 2100 timeframes were investigated for tidal inundation modelling by University of Wollongong (Kumbier et al, 2019).

The level of risk to built and natural assets due to coastal and tidal inundation have been investigated for existing and future timeframes, and the existing and future risk levels were then used to develop the management actions detailed in this CMP.

In all cases, management actions were developed as a priority for threats considered to be high or very high at the present timeframe. Management actions were also developed for future high and very high threats where the future threat is well accepted and requires planning intervention now in order to adequately manage the future threat. This is particularly the case for climate change related risks. For example, planning to enable migration of species with sea level rise into currently suitable / available land areas needs to commence now to secure these suitable land areas into the future.

1.7 The Coastal Management Process in NSW

In 2016, the NSW Government passed the *Coastal Management Act 2016* (CM Act), which repeals the *Coastal Protection Act 1979*. The Act became operational in April 2018 along with several other components of the NSW Governments new Coastal Management Framework. This framework also includes the State Environmental Planning Policy (Coastal Management) 2018 (CM SEPP), and a Coastal Management Manual (OEH, 2018). The new Coastal Management Framework is outlined in Figure 1-5.

A CMP is a strategic and operational document that may be prepared under the CM Act for managing a part of the coastal zone. As noted in Section 1.5.1, the coastal zone is now defined as comprising four coastal management areas (namely coastal wetlands and littoral rainforest, vulnerability, environment, and use, in order of priority). A CMP must identify the area covered by the program,

Introduction and Strategic Context

and what coastal management areas are covered within that area, such as described for Lake Illawarra in Section 1.3.

A CMP must meet the mandatory requirements as set out in the CM Act, and any further requirements specified in the Coastal Management Manual and CM SEPP. The CM Act states that a CMP must:

- identify the coastal management issues affecting the areas to which the program is to apply;
- identify the actions required to address those coastal management issues in an integrated and strategic manner;
- identify how and when those actions are to be implemented, including those to be implemented by local councils under Chapter 13 of the *Local Government Act 1993* (that is, through the councils' IP&R Frameworks), those to be implemented under environmental planning instruments and development control plans under the *Environmental Planning and Assessment Act 1979* and those to be implemented by public authorities (other than the local council);
- identify the costs of those actions, proposed cost-sharing arrangements and other viable funding mechanisms for those actions to ensure the delivery of those actions is consistent with the timing for their implementation under the CMP; and
- if the local council's local government area contains land identified within the coastal vulnerability area and beach erosion, coastal inundation or cliff instability is occurring on that land, include a coastal zone emergency action subplan.

This CMP contains the above mandatory requirements, and has also been prepared in accordance with the Coastal Management Manual available from OEH (2018). Consultation with OEH has been undertaken throughout the preparation of the CMP to ensure the CMP meets the requirements of the Coastal Management Manual.

The Coastal Management Manual (OEH, 2018) specifies 5 stages of preparation of a CMP. Figure 1-6 below briefly explains these stages, and highlights how the companion documents developed as part of preparing the Lake Illawarra CMP are aligned with this 5 stage process.

1.7.1 Legislation

The legislation and policies governing the management of Lake Illawarra and its catchment are complex. Legislation pertaining to the management of Lake Illawarra aims to ensure present actions, procedures, and changes to the Lake's management are in line with values that will aid its health into the future. A comprehensive overview of legislation relating to the management of Lake Illawarra was conducted as part of *Lake Illawarra Information Synthesis Report* (BMT, 2019a) which is contained in Appendix B.

Each piece of legislation covers a specific aspect of managing the Lake's environment. Each legislation is administered by a specific state agency. The agencies are also responsible for preparing policies, management rules and compliance action under their legislation. As an example, an object of the *Fisheries Management Act 1994* is to conserve fish stocks and key fish habitat. DPI Fisheries achieves this through establishing rules around fishing activity, policies to protect fish habitat and conducting compliance action in respect of these rules.

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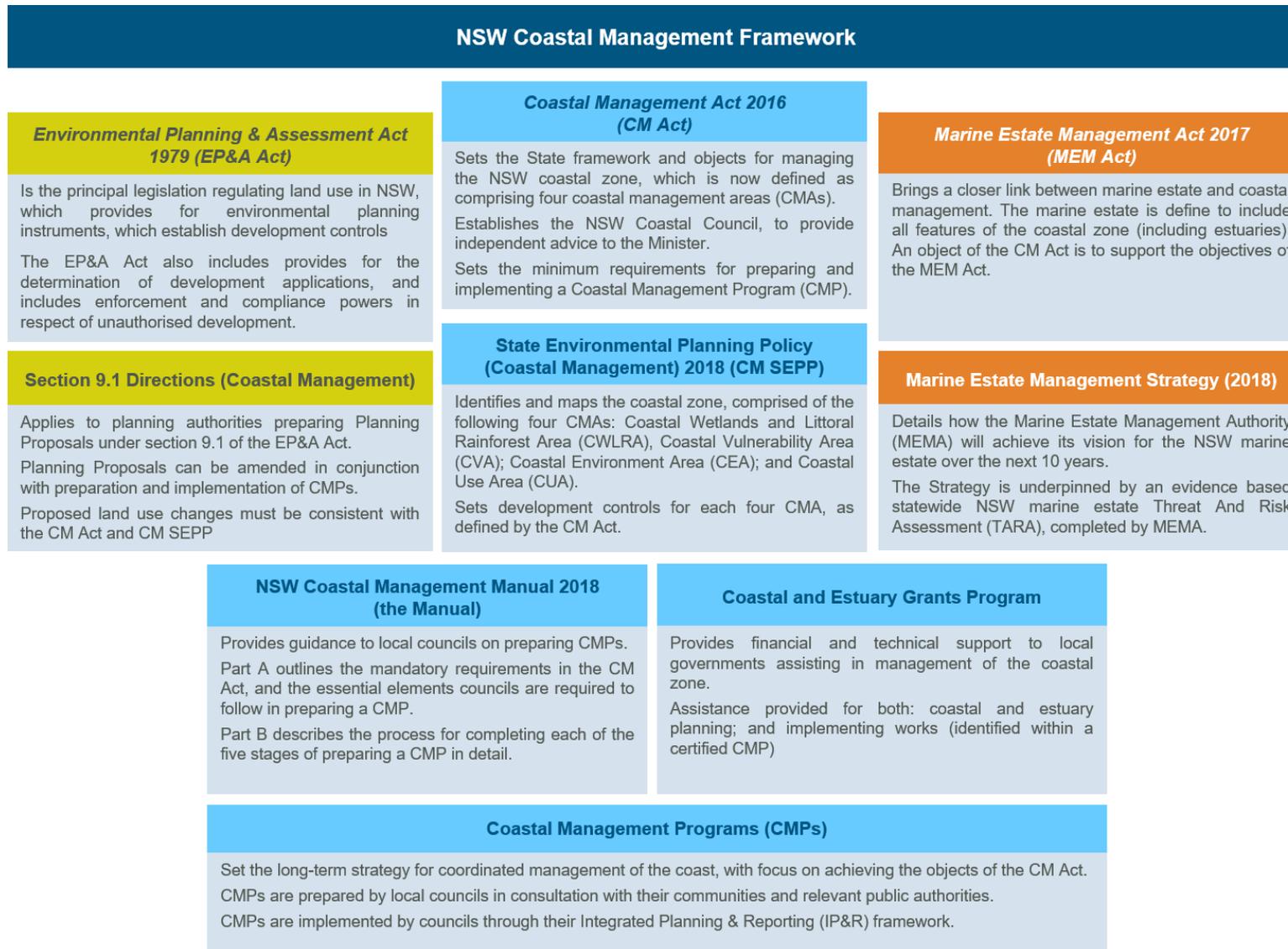


Figure 1-5 NSW Coastal Management Framework

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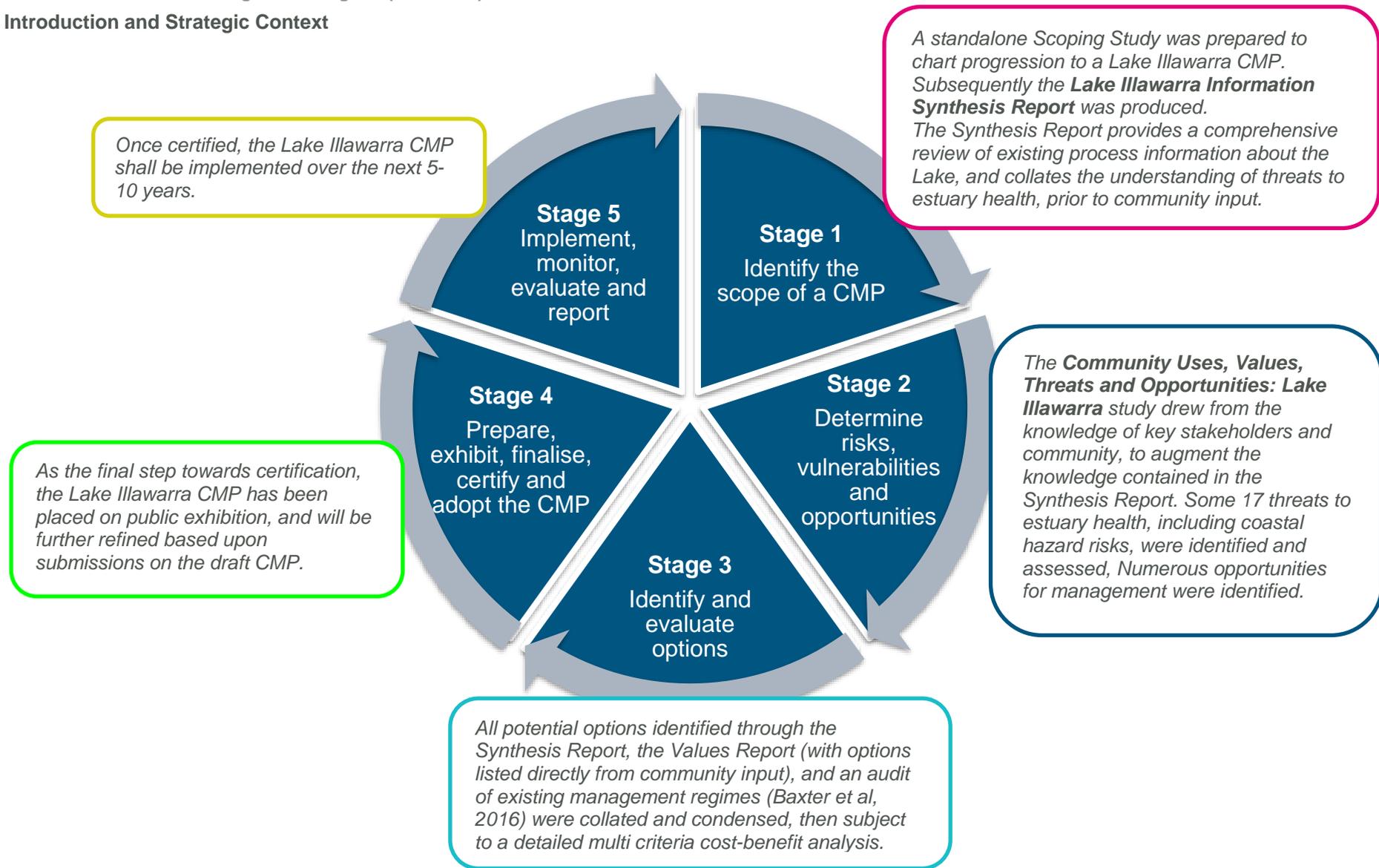


Figure 1-6 Alignment between the 5 Stage Process for CMPs and Lake Illawarra CMP and companion documents

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1.7.2 Integration with the Marine Estate Management Strategy

To reduce social conflict and improve effective management of coastal and marine resources beyond existing marine parks, the NSW Government introduced the *Marine Estate Management Act 2014* (Beeton et. al. 2012). The Act provides for strategic and integrated management of the whole marine estate. The marine estate includes all marine waters, estuaries and coastal areas, as well as the State's six marine parks.

The NSW Government also established a new advisory Marine Estate Management Authority (MEMA). MEMA has undertaken a statewide Threat and Risk Assessment (TARA) to consider and prioritise the social, economic and environmental threats to community benefits of the marine estate. The Marine Estate Management Strategy has been prepared to allow a holistic approach to dealing with the cumulative threats to the marine estate. The nine management initiatives in this plan correspond to the cumulative threat categories identified through the statewide TARA process.

Consistency between the Marine Estate Management strategy and CMPs is an essential element listed in the Coastal Management Manual (OEH, 2018). A cross reference between the Priority Regional Threats for the Central Region and the threats identified for Lake Illawarra is included as Appendix D. Management measures identified within the Marine Estate Management Strategy that address key threats to Lake Illawarra have been incorporated within this CMP.

Although the statewide MEMA threat and risk assessment was undertaken at a much broader scale than Lake Illawarra, information from the MEMA background reports has been integrated into the Synthesis Report and the Values Report.

1.7.3 Emergency Action Sub-Plan

As noted above, inundation relating to catchment rainfall coincident with storm event elevated ocean water levels is already managed through the NSW floodplain risk management framework. Emergency elements of the coastal inundation risk are also already adequately managed through existing emergency action planning processes across both Councils in relation to the floodplain risk management plan, as follows:

- Lake Illawarra Floodplain Risk Management Plan (Cardno, 2012)
- Illawarra Flood Emergency Sub Plan (NSW SES, 2017)
- Illawarra South Coast Regional Emergency Management Plan (Illawarra South Coast Regional Management Committee, 2019)
- Illawarra Local Emergency Management Plan (Illawarra Local Emergency Management Committee, 2017)

The above existing processes are considered to satisfy the requirement in the CM Act for an emergency action sub-plan to manage coastal vulnerability in Lake Illawarra (i.e. inundation risks arising from catchment rainfall and/or elevated ocean levels during storms). It is considered repetitious and potentially confusing to prepare a second set of emergency actions for coastal inundation risks through this CMP process.

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In relation to other elements that comprise coastal vulnerability or hazard under the CM Act, tidal inundation risks and foreshore erosion risks (including within the entrance channel) are not considered to be of a nature requiring emergency actions, because these hazards tend to progress slowly over time rather than only in relation to storm events. Therefore, no additional actions to those already outlined for flood risk in existing processes are considered necessary to address the other elements comprising coastal vulnerability and risk in Lake Illawarra.

1.7.4 Proposed Amendments to Coastal Management Areas

This CMP does not propose any amendments to the existing mapping of coastal management areas currently gazetted with the CM SEPP. Suitable mapping does exist to prepare a coastal vulnerability area for the Lake, however both WCC and SCC have considered and decided not to pursue the option of a Planning Proposal to gazette a coastal vulnerability area for Lake Illawarra at this time.

Clause 12 of the CM SEPP only applies to coastal vulnerability areas where mapping for that area has been gazetted under the SEPP. Regardless, Clause 15 of the CM SEPP applies to all land within the coastal zone, and states that “*development consent must not be granted to development on land within the coastal zone unless the consent authority is satisfied that the proposed development is not likely to cause increased risk of coastal hazards on that land or other land*”.

The existing coastal inundation (storm event and tidal inundation) and other relevant estuary hazard information is already part of existing council development assessment processes. The existing coastal hazard information is suitable to guide proponents in preparing development applications and to guide the councils in providing consent or conditions regarding the potential coastal risk to proposed developments.

1.8 Integrating the CMP with Each Council’s IP&R Framework

A mandatory requirement for this CMP under the CM Act is to establish the links and alignment between management strategies in the CMP and objectives and strategies in the Community Strategic Plan (CSP) of both WCC and SCC.

The Integrated Planning and Reporting (IP&R) framework is a legislative requirement for Councils under the *Local Government Act 1993*. IP&R considers the longer term future of an area and is based around a CSP which reflects the community’s aspirations and needs for the future. The IP&R framework therefore consists of four layers of plans:

- the Community Strategic Plan,
- the Resourcing Strategy is a 10-year plan describing the resources a council will use to achieve the objectives and strategies detailed in its CSP,
- the Delivery Program is a four-year program outlining the commitments and key partnerships required and measures to monitor success in achieving the Strategies, and
- the Operational Plan outlines in more detail the individual Actions that Council will undertake in a financial year in order to meet the commitments made in the Delivery Program.

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In accordance with the CM Act, this CMP needs to align with the IP&R Framework of both WCC and SCC. This aims to mainstream coastal management into councils' overall service delivery and asset management responsibilities. It is also likely that integrating actions from the CMP into the service delivery and asset management processes of the Councils will improve implementation of CMPs.

Generally, the operational plan and delivery program will be updated on a yearly basis (as the delivery program is a rolling four-year program), and it is at this stage that actions from the CMP can and should be incorporated into these documents.

The alignment between this CMP and the strategies and objectives in the CSPs of both SCC and WCC are detailed in Table 6-1. This will assist with the process of incorporating CMP actions into the Councils' delivery programs and operational plans.

1.9 Supporting Documents for this CMP

This CMP is supported by two companion documents.

- The *Lake Illawarra Information Synthesis Report* (the Synthesis Report) (BMT, 2019a) which collates and reviews a wide range of data, reports, plans and policies from over the past decade or more, and is reproduced in Appendix B. Topics reviewed included: physical setting, geomorphology, entrance management works, hydrodynamics, water quality, estuarine ecology, catchment influences, estuary health, community and cultural values, and climate change impacts. Existing and planned controls that apply to the Lake were also reviewed. Information gaps with respect to the estuary environment and management were identified, and a preliminary list of key values and threats was also prepared for the report.
- A *Community Uses, Values, Threats and Opportunities: Lake Illawarra* study (the Values Report) (BMT, 2019b) compiled the community consultation activities, information and outcomes undertaken as part of the CMP process, in addition to outlining the uses, values, threats and risks associated with the Lake. A detailed risk assessment was completed as part of the Values Report which identified the threats listed with accompanying risk rating. The Values Report is provided in Appendix C.

A number of previous studies have supported the preparation of this CMP, in addition to the above companion documents. These studies are listed below for reference.

- *Lake Illawarra Coastal Zone Management Study* (incomplete Draft, LIA 2013), from which substantial information and mapping for issues, threats and management actions has been drawn into this CMP.
- *Lake Illawarra Coastal Risk Assessment* (BMT WBM, 2013), provides details regarding actions to address of coastal inundation to Lake Illawarra within the Shellharbour LGA.
- *Wollongong Coastal Zone Management Plan: Management Study* (BMT WBM, 2017) provides details regarding actions to address of coastal inundation to Lake Illawarra within the Wollongong LGA.

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- *Shellharbour Coastal Zone Management Plan Final Draft* (BMT WBM, 2016), which details coastal management actions for the open coastal zone including Warilla Beach and Windang Island.
- *Lake Illawarra Floodplain Risk Management Plan* (Cardno, 2012) and associated documents (flood study and floodplain risk management study), which provide details regarding flooding and inundation relating to catchment rainfall, with and without elevated ocean levels, and actions to manage flooding risks in Lake Illawarra, and which were used to derive flood planning levels and planning provisions in the LEPs and DCPs of WCC and SCC.
- *Lake Illawarra Estuary Management Study and Strategic Plan* (WBM Oceanics, 2006), which formed the precursor to this CMP and the 2013 draft CZMP document.

1.10 Consultation During Development of the CMP

Consultation with councils, public authorities and the community have been undertaken in accordance with a communication and engagement strategy prepared for this project. The strategy and the outcomes of the consultation undertaken to date were documented in the Values Report, Appendix C. This has included consultation with the councils, state agencies and other stakeholders. A list of the identified target stakeholders for this CMP is provided in Table 1-2.

Table 1-2 Target Stakeholders

Category	Stakeholders
Key Council Staff from WCC and SCC	<ul style="list-style-type: none"> • Engineers • Infrastructure • Planning • Parks • Environment • Senior Management • Councillors • Asset Managers • Service Managers
State Government and other agencies and businesses	<ul style="list-style-type: none"> • Office of Environment and Heritage • Roads and Maritime Services • Local Lands Services • DOI - Crown Lands • DPI Fisheries • Sydney Water • University of Wollongong • Department of Planning • Illawarra Local Aboriginal Lands Council • NSW Commercial Fishers • Tourism operators • Illawarra Business Chamber • Golf Club/ Yacht Club/ Bowls Club

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Category	Stakeholders
	<ul style="list-style-type: none"> • Aishs Seafood • Futureworld Eco - Technology Centre
Community Groups	<ul style="list-style-type: none"> • Aboriginal Knowledge Holders and Traditional Custodians • Land care / coast care/ bushcare groups/ bush restoration teams • Rowing/ Sailing/ Yacht/ Canoe/ Dragon Boat/ Motor Boat Clubs • Recreational Fishing Clubs and Recreational Fishing Alliance of NSW • Conservation Volunteers Australia • Landcare Illawarra • Neighbourhood Forums • Scout Groups • Save the Lake • Seabird Rescue • APRA – Caravan park residents association • Shellharbour City Council Aboriginal Advisory Committee • Wollongong City Council Aboriginal Reference Group
Residents	<ul style="list-style-type: none"> • Foreshore landholders (1500) including caravan park residents. • Wider Catchment (90,000) • Visitors • Aboriginal Community

1.10.1 Community Support

The actions and strategies in the CMP have been developed to target the threats identified and to preserve the values of the Lake. Community consultation undertaken for this CMP, detailed in the Values Report (see Appendix C), indicated the following aspects to be most valued about Lake Illawarra (with over 70% of respondents valuing these aspects), shown in Figure 1-7.

- Water quality, which was the most valued aspect of the Lake,
- Views / How the Lake Looks
- Native wildlife
- Access to Lake Foreshore
- Recreational Facilities, and
- Healthy Vegetation in the Lake.

The highest threats identified during the preparation of this CMP (and described in more detail in Section 2.4, and the Values Report, Appendix C) were:

- Water pollution
- Catchment development, and
- Entrance channel changes.

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Opportunities for action identified by the community were also directly utilised in developing all actions in the CMP. The CMP will be placed on public exhibition to further demonstrate the community's acceptance for actions in the CMP.

See section 2.3 for how threats were identified.

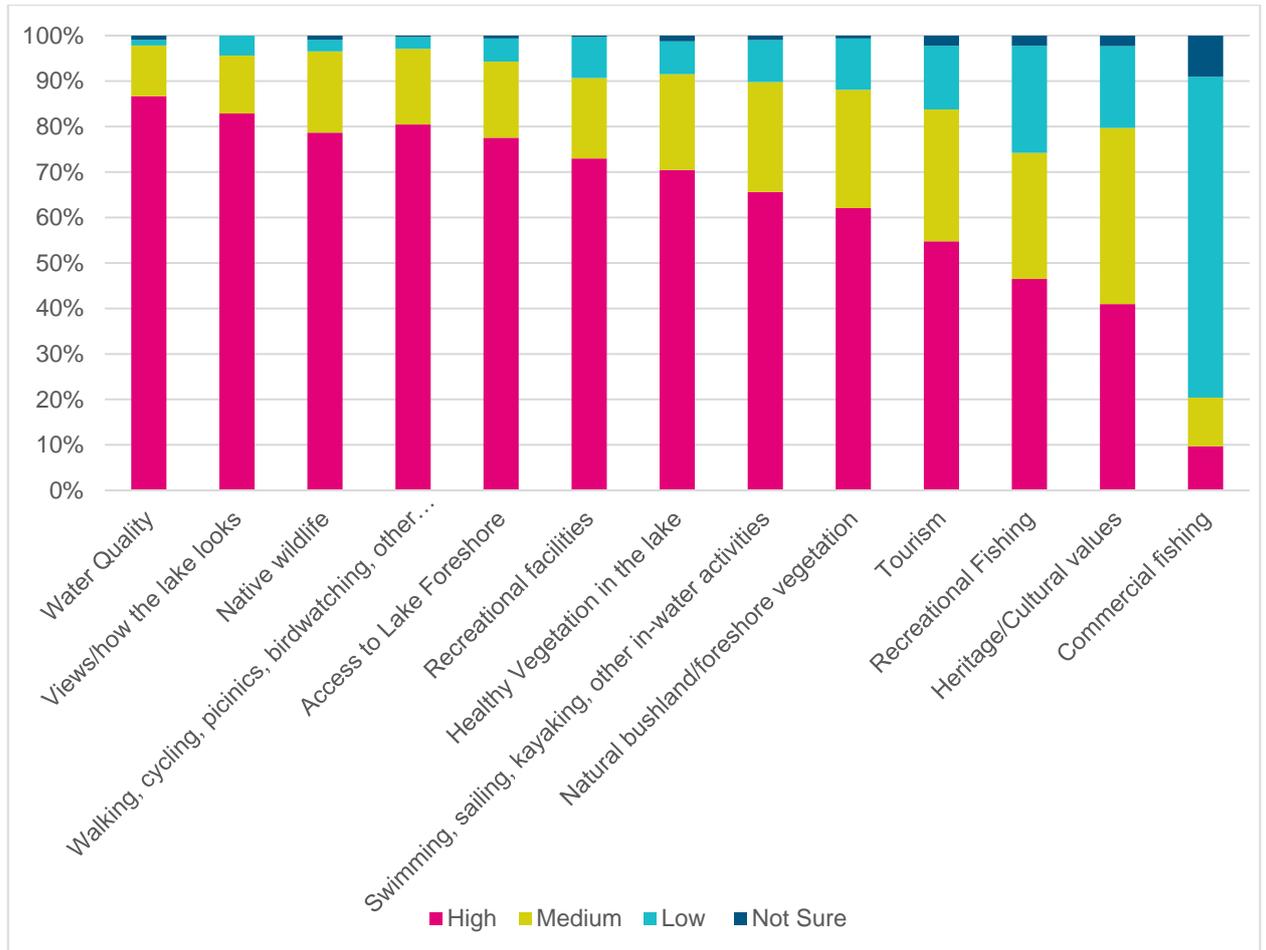


Figure 1-7 Community and Stakeholder Perception of Values Associated with the Lake

2 Lake Illawarra's Processes, Values and Threats

2.1 Chapter Overview

This chapter provides a summary of the Synthesis Report and Values Report that were produced as supporting documentation for this CMP. The objectives of this CMP have a strong focus on ecological health, as this underpins the social, public amenity, and economic values associated with the Lake. The summary of estuary processes below demonstrates the valuable environmental aspects of the Lake, that support its recreational, cultural and economic values.

2.2 Summary of Estuary Processes and Other Influences on Lake Illawarra

2.2.1 Physical character

Lake Illawarra is a large, shallow coastal lake, and is classified as a wave dominated barrier estuary system. From east to west, the Lake is situated between the wide, long coastal barrier system of Windang Peninsular that extends from Windang to Port Kembla (Perkins Beach) and largely impounds the estuary from the ocean; and the steep western backdrop of the Illawarra Escarpment. The Lake is fringed by low lying land, with extensive tidal flats on its eastern margin as part of Windang Peninsular and where Macquarie Rivulet and Mullet Creek flow into the estuary along its western margin.

The main waterbody of the Lake is elongated in a general southwest - northeast direction. It has a surface area of around 35 km² and an average and maximum water depth of 2.1 and 3.2 m respectively (LIA 2013; Sloss, 2005). The average Lake water level is around 0.2 m above sea level (OEHL, 2012). The Lake Illawarra catchment covers an area of 240 km² (OEHL, 2012). The current land uses across the catchment are illustrated in Figure 2-1. Other characteristics of the catchment are summarised in Section 2.2.6, with further details in the Synthesis Report.

A number of major watercourses, small creeks and drainage lines drain into the Lake, with the five major tributaries being: Macquarie Rivulet; Mullet Creek; Brooks Creek; Duck Creek; and Horsley Creek.

The Lake is now permanently open to the sea via an artificially trained entrance channel between twin breakwaters, with the entrance channel positioned between Windang Island and Windang Beach. Prior to construction of the artificially trained entrance, Lake Illawarra was classified as an Intermittently Closed and Open Lake and Lagoon (ICOLL), with the entrance channel shifting from south to north around Windang Island.

2.2.1.1 Ambulatory nature of shorelines

The ambulatory and dynamic nature of the shoreline and how it may affect the study area has been considered in the CMP through using the understanding of coastal processes to inform management response. For example, the entrance channel shoreline is in a state of change as a result of the permanent entrance opening and a consideration of this aspect has resulted in this being identified as a high risk, with management actions to reduce this risk outlined.

Lake Illawarra's Processes, Values and Threats

2.2.2 History of Management of Lake Illawarra

During the 1980s, a combination of high catchment sediment and nutrient loads, climate variations (i.e. drought periods) and natural processes (such as the Lake's frequently closed entrance condition) resulted in poor water quality, algal blooms, seagrass dieback and significant community concern regarding the Lake's management and health. In response to the declining health and environmental condition of the Lake, the LIA was formed by the NSW Government in 1988, previously the Lake was managed by WCC, SCC and other agencies. Over the next 20+ years, the LIA managed Lake Illawarra and undertook numerous foreshore rehabilitation projects as well as algal harvesting, bank stabilisation and the construction of several gross pollutant traps and artificial wetlands around the Lake. The LIA worked collaboratively with WCC and SCC in delivering environmental and infrastructure initiatives.

Sediment and nutrient loads into the Lake continued to increase in line with ongoing development in the catchment, reducing the Lake's water quality. In an attempt to manage poor water quality by increasing tidal flushing, the Lake was substantially modified by the staged construction of a permanent trained entrance, which was completed under the LIA between 2000 and 2007. It was also intended that a permanently trained entrance would bring other social and environmental benefits, particularly building from improved water quality.

The LIA was disbanded in July 2014 and its responsibilities transferred to WCC, SCC, DOI - Crown Lands, and Property NSW.

Foreshore land around the Lake is variously under the ownership and management of WCC, SCC, DOI – Crown Lands, Property NSW or private landholders (including industry such as EnergyAustralia who own the foreshore land of Tallawarra Power Station).

Berkeley Nature Reserve (BNR) lies within Lake Illawarra and is actively managed by the NSW National Parks and Wildlife Service (NPWS). BNR comprises two small islands: Gooseberry Island (6.1 ha) & Hooka Island (2.0ha). The boundary of BNR extends to the mean high water mark of each island. BNR is of international and national significance for its biological values, and regional significance for its cultural heritage and landscape values.

In 2005, a book titled "Lake Illawarra – An Ongoing History" was prepared by Joseph Davis for the LIA. This book contains a wealth of information and history regarding the Lake and should be referred to for further history of the Lake.

2.2.3 Entrance Channel Dynamics

The permanent opening of Lake Illawarra to the ocean has resulted in significant geomorphic, hydrodynamic and ecological changes. Lake water levels are permanently influenced by the diurnal cycle of ocean tides (MHL, 2013), and Lake waters are now permanently saline. The hydraulic efficiency of the entrance tidal inlet has increased significantly in association with the increased tidal prism within the Lake (MHL, 2013). Tidal range in the Lake is increasing at approximately 8mm/year, resulting in increased tidal scour (MHL, 2013).

Lake Illawarra's Processes, Values and Threats

The increased hydraulic capacity of the entrance channel has caused the migration of shoals and tidal channels, resulting in changed patterns in scour, erosion and sedimentation. The substantial impacts throughout the entrance channel are summarised below.

Significant amounts of sediment have been scoured from within the entrance channel since 2007. The marine flood tidal delta at the western end of the channel has grown significantly, extending westwards into the Lake's central mud basin (Baxter and Daly, 2010; MHL, 2013). MHL (2013) measured a net annual westward movement of marine sand into the Lake of approximately 1000 m³/year (MHL, 2013). Bathymetry changes between 2008 and 2016 also illustrate accretion of the ebb tide delta seaward of the breakwaters (BMT, 2019a).

East of Windang Bridge, the channel has migrated northwards, with significant scouring and deepening of the channel occurring along its northern margin along the Windang foreshore, and deposition and shoaling along the southern margin of the channel. The entrance scouring and erosion has significantly undermined assets along the Windang foreshore, including the boardwalk (which has since been replaced), boat ramp, power supply infrastructure, sections of footpath, lighting and other park infrastructure, pylons supporting the northern portion of Windang Bridge, areas of Aboriginal Cultural significance, shorebird habitat and open public space. sections of footpath, lighting and other park infrastructure. The three groynes and a section of rock revetment have experienced significant scour at their ends and toe.

Entrance shoaling and sediment deposition along the southern margin of the channel has resulted in reduced amenity and functioning of the swimming areas near the secondary tidal channel adjacent to Reddall Reserve, with the swimming area frequently choked with sediment. Nesting habitat for shorebirds has also been affected.

West of Windang Bridge, local erosion has also occurred within the channels and on the western side of Bevans and Cudgeree Islands (MHL, 2013). Foreshore erosion is also occurring along Picnic Islands, as well as significant movement of shoals either side of Windang bridge and along the Windang foreshore west of the bridge, due to ongoing channel adjustments. Secondary tidal channels have developed near to the southwest of the main tidal channel, westward of Bevans Island. In contrast, sedimentation is occurring in the popular swimming area on the western side of Berageree Island, which has caused community concern.

Substantial losses of seagrass have been observed throughout the entrance channel due to the expansion of the flood tide delta and scouring of shoals.

Such morphological changes will continue over the next 100 years or more as the entrance channel equilibrates to the new hydraulic regime.

2.2.4 Water Quality

Different aspects of water quality are important for each of the different uses and ecosystem functions relevant to Lake Illawarra. Recreational activities (such as swimming) require water that is not contaminated by human specific bacteria, viruses and other disease or infection causing pathogens, and chemical contaminants. For ecosystem function and estuary health, water quality indicators are related to turbidity, chlorophyll *a* and nutrients, although even in a completely pristine state, these

Lake Illawarra's Processes, Values and Threats

indicators would be highly variable, fluctuating in response to natural events such as high rainfall runoff and entrance breakouts (which occurred prior to the permanent entrance opening). Water quality to support estuary health is directly impacted by chemical contaminants and increased sediment and nutrient loads from catchment development (in terms of both the development process and the ongoing land use that contributes to poor water quality and increased quantity), stormwater, groundwater contamination, litter and marine debris, illegal vehicle access to foreshore areas, sewage overflows, residential land uses, industrial land uses and discharges, agriculture, foreshore development, tree removal and park management practices.

In the past, the condition of the Lake was considered poor, with mass algal blooms frequently occurring (WCC, 2015). Based on monitoring since the entrance was permanently opened, WCC (2018) has found seasonal variability of water quality indicators such as chlorophyll-a, ortho-phosphorus and dissolved oxygen, and variability in water quality and estuary health indicators across the Lake. The data shows consistency in the water quality of the Lake across the monitoring program's duration despite seasonal extremes and anomalies (WCC, 2018a).

Prior to entrance opening, the north-eastern and south-western sections of the Lake consistently experienced significant nutrient enrichment when compared to the middle reaches, entrance, and main body of the Lake (LIA, 2006 and WCC, 2018a). Since entrance opening, this trend has continued as these regions are more enclosed and have lower rates of tidal flushing, allowing accumulated nutrients to remain, rather than be flushed out to sea with the tide, demonstrating that catchment impacts have a major influence on water quality in the Lake.

2.2.5 Ecology

The Lake provides habitat for fringing protected communities such as coastal saltmarsh, swamp oak floodplain forest, littoral rainforest and extensive areas of seagrass. The three main communities of estuarine vegetation (saltmarsh, seagrass and mangroves) provide essential habitat, food supply and nutrient cycling. This in turn supports fish assemblages and wildlife, contributes to good water quality and provides scenic qualities. A number of protected species rely on the Lake, such as Black Necked Storks and Pied Oystercatchers.

Estuarine vegetation is highly variable around the Lake and over time. Estuarine vegetation has been removed for land reclamation and foreshore development, with works including bridge construction, open water reclamation, shoreline hardening and dredging undertaken in and around Lake Illawarra over the past 100 years, by both public and private land managers. Grazing animals, 4WDs and other vehicles, BMX and other bikes, informal walking tracks, and mowing and other inappropriate park management practices have and continue to impact upon fringing estuarine vegetation and riparian vegetation further upstream in the tributary creeks.

These pressures occur in addition to the permanent entrance opening and sea level rise. In response to the permanent opening of the Lake, areas of mangrove are reported to have been increasing, with signs that some of the newly established saltmarsh areas could be outcompeted by mangroves (Baxter and Daly, 2010; Williams and Wiecek, 2017). However, the driving factor for a potential loss of saltmarsh over time is likely to be the increasing tidal range due to the permanent opening. This

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change in tidal range has and will be enhanced by sea level rise over time, with further impacts upon saltmarsh and mangroves to be expected.

Seagrass is particularly important for supporting fish within the Lake, as it provides a food source and shelter for different fish during different stages of their life cycles. Within the Lake, seagrass can and has been impacted by boating activities, particularly from anchors and moorings. Seagrass is protected under Part 7 Division 4 of the *Fisheries Management Act 1994* (FM Act). The FM Act sets out provisions to protect marine vegetation (mangroves, seagrass and seaweeds whether alive or dead) from 'harm'. 'Harm' under the FM Act means gather, cut, pull up, destroy, poison, dig up, remove, injure, prevent light from reaching or otherwise harm the marine vegetation.

Since the permanent opening of the Lake, there is also evidence that seagrasses on the flood tide delta entering the Lake are being smothered by sand (e.g. see Wiecek et al., 2016). Seagrass is also being lost in other areas due to increased flow velocities and scour, most notably, along the channel margins that are experiencing scour. While it is understood that seagrass can naturally vary in distribution throughout the Lake, reducing human impacts will assist in nurturing seagrasses to thrive in the Lake.

Reduced estuarine vegetation combined with poor water quality will directly impact on native fauna of the Lake, including fish.

2.2.6 Influence of Population, and Growth and Changing Demographics

Today the catchment is about 60% cleared land, including urban, industrial and rural land uses, see Figure 2-1. The urban population in both Wollongong and Shellharbour has and is continuing to grow.

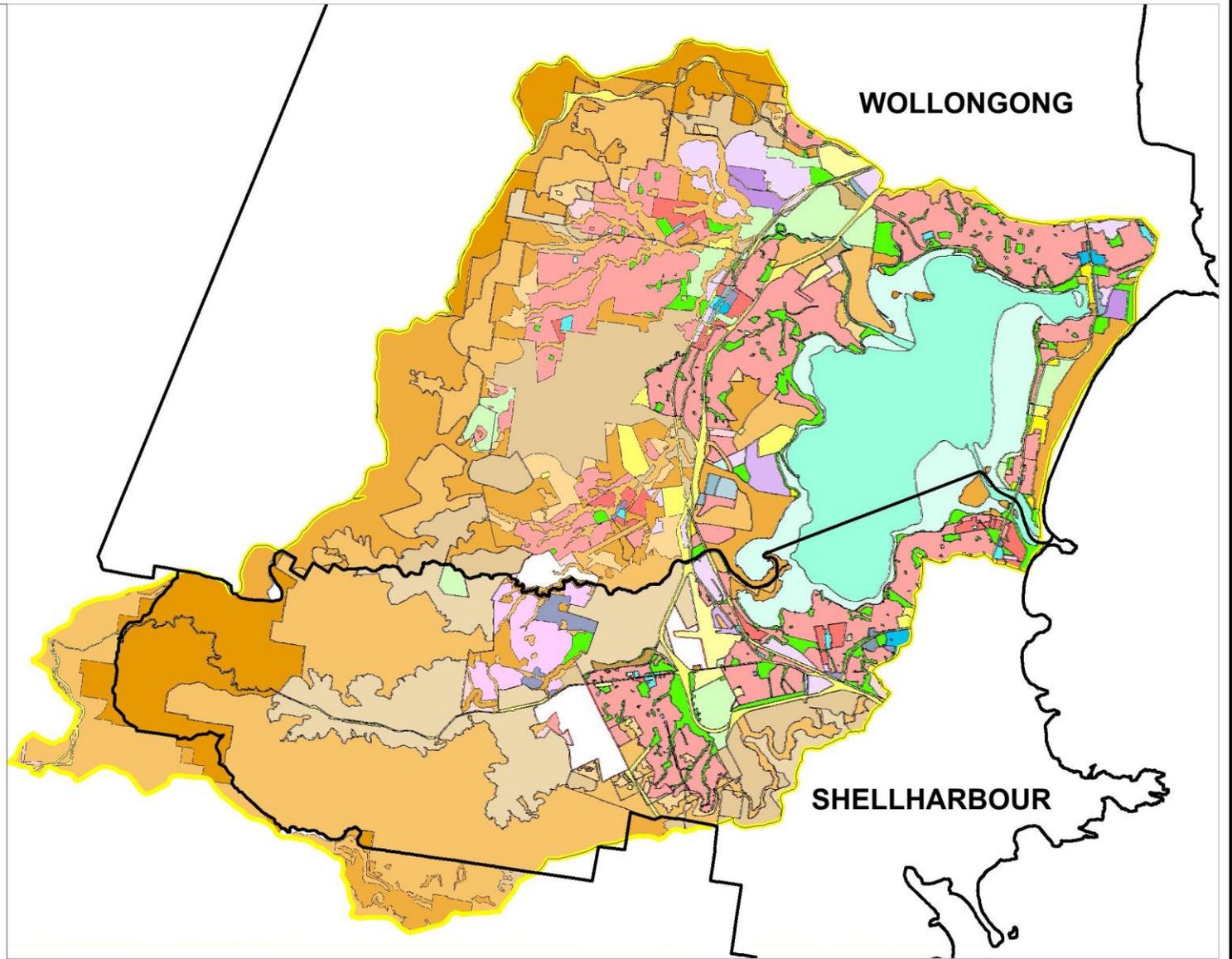
A large portion of the Lake's western catchment is planned to be converted to residential land. The Calderwood development in the Shellharbour LGA has already significantly advanced in the five years since October 2013. Another major development is in West Dapto, which proposes to add about 19,500 households to the catchment over the next 50 years (WCC, 2018b). The Illawarra Shoalhaven Regional Plan (DPE, 2015) states that by 2036 the population of the Illawarra-Shoalhaven region is forecast to increase by 60,400 people from 2016, taking the total population to 463,150. West Dapto has a projected population increase of almost 60,000 once fully developed. Forecast for population growth in SCC is an increase in 17,000 people between 2016 and 2036 - mainly driven by development of greenfield sites in the Lake catchment. Overall, the WCC population is forecast to increase by 43,604 people between 2016 and 2036, equivalent to approximately 20% growth across the period.

Ongoing catchment development is being felt in the Lake as poor water quality (through increased pollutant loads and water quantities both during and after development) (WCC, 2018a). The increased population in the region will also result in an increase in demands for recreational and potentially commercial usage of the Lake. This may have implications on overall estuary health and issues such as recreational opportunities, access and amenity, bank erosion, damage to ecological habitats, and private encroachments onto public land, particularly public foreshores.

Industrial land uses of the past and present have left a legacy of contamination, which through groundwater and surface water runoff can transport contaminated water and sediments into the Lake.

Zone

- B1 Neighbourhood Centre
- B2 Local Centre
- B3 Commercial Core
- B4 Mixed Use
- B6 Enterprise Corridor
- B7 Business Park
- E1 National Parks & Nature Reserves
- E2 Environmental Conservation
- E3 Environmental Management
- E4 Environmental Living
- IN1 General Industrial
- IN2 Light Industrial
- IN3 Heavy Industrial
- IN4 Working Waterfront
- R1 General Residential
- R2 Low Density Residential
- R3 Medium Density Residential
- R4 High Density Residential
- R5 Large Lot Residential
- RE1 Public Recreation
- RE2 Private Recreation
- RU1 Primary Production
- RU2 Rural Landscape
- RU4 Primary Production Small Lots
- SP1 Special Activities
- SP2 Infrastructure
- SP3 Tourist
- W1 Natural Waterways
- W2 Recreational Waterways
- W3 Working Waterways
- SSP SEPP (State Significant Precincts) 2005
- TP SEPP (Three Ports) 2013



Title:
**Lake Illawarra Catchment
 WCC & SCC Land Zoning**

Figure:
2-1

Rev:
A

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



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The Lake is frequently utilised for recreational activities such as fishing, sailboarding, boating, swimming and picnics. There are some 75,000 recreational fishers in the Illawarra, many of whom utilise Lake Illawarra (West *et al.*, 2015). Boat ramps, jetties, wharves and picnic facilities support these uses in the Lake, as well as the associated commercial industries of tourism and fishing. There is a significant general commercial fishing effort in Lake Illawarra with the overall catch dominated by sea mullet, blue swimmer crab, dusky flathead and school prawns.

The Lake contains areas of cultural significance, from both the long history of Aboriginal use of the estuary, and non-indigenous development and use of the Lake over the last 100 years.

2.2.7 Climate Change

Climate change poses a significant threat to the NSW Marine Estate, including the Lake Illawarra estuary system. As previously noted, it is recognised that Lake Illawarra is subject to coastal hazards including storm inundation and tidal inundation. Climate change, particularly sea level rise, will escalate the threat presented by inundation.

Sea level rise will result in an increase in the Lake's water level as the Lake is hydraulically connected with the ocean through the permanently open entrance. When combined with tides, this may result in the foreshores of the Lake and tributaries becoming inundated on a frequent basis with the daily tidal cycle. Hydrodynamic modelling of tidal inundation was recently completed by Kumbier *et al* (2019) that considered the combined impact of sea level rise and the ongoing increase in the Lake's tidal range that is occurring as a result of permanent entrance opening. The model outputs were incorporated into the risk assessment conducted in the Values Report for this CMP and summarised in Section 2.4.

A higher lake water level due to sea level rise also exacerbated storm event based inundation during rainfall and or ocean water level events. Coastal inundation mapping was completed on the WCC side of the Lake by Cardno (2010) using a hydrodynamic approach. For the entire Lake, Cardno (2012) completed coastal inundation mapping including current and future conditions with sea level rise using a simple water height approximation (or 'bath tub') approach. Further discussion of these hazards is provided in the Synthesis Report (BMT, 2019a) in Appendix B.

2.3 Estuary Values of Lake Illawarra

A comprehensive account of Lake Illawarra's uses and values was developed from the combination of output of surveys and discussions with the community with the existing scientific information for the Lake, as detailed in the Values Report (see Appendix C). Values identified for Lake Illawarra are summarised in Table 2-1 below.

It should be noted that recreational hand gathering of cockles has been increasing in Lake Illawarra over recent years, especially over the summer of 2018 to 2019. While recreational hand gathering was not identified as a threat at the time the Synthesis Report and Values Report were initially prepared, given the recent exponential increase in hand gathering effort and local community concern over this activity, actions to align and assist with DPI Fisheries management of this matter have been included in this CMP.

Lake Illawarra's Processes, Values and Threats

Tourism is a key value in the Lake. Tourism values are underpinned by the environmental health and recreational opportunities offered by the Lake. The CMP is focussed on maintaining or improving environmental health and recreational amenity, and in this manner, can support a healthy tourism industry in the Lake. Conversely, other mechanisms of the Councils and State Government exist to develop and promote tourism opportunities, and are therefore not replicated by this CMP.

Table 2-1 Community Values associated with Lake Illawarra (from the Community & Stakeholder Survey)

Value	Key points	Highly Valued*
Water quality	Good water quality is highly valued because it underpins all natural processes and human uses in the Lake.	89%
Views / How the Lake Looks	Views of the water and a natural vegetation backdrop undoubtedly contribute to the Lake's high aesthetic value, although community opinion varies as to the ratio of vegetation to waterway in views.	81%
Native wildlife	Native wildlife is supported by a healthy lake ecosystem and catchment habitats, and supports the biodiversity and productivity of the Lake. The community values native wildlife for birdwatching, nature conservation and its aesthetic value.	80%
Access to Lake Foreshore	8 boat ramps, 13+ jetties/wharves, and foreshore access supports in-water activities (see below). Foreshore parks/reserves support foreshore activities (see below).	78%
Recreational Facilities	As above, plus picnic, shelter and playground facilities, the bicycle shared pathway, and walking tracks. Some infrastructure is aging and doesn't meet peak demand.	73%
Healthy Vegetation in the Lake	Saltmarsh, seagrass and more recently mangroves provide essential habitat, food supply and nutrient cycling. This in turn supports fish abundance, wildlife and good water quality, which also supports scenic and recreational values.	71%
Foreshore Activities	Popular activities include walking, bike riding, picnics, barbeques, bird watching, bushwalking, bush regeneration, and are supported by Access to the Lake Foreshore and Recreational Facilities (see above).	69%
In-water Activities	Popular activities include swimming, kayaking, sailing, boating, as supported by Access to the Lake Foreshore and Recreational Facilities (see above).	65%
Natural bushland / Foreshore vegetation	Riparian vegetation and catchment bushland supports wildlife, as well as filtering water of nutrients and pollutants before it enters the creeks and Lake. The community appreciates the natural beauty provided by riparian vegetation, with a small segment noting foreshore trees impede their views.	64%
Tourism	An exact dollar value on the contribution of Lake Illawarra to the tourism economy is not possible, however, the natural and recreational values noted above for the Lake contribute directly to attracting visitors to the local area.	51%
Recreational Fishing	This popular activity includes boat based and shore based line and trap fishing, and hand gathering.	45%
Heritage / Cultural Values	Lake Illawarra remains strongly significant in Aboriginal culture. It supported established campsites of the Yuin people and a diverse and sustainable source of food and fresh water for some 20,000 years prior to European settlement. 'Official' European settlement of the Illawarra region commenced in 1816. It has profoundly impacted the Lake: positively toward the way we value the Lake today; and negatively due to the displacement of the Aboriginal people from their land and waterways, introduction of foreign plants and animals, land clearing for dairy and cattle farming, cedar cutting, and landscape changes from coal mining.	40%
Commercial Fishing	Commercial fishing contributes ~ \$1M annually at first point of sale, plus further lifecycle economic value. It is permitted under an "Estuary General" licence covering Wollongong to Ulladulla. Commercial fishers primarily use mesh and haul netting and crab traps, and dominantly catch sea mullet, blue swimmer crab and dusky flathead.	8%

* Refers to the percentage of respondents who classified the value as "high" in surveys conducted for the Values Report (see Appendix C for full report).

2.4 Threats Identified for Lake Illawarra

Threats relate to activities that directly or indirectly impact upon the values and benefits associated with the Lake Illawarra estuary. Risk is often characterised by a reference to potential events and consequences, or a combination of these (ISO 31000:2009). In the context of this study, a threat may include a driver (issue, activity or process) that results in a detrimental impact(s) or consequences(s) to the values or benefits of the study area. For example, stormwater runoff (driver) may result in a detrimental impact to water quality (value).

The Lake Illawarra catchment is in a period of significant land use change, with new residential developments underway. This is in parallel to the ecosystem response to permanent changes to the entrance condition and tidal hydraulics of this already highly dynamic lake system. It is also a period of transition in governance in response to the disbanding of the LIA and transition to management by SCC, WCC, and the state government (DOI - Crown Lands, Property NSW) with respect to the entrance management works and foreshore lands. Considerable effort has been expended by the former LIA, SCC, WCC and OEH and other researchers to identify, document and manage the environmental, social and economic values and issues associated with Lake Illawarra.

Through the course of preparing the Synthesis Report and Values Report, a list of threats to the condition and values of Lake Illawarra were identified. Refer to Section 5 of the Synthesis Report (BMT, 2019a) for further details on threats. The threats were then assessed through a risk rating process that considered the frequency of the threats, and the environmental, social and/or economic consequences of the threats across both present day and future timeframes. How the level of threat may change over time due to such influences as population growth, urban development and climate change has also been assessed for the medium term (2040-2050, or 20-30 years from present) and long term of away (2070-2100+, or 50-100 years from present) in Table 2-2.

Some risks can be expected to escalate over time, particularly where the threat is affected by urban development and climate change. Other threats may remain similar over time. Understanding how the threats will change over time is important in designing management actions for the next 10 years of the CMP, and determining and then managing the long term intent for the Lake.

For the purposes of this CMP, current and future threats with potentially high consequence but with a very low probability of occurring within the study region were not included for assessment (e.g. tsunami). For this CMP risk assessment events with a probability of out to 1% AEP (1 in 100 years) were determined to be a sufficient extent for consideration.

It is also recognised that a disengaged community can threaten the success of implementing the CMP and managing the Lake. Many actions in the CMP to treat the direct threats involve education and involvement of the local community, and this is in recognition of the importance of the community to the success of implementing the CMP and managing the Lake.

The final prioritised list of threats and their level of present and future risk is provided in Table 2-2. The development of objectives and management actions for this CMP has focused on the treatment (reduction, elimination, mitigation) of these priority threats.

Lake Illawarra’s Processes, Values and Threats

Table 2-2 Identified Threats Impacting Lake Illawarra

Threat	Risk Rating			Brief Description
	Present Day	Future: 2040-2050	Future: 2070-2100+	
Water pollution	Very High	Very High	Very High	Water quality conditions in estuaries fluctuate as a function of natural processes and human pressures. Water quality in Lake Illawarra is influenced by: urban runoff that discharges into creeks and stormwater outlets connected to the Lake; groundwater flow (in some cases contaminated); tidal exchange with the ocean; mixing of salt, fresh and brackish water; and contamination from sediments. Considering the current rate of urban development, future population growth plans and the increase in tourist visitation forecast for the Lake Illawarra region, it is anticipated that water pollution will continue to be a high risk into the future. Key drivers such as catchment pollution, stormwater runoff and sewage overflows will persist and increase in severity with regional growth if not adequately managed.
Catchment development	Very High	Very High	Very High	Catchment development results in the mechanical disturbance of undeveloped land in addition to an increase in impervious surfaces. This in turn may reduce water quality, increase water quantity, disturb and fragment habitats and increase the demands on community spaces and facilities. Further substantial development is planned for the Lake Illawarra catchment. When forecast population growth and urban development plans for the region are considered, and then combined with climate change, catchment development is likely to remain a very high risk over the medium to long term if adequate management action is not taken.
Changes due to Entrance Channel Opening	Very High	Very High	Very High	Entrance training works to keep the Lake permanently open to the ocean has caused significant geomorphic, hydrodynamic and ecological changes to the Lake. The water level of the Lake has dropped but the tidal range has been increasing, and this is expected to continue as the entrance channel continues to evolve (scour and migrate) in response to the increasing tidal velocities in the channel from a permanently open entrance. The East Coast Low event in June 2016 caused erosion to occur from floodwaters, locally generated wind waves, tidal current and swell wave action within the entrance. In addition to the 2016 storm, the Lake margins in and around the entrance channel continued to respond to the changing tidal regime (increased tidal prism and velocities) introduced through the entrance training works. Areas within the entrance channel continue to erode and at an increasing rate. This has already impacted the boardwalk, areas of Aboriginal Cultural significance and continues to threaten shorebird habitat, open public space and other assets within the entrance channel. Sea level rise will exacerbate the risks associated with entrance channel opening. As the Lake is hydraulically connected with the ocean, sea level rise will directly increase the mean lake water level. The combination of sea level rise and ongoing increase in the tidal range of the Lake will result in low lying foreshores becoming permanently inundated by the end of the century and beyond.

Lake Illawarra's Processes, Values and Threats

Threat	Risk Rating			Brief Description
	Present Day	Future: 2040-2050	Future: 2070-2100+	
Loss of estuarine vegetation	High	High	High	Estuarine vegetation such as saltmarsh, mangroves and seagrass communities provide habitat and food for a range of fish species, birds, mammals, insects and invertebrates. Lake Illawarra has extensive areas of vegetation considered to be of significant natural value that in turn support the biodiversity and productivity of the Lake. If not managed, increased catchment development and population will continue to place pressure on estuarine vegetation through clearing for development and recreation. Increased water temperatures due to climate change could exacerbate this threat by enhancing conditions for weed infestation.
Wetland degradation	High	High	High	Coastal wetlands occur in specific environmental niches and are sensitive to water quality change and mechanical disturbance. At Lake Illawarra, some areas of wetland that have high ecological potential are being degraded by human activities. If not adequately managed, this threat is likely to increase in the future due to the increased population forecasts and urban development for the region.
Litter, plastics and marine debris	High	High	High	This includes rubbish and litter reaching the Lake through stormwater, direct dumping and fishing waste. Long term pollution from degraded plastic results in possible toxic chemical pollution, and the increasing presence of plastic micro beads and disintegrating synthetic fibres compounds this threat. Plastics in these forms can significantly negatively impact on fish and other marine animals. It is anticipated that the threat of litter, plastics and marine debris will present the same level of risk across the short, medium and long term future timeframes. Management actions and education will improve some of the general population's behaviours regarding littering however this improvement is likely to be offset by the notable population increase expected in the Illawarra region.
Contaminated sediments	High	High	High	Contaminated sediments are known to occur within Lake Illawarra, with particularly high concentrations being measured in sediments amongst some saltmarsh areas, and generally within the tributaries. Contaminated sediments can release pollutants into the water column and degrade water quality. Generally, the contaminants are a threat to lake ecology through bioaccumulation in fish and other species, which in turn poses a risk to human health. Where sediments remain undisturbed and continue to be overlain by new, clean sediments, the risks from the contamination would progressively reduce. Conversely, if sediments are scoured during flood events, contaminants could be released. Until an appropriate method to rehabilitate contaminants from sediments is implemented, they will continue to present the threat of releasing pollutants into the Lake into the future. Therefore, the risk from contaminated sediments has been assumed to remain high into the future.

Lake Illawarra’s Processes, Values and Threats

Threat	Risk Rating			Brief Description
	Present Day	Future: 2040-2050	Future: 2070-2100+	
Inappropriate / degraded / insufficient infrastructure	High	High	High	There is a range of coastal infrastructure within and around the Lake that have been constructed both historically and recently to improve amenity, access and other human use aspects of the Lake. There remains uncertainty about who owns and is responsible for the management and upkeep of infrastructure and this exacerbates this risk. In addition, inappropriate infrastructure occurs and is most prevalent within the entrance channel. As sea level rise and climate change impacts are observed, changes in estuary water levels and associated tidal regimes will continue to put existing infrastructure at risk. Ongoing urban development and population growth will increase usage and demands for infrastructure into the future. Therefore, the threat of inappropriate, degraded and insufficient infrastructure will continue to be high.
Loss of tangible and intangible cultural heritage	High	High	High	This threat relates to known and unknown sites and places as well as less tangible aspects such as cultural fishing, cultural resource use, places, stories and traditions. Concerns have been raised around the costs of licences and regulations associated with access and restrictive catch, a lack of open space adjacent to the Lake available for cultural activities and loss of tangible cultural heritage due to factors such as coastal development and rising sea levels. Aboriginal cultural heritage sites and places will continue to be impacted into the future due to sea level rise that will endanger sites in low lying areas. For this reason, this threat has been assumed to remain high into the future. Ongoing urban development will also place pressure on these sites, although existing regulatory requirements are intended to prevent or mitigate impacts from development on Aboriginal cultural heritage.
Foreshore development encroaching public land	Medium	High	Very High	Residential areas fringe a large proportion of the Lake’s boundary, however areas of public land (Crown land or Council land) usually separate private land from the Lake’s foreshore. In some places, private landholders seek to extend their land holdings across the foreshore with action such as mowing, signs and small scale illegal foreshore development (e.g. BBQ areas) on public land. Tidal inundation will continue to squeeze private and public foreshores, and in some areas public foreshore may be lost. This is expected to increase the risks of foreshore development encroaching on public lands, as foreshore lands are reduced and as residents attempt to mitigate unstoppable inundation impacts. Therefore, the risk is expected to increase over time.
Loss of riparian habitat	Medium	High	Very High	Riparian vegetation around the Lake has a range of aesthetic and ecological values. Changes to the extent and condition of various estuarine vegetation communities can occur in response to the health and physical condition of the Lake. Sea level rise and tidal inundation will exacerbate pressures on riparian habitats in locations where they cannot migrate in response to inundation, and this may result in a loss of habitat over time. Therefore the risk of loss of riparian habitats is expected to increase into the future.

Lake Illawarra’s Processes, Values and Threats

Threat	Risk Rating			Brief Description
	Present Day	Future: 2040-2050	Future: 2070-2100+	
Foreshore and bank erosion	Medium	High	High	Erosion threatens a number of foreshore areas across the Lake and embankment areas of inflowing waterways. There are several processes that drive erosion around the Lake margin, including loss of riparian vegetation, mechanical disturbance, stormwater discharge, floodwaters, local wind wave action, tidal currents and ocean swell wave penetrating the entrance channel. Sea level rise, increasing stormwater discharge and changes to the tides and storm swells are likely to escalate the frequency of bank and foreshore erosion. The risk rating for this threat is expected to increase to High across the next 20, 50 and 100 years.
Climate change	Medium	High	High	Climate change and rising sea level will impact the water level within the Lake. This threatening process will mostly certainly increase the loss of saltmarsh areas, the occurrence and levels of inundation of public and built assets and cultural heritage items/places. The threat of climate change will progressively increase in risk rating and severity across the next century. Climate change impacts particularly sea level rise will be linked with several other threats over the 20, 50 and 100 year timeframes including coastal and tidal inundation, foreshore erosion and loss of riparian vegetation.
Park management practices impacting adjacent natural areas	Medium	Medium	Medium	Council Park managers responsible for maintaining the foreshore areas can sometimes have impacts on sensitive areas such as saltmarsh through mowing practices. Increased tourism and population growth in the region will result in added pressure to maintain foreshore areas to a high standard. However, the risk rating for this threat is expected to remain the same (or potentially decrease if adequate management actions and staff training is implemented).
Commercial fishing	Medium	Medium	Medium	Commercial fishing is managed by DPI, and changes to local fishing regulations are beyond the scope of the CMP. There are community concerns regarding the perceived impact on the Lake from commercial fishing, which is in contrast to the known community benefits to the local region from commercial fishing, such as the supply of locally sourced seafood and bait and provision and upkeep of infrastructure (e.g. jetties) by the fishing industry. Regional population growth and increased tourist visitation to the Illawarra region will continue to increase the demands on local commercial fishing, although suitable management measures such as the Fishery Management Strategy are in place to manage this and maintain suitable productivity and protection levels. Therefore, the risk level is expected to remain at medium over time.

Lake Illawarra’s Processes, Values and Threats

Threat	Risk Rating			Brief Description
	Present Day	Future: 2040-2050	Future: 2070-2100+	
Inefficient/ Incorrect Lake management	Medium	Medium	Medium	<p>In July 2014, the Lake Illawarra Authority (whom previously managed the Lake) was disbanded and responsibilities transferred to various state agencies as well as WCC\SCC. Recently the LIEMC was established as a collaborative effort between councils. This ongoing transition of responsibilities poses a threat to longer term Lake management.</p> <p>This threat will continue at the same level of risk (Medium) until the transition of Lake management is finalised. The CMP is an important tool for providing integrated management of the estuary in line with current and future values and needs and will assist with consistent Lake management.</p>
Introduced species	Low	Medium	Medium	<p>Plant and animal (plus fungi) species that are not native to Australia are referred to as introduced species. Since European settlement the Lake Illawarra ecosystem has had to compete with a range of introduced animals and plants.</p> <p>The threat of invasive species is likely to increase to a risk rating of Medium over the medium to long term. As climate change impacts put added pressure on ecological communities and native species, the prevalence of introduced species in the Lake and catchment could increase. This is because native species may be weakened by climate change, allowing for better adapted invasive species to dominate.</p>

3 Selecting Management Actions

3.1 Management Strategies

To better direct management attention towards addressing the identified threats to Lake Illawarra, a set of management strategies were compiled. A total of nine management strategies were identified, and prioritised based upon the risk rating for the threats directly addressed by each strategy, as in Table 3-1 (although it is noted that many of the strategies indirectly address many of the threats). The aim of this approach to developing the strategies was to identify one management strategy for each threat, or group of threats where the management approach would be similar.

A full analysis of how individual actions beneath each strategy directly and indirectly address the threats is provided in Appendix E (Strategies Assessment). Development of the management strategies was also drawn from the community consultation and scientific evaluation as detailed in the Synthesis Report (Appendix B) and Values Report (Appendix C).

3.2 Developing Management Actions

To implement each broad management strategy, a subset of specific management actions was developed using a pool of potential actions identified through various means. Management actions may be designed to reduce the likely occurrence or frequency of a threat, the consequence of a threat or both. The actions may also treat more than one threat, directly or indirectly. The management actions also include monitoring and other data collection actions, which may substantially improve approaches to management in the future by providing better information about the occurrence/frequency and / or consequence of key threats.

There are many aspects of the management of Lake Illawarra that can be targeted through the coastal management framework and there are some aspects that are beyond the reach of this process. Development of management actions was focused on those mechanisms that are available through the CMP process.

In general, management actions may utilise a variety of implementation mechanisms that can act at different levels or on different aspects of the problem. The different types of management actions include:

- Planning and development controls;
- Physical works, such as foreshore protection structures, amenity facilities etc;
- Rehabilitation works;
- Education and awareness programs, and;
- Monitoring programs, data collection and assessments.

A total of 212 potential actions were compiled directly from the audit of the previous management plans for the Lake by Baxter et al (2016), recommendations developed during the Synthesis Report, and from community and agency input listed in the Values Report.

Selecting Management Actions

The list of potential actions was initially assessed by determining which of the nine management strategies each action fell within. The actions within each strategy were then distilled by grouping the same or similar actions, or compiling actions with the same or similar intent. Those actions that could not be grouped were either retained as stand-alone actions, or were directly culled through a coarse cost benefit assessment.

This process left a total of 41 management actions for detailed multi-criteria analysis to further refine the actions, as explained in Section 3.3. Appendix E Table E-1 contains the full list of 212 potential actions, the strategy categorisation, and the action each has been rolled up in to, or otherwise, the outcome of the coarse cost benefit filter.

Table 3-1 Management Strategies and Threats Addressed in Prioritised Order

Management Strategies	Threats																
	Water pollution	Catchment development	Changes due to Entrance Channel Opening	Loss of estuarine vegetation	Wetland degradation	Litter, plastics and marine debris	Contaminated sediments	Inappropriate / degraded / insufficient infrastructure	Loss of tangible and intangible cultural heritage	Foreshore development encroaching public land	Loss of riparian habitat	Foreshore and bank erosion	Climate change	Park management practices impacting adjacent natural areas	Commercial fishing	Inefficient Lake Management	Introduced species
	Very High	Very High	Very High	High	High	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low
Improve Water Quality																	
Improve Planning & Management Arrangements for the Lake																	
Manage Changes to the Entrance Channel																	
Protect and Rehabilitate Estuarine and Riparian Vegetation																	
Maintain and Improve Recreation and Amenity																	
Protect and Promote Cultural Heritage																	
Manage Foreshore and Bank Erosion																	
Prepare for Inundation Risks																	
Protect and Manage Key Fauna																	

Selecting Management Actions

3.3 Multi-Criteria Cost Benefit Analysis

A total of 41 actions were subject to a multi-criteria cost benefit analysis. From this, 36 actions were selected for implementation under the nine strategies, with implementation details provided in Chapter 4.

The multi-criteria cost benefit analysis involved two components, the outputs from which were combined to determine if the action should be implemented in the CMP. The components were:

- Assessment of the ability of the action to mitigate the threats to the estuary, producing a threat mitigation score (see Section 3.3.1), and
- A cost benefit analysis considering seven criteria (see Section 3.3.2), then
- Scores from the above two components were combined to take advantage of actions with high threat mitigation scores and / or high cost benefit analysis scores within the practical financial capabilities of the councils (see Section 3.3.3).

Each step of the assessment is explained in the following section. Based upon this assessment, 36 actions were selected for implementation across the nine strategies. Subsequent to this assessment, an additional action was added taking the total number of actions for implementation to 37. Implementation details for the 37 actions are provided in Chapter 4.

3.3.1 Threat Mitigation Assessment

The potential merit of each action was assessed by determining the influence of the action in mitigating the identified threats to Lake Illawarra. This involved considering the direct or indirect impact of the action on each threat identified for the Lake. The direct or indirect influence could be positive or negative, and was scored as according to Table 3-2.

The influence of each of the 41 actions on mitigating all 17 threats was scored. The scores were then weighted according to the risk level of each threat, as follows:

- Very high threats were given a weighting of 4,
- High a weighting of 3,
- Medium a weighting of 2, and
- Low a weighting of 1.

Each influence score was multiplied by the weighting for that threat, then added to give a cumulative Threat Mitigation Score.

To explain the threat mitigation scoring process, the scoring for Action EV1 “Rehabilitate vegetation along lake foreshores and creek banks” is provided as an example in Table 3-3.

Threat mitigation scores (TMS) for the 41 actions ranged from 59 (Action PM2 “Provide ongoing coordinated management of the Lake”) to -12 (Action RA5 “Undertake dredging of bays within the Lake”). The threat mitigation score provided a clear picture of the likely influence of the various actions on the priority threats, prior to further cost benefit analysis. The influence scores and cumulative threat mitigation score given to each action is provided in Table E-2 of Appendix E.

Table 3-2 Threat Mitigation Potential

Influence	Score
Direct positive	2
Indirect positive	1
No influence	0
Indirect negative	-1
Direct negative	-2

Table 3-3 Example Threat Mitigation Score Process

Action ID	Action Descriptor	Entrance channel changes	Water pollution	Catchment development	Loss of estuarine vegetation	Wetland degradation	Litter, plastics and marine debris	Contaminated sediments	Inappropriate / degraded / insufficient infrastructure	Loss of tangible and intangible cultural heritage	Foreshore development encroaching public land	Loss of riparian habitat	Foreshore and bank erosion	Future climate change	Park management practices impacting adjacent natural areas	Commercial fishing	Introduced species	Cumulative Threat Mitigation Score (TMS)	
																			Weighted according to risk rating of threat
<i>Risk Rating</i>		Very High	Very High	Very High	High	High	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Very high (x4) High (x3) Medium (x2) Low (x1)
		2=direct positive influence, 1= indirect positive influence, 0 = no influence, -1 = indirect negative influence, -2 indirect negative influence																	
Strategy 4: Protect and Rehabilitate Estuarine and Riparian Vegetation (EV)																			
EV1	Rehabilitate vegetation along lake foreshores and creek banks.	1	1	0	2	2	1	1	0	1	1	2	2	1	1	0	1		44

3.3.2 Cost Benefit Analysis

Each of the 41 actions were then assessed for costs and benefits against seven different criteria, namely:

- **Capital Cost** to implement the action initially, with values generally set around the levels at which Councils would need different tendering procedures and approvals before proceeding;
- **Ongoing Costs per annum**, with cut off values generally a quarter to a half of that of the capital cost to implement;
- **Effectiveness**, being the ability of the action to reduce the threat for which the action has been designed or targeted, or otherwise, the provision of important data or knowledge about the target threat by the action;
- **Community Acceptability**, which is based upon general feedback from this locality and other coastal areas regarding the action or type of action;
- **Reversible / Adaptable in the Future**, being the ability for the action to be modified or removed in future, should the situation change and an alternative approach be required. This

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is particularly important where influences such as ongoing channel dynamics and climate change may modify the issues or threats and how they can be managed in future.

- **Legal / Approval Risk**, to highlight the legislative and approval requirements (or impediments) to implementing an action within the current legal framework; and
- **Technical Viability**, to highlight where certain actions may or may not be technically feasible or would require significant engineering (or other) investigations and construction / implementation capabilities.

Scoring for the cost benefit analysis followed a “traffic light” colour system, whereby for each action, the criterion was assessed as either:

- **GO**, with a score of 1
- **SLOW**, and proceed with caution, with a score of 0; or
- **STOP**, with a score of -1.

The “traffic light” rating system for the criteria in the cost-benefit analysis is outlined in Table 3-4. Each of the criterion were given equal weighting. The total score for each action was therefore based on a direct addition of scores against each criterion. Scores for the actions ranged from:

- 7 (WQ1, WQ6, PM4, CH1, FB3, IR1, IR2, IR4, IR5, MF1, see full descriptions in Chapter 4), to
- 1 (EV6, RA5, both of which did not pass the selection process, see Table E-2 of Appendix E).

The outcomes of the cost benefit analysis for each action against each criterion is provided in Table E-2 of Appendix E.

Table 3-4 Cost Benefit Analysis Criteria and Scoring System

Outcome	Capital Costs	Ongoing Costs per	Effectiveness	Community Acceptability	Reversible / Adaptable Future	Legal / Approval Risk	Technical Viability
STOP	Very expensive (>\$300,000)	Very expensive (>\$150,000 p.a.)	Option is unlikely to be effective / substantially reduce targeted threats	Unlikely to be acceptable to community and politically unpalatable; Extensive community education, endorsement by Minister(s) and Council required	Option is irreversible once implemented; Option limits alternatives options in the future	Will require an EIS and/or Govt program to implement; There is a residual risk that approval will not be obtainable for the proposed works / strategy	Is unlikely to be technically viable without substantial engineering (or other) design investigation and capabilities for implementation
SLOW	Moderately expensive (\$100,000 - \$300,000)	Moderately expensive (\$25,000 - \$150,000 p.a.)	Option will not necessarily reduce targeted threat(s) but will provide important knowledge / data about the threat OR Option will bring a minor reduction in the targeted threat(s)	Would be palatable to some, not others (~50/50 response); Briefing to Councillors, GM and community education required	Option is reversible or adaptable, but at considerable cost / effort	Will require Govt approvals to be implemented, or assistance through existing Govt program;	Is likely to be technically viable at the site, but would require further investigations to clarify
GO	Limited cost (<\$100,000)	Limited cost (<\$25,000 p.a.)	Option will be very effective in eliminating / reducing / remediating its target threat(s)	Is very politically palatable, acceptable to community; Minimal education required	Option can be easily adapted for future circumstances or should impacts not occur, option would not negatively impact future generations	No or minimal government approvals required to implement	Is technically viable at the site / location

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3.3.3 Overall outcome

The threat mitigation score provided an indication of an action's ability to mitigate more than one threat, directly or indirectly. However, this score does not indicate how costly or viable it is to implement such an action.

The cost-benefit analysis provided an indication of the financial, technical or other constraints or opportunities associated with each action, including the effectiveness of the action in meeting its aims. However, this score does not explain the ability of the action to mitigate the priority threats.

The thresholds described in Table 3-5 were therefore established to determine which actions to implement through this CMP. The aim of setting these thresholds was to sensibly combine the threat mitigation and cost benefit analysis score, but still capture actions that are a very good idea from either a threat mitigation perspective or from a cost-benefit perspective. That is, some actions have a very high threat mitigation score, but may be a little more costly or resource intensive to implement. These actions should still be pursued because of their overall environmental and social benefit. Conversely, there are actions with a lower threat mitigation score, but that are highly efficient and low cost to implement. Indeed, for some such actions, their lower threat mitigation score reflects the fact that the action is specifically targeted to one threat (e.g. MF1 "Monitor and protect shorebird nesting sites on a yearly basis" had a TMS = 17 and CBA = 7). Such actions should certainly be pursued because of how well they are likely to treat the target threat, and at a high benefit to cost ratio.

The thresholds were also set to exclude actions that may have a high threat mitigation score, but are simply too costly and difficult to implement; or likewise, that may be simple and inexpensive to implement, but are unlikely to bring any real benefit to the Lake.

The overall outcome for each action against these thresholds is provided in Table E-2, Appendix E. Based upon the total multi criteria (threat mitigation and cost benefit) assessment, 36 actions resulted. However an additional action, EC5, was later added, to make the total number of actions for implementation 37, across the nine strategies. Implementation details for the selected strategies and actions are provided in Chapter 4.

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Table 3-5 Threat Mitigation and Cost Benefit Analysis Thresholds for Selecting Actions for Implementation

Threat Mitigation Score (TMS) + Cost Benefit Analysis (CBA) combination	Implementation Outcome	Explanation
TMS > 30 + CBA ≥ 2	GO	The action has a very high threat mitigation score, even though the cost benefit score is relatively low. The action should be pursued through this CMP, as it has such a high potential for environmental benefit.
TMS >15 + CBA ≥ 4	GO	The action has a lower threat mitigation score, with a high cost benefit analysis score. The action should be pursued because it is relatively easy and inexpensive to implement, and will still have a moderate to high social or environmental benefit. Some actions in this category have a lower threat mitigation score because they focus on only one threat (e.g. MF1 “Monitor and protect shorebird nesting sites on a yearly basis” had a TMS = 17 and CBA = 7). Such actions should certainly be pursued because of how well they are likely to treat the target threat, and at a high benefit to cost ratio.
TMS <15 + CBA ≤ 2	STOP	The action has a low threat mitigation score and a low CBA score, and therefore should not be pursued.
TMS <15 + CBA ≥ 4 or TMS > 30 + CBA ≤ 2	SLOW, for future consideration	The action falls somewhere in the middle: it has a high threat mitigation score, but is simply too costly or difficult to implement, as described by its low benefit to cost ratio; OR, the action has a very low threat mitigation score meaning it is unlikely to bring substantial environmental or social benefit, even though it may be easy and cheap to implement. These actions are tagged as “SLOW” in that they will not be detailed for implementation through this CMP, but they remain available for consideration, should funding or other assistance permit.

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Implementation details for the CMP actions are provided in the following sections. The details contained in the tables are explained below.

- **Action ID:** a unique identifier for each action, with the first two letters relating back to the parent management strategy, e.g. Action WQ1 under the parent strategy “Improve Water Quality”.
- **Action:** the action name.
- **Details:** further details on how the action should be implemented.
- **Locations:** the sites at which the action should be applied. Where appropriate, the actions have been mapped, to identify the known sites to which an action applies. Actions in the Lake and foreshore area are displayed across 10 maps or zones, as shown in Figure 5-1. The Action Maps are provided in Chapter 5.
- **Indicative costs:** costs have been specified for each action, and for specific elements within an action if known, for example, for sites in the “location” column, or separate items to implement the action. The costs were originally derived from general sources and the Baxter et al (2016) audit, then updated based on the advice of the relevant council departments or agencies where possible.
- **Responsible organisations:** the parties primarily responsible for implementing the action, via financial and other resources, and are listed first (typically this is both Councils).
- **Supporting organisations:** the organisations who may support the responsible party to implement the action, predominately through the provision of technical or project management support, often considered usual business for that organisation, and subject to availability and funding.
- **Timeframe:** a timeframe for implementation of parts or all of an action are specified, using time that is equivalent with the key IP&R documents, as follows:
 - Year 1: to match with the Operational Plan (which typically extends for one financial year)
 - Year 2 to 4: to match with the Delivery Program which is a four-year program (including the Operational Plan)
 - Year 5 to 10: to match with the Resourcing Plan which is a 10 year financial plan.
 - The term “ongoing” is used where an action will need to be repeated regularly. Where possible, the details for repeating the option have been included (e.g. yearly, etc)
 - Where possible, the timing of different phases of an action have been specified.
- **Performance Measure:** a measure of the implementation and / or of the success of implementing the action (or parts of the action). Similar language to that used in Councils IP&R documents has been used, to assist with transferring the CMP actions into IP&R documents.
- **Further Information:** supporting documents or information that may assist with implementation are detailed in this column.

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It is important to note that in enacting any of the actions in this CMP, all relevant approvals, permits and licences will be acquired, prior to the works / activities being undertaken (for example, REFs in accordance with the EP&A Act, aboriginal cultural heritage assessments for ground disturbance works, and so on).

In addition to the details provided in the implementation tables,

- The **Business Plan** outlining the costs and potential **funding** for the actions is detailed in Chapter 6,
- The **links between actions in this CMP and the IP&R Framework** of both Councils is provided in Section 6.4.

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4.1 Improve Water Quality (WQ)

Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
WQ1	<p>Implement a Risk Based Stormwater Management Framework for the Lake Illawarra catchment</p> <ul style="list-style-type: none"> OEH, in conjunction with both councils, undertake a research project to: <ul style="list-style-type: none"> Identify a range of stormwater treatment trains to achieve the new stormwater management targets and reflect contemporary best practices for integrated water cycle management (including a comparison with current or business as usual practices). Predict life cycle costing of the range of stormwater treatment trains. Outline opportunities (e.g. riparian corridors) and constraints for siting of stormwater infrastructure Provide sustainable funding models to assess the viability of the stormwater treatment trains to deliver tailored mechanisms for funding of life cycle costs of assets Predict (Monetised) co-benefits achieved through contemporary approaches to integrated water cycle management Develop Step by Step Practice Notes or guidelines on how the <i>Risk-based Framework</i> and outcomes of these investigations can be applied to the urban developments in Lake Illawarra. 	The Lake Illawarra catchment	\$200,000 (OEH – already funded)	OEH Supporting: WCC and SCC	Year 1	<p>The project delivers by the end of year one:</p> <ul style="list-style-type: none"> A range of stormwater treatment trains to achieve new targets. Life cycle cost predictions. Opportunities and constraints for infrastructure sittings. Sustainable funding models. Co-benefit predictions. Implementation guidelines or similar. <p>WCC and SCC DCPs are updated by the end of year one to reflect the RBF reduction targets.</p>	<p>Council may consider supplementary funding-for the planning of the additional treatment train. Councils encourage the use of alternative and feasible technologies to meet targets.</p> <p>It is recognised that to achieve the best results, the management of quantity as well as quality of water will need to be addressed by developers.</p> <p>For further information refer to Section 2.8.12 of the Synthesis Report (BMT, 2019a).</p> <p>Updating DCP may be delayed by the release of the standard template.</p>
	<ul style="list-style-type: none"> WCC and SCC update their DCPs and standard conditions of development consent to reflect the Risk Based Framework pollutant reduction targets as 'best practice' for the Lake Illawarra catchment. See WQ4 regarding implementation. 	The Lake Illawarra catchment	Staff time	WCC and SCC Supporting: OEH	Year 1-2		

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
	<ul style="list-style-type: none"> Where a comprehensive water cycle management plan is required, developers will be required to provide whole of life costings for treatment trains for both the original targets and the Risk Based Framework targets. Within the trial period (1 year), Council will expect the best overall environmental outcomes within reasonable long term asset management planning. 	The Lake Illawarra catchment	Staff time	WCC and SCC Supporting: OEH	Year 1-3	Report on number of DAs submitted with two treatment trains. WCC and SCC make a decision re how to best implement the RBF by the end of year 3. DCPs updated accordingly where required.	
	<ul style="list-style-type: none"> Outcomes of the OEH research project and Council trial period will be considered by WCC and SCC to inform future application of the targets under the risk based framework, including whether any further DCP revisions are required. 	The Lake Illawarra catchment	Staff time + \$20 000 for analysis and report preparation	WCC and SCC	Year 3		

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
WQ2	<p>Upgrade existing stormwater quality management measures, or install new devices, which may include water sensitive urban design or other design that will improve water quality as well as enhance habitat and natural values.</p> <p>Wherever possible and practical, the Risk Based Framework (see further information) should be implemented to determine the design and upgrade to the existing stormwater network.</p> <p>Upgrades and new devices must also be designed to better manage stormwater quantity, such as by reducing flow rates to reduce erosion and damage to vegetation, in an environmentally sensitive manner.</p> <ul style="list-style-type: none"> • Audit all stormwater quality management devices in the Lake Illawarra catchment, and determine priorities for upgrade or decommissioning. • Prioritisation of new and retrofitting of existing stormwater quality measures to include cost-benefit and assessment of any potential constraints on effective functioning based on full lifecycle operation. • Identify sites for new devices (including locations recommended here). Prioritisation for new devices may be derived from the Benefit Mapping (Dela-Cruz, et al, 2017, Figure 2-31 in Synthesis Report (BMT, 2019a) • Set aside adequate funds for continued maintenance of new / replaced devices. • Monitor the effectiveness of various devices in different areas/settings, by monitoring the nutrient and sediment loads after devices are installed or upgraded, and above and below device once installed to test performance. The data may also improve the selection of devices for new or replacement sites. The monitoring should link in with the regular monitoring program given by WQ7. • Incorporate the prioritised program of works into the IP&R Plans. • Increase stormwater filtration by rehabilitating native vegetation & weed removal in stormwater channels. 	<p>Catchment wide. Locations for new devices identified in previous studies are:</p> <p>Reddall Reserve – 7 existing devices</p> <p>Whyjuck Bay – 2 existing devices</p> <p>Davies Bay – 1 existing device</p> <p>Karoo Bay – 4 Existing devices</p> <p>Kully Bay Wetlands / Warrawong: new SQID (\$55,000)</p> <p>Primbee shoreline (various)</p> <p>Nicolle Road drain exiting Korrungulla Wetlands (former Port Kembla Copper site). Monitoring by WCC has not identified elevated metals in groundwater at end of Nicole Road. Stormwater treatment devices were designed, but not implemented by the LIA.</p> <p>Retro fitting of stormwater filtering for N/W Lake i.e. from Berkeley Harbour to Hooka Pt</p>	<p>\$100,000 for temporary staff resource shared across Actions WQ1, WQ2, WQ3 and WQ4, to assist with implementation and managing consultancies.</p> <p>\$60,000 for consultancy to conduct audit across both LGAs and recommend program of works.</p> <p>\$10,000 p.a. for monitoring.</p> <p>Upgrades / new devices estimated at \$100,000 - \$500,000 each, numbers to be determined through audit.</p>	<p>WCC, SCC.</p> <p>Supporting: OEH, EPA, Property NSW</p>	<p>Year 1: Commence audit</p> <p>Year 2: Complete audit and develop prioritised program of upgrades, new works and decommissioning</p> <p>Years 3 to 10: implement prioritised program of works; and undertake monitoring</p>	<ul style="list-style-type: none"> • Stormwater audit and renewal program is completed by Year 2. • The prioritised program of works is incorporated into IP&R Plans by Year 3. • Upgrades and new installations commence by Year 4. • Monitoring program for new/upgraded and maintained devices is commenced by Year 4. 	<p>The Risk Based Framework = <i>Risk-based framework for considering waterway health outcomes in strategic land-use planning decisions</i> (Dela Cruz et al, 2017).</p> <p>OEH is currently developing waterway health objectives and other tools to support implementation of the Risk Based Framework.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time- frame (subject to available funding and resources)	Performance Measure	Further Information / References
WQ3	<p>Review and prioritise maintenance and cleaning regime for existing stormwater quality devices, including gross pollutant traps, artificial wetlands and water sensitive urban design features, as informed by actions of WQ2.</p> <p>The maintenance program shall also incorporate any new /upgraded devices implemented through WQ2.</p> <p>Maintenance regimes must also consider efficiencies / new ways to carry out maintenance on specific stormwater quality devices and how the quantity of stormwater can be better managed, to reduce erosion and damage to vegetation from flows from existing stormwater outlets.</p>	<p>All stormwater devices in the catchment, prioritised through review of the program. Known sites include:</p> <p>Reddall Reserve – 6 existing devices, Whyjuck Bay – 4 existing devices</p> <p>Davies Bay – 1 existing device, Karoo Bay – 4 Existing devices</p> <p>Budjong Creek Wetlands</p> <p>Joes Bay Wetland</p> <p>Primbee shoreline</p>	<p>\$100,000 for temporary staff resource shared across Actions WQ1, WQ2, WQ3 and WQ4, to assist with implementation and managing consultancies.</p> <p>\$30,000 for consultancy to review maintenance needs and develop prioritised program.</p> <p>Estimated \$5,000 to \$10,000 per device p.a. for maintenance and cleaning.</p>	WCC, SCC.	<p>Year 1: Conduct review of maintenance regime ad develop program for maintenance.</p> <p>Year 3 to 10: Implement the maintenance program, incorporating new devices as they are installed.</p>	<ul style="list-style-type: none"> Review of maintenance regime completed and program of routine maintenance created and adopted by Year 1. Implementation of the maintenance program is commenced by Year 3. 	
WQ4	<p>Design and implement targeted catchment input monitoring as required for developments resulting in a large-scale change or intensification of land use.</p> <p>The programs should include monitoring of nutrients and sediments in runoff before, during and after development.</p>	<p>At development sites where there will be a large-scale change or intensification in land use.</p>	<p>\$100,000 for temporary staff resource shared across Actions WQ1, WQ2, WQ3 and WQ4, to assist with implementation and managing consultancies.</p> <p>Monitoring regimes will be variable and developed on a case-by-case basis</p>	WCC, SCC or Individual developers, depending on development	As required	<ul style="list-style-type: none"> Monitoring undertaken for large-scale development projects. Enforcement occurred where required. 	<p>Refer to Section 7.4 for other details regarding monitoring.</p> <p>An example of a large-scale change or intensification of land use for which this action may apply would be the subdivision of a large rural lot for residential development of 50+ lots.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time- frame (subject to available funding and resources)	Performance Measure	Further Information / References
WQ5	<p>Reduce sediment load to the Lake by improving compliance with erosion & sediment controls for development sites.</p> <ul style="list-style-type: none"> Increase amount of staff hours spent on reviewing sediment control. Increase the number of compliance audits of development sites, which may require additional staff resources. Audit of sediment and erosion controls to be conducted prior to allowing vegetation clearing and earthworks. Ongoing audits required throughout the development to ensure sediment and erosion controls are maintained and performing as intended. Train Council works staff and contractors regarding best practice erosion and sediment control, and ensure this is being implemented on Council work sites. Work with private certifiers to improve knowledge of best practice. Improve auditing and transparency of the application of sediment and erosion controls on privately certified development sites. Educate land managers on best practice for erosion control. 	All new development sites requiring erosion and sediment controls within the Lake's catchment. Includes private and public work sites.	Additional staff resources required for both Councils: \$160,000 p.a. initially for 2 years, (\$80,000 each).	WCC, SCC. Supporting: OEH, EPA, DPI Fisheries.	Ongoing	<ul style="list-style-type: none"> Increase in staff hours spent on compliance in the field. Number of development sites inspected and the percentage of sites compliant with best practice. Number of Council work sites inspected and the percentage of sites compliant with best practice. 	Local government officers can inspect any construction site under the power of the NSW Local Government Act 1993 Section 191 Power of entry; and 192 Inspection. There are many examples of successful erosion control programs e.g. Get the Site Right – Parramatta River Catchment Group and Love our Lakes – Bega Valley Shire Council.
WQ6	<p>Reduce the impact of sewer overflows.</p> <ul style="list-style-type: none"> Develop a collaborative relationship between the Councils and Sydney Water to improve gathering and sharing of reports of sewer leaks or overflows (location, severity, frequency). Improve reporting of leaks and overflows to Sydney Water to assist with prioritising repairs or upgrades. Identify contacts in Sydney Water and the Councils for record keeping and reporting of leaks and overflows, and sharing of this information as required. Sydney Water to provide information regarding future upgrade works in the catchment at suitable intervals. 	Catchment wide.	Staff time for record keeping and reporting of incidents to/from Sydney Water.	WCC, SCC and Sydney Water Supporting: EPA	Year 1 and ongoing	<ul style="list-style-type: none"> Increase in # of incidents that are properly recorded and reported to Sydney Water. 	Sydney Water may need to undertake routine maintenance, emergency work and/ or environmental protection work on their infrastructure which is located in a Coastal Wetland area from time to time to ensure infrastructure is operating effectively and the potential for sewer overflows is minimised.

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time- frame (subject to available funding and resources)	Performance Measure	Further Information / References
WQ7	<p>Implement existing water quality monitoring program for estuary health, that measures:</p> <ul style="list-style-type: none"> temperature; salinity; pH; dissolved oxygen, turbidity; total, dissolved and reactive forms of nitrogen and phosphorus; and chlorophyll <i>a</i> <p>Set up data exchange arrangements with other land managers, and use in analysis and annual summaries of results.</p> <p>An annual summary of monitoring data and analysis of results shall be compiled, with a review of the program and results every 5 years and subsequent changes made if necessary.</p>	<p>Monthly monitoring at 11 sites (see Section 7.4, Figure 7-1), including:</p> <ul style="list-style-type: none"> Lake entrance sites - Site2, Site 3 Lake edge sites – Site 3A, Site 4, Site 5 and Site 6. In- lake sites – NS1, NS2, NS3, EW1, EW2 <p>Refer to potential contamination sites, Figure 2-27 in Synthesis Report (BMT, 2019a).</p>	\$50,000 / year plus staff costs (time) of \$4,000 / year	WCC on behalf of WCC and SCC Supporting: OEH	Year 1 to Year 5, then reviewed	Annual summary reports completed, displaying monthly monitoring data and analysis of results. Fiver year review undertaken.	Refer to Section 7.4 for detailed information on the monitoring program. WCC's program follows standard procedures consistent with the MER protocols (refer Roper et al, 2011). Other specific monitoring actions are outlined without other management actions, such as WQ2. All will be consistent in methodology and linked to provide effective management advice.
WQ8	<p>Undertake water quality monitoring for Recreational Use in accordance with the NSW Beachwatch sampling protocols. This typically involves sampling for <i>Enterococci</i> over the summer period, and as needed on an event-basis.</p>	Monitoring of 4 sites (BW1, BW2, BW3 and ELL see Section 7.4 Figure 7-1), typically over the summer period.	\$10,000 / year plus staff costs (time) of \$4,000/ year	WCC on behalf of WCC and SCC.	Year 1 to Year 5, then reviewed	Beachwatch data is collected and available to the public during summer, and as needed.	Refer to Section 7.4 for other details.

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time- frame (subject to available funding and resources)	Performance Measure	Further Information / References
WQ9	<p>Investigate and manage potential pollution sources including contaminated sites that contribute to poor water quality in the Lake:</p> <ul style="list-style-type: none"> Gather ground and surface water quality monitoring data from active and historical contaminated sites which may have been collected in accordance with EPA Environment Protection Licence conditions, EPA management of Significantly Contaminated Land, EPA/WCC/SCC management of pollution incidents and conditions of consent of Development Applications. Map the areas of contamination/potential contamination. Identify data gaps. Identify which of the areas are currently being managed and which ones there is scope for improved management. Develop (in consultation with relevant land managers) and implement a ground and/or surface water quality monitoring program targeting potential point source locations, particularly where no historical data is available. WCC/SCC/EPA undertakes negotiation/enforcement action with site owners for remediation. Any involvement by the EPA would be in accordance with their current legislative responsibilities under the Protection of the Environment Operations Act 1997 and the Contaminated Land Management Act 1997. Integrate new contamination information with environmental planning and development assessment policy, procedures and tools including DCPs, development assessment procedures, licence agreements, planning certificates and mapping. 	<p>Griffins Bay – e.g. from Kemblawarra Industrial area (nutrients and chlorophyll a measured at high levels in Griffins Bay in the past. Metals also possible).</p> <p>Windang Peninsula (from historical uncontrolled emplacement of fill)</p> <p>Haywards Bay (emplacement of fill)</p> <p>Tallawarra Power Station</p> <p>Illawarra Regional Airport (PFAS)</p> <p>Warrawong Tank Trap</p> <p>Woolshed Tannery</p> <p>There may be other potential contamination sources and sites.</p>	\$60,000 per annum, plus staff time.	WCC and SCC Supporting: EPA, industries conducting monitoring under licence or other conditions.	Year 2 to 5	<ul style="list-style-type: none"> Sources of contamination , and sites that are likely to be the source(s) are identified The EPA/WCC/SCC has commenced negotiations/enforcement actions with site owners for remediation of runoff (in surface and / or groundwater). 	<p>Sydney Water has a database of some contamination report available for the Lake Illawarra area, these report can be supplied to WCC and SCC upon request (with signed data licence agreement).</p> <p>It should be noted that the ground water monitoring associated with the Haywards Bay development emplacement did not consider geotechnical issues and the flow path is interrupted by an impermeable/very low permeability high that stops the contaminant from reaching the last test point.</p> <p>Refer to each Councils contaminated land registers; a constraint may be the standard DCP template.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time- frame (subject to available funding and resources)	Performance Measure	Further Information / References
WQ10	<p>Undertake water quality monitoring of physico-chemical and bacteriological indicators in the Lake catchment.</p> <p>Review existing programs. Develop a revised program to address the following issues:</p> <ul style="list-style-type: none"> • Localised pollution incidents that trigger further investigation; • Pre- and post- development indicators; • Link to management actions; and • Link to WQ1. • Add additional monitoring locations to account for future development (e.g. Yallah Bay) 	Catchment wide.	\$60, 000 / year plus staff time	SCC, WCC Supporting: OEH	Year 1 then ongoing	Program is developed. Annual summary reports completed.	Refer WQ1

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4.2 Improve Planning and Management Arrangements for the Lake (PM)

Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Timeframe <i>subject to available funding and resources</i>	Performance Measure	Further Information / References
PM1	<p>Commence integration of key objectives and strategies from the CMP into relevant planning and policy documents of both Councils, including the following actions:</p> <ul style="list-style-type: none"> Update the DCPs and relevant consent conditions to specify vegetation buffers, stormwater treatment measures and nutrient/sediment load reduction targets for development within the Lake catchment consistent with outcomes of WQ1, foreshore setbacks, and/or other relevant planning controls, for long term inundation risks (public and private lands), and the Environmentally Friendly Seawall Guidelines. Update or produce new POMs for community or crown land to include relevant CMP actions / objectives. Consider CMP management areas and objectives when revising the LEP. Review and update both Councils' DA checklists to promote preservation of vegetation, erosion and sediment control, management of nutrient and sediment exports, tidal inundation, and landscaping for new developments. Review and update local area plans (e.g. the Windang Town Centre Plan) to include CMP actions and reflect CMP objectives where relevant (e.g. bank protection methods, estuarine vegetation management etc). Work towards the incorporation of actions into regional and state programs and plans. Develop Council policies as required to implement CMP objectives and actions. Provide input to RMS when reviewing the NSW Maritime Infrastructure Plan 2019-2024 to have consistency with the proposed Lake Illawarra Waterways Facilities Plan (see RA1) in terms of recreational facilities; and to provide information relevant to speed / usage of boats in key fauna habitat areas. Provide input to DPI Fisheries when reviewing the commercial fishing status of the Lake regarding benefits or otherwise of commercial fishing being permitted in the Lake. 	Catchment wide	Staff time + consultancy assistance (up to \$50,000 per activity).	WCC and SCC Supporting: DPE, DOI – Crown Lands, OEH, RMS, Sydney Water.	Year 2 to 10	<ul style="list-style-type: none"> Windang Town Centre Plan has been revised to reflect appropriate CMP actions and objectives The DCPs and relevant consent conditions have been revised to include appropriate environmental controls that support Lake health, including the Environmentally Friendly Seawall Guidelines The LEPs have been revised to consider the CMP objectives and management areas The DA checklists have been revised to include CMP actions and objectives # of POMs that are revised or produced that cite CMP actions or objectives 	<p>WCC has allocated \$25,000 to developing the Windang Town Centre Plan</p> <p>Refer also to the Illawarra-Shoalhaven Regional Plan</p> <p>WCC are working on a new Land Dedication Principles Policy, Shell Harbour are considering a similar one.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Timeframe <i>subject to available funding and resources</i>	Performance Measure	Further Information / References
PM2	<p>Provide ongoing coordinated management of the Lake, which will require ongoing support for existing staff resources, to:</p> <ul style="list-style-type: none"> • Develop governance model, and where possible, establish this through and MOU with the relevant parties • Undertake the project management of implementing the CMP. • Facilitate inclusion of CMP actions into both Councils' IPR Framework documents and business plans. • Develop and deliver a resourcing plan to deliver the CMP • Continue to coordinate the LIEMC and foster collaboration with agency stakeholders and recognise LIEMC as priority platform for relationship building between all agencies. • Compile annual reports on CMP implementation, including checking against performance measures, and reporting against supporting documents • Provide ongoing collaboration between SCC, WCC and other stakeholders on Lake management . • Investigate the formation of an Aboriginal Reference Group to support the LIEMC. • Establish a grant support fund and support the application of grants according to Council processes. • Maintain a successful relationship with the University of Wollongong and utilise student resources where possible. 	Catchment and Lake wide	\$250,000 p.a.	WCC, SCC	Year 1 and ongoing.	<p>CMP implementation targets are being met on a yearly basis</p> <p>Annual reports on CMP implementation are completed (through the IPR Framework and / or separate report as required)</p> <p>LIEMC meets four times per year.</p>	<p>This action can be linked to PM3 as an avenue to report on outcomes, build relationships, support stakeholder collaboration. The website can be further used for targeted education and marketing, community surveys etc.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Timeframe <i>subject to available funding and resources</i>	Performance Measure	Further Information / References
PM3	<p>Develop a community engagement and participation strategy that enhances the community's knowledge of, skills in, and commitment to, protecting Lake Illawarra.</p> <p>The program should aim to provide information on the ecological, cultural and commercial values of the Lake and to facilitate changes in behaviour of individuals and groups which affect specific threats. Various avenues for engagement and participation may be used, such as:</p> <ul style="list-style-type: none"> • Development of a logo and standard design theme for signage for use by both Councils • Interpretive signage at key locations to promote specific lake values / habitats • Media announcements (Newspaper, radio, TV, website) • Brochures • Field Days / Market activities • Workshops • Activities in local schools; School holiday programs • Programs targeting specific interest groups e.g. Aboriginal Community, Bushcare, fishers. • Formation of local environmental groups or support current groups to provide engagement and participation and / or undertake activities such as water quality monitoring or estuarine vegetation rehabilitation, passive compliance (e.g. using local residents to monitor and report on behaviours such as illegal vehicle access, littering, vegetation damage, illegal fishing, etc) • Promotion of and inclusion in consultation on plans of management affecting the Lake • Regular community surveys to better understand recreational activities, areas used, facilities required, and understanding of environmental issues • Monitoring (attendance numbers, changes in behaviour etc) to determine what activities / approaches are successful (and should be continued) or should be modified • Formation and maintenance of a website that outlines the environmental management of Lake Illawarra. • Annual review of community programs and processes. 	<p>Sites previously identified for signage include:</p> <p>Hooker Park and Reddall Reserve</p> <p>Foreshore Area of Davies Bay</p> <p>Koona Bay and Mogurah Point</p> <p>Macquarie Rivulet</p> <p>Purry Burry Point</p>	<p>\$80,000 p.a. for a staff member to develop program and \$20,000 p.a. to implement program (i.e. for materials, signs, staff and other resources required).</p>	<p>WCC and SCC</p> <p>Supporting: OEH, ILALC, DPI Fisheries, NPWS</p>	<p>Year 1: Develop program</p> <p>Year 2 and on an annual schedule of works: Implement program and monitor success of the different activities</p>	<p>A Community Engagement & Participation strategy specific to the Lake is developed for both Councils</p> <p>Various activities and material / media are completed and prepared on a yearly basis.</p> <p>Surveys and other monitoring activities indicate the success or otherwise of various education activities / approaches.</p>	<p>See also EV3 and PM2 for further education initiatives and collaboration for this CMP.</p> <p>Lake Illawarra Estuarine Education Resource (Meryl McKerrow, 2010)</p> <p>As part of the engagement strategy new and existing platforms should be used including; Let's Chat, Shellharbour Connect, SCC/WCC Council websites and social media platforms.</p> <p>Engagement will include Aboriginal Advisory Committee, Disability Access Inclusion Advisory Committee groups.</p> <p>Landcare may also be involved with this action.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Timeframe <i>subject to available funding and resources</i>	Performance Measure	Further Information / References
PM4	<p>Establish a Lake Illawarra Asset Management Working Group that provides coordination services for agencies that manage assets around the Lake Illawarra foreshore.</p> <p>The working group would:</p> <ul style="list-style-type: none"> Oversee the development of a framework for the coordinated management of assets around the Lake Illawarra foreshore, including potential cost sharing arrangements; Oversee a review of existing infrastructure around the Lake Illawarra foreshore and then an audit to determine priorities and service specifications for maintenance, renewal, additional assets or decommissioning as per action RA1; Facilitate the inclusion of priorities and service specifications arising from the audit into individual agency asset management plans other IP&R systems and forward planning documents as per RA1; Provide input into the planning, implementation and reporting of relevant asset management actions within the CMP in accordance to Councils IP&R Framework; Discuss asset management issues of a cross-jurisdictional nature including joint grant applications; Provide a forum for improved coordination of the management of assets, for example, the development of a Lake Illawarra Boating Plan, an Around the Lake Shared Path as per RA1; or a lake foreshore parks and reserves adaptation plan for tidal inundation (see also IR2); Provide a forum for exchange of information relating to inundation risk, particularly for forward planning of asset replacement and renewal in areas at risk of tidal or storm event inundation; Oversee and coordinate management of the entrance channel and associated channel migration issues (refer entrance channel area mapped in Figure 5-2); Produce an accurate and correct map of Lake Illawarra's public land and assets ownership and management. 	Whole of lake and foreshore	<p>Working Group \$5,000 p.a. to run plus staff time.</p> <p>Development of a Framework \$20,000</p> <p>Other actions are costed in RA1 and IR2</p>	WCC, SCC Supporting: DOI – Crown Lands and Property NSW	<p>Year 1: Coordinated Management Framework for Lake Illawarra assets endorsed by members of the Working Group.</p> <p>Year 1: Undertake review and conduct Audit.</p> <p>Year 2: Develop priorities and service specifications for agencies to incorporate into Asset Management Plans and other IP&R documents.</p> <p>Years 2-3: develop Boating Plan.</p> <p>Years 3 to 10: Implement prioritised programs</p>	<ul style="list-style-type: none"> The Lake Illawarra Asset Working Group meets at least 4 times a year. Years 1-10. Joint Management Framework for Lake Illawarra assets endorsed by members of the Working Group by end of year 1. Review and audit undertaken by end Year 1. Priorities and service specifications developed by end Year 2. Agency Asset management plans and other IP&R documents updated by end of Year 3 	This action links to RA1 action "manage foreshore and recreational waterway infrastructure", IR1 "Update Asset Management Plans to identify tidal inundation risk timeframes for asset" and IR2 Whole of Lake Foreshore Adaptation Plan.

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4.3 Manage the Entrance Channel (EC)

Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
EC1	<p>Investigate Options to Manage Erosion and Accretion Changes in the Entrance Channel and Implement Management Solutions</p> <p>This study shall investigate the hydrodynamics, sediment transport, erosion and sedimentation patterns occurring in the channel, and develop management options to address any built, environmental and cultural heritage issues, using a cost benefit analysis to assess options. The preferred solution(s) shall then be implemented.</p> <p>Options for managing entrance channel erosion and accretion include:</p> <ul style="list-style-type: none"> soft methods such as sand nourishment, dune repairs, dredging of marine sand for reuse on eroded areas or nearby beaches e.g. Warilla); hard structures e.g. revetments or groynes; or strategic retreat other options e.g. retreat (e.g. erosion on island foreshore where no assets) or limiting ongoing tidal velocity and tidal prism increase. <p>These methods have different environmental and long-term impacts, and may affect the ability to implement other methods in future (e.g. permanent structures are difficult to change once implemented). This must be considered when selecting an erosion control approach. The potential impact on cultural heritage sites from erosion and / or the management action selected must also be considered. Erosion control methods need to optimise environmental outcomes as well as being technically, economically and socially feasible. Changes to the entrance channel affect the entire lake water quality and ecology.</p> <p><i>Note: emergency management and other works may be required for some assets, to ensure public safety before the options study is completed</i></p>	<p>Investigation Area: Entrance Channel (and adjacent coastal or lake zones as required to inform study). The entrance channel is defined as the area between the eastward margin of the ebb tide delta and western margin of the flood tide delta and adjoining lands.</p> <p>Areas in the channel known to be experiencing erosion:</p> <ul style="list-style-type: none"> northern shore of the entrance channel between along Windang Foreshore Park and Windang Beach Tourist Park northern point of Reddall Reserve northern shore of Picnic Island Bevans Island, Berageree Island, swimming lagoon wall, southern training wall and the Windang Bridge. <p>Areas in the channel known to be experiencing sedimentation (deposition / accretion):</p> <ul style="list-style-type: none"> Flood tide delta (drop over) entering the Lake waterbody Some sections of the southern foreshore of the Lake (e.g. swimming areas of Reddall Reserve) 	<p>Lake entrance processes and management options study: (\$460,000, already programmed).</p> <p>Stage 2 detailed options investigation and design (including cost benefit analysis): \$0.5 - \$1M.</p> <p>Implement actions to address foreshore erosion, channel scour and accretion - \$2-5M; longer term actions to control tidal velocity / prism / range increase: \$10-20M.</p>	<p>WCC, SCC, DOI – Crown Lands</p> <p>Supporting: OEH, DOI – Crown Lands, DPI Fisheries</p>	<p>Year 1-2: Conduct investigation</p> <p>Year 3-4: Conduct Options Assessment</p> <p>Year 5-10: Implement preferred options</p>	<p>Study of issues and potential management responses for the entrance channel is completed</p> <p>Preferred actions are implemented</p> <p>Preferred actions are monitored as being effective and environmentally sensitive</p>	<p>Should the preferred action involve dredging of marine sand, and the sand not be required for remediating erosion elsewhere in the channel, that SCC would seek to re-use this sand to nourish Warilla Beach (in accordance with the Shellharbour CZMP), with monitoring for effectiveness and adverse / positive effects on surfing conditions and amenity.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
EC2	<p>Undertake small scale works (e.g. beach scraping, re-shaping etc) to maintain swimming areas.</p> <p>This action allows for dredging and / or beach scraping/re-shaping to improve the recreational amenity of swimming areas in the channel.</p>	Swimming areas of Reddall Reserve.	\$50,000 - \$150,000 per event.	WCC, SCC Supporting: DOI – Crown Lands, RMS, OEH, DPI Fisheries	As required	Access and amenity is restored to swimming and other waterway amenity areas.	Needs to be consistent with EC1.
EC3	<p>Undertake dredging in the entrance channel, as required to maintain navigation</p> <ul style="list-style-type: none"> Undertake dredging when needed to manage sedimentation and improve navigability, and provided dredging is consistent with the preferred solution derived in Action EC1. Reuse dredged marine sand on nearby beaches (e.g. Warilla, Perkins Beach) and suitable lake foreshores. Monitor the success of the dredging in terms of longevity of navigation, effectiveness /longevity of nourished beaches, adverse / positive impacts on surfing breaks / sand bars, and beach amenity. 	<p>Entrance Channel only such as:</p> <ul style="list-style-type: none"> secondary tidal channel opposite Reddall Reserve Flood tide delta 	\$2 million (per event, estimate based on dredging conducted in 2007)	WCC, SCC, DOI – Crown Lands Supporting: RMS, OEH, DPI Fisheries	As required	The dredging campaign has had positive outcomes for navigation and for beach nourishment	Needs to be consistent with Action EC1. If the sand is not required for remediating erosion elsewhere in the channel, SCC would seek to re-use this sand to nourish Warilla Beach (in accordance with the Shellharbour CZMP)
EC4	<p>Monitor changes to the entrance channel.</p> <p>Topographic and bathymetric surveys (using ALS or other efficient method) should be undertaken regularly (every 1-2 years), and the data analysed to determine the trajectory of erosion and accretion patterns occurring in the entrance channel (e.g. bank erosion / accretion and channel migration, deepening or filling), since construction of the breakwaters, and in relation to any further structural works (such as completed through EC1). This action will inform EC3.</p>	Entire entrance channel area, from entrance shoals in the surf zone east of the breakwaters to the drop over inside the Lake.	Drone surveys ~\$10,000 to establish, then \$5,000 per repeat.	WCC, SCC Supporting: OEH, DOI –Crown Lands	Year 1, then every 2 – 5 years or after major storm events	A topographic and bathymetric survey is completed and analysed for changes in the entrance channel at least every 5 years	Subject to statewide priorities, OEH can commission the surveys and share this data with the Councils (and other agencies as needed).

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost <i>(subject to available funding)</i>	Responsibility, Supporting Organisations	Time-frame <i>(subject to available funding and resources)</i>	Performance Measure	Further Information / References
EC5	<p>Monitor, maintain and if required, upgrade existing entrance channel infrastructure, with any works to be informed by EC1-EC2 and EC4.</p> <p>Infrastructure includes but is not limited to:</p> <ul style="list-style-type: none"> • training works • breakwaters • groynes • revetments. 	Entrance Channel	\$150,000 - \$240,000 pa	DOI – Crown Lands Supporting: WCC, SCC, DPI Fisheries and OEH,	Ongoing	Ensure entrance infrastructure is fit for purpose, structurally sound and safe for use.	

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4.4 Protect and Rehabilitate Estuarine and Riparian Vegetation (EV)

Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
EV1	<p>Rehabilitate vegetation and manage public access along foreshores and banks of the Lake, its tributaries, islands and broader low-lying areas. This shall require:</p> <ul style="list-style-type: none"> a site inspection to confirm known and identify new rehabilitation sites; and prioritisation and preparation of a detailed implementation program and action plan for locations, detailing: <ul style="list-style-type: none"> rehabilitation using endemic species, in accordance with best practice, and in line with community values; weed and pest control in accordance with regional pest plans; fencing / access restrictions for sensitive areas, with educational signage to explain activities and damage caused by informal access, mowing, tree lopping etc; permanent public access arrangements, i.e. provision of new / repaired access ways, boardwalks, shared cycleways etc, designed to limit damage to sensitive areas, which may include keeping people on paths; potential impact on cultural heritage sites associated with degraded habitat and / or rehabilitation works; Support for and assistance from volunteer Landcare groups (e.g. Budjong Creek Landcare, Bushcare, Aboriginal Bush Regeneration groups. Support includes funding, technical advice, training, and equipment. Continue to fund and implement Council restoration programs in the Lake and catchment. 	<p>Action to cover Lake foreshores, island foreshores, creek banks and broader low-lying areas around the Lake and tributaries, including coastal wetlands and littoral rainforest areas as defined in the State Environmental Planning Policy (Coastal Management) 2018 if required, and including such areas as:</p> <ul style="list-style-type: none"> Picnic Island (\$10,000); Berageree Island, Pelican View Reserve (\$10,000); Bevans Island, Cudgerree Island (\$5,000), Hooker Park, Boonerah Point Reserve, Whyjuck Bay. Karoo Bay, Moureendah Bay, Oaky Creek. Burroo and Koono Bay, northern bank of Horsley Inlet upstream of Slaters Bridge, Macquarie Rivulet. Shared cost for Horsley, Oaky and Macquarie Rivulet: \$65,000 p.a. Duck Creek (wetlands and riparian corridor, under control of EnergyAustralia) (\$500,000); Nijong Bay. Yallah Bay, Tallawarra Point, Boomberry Point. Mullet Creek, and Purrah Bay (\$500,000, including formal access to reduce uncontrolled damage); Kanahooka foreshore including Brooks Creek. Fred Finch Park (Hooka Creek, Hooka Point Park and Hooka Creek wetland). Berkeley Boat Harbour, Tuggerah Bay. Wollamai Point (\$20,000 p.a.); Lake Heights foreshore, Minnegang Creek, Creek adjacent to Kully Bay Oval. Kully Bay Wetland; Griffins Bay (\$200,000, inc. formal access/boardwalk). 	<p>Bushland weed control and rehabilitation works typically ~ \$2,000-\$10,000 per hectare; small scale foreshore access paths typically \$5,000 - \$20,000.</p>	<p>WCC, SCC; Energy Australia (for their lands only), Property NSW, DOI - Crown Lands</p> <p>Supporting: OEH, DPI Fisheries, NPWS, LLS, CVA, ILALC, NSW Biodiversity Conservation Trust</p>	<p>Year 1 and ongoing (new works and / or upkeep)</p>	<p>Number of hectares of estuarine and riparian vegetation managed / protected.</p>	<p>See also the Purry Burry Point to Heritage Park Site Restoration Plan (2013), Berkeley Nature Reserve POM, Picnic Island Reserve POM; Pelican View POM, Boonerah Point Vegetation Management Plan, Judbooley Parade Landscape Master Plan and POM, Generic POM for the Community Land of WCC, and other relevant community or crown land Plans of Management. This action will also benefit water quality as revegetation throughout the catchment reduces sediment run off into waterways.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
	<ul style="list-style-type: none"> In conjunction with revegetation works, some bank reshaping and erosion control works may be required, particularly on tributaries and creek banks and foreshores Support the implementation of the POM for the Berkeley Nature Reserve. Advocate for appropriate creation of biodiversity stewardship sites and consider possible dedication of biodiversity stewardship sites in the Lake catchment. Support where appropriate increased conservation outcomes and increased vegetation and biodiversity management actions that are proposed in future biodiversity certification applications in the Lake catchment Assess parks and sports grounds fringing the Lake for areas suitable for native vegetation. This can increase habitat, connect corridors of vegetation as well as adding shade trees to sports field perimeters. Action includes all important fringing / riparian vegetation, e.g. Swamp Oak Floodplain Forest. 	<ul style="list-style-type: none"> Korungulla Wetland. Foreshore from Purry Burry Point to Cudgeree Bay, Windang Peninsula. Natural Areas Restoration Program for 3 areas within the WCC LGA: Lake Projects West, North and East (\$190,000 p.a. over Years 1 to 3, already committed). This shall require facilitation of work on private lands. 					Landcare, MEMA and CVA may also be involved with this action.
EV2	<p>Undertake targeted action to control damage to foreshore and lake vegetation, including seagrasses, caused by:</p> <ul style="list-style-type: none"> 4WDs and other vehicles, bikes (including BMX), boating activities, unfenced stock, mowing practices, tree damage and removal, pedestrians, illegal structures (e.g. land reclamation, seawalls, boat ramps (formal or informal), BBQs, seating, fencing, private signage), 	<p>Action is relevant lake wide, with known areas outlined below.</p> <ul style="list-style-type: none"> Foreshore between Jettys by the Lake and Oaklands Village, Windang Whyjuck Bay Mogurah Point, and Yangar Point (restrict access to reduce vegetation clearing, mowing and excessive access, Oak Flats foreshore, Davies Bay and Karoo Bay. Koona Bay (south eastern side), Burroo Bay, Kurrura Point. Macquarie Rivulet coastal wetlands (CM SEPP) area (issues with cattle, 4WDs and other vehicles); Koonawarra Bay 	<p>Depending on physical barrier selected, cost may range from \$10,000 to \$100,000.</p> <p>Additional staff resources for compliance \$80,000 p.a. (shared across both councils).</p>	<p>WCC, SCC, DPI Fisheries.</p> <p>Supporting: DOI – Crown Lands, OEH, NPWS, RMS, LLS.</p>	<p>Year 1 and ongoing</p>	<ul style="list-style-type: none"> Number of hectares of vegetation managed (on private and public land). 	<p>See also the Purry Burry Point to Heritage Park Site Restoration Plan (2013), Berkeley Nature Reserve POM, Picnic Island Reserve POM; Pelican View POM, Boonerah Point Vegetation Management Plan, Judbooley Parade</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
	<ul style="list-style-type: none"> hand gathering (e.g. cockles etc). <p>Actions may include:</p> <ul style="list-style-type: none"> Prioritise and prepare detailed implementation program for mapped locations. Bollards / fencing / gates etc to restrict illegal access (provided they are low key from a visual perspective). Signs to explain estuarine habitat values. Signs or other impediment to replace vegetation removed. Removal of illegal structures (in consultation with landowners). Improved surveillance and compliance (through additional staff resources). Develop a policy for mowing practices on public foreshore lands, and educate Council works staff regarding the policy. Monitor the success of the different approaches for reducing access and damage and modify future approaches accordingly. Managing impacts on cultural heritage sites from vegetation damage and / or access. This may include negotiating voluntary acquisition of critical lands with sensitive habitats. 	<ul style="list-style-type: none"> Brooks Creek Delta (southern end, issues with bike jumps and other activities). Koonawarra Bay (North), Purrah Bay. Hooka Creek, Hooka Point and Berkeley foreshore. Park east of Wollamai Point Primbee Bay (BBQs, ramps, seats), Griffins Bay. Purry Burry Point saltmarsh community (issues with 4WDs), and foreshore southward to Windang <p>Note: there may be new areas identified in the future where similar rehab works need to occur, consistent with best practice and that have minimal disturbance, e.g. in the coastal wetlands and littoral rainforest areas.</p> <p>Tidal inundation may increase the prevalence of illegal / ad hoc structures where foreshore areas are being slowly and permanently reduced in size.</p>					<p>Landscape Master Plan and POM, Generic POM for the Community Land of WCC, and other relevant community or crown land Plans of Management.</p> <p>Target areas: where problems have occurred; and where new view conflicts may arise due to mangrove growth (see medium priority areas from Williams and Wiecek, 2017). MEMA may be involved with this action.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
EV3	<p>Prepare and deliver an information program for the Lake Catchment on:</p> <ul style="list-style-type: none"> mowing and gardening around sensitive foreshore vegetation; the legalities of building of structures (BBQs, seating, boat ramps, seawalls, land reclamation, fences, etc); environmentally friendly designs, habitat rehabilitation options, and planning and approval requirements for foreshore structures and works; illegal access and dumping; the importance of undertaking appropriate and ongoing Pest and Weed Management activities; threatened flora and fauna species, migratory birds and EECs that the Lake supports, and; vegetation damage and removal. <p>Information can include:</p> <ul style="list-style-type: none"> the importance of estuarine vegetation for ecological function, bank protection and water quality; the natural increase in mangroves in the Lake since lake opening; surveillance and reporting methods and prosecution / fines for offences. <p>Activities could include</p> <ul style="list-style-type: none"> Identifying Lake users associated with threatening activities that have a representative organisation or individual, or another means through which they can be reached as a group, with aim to facilitate partnerships to increase community engagement & participation. Develop partnerships that aim for understanding of community needs & use negotiation to reach agreement. field days, brochures, and / or workshops, and signage at relevant locations. Training for Council staff. <p>Audiences may include:</p> <ul style="list-style-type: none"> foreshore land owners, council works staff, landscapers/ builders, and via high schools and general community. DA officers and building certifiers etc. who approve or design foreshore works (for education regarding foreshore structures). 	Catchment wide.	\$20,000 to develop program, plus \$10,000 p.a. for staff time and resources to implement.	WCC, SCC. Supporting: OEH, CVA, LLS, DPI Fisheries and NPWS.	Year 1 and ongoing	Information program is developed by end Year 2 and incorporated into PM3. At least 2 successful partnerships established annually with Lake user groups & relevant activities / programs developed & delivered through those groups.	This action links with PM3. Target areas: where problems have occurred; and where new view conflicts may arise due to mangrove growth (see medium priority areas from Williams and Wiecek, 2017). Council/ other organisations Communication Policies. Lake Illawarra Estuary Management Education Program. Developed by WCC and Dep't of Education 2010. Ocean Watch, Landcare and CVA may also be involved with this action.

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
EV4	<p>Prepare and implement an estuarine macrophyte mapping and monitoring program.</p> <ul style="list-style-type: none"> Undertake estuarine macrophyte mapping for the entire lake, to determine the current coverage and distribution of mangroves, saltmarsh and seagrass. Determine changes in distribution and coverage of macrophytes, by a comparison with the previous mapping. Monitor areas identified as high and medium priority for conservation of saltmarsh in foreshore prioritisation maps (see Appendix F) for 2 years. If it can be shown mangroves are having an impact on saltmarsh, work with relevant stakeholders to determine best strategies to minimise ongoing impacts. Repeat lake wide estuarine macrophyte mapping and analysis every 5 years. 	<p>Lake wide.</p> <p>For comparison of mangroves and saltmarsh, focus on Medium and High Priority areas identified in the Foreshore Prioritisation Maps (as per mapping by Williams and Wiecek (2017), in Figure 7-2, Section 7.4)</p>	<p>\$25,000 per mapping episode, \$10,000 for area specific macrophyte monitoring.</p>	<p>WCC, SCC</p> <p>Supporting: OEH, DPI Fisheries</p>	<p>Year 1 and ongoing</p>	<p>Estuarine macrophyte mapping and analysis completed by Year 2.</p> <p>Area specific monitoring completed by Year 4.</p> <p>Estuarine macrophyte mapping and analysis repeated by Year 6 and Year 10.</p>	<p>This action links with EV5.</p> <p>Refer to guidance in <i>Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols</i> (State of NSW and OEH, 2016).</p> <p>MEMA may also be involved with this action.</p>
EV5	<p>Develop and implement a program to enhance opportunities for estuarine vegetation migration.</p> <ul style="list-style-type: none"> Build on previous work to identify areas that could be modified or managed to permit migration and colonisation by saltmarsh. Previous work is illustrated in Figure 7-2, and in Figure 7-3 with respect to tidal inundation projections, as a starting point of priority areas. From EV4, add areas where action is required to manage saltmarsh retreat. Implement actions to allow saltmarsh migration or manage retreat, e.g. by: land repurchase, MOUs with landowners, removal of physical barriers (e.g. walls, paths) and levelling land. 	<p>Potential areas for migration are identified in the Foreshore Prioritisation Maps, based Williams and Wiecek (2017) mapping in Figure 7-2, and Figure 7-3, in Section 7.4.7).</p>	<p>Staff time or consultancy (\$25,000) to develop and progress action program to achieve security of migration areas into the future. Additional \$ to implement actions.</p>	<p>WCC, SCC.</p> <p>Supporting: OEH, DPI Fisheries, DPE.</p>	<p>Year 2 to 10</p>	<p>Areas are identified and program is prepared by end Year 5.</p> <p>Number of locations where modifications have been made to promote migration or manage retreat.</p>	<p>This action links to / follows on from EV4.</p> <p>Refer to Section 7.4.7, and recommendations by Williams and Wiecek (2017).</p> <p>MEMA may also be involved with this action.</p>

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4.5 Maintain and Improve Recreation and Amenity (RA)

Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
RA1	<p>Manage foreshore and waterway recreational infrastructure in accordance with available Transport and Recreation Asset Management Plans, informed by Plans of Management and approved recreation masterplans.</p> <ol style="list-style-type: none"> 1. Prepare in consultation with Transport NSW and the RMS, the Lake Illawarra Waterways Facilities Plan that prioritises boating facility upgrades based on factors including but not limited to user demand, existing facilities and available navigational access. 2. Undertake a review of existing information on recreational infrastructure (i.e. established hierarchies, recommendations from maintenance programs for existing facilities, user needs now and into the future with population growth, tidal inundation (see IR1) etc, ownership and responsibility (connection with IR2), costs and other resources) and prepare a comprehensive audit and risk assessment to inform next actions (upgrades, renewals, replacements, strategic retreat etc). 3. Consider the provision of additional facilities during the audit (e.g. BBQs, picnic shelters, drinking water stations, toilets, fitness equipment, fish cleaning stations, lighting, dog bags, BMX / skate parks etc). 4. Establish service specifications for priority existing foreshore assets for inclusion in Agency and Council asset management plans and other IP&R documents based on the audit, including ongoing maintenance, upgrades / renewal, replacement, additions to or decommissioning of existing assets. 5. Develop priorities for new assets and improved assets to be incorporated into relevant WCC, SCC, Property NSW and DOI – Crown Lands planning documents for future budget consideration. 6. Upgrades, maintenance and new infrastructure should be designed to be environmentally and fish friendly. 	<p>Works currently programmed include:</p> <ul style="list-style-type: none"> • Reddall Reserve Foreshore Renewal (\$250,000) • Skiway Park renewal of carpark etc (\$1,000,000) • Renew Deakin Reserve carpark and facilities (estimated \$250,000) • Lake Cycleway renewal: Lake Heights to Berkeley Boat Harbour (\$120,000) • Primbee to Windang: Shared path renewal along Windang Road (\$100,000) • Windang foreshore repairs to boardwalk, retaining structures and boat ramp (\$500,000) <p>Future work locations are to be determined by the audit (2) and Lake Illawarra Boating Plan (1).</p>	<p>Maintenance: \$5,000 per item for an estimated 25 sites p.a. (total of \$125,000 p.a.)</p> <p>Programmed upgrades of \$2.22 million.</p> <p>Independent audit: \$60,000 (\$20,000 to DOI – Crown Lands and \$40,000 to WCC/SCC).</p> <p>Lake Illawarra Waterway Facilities Plan: \$50,000.</p> <p>Future upgrades determined through the audit are estimated at a total of \$740,000 per year based on current programmed works, to be confirmed through the course of this action.</p>	<p>WCC, SCC, DOI – Crown Lands, Property NSW</p> <p>Supporting: RMS, DPI Fisheries</p>	<p>Year 1-2: Undertake review and conduct Audit.</p> <p>Year 2-3: Develop prioritised program. Incorporate into forward planning documents, existing Asset Management Plans and other IP&R documents.</p> <p>Years 2-3: develop Boating Plan.</p> <p>Years 4 to 10: Implement prioritised program and asset management plans.</p>	<p>Review and audit undertaken by end Year 2.</p> <p>Prioritised program developed and incorporate new assets into planning documents by end Year 3.</p> <p>Asset management plans and other IP&R documents updated by end of Year 3</p> <p>Boating Plan for Lake Illawarra developed by end Year 3.</p> <p>Prioritised Program and asset management plans are implemented by end Year 10.</p> <p>Yearly maintenance of assets is undertaken.</p>	<p>Ownership of some land and assets around Lake Illawarra is fragmented.</p> <p>Refer to Land Tenure map for current status of land ownership and responsibility for this action</p> <p>This action links to action PM4 “Establish a Lake Illawarra Asset Management Working Group.</p> <p>The action also links with IR1 “Update Asset Management Plans to identify tidal inundation risk timeframes for asset”.</p> <p>Transport NSW may also need to be involved in this action. Links to EC actions</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
RA2	<p>Construct new sections of shared pathway to complete the pathway linkage around the Lake.</p> <ul style="list-style-type: none"> Remove and rehabilitate informal / degraded tracks as new sections are completed. Consider disabled access and facilities, bubblers / drinking stations, and lighting when designing new shared pathway sections. The shared pathway will not be extended through sensitive environmental and / or cultural areas and its siting will accommodate current and future site constraints including tidal inundation. 	<p>Works currently programmed include:</p> <ul style="list-style-type: none"> Feasibility and constraints mapping for an Around the Lake Shared Path Plan (\$120,000). Koona Bay (future stages, design \$50,000; Kanahooka St to Shearwater Blvd likely on-road construction \$350,000) <p><i>Note: location not mapped as preferred siting for this path is yet to be determined.</i></p> <p>Listed below (but not mapped) are locations for shared paths requested by the community for future consideration, but that are not currently in SCC or WCC Infrastructure Delivery Programs:</p> <ul style="list-style-type: none"> Community request a shared pathway link from Macquarie Rivulet to Tallawarra Power Station (so that cyclists do not need to use the highway with 100km speed limit). As part of this, investigate providing shared pathway to Haywards Bay. Kanahooka Point to Purrah Bay; Shared path bridge over Mullet Creek, from Purrah Bay to Currungoba Peninsula Currungoba Peninsula / Koong Burry Bay foreshore, linking to Hooka Park and crossing of Hooka Creek. 	<p>Programmed works: \$520,000.</p> <p>Future works are estimated at \$100,000 to \$1,000,000 per path including design costs, depending on style and length.</p>	<p>WCC, SCC, Private Developers through s94 provisions.</p> <p>Supporting: DOI – Crown Lands, RMS, DPI Fisheries, Property NSW</p>	<p>Year 2: develop Around the Lake Shared Path study.</p> <p>Year 1 to 10: implement upgrades and extensions to cycleway.</p>	<p>Pathway alignments determined by end Year 2.</p> <p>Prioritised program for new path construction developed by Year 3.</p>	<p>While formal access paths will also be constructed through action EV1, sites listed under this action and RA2 are primarily for community and recreational use. This action links to RA3 – public right of way.</p>
RA3	<p>Investigate the opportunities of public access along the foreshore and amend the acquisition layers of the relevant Council Local Environmental Plans if applicable.</p> <p>As part of development applications or rezoning proposals, negotiate with land owners regarding public and private foreshore ownership and allow public access along private foreshore sections as opportunities present themselves.</p>	<p>Apply to areas as appropriate.</p>	<p>Staff time</p>	<p>WCC and SCC</p> <p>Supporting: DOI – Crown Lands, OEH</p>	<p>Year 5 to 10</p>	<p>Length (m) of foreshore where public access is achieved.</p>	<p>Some properties are already designated for acquisition, specific to the Wollongong LEP.</p> <p>Linked to RA2 and objectives around improving public access to the foreshore.</p>

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4.6 Protect and Promote Cultural Heritage (CH)

Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
CH1	<p>Protect and promote cultural heritage in and around the Lake and its catchment.</p> <p>Employ a Cultural Heritage Officer to work on Lake Illawarra with assistance from Federal or State funding processes. This person will work with the Aboriginal and non-indigenous community to further cultural awareness activities, such as:</p> <ul style="list-style-type: none"> Develop and implement a Conservation Management Plan for Lake Illawarra to achieve conservation and protection of Aboriginal heritage sites recognised as being at risk. Protection of eroding heritage sites is also captured by Action FB1. Undertake a strategic review of foreshore infrastructure to consider the heritage and cultural significance of sites such as the Tank Trap and Dix's Wharf. Support trials in cultural burning, assisting in monitoring and evaluation and supporting follow up reporting of outcomes. Build cultural links with other strategies when implementing the CMP. This could include education materials, signage, provision of facilities, rehabilitation works, etc. Encourage suitable cultural tourism ventures in and around the Lake. Implement the re-naming / shared naming of sites of cultural significance around Lake Illawarra to name of relevant Aboriginal origin. Organise a 'festival of the Lake' event that celebrates the areas cultural and ecological values. Develop an Illawarra Events Strategy which integrates compulsory cultural recognition of the Lake and its values into key community events. Support the continuation of the Lake Illawarra Arts Trail around the entire lake foreshore. 	Lake wide	<p>\$100,000 p.a. for additional staff resource. \$20,000 p.a. for operating costs.</p> <p>Costs for heritage protection works included with FB1.</p>	<p>WCC, SCC</p> <p>Supporting: OEH, ILALC, LLS, NPWS.</p>	Year 1 and ongoing		<p>Dance hall on Gooseberry Island (managed by NPWS under the Berkeley Nature Reserve Plan of Management) is an example of a non-indigenous heritage site.</p> <p>Unknown what heritage protection works will be required over the 10 year life of the plan, therefore costings for this have not been included in the business plan.</p> <p>Fire and Rescue and RFS may also need to be involved with this action.</p> <p>This action links to PM3.</p>

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4.7 Manage Foreshore and Bank Erosion and Sedimentation (FB)

Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
FB1	<p>Undertake a bank condition assessment and determine and implement erosion control measures.</p> <ul style="list-style-type: none"> Undertake a bank condition assessment of lake and tributaries to the tidal limit (and beyond if resourcing allows) to map foreshores experiencing erosion. Identify the likely causes of erosion (e.g. stormwater outflow, wind waves, tidal currents). Prioritise the sites based on their severity, risks from ongoing erosion (e.g. to public safety, nearby seagrasses etc), and feasibility and cost of controlling erosion / management action. Determine feasible and appropriate erosion control measure that also optimise environmental outcomes. Concept designs for remedial action should preference the use of revegetation, or otherwise utilise the environmentally friendly seawall guidelines for engineered solutions and aim to improve habitat connectivity and protection of cultural heritage. Potential disturbance of cultural heritage needs also be considered in designs. Monitor success or otherwise of remedial action. Provide bank condition assessment and outcomes to relevant land management authorities including DOI – Crown Lands to assist them in managing their assets. 	<p>A bank condition survey of entire Lake foreshore and tributary creeks to the tidal limit is required to identify current sites of erosion (see actions details and further information).</p> <p><i>While it is noted that foreshores are variously in public and private ownership, identifying all sites allows state agencies to work with private land owners to achieve consistent remediation outcomes.</i></p>	<p>\$70,000 for consultancy for bank condition assessment (allocation of \$15,000 to DOI – Crown Lands and \$55,000 to WCC/SCC) (survey, identification of causes, prioritisation and erosion control recommendations).</p> <p>\$5,000 p.a. for monitoring.</p> <p>\$20,000 to \$200,000 per site for erosion control works, depending on requirements.</p>	<p>WCC, SCC</p> <p>Supporting: OEH, DOI, Lands & Water, DPI Fisheries, LLS</p>	<p>Year 1: Conduct bank condition assessment</p> <p>Year 2 onwards: begin implementing erosion control works. Monitor low risk sites for change in erosion risks.</p> <p>Year 3 and ongoing: monitor effectiveness of erosion control measures.</p>	<p>Bank condition assessment and report is completed by Year 2.</p> <p># of sites where erosion control is implemented.</p> <p># of sites where monitoring demonstrates remedial works are effective.</p>	<p>Due to the lapse of time and the focus on using revegetation to manage many erosion issues (see EV1), the mapping by OEH and LIA of eroding sites is no longer current, and therefore requires updating.</p> <p>The bank condition survey could be teamed with Action FB3, depending on time constraints and methods used.</p>
FB2	<p>Implement Environmentally Friendly Seawall Guidelines or similar for new and upgraded foreshore protection works.</p> <p>This action aims to improve the environmental performance and outcomes for foreshore protection works when the renewal of existing or construction of new infrastructure is required, where appropriate and feasible to do so. The Environmentally Friendly Seawall Guidelines or similar should be used in upgrade designs, to improve the environmental benefits of existing structures.</p>	<p>Locations include:</p> <ul style="list-style-type: none"> Oaklands Village to Jettys by the Lake. Skiway Park Illawarra Yacht Club structures 	<p>\$50,000 to \$150,000 per site, depending on requirements.</p>	<p>WCC, SCC, DOI – Crown Lands</p> <p>Supporting: OEH, DPI Fisheries</p>	<p>Year 2 onwards</p>	<p># of sites upgraded by Year 5.</p>	<p>EC1 will provide information for the entrance channel.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost <i>(subject to available funding)</i>	Responsibility, Supporting Organisations	Time-frame <i>(subject to available funding and resources)</i>	Performance Measure	Further Information / References
FB3	<p>Undertake a bathymetric survey of the entire Lake and tributaries up to the tidal limit.</p> <p>Survey should be conducted along transects used previously in the tributary creeks. Methods such as marine-based LiDAR should be considered. Survey should be compared with previous surveys, to determine if and where sedimentation / erosion is occurring on the Lake or creek bed. Survey to be completed every 10 – 20 years. Senior Management Team in both Councils to be informed when complete.</p>	Entire Lake waterbody and all tributary creeks up to the tidal limit (Future surveys can capture beyond the tidal limit).	\$50,000	WCC, SCC Supporting: OEH	Year 5	A whole of lake and tributary bathymetric survey has been completed and analysed against historical data	

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4.8 Prepare for Inundation Risks (IR)

Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
IR1	<p>Update Asset Management Plans for all publicly owned and managed assets to clearly identify asset at risk from inundation over future timeframes, including tidal inundation.</p> <p>This involves notation of the risk of periodic and permanent inundation on asset management registers for roads, stormwater infrastructure, sewer and water infrastructure, community facilities including parks and reserves, cycleways, jetties, boat ramps, entrance training walls and other waterway infrastructure, environmental assets such as saltmarsh, coastal wetlands, etc.</p> <p>When asset managers progress a refurbishment or replacement of the asset, the inundation risk can then be factored into the redesign / relocation / alternatives of the asset. The asset management plan notation should trigger an options assessment for replacement or major upgrade, to determine a preferred approach that manages inundation risk as well as improving the asset. Novel solutions to relocate, raise or retrofit the asset should be considered. The feasibility and viability of asset relocation including impacts upon upstream and surrounding land need to be investigated.</p> <p>The assessment should identify an inundation response that is suitable to the expected lifespan of the asset and its interdependencies with other assets. Consideration of asset interdependencies should link back to strategic planning, floodplain risk planning and/or adaptation plans for the region. For example, raising of a roadway will need to consider both the servicing of residents and the effect of road raising on flood/inundation behaviour.</p> <p>Asset management plan updates should incorporate findings of Action IR2, when available.</p> <p>Asset management is an important vehicle for implementing adaptation actions in a cost effective and timely manner. Implementing replacement or retrofit actions to manage inundation at the time of asset renewal avoids both the costs of not fulfilling the asset life before inundation reaches an unacceptable level, or the potential costs of maladaptation where action is taken too early. Frequent inundation of assets, such as roads, buildings etc.is also costly in terms of wear and tear and clean up.</p> <p>This action is also a key avenue for capturing asset maintenance activities or refurbishments that are exempt from planning controls or approvals.</p>	All assets affected by tidal inundation over future timeframes (refer Asset Risk Registers and Risk Maps in the Values Report).	Staff time (or \$10,000 per agency / council for minor consultancy) to update asset management plans.	WCC, SCC, DOI – Crown Lands, Property NSW, Sydney Water, RMS, NPWS Supporting: OEH, DPI Fisheries	Year 2-4	All agency asset management plans are updated	The extent and risks from tidal inundation are contained in the Values Report (Appendix C) and Kumbier et al (2019) tidal inundation modelling report. This action links to Action IR2 Whole of Lake Foreshore Adaptation Plan and Action IR5 Investigate novel solutions to manage inundation risks to assets. Cost-benefit assessments should be factored into any management strategies.

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
IR2	<p>Prepare whole of Lake Foreshore Adaptation Plan for public (community and environmental) lands, which will involve adaptation planning for all foreshore parks and reserves, including their associated assets such as cycleways, jetties, boat ramps, to provide a holistic approach to managing and adapting to tidal inundation risks.</p> <p>The action involves assessment and selection of adaptation actions for parks /reserves around the entire Lake Illawarra foreshore, considering tidal inundation and current and future usage demand, to determine:</p> <ul style="list-style-type: none"> • parklands that are more resilient, or can be reconfigured to retain their useability over time; • parklands that are feasible to protect; • land areas that will need to be transitioned from open space to fringing habitat; • land that needs to be secured for future relocation of larger assets such as the cycleway, • land that needs to be secured for future foreshore and wetland habitat migration (linking with Action EV5); • a program of asset raising for jetties and boat ramps (which by their very nature need to be next to or in the waterway) provided access to the asset can be maintained. <p>Outcomes of the adaptation plan should then be fed into masterplans / POMs for the parks, to facilitate implementation of adaptation actions. As required, the outcomes of this action could also be fed into asset management plans (see Action IR1).</p> <p>This action requires collaboration and consolidation for managing foreshore community / recreational and environmental lands, which can be facilitated through Action PM4 Establish a Lake Illawarra Asset Management Working Group.</p> <p>This action aims to recognise that tidal inundation has a very different and detrimental consequence on community recreation reserves and assets compared with storm inundation because it is effectively permanent, with the community losing access and enjoyment of precious and rare foreshore land.</p>	<p>All parks, reserves, sports grounds, and associated assets, particularly those with high usage / demand including but not limited to:</p> <p>Reddall Reserve Fred Finch Park (inc. sports grounds) Shared Path / Cycleway (entire lake) Judbooley Parade Foreshore Windang Foreshore Hooka Park Skiway Park Koonawarra Bay Lakeside Drive Reserve William Beach Reserve Lake Illawarra Foreshore</p>	<p>\$80,000 for an adaptation plan for the park and reserve network around the Lake.</p> <p>Incorporating outcomes into POMs / Masterplans to occur as and when they are updated.</p> <p>Incorporating outcomes into Assets Management Plans to occur through existing costings for Action IR1.</p>	<p>WCC, SCC, DOI – Crown Lands and Property NSW.</p> <p>Supporting: OEH, DPI Fisheries, RMS, NPWS</p>	Year5 -7	<p>An adaptation plan has been prepared.</p> <p>POMs / Masterplans and asset management plans incorporate findings of the plan when they are updated.</p>	<p>The extent and risks from tidal inundation are contained in the Values Report (Appendix C) and Kumbier et al (2019) tidal inundation modelling report.</p>

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
IR3	<p>Incorporate tidal inundation mapping into strategic land use planning documents, for example as a foreshore building line / buffer / setback in the LEPs, DCPs and council policy.</p> <p>Tidal inundation risks are different to storm inundation risks in that the tidal inundation water level occurs so frequently as to be considered permanent (e.g. daily high tides), and the existing land use can no longer be supported. This is a different impact than for storm events where the inundation occurs very infrequently (once in 20 years+) and many land uses can continue between events. And in this case, land use planning controls for flooding will not fully manage tidal inundation risks, and additional controls are needed. The planning controls would apply to both public and private land to enable the continued provision of:</p> <ul style="list-style-type: none"> public right of way and access to the foreshore, land for fringing habitats, and new public assets on community land and infrastructure (i.e. that would not be in existing asset management plans). <p>Areas that are impacted by inundation should not be eligible for land use intensification.</p>	All land affected by tidal inundation.	<p>\$20,000 for consultancy to develop foreshore building line and / or other appropriate controls.</p> <p>Staff time to implement.</p>	WCC and SCC Supporting: DPE, OEH	Year 2 to 4	Planning controls have been amended to include appropriate provision for tidal inundation	Land affected by tidal inundation is illustrated in the Kumbier et al (2019) tidal inundation modelling report.
IR4	<p>Undertake water level and condition monitoring for all lake inundation events (i.e. tidal, ocean anomaly, rainfall), to:</p> <ul style="list-style-type: none"> Record the frequency and details of events, based on review of existing lake water level gauge data, and Record assets affected and impacts / condition after each event or yearly, as required. <p>Asset condition monitoring should prioritise public foreshore assets that are expensive, have a long lifespan, and / or are highly important to the community, include natural assets.</p> <p>This action provides invaluable information to demonstrate the occurrence of coastal inundation, and for developing triggers for site specific management actions into the future.</p>	Key foreshore assets following inundation events including “king high tides” and ocean water level anomaly events.	\$10,000 p.a. for water level and asset condition monitoring;	WCC and SCC Supporting: OEH	Year 1 and ongoing	Water level recording is maintained. Asset condition impacts after inundation events is recorded and used in AMPs	The extent and risks from tidal inundation are contained in the Values Report (Appendix C) and Kumbier et al (2019) tidal inundation modelling report.

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Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
IR5	<p>Investigate novel solutions to manage inundation risks to assets such as stormwater, sewer, and water; cycleways, roads and bridges, etc.</p> <p>This action aims to provide novel and innovative solutions to asset replacement where relocation is not viable. Certain assets by their very nature must be located on low-lying high risk lands, for example sewer and water pump stations and stormwater outlets. This action would involve:</p> <ul style="list-style-type: none"> Literature review identifying the latest technologies and success of their implementation worldwide; Challenges and opportunities defining the viability of solutions in the Lake Illawarra context, including physical processes of inundation in the Lake and interdependencies and connectedness of assets; Research and development of novel solutions, for example <ul style="list-style-type: none"> Bunding around pump stations, Floating cycleways / roads / arterial roads, Bridge designs that allow for habitat migration, Stormwater pump systems and backflow devices, Legalities and practicalities of handover/ acquisition / repurchase of private land to council / state once permanently inundated; and Recommendations for suitable solutions and / or further research / case studies in the Lake Illawarra context. 	Whole of lake	\$30,000 plus partnership (i.e. in-kind contribution or ARC grant) with a private consultancy and/or research organisation to fund for example a PhD or post doctorate position.	WCC and SCC Supporting: OEH	Years 5-10	A report is produced (e.g. PhD thesis, post-doctoral thesis, scientific report etc) on viable novel solutions to inundation risks for asset replacement specific to Lake Illawarra.	

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4.9 Protect and Manage Key Fauna (MF)

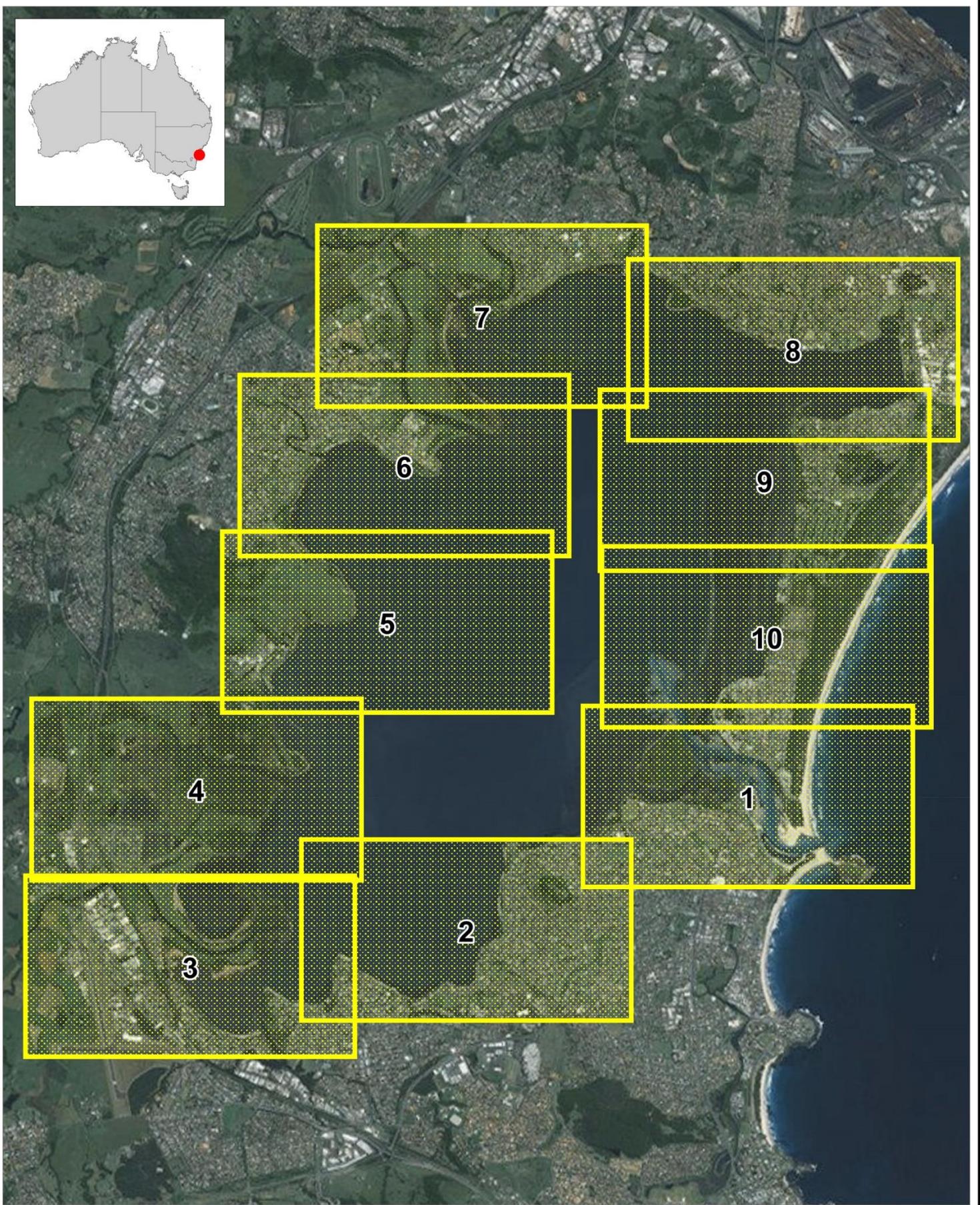
Action ID	Action Details	Locations (see Action Maps also)	Indicative Cost (subject to available funding)	Responsibility, Supporting Organisations / Programs	Time-frame (subject to available funding and resources)	Performance Measure	Further Information / References
MF1	<p>Develop and implement a fauna management program including shorebirds fish and other fauna.</p> <p>This may include but is not limited to the following actions where Council works with stakeholders to:</p> <ul style="list-style-type: none"> Identify, monitor and protect shorebird habitat, foraging, breeding and nesting sites on a yearly basis (refer to Figure 2-20, pp. 52 of the Synthesis Report (BMT, 2019a)) and assist OEH/NPWS in managing the public through education and exclusion works, and / or pest management (e.g. fox control) that may be required; Survey recreational fishers on a regular basis (e.g. every 5 years), to gather data on fish species distribution and numbers in the Lake. Undertake periodic scientific fauna surveys (e.g. every 2-3 years) to better understand fish and other fauna assemblages, distribution and numbers in the Lake. Advocate for and investigate conducting a study on cockle biomass, to assess for the sustainability of cockle harvesting in the Lake and assist in the development of a harvest strategy for the species. Analyse the data sources (i.e. recreational fishers, fauna surveys, commercial fishing data) to identify trends in fauna assemblages. Where a change or impact on fauna health is identified, determine causes and develop and implement actions to mitigate the change / impacts, where possible. Councils to assist in distribution of agency education material concerning fishing and fauna management. 	<p>Lake Wide, including:</p> <ul style="list-style-type: none"> Entrance Channel (various, as nesting sites change year to year) 	<p>\$15,000 to develop fauna management program. \$50,000 for staff and resources to implement actions, e.g. shorebird habitat monitoring, recreational fishing surveys, data management. \$20,000 (consultancy) per ecological survey and analysis.</p>	<p>WCC, SCC. Supporting: OEH, NPWS, DPI Fisheries, RMS, local businesses to support survey distribution where appropriate.</p>	<p>Year 1 and ongoing</p>	<p>Fauna management program is developed by end Year 2. Number of successful shorebird hatchlings per year. Number of surveys returned.</p>	<p>Links to education programs in PM3 and EV3. Local bird clubs could be engaged to help do counts e.g. Illawarra Birders whom already do regular bird counts at various Lake Illawarra sites and share information with agencies. . Refer to survey method guidance in <i>Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols</i> (State of NSW and OEH, 2016). Protection of fauna is done under the general biosecurity duty obligations of the <i>Biosecurity Act 2015</i>.</p>

5 Action Maps

The following chapter contains a series of maps covering the entire foreshore region of the Lake and displaying locations for CMP actions where applicable. A key plan displaying the coverage of each map is provided in Figure 5-1 as an overview to the zone maps.

The Action maps display the known locations for which various actions in the CMP shall be applied and should be read in conjunction with the implementation details provided in Chapter 4.

Not all actions have been mapped, only those actions for which mapping is useful or relevant (e.g. Action PM1 is not mapped as it is not location specific and applies catchment wide, whereas specific areas known to require rehabilitation through action EV1 have been mapped). Not all locations at which an action may apply have been mapped, as new or unknown locations may arise over the life of the plan (for example, there may be new rehabilitation areas identified in future for action under EV1).

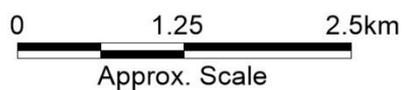


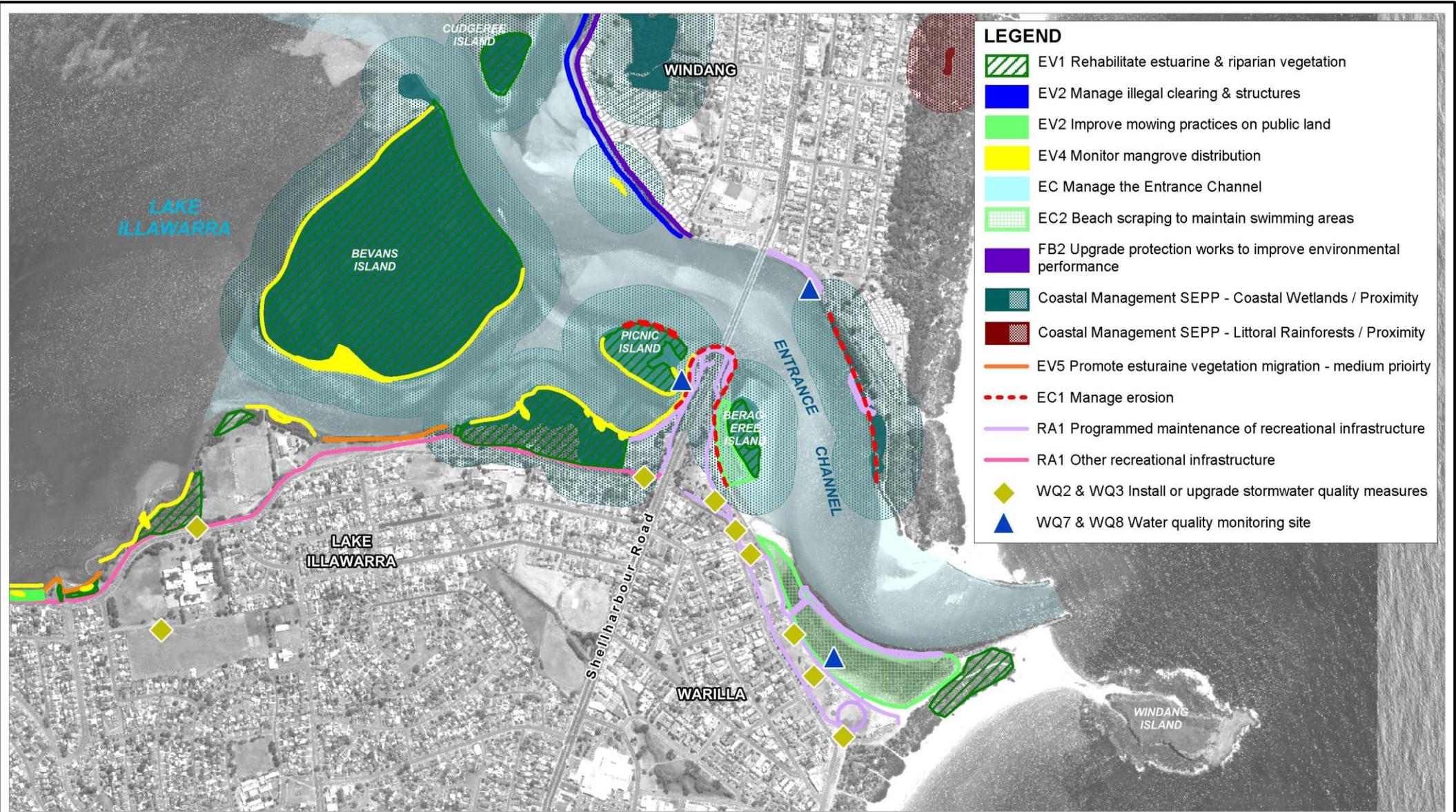
Title:
Lake Illawarra Management Actions - Map Key

Figure:
5-1

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A

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LEGEND

-  EV1 Rehabilitate estuarine & riparian vegetation
-  EV2 Manage illegal clearing & structures
-  EV2 Improve mowing practices on public land
-  EV4 Monitor mangrove distribution
-  EC Manage the Entrance Channel
-  EC2 Beach scraping to maintain swimming areas
-  FB2 Upgrade protection works to improve environmental performance
-  Coastal Management SEPP - Coastal Wetlands / Proximity
-  Coastal Management SEPP - Littoral Rainforests / Proximity
-  EV5 Promote estuarine vegetation migration - medium priority
-  EC1 Manage erosion
-  RA1 Programmed maintenance of recreational infrastructure
-  RA1 Other recreational infrastructure
-  WQ2 & WQ3 Install or upgrade stormwater quality measures
-  WQ7 & WQ8 Water quality monitoring site

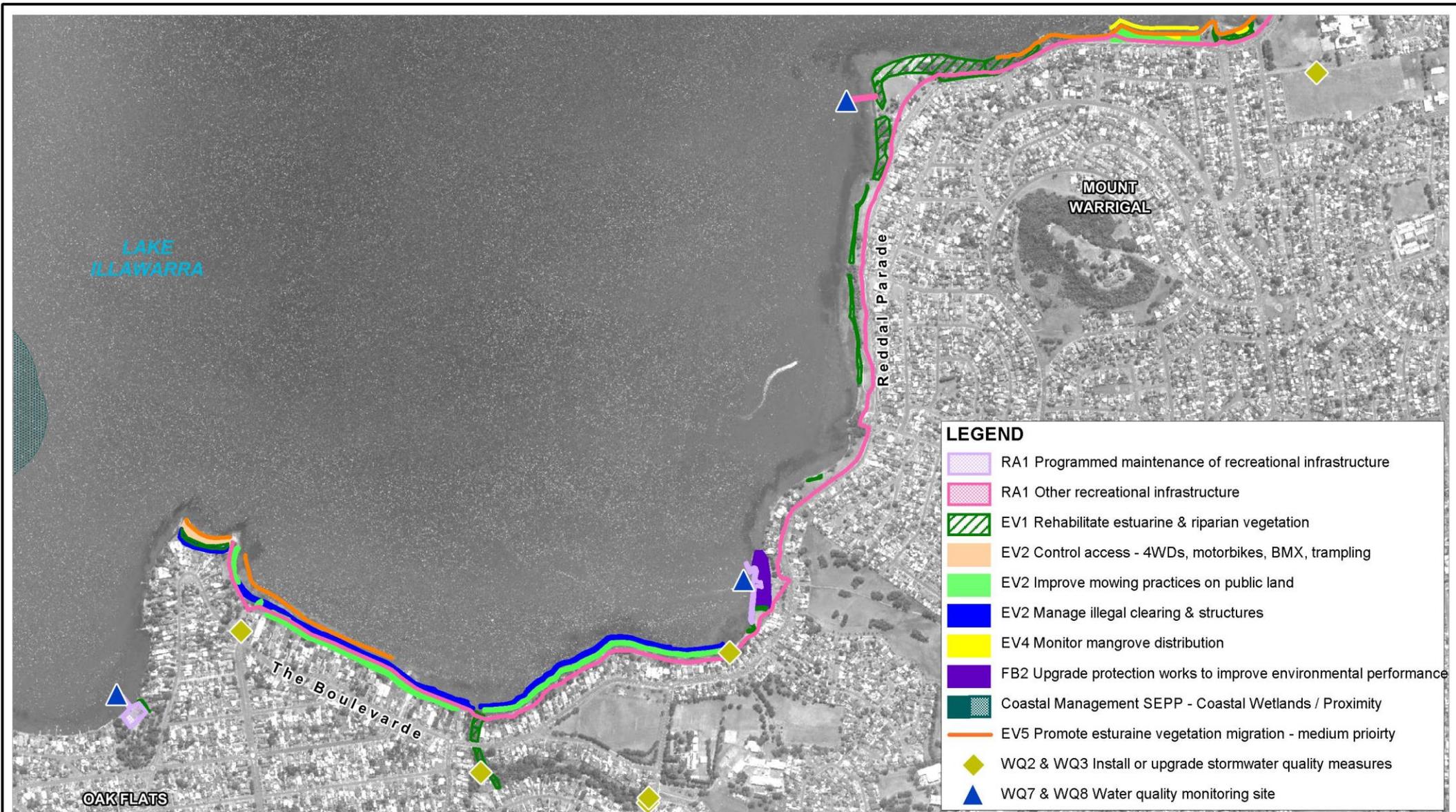
Title:
Lake Illawarra Management Actions - Zone 1

Figure:
5-2

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C

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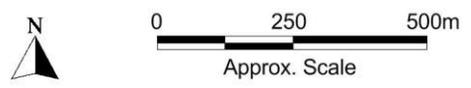


Title:
Lake Illawarra Management Actions - Zone 2

Figure:
5-3

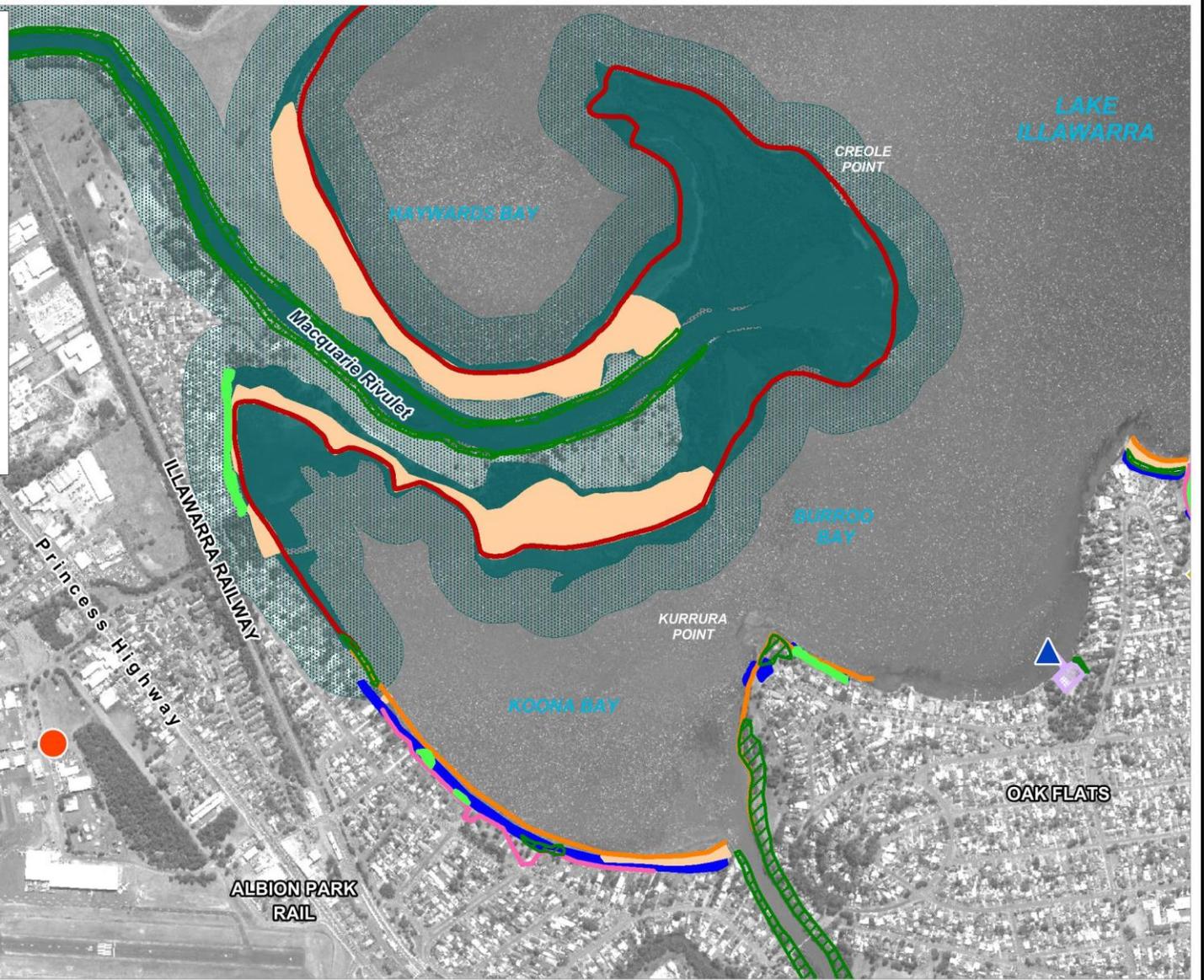
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LEGEND

-  RA1 Programed maintenance of recreational infrastructure
-  RA1 Other recreational infrastructure
-  EV1 Rehabilitate estuarine & riparian vegetation
-  EV2 Control access - 4WDs, motorbikes, BMX, trampling
-  EV2 Improve mowing practices on public land
-  EV2 Manage illegal clearing & structures
-  Coastal Management SEPP - Coastal Wetlands / Proximity
-  EV5 Promote estuarine vegetation migration - high priority
-  EV5 Promote estuarine vegetation migration - medium priority
-  WQ9 Potential pollution source
-  WQ7 & WQ8 Water quality monitoring site

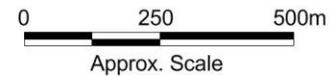


Title:
Lake Illawarra Management Actions - Zone 3

Figure:
5-4

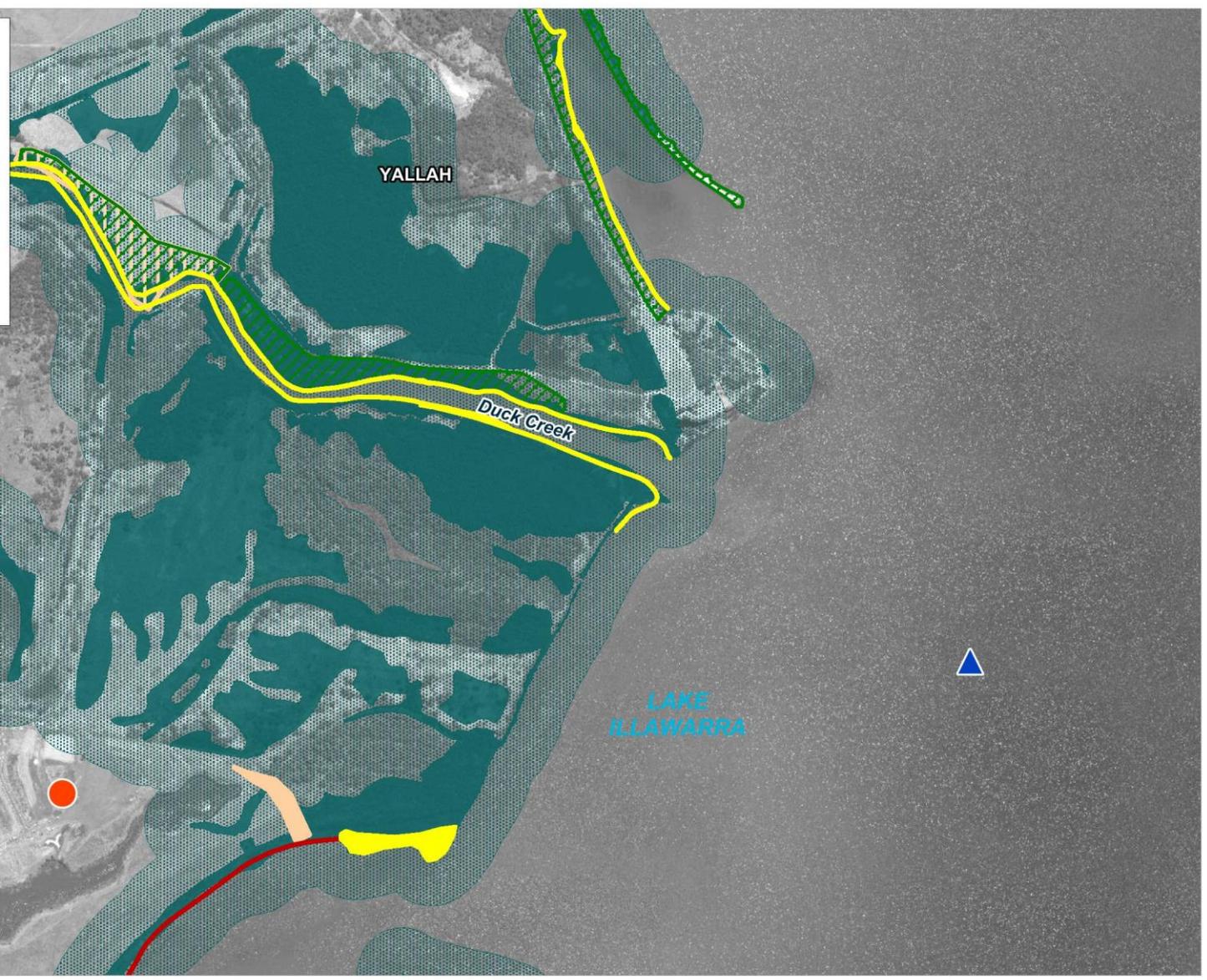
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C

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LEGEND

-  EV1 Rehabilitate estuarine & riparian vegetation
-  EV2 Control access - 4WDs, motorbikes, BMX, trampling
-  EV2 Control access - stock
-  EV4 Monitor mangrove distribution
-  Coastal Management SEPP - Coastal Wetlands / Proximity
-  EV5 Promote estuarine vegetation migration - high priority
-  WQ9 Potential pollution source
-  WQ7 & WQ8 Water quality monitoring site

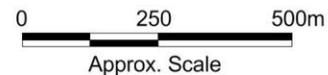


Title:
Lake Illawarra Management Actions - Zone 4

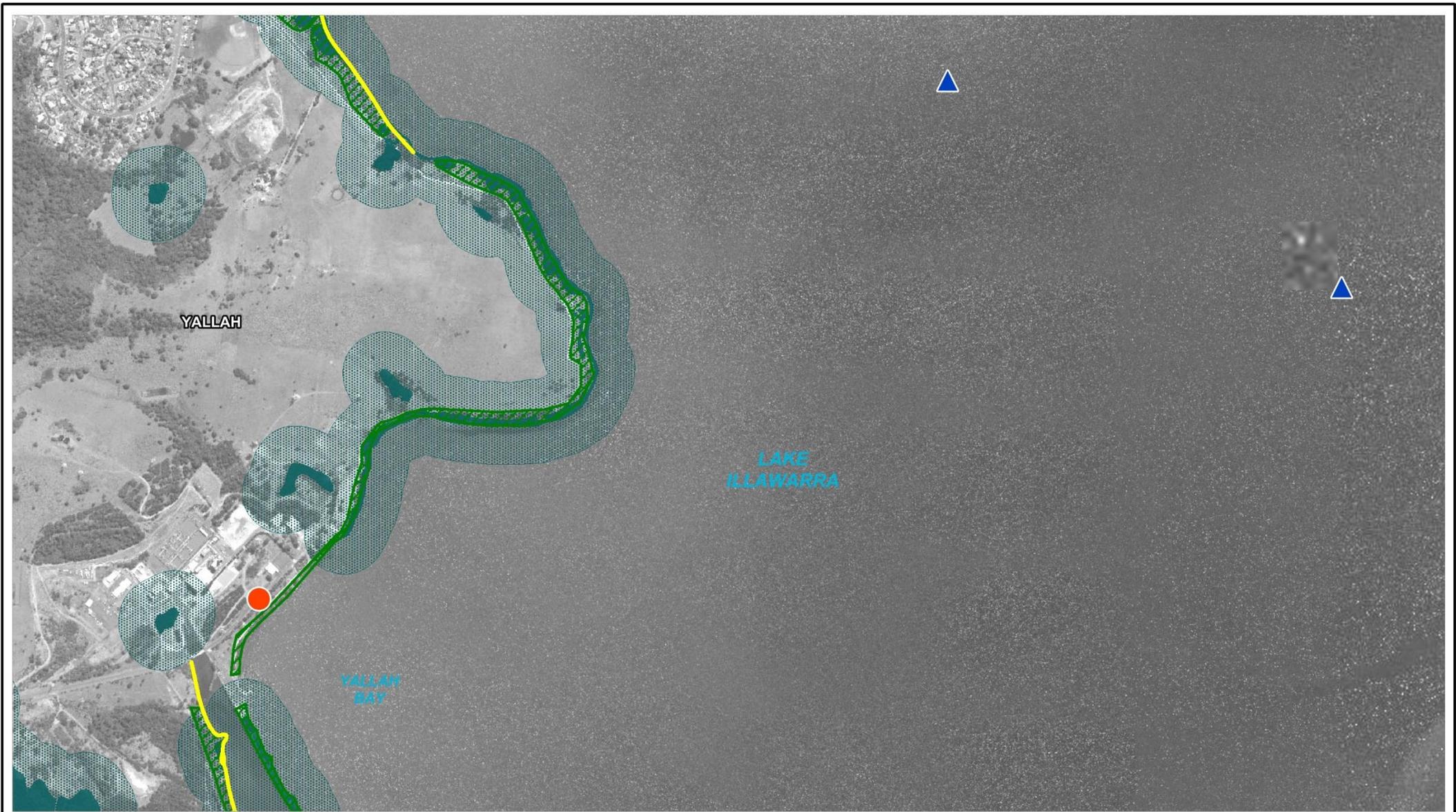
Figure:
5-5

Rev:
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Filepath: K:\N20606_Lake Illawarra CZMP\GIS\GIS_2019\CMP\Workspaces\CMP_Zone4.wor



LEGEND

-  EV1 Rehabilitate estuarine & riparian vegetation
-  EV4 Monitor mangrove distribution
-  Coastal Management SEPP - Coastal Wetlands / Proximity
-  WQ9 Potential pollution source
-  WQ7 & WQ8 Water quality monitoring site

Title:

Lake Illawarra Management Actions - Zone 5

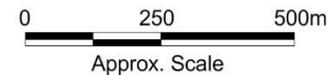
Figure:

5-6

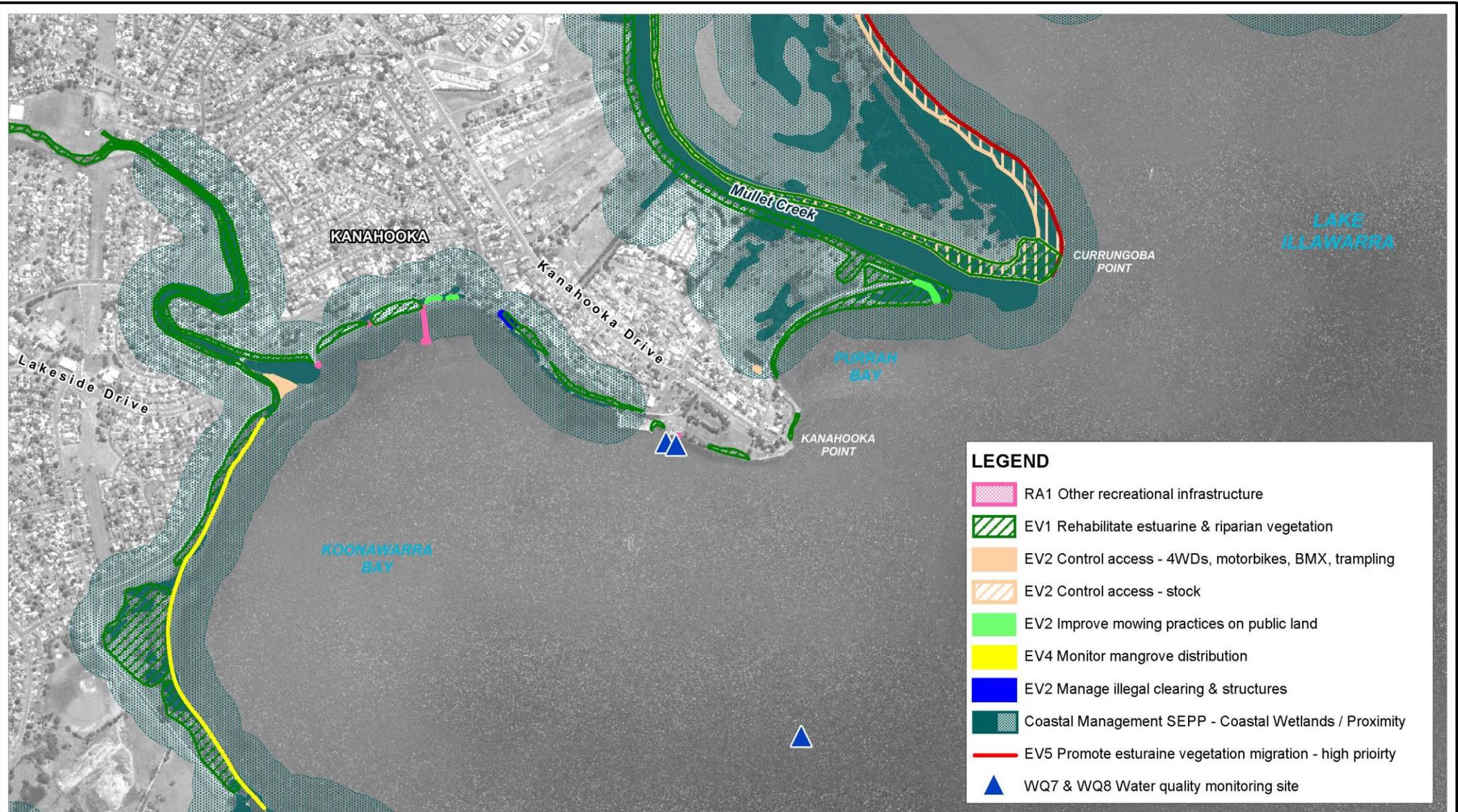
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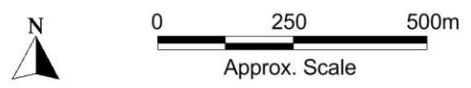


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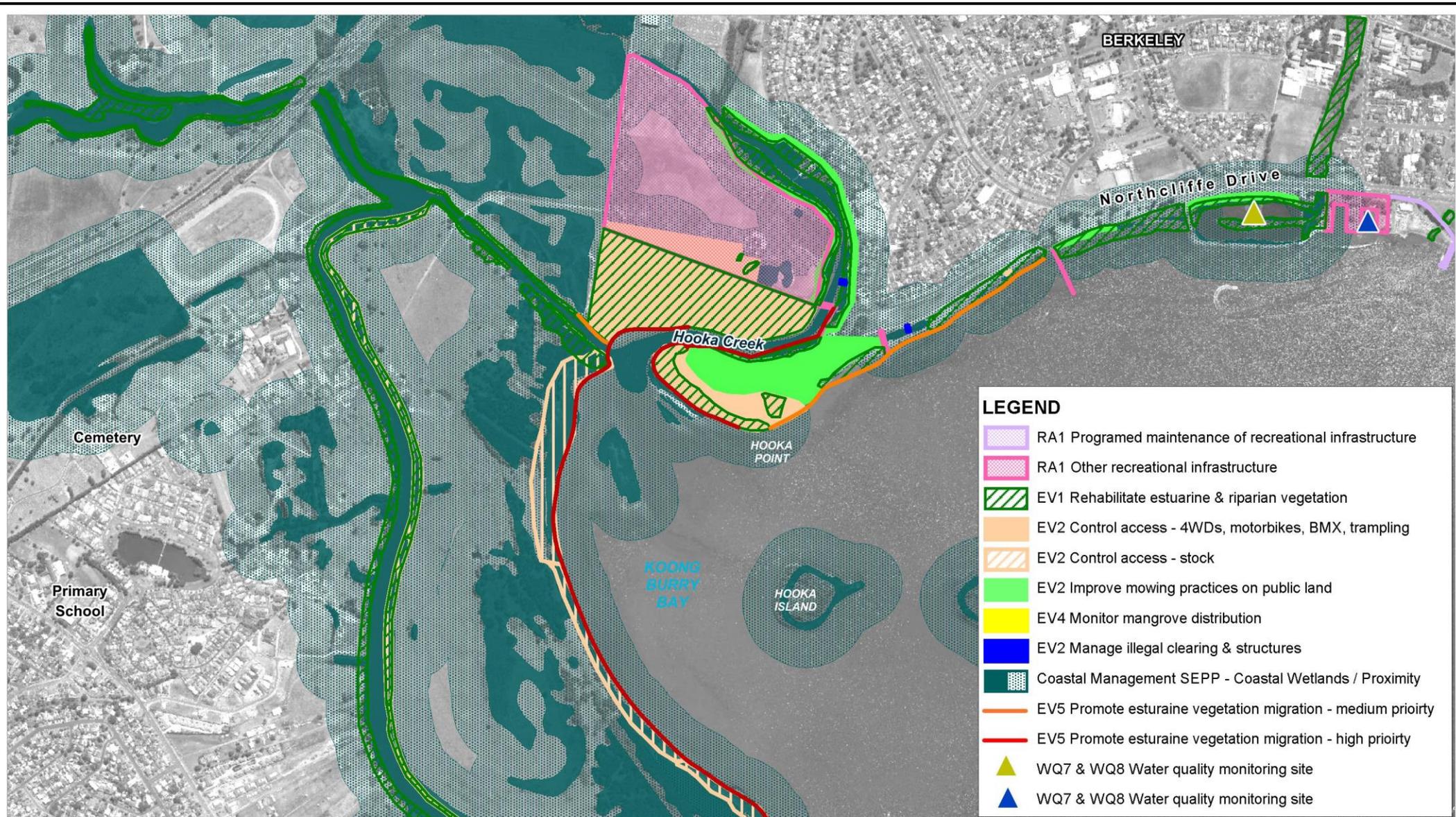


Title: Lake Illawarra Management Actions - Zone 6	Figure: 5-7	Rev: C
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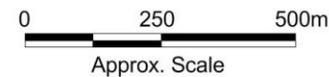


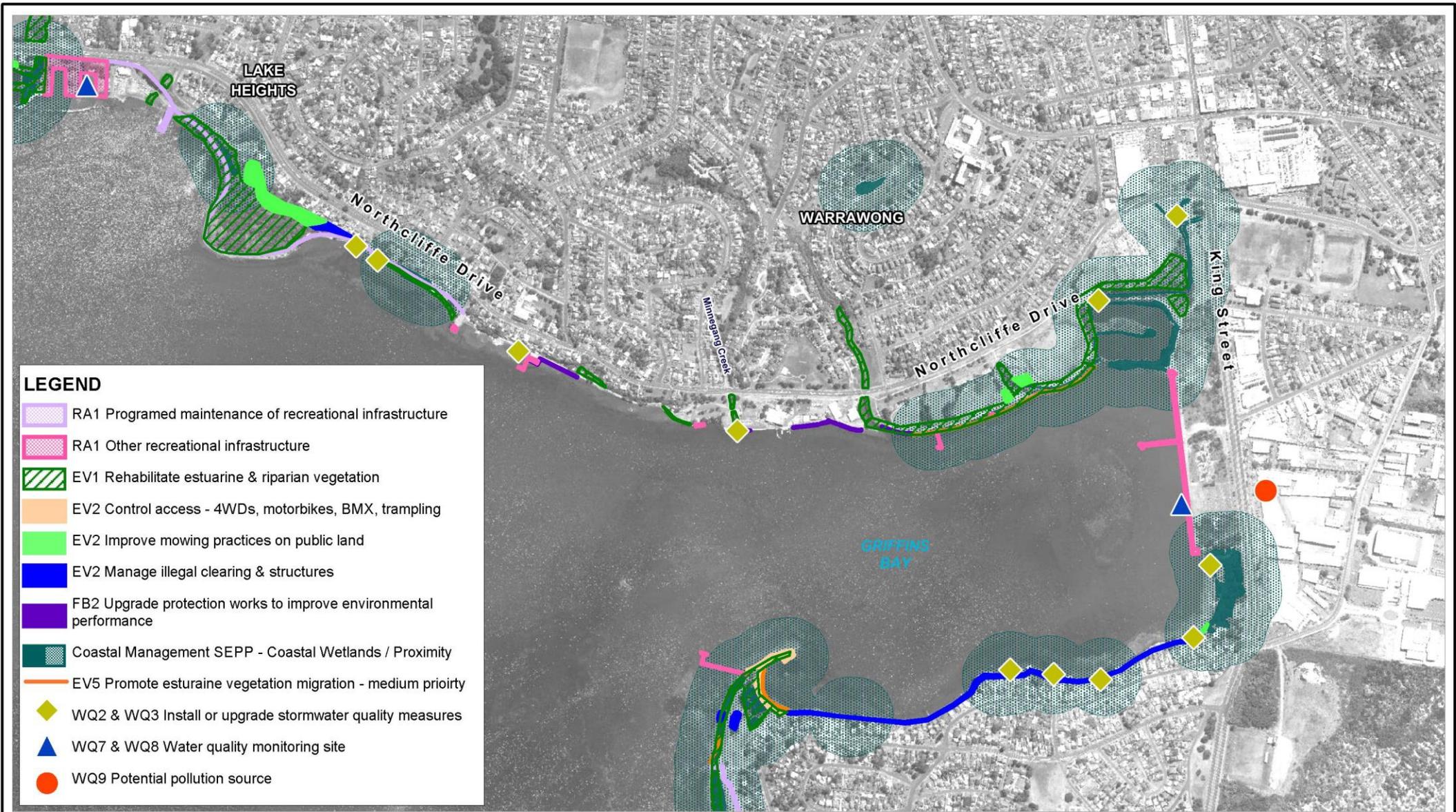
Title:
Lake Illawarra Management Actions - Zone 7

Figure:
5-8

Rev:
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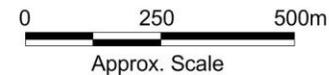


Title:
Lake Illawarra Management Actions - Zone 8

Figure:
5-9

Rev:
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LEGEND

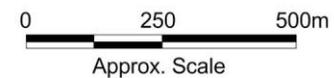
-  RA1 Programmed maintenance of recreational infrastructure
-  RA1 Other recreational infrastructure
-  EV1 Rehabilitate estuarine & riparian vegetation
-  EV2 Control access - 4WDs, motorbikes, BMX, trampling
-  EV2 Improve mowing practices on public land
-  EV2 Manage illegal clearing & structures
-  Coastal Management SEPP - Coastal Wetlands / Proximity
-  Coastal Management SEPP - Littoral Rainforests / Proximity
-  EV5 Promote estuarine vegetation migration - medium priority
-  WQ9 Potential pollution source
-  WQ2 & WQ3 Install or upgrade stormwater quality measures
-  WQ7 & WQ8 Water quality monitoring site

Title:
Lake Illawarra Management Actions - Zone 9

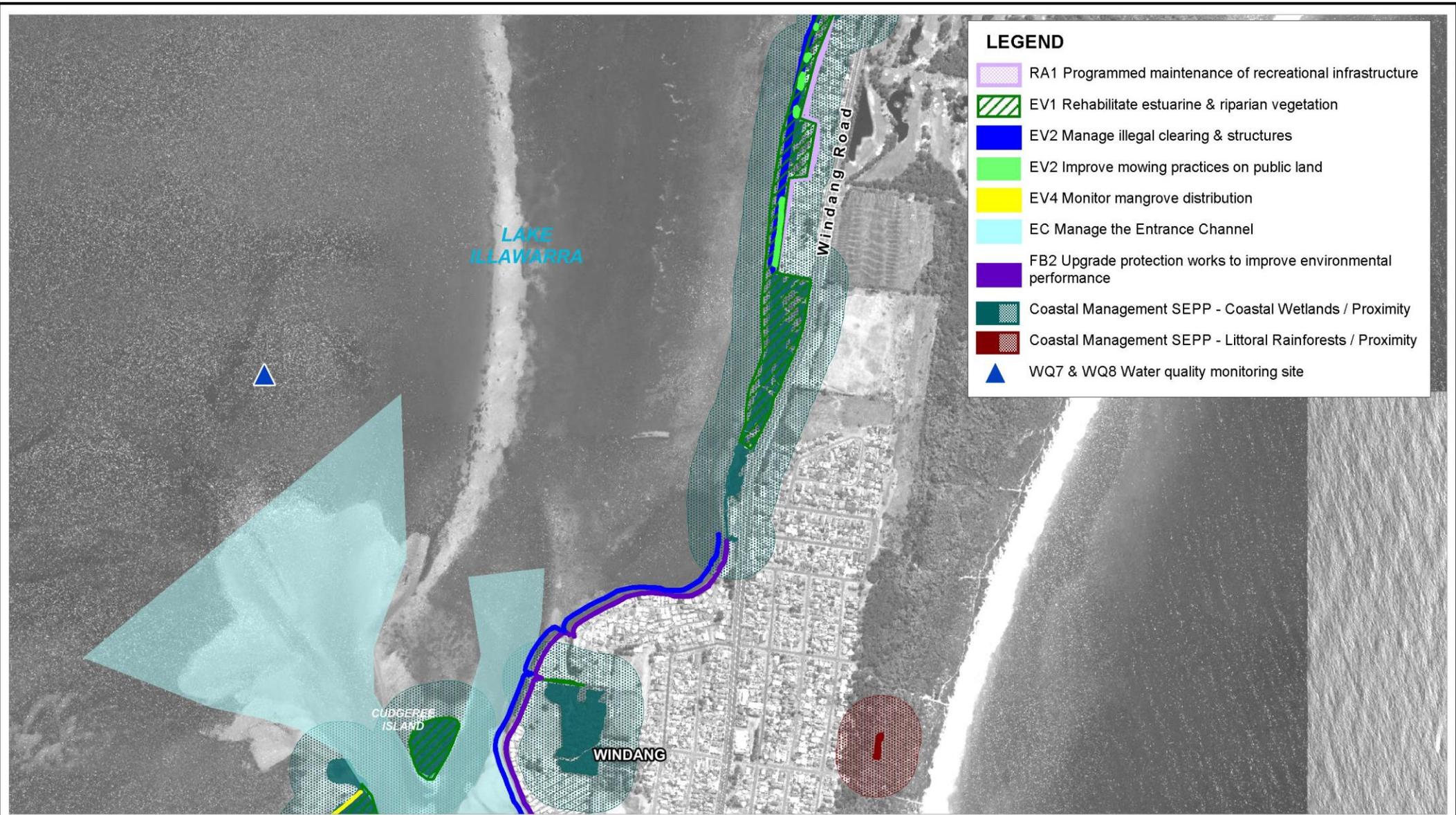
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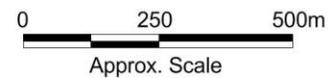


Title:
Lake Illawarra Management Actions - Zone 10

Figure:
5-11

Rev:
C

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6 Business Plan

6.1 Intent and Value of Implementing the Lake Illawarra CMP

Preserving and restoring the water quality and environmental habitats of Lake Illawarra is vital to the culture and economy of the local community, with benefits flowing on to the entire state of NSW. The Lake supports numerous endangered ecological communities such as coastal saltmarsh, and these habitats in turn support threatened species such as the Little Tern. In recognition of their high environmental values, NSW legislation requires such habitats to be protected and maintained.

The Lake Illawarra CMP is a program of physical works, monitoring and investigations, and planning and education initiatives that target the threats to the Lake's ecological and cultural values. The CMP also includes actions directly aimed at improving recreational opportunities for the public.

Investment in the Lake Illawarra CMP provides an opportunity to directly improve and preserve the water quality, environmental habitats, cultural spaces and recreational opportunities of Lake Illawarra, and in doing so, bring benefits to the public. The Lake Illawarra CMP contains 37 actions set out within nine strategies, that aim to manage, preserve, improve, promote and rehabilitate our Lake. Many of the actions are targeted towards improving ecological health, as this is the key to supporting the recreational, cultural and economic values of the Lake. And while ecological actions are more numerous, financial resources are well targeted towards supporting recreational amenity, such as for upgrades to facilities and navigation. Funding is yet to be secured for many of the actions, and will be vital for the success of the CMP.

6.2 Resource and Financial Planning

Delivery of the Lake Illawarra CMP is estimated to cost \$37,355,000 over 10 years. Existing staff resources in the Councils and OEHL are expected to facilitate the delivery of actions as per the Strategy Implementation Plan, with the Councils, state agencies and other stakeholders responsible for funding and/or implementing the actions. It should be acknowledged that as technology and new information changes other management actions may become feasible and will be reviewed for inclusion in the plan. Where additional staff resources have not been identified, this is expected to have an impact on current resourcing levels within both Councils, the financial requirements for this have been included in the Business Plan (e.g. see PM2 in Table 6-1). It is anticipated that both WCC and SCC will work together under a MoU with the guidance of the Lake Illawarra Estuary Management Committee. Each individual council will still be the ultimate decision maker but is expected to provide updates to the Committee.

Based upon the timeframes for actions and estimated costings, \$3,236,500 is required in Year 1 to implement specified actions. A forecast \$15,166,000 is estimated across Year 2 to 5 (inclusive), with a final \$18,932,500 required over Years 6 to 10 for the plan. The cost estimates and their breakdown across the specified years for delivery is provided in Table 6-1.

It should be noted that it is difficult to reliably forecast the costs to funding of the CMP beyond Year 1. Likewise, costings are not indexed. Councils prepare a yearly budget, and through this process, actions from the CMP will be fed into these yearly budgets. For all responsible or supporting organisations that are identified, the actions remain subject to funding, availability of resources, and

Business Plan

organisational and/or government priorities. For example, other Council and State Government priorities and budgetary processes in play that may affect the timing of or ability to implement for implementation of CMP actions. Further to this, there may be situations where CMP actions are delayed, for example funding will be required, and this will change the projections for yearly spend beyond Year 1. As such, costs are provided as a forecast for Year 2 onwards.

Due to many CMP actions involving works on the foreshore of the Lake and its tributaries, Aboriginal Cultural Heritage requirements may be invoked if ground disturbance is needed. Depending on the situation and the works being undertaken, these requirements can be reasonably time consuming and costly. It is therefore possible that particular CMP actions may face implementation delays if this occurs. These requirements are necessary to ensure Aboriginal Cultural Heritage is protected and preserved and as such timeframes may have to be revised as issues arise. This should be considered when updating any forward plans or this Business Plan.

As implementation of the CMP progresses, this Business Plan will be updated on a yearly basis to reflect the budget for the CMP for each upcoming year, to allow relevant actions to be fed into the implementation process, and to account for external grant funding awarded to implement CMP actions (see Financing and Funding below). Councils must integrate these actions into their operational plan, where they can be formally adopted.

Table 6-1 Cost Estimates for CMP Implementation

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe (subject to available funding and resources)	Year 1 (estimate)	Year 2 to 5 (forecast estimate)	Year 6 -10 (forecast estimate)	Potential Funding Sources	Alignment with IP&R Frameworks
	Total cost for CMP	\$37,335,000		\$3,236,500	\$15,166,000	\$18,932,500		
Strategy 1: Improve Water Quality (WQ)								
WQ1	Implement a Risk Based Stormwater Management Framework for the Lake Illawarra catchment	Estimated total of \$220,000 = \$200,000 for OEH research project (already funded), plus \$20,000 for analysis and report preparation, plus staff time throughout	Year 1 to 3	\$200,000	\$20,000		<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) Developer Contributions NSW Coastal and Estuary Management Program 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSIP 2023 • Objective 2.1: Strategy 2.1.1.
WQ2	Install new or replace existing stormwater quality management measures, using water sensitive urban design or other devices that will improve water quality as well as enhance habitat and natural values.	Estimated total of \$1.565 million = \$25,000 for staff resources (\$100,000 for temporary resource to be shared across WQ1 to 4), plus \$60,000 for consultancy to complete stormwater audit, plus \$1.4 million for new/upgrades to devices (estimated 7 devices @\$200,000 each - WCC own 4 of the devices and SCC own 3 of the devices), plus \$80,000 for monitoring (\$10,000 p.a. for 8 years).	Year 1 to 10	\$25,000	\$480,000	\$1,060,000	<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) Council Special Rates NSW Coastal and Estuary Management Program 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSIP 2023 • Objective 2.1: Strategy 2.1.1. • Objective 3.1: Strategy 3.1.2.
WQ3	Review and prioritise maintenance and cleaning regime for existing stormwater quality devices	Estimated total of \$2.455 million = \$25,000 for staff resources (\$100,000 for temporary resource to be shared across WQ1 to 4) plus \$30,000 for consultancy to conduct review and develop maintenance program plus \$2.4 million in maintenance (\$10,000 per device p.a. for approx. 30 devices over 8 years - WCC own 17 of the devices and SCC own 13 of the devices).	Year 1 to 10	\$25,000	\$930,000	\$1,500,000	<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) Council Special Rates 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSIP 2023 • Objective 2.1: Strategy 2.1.1.
WQ4	Design and implement targeted catchment input monitoring as required for developments resulting in a large-scale change or intensification of land use.	Estimated total of \$25,000 for staff resources (\$100,000 for temporary resource to be shared across WQ1 to 4). Cost of monitoring program will be variable and developed on a case by case basis, with costs borne by the developer(s).	As required	\$25,000			<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) Developer Contributions NSW Coastal and Estuary Management Program 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSIP 2023 • Objective 2.1: Strategy 2.1.1.
WQ5	Reduce sediment load to tributaries of the Lake by improving compliance with erosion & sediment controls for development sites.	Estimated total of \$320,000 (based on staff resources of \$160,000 p.a. for 2 years)	Ongoing	\$160,000	\$160,000		<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSIP 2023 • Objective 2.1: Strategy 2.1.1.
WQ6	Reduce the impact of sewer overflows	Staff time only	Year 1 and ongoing				<ul style="list-style-type: none"> Special Infrastructure Contribution (Sydney Water) Council (Ordinary Rates, Revenue) 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSIP 2023 • Objective 2.1: Strategy 2.1.1. • Objective 3.1: Strategy 3.1.2.
WQ7	Implement existing water quality monitoring program for estuary health	Estimated total of \$540,000 = \$50,000 p.a. plus staff time of \$4,000 p.a. for 10 years	Year 1 to 5, then review	\$54,000	\$216,000	\$270,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Council (Ordinary Rates, Revenue) 	WCSP 2022 • Goal 1: Objective 1.2. SCSIP 2023 • Objective 2.1: Strategy 2.1.1.
WQ8	Undertake water quality monitoring for Recreational Use	Estimated total of \$140,000 = \$10,000 p.a. plus staff time of \$4,000 p.a. for 10 years	Year 1 to 5, then review	\$14,000	\$56,000	\$70,000	<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) Special Infrastructure Contribution 	WCSP 2022 • Goal 1: Objective 1.2. SCSIP 2023 • Objective 2.1: Strategy 2.1.1. • Objective 1.1: Strategy 1.2.1.
WQ9	Investigate and manage potential pollution sources including contaminated sites that contribute to poor water quality in the lake	Estimated of \$60,000 = estimated 3 episodes @ \$20,000 each p.a. plus staff time	Year 2 to 5		\$60,000		<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Council (Ordinary Rates, Revenue) 	WCSP 2022 • Goal 1: Objective 1.2. SCSIP 2023 • Objective 2.1: Strategy 2.1.1.
WQ10	Undertake water quality monitoring of physico-chemical and bacteriological indicators in the lake catchment.	Estimated total of \$600,000 = monitoring cost of \$60,000 p.a. for 10 years	Year 1 and ongoing	\$60,000	\$240,000	\$300,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Council (Ordinary Rates, Revenue) 	WCSP 2022 • Goal 1: Objective 1.2. SCSIP 2023 • Objective 2.1: Strategy 2.1.1.

Table 6-1 Cost Estimates for CMP Implementation

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe (subject to available funding and resources)	Year 1 (estimate)	Year 2 to 5 (forecast estimate)	Year 6 -10 (forecast estimate)	Potential Funding Sources	Alignment with IP&R Frameworks
Strategy 2: Improve Planning and Management Arrangements for the Lake (PM)								
PM1	Commence integration of key objectives and strategies from the CMP into relevant planning and policy documents of both Councils	Estimated total of \$100,000 = assumed 2 activities @ \$50,000 per activity plus staff time.	Year 2 to 10		\$100,000		<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program 	WCSP 2022 <ul style="list-style-type: none"> Goal 1: Objective 1.1, Objective 1.6 SCSP 2023 <ul style="list-style-type: none"> Objective 2.1: Strategy 2.1.1, Strategy 2.1.2. Objective 2.3: Strategy 2.3.2.
PM2	Provide ongoing coordinated management of the Lake, which will require ongoing support for existing staff resources.	Estimated total of \$2.5 million = staff resource (\$250,000 p.a. for 10 years)	Year 1 and ongoing	\$250,000	\$1,000,000	\$1,250,000	<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program 	WCSP 2022 <ul style="list-style-type: none"> Goal 1: Objective 1.1, Objective 1.6 SCSP 2023 <ul style="list-style-type: none"> Objective 2.1: Strategy 2.1.3 Objective 2.3: Strategy 2.3.6.
PM3	Develop and implement a community engagement and participation strategy that enhances the community's knowledge of, skills in, and commitment to, protecting Lake Illawarra.	Estimated total of \$980,000 = \$80,000 p.a. for a staff member to develop and implement program plus \$20,000 p.a. for resourcing program implementation.	Year 1 - staff time, then yearly for program	\$80,000	\$400,000	\$500,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Council (Ordinary Rates, Revenue) NSW Environment Trust National Trust Programs 	WCSP 2022 <ul style="list-style-type: none"> Goal 1: Objective 1.1, Objective 1.6 Goal 4: Objective 4.2 SCSP 2023 <ul style="list-style-type: none"> Objective 2.1: Strategy 2.1.2, Strategy 2.1.4 Objective 2.2: Strategy 2.2.1. Objective 1.1: Strategy 1.1.7.
PM4	Establish a Lake Illawarra Asset Management Working Group that provides coordination services for agencies that manage assets around the Lake Illawarra foreshore.	Estimated total of \$70,000 = \$5,000 p.a. for 10 years plus \$20,000 for Development of a Framework document, plus staff time.	Year 1 and ongoing	\$25,000	\$20,000	\$25,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Council (Ordinary Rates, Revenue) NSW Environment Trust National Trust Programs 	WCSP 2022 <ul style="list-style-type: none"> Goal 1: Objective 1.2, Objective 1.6 Goal 5: Objective 5.3, Objective 5.5 SCSP 2023 <ul style="list-style-type: none"> Objective 2.1: Strategy 2.1.3; Objective 2.3: Strategy 2.3.6 Objective 3.1: Strategy 3.1.2 Objective 1.2: Strategy 1.2.3
Strategy 3: Manage the Entrance Channel (EC)								
EC1	Investigate Entrance Channel Processes and Implement Management Solutions	Estimated total of \$6.21 million = \$1.21 million for investigations (\$460,000 for processes investigations + \$750,000 for options feasibility study) plus \$5 million (estimated) for implementation of preferred option.	Year 1 to 10	\$300,000	\$910,000	\$5,000,000	<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program Special Infrastructure Contribution Fisheries Habitat Action Grants 	WCSP 2022 <ul style="list-style-type: none"> Goal 1: Objective 1.2 SCSP 2023 <ul style="list-style-type: none"> Objective 2.1: Strategy 2.1.3.
EC2	Undertake small scale works (e.g. beach scraping, re-shaping etc) to maintain swimming areas.	Estimated total of \$300,000 = assumed 3 episodes @ \$50,000 - \$150,000 per event.	As required		\$150,000	\$150,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Council (Ordinary Rates, Revenue) NSW Environment Trust Fisheries Habitat Action Grants 	WCSP 2022 <ul style="list-style-type: none"> Goal 5: Objective 5.3, Objective 5.5. SCSP 2023 <ul style="list-style-type: none"> Objective 2.1: Strategy 2.1.3 Objective 2.3: Strategy 2.3.6
EC3	Undertake dredging in the entrance channel, as required to maintain navigation	Estimated total of \$2 million for one dredging campaign	As required		\$2,000,000		<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program Special Infrastructure Contribution 	WCSP 2022 <ul style="list-style-type: none"> Goal 5: Objective 5.3, Objective 5.5. SCSP 2023 <ul style="list-style-type: none"> Objective 2.1: Strategy 2.1.3 Objective 2.3: Strategy 2.3.6
EC4	Monitor changes to the entrance channel.	Estimated total of \$20,000 = \$10,000 initially then \$5,000 bi-annually	Year 1, then every 2-5 years	\$10,000	\$5,000	\$5,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Council (Ordinary Rates, Revenue) NSW Environment Trust National Trust Programs 	WCSP 2022 <ul style="list-style-type: none"> Goal 1: Objective 1.2 SCSP 2023 <ul style="list-style-type: none"> Objective 2.1: Strategy 2.1.3
EC5	Monitor, maintain and if required, upgrade existing entrance channel infrastructure, with any works to be informed by EC1-EC2 and EC4.	Estimated total of \$240,000 p.a. (estimated at \$15,000 per metre of seawall)	Ongoing	\$240,000	\$960,000	\$1,200,000	<ul style="list-style-type: none"> Marine Infrastructure maintenance programs (Crown Lands / RMS) Council (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program 	WCSP 2022 <ul style="list-style-type: none"> Goal 1: Objective 1.2 Goal 5: Objective 5.3 SCSP 2023 <ul style="list-style-type: none"> Objective 2.1: Strategy 2.1.3. Objective 2.3: Strategy 2.3.6

Table 6-1 Cost Estimates for CMP Implementation

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe (subject to available funding and resources)	Year 1 (estimate)	Year 2 to 5 (forecast estimate)	Year 6 -10 (forecast estimate)	Potential Funding Sources	Alignment with IP&R Frameworks
Strategy 4: Protect and Rehabilitate Estuarine and Riparian Vegetation (EV)								
EV1	Rehabilitate vegetation and manage public access along foreshores and banks of the Lake, its tidal tributaries, islands and broader low-lying areas.	Estimated total of \$2.855 Million = \$590,000 for SCC sites (\$59,000 p.a. for 10 years), plus \$570,000 (\$190,000 p.a. for 3 years) already committed by WCC to the Natural Areas Restoration Program, plus \$995,000 costed for known WCC sites, plus \$500,000 costed for EnergyAustralia site at Duck Creek, plus \$200,000 for additional new sites (estimated 20 sites @ \$10,000 each - WCC = 15 of the sites and SCC = 5 of the sites).	Year 1 and ongoing	\$368,500	\$1,294,000	\$1,192,500	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program NSW Environment Trust Public Reserve Management Fund Building Resilience to Climate Change NSW Heritage Grant Programs 	WCSP 2022 • Goal 1: Objective 1.2 SCSP 2023 • Objective 2.1: Strategy 2.1.1, Strategy 2.1.2.
EV2	Undertake targeted action to control damage to foreshore vegetation, including seagrasses	Estimated total of \$1.1 million = \$300,000 for works (22 known sites plus 8 new (future) sites @ \$10,000 each - WCC = 22 of the sites and SCC = 8 of the sites), plus \$800,000 in additional staff resources (\$80,000 p.a. for 10 years)	Year 1 and ongoing	\$130,000	\$470,000	\$500,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program NSW Environment Trust Public Reserve Management Fund Building Resilience to Climate Change NSW Heritage Grant Programs 	WCSP 2022 • Goal 1: Objective 1.2 SCSP 2023 • Objective 2.1: Strategy 2.1.1, Strategy 2.1.2, Strategy 2.1.3.
EV3	Prepare and deliver an information program for the Lake Catchment	Estimated total of \$120,000 = \$20,000 to develop program, plus \$100,000 for staff time and resources (\$10,000 p.a. for 10 years)	Year 1 and ongoing	\$30,000	\$40,000	\$50,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Council (Ordinary Rates, Revenue) NSW Environment Trust National Trust Programs 	WCSP 2022 • Goal 1: Objective 1.6. • Goal 4: Objective 4.2. SCSP 2023 • Objective 2.2: Strategy 2.2.1.
EV4	Prepare and implement an estuarine macrophyte mapping and monitoring program.	Estimated total of \$85,000 = \$75,000 (3 mapping events at \$25,000 each) + \$10,000 for area specific monitoring.	Year 1 (mapping), 2 to 4 (monitoring), 6 (mapping), 10 (mapping)	\$25,000	\$35,000	\$25,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program NSW Environment Trust Building Resilience to Climate Change 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSP 2023 • Objective 2.1: Strategy 2.1.2, Strategy 2.1.4.
EV5	Develop and implement a program to enhance opportunities for estuarine vegetation migration.	Estimated total of \$275,000 = \$25,000 for consultancy to develop program, plus \$250,000 (estimated 5 sites at \$50,000 each for migration actions - WCC = 3 of the sites and SCC = 2 of the sites).	Year 2 to 10		\$175,000	\$100,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Building Resilience to Climate Change Coastal Lands Protection Scheme NSW Environment Trust 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSP 2023 • Objective 2.1: Strategy 2.1.1, Strategy 2.1.2. • Objective 2.3: Strategy 2.3.6.
Strategy 5: Maintain and Improve Recreational Amenity (RA)								
RA1	Manage foreshore and waterway recreational infrastructure	Estimated total of \$8.76 million = \$2.22 million in upgrades already programmed in existing Council Infrastructure Delivery Programs - \$720,000 in WCC and \$1,500,000 in SCC (for Years 1-3), plus independent audit of \$60,000 (Year1-2), plus Lake Illawarra Waterway Facilities Plan of \$50,000 + maintenance of \$1.25 million (based on \$5,000 per item for estimated 25 existing waterway assets p.a. over 10 years), plus estimated costing for new renewal items in future delivery programs (\$490,000 p.a. in WCC and \$250,000 p.a. in SCC) from Year 4 to 10 of \$5.18 million (assumed \$740,000 p.a. based on current Infrastructure Delivery Program of \$2.22 M over 3 years).	Year 1 to 10	\$895,000	\$3,540,000	\$4,325,000	<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) Public Reserve Management Fund State Infrastructure Contribution Maritime Infrastructure Delivery Programs (RMS / Crown Lands) 	WCSP 2022 • Goal 5: Objective 5.3, Objective 5.5. SCSP 2023 • Objective 3.1: Strategy 3.1.2. • Objective 1.2: Strategy 1.2.3.
RA2	Construct new sections of shared pathway to complete the pathway linkage around the Lake.	Estimated total of \$1.52 million = \$520,000 for programmed works and feasibility study for and Around the Lake Share Path Plan (\$120,000), plus \$1,000,000 (estimated 5 sites @ \$200,000 each - WCC = 3 of the sites and SCC = 2 of the sites) for new/upgraded sections.	Year 1 to 10	\$100,000	\$820,000	\$600,000	<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) Public Reserve Management Fund (and other DoI - Crown Lands programs) State Infrastructure Contribution 	WCSP 2022 • Goal 5: Objective 5.5. • Goal 6: Objective 6.1 SCSP 2023 • Objective 1.2: Strategy 1.2.4.
RA3	Negotiate a public 'right of way' along the foreshore, as opportunities present themselves	Staff time only	Year 5 to 10				<ul style="list-style-type: none"> Council (Ordinary Rates, Revenue) Building Resilience to Climate Change Coastal Lands Protection Scheme 	WCSP 2022 • Goal 1: Objective 1.6 • Goal 4: Objective 4.2 SCSP 2023 • Objective 2.1: Strategy 2.1.3 • Objective 2.3: Strategy 2.3.2
Strategy 6: Protect and Promote Cultural Heritage (CH)								
CH1	Protect and promote cultural heritage in and around the lake and its catchment.	Estimated total of \$1.2 million = \$1 million for staff resource (\$100,000 p.a. for 10 years) and \$200,000 for operating costs (\$20,000 p.a. for 10 years).	Year 1 and ongoing	\$120,000	\$480,000	\$600,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program NSW Environment Trust NSW Heritage Grant Programs National Trust Programs 	WCSP 2022 • Goal 1: Objective 1.4. SCSP 2023 • Objective 2.3: Strategy 2.3.5 • Objective 4.1: Strategy 4.1.3 • Objective 1.1: Strategy 1.1.1

Table 6-1 Cost Estimates for CMP Implementation

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe (subject to available funding and resources)	Year 1 (estimate)	Year 2 to 5 (forecast estimate)	Year 6 -10 (forecast estimate)	Potential Funding Sources	Alignment with IP&R Frameworks
Strategy 7: Manage Foreshore and Bank Erosion (FB)								
FB1	Undertake a bank condition assessment and determine and implement erosion control measures	Estimated total of \$310,000 = \$70,000 consultancy for condition assessment and recommended controls (allocation of \$15,000 to DoI - Crown Lands and \$55,000 to WCC/SCC), plus \$40,000 for monitoring (\$5,000 p.a. over 8 years), plus \$200,000 for erosion controls works (estimated 5 sites at \$40,000 each - WCC = 3 of the sites and SCC = 2 of the sites).	Year 1 (assessment), Year 2 to 4 (works), Year 3 to 10 (monitoring)	\$70,000	\$215,000	\$25,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program NSW Environment Trust Public Reserve Management Fund Building Resilience to Climate Change NSW Heritage Grant Programs 	WCSP 2022 • Goal 1: Objective 1.2. SCSP 2023 • Objective 2.1: Strategy 2.1.2, Strategy 2.1.3
FB2	Improve the environmental performance and outcomes for foreshore protection works when the renewal of existing or construction of new infrastructure is required, where appropriate and feasible to do so.	Estimated total of \$150,000 (estimated 3 sites at \$50,000 each - WCC = 3 of the sites and SCC = 2 of the sites)	Year 2 to 4		\$150,000		<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program NSW Environment Trust Public Reserve Management Fund Building Resilience to Climate Change 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSP 2023 • Objective 2.1: Strategy 2.1.2, Strategy 2.1.3. • Objective 3.1: Strategy 3.1.2.
FB3	Undertake a bathymetric survey of the entire Lake and tributaries up to the tidal limit.	\$50,000	Year 5		\$50,000		<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program NSW Environment Trust Building Resilience to Climate Change 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6. SCSP 2023 • Objective 2.1: Strategy 2.1.3, Strategy 2.1.4.
Strategy 8: Prepare for Inundation Risks (IR)								
IR1	Update Asset Management Plans for all publicly owned and managed assets to clearly identify asset at risk from inundation over future timeframes, including tidal inundation	Estimated total of \$50,000 (estimated that of the 7 agencies, 5 will utilise minor consultancy assistance at \$10,000 each) + staff time	Year 2 to 4		\$50,000		<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Building Resilience to Climate Change NSW Environment Trust 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6 SCSP 2023 • Objective 2.1: Strategy 2.1.3 • Objective 2.3: Strategy 2.3.6 • Objective 3.1: Strategy 3.1.2
IR2	Whole of Lake Foreshore Adaptation Plan for public (community and environmental) lands	\$80,000 plus staff time to incorporate findings into AMPs, POMs and masterplans as and when they are updated	Year 5 to 7		\$10,000	\$70,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Building Resilience to Climate Change NSW Environment Trust 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6 SCSP 2023 • Objective 2.1: Strategy 2.1.3 • Objective 2.3: Strategy 2.3.6 • Objective 3.1: Strategy 3.1.2
IR3	Incorporate tidal inundation mapping into strategic land use planning documents,	\$20,000 plus staff time	Year 2 to 4		\$20,000		<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Building Resilience to Climate Change Coastal Lands Protection Scheme NSW Environment Trust 	WCSP 2022 • Goal 1: Objective 1.2, Objective 1.6 SCSP 2023 • Objective 2.1: Strategy 2.1.3 • Objective 2.3: Strategy 2.3.2
IR4	Water level and condition monitoring for all lake inundation events	Estimated total of \$100,000 (\$10,000 p.a. for 10 years)	Years 1 to 10	\$10,000	\$40,000	\$50,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Building Resilience to Climate Change NSW Environment Trust 	WCSP 2022 • Goal 1: Objective 1.2 SCSP 2023 • Objective 2.1: Strategy 2.1.3 • Objective 2.3: Strategy 2.3.2.
IR5	Investigate novel solutions to manage inundation risks to assets such as stormwater, sewer, and water; cycleways, roads and bridges, etc	\$30,000 plus research partnership (with a consultancy and/or university)	Years 5 to 10		\$10,000	\$20,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program Building Resilience to Climate Change NSW Environment Trust 	WCSP 2022 • Goal 1: Objective 1.1; Objective 1.6 SCSP 2023 • Objective 2.3: Strategy 2.3.6. • Objective 3.1: Strategy 3.1.2 • Objective 2.1: Strategy 2.1.3
Strategy 9: Protect and Manage Key Fauna (MF)								
MF1	Develop and implement a fauna management program including shorebirds, fish and other fauna.	Estimated total of \$125,000 = \$15,000 to develop program, plus \$60,000 for ecological surveys (3 at \$20,000 each), plus \$50,000 to implement program (e.g. for yearly shorebird habitat monitoring, data management etc).	Year 1 and ongoing	\$20,000	\$60,000	\$45,000	<ul style="list-style-type: none"> NSW Coastal and Estuary Management Program NSW Environment Trust NSW Heritage Grant Programs National Trust Programs Building Resilience to Climate Change 	WCSP 2022 • Goal 1: Objective 1.1. SCSP 2023 • Objective 2.1: Strategy 2.1.1, Strategy 2.1.2, Strategy 2.1.4.

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6.3 Funding and Financing

WCC and SCC have budget allocations to assist with implementing actions to achieve the environmental goals and objectives of their respective Community Strategic Plans. As the Lake Illawarra CMP actions fall largely under these environmental goals and objectives (see details at the end of this Business Plan), the existing budgets of the Council may fund some or part of the actions, particularly in the CMP's first year until grant funding applications can be made. There is a common understanding between the councils that for lake wide actions or actions that span areas in both LGAs that costs are shared at a ratio of 2:1 for WCC to SCC.

There are a range of other funding mechanisms available for financing the implementation of the CMP. Councils have the opportunity to take advantage of the various local, state and federal grant programs, as listed in Table 6-2. The quantity of this funding cannot be accurately quantified until such time as it is awarded.

The staffing resources required to facilitate the implementation of the CMP across the two Councils and their various departments, to forward plan for commencing and progressing the actions over 10 years, and in particular to seek and obtain grant funding to achieve this, are set out for this CMP via Action PM2: Provide ongoing coordinated management of the Lake. This action requires a total investment of ~ \$110,000 p.a. (split across both Councils, increasing over time) to fund the staff required to implement the CMP. Via this specific resource, it will be imperative that both Councils and the state agencies maintain good working relationships, as a basis for successful implementation of the CMP.

Through the use of existing Council budgets, seeking grant funding and donations wherever possible, and funding ongoing staff resources to plan, apply for grants, and then progress implementation of actions, it is hoped there will continue to be sufficient funds available to implement this CMP over its intended life of 5 to 10 years.

Beyond this timeframe, there will continue to be risks to the health and sustainability of the Lake, such as from climate change and development pressures, as well as new emerging risks. This CMP is expected to be revised after 10 years, as well as reviewed annually, as detailed in Chapter 7.

Table 6-2 Local, NSW and Federal Government Funding Mechanisms

Funding Source	Details
Council Funding Mechanisms	
Council Ordinary Rates	A key funding mechanism for Council are statutory rates and charges, which can be applied to private landowners and businesses. Under the <i>Local Government Act 1993</i> (LG Act), ordinary rates can be applied to all rateable land within a local government area. This money can be used to fund delivery of community assets and services, and may also be used to implement coastal management actions.

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Funding Source	Details
Special Rates	<p>Specific works, services, facilities or activities that benefit certain parcels of rateable land can be funded (in whole or part) by Council by applying special rates under the LG Act. Where a coastal management action directly benefits a property owner, special rates provide a mechanism for Council to secure contributions from those landowners over time.</p> <p>Special rates can be implemented in different ways. Council can issue rates over a property or alternatively enter into an arrangement with the owner for payment of a lump-sum amount.</p> <p>Where a property, or properties, benefit from a coastal protection service, a coastal protection service charge can be applied (see below).</p>
Coastal Protection Service Charge	<p>The coastal protection service charge can be applied on rateable land where that land benefits from a coastal protection service, such as a seawall, erosion control measure or beach nourishment for example.</p> <p>The charge can be applied where coastal protection works are constructed by, or on behalf of the owner or occupier (current or previous). The charge can also be applied where coastal works are constructed in a joint arrangement between an owner or occupier and a public authority or council.</p> <p>The charge is applied to cover Council costs for construction, maintenance or repair of the works, as well as managing/remediating the impacts caused by the works.</p> <p>(refer to the NSW Coastal Management Manual (OEH, 2018) for further information).</p>
Development Contributions	<p>Developer contributions, enabled under the <i>Environmental Planning and Assessment Act 1979</i> may be used for coastal management in some instances, such as funding capital works to manage the development impacts on the coast or reduce risk to the development from coastal hazards. WCC and SCC differ in the way that they collect and manage Developer Contributions. The criteria and ability to use those contributions will be dependent on the relevant Developer Contribution Plan.</p>
Revenue Generated by Council	<p>Council can also fund coastal management initiatives through revenue they may generate through hire, rental or other commercial partnerships (e.g. Surf Life Savings Clubs, Holiday Parks etc).</p>
NSW Government Funding Mechanisms	
NSW Coastal and Estuary Grants Program	<p>Under this program, the NSW Government provides grants to local government to support coastal management planning (e.g. hazards studies, management plans/programs) and actions to manage the risks of coastal hazards (e.g. erosion protection), restore degraded coastal habitats (e.g. wetlands, dunes) and improve the health of NSW estuaries.</p> <p>Funding of up to 50% of a project cost is available to successful applications and the programme is administered by OEH. Grant funding will be prioritised to Council applications associated with certified Plans.</p>
Building Resilience to Climate Change	<p>The partnership program between Local Government NSW (LGNSW) and OEH aims to address climate change risks and vulnerabilities facing NSW councils. It aims encourage climate change: planning, minimisation, adaptation and implementation adaptation responses.</p>

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Funding Source	Details
NSW Environment Trust	<p>Funding is available under the NSW Environment Trust to a broad range of organisations for projects that enhance the environment of NSW. Grants may be awarded for on ground rehabilitation and improvement works, research applications, land acquisition, waste reduction and promotion of environmental education.</p> <p>The NSW Environment Trust is an independent statutory body established by the NSW Government to make and supervise the environment grants. The Trust is administered by OEHL. Suitable coastal management grant applications may relate to dune care, for example.</p>
Public Reserve Management Fund	<p>The Crown Reserve Management Improvement Fund (CRIF) is administered by DOI – Crown Lands providing financial support for the development, maintenance and improvement of public reserves. Subject to a competitive application process, the funds may be available to Council for eligible activities / works on coastal Crown reserves managed by Council</p>
NSW Heritage Grant Programs	<p>This program is administered by OEHL and aims to fund projects that provide sustainable, long-term heritage benefits and provide public benefit and enjoyment from heritage. Funding may be available for the management of heritage items in the coastal environment.</p>
Special Infrastructure Contributions	<p>Special Infrastructure Contributions (SIC) help fund the delivery of some of the key pieces of State and regional infrastructure required to support a growing population, such as:</p> <ul style="list-style-type: none"> • state and regional roads; • transport facilities such as bus shelters and interchanges; • regional open space, pedestrian links and cycleways; and • social infrastructure such as schools, healthcare and emergency services. <p>They may also contribute to the cost of planning and offsetting biodiversity impacts. SICs are imposed through a Ministerial Determination. DPE is responsible for the SIC system.</p>
Coastal Lands Protection Scheme	<p>The Coastal Lands Protection Scheme is used to bring significant coastal lands into public ownership and provides for their long term management and care. DPE administers the Scheme, which receives an annual budget allocation of \$3 million for strategic acquisitions, such as for.</p> <ul style="list-style-type: none"> • Public access: to promote public access to the coastal foreshore • Scenic quality: to maintain the scenic quality of the NSW coast • Ecological values: to protect ecological sites of regional, state and/or national significance.
Federal Government Funding Mechanisms	
National Partnership Agreement on Natural Disaster Resilience	<p>The Australian Government partners with State Governments to fund priority disaster resilience initiatives through the National Partnership Agreement on Natural Disaster Resilience. The aim of the program is to enhance Australia's resilience to natural disasters through mitigation works, measures and related activities.</p> <p>Funding is prioritised in terms of states natural disaster risk profile and priorities and focuses on building disaster resilient communities.</p>

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Funding Source	Details
National Trusts Program	The Australia Government Department of Environment administers this program. The Trusts program provides funding for works to preserve and enhance Australian cultural heritage. The Australian Council of National Trusts coordinates activities under the program with National Trusts offices in each State and Territory. Funds may be available for items of Australian cultural heritage within the coastal environment.

6.3.1 Cost Benefit & Distribution (Public/Private)

The multi-criteria cost benefit analysis compared CMP actions with the indirect and direct impact upon identified threats, weighted towards the level of threat. Through this process, actions in the CMP primarily aim to benefit estuary health, with flow-on benefits to the public (through improved recreation etc); and some actions primarily aim to benefit the public, with flow-on benefits to estuary health. There are no actions within the CMP that aim to directly benefit private interests. Therefore, no public-private cost sharing arrangements are required.

6.3.2 Implementation Responsibility, Cost Sharing and Funding Contributors

The implementation details provided in the CMP in Chapter 4 highlight the relevant responsible and supporting organisations, including state agencies, who will likely provide financial, technical and /or staff resources towards implementing various actions in the plan. The responsible organisation is expected to lead implementation of an action and commit financial and/or staff resources. Supporting organisations may support the responsible organisation to implement the action through the provision of technical or project management support (that would usually be considered standard business for that organisation), subject to availability, and in rare cases may provide financial support. The CMP requires each state agency that is identified as a responsible or supporting organisation for an action to agree to this responsibility in writing.

Once the plan is certified, WCC and SCC will be responsible for facilitating through budgetary processes the implementation of the plan, using both specific staff resources and using existing elements of the IP&R Framework of both councils to undertake, track and measure the success of actions in the CMP. The integration into the IP&R framework would be considered through the Asset Management Planning process within the Resourcing Strategy. The Community Strategic Plan provides a vehicle for each community to express its long-term aspirations and is the critical link when translating strategic objectives into actions. The Resourcing Strategy makes clear what elements of the Community Strategic Plan each stakeholder is responsible for, with other levels of government, business, non-government organisations, community groups and individuals also having a role in achieving the outcomes of the Community Strategic Plan. SCC and WCC will consider the identified actions within the Coastal Management Plan and how best to implement them and consider the priorities of the Community as identified in the CSP. Through this process, funding and resource contributions from the state agencies will be sought and managed at the appropriate time (see “resource and financial planning” and “funding and financing options” for details regarding when contributions will be required from lead and support organisations). There is a common understanding between the councils that for lake wide actions or actions that span areas in both LGAs that costs are shared at a ratio of 2:1 for WCC to SCC.

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The public is anticipated to become involved in implementing CMP actions via education strategies that provide activities for the community to attend, and that aim to change the behaviour of community members to benefit the Lake.

6.3.3 Contingent Liabilities

A contingent liability is a potential liability that may occur, depending on the outcome of an uncertain future event. A contingent liability is recorded in the accounting records if the contingency is probable and the amount of the liability can be reasonably estimated.

The hydraulic adjustment of the entrance channel is an area of potential liability. Ongoing erosion of the northern foreshore may require more substantial investment in protection works than has been estimated for Action EC2 (Implement options to manage erosion using environmentally sensitive methods). Entrance processes and ongoing changes in these processes as a result of entrance training will be investigated through Action EC1 (Investigate Entrance Channel Processes and Management). However, adjustment of the channel will and should be expected to continue to occur over the next 100 years or more. Changes will be exacerbated by ongoing sea level rise. There may continue to be investment required as new challenges arise in the entrance channel area.

Managing the ecological response to the opening of the entrance is covered under Action EV5 (Develop and implement a program to enhance opportunities for estuarine vegetation migration) in the CMP. However, there may be a liability for Council should the ecological responses be greater (or worse) than expected, although the risk of this is considered low.

The impacts arising from storms and sea level rise are also considered a liability. In particular, the opening of the entrance channel has left the channel foreshores far more exposed to swell wave action. Remedial works following storms may consume budget allocations otherwise earmarked for environmental actions in this plan, although Councils do have access to disaster relief funding. The timing of impacts from sea level rise is difficult to predict, and there is potential for impacts to occur earlier or have a greater consequence than anticipated, which would in turn require actions to be implemented or brought into the CMP planning process earlier than anticipated.

An identified threats risk assessment has been completed and is outlined previously in Section 2.4, Table 2-2. There is also the possibility of delays to implementation due to NSW planning changes. Annual review of this business plan in combination with review of CMP implementation (see Section 7.2), will allow regular review of new or existing contingent liabilities, with the annual budget updated as necessary.

6.4 Alignment with the Integrated Planning and Reporting Framework

The Lake Illawarra CMP contains 37 actions set out within 9 strategies, that aim to manage, preserve, improve, promote and rehabilitate our Lake. The actions directly link to the identified threats (see Table 3-1). The Lake Illawarra CMP strategies and actions align with the goals, objectives and strategies of the Shellharbour and Wollongong Community Strategic Plans (CSP), as set out previously in Table 6-1. It should be noted that both CSPs are currently undergoing an update, however the goals, objectives and strategies are not expected to substantially change. To assist with scheduling the implementation of actions, a Gantt chart for the actions (timeline and budget) has been included in Table 6-3.

Table 6-3 Detailed Lake Illawarra CMP Gantt Chart - Including Budget (\$)

Action ID	Action	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
WQ1	Implement a risk-based decision-making framework for the Lake Illawarra catchment.	\$200,000	\$20,000									\$220,000
WQ2	Install new or replace existing stormwater quality management measures, using water sensitive urban design or other devices that will improve water quality as well as enhance habitat and natural values.	\$25,000		\$480,000					\$1,060,000			\$1,565,000
WQ3	Review and prioritise maintenance and cleaning regime for existing stormwater quality devices.	\$25,000		\$930,000					\$1,500,000			\$2,455,000
WQ4	Design and implement targeted catchment input monitoring as required for developments resulting in a large-scale change or intensification of land use.						\$25,000					\$25,000
WQ5	Reduce sediment loads to tributaries of the Lake by improving compliance with erosion and sediment controls for development sites.	\$160,000	\$160,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$320,000
WQ6	Reduce the impact of sewer overflows.											\$0
WQ7	Implement existing water quality monitoring program for estuary health.	\$54,000		\$216,000					\$270,000			\$540,000
WQ8	Undertake water quality monitoring for Recreational Use.	\$14,000		\$56,000					\$70,000			\$140,000
WQ9	Investigate and manage potential pollution sources including contaminated sites that contribute to poor water quality in the lake.			\$60,000								\$60,000
WQ10	Undertake water quality monitoring of physico-chemical and bacteriological indicators in the lake catchment.	\$60,000		\$240,000					\$300,000			\$600,000
PM1	Commence integration of key objectives and strategies from the CMP into relevant planning and policy documents of both Councils.			\$100,000								\$100,000
PM2	Provide ongoing coordinated management of the Lake, which will require ongoing support for existing staff resources.	\$250,000	\$250,000	\$250,000	\$250,000	\$250,000	\$250,000	\$250,000	\$250,000	\$250,000	\$250,000	\$2,500,000
PM3	Develop and implement a community engagement and participation strategy that enhances the community's knowledge of, skills in and commitment to, protecting Lake Illawarra.	\$80,000		\$400,000					\$500,000			\$980,000
PM4	Establish a Lake Illawarra Asset Management Working Group that provides coordination services for agencies that manage assets around the Lake Illawarra foreshore.	\$25,000		\$20,000					\$25,000			\$70,000
EC1	Investigate options to manage erosion and accretion changes in the entrance channel and implement management solutions	\$300,000		\$910,000					\$5,000,000			\$6,210,000
EC2	Undertake small scale works (eg beach scraping, re-shaping etc) to maintain swimming areas.			\$150,000					\$150,000			\$300,000
EC3	Undertake dredging in the Entrance Channel, as required to maintain navigation.			\$2,000,000								\$2,000,000
EC4	Monitor changes to the entrance channel.	\$10,000				\$5,000				\$5,000		\$20,000
EC5	Monitor, maintain and if required, upgrade existing entrance channel infrastructure, with any works to be informed by EC1-EC2 and EC4.	\$240,000		\$960,000					\$1,200,000			\$2,400,000
EV1	Rehabilitate vegetation and manage public access along foreshores and banks of the Lake, its tidal tributaries, islands and broader low-lying areas.	\$368,500		\$1,294,000					\$1,192,500			\$2,855,000
EV2	Undertake targeted action to control damage to foreshore and lake vegetation, including seagrasses	\$130,000		\$470,000					\$500,000			\$1,100,000
EV3	Prepare and deliver an information program for the Lake catchment.	\$30,000		\$40,000					\$50,000			\$120,000
EV4	Prepare and implement an estuarine macrophyte mapping and monitoring program.	\$25,000		\$35,000					\$25,000			\$85,000
EV5	Develop and implement a program to enhance opportunities for estuarine vegetation migration.			\$175,000					\$100,000			\$275,000
RA1	Manage foreshore and waterway recreational infrastructure.	\$895,000		\$3,540,000					\$4,325,000			\$8,760,000
RA2	Construct new sections of shared pathway to complete the pathway linkage around the entire Lake.	\$100,000		\$820,000					\$600,000			\$1,520,000
RA3	Negotiate a public "right of way" along the foreshore, as opportunities present themselves.								Staff time only			\$0
CH1	Protect and promote cultural heritage in and around the lake and its catchment.	\$120,000		\$480,000					\$600,000			\$1,200,000
FB1	Undertake a bank condition assessment and determine and begin implementing erosion control works.	\$70,000		\$215,000					\$25,000			\$310,000
FB2	Improve the environmental performance and outcomes for foreshore protection works when the renewal of existing or construction of new infrastructure is required, where appropriate and feasible to do so.			\$150,000								\$150,000
FB3	Undertake bathymetric survey of the entire Lake and tributaries up to the tidal limit.					\$50,000						\$50,000
IR1	Update Asset Management Plans for all publicly owned and managed assets to clearly identify asset at risk from inundation over future timeframes, including tidal inundation.			\$50,000								\$50,000
IR2	Whole of Lake Foreshore Adaptation Plan for public (community and environmental) lands.					\$10,000		\$70,000				\$80,000
IR3	Incorporate tidal inundation mapping into strategic land use planning documents.			\$20,000								\$20,000
IR4	Water level and condition monitoring for all lake inundation events	\$10,000		\$40,000					\$50,000			\$100,000
IR5	Investigate novel solutions to manage inundation risks to assets such as stormwater, sewer, and water; cycleways, roads and bridges, etc					\$10,000			\$20,000			\$30,000
MF1	Develop and implement a fauna management program including shorebirds, fish, and other fauna.	\$20,000		\$60,000					\$45,000			\$125,000

7 Monitoring, Reporting and Review

The Lake Illawarra CMP requires evaluation and reporting regarding the success of its implementation, and the success of actions in reducing the threats and maintaining the values of Lake Illawarra. Where implementation performance is sub-optimal, the evaluation process should identify contingencies to remedy the situation.

This CMP is to be the first of many iterations of a coastal program of works to manage Lake Illawarra, although it is not the first management document for the Lake. Such plans, and the studies that underpin them, should be revised at least every 10 years.

7.1 Internal Communication and Implementation

The importance of internal communications within and between the Councils cannot be over emphasised in the success or otherwise of implementation of this CMP. To support the integration of this CMP with the day to day operations of both councils, it is recommended that 12 months after the CMP is certified, and henceforth at yearly intervals, key staff from both Councils that are responsible for its implementation, in partnership with the regional OEH Coastal representative(s), undertake an internal workshop to gauge the status of implementation of the CMP and general understanding of its objectives through both Councils. The workshop would include a refresher of the CMP contents, to reinvigorate existing staff and for new staff.

7.2 Reporting on CMP Implementation

Both WCC and SCC deliver an Annual Report to document their progress in implementing the respective Councils' Delivery Program and Operational Plan activities over each financial year. Performance measures are included for each action in the Operational Plan.

In the Strategy Implementation Plan of this CMP (Chapter 4), each action has been given a performance measure. This can be used to feed actions into both Councils' Delivery Programs and Operational Plans or longer term Resourcing Plans.

The performance measures shall also be used to gauge whether the actions have been implemented or not, which can then be reported in the Annual Report. This provides for a yearly evaluation of the implementation status of each action in the CMP.

Where actions have not been included in the IP&R Framework, a yearly evaluation of those CMP actions by the officer(s) responsible for facilitating implementation of the CMP is recommended. This may be undertaken through the annual review of the Business Plan (see Section 7.2.1), or as a separate process.

If it is determined that an action has not being implemented in accordance with the nominated timeframe, then one or both of the following contingencies should be adopted:

- Determine the cause for the delay in implementation. If delays are funding based, then seek alternative sources of funding, including applying for new or novel grant funding programs. If delays are resource-based, seek additional assistance from stakeholder agencies and / or consider using an external consultancy to coordinate implementation of the action(s). This can be facilitated through the Business Plan; and if necessary,

Monitoring, Reporting and Review

- Modify and update the CMP to reflect a timeframe or costing for implementation of the action that is more achievable. It should be noted that revisions to the CMP would need to be endorsed by all relevant stakeholders and agencies responsible for implementation.

7.2.1 Annual Business Planning

The CMP Business Plan (Chapter 6) should be updated on an annual basis. The Business Plan reflects the expected cost of the CMP over the coming financial year, and details the resourcing and financing arrangements to meet these costs. The Business Plan demonstrates the contribution from successful grant funding applications to specific actions, and the additional contribution required from the Councils.

The Business Plan reflects what actions: have been implemented, will be brought online for implementation in the coming financial year, are ongoing and require continued funding, have been carried over to the next financial year, and / or have been modified to improve the potential for implementation. The business plan provides an avenue for bringing delayed actions into play (for example, as identified through the reporting process, Section 7.2). Through the Business Plan, the financial, resourcing or timing requirements for delayed actions can be modified, and forecasts adjusted to account for implementation of these actions over the coming or a future financial year.

The business plan will be a key document for tracking success in grant funding applications and part or full contributions from the Councils. It is this financial success that will guarantee the implementation of the CMP.

7.3 CMP Review

A review should be conducted after five years to measure the performance of the CMP in terms of actually managing and reducing the threats to the ecological, social and economic values of the Lake. That is, 'how has the CMP made a difference?' and 'has the level of risk or risk rating for the threats been reduced?'

The main mechanism for gauging whether the CMP has been successful is to re-evaluate the threats through a repeat of the threat assessment process. As for the first threat assessment, all of the existing controls that assist with managing the threats should be included when assessing the level of risk, particularly those actions that have or are being implemented through the CMP. There are two specific questions to be answered:

- Has the level of risk changed? (including for those threats in this plan that are currently assessed as low); and
- Have the very high or high threats been adequately managed / mitigated? (i.e. has the risk rating been reduced to a tolerable level through management?).

If it is determined that the threats have not been adequately managed / mitigated, or that new intolerable threats have arisen, the following contingencies should be adopted:

- Carry out a formal review of the implemented management strategies, identifying possible avenues for increasing the effectiveness of the strategy in managing the risks along the coastline (including new risks);

Monitoring, Reporting and Review

- Commence implementation of additional/back-up management strategies that may assist in meeting the objectives of the CMP (possibly 'fast-tracking' some longer term strategies as necessary);
- Reconsider the urgency of management for key threats. Upscaling from passive to active management may be needed, for example, where climate change or entrance channel related threats have increased in severity and now require intervention to ameliorate impacts.

If the need arises, new actions or items can also be added to the CMP as part of the review process.

Any such changes to the CMP would need to be endorsed by the stakeholders and relevant government agencies, as well as the community.

7.4 Water Quality and Estuary Health Monitoring Program

7.4.1 Preamble

A CMP requires a monitoring, evaluation and reporting framework to be established to help determine whether the outcomes intended from the CMP implementation are being realised. One of the outcomes for the Lake Illawarra CMP is protection and improvement in water quality and estuary health of the Lake. The monitoring regime being recommended for this is outlined below.

7.4.2 Background

Water quality monitoring has been ongoing continuously since 2005, but has been added to and refined in more recent years to focus on estuary health. Additionally, recreational monitoring was expanded to cover 4 sites in the lake in late 2018.

It is noted, however, that a focus is on assessing estuary ecosystem health based on water quality indicators alone is somewhat limited. There is opportunity in an ongoing program to include other indicators that are also important for estuary health (such as macrophyte distributions), and to assess water quality for recreational use, given the lake is commonly used for recreational purposes by the community, and the potential for greater use of the lake for this purpose in the future.

Inputs from the catchment have a significant influence on the condition of the lake, and many of the management actions in the CMP relate to reducing these inputs over time. Therefore, targeted monitoring of catchment inputs is also recommended to assess how pollution loads being delivered to the lake are changing over time.

7.4.3 Objectives of the Monitoring Program

The objectives of the water quality and estuary health monitoring program are:

- (1) Track the water quality and estuary health condition of the Lake for protection of aquatic ecosystems and for recreational use.
- (2) Track the effectiveness of the CMP in reducing catchment inputs to the Lake, by undertaking targeting monitoring of pollution loads.
- (3) Identify any emerging water quality and estuary health issues to inform the ongoing management strategy for the Lake.

Monitoring, Reporting and Review

- (4) Keep the community updated on the water quality and estuary health condition of the Lake.

7.4.4 Lake Monitoring at Present

Under the current program being coordinated by WCC, the Lake is monitored at six foreshore and five in-lake locations. An analysis of the results collected over several years has shown that a number of these sites have very similar water quality (WCC, 2015, 2016, 2017, 2018a). Therefore, the number of sites recommended for ongoing monitoring can be rationalised, ensuring that sites with the longest data records are generally retained.

7.4.5 Catchment Monitoring at Present

SCC currently undertakes quarterly water quality sampling at sites throughout the LGA including the Lake Illawarra catchment. Results are reported through the Community Strategic Plan. This monitoring program is currently being reviewed. Physicochemical, nutrient and bacteriological data is gathered and is used inform management actions and identify areas of non-compliance where further investigation is required.

7.4.6 Monitoring Program for this CMP

Table 7-1 describes the overall monitoring design for the Lake, including the requirements for macrophyte monitoring. Action WQ7 outlines the costs, timeframes and responsibilities for undertaking the water quality monitoring program as it is proposed in Table 7-1. Action EV4 provides the details, costs, timeframes and responsibilities for undertaking the macrophyte mapping and monitoring, as proposed in Table 7-1 also.

The sites recommended for ongoing monitoring are shown in Figure 7-1. Table 7-2 presents further information on the location of the water quality sites. No attempt has been made to relabel the sites to ensure they can be related with earlier records. Three new sites have been added for recreational use monitoring. These are areas around the Lake that are already commonly used for a number of recreational activities. This is in addition to the site at Entrance Lagoon Beach that is currently monitored under the Beachwatch program.

Monitoring, Reporting and Review

Table 7-1 Monitoring Design for Lake Illawarra

Lake use / value	Indicator	Sites	Frequency	Notes
Protection of aquatic ecosystems	Water quality: physico-chemical indicators (temperature, salinity, pH, dissolved oxygen, turbidity; total, dissolved and reactive forms of nitrogen and phosphorus), and chlorophyll <i>a</i>	Foreshore sites – 1,2,3, 4, 5, 6 Lake sites – NS1, NS2, NS3, EW1, EW2	Monthly	Protocols being used in the council program follow standard procedures consistent with the MER protocols, and these procedures can be retained.
	Macrophytes – seagrass, saltmarsh, mangroves	Entire lake	Within 2 years, then every 5 years	Follow guidelines in State of NSW and OEH (2016)
Recreational use	Enterococci	BW1, BW2, BW3, ELL	As per the NSW Beachwatch sampling regime	Follow Beachwatch protocol

Table 7-2 Location of Water Quality Monitoring Sites in Lake Illawarra

ID	Site Location	Lake Zone	Purpose
Site 2	Boat ramp at Windang Peninsula	Lake Entrance	For water quality and estuary health
Site 3	At Picnic Island	Lake Entrance	
Site 3A	Jetty at Boonerah Point Reserve	Lake Edge	
Site 4	Jetty at Sailing Club at Burroo Bay	Lake Edge	
Site 5	Boat ramp and jetty at Kanahooka	Lake Edge	
Site 6	Jetty at Griffins Bay Wharf	Lake Edge	
NS1	North along a north-south transect	In-lake	
NS2	Middle along a north-south transect	In-lake	
NS3	South along a north-south transect	In-lake	
EW1	East along an east-west transect	In-lake	
EW2	West along an east-west transect	In-lake	
BW1	At Ski Way Park	Lake Edge	
BW2	At Kanahooka Boat Ramp	Lake Edge	
BW3	At Purry Burry Point, Primbee	Lake Edge	
ELL	At Entrance Lagoon Beach	Lake Entrance	



Figure 7-1 Location of Sampling Sites for the Water Quality and Estuary Health Monitoring Program and for Recreational Use

7.4.7 Information Relevant to Estuarine Macrophyte Monitoring

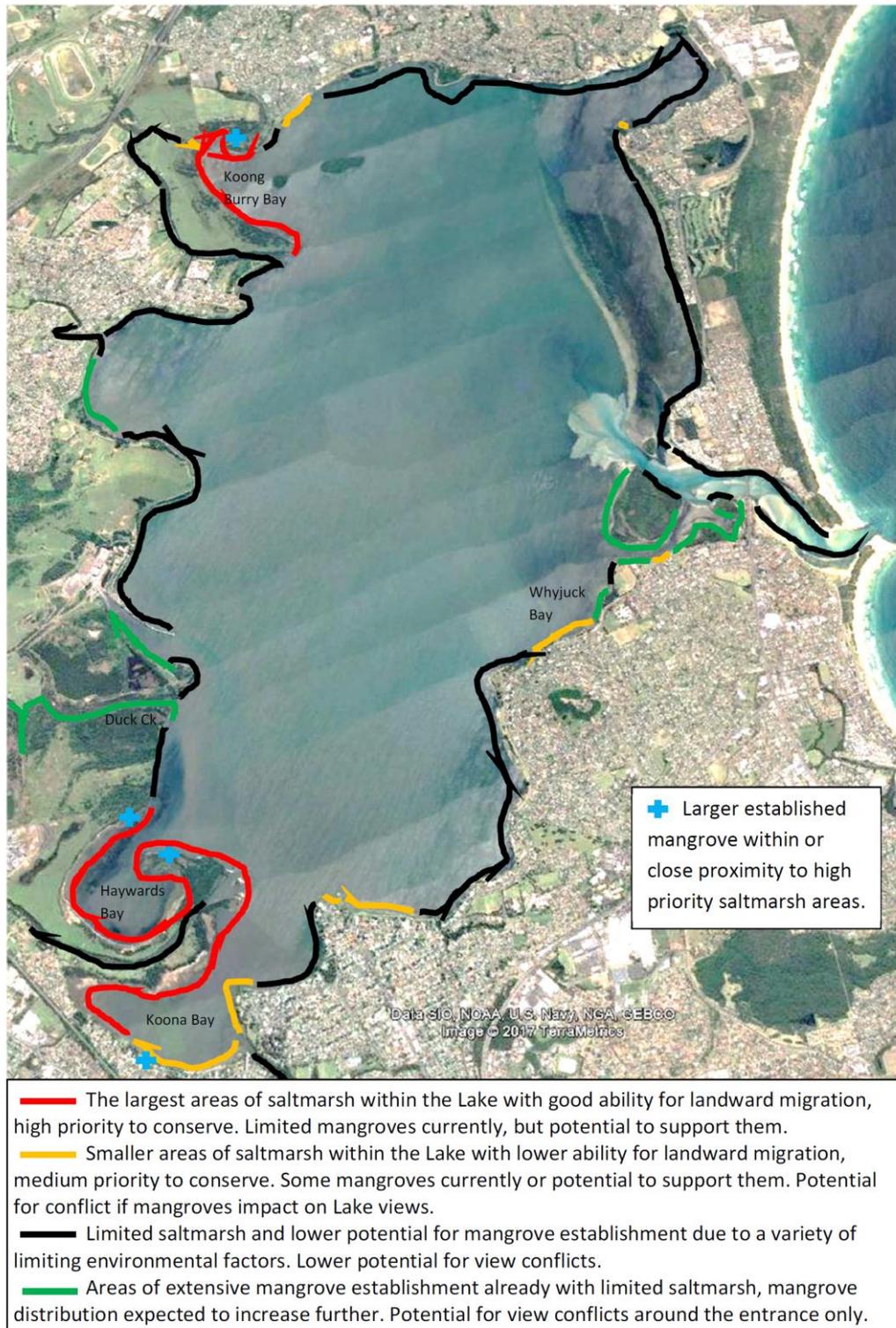


Figure 7-2 Foreshore prioritisation map to guide where effort on mangrove monitoring and conservation of saltmarsh distribution is best placed (reproduced from Williams and Wiecek, 2017)



LEGEND

- Identified potential areas for estuarine vegetation migration (Wiecek, 2018)
- 2016 HHWSS
- 2100 HHWSS

Title:

Lake Illawarra Estuarine Vegetation Migration Investigation Areas

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



Figure:

4-1

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Appendix A NSW Coastal Management Framework and Mandatory Requirements

A.1 Definition and Objectives for the Coastal Management Areas

A.1.1 Coastal Wetlands and Littoral Rainforest Area

Coastal wetlands and littoral rainforest support high value biodiversity that are particularly sensitive to development. This management area is defined in the CM Act as land which displays '*the hydrological and floristic characteristics of coastal wetlands or littoral rainforests and land adjoining those features*' (DPE, 2016). This area focusses on protecting well established and more extensive vegetation communities (as opposed to single trees or isolated stands). Specific controls on development apply to this management area, as set out in the Coastal Management SEPP.

The **objectives of the coastal wetland and littoral rainforest management area** within the *CM Act* are to:

- protect coastal wetlands and littoral rainforests in their natural state, including their biological diversity and ecosystem integrity;
- promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests;
- improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration;
- support the social and cultural values of coastal wetland and littoral rainforest communities, and;
- promote the objectives of State policies and programs for wetlands or littoral rainforest management.

Mapping at Lake Illawarra identifies coastal wetlands to extend across the low lying margins of the Lake, namely around Mullet Creek, Duck Creek and Macquarie Rivulet flood tide deltas, but also within and around the entrance channel and the Windang Peninsula region (see Figure 1-4). Littoral Rainforest areas are present on Windang Peninsula.

A.1.2 Coastal Vulnerability Area

Coastal fringing land threatened by coastal hazards will be encompassed within the coastal vulnerability management area. This area focusses on identifying land subject to current and future coastal hazards, and applying specific controls to inform land use decisions. Development in this management area is permitted, but must comply with the Coastal Management SEPP requirements (DPE, 2016).

The summarised **objectives of the coastal vulnerability management area** within the *CM Act* are to:

- ensure public safety and prevent risks to human life;
- mitigate current and future coastal hazards;
- maintain the presence of beaches, dunes and other natural features;

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- maintain public access, amenity and use of the coast;
- encourage land use that reduces exposure to hazards, including through siting, design, construction and operational decisions;
- adopt coastal management strategies that reduce exposure to hazards, in the first instance by restoring or enhancing natural defences such as dunes, and thereafter by taking other action and;
- if taking other action, to;
 - avoid significant degradation or disruption of biological diversity, ecosystem integrity, coastal processes (ecological, biophysical, geological, geomorphological), beach and foreshore amenity, and social and cultural values;
 - avoid adverse offsite impacts, or otherwise restore the land if any impacts are caused by the action to reduce exposure to hazards;
- maintain essential infrastructure, and;
- improve community resilience and reduce reliance on emergency responses.

Hazard types specific to Lake Illawarra include entrance instability, coastal and tidal inundation, and foreshore erosion. The coastal vulnerability management area is not currently mapped in the CM SEPP. The Department of Planning and Environment (DPE) intends to identify areas to be included in the coastal vulnerability area over time (DPE, 2016).

Even though the SEPP mapping does not identify a vulnerability area in the Lake Illawarra coastal zone at present, these hazards do exist. The coastal inundation hazard area derived by Cardno (2010, 2012) may be used to represent the coastal vulnerability area for Lake Illawarra. The coastal inundation hazard area was modelled by Cardno (2010, 2012), using the levels shown in Table A-1, which represents inundation levels inside Lake Illawarra due to present day ocean water level events, and such events at 2050 and 2100 factoring in SLR. The 100 year Average Recurrence Interval (ARI) ocean water level for the present day of 1.44 m AHD was derived from guidance by OEH (formerly DECCW) for Fort Denison in Sydney. For the future time periods of 2050 and 2100, Cardno (2010, 2012) adopted a projected sea level rise of 0.4 m and 0.9 m respectively.

Wave set up was not included in the ocean water level boundary conditions, as swell waves do not penetrate into the estuary further than Windang Bridge, and as such, do not shoal and break to generate wave set up.

Cardno (2010) found that the peak ocean still water levels are modified in the estuary due to tidal attenuation through the Lake entrance. For example, the peak 100-years ARI storm ocean water level of 1.44 m AHD translated into an estuarine water level of 0.7 m AHD upstream of Windang Bridge.

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Table A-1 Ocean Water Level Boundary Conditions for Coastal Inundation Modelling

Ocean Water Level Scenario	Indicative Timeframe	Water Level (m AHD)
Immediate: 100 yr. ARI ocean water level	Present Day	1.44
High risk: 100 yr. ARI ocean water level + 0.4 m SLR	2050	1.84
Low risk: 100 yr. ARI ocean water level + 0.9 m SLR	2100	2.34

A.1.3 Coastal Environmental Area

The NSW coastal environment is diverse and encompasses a range of different landforms, processes and environments. The coastal environment management area is land containing features such as the coastal waters of the State, estuaries, coastal lakes and lagoons, and land adjoining those features such as headlands and rock platforms.

The **objectives of the coastal environmental area** within the *CM Act* are to:

- protect and enhance coastal environmental values and natural processes of coastal waters, estuaries, coastal lakes, coastal lagoons, and enhance natural character, scenic value, biological diversity and ecosystem integrity;
- reduce threats to and improve resilience of these coastal environments, including in response to climate change;
- maintain and improve water quality and estuary health;
- support social and cultural values of the coastal environments;
- maintain the presence of beaches, dunes and natural features of the foreshore; and
- maintain and improve public access, amenity and use of the coast.

The Coastal Management SEPP acknowledges the important environmental values of the coastal environment management area and outlines a range of specific controls that aim to minimise the impact of development on this area (DPE, 2016). Draft mapping of the coastal environment area at Lake Illawarra encompasses the estuary waterbody and its entrance channel, plus a 500m fringe landward of the Lake and entrance foreshore, in addition to 1km upstream beyond the Highest Astronomical Tide within its tidal tributaries (see Figure 1-4).

A.1.4 Coastal Use Area

The coastal zone comprises land that is extremely valuable in terms of the economy and society. Indeed, the coastal zone supports a range of human uses and development types that enable the wider coastal community to live, work and play on the coast. The coastal use management area encompasses land adjacent to coastal waterways (ocean, estuaries, lakes etc.) where impacts of

NSW Coastal Management Framework and Mandatory Requirements

development on the use and enjoyment of the beaches, dunes, estuaries and lakes need to be considered.

The **objectives of the coastal use management area** within the *CM Act* are to:

- protect and enhance the scenic, social and cultural values of the coast by ensuring that:
 - the type, bulk, scale and size of development is appropriate for the location and natural scenic quality of the coast,
 - adverse impacts of development on cultural and built environmental heritage are avoided or mitigated,
 - urban design, including water sensitive urban design, is supported and incorporated into development activities,
 - adequate public open space is provided, including for recreational activities and associated infrastructure, and
 - the use of the surf zone is considered;
- accommodate both urbanised and natural stretches of coastline.

The Coastal Management SEPP sets out controls specific for the coastal use management area that ensure development proposals address a range of public interest criteria.

A.2 Meeting the Mandatory Requirements and Essential Elements

Table A-2 Mandatory Requirements for a Coastal Management Program Relevant to Preparation of the CMP

Section 14 of the Coastal Management Act 2016 defines the preparation of CMPs as follows	How this CMP addresses these requirements
(1) A local council is to prepare a coastal management program in accordance with the coastal management manual.	The Lake Illawarra CMP has been prepared in accordance with both the current Guidelines for preparing coastal zone management plans (OEH, 2013) and the NSW Coastal Management Manual (OEH, 2018) that was current at the time of this CMP's preparation.
(2) The Minister may, by notice in writing given to a local council, direct the local council in its preparation of a coastal management program. A direction under this subsection prevails to the extent of any inconsistency between it and the coastal management manual.	The Minister has not directed the local councils in preparation of this CMP.
(3) In preparing a coastal management program, a local council must:	
(a) consider and promote the objects of this Act, and	The objects of the CM Act are reflected in the objectives of this CMP, see Section 1.5.

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Section 14 of the Coastal Management Act 2016 defines the preparation of CMPs as follows	How this CMP addresses these requirements
(b) give effect to the management objectives for the coastal management areas covered by the program, and	The management objectives for the coastal management areas are re-iterated in the coastal strategy statement and objectives of this CMP, see Section 1.5.
(c) consider the State and regional policies and plans prescribed by the regulations for the purposes of this section.	Legislation relating to the management of the Lake is considered in Section 1.4.
(4) A direction under this section may specify the time within which the direction must be complied with.	This subsection does not apply as the Minister has not directed the local councils in preparation of this CMP.

Section 15 of the Coastal Management Act 2016 defines the matters to be dealt with in a CMP as follows	How this CMP addresses these requirements
(1) A coastal management program must:	
(a) identify the coastal management issues affecting the areas to which the program is to apply, and	A summary of the threats affecting Lake Illawarra is provided in Section 2.4, with detailed analysis of the threats outlined in the Community Uses, Values, Threats and Opportunities Lake Illawarra Report (BMT, 2019b) in Appendix C.
(b) identify the actions required to address those coastal management issues in an integrated and strategic manner, and	A detailed multicriteria cost benefit analysis of the options was conducted, including assessment of the options direct influence on the threats to the Lake, in order to identify suitable actions for the CMP. This assessment is detailed in Section 3.3 and Appendix E.
(c) identify how and when those actions are to be implemented, including those to be implemented by local councils under Chapter 13 of the <i>Local Government Act 1993</i> , those to be implemented under environmental planning instruments and development control plans under the <i>Environmental Planning and Assessment Act 1979</i> and those to be implemented by public authorities (other than the local council), and	The Strategy Implementation Plan in Chapter 4 provides details of how and when actions are to be implemented, and responsibilities for implementation (lead and support), including the local councils (WCC and SCC) and other public authorities. The implementation tables also indicate those actions to be implemented through changes to the LEP, DCP or other planning documents. The implementation tables also provide details to enable the actions to be implemented through both councils IP&R Frameworks.
(d) identify the costs of those actions and proposed cost-sharing arrangements and other viable funding mechanisms for those actions to ensure the delivery of those actions is consistent with the timing for their implementation under the coastal management program, and	The Strategy Implementation Plan in Chapter 4 provides details of estimated costs for the actions. The Business Plan in Chapter 6 details further the financing and funding mechanisms for implementing the actions in the CMP.

NSW Coastal Management Framework and Mandatory Requirements

Section 15 of the Coastal Management Act 2016 defines the matters to be dealt with in a CMP as follows	How this CMP addresses these requirements
(e) if the local council's local government area contains land within the coastal vulnerability area and beach erosion, coastal inundation or cliff instability is occurring on that land, include a coastal zone emergency action subplan.	Present day storm inundation risks are currently effectively managed through the Flood Risk Emergency Management process. This CMP sets out the process for defining the coastal vulnerability area for Lake Illawarra, refer to Section 1.5.2.
(2) A coastal management program may also include other matters as may be authorised or permitted by the coastal management manual.	This Lake Illawarra CMP focuses on improving or maintaining the environmental values of the Lake.
(3) A coastal zone emergency action subplan is a plan that outlines the roles and responsibilities of all public authorities (including the local council) in response to emergencies immediately preceding or during periods of beach erosion, coastal inundation or cliff instability, where the beach erosion, coastal inundation or cliff instability occurs through storm activity or an extreme or irregular event. For the purposes of this subsection, those roles and responsibilities include the carrying out of works for the protection of property affected or likely to be affected by beach erosion, coastal inundation or cliff instability.	A coastal zone emergency action subplan is not required for this Lake Illawarra CMP.
(4) A coastal management program must not include the following:	
(a) matters dealt with in any plan made under the <i>State Emergency and Rescue Management Act 1989</i> in relation to the response to emergencies,	This plan does not deal with such matters.
(b) proposed actions or activities to be carried out by any public authority or relating to any land or other assets owned or managed by a public authority, unless the public authority has agreed to the inclusion of those proposed actions or activities in the program.	WCC and SCC have primary responsibility for all actions except WQ6 which is a shared responsibility with Sydney Water, with other agencies listed as support organisations.

NSW Coastal Management Framework and Mandatory Requirements

Table A-3 Essential Elements for a Coastal Management Program Relevant to Preparation of the CMP

Draft essential elements associated with Section 14 of the CM Act: Preparation of CMPs	How this CMP addresses these elements
4) A CMP is to be prepared using the staged process set out in the manual (see Figure 3 of the Introduction for an outline of the five stages), noting that all stages do not need to be completed if they are not relevant.	The Lake Illawarra CMP has been prepared in accordance with both the current Guidelines for preparing coastal zone management plans (OEH, 2013) and the NSW Coastal Management Manual (OEH, 2018) that was current at the time of this CMP's preparation.
5) All councils commencing the preparation or review of a CMP must complete Stage 1 (scoping study) of the process. At the conclusion of the scoping study, councils should take the opportunity to seek advice from OEH and the Coastal Council on which of the subsequent stages are applicable.	A scoping study has been compiled by WCC and SCC. Advice from OEH was sought, and stated that the Lake Illawarra project could be completed as a CMP. Prior stages of preparing this CMP included an Information Synthesis Report detailing current knowledge of the Lake's processes (Appendix B), and a Community Uses, Values, Threats and Opportunities Lake Illawarra report (Appendix C). Stakeholder and community engagement was undertaken throughout the studies.
6) Councils should take the opportunity to seek advice from OEH and the Coastal Council at the conclusion of key stages of the CMP process.	At each stage of the preparation of this CMP, OEH has been involved in the review of documents and provided guidance on subsequent stages of the CMP.
7) Councils should submit a draft CMP that is consistent with the requirements of the Manual to OEH. After exhibition of the draft CMP, Councils should provide a copy of the final draft of the CMP to OEH for review before it is submitted to the Minister for certification. The Minister may refer the CMP to the Coastal Council for advice before the Minister considers certification.	This is the process to be followed for the Lake Illawarra CMP certification.
8) Councils should identify priority objectives for their coastal management areas. When identifying objectives for a CMP that includes one or more coastal management areas, councils must be consistent with the objectives for coastal management areas as required by the draft CM Bill and proposed CM SEPP. The objectives must align with the objectives identified by the local community in developing the Community Strategic Plan.	The objectives for this CMP have been aligned with the objectives specified in the CM Act, see Section 1.5

NSW Coastal Management Framework and Mandatory Requirements

Draft essential elements associated with Section 14 of the CM Act: Preparation of CMPs	How this CMP addresses these elements
<p>9) Councils should identify the priority management issues and opportunities affecting the coastal zone where the program is to apply. These may relate to:</p> <ul style="list-style-type: none"> a) coastal processes and environmental values b) social and cultural values c) Aboriginal values d) coastal economies e) coastal development and land use planning f) current and future risk from coastal hazards and climate change g) the ambulatory nature of the shoreline h) integration and coordination of planning and management i) resilience of coastal assets j) public participation, and k) marine estate. l) What outcomes are required from a CMP process 	<p>A comprehensive assessment of coastal management issues and opportunities has been undertaken as part of this Lake Illawarra CMP.</p> <p>Coastal management issues and opportunities affecting the Lake were identified primarily through the Synthesis Report (Appendix B) and the Community Uses, Values, Threats and Opportunities Lake Illawarra Report (Appendix C) completed as a precursor to this CMP.</p>
<p>10) The CMP should be developed after the preparation of:</p>	
<p>a) a Coastal Strategy Statement. The Strategy Statement sets the long-term strategy for the integrated and coordinated management of the coastal zone with a focus on achieving the objectives of the draft CM Bill. This includes identification of:</p> <ul style="list-style-type: none"> i. coastal management issues and opportunities ii. strategies and actions linked to coastal management areas covered by the CMP, including a map of proposed actions 	<p>A coastal strategy statement for this CMP has been prepared in Section 1.5.</p>
<p>b) specific trigger points or indicators of when a strategic approach will no longer be viable. This should be based on thresholds for intolerable and unacceptable risk at that locality.</p>	<p>Strategy “Prepare for Inundation Risks” in Section 4.8 provides the strategies through which trigger points and indicators will be implemented. A tidal inundation risk assessment was conducted for this CMP, and combined with the existing coastal inundation risk registers already completed for the Lake provides detail regarding the specific assets (including natural assets) at risk over specified future timeframes.</p>

NSW Coastal Management Framework and Mandatory Requirements

Draft essential elements associated with Section 14 of the CM Act: Preparation of CMPs	How this CMP addresses these elements
identification of coastal management actions that are council's responsibility, and are consistent with the Strategy Statement. After certification and adoption of the CMP, the final council actions will be incorporated in council's IP&R framework and land use planning system	The Strategy Implementation Plan in Chapter 4 identifies the responsibilities for implementation (lead and support), including the local councils (WCC and SCC) and other public authorities. The implementation tables also provide details to enable the actions to be implemented through both councils IP&R Frameworks.
c) identification of coastal management actions that are consistent with the Strategy Statement and require coordination with adjoining councils or are the responsibility of public authorities. The draft CMP should include an acknowledged acceptance of these management actions where they include public authority responsibilities and/or coordination with adjoining councils prior to certification by the Minister, and	The Strategy Implementation Plan in Chapter 4 identifies the responsibilities for implementation (lead and support), including the local councils (WCC and SCC) and other public authorities. WCC and SCC have primary responsibility for all actions except WQ6 which is a shared responsibility with Sydney Water, with other agencies listed as support organisations. Acknowledged acceptance of their roles shall be provided prior to certification of the CMP.
d) a business plan to demonstrate viable funding of proposed actions.	A business plan for the CMP is provided in Chapter 6.
A CMP should include: e) a summary statement of the overall CMP Strategy that demonstrates how the CMP provides an integrated and sustainable program of coastal management in line with the Objectives in the CM Bill, any regional objectives and the objectives of the council	Overarching summary statements regarding the purpose, intent, context and objectives of this CMP are delivered in Chapter 1.
f) coastal management actions to be implemented by council through IP&R and land use planning processes which are consistent with the Strategy Statement and are the responsibility of the council, in addition the actions to be implemented by adjoining councils (where relevant) and public authorities	The Strategy Implementation Plan in Chapter 4 identifies the responsibilities for implementation (lead and support), including the local councils (WCC and SCC) and other public authorities. The implementation tables also provide details to enable the actions to be implemented through both councils IP&R Frameworks. The implementation tables also indicate those actions to be implemented through changes to the LEP, DCP or other planning documents.
g) a brief summary of the business plan outlining the key components of the funding strategy for the proposed actions	A business plan for the CMP is provided in Chapter 6.
h) where the CMP is being prepared for a coastal vulnerability area, a coastal erosion emergency action sub-plan, and	As outlined in detail in Section 1.7.3, present day inundation risks are currently effectively managed through the Flood Risk Emergency Management process.

NSW Coastal Management Framework and Mandatory Requirements

Draft essential elements associated with Section 14 of the CM Act: Preparation of CMPs	How this CMP addresses these elements
<p>i) a map (or maps) showing linked actions for each relevant coastal management area along the coast. These maps should include adjoining local council areas where cross boundary management needs to be consistent or fully aligned to address issues such as regional scale sediment compartment processes, or where an estuary or wetland and its catchment straddles a council boundary.</p>	<p>Management Strategy Maps for the Lake are provided in Chapter 5.</p>
<p>Supporting documentation for a CMP will include:</p> <p>j) a detailed Coastal Strategy Statement which provides context and objectives and establishes council's strategic direction(s) for the coast</p>	<p>A coastal strategy statement for this CMP has been prepared in Section 1.5.</p>
<p>k) a detailed business plan for implementation of the CM, and</p>	<p>A business plan for the CMP is provided in Chapter 6.</p>
<p>l) a listing of all detailed reports relied on in the preparation of the CMP, and a statement as to how to publicly access any of the listed documents.</p>	<p>Previous studies supporting this CMP are discussed in Section 1.9. The Synthesis Report is provided in Appendix B, and a Community Uses, Values, Threats and Opportunities Lake Illawarra report is provided in Appendix C.</p>
<p>11) Councils should identify management actions which reduce risks and contribute to achieving the proposed strategic direction for each coastal management unit. Proposed management responses should reduce consequences or reduce the likelihood of a hazard or threat affecting a vulnerable asset (natural, social or economic).</p> <p>These responses should:</p> <p>a) reflect the vulnerability and opportunities in the coastal management program area</p> <p>b) reduce risks affecting coastal ecosystems and biodiversity and identify opportunities to improve the health of coastal ecosystems</p> <p>c) identify opportunities to improve coastal use, access and amenity, and coast dependent economic activity, and</p> <p>d) be identified in consultation with stakeholders.</p>	<p>The process for identifying management actions is outlined in Chapter 3, with the strategies assessment outcomes documented in Appendix E. The process included a detailed multicriteria cost benefit analysis of the options, including assessment of the options direct influence on the threats to the Lake, in order to identify suitable actions for the CMP.</p>

NSW Coastal Management Framework and Mandatory Requirements

Draft essential elements associated with Section 14 of the CM Act: Preparation of CMPs	How this CMP addresses these elements
<p>12) Councils must develop a business plan that demonstrates viable funding mechanisms for proposed coastal management actions that are consistent with their IP&R Resourcing Strategy. In the business plan:</p> <ol style="list-style-type: none"> a) councils should identify and consider the full capital, operational and maintenance costs of potential coastal management actions b) councils should identify the distribution of costs and benefits of potential management actions. The distribution analysis should consider council, agency, directly affected coastal community stakeholders (such as landholders in coastal hazard areas), indirectly affected coastal community stakeholders and the environment, and c) the costs of coastal management actions should be apportioned among beneficiaries, taking into account capacity to pay. 	<p>A business plan for the CMP is provided in Chapter 6.</p>
<p>13) If a CMP is prepared to address a coastal vulnerability area, that program should include all parts of the coastal zone that are:</p> <ol style="list-style-type: none"> a) vulnerable to existing or potential hazards (including extreme events), or b) likely be affected by coastal hazards over a defined planning horizon. c) This could include the waters, beaches, dunes and headlands of the open coast, the waters, shorelines and riparian areas of coastal lakes and the shorelines, and the waters, banks, riparian areas and floodplains of estuaries, as far upstream as the tidal limit. 	<p>This CMP sets out the process for defining the coastal vulnerability area for Lake Illawarra, refer to Section 1.5.2.1. Present day inundation risks are currently effectively managed through the Flood Risk Emergency Management process.</p> <p>Coastal inundation for Lake Illawarra was mapped through the course of the Lake Illawarra Floodplain Risk Management Plan (Cardno, 2012), and the Wollongong Coastal Zone Study (Cardno, 2010).</p> <p>A risk assessment was undertaken for coastal inundation in Lake Illawarra, and management strategies developed to address this risk in two key supporting documents to this CMP:</p> <ul style="list-style-type: none"> • Lake Illawarra Coastal Risk Assessment (BMT WBM, 2013) • Wollongong Coastal Zone Management Plan: Management Study (BMT WBM, 2017). <p>Tidal inundation risks were assessed through a separate hydrodynamic modelling exercise by Kumbier et al (2019) and then a risk assessment was conducted specifically for tidal inundation as documented in the Values Report.</p> <p>Management actions to address future storm and tidal inundation risks are specified in Section 4.8, as well as through other specific actions in the plan.</p>

NSW Coastal Management Framework and Mandatory Requirements

Draft essential elements associated with Section 14 of the CM Act: Preparation of CMPs	How this CMP addresses these elements
14) The CMP should be developed to consider potential very large, low probability events and ongoing long-term changes, at timeframes up to, and if appropriate, beyond 100 years. Different levels of hazard and risk assessment detail are appropriate for long-term (less certain) and near-term hazards and risks.	The timeframes and events considered through the course of this CMP are outlined in Section 1.6.
15) The area covered by the CMP should allow for uncertainty about the impacts of future coastal hazards and potential threats to coastal biodiversity and socio-economic assets and their condition.	This CMP sets out the process for defining the coastal vulnerability area for Lake Illawarra, refer to Section 1.5.2.1. The threat and risk assessment conducted for this CMP in the Values Report also considered future changes that will affect the future level of risk from identified threats.
16) The planning horizons should consider potential coastal change, including <ul style="list-style-type: none"> a) climate change, including relative sea level rise b) population growth, and c) projected use of coastal land for infrastructure, housing, commercial, recreational and conservation purposes. 	The intended timeframe for implementation of this CMP is 10 years, as consistent with the CM Act. Actions are typically focussed on achieving improvements over this timeframe, with some actions incidentally having a longer term effect. With respect to coastal inundation risks, a longer planning horizon has been considered when developing actions.
17) A CMP may also include opportunities to enhance biodiversity (within coastal wetlands and littoral rainforest areas and coastal environment areas) and social and economic assets and conditions in the coastal zone including enhanced public access and enjoyment of the coastal amenity. The area covered by the CMP should include appropriate buffer areas to allow for uncertainty and change over time.	The Lake Illawarra CMP is focussed on actions to remediate the threats to the Lake and to enhance its environmental and thereby social and economic values. A number of actions in the CMP directly intend to enhance biodiversity, and social and economic assets of the Lake. The area covered by this CMP (as outlined in Section 1.3) provides an appropriate buffer to allow for uncertainty and change over time.

Appendix B Lake Illawarra Information Synthesis Report



Appendix C Community Uses, Values, Threats and Opportunities Lake Illawarra

Links to the Marine Estate Management Act

Appendix D Links to the Marine Estate Management Act

Table D-1 Links between the MEMA Threat and Risk Assessment and the LI CMP Threat Assessment

Ranked Priority Regional Threats identified in State-wide MEMA Environmental Threat and Risk Assessment (TARA): Central Region	Stressors from MEMA TARA	Relevant threat category in Lake Illawarra CMP
Urban stormwater discharge	Water pollution –through nutrients and organic matter, toxic contaminants; sediment resuspension, pathogens Sedimentation Marine debris (including microplastics)	<ul style="list-style-type: none"> • Water pollution • Catchment development • Litter, plastics and marine debris
Foreshore development	Water pollution – toxic contaminants through antifouling paint and oil spills; sediment resuspension Physical disturbance resulting from beach grooming, shoreline infrastructure, sediment re-suspension and shading resulting in light limitation, sediment deposition Wildlife disturbance through pollution and habitat loss Marine debris	<ul style="list-style-type: none"> • Foreshore development encroaching public land • Water pollution • Loss of estuarine vegetation • Wetland degradation
Estuary entrance modifications	Changes to tidal flow and tidal prism Water pollution – contamination through acid sulphate soils Sedimentation Physical disturbance resulting from sediment re-suspension, habitat loss Sedimentation Wildlife disturbance	<ul style="list-style-type: none"> • Entrance channel changes
Agricultural diffuse source runoff	Water pollution - major impacts almost certain from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants.	<ul style="list-style-type: none"> • Water pollution • Contaminated sediments • Introduced species • Loss of estuarine vegetation • Wetland degradation
Clearing riparian and adjacent habitat including wetland drainage	Water pollution – contamination through nutrients, toxicants; sediment resuspension, acid sulphate soils Sedimentation Physical disturbance, changes to tidal flow velocity and patterns – major impacts possible due to damage to habitat during removal and clearing, altering water tables and connectivity.	<ul style="list-style-type: none"> • Loss of estuarine vegetation • Wetland degradation • Foreshore development encroaching public land • Loss of riparian habitat • Foreshore and bank erosion

Links to the Marine Estate Management Act

Ranked Priority Regional Threats identified in State-wide MEMA Environmental Threat and Risk Assessment (TARA): Central Region	Stressors from MEMA TARA	Relevant threat category in Lake Illawarra CMP
Climate change 20 years	Physical disturbance, wildlife disturbance, water pollution and reduction in abundances of species and trophic levels due to climate change components of altered ocean currents and nutrient inputs, ocean acidification, climate and sea temperature rise, sea level rise and altered storm and cyclone activity	<ul style="list-style-type: none"> Climate change
Recreational Boating - Boating and boating infrastructure	Antifouling paints and fuel spills impacting water quality-considered 'moderate' reflecting the level of impact of the defined stressors and considered 'likely' that this level of impact would occur due to the amount of vessel activity in the identified estuaries. Physical disturbance, of habitats such as seagrass, beaches and mudflats, shallow soft sediments resulting from propellers, anchoring, moorings, sediment re-suspension and shading from boats/jetties resulting in light limitation, fuel spills), and the low resilience of the habitat to these impacts.	<ul style="list-style-type: none"> Litter, plastics and marine debris Contaminated sediments
Sewage effluent and septic runoff	Water pollution - major impacts almost certain from combined stressors of nutrients, suspended sediments and toxic contaminants.	<ul style="list-style-type: none"> Water pollution Contaminated sediments
Navigation & entrance management and modification, harbour maintenance, etc.	Water pollution, physical disturbance – major impacts were considered likely due to sediment re-suspension from operations and dewatering in barges leading to turbidity and potential release of toxic contaminants. Physical disturbances and removal in generally small areas for discrete projects such as jetties, marinas. Likely to occur at a local scale.	<ul style="list-style-type: none"> Water pollution Contaminated sediments
Modified Freshwater flows - Modified freshwater flows	Water pollution – moderate impacts likely to occur from acid sulphate soils leaching and reducing pH. Changes to tidal flow and patterns impacting saltmarsh and mangroves– major impacts likely through changed water table and inundation regimes results in very broad overall impacts	<ul style="list-style-type: none"> <i>Lake Illawarra does not have any large scale dams in the catchment. Changes to freshwater flows are related to catchment flows of water quantity and quality changes. These are addressed through Stormwater Considerations.</i>
Industrial discharges	Water pollution - moderate impacts likely from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants.	<ul style="list-style-type: none"> Water Pollution Industrial Discharges
Recreation and tourism - Four wheel driving	Physical disturbance - extensive physical destruction and soil compaction possible, but under current management there is limited access to saltmarsh area for four wheel drives, and limited saltmarsh where there is access, although some illegal activity. Major impacts possible in localised areas.	<ul style="list-style-type: none"> Wetland degradation Loss of estuarine vegetation Litter, plastics and marine debris
Stock grazing of riparian and marine vegetation	Physical disturbance, water pollution– major impacts considered almost certain from the physical disturbance from trampling and grazing and nutrients via defecation.	<ul style="list-style-type: none"> Wetland degradation Loss of estuarine vegetation

Links to the Marine Estate Management Act

Ranked Priority Regional Threats identified in State-wide MEMA Environmental Threat and Risk Assessment (TARA): Central Region	Stressors from MEMA TARA	Relevant threat category in Lake Illawarra CMP
Small commercial vessels (ferries, charter boats, whale watching vessels, fishing vessels etc.)	Water pollution - considered possible that moderate impacts could occur due to potential oil spills, the low resilience of the habitat, and the level of this activity in the estuaries.	<ul style="list-style-type: none"> • Less of an issue for Lake Illawarra than other large estuaries (Botany Bay, Hawkesbury or Sydney Harbour.): • Water Pollution • Wetland Degradation
Service infrastructure - pipes, cables trenching and boring	Physical disturbance, sedimentation and water pollution – moderate impacts likely, but pulsed impacts at time of construction and mostly highly localised.	<ul style="list-style-type: none"> • <u>Not directly considered</u>
Recreational fishing - Shore-based line and trap fishing	<p>Harvest - the impact on harvested assemblages as a result of shore-based recreational fishing relates to approx. even levels of recent statewide landings taken from each region, dominated by several species which makes up a majority of the landings, and several that are either overfished, growth overfished or fully fished and/or have either moderate-high to low resilience.</p> <p>Bycatch – risks from bycatch of assemblages associated with the recreational shore-based fishery is considered to be moderate as negative impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic/community structure is not evident in most of the estuaries.</p> <p>Marine debris Ghost fishing</p>	<ul style="list-style-type: none"> • <u>Not directly considered</u> • Litter, plastics and marine debris
Recreational fishing - Boat-based line and trap fishing	<p>Harvest - the impact on harvested assemblages as a result of shore-based recreational fishing relates to approx. even levels of recent statewide landings taken from each region, dominated by several species which makes up a majority of the landings, and several that are either overfished, growth overfished or fully fished and/or have either moderate-high to low resilience.</p> <p>Bycatch – risks from bycatch of assemblages associated with the recreational shore-based fishery is considered to be moderate as negative impacts on bycatch assemblages are evident, however, the level of impact has not influenced their overall recovery capacity, and a change in the overall trophic/community structure is not evident in most of the estuaries.</p> <p>Marine debris Ghost fishing</p>	<ul style="list-style-type: none"> • <u>Not directly considered</u> • Litter, plastics and marine debris

Links to the Marine Estate Management Act

Ranked Priority Regional Threats identified in State-wide MEMA Environmental Threat and Risk Assessment (TARA): Central Region	Stressors from MEMA TARA	Relevant threat category in Lake Illawarra CMP
Recreation and tourism - Passive Recreational Use	Physical disturbance, wildlife disturbance, marine debris – moderate consequence considered likely due to a strong evidence base on the threat of recreational activities, particularly domestic dogs, to wildlife. Evidence suggests a moderate risk to threatened shorebirds from domestic dogs including impacts on behaviour, breeding success, as well as direct mortalities. Wildlife are also impacted by marine debris and human disturbance including breaches of the marine mammal approach distance regulations.	<ul style="list-style-type: none"> Wetland degradation Loss of estuarine vegetation Litter, plastics and marine debris
Thermal discharges	<p>Water pollution – major impacts almost certain from elevated water temperature and changing dissolved oxygen within the affected system</p> <p>Thermal pollution – major impacts considered almost certain with <i>Zostera</i> killed by elevated water temperatures. Species richness impacts, associated biota impacts, but limited to local impacts. On-going discharges exist.</p> <p>Water pollution, physical disturbance – known issues of thermal discharges on marine wildlife experiencing thermal shock or getting caught in inlet canals of power stations. Additional impacts from loss of foraging habitat due to loss of seagrass.</p>	<ul style="list-style-type: none"> Water pollution
Commercial fishing - Estuary general	Physical disturbance – minor impacts are likely due to activities associated with fishing and trawl gear Wildlife disturbance (shorebirds, turtles, whales)	<ul style="list-style-type: none"> Commercial Fishing
Oyster aquaculture		<ul style="list-style-type: none"> Not relevant to Lake Illawarra
Recreational fishing - Hand gathering	Wildlife disturbance, physical disturbance, marine debris - minor consequence considered likely due to disturbance to endangered shorebirds from hand-gathering. Disturbance at roosting, foraging, and nesting sites is a key threat to shorebirds in NSW. Displacement from foraging areas is a significant threat to endangered shorebirds such as beach-stone curlews, particularly during summer holiday periods.	<ul style="list-style-type: none"> Cockle Harvesting Actions <u>Not directly considered</u>
Mining and extractive industries	Physical disturbance - major impacts considered possible from subsidence as it affects seagrass viability at depth. Coal mines still mine under seagrass beds, with moderate impacts likely.	<ul style="list-style-type: none"> <u>Not directly considered.</u>

Appendix E Strategies Assessment

Table E-1 Complete List of Options Identified for Lake Illawarra CMP

¹ Option identifier from Audit by Baxter et al (2016), Values Report (VR), Synthesis Report (SR) or Project Management Team (PMT)² Based upon Audit by Baxter et al (2016)³ As stated in original source document⁴ CMP Strategy and Action that the option has been rolled into⁵ for N/A actions only. Remaining options assessed through analysis of CMP Action

#	ID ¹	Option ²	Source of Option	Details ²	Completion Status ³	Cost ²	Recommendation for this CMP (from Synthesis Report)	CMP Strategy ⁴	CMP Action ID ⁴	Coarse Cost Benefit Filter Outcome ⁵
1	1a	Prepare a plan of management for the public land between Oaklands Village Caravan Park and Windang Bridge. Provide a 'right of public access' around the edge of the Lake Illawarra Village (Jettys by the Lake) and Oaklands Village.	2011 Draft Lake Illawarra Estuary Management Plan	The foreshore between Oaklands village and Jetties by the Lake (onto Windang Bridge) was identified as a missing link in the pathway around the Lake. This site is currently exposed to uncontrolled access resulting in some erosion.	Pathway from Oaklands to Jetties by the Lake not completed. Ministerial papers and Executive Council Minute re boundary adjustment to provide a 3m strip for continuous public access along Oaklands has been approved by the Governor. Gazettal notice placed 16/4/2010. Agreement for Lease has been finalised with Jettys by the Lake re building encroachments. Certificate of Title to foreshore land issued 8/9/2010. Lease to be executed.	\$250,000	Windang town centre plan has been completed. Public 'right of way' is for future consideration.	Maintain and Improve Recreation and Amenity	RA3	
2	1b	Windang Foreshore (Jetties by the Lake and Oaklands) rehabilitation	2011 Draft Lake Illawarra Estuary Management Plan Oaklands Village and Jettys by the Lake, Windang Proposed Foreshore Stabilisation Project (2013).	Shoreline is composed of various types of bank protection structures along with other structures in various states of disrepair. Survey and assessment of the foreshore was undertaken and a draft restoration plan was proposed/ completed? Plan considered habitat friendly seawalls and removal of various uncontrolled fill and structures. Working with adjacent landholders', foreshore rehabilitation will ensure improvements in public safety and environmental value.	Preliminary concept designs completed through funding from OEH (2013).	Unknown	For future consideration.	Manage Foreshore and Bank Erosion	FB2	
3	1d	Judbooley Parade Foreshore Erosion control	Judbooley Parade Landscape Master Plan 2010	Foreshore protection works required to ensure bank stability.	Ongoing Some works are currently being undertaken by WCC to ensure bank stability and protection.	\$10,000 pa	Works for future consideration by WCC in accordance with the Judbooley Parade Plan of Management.	Manage Foreshore and Bank Erosion	FB2	
4	1e	Bank erosion control and rehabilitation. Provide bank protection along the northern shore of the entrance channel adjoining Windang Foreshore (Pine Tree) Park to protect foreshore assets against channel migration.	2011 Draft Lake Illawarra Estuary Management Plan	Dynamic shifts in the geomorphology of the entrance channel occurring as a result of the entrance being trained. With this more in depth entrance monitoring and management is now required. Erosion control and bank rehabilitation works will also need to be undertaken over time as shoreline areas become exposed through increases in channel dimensions and channel movement. Groynes have recently been installed in some areas to limit erosion. Monitoring of these structures and nearby areas should continue to identify their effectiveness in limiting erosion and if further action is required.	Two groynes (\$125,000) and a rock revetment wall (\$75,000) constructed in 2012. Repair works are currently being undertaken by WCC following recent extreme weather events.		Ongoing.	Manage Changes to the Entrance Channel	EC1	

Table E-1 Complete List of Options Identified for Lake Illawarra CMP

¹ Option identifier from Audit by Baxter et al (2016), Values Report (VR), Synthesis Report (SR) or Project Management Team (PMT)² Based upon Audit by Baxter et al (2016)³ As stated in original source document⁴ CMP Strategy and Action that the option has been rolled into⁵ for N/A actions only. Remaining options assessed through analysis of CMP Action

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5	1g	Protection of migratory bird habitat. Develop shorebird habitat management plan for the entrance channel area including monitoring of sand movements around the bird island area	2011 Draft Lake Illawarra Estuary Management Plan	Sand shoals provide valuable habitat for migratory bird species such as Little terns and Pied Oystercatchers. This unique habitat is subject to disturbance from a number of external factors such as dogs, foxes, humans, channel dynamics etc. Ongoing effort has been undertaken to protect this habitat particularly during key reproductive seasons for migratory birds.	Ongoing	\$10,000 (management plan)	Option remains relevant for entrance channel, but not necessarily the bird island which has been absent for several years.	Protect and Manage Key Fauna	MF1	
6	1i	Undertake entrance stability assessment	2011 Draft Lake Illawarra Estuary Management Plan	Ongoing maintenance is associated with the entrance structures such as shifts in the breakwaters and mitigation of extreme changed in flow hydrodynamics.	Manly Hydraulics Laboratory engaged to undertake stability assessment in 2012.	\$15,000 (Stability assessment)	OEH are continuing monitoring of the entrance channel. WCC is considering an additional entrance stability survey to inform an implementation plan for works along entrance foreshores.	Manage Changes to the Entrance Channel	EC1	
7	1j	Undertake 'as required' dredging of the entrance channel.	2011 Draft Lake Illawarra Estuary Management Plan	Works were continually being undertaken to manage the entrance channel to ensure boating access and improved flows preventing algal build up.	Ongoing. Channel condition including drop off area being regularly monitored – quarterly aerial photos and site inspections with NSW Roads and Maritime Services Boating Officer. NSW Roads and Maritime Services maintain navigation aids as required.	\$100,000 per occurrence	For future consideration.	Manage Changes to the Entrance Channel	EC3	
8	1k	Foreshore improvements to Reddall Reserve including lighting, car parking, replacement of toilet block, shade structures, landscaping and wharf.	2011 Draft Lake Illawarra Estuary Management Plan	Floating pontoon installed at boat ramp (2010). Replacement of toilet block to be considered. Kiosk upgraded (2011). EOI called to operate upgraded kiosk. New Operator appointed (2011)	Works in progress. Floating pontoon installed at boat ramp (2010). Replacement of toilet block undertaken in 2015. Kiosk upgraded and new Operator appointed (2011) with arrangement extended in 2015. Reddall Reserve south amenities replaced 2013/14. Shareway from Ocean St to Windang St replaced 2014/15. Design phase underway for replacement of deteriorated promenade with footpath.	\$500,000	SCC Aquatic Feasibility study recommended a water play area to be constructed on this site (north of the kiosk). SCC is considering updating the Masterplan for this area. Current Masterplan was developed in the early 2000's.	Maintain and Improve Recreation and Amenity	RA1	
9	1l	Revegetation and weed control of Picnic Island, Berageree Island and the adjacent Pelican View Reserve.	2011 Draft Lake Illawarra Estuary Management Plan Ecological and Bushfire Assessment and Plan of Management, Picnic Island Reserve (ELA, 2015).	These islands are subjected to weed encroachments and degradation of vegetation due to a number of factors including uncontrolled access, erosion and natural processes.	Revegetation and weed control work has been undertaken with grant assistance and as a part of the relevant Plans of Management.	\$10,000	Works for future consideration by SCC in accordance with the Picnic Island Reserve Plan of Management, Pelican View Plan of Management	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	

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10	1m	Formalise walkway around Picnic Island	2011 Draft Lake Illawarra Estuary Management Plan Ecological and Bushfire Assessment and Plan of Management, Picnic Island Reserve (ELA, 2015).	An informal track is currently used across Picnic Island. This track is eroded and uncontrolled resulting in a loss of vegetation. The Picnic Island Reserve Plan of Management identifies the use of fencing and signage to discourage access beyond the existing walking track.	A design was prepared for a raised concrete walkway but it was not constructed due to stakeholder concerns.	\$70,000	Works for future consideration by SCC in accordance with the Picnic Island Reserve Plan of Management	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
11	1n	Maintain, protect and enhance Bevans Island, Cudgerie Island and Windang Island.	2011 Draft Lake Illawarra Estuary Management Plan	These islands contain approximately four endangered ecological communities and key habitat for a number of species. Due to their isolation these islands are subject to antisocial behaviour and invasion by introduced species.	To be considered LIA was Trustee for these Islands.	\$5,000 pa	Windang Island is managed under separate plan of management (ELA, 2015) and will not be considered as a part of the Lake Illawarra CZMP.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
12	2a	Continue maintenance of existing stormwater drains and controls discharging into the Back Channel and Whyjuck Bay.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	Sediment inflows and channel dynamics often result in blockages to the Whyjuck Bay area preventing dispersal of the poor water quality inflows.	As required 2015/16 Maintenance undertaken on wetlands by SCC in south east corner of Howard Fowles. Capital project for flow improvements currently in design phase. 2015/16 Maintenance undertaken by SCC at outlet opposite Trumper St to remove flow restrictions. 2015/16 CCTV inspection undertaken by SCC on several stormwater networks.	\$5,000 pa	For future consideration as required.	Improve Water Quality	WQ3	
13	2c	Formalise foreshore pathway along Mt Warrigal foreshore to Boonerah Point	2011 Draft Lake Illawarra Estuary Management Plan	This area is currently used regularly for walking and bike riding resulting in erosion of the formed track.	Complete	\$30,000	For future consideration. All works to be undertaken in accordance with the vegetation management plan for Boonerah Point.	Protect and Rehabilitate Estuarine and Riparian Vegetation	N/A	Action has been completed since Baxter et al (2016) audit was compiled.
14	2d	Enhance and protect existing riparian vegetation, Boonerah Point. Plant native vegetation buffer along the shoreline. Provide bank protection to the area of shoreline that is eroding in the small bay (part of Whyjuck Bay) to the east of the Scout Hall on Boonerah Point.	2011 Draft Lake Illawarra Estuary Management Plan Boonerah Point Vegetation Management Plan (SCC, 2016)	The Boonerah Point Park was in disrepair and required upgrades to the parkland. Revegetation works to be undertaken in accordance with the Boonerah Point Vegetation Management Plan (SCC, 2016). An identified area of bank erosion is adjacent to the site regularly used by the Scout hall.	To be considered. SCC completed landscaping on Boonerah Point (2007/08). Scout Group propose installing a jetty and ramp to launch canoes (2011).	\$20,000 (revegetation and park repairs) \$200,000 (Bank stability and jetty installation).	Ongoing works to be undertaken by SCC in accordance with the 2016 Management Plans for the site.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
15	2f	Create a beach (adjacent to the Scout Hall) and nourish over time (as the sand washes away) to help reduce bank erosion and aid with removal of seagrass wrack.	2011 Draft Lake Illawarra Estuary Management Plan	Shoreline area used regularly by the scout hall for launching and retrieving boats.	To be considered No work done to date.	\$50,000	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
16	2g	Provide bank stabilisation/erosion protection at selected locations along the foreshore.	2011 Draft Lake Illawarra Estuary Management Plan	General areas of steep slopes, which require stability.	To be considered	\$25,000	For future consideration.	Manage Foreshore and Bank Erosion	FB1	

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17	2h	Restrict access to Mogurah and Yangar Point foreshore areas to allow native endangered vegetation communities to re-establish	2011 Draft Lake Illawarra Estuary Management Plan	Excessive trampling of the saltmarsh in this sheltered embayment is resulting in a loss of saltmarsh community and faunal habitat. Protection is needed from misuse and vandalism such as illegal vegetation clearing, mowing and excessive access which degrade the quality of these habitats. Bollards are proposed to reduce excessive access to this site.	To be considered. No work done to date.	\$10,000	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV2	
18	3a	Upgrade Deakin Reserve carpark area adjacent to jetty and boat ramp.	2011 Draft Lake Illawarra Estuary Management Plan	The carpark currently consists of an informal gravel area, which is subjected to erosion during heavy usage and high rainfall. A sealed surface was considered a better alternative at this location.	To be considered No work done to date.	\$30,000	For future consideration.	Maintain and Improve Recreation and Amenity	RA1	
19	3b	Provide public access way along this section of foreshore if reclamation is carried out as part of Burroo Bay dredging.	2011 Draft Lake Illawarra Estuary Management Plan	The sewer alignment is currently within the Lake at this location. In addition to this, there is a need to formal access to prevent uncontrolled access and improve public safety.	To be considered as part of any future dredging works – unlikely due to resident concerns. Private jetties are an obstacle here. No work done to date.	\$100,000	For future consideration.	Maintain and Improve Recreation and Amenity	N/A	Burroo Bay dredging has been completed since Baxter et al (2016) audit was compiled. Had limited effectiveness.
20	3d	Provide a shared pathway and boardwalk (where necessary over sections of saltmarsh) around the shoreline the Koona Bay.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	This shareway will provide a key linkage around the southern aspect of the Lake and will aim to prevent uncontrolled access and promote regrowth of damage saltmarsh.	SCC has approved preferred option 'partial foreshore filling. Approval has been granted under Part 5 of the EP&A Act. Work to be staged. Stage 1 between Wilson Memorial park and Kanahooka St completed (2010). Stage 2 between Karoo St and Wooroo St is currently under construction to be completed late 2013. Biosis engaged to prepare AHIP (2011). Stage 3 plans between Kanahooka St and Shearwater Blvde were exhibited and approved by SCC as a preferred option in 2007. Subject to further design work and environmental approvals. Stage 4 between Shearwater Blvde and Macquarie Rivulet and Stage 5 from Waroo Street to Koona Bay Foreshore Reserve are yet to be considered.	\$400,000	Include Stage 3 to 5 as option for future consideration. Design of Stage 3 deferred by SCC to 2018/19 due to competing priorities of footpath capital projects. Renewal of shareway in Mount Warrigal and Warilla programmed for 2016/17 and 2018/19.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
21	3e	Construct wharf / low level platform on Macquarie Rivulet (southern bank) for launching / retrieval of small watercraft e.g. canoes / kayaks.	2011 Draft Lake Illawarra Estuary Management Plan	Watercraft such as canoes and kayaks are currently launched at informal parts of the bank resulting in bank erosion.	To be considered No work done to date.	\$50,000	For future consideration.	Maintain and Improve Recreation and Amenity	RA1	

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22	3f	Restrict Access to the Macquarie Rivulet SEPP 14 area.	2011 Draft Lake Illawarra Estuary Management Plan	The saltmarsh habitat of Macquarie Rivulet Delta has become degraded through misuse such as illegal vehicle access and allowing cattle to graze and trample the area. Access to this site needs to be controlled to allow this large area of habitat to become restored and fully utilised as habitat for a number of species of aquatic birds. Fences in neighbouring parcels of land also need to be repaired to prevent stock escaping this area.	Ongoing RCL have to date installed security gates, signage, and concrete blocks on the northern side of the wetland. A maintenance contractor and in more recent time local residents have been providing surveillance of the area. Recently four-wheel drive access was controlled through residents contacting the police. The stage 4 works (above at 3d) are considered part of the solution for this issue on the southern side of the rivulet.	\$10,000	Ongoing. For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV2	
23	4a	Investigate options to link the shared pathway from the Macquarie Rivulet Arboretum to Haywards Bay.	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	Connecting link between Haywards Bay and Oakflats.	Options include new bridge across rivulet or connection to highway bridge. Preliminary plans developed and supplied to SCC in 2013 by the LIA..	\$10,000	For future consideration.	Maintain and Improve Recreation and Amenity	RA2	
24	4b	Finalise transfer of freehold foreshore land extending to the mouth of Macquarie Rivulet and around Haywards Bay for environmental protection and public open space. Enhance riparian zone and limit illegal access of Macquarie Rivulet Riparian Habitat.	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	This foreshore stretch of land, in ownership of TRUenergy), is not currently maintained and is subjected to weed invasion, degradation through uncontrolled access and dumping of waste material. This foreshore land contains strong heritage and ecological values. The Haywards Bay Foreshore land currently maintained by Winten (now RCL) was also under negotiation with the LIA for the transfer of this land. Illegal vehicle access to the Macquarie Rivulet Delta has been destroying large areas of saltmarsh. Vehicle access needs to be limited in these areas through the use of bollards or other structures.	Under the current Deed, Winten must transfer the land to the LIA. LIA had agreed to accept the land transfer excluding the area of the water quality control pond (wetland) on the proviso that Winten maintain the wetland to meet performance criteria set down by WCC whilst development works were ongoing. WCC to provide status of hand over process?? Under the Council's conditions of consent monitoring of the wetland is to continue for 15 years after 80% of the subdivision is complete.	\$10,000 for transfer costs \$500,000 for rehabilitation and access control works.	Land currently under control of RCL (formerly Winten) and TRUenergy. For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV6	
25	4c	Enhance wetland areas and riparian corridor of Duck Ck.	2011 Draft Lake Illawarra Estuary Management Plan	High occurrence of invasive species.	To be considered (part of TRUenergy development?)	\$500,000	Under control of TRUenergy. For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
26	5d	Provide bank protection measures to eroded sections of shoreline.	2011 Draft Lake Illawarra Estuary Management Plan	General areas of slope, which require stability.	To be considered	\$200,000	For future consideration as required.	Manage Foreshore and Bank Erosion	FB1	
27	5e	Prevent access and install signage on the southern end of the Brooks Creek Delta	2011 Draft Lake Illawarra Estuary Management Plan	Saltmarsh is currently restricted from growing at the Brooks Creek delta due to uncontrolled access including the formation of bike jumps and other activities. Isolation of this area would result in the regeneration of this area with saltmarsh and an improvement in the habitat values of this location.	To be considered. No work done to date.	\$10,000	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV2	

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28	6a	Construct shared pathway linking Kanahooka Point to Purrah Bay.	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	There is no shareway linkage around Kanahooka Point requiring pedestrians to walk up Murra Mura Road between foreshore parks.	To be considered. Residents adjacent to this area expressed concerns about this shared pathway. Shared pathway would require elevated boardwalk installed into the rock platform. Concept design developed. No work done to date.	\$50,000	For future consideration.	Maintain and Improve Recreation and Amenity	RA2	
29	6b	Enhance riparian zone of Mullet Creek and Purrah Bay Foreshore.	2011 Draft Lake Illawarra Estuary Management Plan	The Mullet Creek foreshore is subject to a large population of invasive weeds with some bank stability issues located upstream. Public access along the foreshore was also discussed as a potential future benefit to prevent uncontrolled access along the foreshore.	To be considered. WCC has completed bank stabilisation works at William Beach Park (2009/10).	\$500,000	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
30	6c	Provide public shelters, picnic tables and seats, Purrah Bay.	2011 Draft Lake Illawarra Estuary Management Plan	There are not currently any shelters, seats or tables at the end of the Purrah Bay pathway.	To be considered. No work done to date.	\$25,000	For future consideration.	Maintain and Improve Recreation and Amenity	RA1	
31	6d	Establish a vegetative border around existing saltmarsh beds, Kanahooka and Purrah Bay.	2011 Draft Lake Illawarra Estuary Management Plan	The use of a vegetative border such as Juncus or Lomandra has proven an effective deterrent for access to saltmarsh beds. These species or consistent with these communities and dur their spikey nature limit free access through the area. The use of this species can also control mowing boundaries and can allow migration of saltmarsh species.	Has been undertaken at some locations with success. To be considered within suite of options to improve saltmarsh habitats.	\$10,000	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
32	7b	Investigate foreshore linkage along Koong Burry Bay foreshore (this could include the construction of a boardwalk).	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	This area is currently accessed by cattle resulting in degradation of saltmarsh. A boardwalk though this area would protect the saltmarsh and provide recreational amenity.	To be considered (part of Currungoba land acquisition). No work done to date.	\$20,000	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV6	
33	7c	Investigate the possible acquisition of the land at Currungoba Peninsula (including the Tank Trap) for the purpose of constructing a regional wetland and / or providing bank protection measures to the Tank Trap.	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	Negotiations commenced with the owners of the land known as Currungoba Peninsula to purchase the land (or part thereof) for environmental and recreational purposes. The owner hasn't indicated whether or not he is willing to sell. The Department of Planning has advised that should the owners decide on progressing the acquisition the Authority could make an application for funding assistance under the Coastal Lands Protection Scheme.	Valuation of the land completed (2008).	\$1,000,000	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV6	
34	7d	Construct wharf / low level platform on Hooka Creek for launching / retrieval of small watercraft e.g. canoes / kayaks.	2011 Draft Lake Illawarra Estuary Management Plan	Hooka Creek was identified as a key access point, which would allow access for boats including recreational uses such as fishing.	To be considered. No work done to date.	\$50,000	For future consideration.	Maintain and Improve Recreation and Amenity	RA1	

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35	7e	Protect and enhance bird habitat area (eastern mud flats) through signage.	2011 Draft Lake Illawarra Estuary Management Plan	This key area of bird habitat is often subject to disturbance from local children and the use of vessels such as hovercrafts and kayaks. This area is utilised for feeding and nesting grounds for a number of water birds.	To be considered No work done to date.	\$10,000	For future consideration in consultation with OEH.	Protect and Manage Key Fauna	EV1	
38	8a	Berkeley Boat Harbour Improvements	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	A number of improvements have been proposed for the harbour, which focus on water quality improvements, protection of birds such as pelicans using the area and ensuring the maintenance of harbour environment. Other issues identified include vermin, littering, arson and sedimentation.	Maintenance of western navigation channel undertaken (December 2009). Maintenance of eastern channel undertaken (May 2011). Signage installed on the seawall to deter people (and dogs) from accessing the area - "Waterbird Roosting Area – Do Not Disturb". Designs for the upgrade to the eastern basin of harbour with formalised trailer parking and boat wash down were finalised in 2013 but not progressed due to cost. Construction of an upgraded carpark is currently in the draft WCC forward program.	\$5,000 pa	For future consideration.	Maintain and Improve Recreation and Amenity	RA1	
39	8b	Continue maintenance of the existing Budjong Ck Wetland.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	Budjong Creek Wetland provides key bird habitat for a number of species, which utilised the Lake. This wetland also functions in improving water quality prior to discharge to the Lake. As such, sediment and litter accumulate in this wetland from time to time.	As required	\$5,000 pa	For future consideration as required.	Improve Water Quality	WQ3	
40	8c	Continue weed removal and bush regeneration activities on Wollamai Point.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	Ongoing bush regeneration activities to improve the ecological value of the park.	As required - works in progress – Budjong Ck Landcare Group. Ongoing works currently being undertaken as part of an OEH grant program.	\$20,000 pa	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
41	8d	Enhance the reclaimed 'spur'.	2011 Draft Lake Illawarra Estuary Management Plan	Located adjacent to 81 Northcliffe Drive, this parkland area is currently prone to antisocial behaviour and is underutilised.	To be considered. No work done to date.	\$40,000	For future consideration.	Maintain and Improve Recreation and Amenity	RA1	
42	8e	Upgrade former 'Merinda' site wharf and car park area including bank protection of eroded shoreline.	2011 Draft Lake Illawarra Estuary Management Plan	This site is degraded and often experiences antisocial behaviours.	Ongoing, rock rip rap placed.	\$100,000	For future consideration.	Manage Foreshore and Bank Erosion	FB2	
43	9a	Upgrade seawalls adjacent to the Yacht Club in accordance with best practice guidelines.	2011 Draft Lake Illawarra Estuary Management Plan	Seawalls should be upgraded to incorporate environmentally friendly principles when it is at the end of its design life and needs to be replaced.	As required No work done to date.	Unknown	For future consideration.	Manage Foreshore and Bank Erosion	FB2	
47	9e	Implement foreshore improvements e.g. weed removal, landscaping provision of seats and tables and possible boardwalk through Kully Bay wetland area.	2011 Draft Lake Illawarra Estuary Management Plan	Areas of the Griffins Bay foreshore including Kully Bay Wetland, require rehabilitation and in some areas formalisation of access to allow vegetation such as saltmarsh to rehabilitate.	To be considered Master Plan (1997) for Joes Bay area to be reconsidered	\$200,000	For future consideration by Government Property NSW.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	

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48	9f	Continue maintenance of the existing Joes Bay wetland at the southern end of King Street area and the Primbee shoreline.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	This wetland functions in improving water quality prior to discharge to the Lake. As such, sediment and litter accumulate in this wetland from time to time. This wetland is also used by water birds to feeding and nesting.	Works were undertaken as required.	\$10,000 pa	For future consideration as required.	Improve Water Quality	WQ3	
49	10a	Investigate problems of surface and groundwater pollution from the Kemblawarra Industrial area.	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	Water quality in the Griffins Bay area at times experience peaks in nutrient and metals. There are a number of potential sources of pollutant discharge upstream of this area including industrial land uses.	Monitoring of water quality in the Lake indicates Griffins Bay to have very high concentrations of nutrients and chlorophyll a. Any direct links to inputs from Kemblawarra yet to be established.	\$120,000	Ongoing monitoring to identify changes in water quality.	Improve Water Quality	WQ9	
50	10b	Provide a SQID on the Nicolle Rd drain at the d/s end of Korrongulla Swamp.	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	Treatment of outflowing stormwater required to capture litter flowing through the stormwater system.	In early 2000, Port Kembla Copper commenced infilling of the dredged pond with copper slag. Approximately 1.5 MT of copper slag has been placed in the pond since decommissioning of the Copper Smelter. PKC currently monitors groundwater, surface water and sediment at the site under Licence 2509. Recent monitoring by WCC has not identified elevated levels of metals in groundwater at the end of Nicole Road. Port Kembla Copper is currently in negotiation with WCC on an exit strategy for the site. SQID designs were finalised by the LIA. Construction appears to have not been undertaken.	Not defined	For future consideration.	Improve Water Quality	WQ2	
51	10c	Investigate problems of groundwater pollution (high ammonia) along the Windang Peninsula.	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	Water quality in the Griffins Bay area at times experience peaks in nutrient and metals. There are a number of potential sources of pollutant discharge upstream of this area including historical emplacements of uncontrolled fill.	Studies have confirmed high concentrations of ammonia in the groundwater in the area. A study currently underway to identify groundwater flow paths, including the connection with the Lake.	Not defined	Ongoing monitoring to identify changes in water quality.	Improve Water Quality	WQ9	
52	10d	Limit public access to saltmarsh community, Purry Burry Point	2011 Draft Lake Illawarra Estuary Management Plan Purry Burry Point to Heritage Park Site Restoration Plan (2013)	This tidal mudflat provides unique habitat for both saltmarsh vegetation communities and wader birds. Uncontrolled access to this area has resulted in degradation of this habitat.	Considered in Purry Burry Point to Heritage Park Site Restoration Plan (2013). No works undertaken.	\$10,000	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV2	
53	10e	Remove illegal and 'unsightly' foreshore structures and materials along Primbee Bay.	2011 Draft Lake Illawarra Estuary Management Plan Purry Burry Point to Heritage Park Site Restoration Plan (2013)	A number of residents along the Primbee foreshore have built structures on the edge of the Lake, outside their property boundary. Structures include jetties, BBQ facilities, seating, informal ramps etc.	Review of unauthorised foreshore structures completed (2007/08). Monitoring of foreshore area undertaken on regular basis. Purry Burry Point to Heritage Park Site Restoration Plan completed in 2013.	N/A	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV2	

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54	10f	Provide public access linkage along the Primbee Bay shoreline if reclamation is carried out as part of Griffins Bay dredging.	2011 Draft Lake Illawarra Estuary Management Plan 2006 Lake Illawarra Estuary Management Study and Strategic Plan	The Primbee foreshore is regularly utilised for public access. Formalisation of this walkway was proposed to improve access and prevent erosion and loss of vegetation.	To be considered – unlikely due to resident concerns. No work done to date.	\$100,000	For future consideration.	Maintain and Improve Recreation and Amenity	RA3	
55	Xa	Improved opportunities for estuarine vegetation migration	2011 Draft Lake Illawarra Estuary Management Plan	Foreshore landscaping and infrastructure preventing the natural migration of estuarine vegetation as a result of increased sea levels.	No actions undertaken	Unknown	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV5	
56	Xb	Creek rehabilitation	2011 Draft Lake Illawarra Estuary Management Plan	Creeks discharging into the Lake often characterised by a high occurrence of litter, weeds and in some locations sediment build up or structures resulting in blockages.	Ongoing, dredging and clean ups were undertaken each year by the LIA targeting the most effected outflows	Unknown	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
57	Xc	Mangrove migrations Develop ongoing monitoring program to assess encroachment of mangroves and changes in distribution throughout Lake Illawarra	2011 Draft Lake Illawarra Estuary Management Plan	An increasing population of mangroves since ~2007 are resulting in decreases in saltmarsh areas but conversely this protected species is also being removed in areas by neighbouring residents. With mangroves flourishing, monitoring should be undertaken to identify the impacts of this increasing plant species on the existing species in the area.	Draft baseline vegetation mapping was undertaken as part of 2011 EMP process. Research is currently being undertaken by UoW in partnership with OEH.	\$20,000	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV4	
58	Xd	Revegetation and weed control	2011 Draft Lake Illawarra Estuary Management Plan	Areas dominated by invasive species or low quality vegetation.	Ongoing	Unknown	Ongoing through various programs of works.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
59	Xe	Revise mowing strategy	2011 Draft Lake Illawarra Estuary Management Plan	Mowing of foreshore areas is resulting in damage to migrating saltmarsh and changes to the species distribution.	Areas within Shellharbour municipality have been the subject of changed mowing strategies for vegetation improvement with some success.	Unknown	For future consideration.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV2	
60	Xf	Stormwater management	2011 Draft Lake Illawarra Estuary Management Plan	Untreated stormwater outflows resulting in decreased water quality and introduction of garbage to the Lake.	Numerous completed in accordance with the developed strategy with many more still to be undertaken.	A stormwater strategy has been completed for the Lake identifying known outflow points.	For future consideration.	Improve Water Quality	WQ1, 2, 3	
61	Xg	Formalise access routes	2011 Draft Lake Illawarra Estuary Management Plan	Informal access tracks result in a loss in vegetation along these areas leading to erosion in some areas.	Ongoing, some completed.	See shareway strategy (2012)	For future consideration.	Maintain and Improve Recreation and Amenity	RA2	
62	Xh	Manage illegal vegetation clearing	2011 Draft Lake Illawarra Estuary Management Plan	Large areas of vegetation are cleared to allow for private recreational amity	Ongoing	Unknown	Ongoing as required.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV2	
63	Xi	Restrict access to sensitive shoreline areas	2011 Draft Lake Illawarra Estuary Management Plan	Shoreline areas open to access can be utilised for activities such as dragging boats, four-wheel-driving and horse riding resulting in degradation of saltmarsh and shoreline erosion.	Ongoing. Bollards have been used to varying degrees of success around the Lake.	Unknown	Ongoing as required.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1, 2	

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64	Xj	Erosion control and bank stabilisation	2011 Draft Lake Illawarra Estuary Management Plan	Degraded slopes requiring bank protection of stabilisation.	Ongoing	Unknown	Ongoing as required.	Manage Foreshore and Bank Erosion	FB1	
65	Xk	Community education	2011 Draft Lake Illawarra Estuary Management Plan	Community engagement mediums such as signage and brochures can educate local and visiting residence on the importance of the estuarine environment and the need for its protection.	Ongoing Saltmarsh brochure was under development in partnership with DPI – Fisheries. Future world educational package developed in partnership between LIA, WCC and Futureworld.	Unknown	Ongoing activity undertaken by councils and government agencies.	Improve Planning and Management Arrangements for the Lake	PM3	
66	Xl	Illegal structures and reclamation	2011 Draft Lake Illawarra Estuary Management Plan	Uncontrolled reclamation or structures have been built in numerous foreshore areas around the Lake removing estuarine habitat and having other environmental impacts.	Ongoing A review of existing unauthorised structures and foreshore reclamations in the Lake is Complete. Existing structures at Jettys By The Lake to be assessed for licensing purposes. Shared Use Jetty proposed.	Unknown	Ongoing as required.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV3	
68	Xn	Investigate dredging (and disposal) in selected areas of the Lake including:	2011 Draft Lake Illawarra Estuary Management Plan	Dredging was an ongoing process of the LIA to ensure flows circulated through the Lake improving water quality and boating safety. These dredging programs were limited due to the need to store PASS classed material resulting from the activity.	Dredging program on hold subject to identifying suitable disposal location(s) for dredged spoil (PASS) – preferred disposal site is within the Lake e.g. the hole created as part of sand extraction at Purry Burry Point. Minor work undertaken in Koonawarra Bay to improve boating access to Lakeside Drive Jetty (2010). Minor dredging of Burroo Bay undertaken (2013)	Griffins Bay, Southern Back Channel, Karoo Bay, Burroo Bay, Koonawarra Bay, Haywards Bay, Koonawarra Bay, Purrah Bay, Koong Burry Bay & Tuggerah Bay \$2.3M - 3M, \$1.9M - 3M, \$0.75M - 1M, \$1.1M - 1.5M, \$4.5M - 6M, \$0.75M - 1M, \$0.75M - 1M, \$1.1M - 1.5M, \$5.6M - 7.5M, \$15,000 - 20,000,	For future consideration.	Maintain and Improve Recreation and Amenity	RA5	

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69	Xo	Adopt a policy requiring Water Sensitive Urban Design for all new urban development and provide incentives for implementation of on-site stormwater treatment and re-use for existing developments around the Lake.	2011 Draft Lake Illawarra Estuary Management Plan	The water quality of Lake Illawarra is largely control by the quality of catchment inflows. Correlation have been drawn between the increase in urban density in the catchment and the resulting decline in the water quality of Lake Illawarra. Improving outflows through stricter development controls is one method to try and reduce this impact.	It is the Councils responsibility to ensure WSUD in developments as per planning instruments. Councils have prepared consolidated DCPs. Wollongong DCP Chapter E15 (2009) outlines WCC's requirements for WSUD for certain types of development.	N/A	N/A	Improve Water Quality	WQ1	
70	Xp	Undertake further research into the driving mechanisms behind algal blooms and the dynamics of macroalgae and microalgae interactions with primary producers in the Lake.	2011 Draft Lake Illawarra Estuary Management Plan	Algal blooms occur within the Lake due to a number of potential factors. These blooms can be toxic to both humans and other fauna.	Potential University partnership project. Research presented at the 2009 summarised a study undertaken titled "Planktonic primary production: a decisive tool for monitoring the health of Lake Illawarra" (S. Kneeshaw et. al).	\$20,000 pa	For future consideration.	Maintain and Improve Recreation and Amenity	RA6	
71	Xq	Continue harvesting of macroalgae in the Lake on an as needs basis.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	Since 1988 approximately 30,000T has been removed. This has resulted in the removal of substantial volumes of nutrients such as nitrogen and phosphorus from the Lake as well as improving odour.	Work was undertaken by the LIA as required.	\$125,000 pa	For future consideration.	Maintain and Improve Recreation and Amenity	RA6	
72	Xr	Continue clean-up of foreshore areas including removal of decomposing seagrass wrack around the Lake on an as needs basis.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	Since 1988 approximately 50,000T has been removed. This has resulted in the removal of substantial volumes of nutrients such as nitrogen and phosphorus from the Lake as well as improving odour.	Work was undertaken by the LIA as required. In June 2016 collection of seagrass wrack was undertaken following extreme weather in a once off collection event.	\$125,000 pa	For future consideration.	Maintain and Improve Recreation and Amenity	RA6	
73	Xs	Continue to provide information to the community on processes and projects within the catchment of the Lake via media announcements, pamphlets, newsletters, publications, relevant websites etc.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	Ongoing mediums of community engagement to educate the community on the values of the Lake and works being undertaken.	As required – Community Updates prepared following each LIA meeting.	\$5,000 pa	Ongoing activity undertaken by councils and government agencies.	Improve Planning and Management Arrangements for the Lake	PM3	
74	Xt	Continue to encourage volunteer groups such as Landcare Groups, 'Friends of Lake Illawarra', Green Corps etc. to become involved in worthwhile projects and activities within the Lake catchment. Investigate opportunities to utilise the Education Study Centre off Northcliffe Drive, Warrawong	2006 Lake Illawarra Estuary Management Study and Strategic Plan	Activities undertaken to encourage participation of Lake protection and education of Lake values.	As required Future World was historically on a month by month holding over licence with one months notice required from either party.	N/A	For future consideration by Government Property NSW.	Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	

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75	Xu	Continue monitoring of water quality and water level from the 2 recording stations on the Lake	2006 Lake Illawarra Estuary Management Study and Strategic Plan 2015 Lake Illawarra Water Quality and Estuary Health Monitoring Program.	MHL operate and maintain LIA stations on an annual basis under agreement. Monthly water quality monitoring to continue in accordance with the 2015 Lake Illawarra Water Quality and Estuary Health Monitoring Program. Sydney Water sample entrance swimming lagoon area (every 6 days) as part of the Beachwatch Program.	Ongoing	\$80,000 pa	Ongoing.	Improve Water Quality	WQ7	
76	Xv	Monitor changes to the ecology of the Lake and key performance indicators e.g. water sediment, biota and amenity.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	Undertake regular surveys of key ecological parameters.	Seagrass surveys conducted in 2007/08 and 2008/09. Symposium on Lake Illawarra held (2009). Condition / Health Assessment of the Lake prepared (2010). Research Plan prepared (2010)	\$60,000	For future consideration.	Improve Water Quality	WQ9, EV5	
77	Xw	Investigate fish stock trends and commercial and recreational fishing practices in Lake Illawarra to determine if any seasonal restrictions or upper limits on number of commercial licences required.	2006 Lake Illawarra Estuary Management Study and Strategic Plan	Carry out surveys on recreational and commercial fishing effort and catch as well as surveys on important species.	DPI – Fisheries collecting ongoing data.	\$10,000	For future consideration.	Protect and Manage Key Fauna	MF1, PM1	
78	Xx	Maintenance of existing stormwater drains and controls discharging into the Lake.	2011 Draft Lake Illawarra Estuary Management Plan	Stormwater outflow drains at are subject to discharging poor water of varying quality from the surrounding catchment. In addition to this, the drains are subject to blockage by sand or sediment deposition. Works include alterations to drainage channels and the installation of Gross Pollutant Traps.	Ongoing.	Undefined	For future consideration as required	Improve Water Quality	WQ3	
114	VR1	Funding raised from commercial use of area to fund Lake actions	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	N/A	Option is unclear regarding intent or how this may be implemented. Therefore, this option was not included in the CMP.
115	VR2	More boat washing facilities at Berkeley Harbour	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenities	RA1	
116	VR3	Gooseberry Island (and other islands) - better use and access depending on planning controls	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenities	N/A	A Plan of Management exists for the Berkeley Nature Reserve that considers the appropriateness or otherwise of public access to Islands within the reserve.
117	VR4	Improved flushing and water quality in Griffin Bay (other means besides second entrance)	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ9	
118	VR5	Annual boat show or event to raise community awareness of Lake's value	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	

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119	VR6	Public transport over the water from Wollongong to Shell Harbour	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	N/A	Public transport requirements are a state government issue and beyond the scope of a Coastal management plan. Therefore, this option was not included in the CMP.
120	VR7	Event with Wings over Illawarra; sea plane rides over the Lake	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	
121	VR8	Kite boarding event at Purry Burry/Windang beach depending on wind direction	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	
122	VR9	Activities for school children such as those run by Future World	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3	
123	VR10	Heritage - tremendous values and potential that should not be lost	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	
124	VR11	Enhance bike track all the way around and promote wildy	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2	
125	VR12	Improve configuration and design of entrance training to improve water quality and sedimentation	Values Report (BMT WBM, 2017)					Manage Changes to the Entrance Channel	EC1	
126	VR13	Improve access along foreshore and connect with Heritage Park	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA3	
127	VR14	Tourism opportunities	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA4, CH1	
128	VR15	Gross pollutant traps and other end of pipe solutions	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ1, 2	
129	VR16	In-school education about marine debris	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3	
130	VR17	Development controls on new developments such as WSUD measures etc	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ1	
131	VR18	Increased recreational use of the Lake - increases peoples' values as they are more likely to look after the Lake	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1, RA2, CH1	
132	VR19	Fitness equipment to encourage people to use the Lake and look after it	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
133	VR20	King Street area - turn into parkland with the view to eventually do more, ie; picnic shelters/bbqs, bench seats etc.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
134	VR21	Lake side tourist development	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA4	
135	VR22	Boat shed - boat hire, encourage boat hire businesses	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA4	
136	VR23	Views - line of site strategy that prioritises walkers and public users	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity		Both Councils are preparing strategies to address this issue. Therefore, this option was not included in the CMP.

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137	VR24	State Government management of the entrance	Values Report (BMT WBM, 2017)					Manage Changes to the Entrance Channel	EC1	
138	VR25	Interpretative signage	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3	
139	VR26	Fix up entrance erosion area	Values Report (BMT WBM, 2017)					Manage Changes to the Entrance Channel	EC1	
140	VR27	Gravel at end of boat ramp	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
141	VR28	Flow directors on bridge	Values Report (BMT WBM, 2017)					Manage Changes to the Entrance Channel	EC1	
142	VR29	Kiosk etc. to encourage usage. Council could lease out McKenzie Small reserve	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA4	
143	VR30	Considered community land - surplus to needs	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	N/A	Option is unclear regarding intent. Public access to foreshore land is a tenet of the Coastal Management Act 2016, and is supported by other actions in this CMP. Therefore, this option was not included in the CMP.
144	VR31	Jetty with restaurant	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA4	
145	VR32	Rubbish rack/artificial wetland - was previously suggested by LIA but not completed because of commercial fishing	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ2	
146	VR35	Cycleway connection - at the moment users have to go along the highway (100 km speed limit). Link the cycleway from Macquarie Rivulet to the power station	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2	
147	VR36	Connect cycleway - should be a proper cycleway across Slaters Bridge	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2	
148	VR37	Connect cycleway - Pelican Point	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2	
149	VR38	Bollards to stop bikes on bike tracks	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2, EV2	
150	VR39	Community facilities in and around the Lake on the Wollongong side	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1, RA2	
151	VR40	Park staff need to understand sensitive locations	Values Report (BMT WBM, 2017)					Protect and Rehabilitate Estuarine and Riparian Vegetation	EV2	
152	VR41	No townhouses/high density development here	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM1	
153	VR42	Kayaks etc monitoring water quality	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ7	

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154	VR43	School holiday program with free activities on around Lake Illawarra	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3	
155	VR44	Ban the use of 2 stroke motors to get oil out of the Lake	Values Report (BMT WBM, 2017)					Improve Water Quality	N/A	Recreational boating is a major attraction for the Lake. Banning of 2-stroke boat motors is likely to be highly contentious to other sectors of the community, making this option unworkable. Therefore, this option was not included in the CMP.
156	VR45	GPTs not cleaned out regularly - monitor before rain events	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ3	
157	VR46	Install stormwater/artificial wetlands	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ1	
157	VR47	Install stormwater/artificial wetlands	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ1	
159	VR48	Some of the LIA jetties are never used because it is too shallow	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
160	VR49	More work in Deakin Park re: amenities ie; benches, barbeques. Landcare group were active here but not anymore - need more support	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
161	VR50	Spread money into more than just the entrance area in terms of environmental and recreational improvements	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1, RA2, EV1	
162	VR51	Disabled fishing facilities - need more wharves/platforms with wheelchair access ramps	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
163	VR52	Working with Wingecarribee Council for better land management ie; no till cropping for potato farmers in Robertson	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM1	
164	VR53	Better support for local groups to manage their own patch	Values Report (BMT WBM, 2017)					Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
165	VR54	GPTs and SQIDs in local creeks to treat creek runoff	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ1, 2, 3	
166	VR55	Removal of seagrass wrack build-up	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA6	
167	VR56	Councils need to work together	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM2	
168	VR57	Bubblers/drinking stations along the bike path	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1, RA2	
169	VR58	More bins in parks and along bike paths	Values Report (BMT WBM, 2017)					Improve Water Quality	RA1, RA2	
170	VR59	Cleaning out creeks of sediment build-up - putting in sediment traps	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ2, 3	

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171	VR60	Open the back channel to increase the flows and flushing along the southern foreshore	Values Report (BMT WBM, 2017)					Improve Water Quality	N/A	Cursory consideration of this option indicates it is not technically viable: outflows from the lake are not sufficient to maintain an open back channel (therefore reducing the aim of this option). And the negative environmental impacts of this option also make it unviable. Therefore, this option was not included in the CMP.
172	VR61	Foreshore boat hire and more kiosks and/or other tourism related opportunities	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA4	
	VR62	Happy with the opening - better water quality (dramatic improvements) and no more odour	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ7	
174	VR63	Bike track is great, but needs to be looked after. Grass needs to be cut away from the edges along Reddall Parade.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
175	VR64	Need to keep public access to the Lake - it is important to be able to enjoy it	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2, RA3	
176	VR65	Need to ensure that everything is accessible for people with disabilities such as picnic tables, shelters, linking paths. Opportunity for more people to be involved	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
177	VR66	Freshwater is needed at Tallawarra to clean kayaks and fish. Water wash down area to reduce spread of diseases	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
178	VR67	Marine Rescue do a great job every weekend. Would like to see more support for them.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	N/A	Option is unclear regarding intent. Generally, support for life-savings organisations is not within the scope of a CMP. Therefore, this option was not included in the CMP.
179	VR68	Dredging of southern foreshore	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA5	
180	VR69	Improved entrance management to reduce foreshore erosion	Values Report (BMT WBM, 2017)					Manage Changes to the Entrance Channel	EC1	
181	VR70	Improved catchment management	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM1, PM2	
182	VR71	Dredge back channel	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA5	
183	VR72	A balanced approach to vegetation management around the Lake	Values Report (BMT WBM, 2017)					Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
184	VR73	Improve drainage system and stormwater management	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ1, 2, 3	

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#	ID ¹	Option ²	Source of Option	Details ²	Completion Status ³	Cost ²	Recommendation for this CMP (from Synthesis Report)	CMP Strategy ⁴	CMP Action ID ⁴	Coarse Cost Benefit Filter Outcome ⁵
185	VR74	Improve sewer management	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ5	
186	VR75	Potential dredging of Mullet Creek and Koonwarra Bay	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA5	
187	VR76	Completion of shared use pathway and upgrade of associated amenities	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1, RA2	
188	VR77	Business opportunities	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA4	
189	VR78	Future World do great stuff and should be continued - lots of activities for kids and adults	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3	
190	VR79	Should fill in the bay to help the Lake out	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA5	
191	VR80	Cycleway not at Primbee - needs to link to this area	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2	
	VR81	Water used to be a lot worse in the Bay. Less smelly and less seaweed	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ7, 10	
193	VR82	Walkway in this area would be good. LIA did a good draft of it.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2	
194	VR83	Declare lake a recreational fishing zone	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM1	
195	VR84	SCC does a better job of looking after the cycle ways than WCC. Would be nice if it went the whole way around i.e.; Mt Warrigal and Primbee	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2	
196	VR85	Pressure as much as possible - long term preservation needed. Concerned about SCC cutting down trees	Values Report (BMT WBM, 2017)					Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
79	VR86	Programs to support environmental conservation, water quality and the promotion of passive recreation options.	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3	
80	VR87	Where possible, work with Aboriginal people on actions related to bush regeneration and art.	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	
82	VR88	Repair/installation of Lake amenities including jetties, lights along footpaths, signage, public toilets, boat ramps, dog bags, drinking fountains and picnic areas, with increased points of access to the Lake and the foreshore and fenced off-leash areas for dog owners.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1	
83	VR89	Installation of secure-lid bins along the perimeter of the Lake, particularly in picnic areas and popular fishing spots.	Values Report (BMT WBM, 2017)					Improve Water Quality	RA1, RA2	

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84	VR90	Completion of public access to the Lake's foreshore including a shared pathway extending around the entire perimeter. Areas for particular completion include between Fred Finch Park and Kanahooka Point to ensure the safety of people using the Lake for transport.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA2	
85	VR91	Revision of the Lake as a commercial fishing area with respect to increasing fish stocks, tourism assets and research into aquatic species populations to establish sustainable catch limits. Further measures include more active rangers/inspectors to enforce size and catch limits.	Values Report (BMT WBM, 2017)					Protect and Manage Key Fauna	MF1, PM1	
86	VR92	Stricter measures in place to limit catchment development with revised planning policies to ensure sustainability, protection, and enhancement of the Lake's health. Strict penalties for breaching of DA regulations and opportunities to incorporate sustainable designs.	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM1	
87	VR93	Public education/awareness programs and initiatives highlighting the environmental threats to the lake and measures required to mitigate these. This could be undertaken by the formation of a community action group in liaison with Council to develop sustainability measures for the Lake and its foreshore. A number of responses expressed their interest in forming local environmental groups or using current groups, such as Bushcare, for water quality monitoring and other initiatives. Other options include working with local schools to educate the students and promote the environmental value of the Lake.	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3	
88	VR94	Restrictions on the usage or speed of motorised watercraft in the Lake, particularly in the breeding and feeding areas of birds and other aquatic animals, and in other areas requiring rehabilitation.	Values Report (BMT WBM, 2017)					Protect and Manage Key Fauna	PM1	

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#	ID ¹	Option ²	Source of Option	Details ²	Completion Status ³	Cost ²	Recommendation for this CMP (from Synthesis Report)	CMP Strategy ⁴	CMP Action ID ⁴	Coarse Cost Benefit Filter Outcome ⁵
89	VR95	Ongoing maintenance for foreshore vegetation (such as mowing of recreational areas) particularly in areas accessed by the public, such as between Fred Finch Park and Kanahooka Point. Replanting appropriate vegetation in these areas and restricted areas in erosion and high-stress hotspots. Weed and intrusive species removal program to enhance public access to the Lake.	Values Report (BMT WBM, 2017)					Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
90	VR96	Ongoing maintenance of the Lake foreshore in general, particularly for overgrown vegetation in residential areas.	Values Report (BMT WBM, 2017)					Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
91	VR97	Reduction of silt, run off and pollution into the Lake. A number of responses identified the need for better drains, constructed wetlands and pollutant traps to reduce the amount of litter entering the Lake.	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ1, 2, 3	
92	VR98	Increased infrastructure to promote tourism such as cruises around the Lake and kayak/watercraft hire.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA1, RA4	
93	VR99	Formation of a group to oversee the funding, works, environmental monitoring, and general activities on the Lake, similar to the LIA.	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM2	
94	VR100	Enhancement of activities on the Lake including boat races, sailing, paddling, and recreational fishing to maintain and promote tourism to the area. Other activities and opportunities include monthly food and market stalls, kiosks, cultural events, sculpture and art exhibitions, food and coffee vans/pop-ups, picnic benches, education signage and fitness stations to encourage use of the area.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA4	
95	VR101	Management of siltation and sand build up with measures in place to reduce erosion around the Lake and places where sediment enters from the broader catchment. Possible dredging in major access points.	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ4, RA5	

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96	VR102	Regular emptying of trash racks and pollutant traps with increased maintenance during major rain/storm events to remove rubbish, vegetation and debris.	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ3	
97	VR103	Development of foreshore areas such as the King Street foreshore and Windang area to include cafes, restaurants, markets, stalls and exhibitions to promote tourism and residential use of the Lake, particularly in off-peak seasons.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	RA4	
98	VR104	Regulation of prohibited activities such as littering, illegal fishing methods and places, use of motorbikes on shared paths and car access to the foreshore causing destruction of the riparian vegetation and causing erosion.	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3, EV2	
99	VR105	Greater transparency and community engagement in the management of the Lake in terms of funding, management committees, committee members, with activities/initiatives or any other plans being made known to the public.	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM1, PM2	
100	VR106	Consider large scale events such as seaplanes in Wings Over the Illawarra. The foreshore at Koonawarra might be a good location for this. It would add an extra element to the air show and make good use of the lake. An Illawarra boat show held on the lake, possibly in the area between Kully Bay and the yacht club. Obviously this would have to be a "small boats" show. Or alternatively a small sail craft show or a kiteboarding competition at Primbee (Purry Burry Reserve).	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	
101	VR107	Selective tree removal to improve views.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity		Both Councils are preparing strategies to address this issue. Therefore, this option was not included in the CMP.
102	VR108	A collaborative approach to environmental monitoring on the lake.	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ6, 7, 8, 10	

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103	VR109	Removal of marine sand deposits from popular swimming areas downstream of the Windang road bridge. Relocation of these sediments to Warilla Beach or Shellharbour Village Foreshore.	Values Report (BMT WBM, 2017)					Manage Changes to the Entrance Channel	EC2	
104	VR110	Educational Signage at regeneration / rehabilitation sites	Values Report (BMT WBM, 2017)					Protect and Rehabilitate Estuarine and Riparian Vegetation	EV1	
105	VR111	Cultural burning as a weed management tool led by Aboriginal knowledge holders	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	
106	VR112	Dredging behind groyne near Redall Reserve	Values Report (BMT WBM, 2017)					Manage Changes to the Entrance Channel	EC3	
107	VR113	Large signs to address tree vandalism	Values Report (BMT WBM, 2017)					Protect and Rehabilitate Estuarine and Riparian Vegetation	EV2	
108	VR114	Passive surveillance (e.g. encourage grey nomads to use carpark near Hooka Point wetlands)	Values Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3	
109	VR115	Improved maintenance of existing stormwater management devices	Values Report (BMT WBM, 2017)					Improve Water Quality	WQ3	
110	VR116	Work with BMX riding kids to find an area that they can create jumps etc.	Values Report (BMT WBM, 2017)					Maintain and Improve Recreation and Amenity	EV2, RA1	
111	VR117	Aboriginal Land and Sea Ranger Program – Funds sourced by Federal Grants for Caring for Country has increased opportunities for Aboriginal employment and cultural tourism initiatives could provide funding to increase employment.	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	
112	VR118	Cultural Tourism- Aboriginal Tourism venture conducting tours around the lake, reclaiming cultural practices such as telling of dreamtime stories, star gazing, fishing tours etc.	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	
113	VR119	Educational programs in relation to Aboriginal Culture and Heritage	Values Report (BMT WBM, 2017)					Protect and Promote Cultural Heritage	CH1	
197	SR1	Assessment of permanent tidal inundation with sea level rise	Synthesis Report (BMT WBM, 2017)					Prepare for Inundation Risks	IR1	
198	SR2	Bank condition assessment (to determine location, extent and cause of erosion)	Synthesis Report (BMT WBM, 2017)					Manage Foreshore and Bank Erosion	FB1	
199	SR3	Education for land managers (public and private) regarding environmental approaches to bank erosion management	Synthesis Report (BMT WBM, 2017)					Manage Foreshore and Bank Erosion	EV3	
200	SR4	Updated estuarine macrophyte mapping	Synthesis Report (BMT WBM, 2017)					Protect and Rehabilitate Estuarine and Riparian Vegetation	EV4	

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201	SR5	Investigate the source of contamination at Entrance Beach	Synthesis Report (BMT WBM, 2017)					Improve Water Quality	WQ6, 8	
202	SR6	Monitoring of changes to the entrance channel (bathymetry-topography) relating to permanent entrance opening	Synthesis Report (BMT WBM, 2017)					Manage Changes to the Entrance Channel	EC4	
203	SR7	Work with EPA and Tallawarra Powerstation to reduce thermal discharges (e.g. when licensing renewal arises).	Synthesis Report (BMT WBM, 2017)					Improve Water Quality	WQ11	
204	SR8	Undertake fauna surveys using methods recommended by OEH (2016) to better understand fish and other fauna assemblages	Synthesis Report (BMT WBM, 2017)					Protect and Manage Key Fauna	MF1	
205	SR9	Develop and apply minimum standards and targets for stormwater quality and quantity to apply to new developments	Synthesis Report (BMT WBM, 2017)					Improve Water Quality	WQ1	
206	SR10	Survey of recreational fishers to provide data on fish species occurring in the Lake	Synthesis Report (BMT WBM, 2017)					Protect and Manage Key Fauna	MF1	
207	SR11	Community recreation survey to better understand recreational activities, areas used and facilities required.	Synthesis Report (BMT WBM, 2017)					Improve Planning and Management Arrangements for the Lake	PM3	
208	PMT1	Ongoing coordinated management of the lake	The PMT					Improve Planning and Management Arrangements for the Lake	PM2	
209	PMT2	Water quality monitoring	The PMT					Improve Water Quality	WQ7, 8, 10	
210	PMT3	Protection of shore birds	The PMT					Protect and Manage Key Fauna	MF1	
211	PMT4	Work with the Aboriginal community to further cultural awareness activities.	The PMT					Protect and Promote Cultural Heritage	CH1	
212	PMT5	Loss of access / connection to the lake	The PMT					Maintain and Improve Recreation and Amenity	RA2, RA3, CH1	

Table E-2 Multi-criteria Cost Benefit Analysis of Actions for the Lake Illawarra CMP

Action ID	Action Descriptor	Details	Entrance channel changes	Water pollution	Catchment development	Loss of estuarine vegetation	Wetland degradation	Litter, plastics and marine debris	Contaminated sediments	Inappropriate / degraded / insufficient infrastructure	Loss of tangible and intangible cultural heritage	Foreshore development encroaching public land	Loss of riparian habitat	Foreshore and bank erosion	Future climate change	Park management practices impacting adjacent natural areas	Commercial fishing	Introduced species	Cumulative Threat Mitigation Score (TMS) Weighted according to risk rating of threat	Capital Costs	Recurrent Costs	Effectiveness	Community Acceptability	Reversible / Adaptable Future	Legal / Approval Risk	Technical Viability	CBA Score	Overall Outcome (considering TMS and CBA)	
			Very High	Very High	Very High	High	High	High	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium		Low	Very high (x4) High (x3) Medium (x2) Low (x1)	CBA Scoring: Go = 1, Slow = 0, Stop = -1							
<i>Risk Rating</i>			Very High	Very High	Very High	High	High	High	High	High	High	High	High	High	High	High	High	High	Very high (x4) High (x3) Medium (x2) Low (x1)	CBA Scoring: Go = 1, Slow = 0, Stop = -1						TMS > 30 + CBA ≥ 2 = GO TMS > 15 + CBA ≥ 4 = GO TMS < 15 + CBA ≤ 2 = STOP TMS < 15 + CBA ≥ 4 or TMS > 30 + CBA ≤ 2 = SLOW (for future consideration)			
			2=direct positive influence, 1= indirect positive influence, 0 = no influence, -1 = indirect negative influence, -2 indirect negative influence																										
Strategy 1: Improve Water Quality (WQ)																													
WQ1	Implement a Risk Based Stormwater Management Framework for the Lake Illawarra catchment	OEH to undertake a research project that then guides WCC and SCC on DCP updates with 'best practise' pollutant reduction targets for the catchment. Undertake a trial period to compare the new and old pollutant load targets, then determine future application of the targets, including further DCP amendments.	0	2	2	1	1	2	1	0	0	0	1	1	0	0	0	0	35	Go	Go	Go	Go	Go	Go	Go	Go	7	GO
WQ2	Install new or replace existing stormwater quality management measures, using water sensitive urban design or other devices that will improve water quality as well as enhance habitat and natural values	<ul style="list-style-type: none"> Audit all stormwater quality management devices in the Lake Illawarra catchment, and determine priorities for replacement. Identify sites for new devices (including locations recommended here). Prioritisation for new devices may be derived from the Benefit Mapping (Dela-Cruz, et al, 2017, reproduced in Figure 4 1). Set aside adequate funds for continued maintenance of new/replaced devices. Monitor the effectiveness of various devices in different areas/settings, by monitoring the nutrient loads exported before and after devices are installed or upgraded. The data may also improve the selection of devices for new or replacement sites. 	0	2	2	1	1	2	2	1	0	0	1	1	0	0	0	0	41	Slow	Go	Go	Go	Go	Go	Go	Go	6	GO
WQ3	Review, prioritise and improve maintenance and cleaning regime for existing stormwater quality devices	Gross pollutant traps, artificial wetlands and water sensitive urban design features.	0	2	1	1	1	2	2	1	0	0	0	1	0	0	0	0	35	Go	Slow	Go	Go	Go	Go	Go	Go	6	GO
WQ4	Design and implement targeted catchment input monitoring as required for developments resulting in a large-scale change or intensification of land use	The programs should include monitoring of nutrients in runoff before and after development.	0	2	2	0	2	2	2	0	0	0	0	0	0	0	0	0	34	Go	Go	Slow	Go	Go	Go	Go	6	GO	
WQ5	Improve compliance with erosion and sediment controls for development sites	<ul style="list-style-type: none"> Increase the number of compliance audits of development sites, which may require additional staff resources. Audit of sediment and erosion controls to be conducted prior to allowing vegetation clearing and earthworks. Ongoing audits required throughout the development to ensure sediment and erosion controls are maintained and performing as intended. Educate Council works staff and contractors regarding best practise erosion and sediment control, and ensure this is being implemented on Council work sites. Work with private certifiers to improve knowledge of best practise, and auditing and transparency regarding the application of sediment and erosion controls on privately certified development sites. 	0	2	2	1	2	2	2	0	0	0	0	2	0	0	0	0	0	41	Slow	Slow	Go	Go	Go	Go	Go	5	GO
WQ6	Reduce the impact of sewer overflows	<ul style="list-style-type: none"> Develop a collaborative relationship between the Councils and Sydney Water to improve gathering and sharing of reports of sewer leaks or overflows (location, severity, frequency). Improve reporting of leaks and overflows to Sydney Water to assist with prioritising repairs or upgrades. 	0	2	1	1	2	1	2	2	0	0	0	0	0	0	0	0	0	36	Go	Go	Go	Go	Go	Go	Go	7	GO
WQ7	Implement existing water quality monitoring program for estuary health	<ul style="list-style-type: none"> Temperature, salinity, pH, dissolved oxygen, turbidity; total, dissolved and reactive forms of nitrogen and phosphorus; and chlorophyll a Set up data exchange arrangements with other land managers, and used in analysis and annual summaries of results. An annual summary of monitoring data and analysis of results shall be compiled, with a review of the program and results every 5 years.	0	2	1	1	1	1	0	0	1	0	1	0	0	0	0	1	1	29	Go	Go	Slow	Go	Go	Go	Go	6	GO
WQ8	Undertake water quality monitoring for Recreational Use	Done in accordance with the NSW Beachwatch sampling protocols. This typically involves sampling for Enterococci over the summer period, and as needed on an event-basis.	1	2	0	0	0	2	2	0	1	0	0	0	0	0	0	0	27	Go	Go	Slow	Go	Go	Go	Go	6	GO	

Table E-2 Multi-criteria Cost Benefit Analysis of Actions for the Lake Illawarra CMP

Action ID	Action Descriptor	Details	Entrance channel changes	Water pollution	Catchment development	Loss of estuarine vegetation	Wetland degradation	Litter, plastics and marine debris	Contaminated sediments	Inappropriate / degraded / insufficient infrastructure	Loss of tangible and intangible cultural heritage	Foreshore development encroaching public land	Loss of riparian habitat	Foreshore and bank erosion	Future climate change	Park management practices impacting adjacent natural areas	Commercial fishing	Introduced species	Cumulative Threat Mitigation Score (TMS) Weighted according to risk rating of threat	Capital Costs	Recurrent Costs	Effectiveness	Community Acceptability	Reversible / Adaptable Future	Legal / Approval Risk	Technical Viability	CBA Score	Overall Outcome (considering TMS and CBA)		
			Very High	Very High	Very High	High	High	High	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium		Low	Very high (x4) High (x3) Medium (x2) Low (x1)	CBA Scoring: Go = 1, Slow = 0, Stop = -1								
<i>Risk Rating</i>			Very High	Very High	Very High	High	High	High	High	High	High	High	High	High	High	High	High	High	Very high (x4) High (x3) Medium (x2) Low (x1)	CBA Scoring: Go = 1, Slow = 0, Stop = -1						TMS > 30 + CBA ≥ 2 = GO TMS > 15 + CBA ≥ 4 = GO TMS < 15 + CBA ≤ 2 = STOP TMS < 15 + CBA ≥ 4 or TMS > 30 + CBA ≤ 2 = SLOW (for future consideration)				
			<i>2=direct positive influence, 1= indirect positive influence, 0 = no influence, -1 = indirect negative influence, -2 indirect negative influence</i>																											
WQ9	Investigate the contribution of contaminated sites to poor water quality in the lake	<ul style="list-style-type: none"> Gather ground and surface water quality monitoring data from active and historical contaminated sites, which may be/have been collected in accordance with EPA licence or other conditions. Develop and implement a ground and/or surface water quality monitoring program targeting potential point source locations, particularly where no historical data is available. Liaise with the EPA to target those sites that are found likely to be the source of contaminants to undertake remediation works. 	0	2	1	1	1	1	2	0	0	0	1	0	0	0	0	1	1	32	Go	Go	Slow	Go	Go	Go	Go	6	GO	
WQ10	Undertake water quality monitoring of physico-chemical and bacteriological indicators in the lake catchment	<ul style="list-style-type: none"> Review existing programs. Develop a revised program to address the following issues: Localised pollution incidents that trigger further investigation. Pre- and post- development indicators. Link to management actions. Link to WQ1. 	0	2	1	1	1	1	0	0	1	0	1	0	0	0	0	1	1	29	Go	Go	Slow	Go	Go	Go	Go	6	GO	
WQ11	Work with EPA and Tallawarra Powerstation to reduce thermal discharges (e.g. when licensing renewal arises)		0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	11	Go	Go	Slow	Go	Go	Go	Go	6	SLOW		
Strategy 2: Improve Planning and Management Arrangements for the Lake (PM)																														
PM1	Commence integration of key objectives and strategies from the CMP into relevant planning and policy documents of both Councils	<ul style="list-style-type: none"> Update the DCPs to specify vegetation buffers, stormwater treatment measures (such as WSUD), nutrient and sediment load targets for developments within the Lake catchment and foreshore, and the Environmentally Friendly Seawall Guidelines. Update or produce new POMs for community or crown land to include relevant CMP actions / objectives. Consider CMP management areas and objectives when revising the LEP. Review and update Councils' DA checklists to promote preservation of vegetation, erosion and sediment control, management of nutrient and sediment exports, and landscaping for new developments. Review and update local area plans (e.g. the Windang Town Centre Plan) to include CMP actions and reflect CMP objectives where relevant (e.g. bank protection methods, estuarine vegetation management etc). Work towards the incorporation of actions into regional and state programs and plans. Develop Council policies as required to implement CMP objectives and actions. Provide input to RMS when reviewing the Shoalhaven – Illawarra Regional Boating Plan to have consistency with the proposed Lake Illawarra Boating Plan (see RA1) in terms of recreational facilities; and to provide information relevant to speed / usage of boats in key fauna habitat areas. Provide input to DPI Fisheries when reviewing the commercial fishing status of the Lake regarding benefits or otherwise of commercial fishing being permitted in the Lake. 	1	1	2	2	1	1	1	1	1	2	2	2	2	1	0	0	0	51	Go	Go	Go	Go	Go	Go	Slow	Go	6	GO
PM2	Provide ongoing coordinated management of the Lake, which will require ongoing support for existing staff resources	Which will require ongoing support for existing staff resources.	1	2	1	2	1	1	1	2	1	2	2	2	1	2	0	1	59	Slow	Slow	Go	Go	Go	Go	Go	5	GO		
PM3	Develop and implement a targeted education and marketing strategy that enhances the community's knowledge of, skills in, and commitment to, protecting Lake Illawarra	That enhances the community's knowledge of, skills in, and commitment to, protecting Lake Illawarra.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	41	Go	Go	Slow	Go	Go	Go	Go	6	Go		
PM4	Establish a Lake Illawarra Asset Management Working Group that provides coordination services for agencies that manage assets around the Lake Illawarra foreshore	Aims to bring WCC, SCC, Dept of Industry – Crown Lands and PropertyNSW together to manage their lake and foreshore assets in a coordinated manner, considering cost-sharing arrangements, economies of scale, maintenance requirements, renewal and additional asset needs as per RA1.	1	0	0	0	0	0	2	1	2	1	2	1	2	0	0	29	Go	Go	Go	Go	Go	Go	Go	7	Go			

Table E-2 Multi-criteria Cost Benefit Analysis of Actions for the Lake Illawarra CMP

Action ID	Action Descriptor	Details	Entrance channel changes	Water pollution	Catchment development	Loss of estuarine vegetation	Wetland degradation	Litter, plastics and marine debris	Contaminated sediments	Inappropriate / degraded / insufficient infrastructure	Loss of tangible and intangible cultural heritage	Foreshore development encroaching public land	Loss of riparian habitat	Foreshore and bank erosion	Future climate change	Park management practices impacting adjacent natural areas	Commercial fishing	Introduced species	Cumulative Threat Mitigation Score (TMS) Weighted according to risk rating of threat	Capital Costs	Recurrent Costs	Effectiveness	Community Acceptability	Reversible / Adaptable	Future Legal / Approval Risk	Technical Viability	CBA Score	Overall Outcome (considering TMS and CBA)	
			Very High	Very High	Very High	High	High	High	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium		Low	Very high (x4) High (x3) Medium (x2) Low (x1)	CBA Scoring: Go = 1, Slow = 0, Stop = -1							
<i>Risk Rating</i>			Very High	Very High	Very High	High	High	High	High	High	High	High	High	High	High	High	High	High	Very high (x4) High (x3) Medium (x2) Low (x1)	CBA Scoring: Go = 1, Slow = 0, Stop = -1						TMS > 30 + CBA ≥ 2 = GO TMS > 15 + CBA ≥ 4 = GO TMS < 15 + CBA ≤ 2 = STOP TMS < 15 + CBA ≥ 4 or TMS > 30 + CBA ≤ 2 = SLOW (for future consideration)			
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Strategy 3: Manage Changes to the Entrance Channel (EC)																													
EC1	Investigate Entrance Channel Processes and Implement Management Solutions	This study shall investigate the hydrodynamics, sediment transport, erosion and sedimentation patterns occurring in the channel, and develop management options to address the issues, using a cost benefit analysis to assess options. The preferred solution(s) shall then be implemented.	2	0	0	1	1	0	0	2	1	1	1	2	1	0	0	0	33	Stop	Slow	Slow	Go	Slow	Go	Go	Go	2	GO
EC2	Undertake beach scraping to maintain swimming areas	This action allows for dredging and / or beach scraping/re-shaping to improve the recreational amenity of swimming areas in the channel.	2	0	0	0	0	0	0	2	0	0	0	1	1	0	0	0	18	Go	Go	Slow	Go	Go	Go	Go	Go	6	GO
EC3	Undertake dredging in the entrance channel, as required to maintain navigation	<ul style="list-style-type: none"> Undertake dredging when needed to manage sedimentation and improve navigability, and provided dredging is consistent with the preferred solution derived in Action EC1. Reuse dredged marine sand on nearby beaches (e.g. Warilla, Perkins Beach) and suitable lake foreshores. Monitor the success of the dredging in terms of longevity of navigation, effectiveness / longevity of nourished beaches, adverse / positive impacts on surfing breaks / sand bars, and beach amenity. 	2	0	0	1	0	0	0	2	0	0	0	2	0	0	0	0	21	Stop	Go	Slow	Go	Go	Go	Go	Go	4	GO
EC4	Monitor changes to the entrance channel	Topographic and bathymetric surveys (using ALS or other efficient method) should be undertaken regularly (every 1-2 years), and the data analysed to determine the trajectory of erosion and accretion patterns, occurring in the entrance channel (e.g. bank erosion / accretion and channel migration, deepening or filling), since construction of the breakwaters, and in relation to any further structural works.	2	0	0	2	0	0	0	1	1	0	0	2	0	0	0	0	24	Go	Go	Slow	Go	Go	Go	Go	Go	6	GO
Strategy 4: Protect and Rehabilitate Estuarine and Riparian Vegetation (EV)																													
EV1	Rehabilitate vegetation and manage public access along foreshores and banks of the Lake, its tidal tributaries, islands and broader low-lying areas	<ul style="list-style-type: none"> Conduct a site inspection to confirm known and identify new rehabilitation sites. Prioritise and prepare a detailed implementation program and action plan for mapped locations. Continue to fund and implement Council restoration programs within the Lake's catchment. Support the implementation of the Plans of Management for the Berkeley Nature Reserve. 	1	1	1	2	2	1	1	0	1	1	2	2	1	1	0	1	48	Stop	Stop	Go	Go	Go	Go	Go	Go	3	GO
EV2	Undertake targeted action to control damage to foreshore vegetation, including seagrasses	Caused by: 4WDs and other vehicles, bikes (including BMX), boating activities, unfenced stock, mowing practices, tree damage and removal, pedestrians, illegal structures (e.g. land reclamation, seawalls, boat ramps (formal or informal), BBQs, seating, fencing, private signage).	0	1	1	2	2	1	1	0	1	2	2	2	0	2	0	1	46	Slow	Slow	Go	Go	Go	Go	Go	Go	5	GO
EV3	Provide education to foreshore landowners	Education regarding: <ul style="list-style-type: none"> mowing and gardening around sensitive foreshore vegetation; the legalities of building of structures (BBQs, seating, boat ramps, seawalls, land reclamation, fences, etc); for foreshore structures and works, education on environmentally friendly designs, habitat rehabilitation options, and planning and approval requirements; Illegal access and dumping; and vegetation damage and removal. 	0	0	1	2	2	1	1	0	1	2	2	2	1	1	0	1	42	Go	Go	Slow	Go	Go	Go	Go	Go	6	GO
EV4	Prepare and implement an estuarine macrophyte mapping and monitoring program	<ul style="list-style-type: none"> Undertake estuarine macrophyte mapping for the entire lake, to determine the current coverage and distribution of mangroves, saltmarsh and seagrass. Determine changes in distribution and coverage of macrophytes, by a comparison with the previous mapping. Monitor areas identified in Action Maps for conservation of saltmarsh for 2 years, to determine pattern of changes. If areas require action to manage saltmarsh retreat, include these in action EV5. Repeat lake wide estuarine macrophyte mapping and analysis every 5 years. 	0	0	0	2	2	0	0	0	0	2	2	0	1	1	0	1	25	Go	Go	Slow	Go	Go	Go	Go	Go	6	GO
EV5	Develop and implement a program to enhance opportunities for estuarine vegetation migration	<ul style="list-style-type: none"> Build on previous work to identify areas that could be modified or managed to permit migration and colonisation by saltmarsh. From EV4, add areas where action is required to manage saltmarsh retreat. Develop actions to allow saltmarsh migration or manage retreat, e.g. by: land repurchase, MOUs with landowners, removal of physical barriers (e.g. walls, paths) and levelling land. 	0	0	0	2	2	0	0	0	1	2	2	1	2	1	0	1	32	Slow	Slow	Go	Go	Go	Go	Go	Go	5	GO
EV6	Investigate land acquisition or transfer from private to public ownership	<ul style="list-style-type: none"> Mouth of Macquarie Rivulet and Haywards Bay. Potential transfer to Council or State Government, and rezoning to environment protection. Land is currently owned by RCL and Tru Energy (\$10,000 for transfer costs, \$500,000 for rehabilitation and access works). Currungoba Peninsula, including Tank Trap. Potential acquisition by State Government (\$1M for land acquisition, \$250,000 for rehabilitation and access works). 	0	2	2	2	2	0	1	0	1	1	2	2	2	0	0	0	48	Stop	Stop	Go	Slow	Go	Slow	Go	1	SLOW	

Table E-2 Multi-criteria Cost Benefit Analysis of Actions for the Lake Illawarra CMP

Action ID	Action Descriptor	Details	Entrance channel changes	Water pollution	Catchment development	Loss of estuarine vegetation	Wetland degradation	Litter, plastics and marine debris	Contaminated sediments	Inappropriate / degraded / insufficient infrastructure	Loss of tangible and intangible cultural heritage	Foreshore development encroaching public land	Loss of riparian habitat	Foreshore and bank erosion	Future climate change	Park management practices impacting adjacent natural areas	Commercial fishing	Introduced species	Cumulative Threat Mitigation Score (TMS) <small>Weighted according to risk rating of threat</small>	Capital Costs	Recurrent Costs	Effectiveness	Community Acceptability	Reversible / Adaptable Future	Legal / Approval Risk	Technical Viability	CBA Score	Overall Outcome (considering TMS and CBA)	
																													Risk Rating
			<p style="text-align: center;"><i>2=direct positive influence, 1= indirect positive influence, 0 = no influence, -1 = indirect negative influence, -2 indirect negative influence</i></p>															<p>Very high (x4) High (x3) Medium (x2) Low (x1)</p>					<p>CBA Scoring: Go = 1, Slow = 0, Stop = -1</p>					<p>TMS > 30 + CBA ≥ 2 = GO TMS >15 + CBA ≥ 4 = GO TMS <15 + CBA ≤ 2 = STOP TMS <15 + CBA ≥ 4 or TMS > 30 + CBA ≤ 2 = SLOW (for future consideration)</p>	
Strategy 5: Maintain and Improve Recreational Amenity (RA)																													
RA1	Upgrade and renew foreshore / waterway recreational infrastructure	Upgrade and renew foreshore / waterway recreational infrastructure in accordance with available Transport and Recreation Asset Management Plans, informed by Plans of Management and approved recreation masterplans. Action also aims to improve maintenance programs, with priority given to existing shared pathways and marine assets.	1	0	0	0	0	0	0	2	1	2	0	1	0	2	0	0	23	Stop	Slow	Go	Go	Go	Go	Go	Go	4	GO
RA2	Construct new sections of shareway to complete the pathway linkage around the entire Lake	<ul style="list-style-type: none"> Remove and rehabilitate informal / degraded tracks as new sections are completed. Consider disabled access and facilities, bubblers / drinking stations, and lighting when designing new shared pathway sections. Ensure siting of the shared pathway does not impact on sensitive environmental and / or cultural areas. 	0	0	0	2	0	0	0	2	1	1	2	2	0	0	0	0	25	Stop	Slow	Go	Go	Go	Go	Go	Go	4	GO
RA3	Negotiate a public 'right of way' along the foreshore	Consult with land owners regarding public and private foreshore ownership, to re-open public foreshore sections, and allow public access along private foreshore sections.	0	0	0	1	0	0	0	2	1	2	1	0	0	0	0	0	18	Go	Go	Go	Slow	Go	Slow	Go	5	GO	
RA4	Investigate commercial partnerships to enhance tourism and recreational opportunities around the lake (e.g. boat hire, kiosks, etc)	This may involve tenders for use of public areas by private businesses, or more permanent structures, to provide services such as: <ul style="list-style-type: none"> Boat hire, for boats and / or small watercraft such as kayaks and canoes, Cruises, Kiosks / pop-up facilities / markets / stalls / exhibitions in high use parks and reserves, or at peak times (e.g. holidays), Cafes / restaurants in suitable locations. 	0	0	0	0	0	-1	0	2	1	0	0	0	0	0	0	0	6	Slow	Slow	Go	Go	Go	Go	Go	5	SLOW	
RA5	Undertake dredging of bays within the Lake	The aim of this action would be to improve recreational amenity, however this would need to be demonstrated by feasibility studies. Indicative costs and locations: <ul style="list-style-type: none"> Griffins Bay (\$2.3M - 3M) Southern Back Channel (\$1.9M - 3M) Karoo Bay (\$0.75M - 1M) Koona Bay (\$4.5M - 6M) Haywards Bay (\$0.75M - 1M) Koonawarra Bay (inc Mullet Creek) (\$0.75M - 1M) Purrah Bay (\$1.1M - 1.5M) Koong Burry Bay (\$5.6M - 7.5M) Tuggerah Bay (\$15,000 - 20,000) 	0	0	0	-1	0	0	1	1	0	0	-1	0	0	0	0	0	1	Stop	Stop	Slow	Slow	Go	Go	Go	1	STOP	
RA6	Continue harvesting of macroalgae in the Lake on an as needs basis. Undertake further research into the driving mechanisms behind algal blooms and the dynamics of macroalgae and microalgae interactions with primary producers in the Lake	Since 1988 approximately 30,000T has been removed. This has resulted in the removal of substantial volumes of nutrients such as nitrogen and phosphorus from the Lake as well as improving odour. Indicative cost: 125,000 p.a. Algal blooms occur within the Lake due to a number of potential factors. The impacts of removing wrack upon fish etc that may rely on wrack and other macroalgae for food resources has not been investigated. Indicative cost: 20,000 p.a. Responsibility: WCC and SCC as a partnership project with Wollongong or other University.	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	Slow	Slow	Stop	Go	Go	Slow	Go	2	STOP	

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																													Risk Rating	Very High
			2=direct positive influence, 1= indirect positive influence, 0 = no influence, -1 = indirect negative influence, -2 indirect negative influence																											
Strategy 6: Protect and Promote Cultural Heritage (CH)																														
CH1	Protect and promote cultural heritage in and around the lake and its catchment	Employ a Cultural Heritage Officer to work on Lake Illawarra with assistance from Federal or State funding processes. This person will work with the Aboriginal and non-Aboriginal community to further cultural awareness activities.	0	1	0	1	1	0	0	1	2	0	1	2	0	1	0	0	27	Go	Go	Go	Go	Go	Go	Go	Go	7	GO	
Strategy 7: Manage Foreshore and Bank Erosion and Sedimentation (FB)																														
FB1	Undertake a bank condition assessment and determine environmentally sensitive erosion control measures	<ul style="list-style-type: none"> Undertake a bank condition assessment to map foreshores experiencing erosion. Identify the likely causes of erosion (e.g. stormwater outflow, wind waves, tidal currents). Prioritise the sites based on their severity, risks from ongoing erosion (e.g. to public safety, nearby seagrasses etc), and feasibility and cost of controlling erosion. Determine actions to manage erosion, which may include monitoring for sites of low priority / low risk / poor information. Concept designs for remedial action should preference the use of revegetation, or otherwise utilise the environmentally friendly seawall guidelines for engineered solutions and aim to improve habitat connectivity. Monitor success or otherwise of remedial action. 	2	2	0	1	0	0	1	1	0	1	2	2	0	0	0	0	35	Slow	Slow	Go	Go	Go	Slow	Go	Go	4	GO	
FB2	Upgrade foreshore protection works to improve environmental performance and outcomes	The Environmentally Friendly Seawall Guidelines should be used in upgrade designs, to improve the environmental benefits of existing structures.	2	1	0	1	0	0	0	2	0	1	0	2	0	0	0	0	27	Slow	Slow	Go	Go	Go	Slow	Go	Go	4	GO	
FB3	Undertake a bathymetric survey of the entire Lake and tributaries up to the tidal limit	Survey should be conducted along transects used previously in the tributary creeks. Methods such as marine-based LiDAR should be considered. Survey should be compared with previous surveys, to determine if and where sedimentation / erosion is occurring on the lake or creek bed. Survey to be completed every 10 – 20 years	0	0	1	1	1	0	1	0	0	1	1	1	1	1	0	0	23	Go	Go	Go	Go	Go	Go	Go	Go	7	GO	
Strategy 8: Prepare for Inundation Risks (IR)																														
IR1	Update Asset Management Plans for all publicly owned and managed assets	This involves notation of the risk of periodic and permanent inundation and timeframe of likely impact on asset management registers for roads, stormwater infrastructure, sewer and water infrastructure, community facilities including parks and reserves, cycleways, jetties, boat ramps, entrance training walls and other waterway infrastructure, environmental assets such as saltmarsh, coastal wetlands, etc.	1	0	0	1	1	0	0	2	2	1	1	1	2	1	0	0	34	Go	Go	Go	Go	Go	Go	Go	Go	7	GO	
IR2	Whole of Lake Foreshore Adaptation Plan for public (community and environmental) lands	The action involves assessment and selection of adaptation actions for parks /reserves, including their associated assets such as cycleways, jetties, boat ramps, around the entire Lake Illawarra foreshore considering tidal inundation and current and future usage demand	1	0	1	2	1	0	0	2	2	1	2	1	2	0	0	0	41	Go	Go	Go	Go	Go	Go	Go	Go	7	GO	
IR3	Incorporate tidal inundation mapping into strategic land use planning documents	For example as a foreshore building line / buffer / setback in the LEPs, DCPs and council policy. Land use planning controls for flooding will not fully manage tidal inundation risks, and additional controls are needed.	1	0	2	2	1	0	0	1	0	2	2	1	2	0	0	0	38	Go	Go	Go	Go	Slow	Go	Go	Go	6	GO	
IR4	Water level and condition monitoring for all lake inundation events	<ul style="list-style-type: none"> Record the frequency of inundation events (i.e. tidal, ocean anomaly, rainfall), based on review of existing lake water level gauge data, and Record assets affected and impacts / condition after each event or yearly, as required. 	1	0	0	0	0	0	0	2	1	1	1	2	2	0	0	0	25	Go	Go	Go	Go	Go	Go	Go	Go	7	GO	
IR5	Investigate novel solutions to manage inundation risks to assets	This action aims to provide novel and innovative solutions to asset replacement where relocation is not viable. Certain assets by their very nature must be located on low-lying high risk lands, for example sewer and water pump stations and stormwater outlets. Other assets targeted include cycleways, roads and bridges, etc.	1	0	1	2	1	0	0	2	0	2	2	1	2	0	0	0	37	Go	Go	Go	Go	Go	Go	Go	Go	7	GO	
Strategy 9: Protect and Manage Key Fauna (MF)																														
MF1	Develop and implement a fauna management program including shorebirds fish and other fauna	<ul style="list-style-type: none"> Monitor and protect shorebird habitat, foraging and nesting sites on a yearly basis. Survey recreational fishers on a regular basis (e.g. every 2 years), to gather data on fish species distribution and numbers in the Lake. Undertake regular official fauna surveys (e.g. every 2-3 years) to better understand fish and other fauna assemblages, distribution and numbers in the lake. Analyse the data sources (i.e. recreational fishers, fauna surveys, commercial fishing data) to identify trends (increase or decline) in fauna assemblages, numbers etc. Where a decline or impact on fauna health is identified, determine causes and develop and implement actions to mitigate the decline / impacts, where possible. 	1	0	0	1	1	0	0	0	1	1	1	1	1	1	1	2	2	29	Go	Go	Go	Go	Go	Go	Go	Go	7	GO



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