BMT

Community Uses, Values, Threats and Opportunities

Lake Illawarra

February 2020

wollongong
city of innovation

NSW GOVERNMENT | Planning, Industry & Environment

Shellharbour CITY COUNCIL

Document Control Sheet

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Document:	R.N20606.002.08.ValuesReport.docx
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Synopsis: **This report on Community Uses, Values, Threats and Opportunities of Lake Illawarra has been compiled to identify the community uses and values of Lake Illawarra, and identify and assess the threats to the Lake and its uses and values, as a precursor to the development of the Lake Illawarra Coastal Management Program.**

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
0	February 2017	PD		MF	
1		MF		MF	
2	August 2017	MF		MF	
3	not used				
4	February 2018	VPR		VPR	
5	April 2019	VPR		VPR	
6	June 2019	VPR		VPR	
7	January 2020	VPR		VPR	
8	February 2020	VPR	V.Rollason.	VPR	V.Rollason.

DISTRIBUTION

Destination	Revision										
	0	1	2	3	4	5	6	7	8	9	10
WCC and SCC	PDF	PDF	PDF		PDF	PDF	PDF	PDF	PDF		
BMT File	PDF	PDF	PDF		PDF	PDF	PDF	PDF	PDF		
BMT Library	PDF										

Glossary of Terms

Aboriginal Cultural Heritage includes tangible (physical) and intangible (non-physical) aspects – it is the landscapes, places, objects, customs and cultural traditions and practices that communities have inherited from the past and wish to conserve as part of their Country for the benefit of current and future generations.

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.

Catchment area The area which drains naturally to a particular point on a river, thus contributing to its natural discharge.

Climate change The long-term change (decades or longer) in patterns of weather, and related changes in oceans, land surfaces and ice sheets.

Dredging An underwater excavation activity intended to remove sediments and debris. Often used to keep navigable pathways within waterways

Ecosystem A community of living organisms and the surrounding nonliving environment interacting as a system.

Endangered Ecological Community An assemblage of species occupying a particular area, listed as endangered under relevant State and Federal legislation.

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 vegetation Vegetation found in the sub-tidal zone, inter-tidal zone, and riparian vegetation which include seagrasses, mangroves, saltmarsh, and Swamp-oak forest.

Estuary The section of a river affected by tidal activity where fresh water from the river mixes with salt water from the ocean.

Foreshore The section of the shore between the low and high tidal limits.

Geomorphic relating to the formation of the earth's surface, distribution of land, water etc.

Gross pollutant trap (GPT) A filter that catches stormwater pollution before it has a chance to enter the waterways. GPTs catch most of the litter and silt but don't stop chemicals going into the environment.

Groundwater Water that is located beneath the earth's surface accumulated from rain and rivers that penetrates the ground through soils and rocks where it is then stored.

Hydrodynamic Relates to the specific scientific principles that deal with the motion of fluids and the forces acting on solid bodies immersed in fluids, and in motion relative to them.

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).

Marine debris Solid man-made material which is disposed of directly or indirectly into the marine environment.

Marine pest Introduced (or non-native) plant or animal that has 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.

Natural processes The processes over which people have no control, such as wind and waves.

Nutrient cycling The movement and exchange of organic and inorganic matter back into the production of matter.

Rehabilitation The process of returning the environment in a given area to some degree of its natural state, after some process has resulted in its damage.

Riparian vegetation Vegetation located along the banks of a body of water, usually rivers.

Risk-based Framework a protocol that decision-makers, such as councils and environmental regulators, can use to help manage the impact of land-use activities on the health of waterways in New South Wales.

Scour Localised loss of soil often present around a foundation element.

Semi-diurnal A water body that experiences two high and two low tides of approximately equal size every lunar day.

Shoal A sandbank or sand bar in the bed of a body of water, especially one that is exposed above the surface of the water at low tide.

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.

Siltation Pollution of a water body by particulate material.

Spatial scale The extent or size of a length, distance or area studied or described.

Stakeholders Persons or organisations with an interest or concern in a given matter.

Sustainability A state in which the demands placed on the environment can be met without reducing its capacity to allow all people to live well, now and in the future.

Temporal scale The habitat lifespan relative to the generation.

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).

Tidal Prism The total amount of water that flows into a harbour, estuary or lake or out again with movement of the tide, excluding any fresh water flow.

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.

Acronyms

Acronym	Meaning
CMP	Coastal Management Program
CZMP	Coastal Zone Management Plan
DPI Fisheries	DPIE Regions, Industry, Agriculture and Resources – Department of Primary Industries Fisheries
DPIE	Department of Planning, Industry and Environment
DPIE – Coasts & Estuaries	Department of Planning, Industry and Environment – Environment, Energy and Science: Coasts & Estuaries Branch
DPIE – Crown Lands	Department of Planning, Industry and Environment – Crown Lands
EEC	Endangered Environmental Communities
EPA	Environment Protection Authority
GPT	Gross Pollutant Trap
LGA	Local Government Area
LI	Lake Illawarra
LIA	Lake Illawarra Authority
LIEMC	Lake Illawarra Estuary Management Committee
LLS	DPIE Regions, Industry, Agriculture and Resources – Local Land Services
MEMA	Marine Estate Management Authority
NPWS	Department of Planning, Industry and Environment – National Parks and Wildlife Services
OEH	Office of Environment and Heritage (now DPIE - Coasts & Estuaries)
POM	Plan of Management
SCC	Shellharbour City Council
SQID	Stormwater Quality Improvement Device
TfNSW	Transport for New South Wales
WCC	Wollongong City Council
WSUD	Water Sensitive Urban Design

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1 Introduction

1.1 Acknowledging Country

While this report focusses on the present-day community uses and values of Lake Illawarra and its surrounds, it is written with acknowledgement for the tens of thousands of years of interconnectedness of this landscape with Aboriginal people. Aboriginal Australia is recognised as the oldest living culture in the world. The Aboriginal people connected to Lake Illawarra experienced massive change to their way of life as a result of European settlement.

For specific information on the consultation aimed at engaging the Aboriginal community and an interpretation of the information collected, please refer to Section 2.4.

1.2 Aims and Scope of this Assessment

This report on Community Uses, Values, Threats and Opportunities of Lake Illawarra has been compiled as a precursor to the development of the Lake Illawarra Coastal Management Program (CMP). A CMP is a strategic document that outlines priority actions to be implemented over a 5-10-year period, to protect valued aspects and tackle the key threats identified for the Lake.

The overarching aim of this assessment is to identify the community uses and values of Lake Illawarra, and identify and assess the threats to the Lake and its uses and values. A secondary aim of this report is to document the consultation activities undertaken to date and outcomes, as part of the wider Lake Illawarra CMP project. The outcomes of the values and threat assessments will be used to guide development and selection of management actions for the Lake Illawarra CMP.

It should be noted that the views and results of the community consultation do not necessarily reflect the views of the authors of this report and are recorded here as one source of information to be considered as part of the development of management actions.

1.3 Locality

Lake Illawarra is a barrier estuary system located 80 km south of Sydney and 10 km south of Wollongong. The Lakes catchment covers an area of around 240km^2 which is drained by a number of watercourses, including Macquarie Rivulet and Mullet Creek. The Lake remains permanently open to the ocean via the entrance channel which is trained by two breakwaters constructed between 2000 and 2007.

The Lake and its catchment spans across both Wollongong and Shellharbour City Council LGA's and the two Councils currently manage the Lake as well as by State agencies (e.g. Department of Planning, Industry and Environment (DPIE)). Land use within the catchment ranges from natural bushland, grazing land, urban residential areas, and industrial land uses. Lake Illawarra is a significant natural asset for the Illawarra region, and is highly valued by the community.

1.4 Acknowledgement

The study team wish to thank the many participants who contributed to the consultation process.

2 Community and Stakeholder Consultation

All stakeholder engagement activities have been completed in accordance with the relevant Wollongong City and Shellharbour City Council policies, procedures and codes of conduct.

The consultation undertaken thus far also exceeds the minimum requirements in the *Coastal Management Act 2016* as well as the requirements set out in the NSW Coastal Management Manual.

A list of the identified target stakeholders for this CMP is provided in Table 2-1 .

Table 2-1 Target Stakeholders

Residents Foreshore landholders (1500) including caravan park residents. Wider Catchment (90,000) Visitors Aboriginal Community	**Key Council Staff** Engineers Infrastructure Planning Parks Environment Senior Management Councillors Asset Managers Service Managers Cultural Heritage
State Government and other agencies and businesses DPIE – Environment, Energy and Science (DPIE - Coasts & Estuaries) Transport for NSW – Roads and Maritime Services (TfNSW) DPIE Regions, Industry, Agriculture and Resources – South Coast Local Land Services (LLS) DPIE – Crown Lands DPIE Regions, Industry, Agriculture and Resources – Fisheries (DPI Fisheries) Sydney Water University of Wollongong DPIE – Planning and Assessment (DPIE – PA) Illawarra Local Aboriginal Lands Council NSW Commercial Fishers Tourism operators Illawarra Business Chamber Golf Club/ Yacht Club/ Bowls Club Aishs Seafood Futureworld Eco - Technology Centre	**Community Groups** 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

2.1 Aims of Consultation

The aims of the engagement activities reported on within this report were to:

- Establish the context for management of the Lake and its catchment, including communicating the outcomes of previous relevant studies, management actions and identified values and identifying additional issues for management;
- Confirm and prioritise the status of the issues raised during the review of existing documents and data; and
- Investigate community held values and uses for the Lake and relevant parts of its catchment.

2.2 Methods of Stakeholder Engagement

An overview of the various techniques used to engage with stakeholders is set out below.

Workshop: Lake Illawarra Estuary Management Committee

Consultation was undertaken at the Lake Illawarra Estuary Management Committee (LIEMC) meeting held on 10 August 2016. At that meeting, committee members as well as other attendees were asked to:

- Add to and modify the first pass list of values and threats developed through writing of the Lake Illawarra Information Synthesis Report (herein 'the Synthesis Report') (BMT, 2020a).
- Indicate their own priority score against the revised values and threats lists. This was done via the placement of coloured dots (numbered 1 to 5, where 1 indicated the highest priority and 5 the lowest priority) against the various individual items.

Project Webpage

A project webpage was established on the Wollongong City Council website (see Figure 2-1). The webpage included details on the study objectives, frequently asked questions and an opportunity to complete the survey online.

Community and Stakeholder Survey

The survey was designed to elicit basic information about values, threats and opportunities for managing Lake Illawarra. It was distributed via the mail out (refer to Appendix A), electronically on the website (refer to Figure 2-1), as hardcopies at the pop ups and information evenings (refer to Section 2.5). It was also distributed opportunistically by council staff at other times and included in correspondence with other stakeholders. A hard copy of the survey is included as Appendix A.

Mail out to Foreshore Residents

Council provided the addresses of 1406 foreshore residents and each were mailed an information pack. The pack included an introductory letter, flyer about the information sessions and a hard copy of the survey with a reply-paid envelope. The resident pack is included as Appendix A.

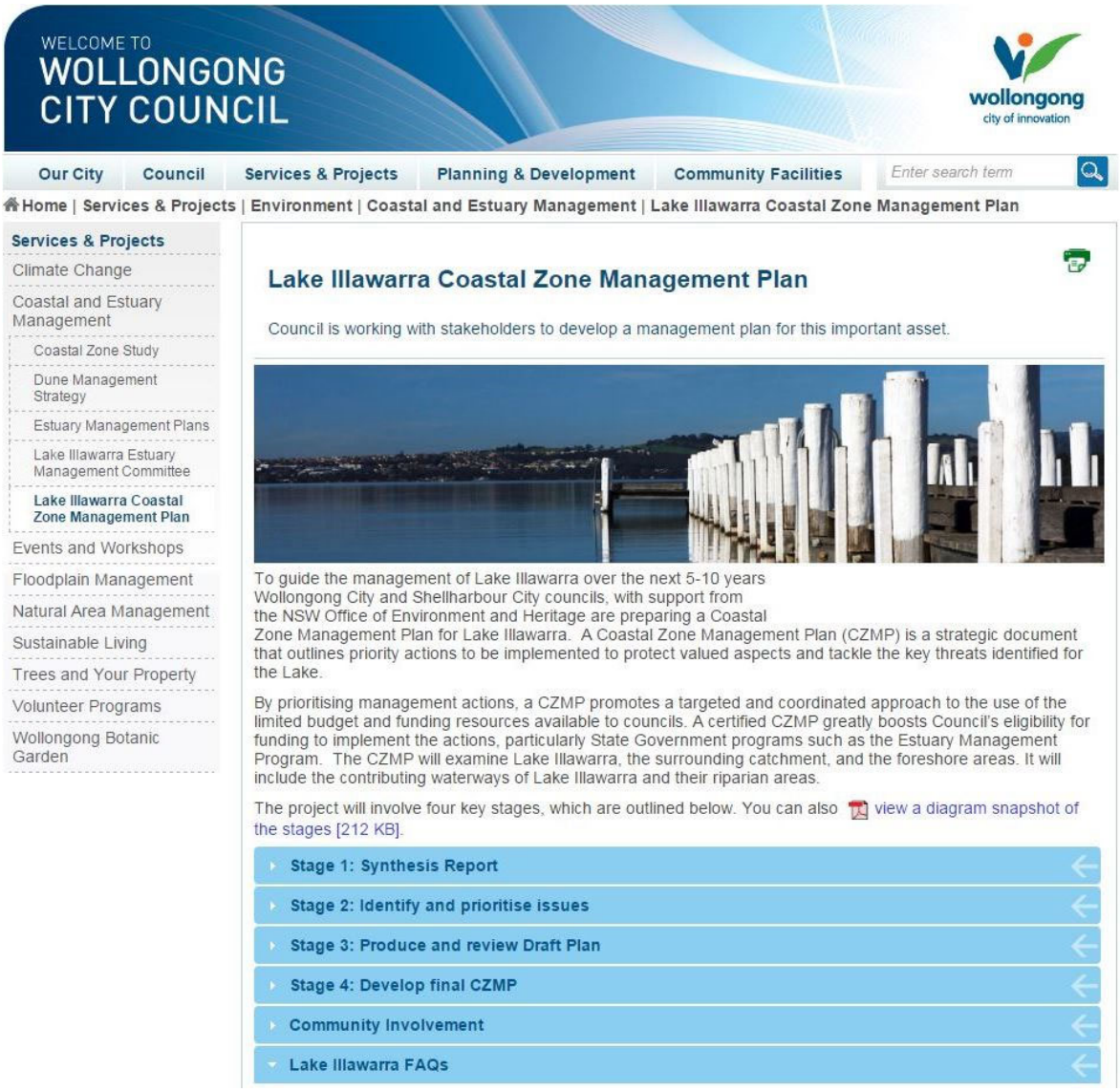


Figure 2-1 Lake Illawarra Coastal Zone Management Plan webpage available on Wollongong City Council website

Pop-ups

Pop-up information stalls were held on a number of days. The stalls had information brochures, posters and surveys and were staffed by various representatives of Wollongong City and Shellharbour City Councils and DPIE - Coasts & Estuaries. Over 50 surveys were collected through this process. Dates and locations for the popups are given in Table 2-2.

Table 2-2 Dates and Locations for Pop Up information stalls

Date	Location
3rd November 2016	• Warrawong Shopping Centre and Warrawong Bunnings
4th November 2016	• Albion Park Shopping Centre and Dapto Mall • Around the Lake at various sites • The Berkeley Bounce Community Fun Activity • Hooka Point Blitz
5th November 2016	• Hooka Point Blitz + rubbish collection and guided walk
8th November 2016	• Around the Lake at various sites
9th November 2016	• Around the Lake at various sites

Information Drop in Sessions

Information drop in sessions were staffed by representatives of both Wollongong and Shellharbour City Councils, DPIE - Coasts & Estuaries and BMT. The focus was on spatial mapping of values, threats and opportunities using large hard copy maps. Dates and numbers of participants are given in Table 2-3.

In recognition of the special relationship between Aboriginal people and the landscape and the long and ongoing connection between Lake Illawarra and Aboriginal people, additional effort was applied to consulting with the Aboriginal community.

We have not made any assumptions about geographic or cultural boundaries of the local Aboriginal community. As with the broader community, input to the development of a CMP is open to everyone.

Two formal meetings were held on the 28th and 29th of November.

Table 2-3 Community Drop in Sessions

Date	Location	Number of Participants
11.30am – 2.30pm Monday 28th November 2016	Aboriginal Community drop-in information session Ribbonwood Centre Dapto	1
5.30pm – 8pm Monday 28th November 2016	SCC Public drop-in information session Oak Flats Neighbourhood Centre	30
2pm – 4.30pm Tuesday 29th November 2016	Aboriginal Community drop-in information session Stocklands Shellharbour	15
5.30pm – 8pm Tuesday 29th November 2016	WCC Public drop-in information session Illawarra Yacht Club Warrawong	15

Emails and Letters to other stakeholders

A letter was mailed to key government agencies advising of the project and encouraging submissions. Emails were also sent to a long list of identified stakeholder groups. In particular, DPIE – Crown Lands, DPI Fisheries, Sydney Water, DPIE - Coasts & Estuaries and Energy Australia have provided detailed information regarding available monitoring data, issues and opportunities.

Bus Trip: Lake Illawarra Estuary Management Committee

On the 22nd of September 2016, a bus trip around the Lake was organised for members of the LIEMC and key Council staff to share knowledge and learn from each other about the values, issues and opportunities associated with Lake Illawarra. The bus trip stopped at various locations around the Lake and, various brief presentations and discussions were had. The itinerary included the Locations and Issues shown in Table 2-4.

Table 2-4 Locations and Issues featured on the bus trip

Location	Issue	Discussion Lead
Kully Bay, Warrawong	SQID, stormwater control, Artificial Wetland construction, water quality.	Danny Wiecek, DPIE - Coasts & Estuaries. Tony Miskiewicz WCC.
Berkeley	Wind driven organic debris, PWS Management of islands, Council infrastructure. WCC weed/ revegetation project at Wollamai Point.	Kristy Blackburn SCC & WCC, Matt Watts WCC
Hooka Point Wetlands - Carpark Cnr Sussex St/ Holborn St Berkley	Saltmarsh conservation, illegal access and vandalism, water quality, cultural project.	Annie Marlow
William Beach Memorial Park, Brownsville - Walk around foreshore	Vegetation management, Council/ care group/ CVA working together, fish habitat, water quality in Mullet Creek	William Beach Bushcare group members
Drive from William Beach to Koona Bay via Tallawarra and Haywards Bay	• West Dapto Urban Land release, infrastructure demands, increased pressure in catchment, water quality • Tallawarra Licenced via EPA, Water discharge, weed control grant 15/16 financial years (north of plant) • Water quality, land/ infrastructure development.	Kristy Blackburn SCC & WCC, Tony Miskiewicz WCC
Koona Bay, Kanahooka St Albion Park	Constructed shareway, public/ private access, water quality, sewage overflows, saltmarsh, Bushcare group activity.	Donna Flanagan SCC, Andrew Williams/ Andrew Lee SCC
Oakey Creek	Care Group works, weeding and re-vegetation.	Andrew Lee SCC/ Andrew Williams SCC
Mt Warrigal foreshore	Illegal clearing, Vegetation management along foreshore	Andrew Lee SCC/ Andrew Williams SCC
Boonarah Point Reserve, Mt Warrigal	Vegetation Management Planning, 'Care' group works.	John Davey

Location	Issue	Discussion Lead
Foreshore Reddall Pde – opposite LSPS	Weed removal, SCC works.	Andrew Lee, SCC
Foreshore next to Reddall Reserve	Encroachment of mangroves. Mangroves vs saltmarsh. Also this is the start of the Art Path.	John Davey
Picnic Island, Reddall Pde Lake Illawarra	Berrim Nuru on-ground works with support from SCC, Aboriginal heritage, erosion, public access.	Andrew Lee, SCC
Foreshore near Kiosk eastern side of bridge off Reddall Pde Lake Illawarra	Permanent entrance, SCC foreshore works, sand accumulation and past/ potential dredging, public use.	Max Boenisch SCC
Judbooley Pde, Windang	Council works, erosion of foreshore, Aboriginal heritage, public use	Kristy Blackburn SCC & WCC
Public land between Oaklands Caravan Park and foreshore Windang	Public/ private access to foreshore, shorebird habitat (off-shore islands), fisheries management, illegal structures.	Kristy Blackburn SCC & WCC
Foreshore, Fern Street Windang	Scouring of channel, erosion of foreshore, impact on infrastructure. Council Emergency works. Public use.	Danny Wiecek, DPIE - Coasts & Estuaries. Kristy Blackburn SCC & WCC
Public land, Windang Peninsula Heritage Park	Public land now blocked off and unused. WCC grant – weed control grant 15/16 financial years	Kristy Blackburn SCC & WCC
Port Kembla Golf Club, Korrongulla Swamp Shellharbour Road, Port Kembla	Groundwater contamination, industrial site – handover to Council.	Brian Jones, UoW
Mackie Park, Primbee	Illegal veg clearing management. Water quality.	Kristy Blackburn SCC & WCC
Griffiths Bay - King Street, Warrawong	Water quality, state/ local government land ownership issues, maintenance of infrastructure.	Kristy Blackburn SCC & WCC

WCC – Wollongong City Council
SCC – Shellharbour City Council
DPIE - Coasts & Estuaries – Department of Planning, Industry and Environment – Environment, Energy and Science: Coasts and Estuaries
UoW – University of Wollongong

Additional Consultation undertaken by Environmental Strategy Officer – Lake Illawarra

Kristy Blackburn has continually liaised with stakeholders and provided ongoing input to the development of the CMP. This has included meeting with DPI Fisheries, participating in site walkovers, organising a stormwater workshop with DPIE - Coasts & Estuaries and relevant Council Officers and liaising with Sydney Water. This information will be valuable for designing and refining management options.

2.3 Results of Consultation

Workshop: Lake Illawarra Estuary Management Committee

The results of the workshop are summarised in Table 2-5 and Table 2-6. It is important to note that this assessment was based on a very preliminary "first pass" list of values and issues developed early in the project. This list has been extended through subsequent consultation that took place after this initial workshop. A more comprehensive list is included in chapters 4 and 5 of this report.

Table 2-5 Preliminary Value Prioritisation at LIEMC meeting on August 10, 2016

Value	Priority*
Foreshore – public access and activation	1
High water quality for ecological function	2
Diverse habitats (including saltmarsh, seagrass)	3
Foreshore recreation	4
Clean and safe water for recreational uses	5
Amenity – smell, appearance, use	6
Visibility and access to the Lake	7
Tourism	8
Riparian vegetation and protection of water quality	=9
Protection against erosion	=9
Aboriginal cultural and heritage	11
Recreational fishing	12
Commercial fishing	=13
Species protected under legislation	=13
Diversity of native fauna	- No dots placed

* Based on a score calculated by the placement of coloured dots by attendees.

Table 2-6 Preliminary Threat Prioritisation at LIEMC meeting on August 10, 2016

Threat	Priority*
Catchment development	1
Management, funding, maintenance [of infrastructure]	2
Allocation of responsibility/ownership	3
Foreshore development vs public land	4
Conflicting human uses	5
Loss of visibility and access	6
Wetland degradation	7
Rubbish/ plastic	8
Water pollution	=9
Climate change	=9
Contaminated sediments	=11
Potential loss of saltmarsh areas	=11
Entrance channel erosion	12
Loss of riparian habitat	13
Potential introduction of marine pests	- No dots placed
Park management practices impacting on adjacent natural areas	- No dots placed
Water depth	- No dots placed
[community] Expectations	- No dots placed
Design vs intent	- No dots placed

* Based on a score calculated by the placement of coloured dots by attendees.

Project Website

The website was well utilised with 741 visits, 161 document downloads and 126 completed online surveys. Figure 2-2 shows the counts of page views, visitors and visits over the consultation period.

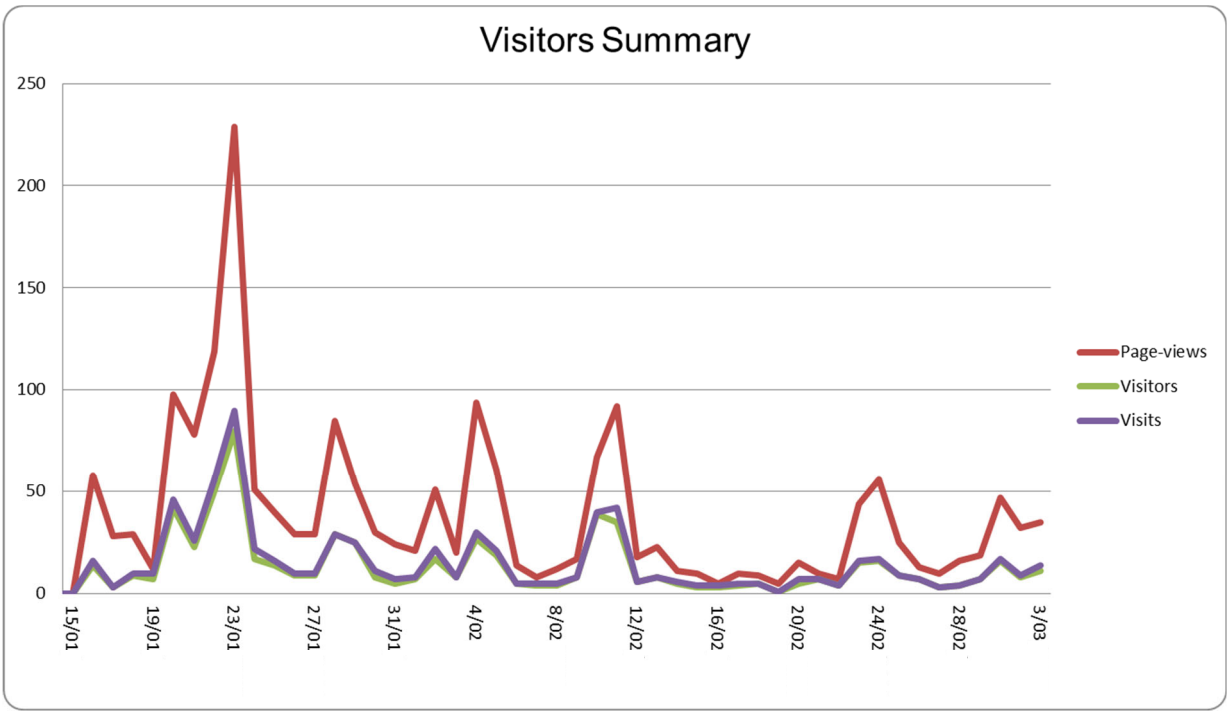


Figure 2-2 Website Visitors Summary 2016

Mail out and Pop-ups

The response to the mail out cannot be directly measured as some of the posted surveys received may have been from the popups, and similarly, a portion of the online surveys may have been completed by people who did not receive the mailout. Many participants in the community information evenings had received the mail out, however, the percentage of recipients that attended has not been recorded.

Bus Trip: Lake Illawarra Estuary Management Committee

The most important result from the bus trip was the discussions and shared understanding between different managers and stakeholders of the values, issues and opportunities related to Lake Illawarra. Ground truthing of knowledge, ideas and issues was also important for participants who do not necessarily frequent all areas around the Lake. The information shared on that day as well as a number of photographs taken by DPIE - Coasts & Estuaries and BMT are incorporated into the values discussions in Chapter 3. Brief notes collected by BMT during the course of the day are included as Appendix B.

2.3.1 Survey

2.3.1.1 Response

A combined number of four hundred and fifty-one (451) surveys were received through the post and online.

2.3.1.2 Values and Uses

A word cluster diagram has been prepared based on the frequency of words used in response to question three of the survey (Q3 What do you do at Lake Illawarra? (e.g. swimming, fishing, boating, bush care, picnics, bird watching, biking, or other please specify). The top 20 words are shown in the word cluster diagram, in font sizes relative to the frequency with which they appeared. As an indication, the word fish (or fishing) was included in 167 of the 451 responses received. Although the information supplied is qualitative only, it does indicate that passive foreshore based activities such as walking, birdwatching and picnicking are very popular. Similarly, on water activities such as fishing, boating and kayaking are also popular.

The results of the survey (see Figure 2-4) demonstrated in general what the community valued most about the Lake, and what they were most concerned about. Values were given a rating of 'high' to 'not sure' to gauge the response of the community to a number of key issues.

Overall, water quality was perceived to be the most highly valued aspect of the Lake with almost 90% of respondents relaying this. Access to the Lake foreshore, Lake aesthetics, wildlife, recreational facilities, and healthy vegetation also receiving a large number of responses deeming them highly valued (between 70% and 80% of responses). One of the lowest valued aspects of the Lake gauged from the responses was commercial fishing.

2.3.1.3 Threats

Information gained from the survey also demonstrates in general what the community perceived to be the greatest threats to the Lake in terms of environmental health (see Figure 2-5). The survey results show that issues surrounding litter/plastic were of greatest concern to the respondents, such as litter in and around the Lake, inadequate bins and greater enforcement for dumping in public areas. Water pollution was also noted as a significant threat to the health of the Lake, with comments referring to excessive runoff, poorly maintained drains, stormwater overflows, and rubbish/debris entering the water. Conflicting human uses was also seen as a threat among many responses, particularly regarding commercial fishing, policing illegal activities such as 4WD access and motorbikes, and different motorised watercraft using the Lake.

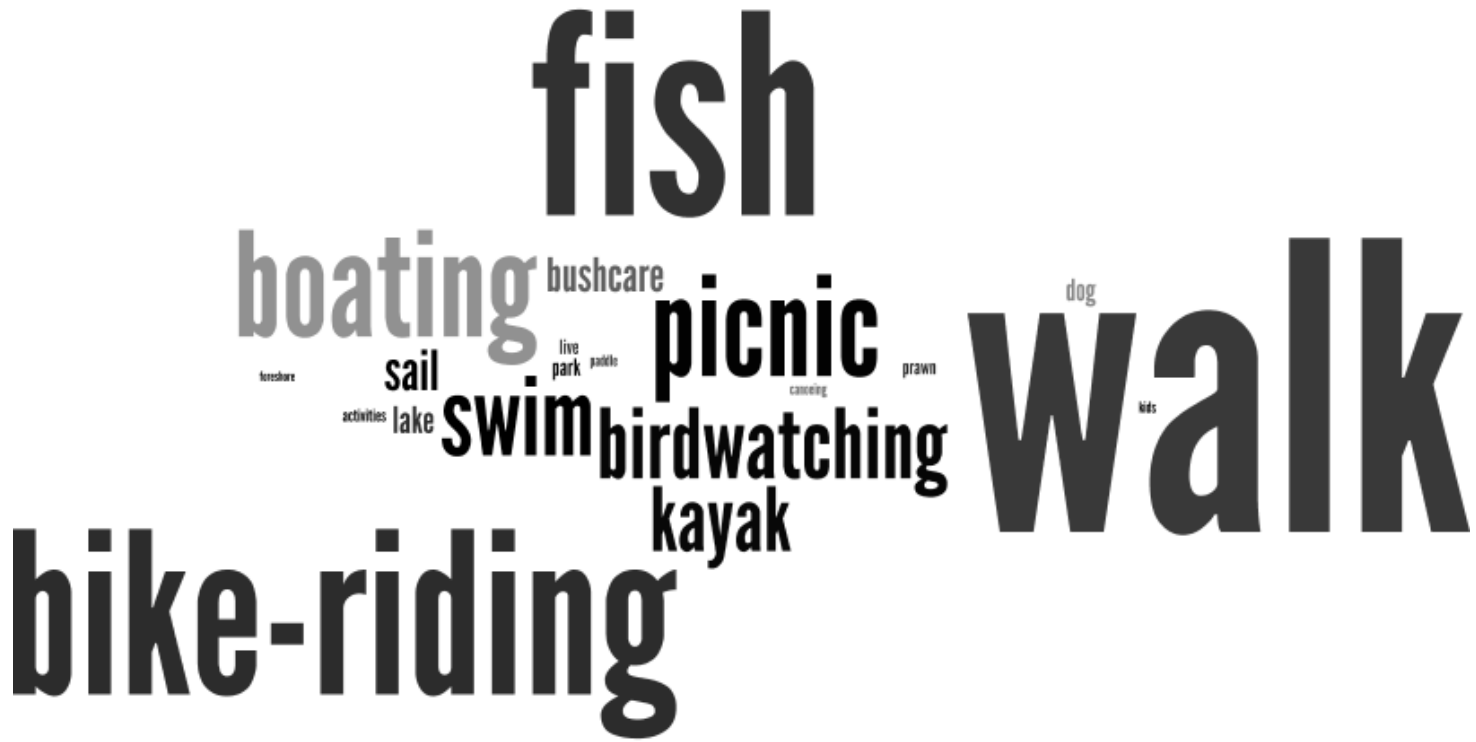


Figure 2-3 Word Cluster Diagram based on the 20 most commonly used words in open responses to the survey regarding uses of the Lake and its foreshores. Words used more frequently appear larger in the image

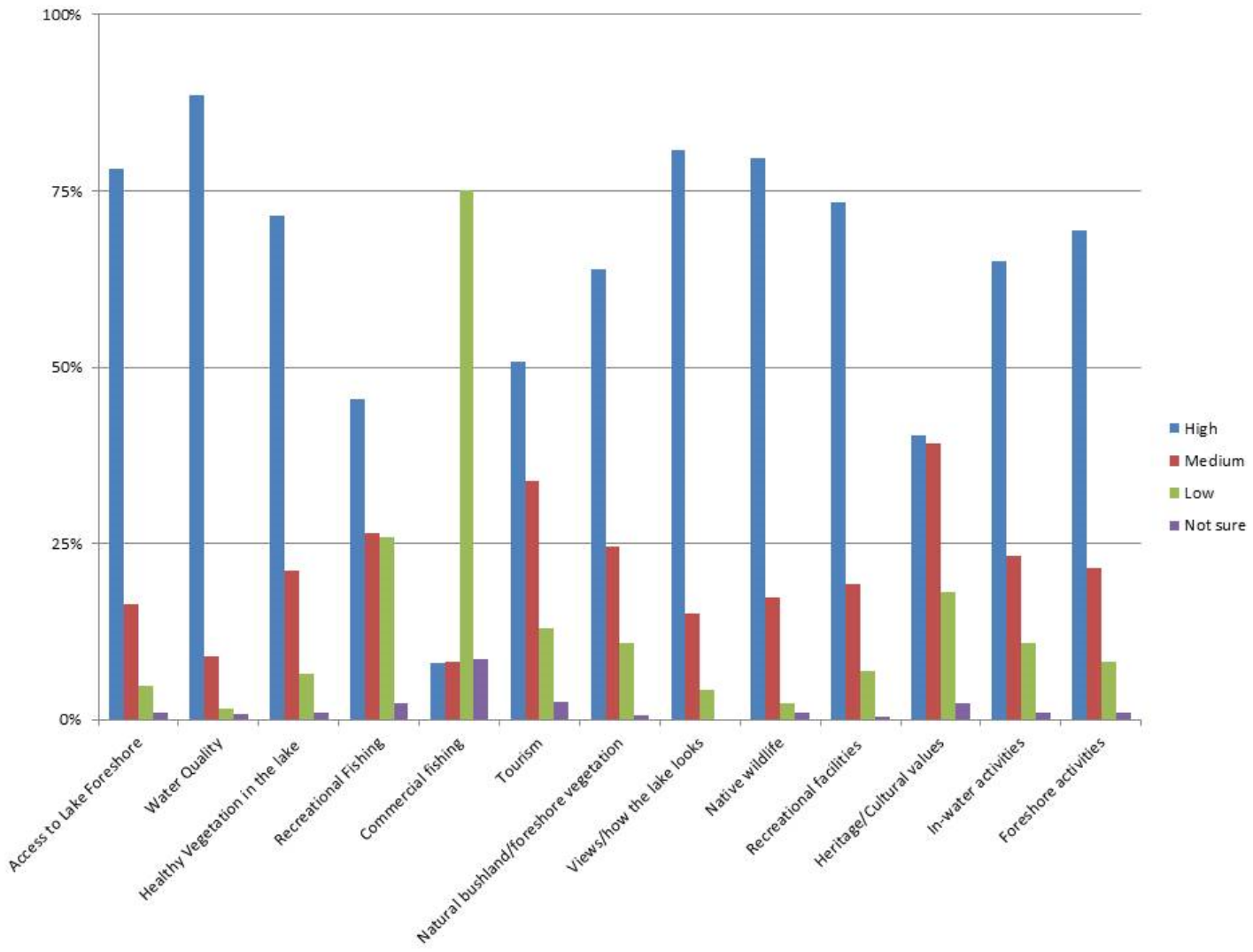


Figure 2-4 Summary of Results from the Community and stakeholder survey on valued aspects of the Lake

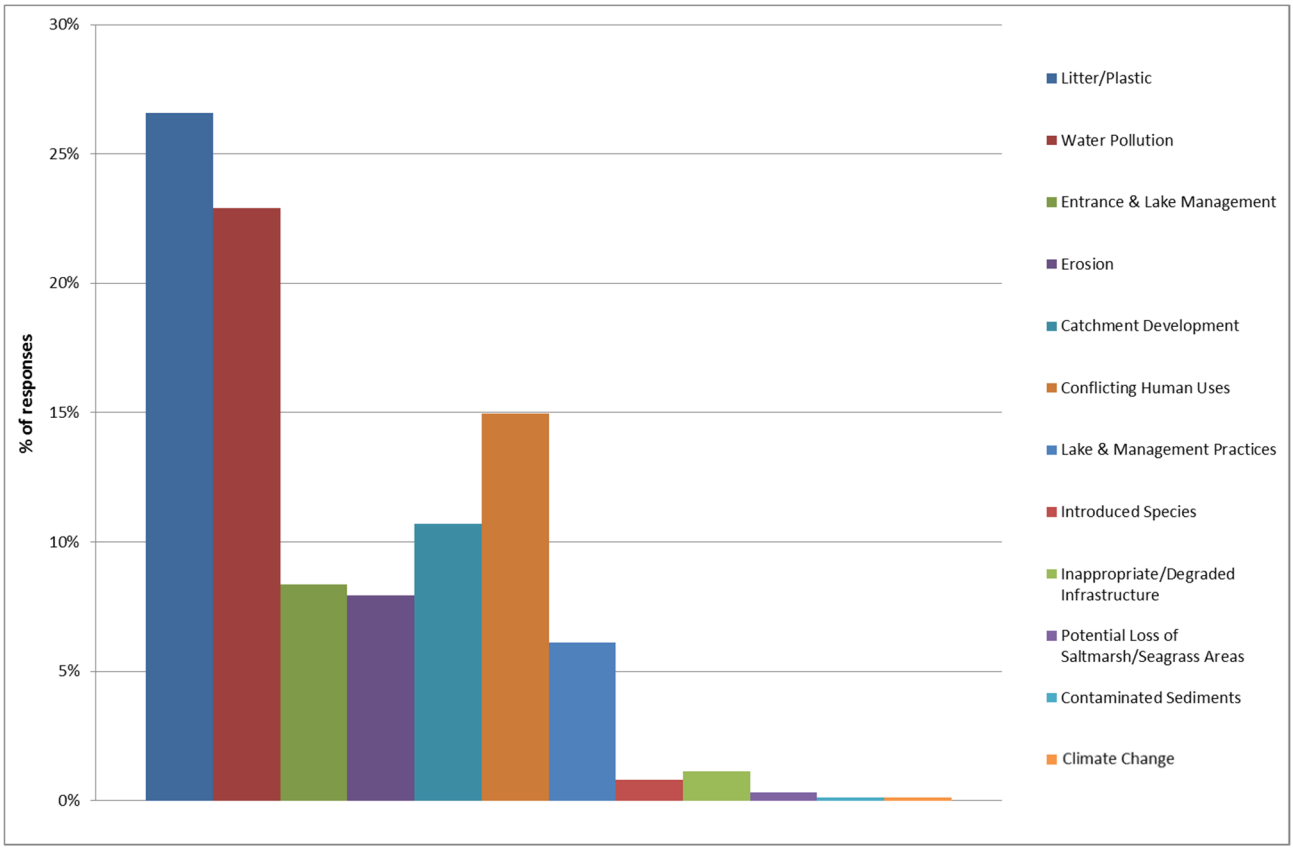


Figure 2-5 Results demonstrating threats to the health of the Lake

2.4 Consultation with the Aboriginal Community

The Aboriginal community is diverse and the information presented below represents the ideas of those that participated in the consultation. A number of participants in the consultation from the Aboriginal Community had strong concerns regarding the manner in which Aboriginal knowledge had been acquired and applied during recent Council lead processes and were hesitant to participate. In particular, some raised a strong aversion to the Heritage Toolkit adopted by Shellharbour City Council in consultation with Wollongong City and Kiama Councils.

The meeting with Coomaditchie residents indicated that the Lake had long been an important focal point for the Aboriginal Community and was related to important local stories including those of the Black Swan. The cultural use of the Lake by those around Coomaditchie could be improved through facilities such as BBQ's and seating near Kully Bay which would increase the ability for groups to share a meal and other cultural activities near the waterway. The potential of rehabilitation works to be completed by Green Teams staffed by Aboriginal workers was discussed. The representatives indicated an interest in the study and plan and will be contacted again for their thoughts on actions as these are developed and refined.

Both the SCC Aboriginal Advisory Committee and the WCC Aboriginal Reference Group have been provided opportunities to participate in the development of this document and in the development of

the CMP. This document has been reviewed by relevant Aboriginal Liaison staff at both SCC and WCC.

Values identified through the meetings with the Aboriginal Community included:

- Items of cultural significance such as middens and burial;
- Stories specific to the Lake; and
- Geographical Names in endemic languages.

Threats to Aboriginal Cultural Heritage and use included:

- Dependence on Aboriginal representatives to give their expertise for free, when many others seated at the table are paid public servants;
- Pollution;
- Catchment development; and
- Foreshore ownership.

Opportunities related to cultural heritage and use included:

- Where possible, work with Coomaditchie on actions related to bush regeneration and art;
- Consider the use of cultural burning for weed management;
- A specific, paid Committee of Aboriginal representatives to provide guidance on Lake management where relevant;
- Aboriginal Land and Sea Ranger Program;
- BBQ's and seating near Kully Bay; and
- Aboriginal tourism centre connected to the Lake.

2.5 Information Evenings

The information evenings were well attended with more than 45 participants. The evenings facilitated a genuine exchange of information and knowledge between the Council Representatives, Office of Environment and Heritage staff (now part of DPIE), project consultant and the community.

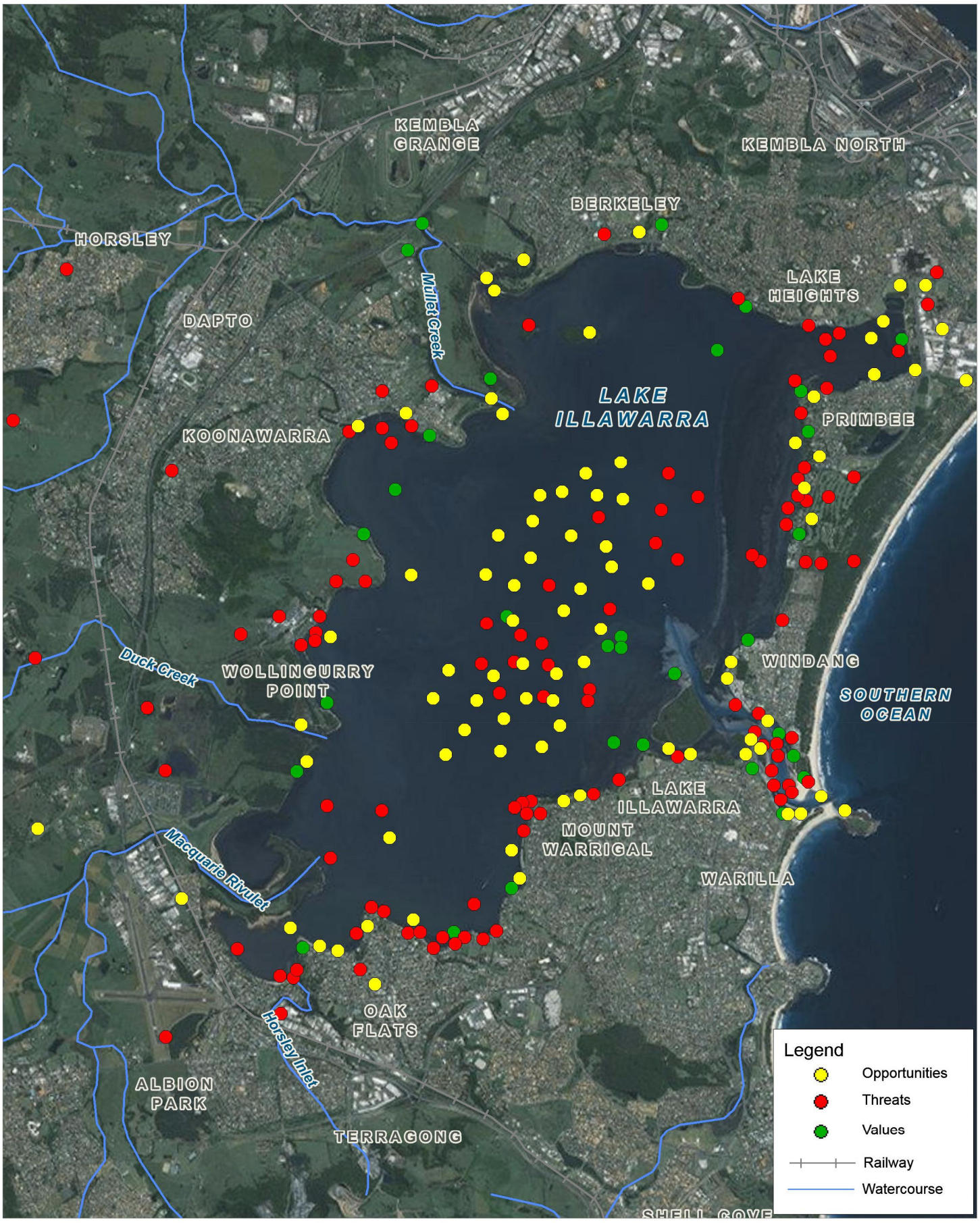
During the information evenings large A0 sized aerial photographs of the Lake and its catchment were laid out on tables. Members of the community sat down at a table with one of the study team representatives and pointed out values, threats and opportunities. Coloured sticky dots were used to identify values (green dots), threats (or issues: red dots) and opportunities (or suggestions: yellow dots) on the maps. Each of the dots were numbered and detailed notes of the information and ideas contributed by the community were made. The information on the maps has been digitised and presented in Figure 2-6, Figure 2-7, Figure 2-8 and Figure 2-9.

The mapping of values, threats and opportunities identified by the community was a key output from these sessions. The maps give a great visual representation of the information collected during the information evenings, although it is important to note that this information is not a complete representation of all the values, threats and opportunities of the Lake. It should also be noted that

the maps are not quantitative, that is, the number of dots does not necessarily reflect the scale of an issue. For example, additional issues not represented in the threats map included:

- conflicting uses in the northern area (specifically dirt/BMX biking and wetland rehabilitation and passive verse active waterway uses);
- threats such as catchment development, degraded infrastructure and sedimentation and creek inlets are recognised by most people interested in the Lake; and
- Not all locations where erosion is an issue are indicated on the maps.

All of the opportunities suggested by the community for the Lake, as summarised in Table 2-7 and mapped in Figure 2-9 were considered as options within the management strategies adopted in the CMP. Readers can find the opportunities listed within the options assessment provided in the CMP (see BMT, 2020b), denoted as “VR” and number listed in Table 2-7, for ease of reference.



Title:

Values, Threats and Opportunities Lake Illawarra

Figure: **2-6**

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Approx. Scale

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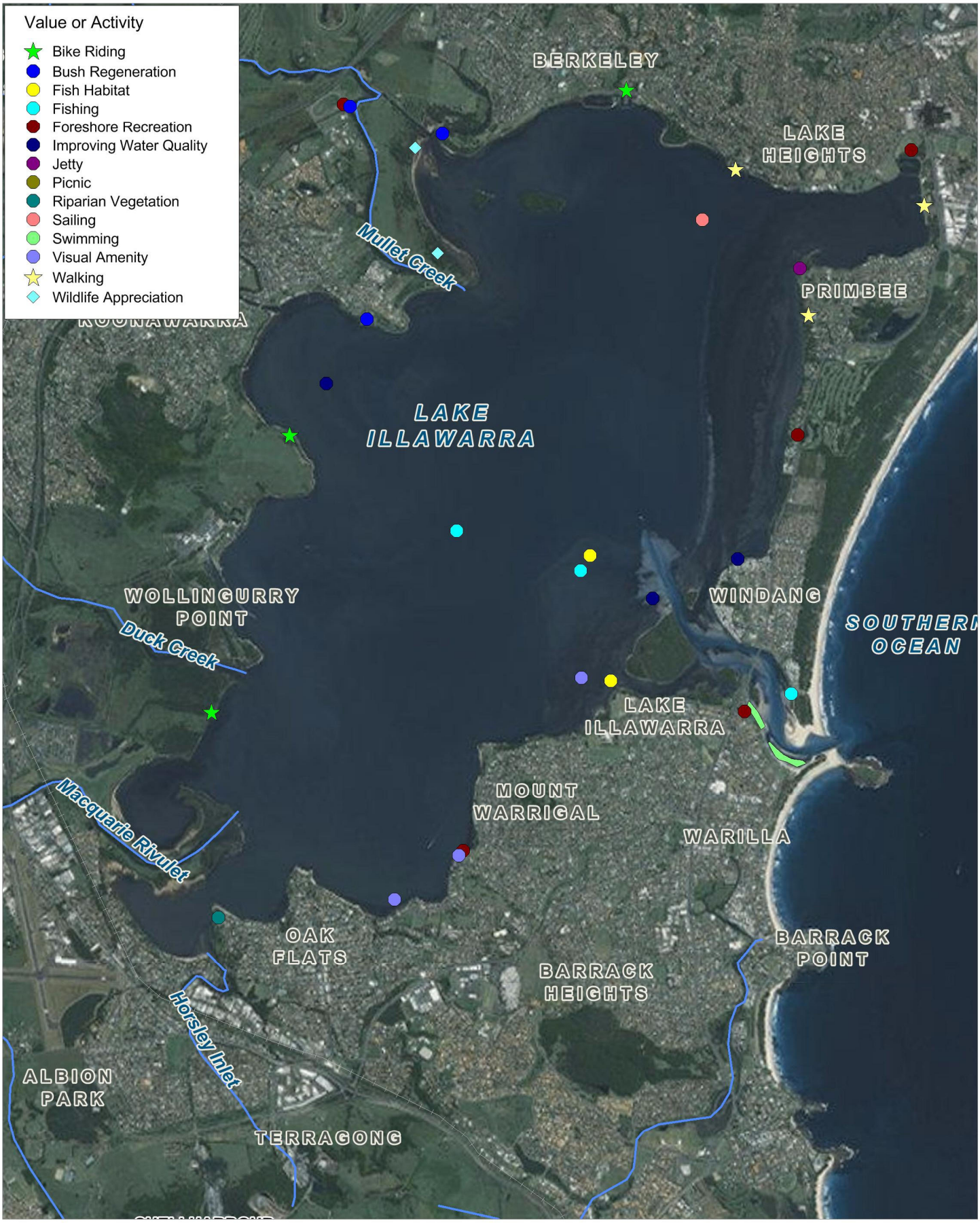

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Value and Activity Points Mapped at Information Evenings

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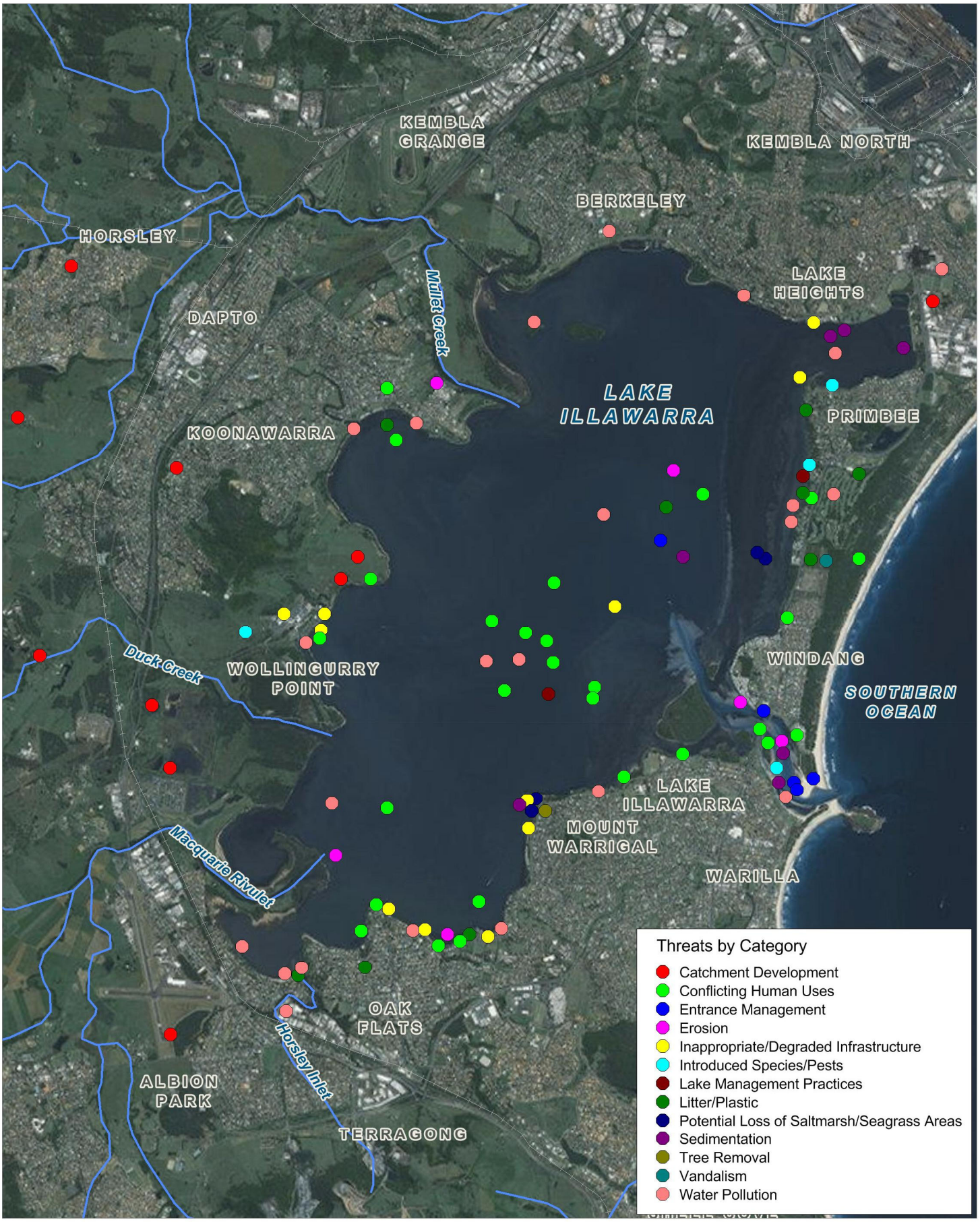

Title:
Threats

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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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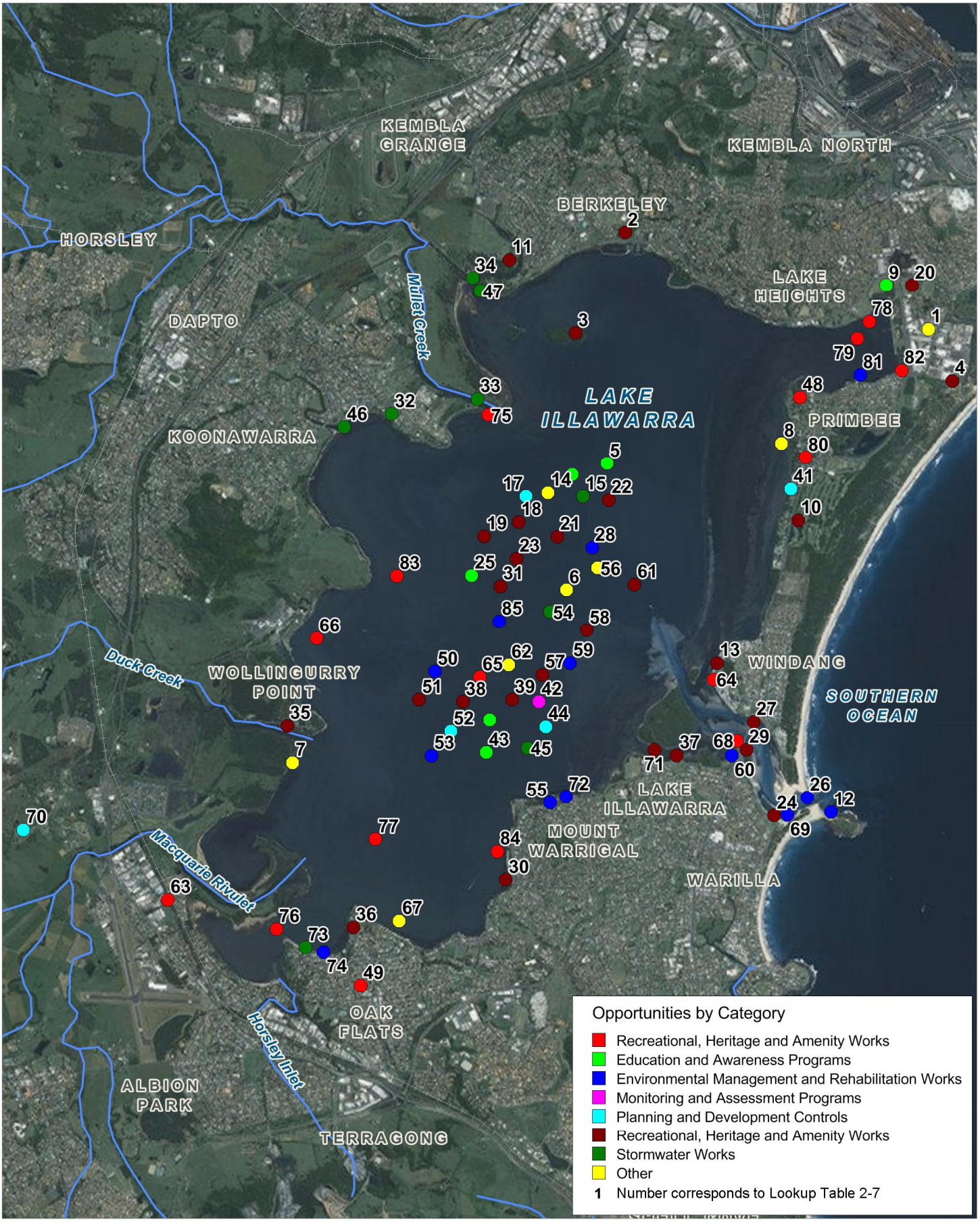

Title:

Opportunities Spatial Data Collected During the Information Evenings

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Table 2-7 Lookup table for opportunities mapped in Figure 2-9

VR Ref	Category	Brief summary
1	Other	Funding raised from commercial use of area to fund Lake actions
2	Recreational, Heritage and Amenity Works	More boat washing facilities at Berkeley Harbour
3	Recreational, Heritage and Amenity Works	Gooseberry Island (and other islands) - better use and access depending on planning controls
4	Recreational, Heritage and Amenity Works	Improved flushing and water quality in Griffin Bay (other means besides second entrance)
5	Education and Awareness Programs	Annual boat show or event to raise community awareness of Lake's value
6	Other	Public transport over the water from Wollongong to Shell Harbour
7	Other	Event with Wings over Illawarra; sea plane rides over the Lake
8	Other	Kite boarding event at Purry Burry/Windang beach depending on wind direction
9	Education and Awareness Programs	Activities for school children such as those run by Future World
10	Recreational, Heritage and Amenity Works	Heritage - tremendous values and potential that should not be lost
11	Recreational, Heritage and Amenity Works	Enhance bike track all the way around and promote wildly
12	Environmental Management and Rehabilitation Works	Improve configuration and design of entrance training to improve water quality and sedimentation
13	Recreational, Heritage and Amenity Works	Improve access along foreshore and connect with Heritage Park
14	Other	Tourism opportunities
15	Stormwater Works	Gross pollutant traps and other end of pipe solutions
16	Education and Awareness Programs	In-school education about marine debris
17	Planning and Development Controls	Development controls on new developments such as WSUD measures etc
18	Recreational, Heritage and Amenity Works	Increased recreational use of the Lake - increases peoples' values as they are more likely to look after the Lake
19	Recreational, Heritage and Amenity Works	Fitness equipment to encourage people to use the Lake and look after it
20	Recreational, Heritage and Amenity Works	King Street area - turn into parkland with the view to eventually do more, i.e.; picnic shelters/BBQs, bench seats etc.
21	Recreational, Heritage and Amenity Works	Lake side tourist development
22	Recreational, Heritage and Amenity Works	Boat shed - boat hire, encourage boat hire businesses
23	Recreational, Heritage and Amenity Works	Views - line of site strategy that prioritises walkers and public users
24	Recreational, Heritage and Amenity Works	State Government management of the entrance
25	Education and Awareness Programs	Interpretative signage
26	Environmental Management and Rehabilitation Works	Fix up entrance erosion area

VR Ref	Category	Brief summary
27	Recreational, Heritage and Amenity Works	Gravel at end of boat ramp
28	Environmental Management and Rehabilitation Works	Flow directors on bridge
29	Recreational, Heritage and Amenity Works	Kiosk etc. to encourage usage. Council could lease out McKenzie Small reserve
30	Recreational, Heritage and Amenity Works	Considered community land - surplus to needs
31	Recreational, Heritage and Amenity Works	Jetty with restaurant
32	Stormwater Works	Rubbish rack/artificial wetland - was previously suggested by LIA but not completed because of commercial fishing
33	Stormwater Works	Rubbish rack/artificial wetland
34	Stormwater Works	Rubbish rack/artificial wetland
35	Recreational, Heritage and Amenity Works	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
36	Recreational, Heritage and Amenity Works	Connect cycleway - should be a proper cycleway across Slaters Bridge
37	Recreational, Heritage and Amenity Works	Connect cycleway - Pelican Point
38	Recreational, Heritage and Amenity Works	Bollards to stop bikes on bike tracks
39	Recreational, Heritage and Amenity Works	Community facilities in and around the Lake on the Wollongong side
40	Education and Awareness Programs	Park staff need to understand sensitive locations
41	Planning and Development Controls	No townhouses/high density development here
42	Monitoring and Assessment Programs	Kayaks etc monitoring water quality
43	Education and Awareness Programs	School holiday program with free activities on/around Lake Illawarra
44	Planning and Development Controls	Ban the use of 2 stroke motors to get oil out of the Lake
45	Stormwater Works	GPTs not cleaned out regularly - monitor before rain events
46	Stormwater Works	Install stormwater/artificial wetlands
47	Stormwater Works	Install stormwater/artificial wetlands
48	Recreational, Heritage and Amenity Works	Some of the LIA jetties are never used because it is too shallow
49	Recreational, Heritage and Amenity Works	More work in Deakin Park re: amenities i.e.; benches, barbeques. Landcare group were active here but not anymore - need more support
50	Environmental Management and Rehabilitation Works	Spread money into more than just the entrance area in terms of environmental and recreational improvements
51	Recreational, Heritage and Amenity Works	Disabled fishing facilities - need more wharves/platforms with wheelchair access ramps
52	Planning and Development Controls	Working with Wingecarribee Council for better land management i.e.; no till cropping for potato farmers in Robertson

VR Ref	Category	Brief summary
53	Environmental Management and Rehabilitation Works	Better support for local groups to manage their own patch
54	Stormwater Works	GPTs and SQIDs in local creeks to treat creek runoff
55	Environmental Management and Rehabilitation Works	Removal of seagrass wrack build-up
56	Other	Councils need to work together
57	Recreational, Heritage and Amenity Works	Bubblers/drinking stations along the bike path
58	Recreational, Heritage and Amenity Works	More bins in parks and along bike paths
59	Environmental Management and Rehabilitation Works	Cleaning out creeks of sediment build-up - putting in sediment traps
60	Environmental Management and Rehabilitation Works	Open the back channel to increase the flows and flushing along the southern foreshore
61	Recreational, Heritage and Amenity Works	Foreshore boat hire and more kiosks and/or other tourism related opportunities
62	Other	Happy with the opening - better water quality (dramatic improvements) and no more odour
63	Recreational, Heritage and Amenity Works	Bike track is great, but needs to be looked after. Grass needs to be cut away from the edges along Reddall Parade.
64	Recreational, Heritage and Amenity Works	Need to keep public access to the Lake - it is important to be able to enjoy it
65	Recreational, Heritage and Amenity Works	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
66	Recreational, Heritage and Amenity Works	Freshwater is needed at Tallawarra to clean kayaks and fish. Water wash down area to reduce spread of diseases
67	Other	Marine Rescue do a great job every weekend. Would like to see more support for them.
68	Recreational, Heritage and Amenity Works	Dredging of southern foreshore
69	Environmental Management and Rehabilitation Works	Improved entrance management to reduce foreshore erosion
70	Planning and Development Controls	Improved catchment management
71	Recreational, Heritage and Amenity Works	Dredge back channel
72	Environmental Management and Rehabilitation Works	A balanced approach to vegetation management around the Lake
73	Stormwater Works	Improve drainage system and stormwater management
74	Environmental Management and Rehabilitation Works	Improve sewer management
75	Recreational, Heritage and Amenity Works	Potential dredging of Mullet Creek and Koonwarra Bay
76	Recreational, Heritage and Amenity Works	Completion of shared use pathway and upgrade of associated amenities

VR Ref	Category	Brief summary
77	Recreational, Heritage and Amenity Works	Business opportunities
78	Recreational, Heritage and Amenity Works	Future World do great stuff and should be continued - lots of activities for kids and adults
79	Recreational, Heritage and Amenity Works	Should fill in the bay to help the Lake out
80	Recreational, Heritage and Amenity Works	Cycleway not at Primbee - needs to link to this area
81	Environmental Management and Rehabilitation Works	Water used to be a lot worse in the Bay. Less smelly and less seaweed
82	Recreational, Heritage and Amenity Works	Walkway in this area would be good. LIA did a good draft of it.
83	Recreational, Heritage and Amenity Works	Declare lake a recreational fishing zone
84	Recreational, Heritage and Amenity Works	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
85	Environmental Management and Rehabilitation Works	Pressure as much as possible - long term preservation needed. Concerned about SCC cutting down trees

3 Summary of Uses and Values

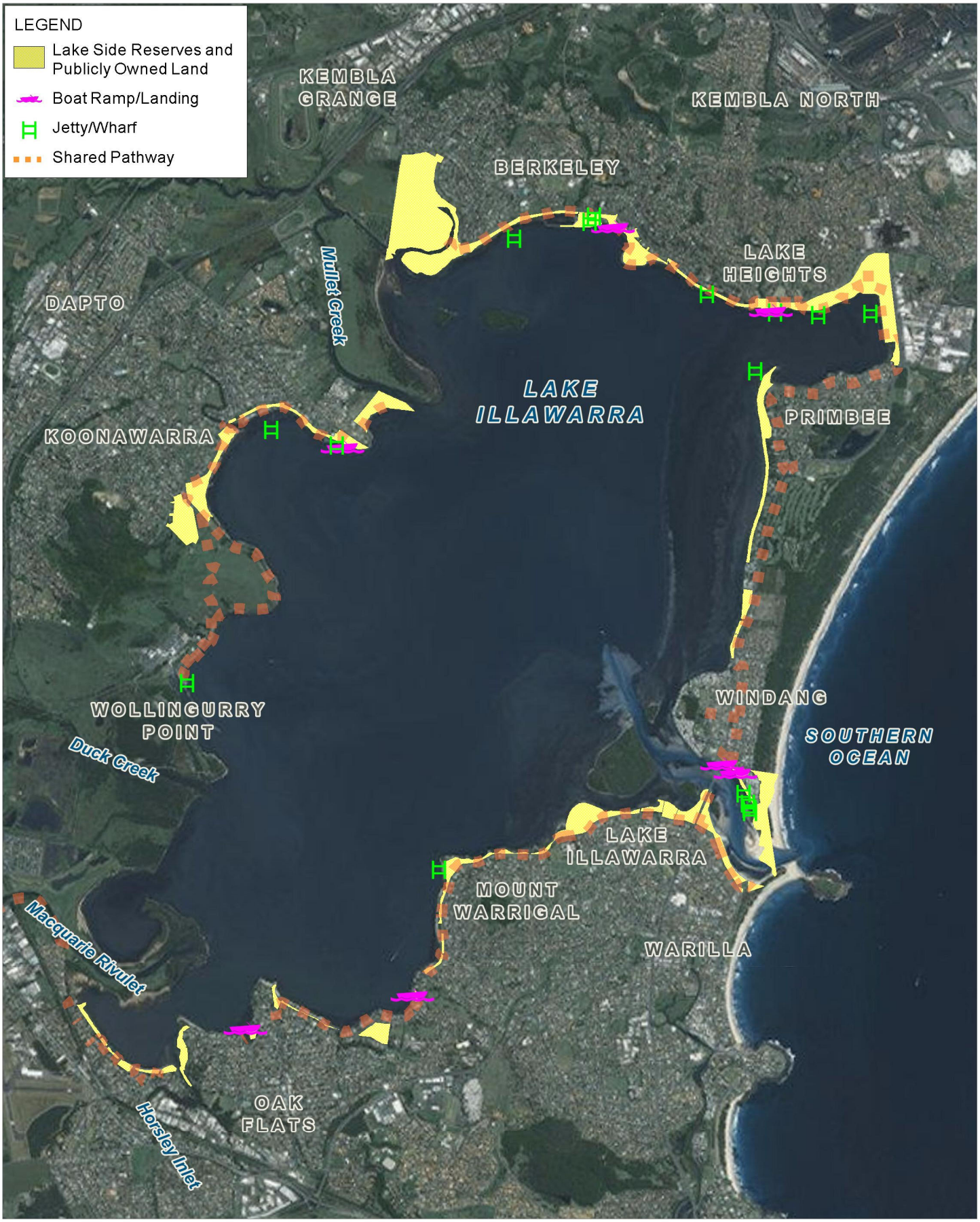
The open waterway, foreshores and near shore areas of Lake Illawarra are utilised by the community and visitors. Quantitative information about the Lake and how it is used is not available in the background information, however information provided through the survey responses and discussions through the consultation activities for this project indicate that popular uses include bike riding, boating, kayaking, nature conservation (such as bush regeneration activities), fishing, bushwalking and birdwatching.

3.1 Infrastructure and Access to Foreshore

Recreational facilities around the Lake were important to the respondents of the community consultation. Recreational facilities were considered to be a high value by 73% of respondents. Another 19% considered these to be a medium value. Investment in infrastructure by the Lake Illawarra Authority was significant and included significant sections of the shared pathway. There are eight boat ramps and more than 13 jetties / wharves located around the Lake for recreational boating. The available mapping of these from Councils is shown in Figure 3-1. This data is likely to be out of date, and does not give an indication of the present condition of infrastructure (refer to Section 4.10).

In a previous project undertaken by Transport for NSW (TfNSW), it was recognised that current Lake access infrastructure does not meet demands during high-use periods, such as holiday periods, with some of the Lake's infrastructure aged and offering only a basic level of amenity. Stakeholder feedback recognised that the condition of the existing facilities was of great concern, particularly boat ramps (TfNSW, 2014).

People enjoy accessing the foreshore for picnics, bush regeneration, BBQ's and bird watching. The community survey responses indicated that more than 70% of respondents ranked this value as "High". The comments indicate that there are different perspectives on the aspects of the foreshore that are valued, with some respondents indicating that tree removal is desirable and others seeing it as a threat.



Title:

Community Access and Infrastructure

Figure: 3-1

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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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3.2 Water Quality

Water quality is valued by stakeholders because they recognise that it underpins all the natural processes and human uses that occur within the estuary. The water quality of Lake Illawarra, even in a completely pristine state would be highly variable. Estuaries are such dynamic zones due to their position as an ecotone between fresh and saltwater and their susceptibility to short term factors such as wind, rainfall and prevailing coastal processes. Water quality was the value that was rated as High most frequently during the community survey (refer to Section 2.3.1.2). It is also a key input used to understand estuary health (refer to BMT, 2019a).

Different aspects of water quality are important for each of the different uses and ecosystem functions relevant to Lake Illawarra. For example, primary recreational activities (such as swimming) require water that is not contaminated by human specific bacteria, viruses and other disease or infection causing pathogens. For this reason, the suitability for Lake Illawarra for recreational activities is indicated by the measured concentration of enterococci (refer to BMT, 2019a). In terms of ecosystem function and estuary health, water quality indicators are related to turbidity, chlorophyll a and nutrients (refer to BMT, 2019a).

Water quality is highly vulnerable to a large number of threats. As described in the Synthesis Report (BMT, 2020a), the permanent entrance opening has changed the water quality permanently. Water quality remains an issue in the more enclosed reaches, such as those in the north east and south west reaches (BMT, 2019a). For example, Wiecek *et al.* (2016) reported that results averaged across monitoring sites from three lake zones for chlorophyll *a* and turbidity levels continued to exceed trigger values after entrance opening.

The threats the water quality of Lake Illawarra remains susceptible to include catchment development, stormwater, groundwater contamination, litter and marine debris, illegal vehicle access to foreshore areas, sewage overflows, industrial land uses and discharges, agriculture, foreshore development, tree removal and park management practices.

3.3 Healthy Vegetation in the Lake

Healthy vegetation in the Lake was valued as a High value by more than 70% of participants in the community survey. The vegetation within the Lake includes the four main communities of estuarine vegetation: saltmarsh, swamp oak, seagrass and mangroves. Each of these has scenic value as well as providing essential ecosystem services such as habitat, food supply and nutrient cycling. This relates to human values as it supports fish assemblages, wildlife and contributes to an overall healthy Lake ecosystem.

Vegetation within the Lake is highly variable over spatial and temporal scales in response to prevailing catchment and coastal processes. The permanently opened entrance and ongoing changes to tidal inflows and other processes is changing the natural variability and ranges of vegetation within the Lake (refer to BMT, 2019a).

Saltmarsh is an Endangered Ecological Community (EEC) found around the foreshore of Lake Illawarra. Saltmarsh is an important community for wildlife, being a dominant source of nutrition for aquatic fauna in Lake Illawarra and providing important habitat. Before the permanent opening saltmarsh communities constantly fluctuated due to the intermittent nature of the Lake's opening and

its effect on elevation, tide and salinity. This constant fluctuation made it difficult for saltmarsh communities to thrive in many locations (Baxter & Daly, 2010). Since the permanent entrance severe fluctuations in elevation, tide and salinity of the Lake have decreased, which has allowed saltmarsh communities to establish in previously uninhabitable areas. However, since the permanent opening the tidal range of the Lake is increasing, which has the potential to impact on saltmarsh. As tides become higher over time, saltmarsh communities will be forced to migrate landward, this is possible in undeveloped areas, however in many locations it will be constrained by foreshore development (Wiecek et al, 2016).

Seagrass beds in Lake Illawarra are important for aquatic fauna, playing an important role in reproduction and as a nursery area for juvenile fauna (Ganassin and Gibbs, 2008). Zostera capricorni and Ruppia megacarpa are the dominant species of seagrass in the Lake, and due to their fast growing nature dynamic changes in seagrass distribution are often seen in response to changes in physical and chemical properties of the Lake as well as seasonal changes. Seagrass distribution in Lake Illawarra has altered since the permanent opening and has affected each species in a unique way. Zostera experienced some increase from 2009 to 2012 but has continued to decline since then, while Ruppia spp. and Halophila spp. slightly increased after the opening, then dropped significantly the following summer. Since 2014 Halophila has expanded to levels never before seen in the Lake. Seagrass has been lost in the shallow margins around the entire lake foreshore and 20 other shallow areas including Koona Bay, in front of major tributaries including Mullet Creek, Hooka Creek, and Macquarie Rivulet, as well as the flood tide delta. Turbidity in shallower waters continues to place stress on seagrasses. An increasing tidal range may provide opportunity for seagrass colonisation in other parts of the Lake but this has not yet been recorded (Wiecek et al, 2016).

The extent of mangroves has increased due to the regular tidal exchange that has occurred with permanent opening of the entrance in 2007, specifically in the entrance back channel and Duck Creek. Expansion of mangroves around Lake Illawarra is likely to continue, but will be limited along the more exposed foreshores and where other factors constrain establishment. Some loss of saltmarsh attributable to encroachment of mangroves is currently evident, but only in one specific location, the entrance back channel (Wiecek et al., 2016).

3.4 Recreational Fishing

Recreational fishing is a popular activity in Lake Illawarra. This includes boat based and shore based line and trap fishing. Fishing activity is regulated through DPI Fisheries. This includes a requirement to have a fishing licence, bag and size limits and gear restrictions. Funds collected by DPI Fisheries from the license fees form part of the recreational fishing trust and this fund has been utilised for some of the infrastructure around the Lake including fish cleaning tables, fishing platforms and jetties.

The survey results indicated that 46% of respondents considered recreational fishing to be a High priority value (refer Figure 2-4).

Anecdotal evidence provided by the community through survey responses and discussions during the information sessions implies a change to the catch in response to the permanent entrance opening. This includes a perceived reduction in the size of individual prawns and an overall reduction in the average size of catch. Further research would be required to confirm these observations and to determine if they can be attributed to the changes to entrance management.

3.5 Commercial fishing

Commercial fishing businesses operate in Lake Illawarra. The commercial fishing undertaken is categorised as “Estuary General”. Licenses relevant to Lake Illawarra cover a broad area categorised by DPI Fisheries as region 6. This covers the area from Wollongong to Ulladulla. Commercial fishing activity and take is heavily regulated. Rules are in place to ensure sustainable harvest of fish stocks.

In Lake Illawarra, commercial fishers primarily use mesh and haul netting and crab traps. The overall catch in Lake Illawarra is dominated by sea mullet, blue swimmer crab and dusky flathead. The composition of catch has changed since the permanent opening, with a substantial reduction in the catch of prawns over the last few years (DPI Fisheries, 2019).

Commercial Fishing in Lake Illawarra contributes to the economy of the Region. This includes through employment and sales and through contributing to tourism, by allowing locally caught fish to be bought and consumed. In research undertaken by UTS in the Shoalhaven and Illawarra region, an overwhelming majority of surveyed residents (97%) agreed that it is important that we produce our own seafood in NSW instead of relying on imports. Other values attributed to commercial fishing in the Illawarra region through this research included the supply of locally sourced bait and provision and upkeep of infrastructure and jetties managed and maintained by the fishing industry. The heritage, knowledge and community aspects of the industry are also valued.

Concerns were raised through the community consultation for the present project about the impacts of commercial fishing in Lake Illawarra. To get a better understanding of the issue, some participants within the information sessions who raised concerns about commercial fishing were asked about the value of being able to buy locally caught seafood and most agreed that this was very important and that complete closures would threaten this. The survey results reported on in the present report show that commercial fishing was the only value or use where more respondents marked it as low than medium or high. This general opinion is also reflected through newspaper articles calling for the ban of commercial fishing in Lake Illawarra (UTS, 2016). While commercial fishing reform will be managed through a separate process to the CMP, it is important to note the conflicting values around commercial fishing.

Commercial Fishing Reform planned for NSW through the Commercial Fisheries Business Adjustment Program involves the introduction of minimum shareholding, meaning fishers must hold a certain number of shares to be endorsed to fish (Gorton, 2016). Fishing is managed by DPI Fisheries. Although actions included in the CMP may be related to fishing (recreational and/or commercial), it would be up to DPI Fisheries and the relevant management processes to make changes to the fishing regulations.

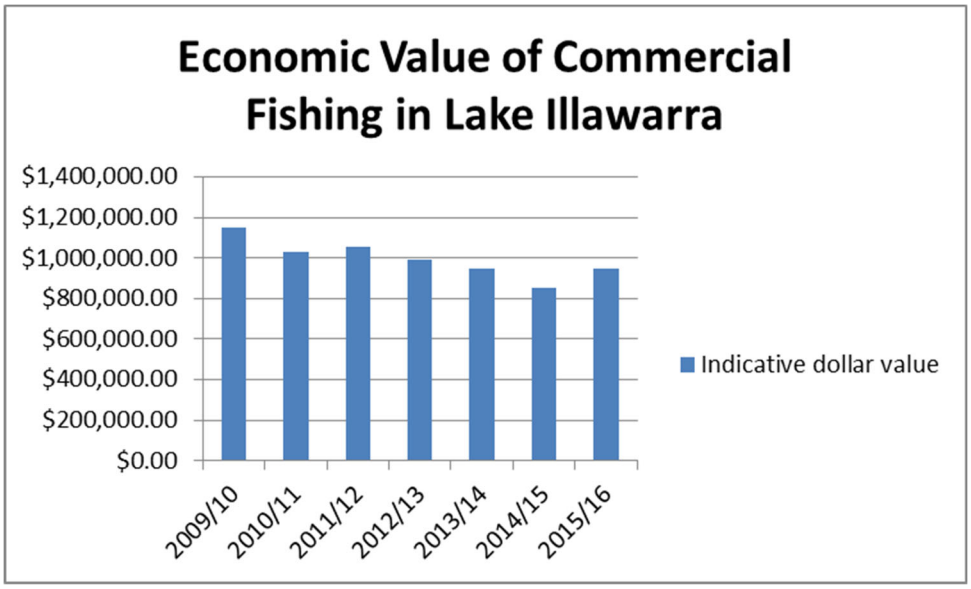

Figure 3-2 Economic Value of Commercial Fishing in Lake Illawarra

*Note that the dollar value is based on the first point of sale, so is not indicative of the full lifecycle economic value (e.g. excludes restaurant sale etc.) Source: MEMA 2016

3.6 Tourism

While tourism adds both cultural and economic value for the Wollongong and Shellharbour areas, the extent of tourism related to Lake Illawarra is unclear. Tourism related businesses applicable to the Lake would include boat hire, bait and tackle shops, the caravan park at Windang, and other associated accommodation and food providers.

3.7 Natural bushland/foreshore vegetation

The ecological and environmental values of the riparian and foreshore vegetation were described in the Synthesis Report (BMT, 2020a). Through the community consultation, 64% of respondents to the survey indicated that this was a high value. Within the qualitative descriptions, it is clear that intrinsic, biodiversity and aesthetic aspects of foreshore vegetation is valued. This contrasts with 11% of respondents that consider this aspect of low value and there were a number of qualitative comments regarding the impacts of foreshore vegetation on views to the Lake, for example:

"Limit trees that block views" and "*Vegetation needs to be managed regarding views*". This can be compared with the alternate perspective, with comments such as "*Its natural beauty. I'd like to see more regeneration of native bushes at the Lakes edge which will improve water quality*".

Bush regeneration is also a valued community use of the Lake Illawarra foreshore. There are many environmental benefits to regeneration activities, including increased habitat for native wildlife, water quality improvements, weed management, improved aesthetics and erosion stabilisation. Restored areas improve the connectivity between natural areas and help to create wildlife corridors and increase biodiversity. These aspects are discussed and mapped in the Synthesis Report.

Wollongong City Council Bushcare and Shellharbour City Bushcare have a series of Bushcare training manuals and resources available to Bushcare volunteers.

3.8 Views/how the Lake looks

Aesthetic values of the Lake are important to many residents and visitors. Discussions through community and stakeholder consultation and qualitative survey responses indicate that there are different perspectives on what constitutes high quality views. Some residents are concerned that extensive foreshore vegetation, such as casuarinas, restrict line of site to the waterway and interfere with a sense of connection with the Lake. Other residents feel that loss of trees is negatively impacting on the views of Lake as a part of a healthy landscape. Ecological and other environmental values associated with foreshore vegetation is categorised under Section 3.7

3.9 Swimming, sailing, kayaking, other in-water activities

These activities are all known to be enjoyed on the Lake. Popular swimming locations include near the secondary tidal channel adjacent to Reddall Reserve, the area located behind Warilla Beach to the south of the southern breakwater. These areas are very popular with families and particularly younger children due to the gently sloping nature of the beaches. Concerns regarding water quality at the Entrance Beach were discussed in the Synthesis Report.

Boating within Lake Illawarra is subject to the Regional Boating Plan devised by Transport for NSW (TfNSW) in 2015. The plan was developed to enhance the experience of recreational boating across NSW by identifying boating safety, access, and infrastructure to be implemented.

3.10 Walking, cycling, picnics, birdwatching, other foreshore activities

Many respondents to the survey described foreshore activities, including walking, birdwatching and bike riding. Reddall Reserve was described by many as a popular location due to the facilities and recreational opportunities there. Birdwatching was a popular activity listed and submissions received from Birding clubs will be incorporated into action design. Shorebird nesting and feeding habitat is an important estuarine value that was identified in the Synthesis Report (BMT, 2020a) as being threatened by entrance management, introduced species (predation from foxes and dogs) and disturbance.

Almost all foreshore land around the Lake has been developed, with very few nearshore vegetated areas remaining (see mapping in the Synthesis Report). This is due to the proximity of private developments to the Lake's edge, and pressures of land release for urban growth. Apart from a narrow strip around large sections of the Lake, private ownership of lots adjacent to the Lake consequentially restricts public access to foreshore land, and includes private residences, industrial areas such as Tallawarra Power Station, or business/commercial areas such as holiday parks (WBM Oceanics, 2006). A map of the bike path is presented below in Figure 3-3.

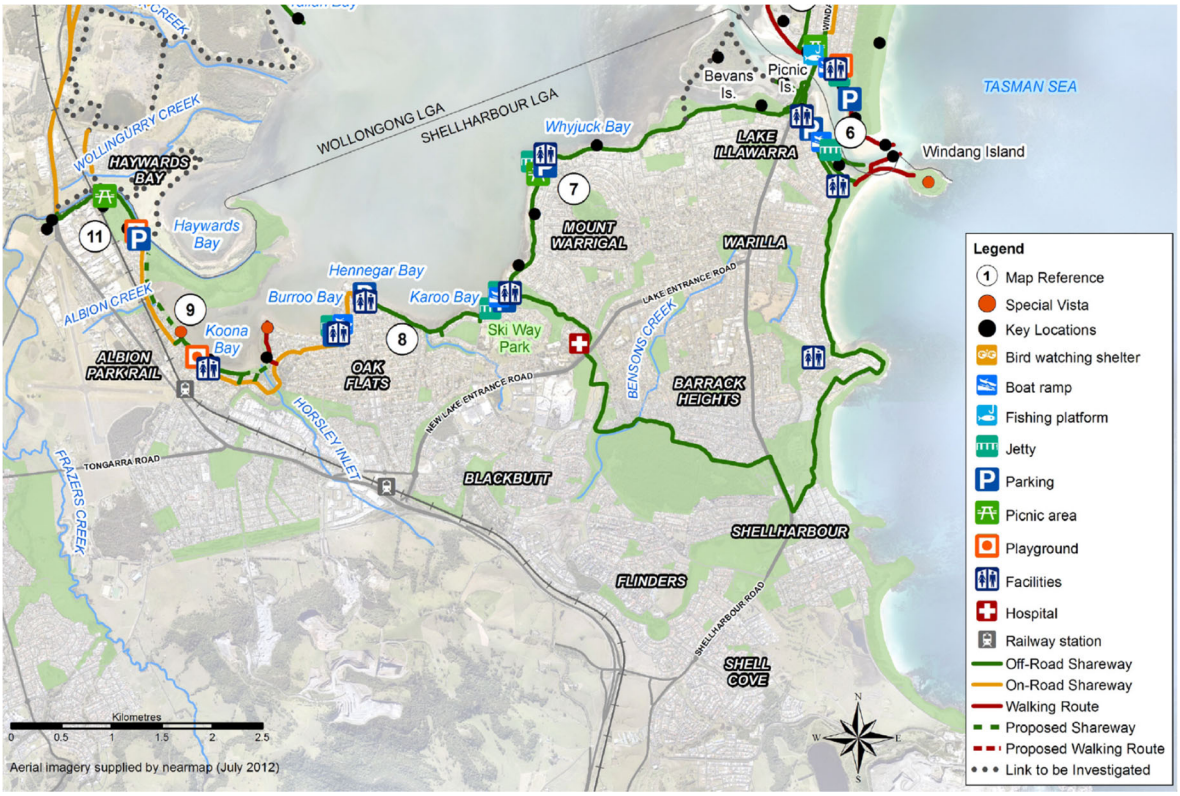

Figure 3-3 Shellharbour LGA Bike Map (source: www.shellharbour.nsw.gov.au)

3.11 Aboriginal Cultural Heritage and Use

3.11.1 Foreword

Aboriginal cultural heritage consists of places and items that are of significance to Aboriginal people because of their traditions, observances, lore, customs, beliefs and history. It provides evidence of the lives and existence of Aboriginal people before European settlement through to the present. Aboriginal cultural heritage is dynamic and may comprise physical (tangible) or non-physical (intangible) elements. It includes things made and used in traditional societies, such as stone tools, art sites and ceremonial or burial grounds. It also includes more contemporary and/or historical elements such as old mission buildings, massacre sites and cemeteries. Tangible heritage is situated in a broader cultural landscape and needs to be considered in that context and in a holistic manner.

Aboriginal cultural heritage also relates to the connection and sense of belonging that people have with the landscape and each other. It recognises that Aboriginal people understand cultural heritage and cultural practices as being part of both the past and the present and that cultural heritage is kept alive and strong by being part of everyday life.

Cultural heritage is not confined to sites; it also includes peoples' memories, storylines, ceremonies, language and 'ways of doing things' that continue to enrich local knowledge about the cultural landscape. It involves teaching and educating younger generations. It is also about learning and looking after cultural traditions and places, and passing on knowledge. It is enduring but also changing. It is ancient but also new.

Aboriginal cultural knowledge provides crucial links between the past and present and therefore represents an essential part of the identities of Aboriginal people and all Australians (OEH, 2018).

3.11.2 Values

The cultural significance of Lake Illawarra remains strong in Aboriginal culture. There is wide-spread understanding that the Yuin people are the Traditional occupants of the land of the Illawarra region. The coastal landscape at Lake Illawarra supported the established campsites of the Aboriginal people and provided a diverse and sustainable source of food and fresh water for some 20,000 years prior to European arrival to Australia.

Archaeological evidence indicates that the harmonious and balanced relationship between the Aboriginal people and the environment had existed for thousands of years prior to settlement. The longevity of the use of Lake Illawarra as a camping and meeting place indicates its significance to the Aboriginal people of this region. Both documentary and oral evidence indicate that Lake Illawarra was, and is, considered to be an extremely important place by local Aboriginal people. Although the significance of this site to the Yuin people stretches for thousands of years into the past, its importance to the Aboriginal community continues today.

During the nineteenth century, Windang, on the northern side of the entrance of Lake Illawarra, was the location of the distribution of government rations for the Illawarra, and the site of large corroborees after the event (Weston, 1977). Towards the end of that century, the Lake entrance appears also to have been the location of a relatively permanent Aboriginal encampment.

Lake Illawarra has a long, rich history of Aboriginal occupation, extending from thousands of years prior to European settlement, and continuing to the present day. Evidence of historical presence includes specific sites and items around the Lake, traditional place names in language and stories relevant to the Lake. It is not appropriate to map or describe these in a publicly available document, and some sites, stories and places remain kept by elders and knowledge holders.

Evidence of historical presence in terms of specific archaeological deposits (sites and items) in the coastal zone are also very likely to have been damaged by rising and falling sea levels over the past few thousand years. Most notably, the last glacial sea level low occurred about 20,000 years ago around 120 m below present levels, before a relatively rapid sea level rise occurred between 18,000 and 6,000-7,000 years ago with sea levels reaching about 1-2m above present levels, then subsequently falling to and remaining relatively stable at the present level since about 3,000 years ago (Chappell & Polach 1991; Sloss *et al* 2007).

The Aboriginal people of the Lake Illawarra region accessed the Lake using canoes made of bark folded in the ends as they fished with multi-pronged spears, nets and traps (Cruse et al., 2005). Aboriginal people on the south coast of NSW are reported to be the first in Australia to use a fish hook made from the edge of a shell.

The Aboriginal people of the Lake Illawarra region are intrinsically connected to the Lake. This stems from their practical experience of natural resources and the understanding of the interrelated systems and functions of the natural world (DEC, 2005). They shaped the landscape and lived synergistically with the land and ecosystems to maintain and maximise their precious resources on which they based their livelihoods. The Lake, and its once dense and diverse surrounds, provided a food source,

such as fish from the Lake, small mammals from the riparian vegetation, and the numerous edible plants (Davis, 2005; LIA, 2013).

The Lake provided more than just a food source for the Aboriginal people 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 connection to the land is evidenced by burial sites and middens found along Windang and its surrounds. These relics indicate areas used for spiritual ceremonies and corroborees, and are highly meaningful to the Aboriginal people (LIA, 2013).

Traditionally, south coast Aboriginal groups travelled between the coast and the mountains to participate in large gatherings which centred on seasonal resources (Cruse et al., 2005). Favoured sites of the local Aboriginal people came under threat as the white settlement on the south coast expanded and this was a period of violent dispossession from rich river flats like those surrounding Lake Illawarra (Cruse et al., 2005). By the twentieth century, many local Aboriginal people were extremely limited in the traditional lands they could access but many families continued to travel, camp and fish up and down the coast at key sites including, locally, Hill 60 and Bass Point. This tradition allowed the sharing of stories and language that continue to the present day.

The Illawarra region's traditional Aboriginal Custodians are members of the Yuin people who speak a dialect of Dharawal language (DEC, 2005). The speakers of this language originate, and still reside, in the country from Botany Bay and Campbelltown in the north through the Nepean, Wollondilly, Georges, and Cataract catchments, west to Moss Vale and south to the Shoalhaven and Jervis Bay regions. People from other language groups located inland journeyed to the Illawarra region to exchange foods, materials, and artefacts (DEC, 2005). The spatial distribution of the Yuin people indicates their affinity to the water, both to fresh and saltwater, and their occupation within the coastal regions, swamps, plateaus and inland rivers.

3.12 European Heritage

Europeans were sighted in the Illawarra region in 1796 when the first boat, the Tom Thumb, landed at Port Kembla. At the helm of the whale boat was George Bass, Matthew Flinders and William Martin who explored the area. Flinders, in his journaled observations, noted the presence of white men and women living with a local tribe who were presumed to be survivors of shipwrecks off the Illawarra coast, or escaped convicts (Organ & Doyle, 1995; DEC, 2005; LIA, 2013). Following Flinders' exploration of the area, in 1812 surveyor G.W. Evans is said to have traversed the land from Jervis Bay to Appin via the coast of the Illawarra region. During these travels it is said he crossed the entrance of the Lake (Organ & Doyle, 1995; LIA, 2013).

However, 'official' European settlement in the Illawarra region didn't commence until 1816 following a Government land survey. Following this, five land grants were issued to Europeans in 1817 beginning a period of alienation of the Aboriginal people from their land. As many of the land grants issued fronted creeks or rivers, the Aboriginal people's access to these resources were restricted drastically reducing their access to freshwater and changing their ways of life (DEC, 2005). Additionally, the foreshores of the Lake were intensely modified by European agriculture, changing the ways the Aboriginal people hunted for food (Davis, 2005).

European settlement in the Illawarra region had profound impacts on the natural resources. The introduction of foreign plant and animal species by the Europeans drastically changed the distribution of native vegetation and animals. Further changes to the land included extensive land clearing for dairy and cattle farming and coal mining which altered the access and capacity of the Aboriginal people to occupy or traverse this land (DEC, 2005). Cattle farming and cedar cutters were the first industries set up in the Illawarra region, commencing sometime around 1815. Following the allocation of land grants, a number of farms were established around the Lake growing crops such as wheat, oats, and potatoes. Later in the 1880s dairy farming became more widespread (LIA, 2013). These industries heavily modified the natural environment causing infilling of the Lake and its tributaries, altered river and drainage systems, removal of native vegetation and increased rates of sedimentation (DEC, 2005).

During the 1890s the then NSW Governments enabled a private company, The Illawarra Harbour and Land Corporation, to construct a harbour in the Lake (Davis, 2005). Initially, dredging of a 23-feet deep and a 100-feet wide channel across the Lake was to occur to allow for the shipping of coal, lead and other products. To carry this out, a railway extending along the then Windang Island was constructed to carry rock cut from the island to build the breakwaters. However, due to rough ocean conditions, any progression on the project was destroyed, leading to its abandonment (Davis, 2005; LIA, 2013).

A complete history of the Lake is available in Davis (2005).

4 Threat and Risk Assessment

4.1 Overview of Risk Assessment Process

Each of the threats identified for Lake Illawarra is described in the following section. A risk rating has been applied to each of the threats so they can be prioritised. The methodology used for prioritising the threats is a risk-based framework. The use of a risk-based approach is a requirement of the CMP Guidelines (OEH, 2013) and accords with current international best practice for natural resource management.

The standard risk management approach defines the magnitude of risk as a combination of

i) the *likelihood* of a risk event occurring, and;

ii) the *consequence* if such an event does occur.

For this project, a variation on the standard risk approach has been adopted to address management of existing threats that already have a known 'frequency' of occurrence, as opposed to future / unrealised risks that have a 'likelihood' of occurrence.

Table 4-1 Threat Frequency Categories

Scale	Frequency Descriptor	Indicative Timeframe
1	Almost Never	Generationally (15 to 20 years)
2	Infrequent	3 to 10 years
3	Occasionally	Monthly to seasonal (up to 12 times each year)
4	Often / continual	Daily / weekly

Consequences were assessed based on the scale defined in Table 4-2. Once the frequency and consequence values have been assigned, a threat level can be determined from the matrix given in Table 4-3.

Table 4-2 Threat Consequence Descriptors

Scale	Consequence Level	Environmental Consequence Descriptor	Social Consequence Descriptor	Economic Consequence Descriptor
1	Negligible	No measurable negative impacts are or will be possible against natural variations	Little to no change to amenity / heritage value	Little to no financial loss (<$20,000) or less than $10,000 ongoing funding costs per year
2	Small but measurable	Small measurable negative impacts outside of natural variation are or will be evident. Any impacts identified have not or will not substantially affect environmental processes	Minor impact to amenity/ heritage value, mainly reversible through management efforts. Access / facilities of a similar nature available nearby	Notable financial loss ($20,000 - $350,000) or ongoing funding costs of $10,000-$50,000 per year
3	Moderate	Moderate measurable and on-going negative impacts are or will be evident in one or more locations, and the level, duration and/or the proportion of area is such that environmental processes are or will be adversely affected. Recovery still possible.	Moderate impact on the amenity / heritage value mainly reversible through management efforts. No similar access points or facilities available nearby for use in the short term.	Moderate to major financial loss ($350,000 - $1m) or ongoing funding costs of $50,000-$100,000 per year
4	Permanent	Substantial measurable on-going negative impacts in one or more locations are or will be evident that are or will endanger environmental processes and their underlying ecological assets in the long-term	Substantial measurable widespread long-term impacts on the amenity / heritage value – e.g. complete loss of access	Substantial financial loss (>$1m) or ongoing funding costs of $100,000 per year

Table 4-3 Threat Matrix

		CONSEQUENCE			
		Negligible	Small but measurable	Moderate	Permanent
LIKELIHOOD	Often / continuous	Low	Medium	High	Very High
	Occasionally	Low	Medium	High	High
	Infrequent	Low	Low	Medium	High
	Almost Never	Low	Low	Low	Medium

4.2 Threats

The threats associated with Lake Illawarra have been identified through the Synthesis Report (BMT, 2020a) combined with the outcomes of the community consultation documented in previous sections. The risk assessment is based on the information available in the Synthesis Report as well as the perspectives provided through consultation. The threats are outlined in detail in the following sections.

The threats are listed in prioritised order from 'very high' to 'low' in Table 4-4. This prioritised list of threats will be used to develop management options, and also, the management options will be assessed for their ability to mitigate the threats, with scoring for the options weighted according to the level of threat (i.e. treatment of very high threats is weighted more highly than treatment of low threats).

Table 4-4 Prioritised List of Threats Identified for Lake Illawarra

Threat	Risk Rating		
	Present Day	Future: 2040-2050	Future: 2070-2100+
Water pollution	Very High	Very High	Very High
Catchment development	Very High	Very High	Very High
Changes due to entrance channel opening	Very High	Very High	Very High
Loss of estuarine vegetation	High	High	High
Wetland degradation	High	High	High
Litter, plastics and marine debris	High	High	High
Contaminated sediments	High	High	High
Inappropriate / degraded / insufficient infrastructure	High	High	High
Loss of tangible and intangible cultural heritage	High	High	High
Foreshore development encroaching public land	Medium	High	Very High
Loss of riparian habitat	Medium	High	Very High
Foreshore and bank erosion	Medium	High	High
Climate change	Medium	High	High
Park management practices impacting adjacent natural areas	Medium	Medium	Medium
Commercial fishing	Medium	Medium	Medium
Lack of Lake management	Medium	Medium	Medium
Introduced species	Low	Medium	Medium

4.3 Water Pollution

Description

Water quality conditions in estuaries fluctuate as a function of natural processes and human pressures. Water quality in Lake Illawarra is influenced by: discharge from several creeks (influenced by sub catchment land use practices); stormwater outlets draining urban areas; groundwater flow that are in some cases contaminated; tidal exchange with the ocean; mixing of salt, fresh and brackish water; and contamination from sediments. Water quality and estuary health in the Lake improves around the middle reaches, main body, and the entrance area, and decreases in the enclosed north-east and south-west reaches. Several key drivers identified as a water pollution threat include:

- increase in urban development resulting in sediment flows in stormwater runoff during construction (see Section 3.2)
- agricultural runoff
- industrial land uses and discharges
- changes in land use
- groundwater flows from contaminated land
- sewerage overflows
- thermal discharges
- changes in hydrology

Unfiltered stormwater inlets flow into the Lake from established suburbs. In its last annual report, the LIA noted that just 47% of stormwater inlets to the Lake have some form of filtering, and most were rudimentary. During the bus trip, it was observed that maintenance of existing gross pollution traps is also poor. This was said to have not been a priority for the LGAs since resuming lake management.

The Entrance Beach is the only site in the Lake where water quality has been monitored for human health consistently over time, and there is a push to address this by including additional monitoring sites around the Lake. Samples previously taken from the northern and western sides of the Lake indicated ANZECC guidelines for human contact were not being met. Water pollution was the second highest threat rated through the community survey. In the LIEMC workshop it was rated as ninth out of 14 rated threats.

Risk Rating

The threat and risk assessment undertaken for this report regarding water pollution impacts to Lake Illawarra identifies a present-day risk rating of Very High, see Table 4-5. Considering the current rate of urban development, future population growth plans and the increase in tourist visitation forecast for the Lake Illawarra region, water pollution will continue to be a very high risk into the future if not adequately managed.

Table 4-5 Risk Rating: Water Pollution

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Often / Continuous	Permanent	Very High
Future (~2040-2050)	Often / Continuous	Permanent	Very High
Future (~2070 to 2100+)	Often / Continuous	Permanent	Very High

4.4 Catchment Development

Description

Catchment development results in the mechanical disturbance of undeveloped land in addition to an increase in impervious surfaces. Substantial development is planned for the Lake Illawarra Catchment and this has potential to have significant impacts on the Lake through increased freshwater inputs and increases in most pollutants (particularly sediments and nutrients) being washed into the catchment waterways and ultimately the Lake.

Soils within the Lake Illawarra catchment are particularly susceptible to erosion as a result of development activities and other mechanical disturbance, as demonstrated through the substantial growth of Macquarie Rivulet delta in response to soil and sediment erosion driven by changes in land use practices. Hopley (2013) characterises the soil erodibility for the catchment.

Significant areas of current and future urban release are planned within the catchment, and particularly within the Macquarie Rivulet, Duck Creek and Mullet Creek sub-catchments. These areas include:

- West Dapto urban release area
- Calderwood urban release area
- Huntley urban release area
- Tallawarra urban release area

Additional details on planned catchment development within the Lake's catchment and its associated impacts and threats are available in the Synthesis Report (BMT, 2020a). Through the community and stakeholder consultation, several participants raised concerns regarding the control of sediment contamination from construction sites. There were concerns raised through submissions regarding Wollongong City Council's Private Principal Certifying Authority Complaint Policy as a potential impediment to the control of sediment from construction sites in the Lake catchment. Catchment Development was rated the highest threat to Lake Illawarra by the LIEMC. Through the community survey it was rated as the fifth of 12 threats.

Risk Rating

The threat and risk assessment undertaken for this report regarding catchment development impacts on Lake Illawarra identifies a risk rating of Very High, see Table 4-6. 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.

Table 4-6 Risk Rating: Catchment Development

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Often / continuous	Permanent	Very High
Future (~2040-2050)	Often / continuous	Permanent	Very High
Future (~2070 to 2100+)	Often / continuous	Permanent	Very High

4.5 Changes due to Entrance Channel Opening

Description

Construction of twin breakwaters at the entrance channel occurred between 2000 and 2007 to improve water quality within the Lake, in addition to other secondary objectives. The entrance training works have resulted in the Lake becoming permanently open to the ocean. This change has caused significant geomorphic, hydrodynamic and ecological changes to the Lake (see Wiecek et al., 2016), as follows, noting that this description of physical changes is not exhaustive.

- The Lake's water level now constantly fluctuates on a semi-diurnal cycle driven by ocean tides. The average lake water level has decreased, but the tidal range in the Lake has increased, and is projected to continue to increase for a long time.
- Tidal velocities through the open entrance have increased, in turn increasing sediment transport in the channel and changed patterns of scour and deposition.
- Significant amounts of sediment have been scoured from within the entrance channel since 2007, with key areas of deposition including the flood tide delta, or drop over, where the channel enters the main lake body, as well as the ebb tide delta seaward of the breakwalls where sediment is then subject to movement by coastal processes. A loss of seagrass due to both sediment accretion and scouring has been observed within the entrance channel, with substantial losses due to the expansion of the flood tide delta and scouring of shoals.
- Downstream of Windang Bridge, increased tidal flow velocities and resultant entrance scour and deposition have been observed mostly as a northward migration of the channel. This has meant significant scouring and deepening of the channel along its northern margin, and deposition and shoaling along the southern margin of the channel. Upstream of Windang Bridge has seen erosion along both Picnic and Bevans Island due to channel expansion and migration of the channel in a southerly direction.
- Entrance shoaling and 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 chocked with sediment. Nesting habitat for shorebirds has also been affected.
- In contrast, entrance channel scour has significantly undermined boardwalks and other coastal infrastructure along the Windang foreshore. Entrance scour and migration has also threatened areas of Aboriginal Cultural significance, shorebird habitat, open public space, and potentially other more major infrastructure if not managed properly e.g. Reddall Parade during the June 2016 east coast low event (see also Section 4.10).

- Wave action from ocean swells can now more freely penetrate the entrance channel which has resulted in foreshore erosion in some locations (see also Section 4.14). The East Coast Low event in June 2016 caused erosion to occur from floodwaters, locally generated wind waves, tidal currents and swell wave action within the entrance.
- Regular changes in the water level (i.e. on a tidal timescale) plus increased flushing with marine waters are also changing the Lake's ecology. For example, mangroves are now flourishing on some Lake foreshores. And species within the Lake waterbody will begin to favour marine species over estuarine /brackish species.

Climate change is expected to result in increased storminess and continued and accelerating sea level rise. These drivers will increase the existing threats associated with changed water levels, tide regime and wave conditions from permanent entrance opening.

Significant and permanent impacts due to entrance channel erosion were identified through the consultation with the Aboriginal Community during the consultation process. The community survey results showed that entrance management and erosion were ranked as third and fourth out of 12 threat categories. The LIEMC ranked entrance channel erosion as 12th out of 14 threats.

Risk Rating

The threat and risk assessment undertaken regarding entrance channel changes at Lake Illawarra identifies a risk rating of Very High, see Table 4-7, based upon the description given above.

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. The future risk rating is therefore identified as Very High at future timeframes.

Table 4-7 Risk Rating: Physical Changes due to Entrance Opening

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Often / continuous	Permanent	Very High
Future (~2040-2050)	Often / continuous	Permanent	Very High
Future (~2070 to 2100+)	Often / continuous	Permanent	Very High

4.5.1 Tidal Inundation

A key risk to various built and natural assets around the Lake is the ongoing increase in lake water levels, which is occurring due to:

- Permanent opening of the Lake's entrance with twin breakwaters, with the tidal range in the Lake increasing at an average rate of 8 mm/year in the entrance and 6 mm/year within the Lake basin between 2007 and 2016 (Wiecek et al 2016), and an increase of this magnitude is expected to continue due to the ongoing evolution of the entrance channel in response to the increased exposure to open ocean processes particularly increased tidal velocities; and
- Sea level rise which will increase lake water levels as the Lake is directly connected to the ocean.

To better understand the risks associated with the ongoing increase in tidal range inside the Lake due to permanent opening of the entrance plus future sea level rise, tidal inundation modelling and a risk assessment was conducted, as documented in Appendix C. Risk levels at present, 2040, 2070 and 2100 for different built and natural assets potentially affected by tidal inundation around the Lake are listed in risk register tables and mapped in Appendix C.

4.6 Loss of Estuarine Vegetation

Description

Estuarine vegetation such as saltmarsh, mangroves and swamp oak forest communities provide habitat and food for a range of fishes, birds, mammals, insects and invertebrates. Lake Illawarra has extensive areas of vegetation considered to be of significant natural value.

Saltmarshes are particularly susceptible to a range of pressures and are in decline across NSW. The key drivers threatening estuarine vegetation in Lake Illawarra are listed below.

- entrance management
- catchment development
- mangrove enrichment and encroachment threatening saltmarsh
- climate change, resulting in sea level rise and increased temperature
- weed infestation
- bait hunting by fisherman
- foreshore management practices (e.g. mowing)
- fragmentation
- loss of buffers
- trampling
- illegal vehicle access

This threat was ranked ninth out of 12 through the community survey and 11th out of 14 during the LIEMC workshop. It was a topic raised a number of times through qualitative discussions in the information evenings.

Risk Rating

The threat and risk assessment undertaken for this report regarding the potential loss of estuarine vegetation at Lake Illawarra identifies a risk rating of High, see Table 4-8. 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 will exacerbate this threat by placing stress on the estuarine vegetation which in turn improves the opportunities for weeds to establish.

Table 4-8 Risk Rating: Potential Loss of Estuarine Vegetation

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Often / Continuous	Moderate	High
Future (~2040-2050)	Often / Continuous	Moderate	High
Future (~2070 to 2100+)	Often / Continuous	Moderate	High

4.7 Wetland Degradation

Description

Coastal wetlands occurring at Lake Illawarra encompass a range of estuarine vegetation types and assemblages including seagrass, saltmarsh and mangroves. Coastal wetlands provide important habitat and food source to a range of fauna and provide additional ecosystem services such as shoreline stabilisation and improved water quality. Coastal wetlands occur in specific environmental niches and are sensitive to change and mechanical disturbance.

At Lake Illawarra, some areas of wetland that have high ecological potential are being degraded by human activities. The key drivers threatening wetlands in and around the Lake include:

- litter, dumping and marine debris
- grazing by cattle, particularly on the western shoreline
- BMX, motorbike and 4WD track creation in saltmarsh areas.

There is community passion around assisting these areas to meet their full ecological potential and motivation to work on finding alternate locations for activities such as BMX riding for example. Detailed submissions were received during the consultation that will be used to assist in the drafting of potential management options. Wetland degradation was rated seventh out of 14 at the LIEMC workshop.

Risk Rating

The threat and risk assessment undertaken for this report regarding wetland degradation at Lake Illawarra identifies a risk rating of High, see Table 4-9. If not adequately managed, this threat is likely to increase the future due to the increased population forecasts and urban development for the region, because of the influence on water quality and clearing.

Table 4-9 Risk Rating: Wetland Degradation

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Occasionally	Moderate	High
Future (~2040-2050)	Often / Continuous	Moderate	High
Future (~2070 to 2100+)	Often / Continuous	Moderate	High

4.8 Litter, Plastics and Marine Debris

Description

This includes rubbish and litter reaching the Lake through stormwater, direct dumping and fishing waste. Discarded fishing line is impacting sea birds around Lake Illawarra. Marine debris arising from recreational fishing (e.g. discarded fishing gear, bait bags, general litter) poses a threat to seabirds that can be severely injured or die from entanglement in marine debris, causing restricted mobility, starvation, infection, amputation, and drowning. Litter significantly detracts from aesthetic and recreational values. Long term pollution from degraded plastic may result in toxic chemical pollution, and the increasing presence of plastic micro beads and disintegrating synthetic fibres compounds this threat. The community survey rated this as the highest threat to the Lake. The LIEMC rated it as eighth from 14 ranked threats.

Risk Rating

The threat and risk assessment undertaken for this report regarding litter, plastics and marine debris within the Lake identifies a risk rating of High, see Table 4-10. 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.

Table 4-10 Risk Rating: Litter Plastics and Marine Debris

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Often / Continuous	Moderate	High
Future (~2040-2050)	Often / Continuous	Moderate	High
Future (~2070 to 2100+)	Often / Continuous	Moderate	High

4.9 Contaminated Sediments

Description

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. Some contaminants may also directly pose a threat to human health through direct contact and ingestion.

Contaminated sediments are known to occur within Lake Illawarra, with particularly high concentrations being measured in Wegit and Minnegang Creeks, located towards Port Kembla and Griffins Bay. Contaminated muds measured within the top 20 cm of the central estuarine basin have been attributed to historical industrial activities. Sediments cores have found high levels of metals including copper, zinc, arsenic, selenium, cadmium and lead, which may be attributed to historical events or uses. Acid sulphate soil exposure during excavation projects is also a risk.

Contaminated sediments were not highly rated threats by either the community survey or the LIEMC workshop. The survey shows it rated as eighth out of 12 and the LIEMC workshop rated it 11th out of 14 threats.

Risk Rating

The threat and risk assessment undertaken for this report regarding contaminated sediments identifies a risk rating of High, see Table 4-11. 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 or otherwise disturbed, 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.

Table 4-11 Risk Rating: Contaminated Sediments

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Often / continuous	Moderate	High
Future (~2040-2050)	Often / continuous	Moderate	High
Future (~2070 to 2100+)	Often / continuous	Moderate	High

4.10 Inappropriate / Degraded / Insufficient Infrastructure

Description

A range of coastal infrastructure within and around the Lake have been constructed both historically and in recent times to provide amenity, access, recreation and coastal protection, for example:

- public jetties
- swimming enclosures
- entrance training works
- boat ramps
- foreshore protection works

The former Lake Illawarra Authority managed some of the above infrastructure, but also built much of the coastal infrastructure including jetties, boat ramps, and the entrance training works. With the disbanding of the LIA, there is now uncertainty about who owns and is responsible for the upkeep of this infrastructure. Particularly in the entrance channel, many structures were not originally designed for the new conditions arising since entrance opening resulting in damages to this infrastructure from increases in the tidal prism, the erosive potential of tidal flows, entrance channel migration and wave exposure. For example, the boardwalk downstream of Windang Bridge has been significantly damaged by increased tidal flows and entrance channel migration (see Section 4.5).

Some jetties are now less viable because the average lake water level has dropped since the permanent entrance opening. Concerns regarding the safety of boat ramps have also been raised.

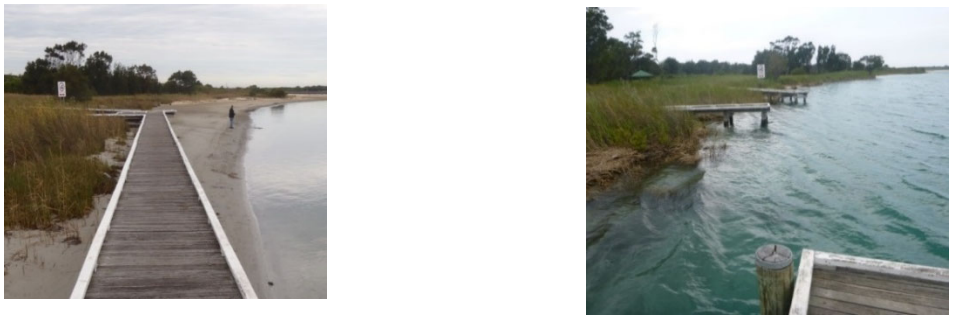

Figure 4-1 Damage to sections of the boardwalk downstream of Windang Bridge (2012 - 2015) (Source Wiecek *et al., 2016*)

Risk Rating

The threat and risk assessment identifies a risk rating of High for inappropriate/degraded/insufficient infrastructure in and around Lake Illawarra, see Table 4-12. Across future timeframes the threat is expected to remain High. Sea level rise and tidal changes in estuary water levels will continue to change the usability of existing infrastructure, while ongoing urban development and population growth will increase usage and demands for infrastructure into the future.

Table 4-12 Risk Rating: Inappropriate / Degraded / Insufficient Infrastructure

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Occasionally	Moderate	High
Future (~2040-2050)	Occasionally	Moderate	High
Future (~2070 to 2100+)	Occasionally	Moderate	High

4.11 Loss of Tangible and Intangible Aboriginal Cultural Heritage

Description

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 that catch limits are restrictive. Concerns have also been raised around a lack of open space adjacent to the Lake available for cultural activities.

Other concerns identified include the loss of tangible cultural heritage due to factors such as coastal development and rising sea levels. Some examples of threats (modified from Feary (2015)) include:

- environmental degradation impacting on spiritual connections (including depletion or contamination of resources such as fish stocks and damage to totemic or culturally significant species
- damage to sacred or Dreaming places and places associated with cultural practices and traditions
- management regimes that don't recognise Aboriginal values
- restrictions on access to resources

An important factor when considering this threat is the vulnerability of tangible and intangible cultural heritage, loss is usually permanent.

Risk Rating

The threat and risk assessment undertaken for this report regarding loss of tangible and intangible Aboriginal cultural heritage identifies a risk rating of High, see Table 4-13. 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.

Table 4-13 Risk Rating: Loss of Tangible and Intangible Aboriginal Cultural Heritage

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Occasionally	Permanent	High
Future (~2040-2050)	Occasionally	Permanent	High
Future (~2070 to 2100+)	Occasionally	Permanent	High

4.12 Foreshore Development Encroaching Public Land

Description

Residential areas fringe a large proportion of the Lakes boundary, however areas of public land (Crown land or Council land) usually separates the private boundary from the Lakes foreshore. Some private landholders seek to extend their foreshore blocks by mowing and adding small scale illegal foreshore development (e.g. BBQ areas) on public land.

The following list of practices contribute to the overarching threat of foreshore development encroaching on public land:

- Mowing;
- Illegal pruning and removal of foreshore vegetation;
- Disposal of clippings;
- Introduction of weeds;
- Foreshore access;
- Signs on public land, and
- Occasionally, foreshore protection-type structures.

This threat was rated as fourth out of 14 threats by the LIEMC workshop.

Risk Rating

The threat and risk assessment undertaken for this report regarding foreshore development encroaching on public land around Lake Illawarra identifies a risk rating of Medium, see Table 4-14. The risk is expected to increase over time, because tidal inundation will continue to squeeze (narrow) 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.

Table 4-14 Risk Rating: Foreshore Development Encroaching Public Land

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Often / Continuous	Small but measurable	Medium
Future (~2040-2050)	Often / Continuous	Moderate	High
Future (~2070 to 2100+)	Often / Continuous	Permanent	Very High

4.13 Loss of Riparian Habitat

Description

Riparian vegetation around the Lake has a range of aesthetic and ecological values. For example, a number of endangered ecological communities specific to floodplain and estuarine habitats occur around the fringes of the Lake, including Swamp Oak Floodplain Forest EEC, Freshwater Wetlands EEC and Coastal Saltmarsh EEC. Riparian vegetation at Lake Illawarra also provides important habitat for shorebird communities.

Riparian vegetation communities in the upper catchment are also important for a number of reasons. They can support diverse vegetation, help maintain bank stability, and increase ecological and economic productivity. Healthy riparian corridors in the upper catchment support cleaner water, reduce disease and pests, and retain important nutrients and soil. Healthy riparian vegetation improves the health of Lake Illawarra. Riparian areas are vulnerable and easily degraded. The key drivers threatening riparian habitat in the Lake Illawarra Catchment include:

- illegal tree removal (poisoning, cutting down of trees)
- uncontrolled stock access - grazing, trampling and waste pollution
- bank or foreshore erosion
- invasion by pests and feral animals
- illegal / environmentally unfriendly seawalls or foreshore structures
- ad-hoc access
- clearing for foreshore development
- weeds

Loss of riparian habitat was the lowest ranked threat by the LIEMC workshop. Loss of riparian habitat was not rated through the community surveys, however the qualitative comments include a mix of responses suggesting either further regeneration of riparian habitat for ecological, scenic values or selective removal of riparian habitat to improve views to the waterway. Removal of regeneration stock has been experienced at some Bushcare sites.

Risk Rating

The threat and risk assessment undertaken regarding the loss of riparian habitat at Lake Illawarra identifies a risk rating of Medium, in Table 4-15 below. While landholder behaviours can be shaped over time (to reduce illegal clearing), 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.

Table 4-15 Risk Rating: Loss of Riparian Habitat

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Occasionally	Small but measurable	Medium
Future (~2040-2050)	Occasionally	Moderate	High
Future (~2070 to 2100+)	Often / Continuous	Permanent	Very High

4.14 Foreshore and Bank Erosion

Description

This threat overlaps with the threat described in Section 4.5, with this threat relating specifically to erosion of Lake foreshores but excluding the entrance channel due to the different causation of erosion in the channel.

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 (see Section 4.13 also), mechanical disturbance, stormwater discharge, floodwaters and local wind wave action. As discussed in Section 4.5, erosion in the entrance channel is additionally caused by tidal currents and ocean swell wave penetrating the entrance channel.

Erosion was discussed as a significant threat to cultural heritage through consultation with the Aboriginal community. The community survey showed a rating of fourth out of 12 threats for the general category of erosion.

Risk Rating

The threat and risk assessment undertaken regarding foreshore and bank erosion identifies a risk rating of Medium, in Table 4-16 below. The risk rating for this threat is expected to increase to High across the next 20, 50 and 100 years. 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 around the Lake and creek foreshores. The future planned regional population growth and the increase of visitation to the Illawarra region that increases recreational usage of the Lake which could lead to foreshore bank erosion if access is not controlled.

Table 4-16 Risk Rating: Foreshore and Bank Erosion

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Infrequent	Moderate	Medium
Future (~2040-2050)	Occasionally	Moderate	High
Future (~2070 to 2100+)	Occasionally	Moderate	High

4.15 Climate Change

Description

Climate change, particularly rising sea level will impact the water level within the Lake. This threatening process will result in several impacts to the Lake, including:

- Loss of saltmarsh areas, due to the sensitivity of this community to environmental changes and the limited opportunity for saltmarsh to migrate landwards with sea level rise in some instances (see Section 4.6 also).
- Increasing occurrence and levels of inundation of public and built assets, from both a permanent rise in water levels and the episodic inundation due to storm surge and flooding (see BMT WBM, 2013 for more details); and
- Inundation of cultural and/or loss of cultural heritage items/places.

To further investigate the permanent impacts of rising sea levels combined with ongoing increases in the Lake's tidal range due to permanent entrance opening, a detailed tidal inundation modelling and risk assessment exercise was undertaken. The risks associated with tidal inundation were described in Section 4.5.1, and are outlined in detail in Appendix C.

Other impacts from climate change are also expected to impact the values of Lake Illawarra in the longer term. These include impacts to the lifecycles of a range of organisms through ocean acidification and change to ecological triggers. The issue of sea level rise was discussed with the participants of the consultation from the Aboriginal Community and is a significant threat to cultural heritage. This was the lowest rated issue through the community consultation and rated as nine out of 14 threats by the LIEMC.

Risk Rating

The threat and risk assessment undertaken for this report regarding climate change impacts to Lake Illawarra identifies a risk rating of Medium, see Table 4-17. 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.

Table 4-17 Risk Rating: Climate Change

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Almost Never	Permanent	Medium
Future (~2040-2050)	Infrequent	Permanent	High
Future (~2070 to 2100+)	Infrequent	Permanent	High

4.16 Park Management Practices Impacting Adjacent Natural Areas

Description

Council Park managers responsible for maintaining the foreshore areas are sometimes in contradiction to best environmental practice. Examples raised through the consultation and observed on site visits have included:

- lack of weed management,
- mowing practices (e.g. mowing areas where salt marsh may otherwise flourish)
- disposal of clippings

This sets an inappropriate example for the community, particularly the private foreshore residents.

Many respondents also commented about the state of the foreshores with several considering the areas not maintained to a high enough standard and litter and waste was considered a threat to foreshore value. Within the comments regarding access to the foreshore, issues were raised regarding a lack of car parking, for example at Madigan Boulevarde near Moureendah Bay.

Risk Rating

The threat and risk assessment undertaken for this report regarding Park Management Practices Impacting Adjacent Natural Areas identifies a risk rating of Medium, see Table 4-18. 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).

Table 4-18 Risk Rating: Park Management Practices Impacting Adjacent Natural Areas

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Occasionally	Small but measurable	Medium
Future (~2040-2050)	Occasionally	Small but measurable	Medium
Future (~2070 to 2100+)	Occasionally	Small but measurable	Medium

4.17 Commercial Fishing

Description

Commercial Fishing is managed through DPI Fisheries and changes to commercial fishing regulations are beyond the scope of the CMP being prepared for Lake Illawarra. However, an assessment of the threat is included here as a reflection of community concerns raised.

Commercial Fishing was the one value within the survey that attracted more prioritisation as "low" than high (refer to Figure 2-4). Through the information drop-in sessions and through the qualitative comments there was also anecdotal information regarding a community perception that commercial fishing is having a high impact on the Lake.

A comprehensive Fishery Management Strategy was prepared for the Estuary General Fishery and approved by the Minister for Primary Industries in February 2003. The Strategy includes a description of the fishery and the management arrangements that applied at that time. Before the Strategy was finalised, a draft strategy was subject to a comprehensive environmental impact assessment process, including extensive stakeholder and public consultation, under the *NSW Environmental Planning and Assessment Act 1979*. Subsequently an Environmental Impact Statement was prepared detailing the assessment of the environmental impacts of the management rules and risk mitigation measures.

Risk Rating

The threat and risk assessment undertaken for this report regarding commercial fishing in Lake Illawarra identifies a risk rating of Medium, see Table 4-19. 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.

Table 4-19 Risk Rating: Commercial Fishing

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Occasionally	Small but measurable	Medium
Future (~2040-2050)	Occasionally	Small but measurable	Medium
Future (~2070 to 2100+)	Occasionally	Small but measurable	Medium

4.18 Lack of Lake Management

Description

From 1988 to 2014 Lake Illawarra and its surrounding environment were managed by the Lake Illawarra Authority. In July 2014, this authority was disbanded and responsibilities transferred to

various state agencies as well as Wollongong and Shellharbour Councils. More recently the LIEMC was established as a collaborative effort between councils to ensure the judicious management of the Lake and its surrounds. This ongoing transition of responsibilities poses a threat to longer term Lake management.

Risk Rating

The threat and risk assessment undertaken for this report regarding the lack of coordinated management of Lake Illawarra identifies a risk rating of Medium, see Table 4-20. This threat, which was also identified by the community, will continue at the same level of risk (Medium) unless this CMP can be delivered successfully. 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.

Table 4-20 Risk Rating: Lack of Lake Management

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Often / Continuous	Small but measurable	Medium
Future (~2040-2050)	Often / Continuous	Small but measurable	Medium
Future (~2070 to 2100+)	Often / Continuous	Small but measurable	Medium

4.19 Introduced Species

Description

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. For example, native plants may become overgrown by weeds.

Hard hoofed animals such as stock, horses and feral deer impact on natural areas within the Lake Illawarra catchment, through trampling and grazing of native vegetation and compacting soils. This causes mechanical disturbance of soils and reduced vegetation growth, which results in erosion of soils. Weed invasion is another threat to the natural areas and ecosystems within and around the Lake.

There has also been legacy introduction of species within the Lake itself, which has caused changes to the estuarine ecosystem health and functioning. In addition, there is also the threat of marine pest being introduced to the Lake in the future due to the permanent opening of the entrance. The permanently open entrance increases the chance of marine pests being introduced into Lake Illawarra. Known locally specific pests that may possibly be introduced include the European Shore Crab (*Carcius maenas*) and the Japanese Goby (*Tridentiger trigonocephalus*). In addition to the entrance training works, recreational boating may also be a potential driver of this threat. The Synthesis Report (BMT, 2020a) discusses the recent discovery of the upside-down jellyfish within Lake Illawarra.

The potential introduction of marine pests was not prioritised by the LIEMC workshop. The community survey showed it rated as ninth out of 12 threats. Qualitative comments received through the consultation showed weed invasion of wetland and riparian areas were considered a significant threat to some people.

Risk Rating

The threat and risk assessment undertaken for this report regarding introduced species into Lake Illawarra and its catchment areas identifies a risk rating of Low, see Table 4-21. 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 are less able to adjust to temperature increases, rainfall variability and so on with climate change.

Table 4-21 Risk Rating: Introduced Species

Timeframe	Frequency	Consequence	Risk Rating
Present (~ 2020)	Infrequent	Small but measurable	Low
Future (~2040-2050)	Infrequent	Moderate	Medium
Future (~2070 to 2100+)	Infrequent	Moderate	Medium

4.20 Comparison with Issues Previously Identified

While specific threats were not identified or assessed, the previous Lake Illawarra Estuary Management Study and Strategic Plan ('LI Strategic Plan') (WBM Oceanics, 2006) did outline the issues affecting Lake Illawarra. Similarly, significant detail on estuary health, coastal processes and hazards, heritage, and community use was provided in the Draft CZMS (LIA, 2013), a specific list of issues or threats was not detailed. The list of issues from the LI Strategic Plan has been compared with the prioritised list of threats for Lake Illawarra in Table 4-22.

Many of the threats are the same or similar to the issues identified in 2006 for the LI Strategic Plan. For example, poor water quality or water pollution remains a threat, as does the loss of seagrass, loss of riparian habitat, wetland degradation, foreshore and bank erosion, littering, and public access and infrastructure to the foreshore and waterway.

The issues of macro algal blooms and seagrass wrack are no longer considered a threat to Lake Illawarra, largely due to a better understanding of the importance of wrack to the nutrient cycling and ecology of the Lake. Flooding is certainly still a threat to Lake Illawarra, however the majority of this threat has been investigated and managed through the NSW floodplain risk management process. Only threats from permanent tidal inundation due to sea level rise remain an issue of concern to the CMP, and these are encompassed in the Climate Change threat for the present CMP.

The issues for the entrance area are different now compared with the LI Strategic Plan, in that the permanent entrance opening was built after the plan was written. The threats in the entrance area now relate to the ongoing evolution of the channel in response to entrance training, which will result in shifts in erosion and accretion patterns, possibly over the next 100 years or more.

New threats recognised in this CMP compared with the LI Strategic Plan include catchment development, the loss of cultural heritage, climate change, park management practises, introduced species and lake management (although, the previously identified issue of funding and revenue is part of the threat of poor lake management). It is likely that these threats existed in 2006, but were not as prominent or recognised as they are at present.

Table 4-22 Comparison of Prioritised Threats with Issues Identified in LI Strategic Plan

Threat identified in the LI CMP	Present Risk Rating	Equivalent issue from the LI Strategic Plan
Water pollution	Very High	2. Water Quality
Catchment development	Very High	
Entrance channel changes	Very High	8. Entrance Condition
Loss of estuarine vegetation	High	6. Seagrass Beds
Wetland degradation	High	10. Wetland Degradation and Riparian Vegetation Loss
Litter, plastics and marine debris	High	7. Littering of Lake and foreshores
Contaminated sediments	High	5. Sedimentation and Build-up of Organic Material in Lake
Inappropriate / degraded / insufficient infrastructure	High	13. Waterway Usage; 11. Foreshore Access
Loss of tangible and intangible cultural heritage	High	
Foreshore development encroaching public land	Medium	11. Foreshore Access
Loss of riparian habitat	Medium	10. Wetland Degradation and Riparian Vegetation Loss
Foreshore and bank erosion	Medium	12. Lake foreshore erosion
Climate change	Medium	
Park management practices impacting adjacent natural areas	Medium	
Commercial fishing	Medium	4. Fish and Prawn Stocks
Lack of Lake management	Medium	
Introduced species	Low	
		1. Macroalgal Blooms
		3. Seagrass Wrack and Algal Accumulation on Foreshore areas
		9. Flooding
		14. Tourism Opportunities
		15. Funding (Revenue)

5 Opportunities

During the survey participants were given the opportunity to comment on actions/initiatives they would like to occur to help improve the health of the Lake and the broader catchment. It should be noted that all suggestions are being compiled at this point and will be subject to a multi criteria assessment to select the most suitable options (refer to Section 6).

A review of the opportunities map created through the information sessions by the community indicates that there is an appreciation for the influence of the catchment on the condition of the Lake. The suggestions are qualitative only, and will need to be considered in the wider context of legislation and planning controls, environmental condition, practicality, cost and potential benefits for the Lake.

The opportunities suggested through the community survey are listed below, and have also been included in the assessment of management options for the CMP. Please note that the opportunities listed here are not the only options considered in the preparation of the CMP. For ease of reference, the number denoted here has been used in the CMP options assessment, denoted with a “VR” (for Values Report).

(86) Programs to support environmental conservation, water quality and the promotion of passive recreation options.

(87) Where possible, work with the Aboriginal community on actions related to bush regeneration and art;

(88) 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.

(89) Installation of secure-lid bins along the perimeter of the Lake, particularly in picnic areas and popular fishing spots.

(90) Completion of public access to the Lake's foreshore including a shared pathway extending around the entire perimeter. Areas for completion include between Fred Finch Park and Kanahooka Point to ensure the safety of people using the Lake for transport.

(91) 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.

(92) 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.

(93) 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.

(94) Cultural Tourism- Aboriginal Tourism venture conducting tours around the Lake, reclaiming cultural practices such as telling of dreamtime stories, star gazing, fishing tours etc.

(95) 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.

(96) Educational programs in relation to Aboriginal Culture and Heritage.

(97) 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.

(98) 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.

(99) Ongoing maintenance of the Lake foreshore in general, particularly for overgrown vegetation in residential areas.

(100) 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.

(101) Increased infrastructure to promote tourism such as cruises around the Lake and kayak/watercraft hire.

(102) Formation of a group to oversee the funding, works, environmental monitoring, and general activities on the Lake, similar to the LIA.

(103) 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.

(104) 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.

(105) Regular emptying of trash racks and pollutant traps with increased maintenance during major rain/storm events to remove rubbish, vegetation and debris.

(106) 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.

(107) 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.

(108) 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.

(109) 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).

(110) Selective tree removal to improve views.

(111) A collaborative approach to environmental monitoring on the Lake.

(112) 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.

(113) Educational signage at regeneration / rehabilitation sites.

(114) Cultural burning as a weed management tool led by Aboriginal knowledge holders.

(115) Dredging behind groyne near Reddall Reserve.

(116) Large signs to address tree vandalism.

(117) Passive surveillance (e.g. encourage grey nomads to use carpark near Hooka Point wetlands).

(118) Improved maintenance of existing stormwater management devices.

(119) Work with BMX riding kids to find an area that they can create jumps etc..

6 Where to From Here

The next step in this process is an options assessment which will consider the options contributed by the community, remaining options from previous plans and other options developed by government agencies, councils and the consultant team.

Management Actions Assessment

Choosing one management option over another will be dependent on a number of factors. The following considerations will be a starting point for selection criteria for the options:

- Capital costs;
- Operational/ maintenance costs;
- Environmental benefits, or impacts, of the option, including the benefits/impacts upon amenity, recreation, public access and use and ecological habitats (noting there may be trade-off between these aspects for some options);
- Impact on Aboriginal culture and heritage;
- Adaptability of the option (e.g. is it reversible or permanent);
- Likely effectiveness of the option;
- Likely acceptability of the option to the community;
- Degree of difficulty in implementing the option (including sourcing the necessary funds); and
- Ability of the option to treat more than one risk (and the relative priority of the risks).

Following the options assessment, a CMP will be drafted in compliance with the relevant NSW guidelines and legislation. Given the anticipated transition between old and new legislation this may be in the format of a CMP.

A key focus will be obtaining a balance between potentially conflicting uses and values of Lake Illawarra and the wider catchment.

The document will include a description of:

- How the relevant Coastal Management Principles have been considered;
- The community and stakeholder consultation process, including details of key issues and how these have been addressed; and
- The process for management option identification, evaluation and prioritisation.

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Appendix A Compiled Resident Package

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Our Ref: L.N20606.001.docx

21 October 2016

Dear Resident,

Have your say in the environmental management of Lake Illawarra

A Coastal Zone Management Plan for Lake Illawarra is being written for Shellharbour City and Wollongong City councils with support from the NSW Office of Environment and Heritage.

A Coastal Zone Management Plan (CZMP) is a document that outlines priority actions to be undertaken by Councils and other agencies over a five -ten year period, in order to protect and improve the health of the lake.

Having a management plan means that limited budgets can be better allocated which will result in improved outcomes for the lake and its residents. A CZMP makes Councils eligible to apply for NSW State Government funding to implement the agreed actions.

The plan will look at Lake Illawarra, its foreshore and the surrounding catchment. This includes waterways going into the lake.

As a local resident, we are interested in understanding your views on:

- How often you visit Lake Illawarra and what areas you use,
- What you do at Lake Illawarra,
- The aspects of Lake Illawarra that are important to you,
- Threats or issues that you feel need to be managed and any suggested solutions to these threats if you have them,
- What you would like to see stay the same about the Lake or the way it is managed, and
- What you would like to see change about the Lake or the way it is managed.

You can respond in a number of ways:

- Writing a response to the dot points above and returning it to me in the enclosed reply paid envelope and/or,
- Writing a response to the dot points above and sending it to me via email - see details below and/or,
- Filling in the enclosed community survey and sending it back in the reply paid envelope and/or,
- Completing the survey on-line. It is available at www.haveyoursaywollongong.com.au/lake-illawarra-coastal-zone-management-plan and/or
- Attending one of the community drop-in sessions (see enclosed Community Meeting Flyer).

5.30pm – 8pm Monday 28th November Oak Flats Neighbourhood Centre Fisher Street, Oak Flats	5.30pm – 8pm Tuesday 29th November Illawarra Yacht Club Northcliffe Drive, Warrawong

We have a tight project time line, and ask that you provide your response by **7th December 2016**. Please feel free to contact me by telephone or email to discuss the project on email michelle.fletcher@bmtwbm.com.au or telephone 4940 8882.

Thank you for your assistance.

Yours Faithfully

BMT WBM Pty Ltd

Michelle Fletcher
Senior Coastal Scientist

Have your say – Community Survey
Lake Illawarra Coastal Zone Management Plan

The information collected will inform the development of a Coastal Zone Management Plan.

This survey is available on line at www.haveyoursaywollongong.com.au/lake-illawarra-coastal-zone-management-plan

Please attach extra sheets of paper if you would like to respond to questions in more detail

Q1 How often do you visit Lake Illawarra? *(e.g. Daily, weekly, monthly, 3 – 5 times a year or rarely)*

_____

Q2 What part or parts of Lake Illawarra do you visit most?

_____

Q3What do you do at Lake Illawarra? *(e.g. swimming, fishing, boating, bushcare, picnics, birdwatching, biking, or other please specify)*

_____

Q4 How important are the following aspects of Lake Illawarra to you? *(Please add to the list if you consider important aspects are missing)*

Aspect	High	Medium	Low	Not Sure
Access to the lake foreshore	◯	◯	◯	◯
Water quality	◯	◯	◯	◯
Healthy vegetation in the lake (Saltmarsh, seagrass etc.)	◯	◯	◯	◯
Recreational fishing	◯	◯	◯	◯
Commercial fishing	◯	◯	◯	◯
Tourism	◯	◯	◯	◯
Natural bushland/ foreshore vegetation	◯	◯	◯	◯
Views / how the lake looks	◯	◯	◯	◯
Native wildlife	◯	◯	◯	◯
Recreational facilities (bike paths, parks, public toilets, jetties, boat ramps)	◯	◯	◯	◯

Aspect	High	Medium	Low	Not Sure
Heritage / cultural values	○	○	○	○
Swimming, sailing, kayaking, other in-water activities	○	○	○	○
Walking, cycling, picnics, birdwatching, other foreshore activities	○	○	○	○
Please add another aspect if you need to	○	○	○	○
Please add another aspect if you need to	○	○	○	○

Q5 What do you believe are the main threats to the Lake? *e.g. water pollution, erosion, catchment development, litter/plastic, conflicting human uses , or specify others*_____

_____

_____

Q6 What would you like to see stay the same about the Lake or the way it is managed?

_____

_____

Q7 What would you like to see change about the Lake or the way it is managed?

_____

_____

Any other comments?

_____

_____

_____

Thanks very much for your time.

Your Contact Details (optional)*

Name: _____

*Email:*_____

Address/Phone Number: _____

_____

**By providing your contact details you agree to be included in a database and Council can notify you regarding upcoming community events.*

Please send your completed form to Michelle Fletcher via email: michelle.fletcher@bmtwbm.com.au or by post to PO Box 266 Broadmeadow NSW 2292

Shellharbour CITY COUNCIL

wollongong city of innovation

Have your say

Lake Illawarra
Coastal Zone Management Plan

A Coastal Zone Management Plan (CZMP) to protect and enhance the health of Lake Illawarra is being prepared on behalf of Wollongong and Shellharbour City Councils. The CZMP will build on the work already done by the former Lake Illawarra Authority and others. While the CZMP is being prepared, Council and other agencies will continue to manage the Lake and its surrounds.

The finalised CZMP will outline key priority actions required to be undertaken in order to protect valued aspects of Lake Illawarra, and to manage key issues over the next 5 to 10 years. The CZMP will allow for a coordinated effort between the Councils, NSW Government, and the wider community, and it will assist the Councils in gaining eligibility for necessary funding. Actions included in the final CZMP are eligible to apply for funding through the NSW Government Estuary Management Program and are more likely to meet criteria for other funding programs.

The success of CZMPs depends upon on the information, participation, and support of the community. Community input is welcomed throughout the plan, but is now being sought on:

- Aspects of Lake Illawarra that are highly valued;
- Uses of the Lake;
- Key issues that require management;
- Ideas for management actions to be included in the CZMP; and
- Ideas for the inclusion of the community in implementing the CZMP.

Development of the CZMP will take approximately 18 months, and is divided into four key stages:

Stage 2 is dependent on the input of the community. The first opportunity to be involved is by completing an online survey available at *www.haveyoursaywollongong.com.au/lake-illawarra-coastal-zone-management-plan*.

You are also encouraged to attend a community drop-in session. These are being held:

5.30pm – 8pm
Monday 28th November
Oak Flats Neighbourhood Centre
Fisher Street, Oak Flats

5.30pm – 8pm
Tuesday 29th November
Illawarra Yacht Club
Northcliffe Drive, Warrawong

If you are unable to attend an information evening, but would still like to have your say, please contact BMT WBM's Project Manager, Michelle Fletcher on email *michelle.fletcher@bmtwbm.com.au* or telephone 4940 8882.

BMT WBM

wollongong
city of innovation

Shellharbour
CITY COUNCIL

NSW GOVERNMENT Office of Environment & Heritage

The CZMP is being developed by BMT WBM under the guidance of the Lake Illawarra Estuary Management Committee on behalf of Wollongong City and Shellharbour City Council's with support from the Office of Environment and Heritage.

Appendix B Field Notes from the Bus Trip

On the 22nd of September 2016, a bus trip around the Lake was organised for members of the LIEMC and key Council staff to share knowledge and learn from each other about the values, issues and opportunities associated with Lake Illawarra. The bus trip stopped at various locations around the Lake and, various brief presentations and discussions were had. The itinerary included the Locations and Issues shown in Table 2-4 (main report).

Table B-1 Notes on threats taken during the Bus Trip

Threat	What values does it impact?	Existing controls?	Management Options
Off-road vehicles- illegal access Trail bikes	Wetlands – for example at Hooka Point Saltmarsh Marine Debris	Access controls (saltmarsh recovers quickly when access is stopped- high recovery potential) Boom Gate on Macquarie Rivulet	Gates work for a few months Changing social norms longer lasting Idea of passive surveillance by increasing usage
ASS in slag etc			
Commercial Fishing	Fish diversity and abundance	Buy backs – no one in Lake Illawarra took this up	
Development	Water quality	Sediment controls on construction sites	
Legacy coal wash / fill (e.g. Haywards Bay- company now gone)	Nutrients – WQ	Groundwater bore monitoring – but criteria set were not stringent enough and bores are inappropriately placed. LIA and developer established the agreement- but both no longer exist. Foreshore is part of Pleistocene barrier but bores are not necessarily picking up pollutants from land	
Mangrove encroachment (Back channel, Duck Creek, Tallawarra) Not in Koona Bay or Macquarie Rivulet which are key saltmarsh areas	Narrow band of saltmarsh Views / visual connection to Lake	Uni student mapping changes	Two distinct populations (size wise)
Wrack (anecdotally not as bad)	Aesthetics	Formerly removed by LIA- stopped once permanent opening	
Removal of regeneration plant stock	Regeneration		Education?
Siltation / sedimentation (Near Hooka Point in vicinity of Hooka Island from West Dapto development)			Artificial wetlands (PhD Carl Hopley)
Heavy metals	WQ etc	End to industrial land use- recent cores show cleaner sediment layer over top	UOW sampling soils
Migrating entrance marine shoals	Recreational Swimming Seagrass	Have dredged previously	Dredging (note recent DPIE - Coasts & Estuaries survey)

Threat	What values does it impact?	Existing controls?	Management Options
			LIA primarily dredged to keep the entrance open
Tree vandalism		Purry Burry sign	
Marine Debris from recreational fishing			
Legacy dilapidated infrastructure			
Wave penetration / elevated water levels during events	Residential / Recreational Reddall Parade		Raising Reddall parade???
Lack of foreshore access	Public access e.g. caravan park treating foreshore as their own, jetties/ infrastructure etc extending onto public land	Not encouraging public access but not preventing it	
Boat ramp design no longer appropriate due to changed tidal regime	Safety / recreational values		Gravel fill- temporary fix
Readjusting to changed tidal regime (almost doubled prism!!)	Bank stability / infrastructure / estuarine vegetation	Groynes – not working scour and eddy's visible off the end	Requires a full response from the bridge to breakwaters
Old nightsoil deposits near golf course	WQ	Diminishing naturally – not a huge issue	

Table B-2 Notes on Opportunities taken during the Bus Trip

Opportunity	Values protected	Threats mitigated	Partners / links to existing strategies	Other comments
Educational Signage at regeneration / rehabilitation sites	Foreshore vegetation, biodiversity, water quality	Removal of seedlings / vandalism, erosion, water pollution		Investment in play equipment and other facilities near rehabilitation sites has also shown increased valuing of the work done
Cultural burning	Foreshore vegetation, habitat, cultural connections	Weed invasion	NPWS, Aboriginal Community e.g. Picnic Island	
Dredging behind groyne near Reddall Reserve	Recreational swimming	Migration of the marine shoal	DPIE - Coasts & Estuaries hydrosurvey	Sand extracted could be used to nourish Warilla Beach
Large signs to address tree vandalism	Habitat, foreshore / riparian vegetation	Tree vandalism	Example at Purry Burry	
Passive surveillance (e.g. encourage grey nomads to use carpark near Hooka Point wetlands)	saltmarsh	Trail bikes		
Supporting volunteers	Saltmarsh, bird habitat, aesthetics, biodiversity	Erosion, pollution,	National tree day, TAFE training, Birra Aboriginal work crew	Reduce mowing load, important to consult to avoid vandalism of seedlings.
Improved maintenance of existing stormwater management devices		Marine debris		Issues cleaning out- potential for low DO water etc.
Work with BMX riding kids to find an area that they can create jumps etc.	Conservation areas		Community forum	Liability- Towradgi bowling club example

Table B-3 Notes on Values taken during the Bus Trip

Value	Where	Comments	Threats
Hooka Point Wetland Casuarinas Saltmarsh	22Ha	Amazing example of volunteer potential!!	Dirt Bikes BMX Bikes Off-road vehicles Norfolk Island Hibiscus (used as street tree)
Heritage	Art walking Trail near Hooka Point William Beach- world sculling champion, blacksmith- Bill Beach Park, Mullet Creek, Dapto.		
Recreational Values	Cycleway, foreshore access		Private ownership Restriction to public land Dilapidated facilities
Ash Pond	Tallawarra	Bird watching etc	Development – approved housing and light industrial
Breakwater access			Maintenance works

Appendix C Links to the Marine Estate Management Act

Table C-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)	• 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	• 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	• Entrance channel changes
Agricultural diffuse source runoff	Water pollution - major impacts almost certain from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants.	• 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.	• Loss of estuarine vegetation • Wetland degradation • Foreshore development encroaching public land • Loss of riparian habitat • Foreshore and bank erosion
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	• Climate change

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
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.	• 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.	• 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.	• 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	• *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.*
Industrial discharges	Water pollution - moderate impacts likely from combined stressors of nutrients, suspended sediments, and potentially toxic contaminants.	• 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.	• 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.	• Wetland degradation • Loss of estuarine vegetation

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.	• 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.	• Not directly considered
Recreational fishing - Shore-based line and trap fishing	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. 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. Marine debris Ghost fishing	• Not directly considered • Litter, plastics and marine debris
Recreational fishing - Boat-based line and trap fishing	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. 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. Marine debris Ghost fishing	• Not directly considered • Litter, plastics and marine debris

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.	• Wetland degradation • Loss of estuarine vegetation • Litter, plastics and marine debris
Thermal discharges	Water pollution – major impacts almost certain from elevated water temperature and changing dissolved oxygen within the affected system Thermal pollution – major impacts considered almost certain with *Zostera* killed by elevated water temperatures. Species richness impacts, associated biota impacts, but limited to local impacts. On-going discharges exist. 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. While these effects may have been measured elsewhere / in the past, ongoing and regular seagrass and other monitoring by EnergyAustralia in Lake Illawarra in accordance with their Environment Protection License (EPL) have shown that Tallawarra Power Station: • is not having a significant effect on all seagrass species distribution or volume • continues to comply with its EPL requirements to ensure it is not causing water pollution from thermal discharges • the use of heated water to minimise bi-fouling of the powerstation system rather than chemicals is designed to reduce the impact to Lake Illawarra.	• 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)	• Commercial Fishing
Oyster aquaculture		• 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.	• Cockle Harvesting Actions • Not directly considered

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
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.	• Not directly considered.

Appendix D Tidal Inundation Risk Assessment

D.1 Introduction

To support the preparation of the Lake Illawarra CMP under the NSW Coastal Management Framework (which includes the *Coastal Management Act 2016*, *State Environmental Planning Policy (Coastal Management) 2018*, and the Coastal Management Manual), an updated assessment of the tidal inundation risks was required. Under the Coastal Management Act 2016 and the Manual, a coastal management program (CMP) must identify those coastal hazards that relate to the CMP study area in sufficient detail to enable adequate management of coastal vulnerability through the CMP.

The assessment of tidal inundation risk in Lake Illawarra has been undertaken in two stages, being:

- a tidal inundation hydrodynamic modelling assessment completed by Kumbier et al, 2019 and summarised below; and
- an assessment of the level of risk from tidal inundation to various assets over current and future timeframes, as detailed in the following sections of this Appendix.

An important element of the assessment of tidal inundation in Lake Illawarra into the future is that permanent opening has exposed the Lake to regular ocean tides, with the tidal range within the Lake waterbody increasing at a steady rate since 2007. Permanent entrance opening has resulted in the entrance channel experiencing significantly enhanced tidal current velocities that are acting to scour and change the shape of the entrance channel. The increased and increasing hydraulic efficiency of the channel is then gradually exposing the Lake waterbody to greater tidal influence, with the Lake waterbody experiencing an ongoing increase in tidal range, which is the difference in water level between a low and high tide. The increase in tidal range in the Lake is expected to continue into the future (MHL, 2013; Wiecek et al., 2016).

Sea level rise poses an additional element to this existing tidal inundation risk, which will increase the average lake water level and the high tide level above this. The tidal inundation risk assessment is detailed herein.

D.2 Summary of Tidal Inundation Modelling

The *Lake Illawarra Hydrodynamic Inundation Modelling – An assessment of sea-level rise scenarios using tidal plane information* (herein referred to as 'tidal inundation modelling') by Kumbier et al (2019) involved the assessment of a range of scenarios for tidal range and sea level rise over current and future timeframes. The 12 modelling scenarios are listed in Table D-1 and explained below. Results for the scenarios are described in Kumbier et al (2019).

Two tidal planes were selected for modelling, being the Mean High Water Spring (MHWS), which represents the spring tidal level occurring approximately monthly, and the High High Water Solstice Spring (HHWSS) which is the highest spring tide occurring around twice per year, commonly referred to as a "king tide".

Four timeframes were chosen for model output, being the present day (represented as 2016, as this is the date for measured tidal data used in the modelling), 2040 (representing 20 years from present),

2070 (representing 50 years from present) and 2100 (being the commonly applied planning horizon in NSW and generally the longest available projection date for sea level rise).

Table D-1 Model Scenario Parameters (after Kumbier et al., 2019)

Sim No.		Tidal plane height (m AHD) + SLR				Tidal range (m)	
	Simulation Parameters	Present (2016)	2040	2070	2100	MHWS	HHWSS
1	MHWS present	0.48				0.71	
2	HHWSS present	0.71					1.11
3	MHWS + 0.17m SLR[1] + TR[2] ↑ 8mm/yr		0.65			0.886	
4	HHWSS + 0.17m SLR[1] + TR[2] ↑ 12mm/yr		0.88				1.374
5	MHWS + 0.5m SLR[1] + TR[2] ↑ 8mm/yr			0.98		1.126	
6	HHWSS + 0.5m SLR[1] + TR[2] ↑ 12mm/yr			1.21			1.734
7	MHWS + 0.5m SLR[1] + decelerated TR[2] ↑ 4mm/yr			0.98		0.918	
8	HHWSS + 0.5m SLR[1] + decelerated TR[2] ↑ 6mm/yr			1.21			1.422
9	MHWS + 0.98m SLR[1] + TR[2] ↑ 8mm/yr				1.46	1.366	
10	HHWSS + 0.98m SLR[1] + TR[2] ↑ 12mm/yr				1.69		2.097
11	MHWS + 0.98m SLR[1] + decelerated TR[2] ↑ 4mm/yr				1.46	1.038	
12	HHWSS + 0.98m SLR[1] + decelerated TR[2] ↑ 6mm/yr				1.69		1.6035

[1] *Sea-level Rise (SLR) values are the High RCP8.5 values specified for use in coastal risk assessments for the NSW south coast by Whitehead and Associates (2014).*
[2] *Tidal range (TR) increases were determined by Wiecek et al (2016) analysis of measured tidal data from Lake Illawarra since permanent entrance opening. The decelerated TR scenarios are taken as half the expected TR increase expected for the tidal planes, i.e. Mean High Water Spring (MHWS) and High High Water Solstice Spring (HHWSS).*

A steady increase in the Lake's tidal range (i.e. the difference between low tide and high tide water levels) has been observed since the Lake was permanently opened to the ocean. For the tidal inundation modelling, the tidal range scenarios adopted were based upon the analysis of tidal gauge information by Wiecek et al (2016) of 8mm/year for spring tides, and 12 mm/year for "king" tides.

Sea level rise scenarios were adopted based upon the guidance of Whitehead and Associates (2014) for the south coast that recommended "RCP8.5 is a suitable basis for sea level rise projection" and "that RCP8.5 be adopted as a basis for decision making". RCP8.5 or Representative Concentration Pathway 8.5 is the very high greenhouse gas emissions scenario modelled for the IPCC's fifth climate change assessment report (Climate Change 2014 Synthesis Report, or AR5). Modelling completed for the IPCC's AR5 found that scenarios without additional efforts to constrain emissions ('baseline scenarios') lead to pathways ranging between RCP6.0 (an intermediate mitigation scenario) and RCP8.5 (the very high greenhouse gas emission scenario).

For the tidal inundation modelling scenarios, sea level rises above AHD in 2015 of 0.17 m (2040), 0.5 m (2070) and 0.98 m (2100) were adopted, based upon the High projections for RCP8.5 locally adjusted for the south coast (Whitehead and Associates, 2014). These values equate to the high

value for which 95% of model outputs were equal to or less than (i.e. from the IPCC's Coupled Model Intercomparison Project Phase 5 for AR5). The IPCC (2014) indicates that if RCP 8.5 is realised, the Low to High projections are the *likely* range for sea level rise.

Kumbier et al (2019) produced output for each of the 12 model scenarios, as both a maximum inundation extent and a maximum inundation depth. For the purpose of assessing risk to assets over future timeframes, the inundation extent was utilised, as this represents all areas affected by inundation. Tidal inundation extents for the HHWSS scenarios are provided in the Synthesis Report (BMT, 2020a).

Prior to running scenarios, the hydrodynamic model was calibrated against measured tidal data from a spring tidal event during March 2016. The model scenarios were then developed using the measured tidal data as a basis (refer to Kumbier et al 2019 for further details).

Potential limitations of the modelling assessment were identified as follows.

- The modelling approach does not account for changes to the entrance configuration (i.e. changes in entrance morphology such as depth, location, shoaling, scouring etc) that will occur into the future, as it is indeed this process that is allowing increased tidal flow and therefore tidal range into the Lake. Indeed sea level rise may introduce further changes in the rate and extent of change in entrance channel morphology, in turn affecting the rate of change in the tidal range over the same timeframes (e.g. with sea level rise, the rate of tidal range increase could perhaps be faster than 12mm/year because of enhanced entrance scour, which in turn will result in inundation extents being realised earlier than currently modelled).
- Kumbier et al (2019) indicated that tidal pumping effects were excluded from the model output and analysis, because the calibration for these events was not adequate (the model scenarios slightly exaggerated the tidal water levels compared with the measured data). Potentially, if tidal pumping could be adequately represented in the model, then inundation extents may be higher over a spring tidal cycle than that used in this risk assessment. In simple terms, tidal pumping may occur during a spring tide event where, because the water doesn't completely drain from the Lake before the next high tide occurs, a higher tidal water level occurs at the next high tide because the Lake is already relatively full.
- While not used for the risk assessment below, the tidal inundation modelling results for a decelerated (i.e. reduced) rate of tidal range increase produced a greater extent of inundation than compared with the existing rate of tidal range increase. Kumbier et al (2019) suggest that this is because the low tide level for the decelerated scenarios is higher than the existing tidal range scenarios. Similar to tidal pumping, this would mean that the Lake is fuller before the next high tide, and so a higher tidal water level may occur even though the tidal range (i.e. difference between high and low tide) is smaller.

While the above limitations are noted, the tidal inundation modelling by Kumbier et al (2019) is considered suitable and fit for purpose for this tidal inundation risk assessment and the subsequent development of actions to address tidal inundation risks in Lake Illawarra that will occur through the CMP.

D.2.1 A Note on Previous Coastal Inundation Modelling

As discussed in detail in the Synthesis Report (BMT, 2020a), various flood and coastal inundation modelling exercises have been completed to date, as listed below. There are important differences between these previous studies and the tidal inundation modelling completed by Kumbier et al (2019), as noted here:

- The *Wollongong City Council Coastal Zone Study* (Cardno, 2010) and *Coastal Hazard Assessment – 100 year ARI Extents* (Cardno 2012) investigated inundation levels in the Lake due to ocean storm events at present and in future with sea level rise. The Cardno (2010, 2012) modelling considered only the 1 in 100 year ARI ocean water level (of 1.44 m AHD) for present and future scenarios. The assessment included sea level rises of 0.4m by 2050 and 0.9m by 2100 in addition to the ocean water level. This mapping underpinned the assessment of coastal inundation developed for the *Wollongong Coastal Zone Management Plan: Management Study* (BMT WBM, 2017) and the *Lake Illawarra Coastal Risk Assessment* (BMT WBM, 2013), both of which have been utilised and incorporated into the Lake Illawarra CMP where appropriate.
- The Lake Illawarra, Mount Warrigal and Oak Flats Flood Study (BMT, 2019) provided an investigation of inundation levels at these suburbs occurring during a 1.45 m AHD “tide” at present (noting this level is actually equivalent to the 100 year ARI ocean water level), plus sea level rises of 0.4m by 2050 and 0.9 m by 2100. The modelling was provided as a scenario for comparison with inundation levels from catchment derived flooding and rainfall, that is, the tidal inundation scenario presented by BMT (2019) does not include catchment flooding.
- Unlike the Kumbier et al (2019) work, both the Cardno (2010, 2012) and the BMT (2019c) assessments do not consider inundation levels during regular spring tides (MHWS) and “king” tides (HHWSS) at present; and do not consider the increase in tidal levels projected to occur in future due to the permanent entrance opening.

D.3 Risk Assessment for Tidal Inundation

To retain consistency with the approach developed for and endorsed by Wollongong City Council and Shellharbour City Council and other stakeholders for the CMP, the same risk scales and matrices as applied for the threat assessment in main body of report has been applied here, and reproduced in Table D-2, Table D-4, and Table D-6.

Then, the process of assessing risk from tidal inundation to built and natural assets followed the same approach as utilised for the assessment of risk from coastal inundation during ocean storm events in the *Lake Illawarra Coastal Risk Assessment* (BMT WBM, 2013) and the *Wollongong Coastal Zone Management Plan: Management Study* (BMT WBM, 2017). That is, the risk assessment process applied was as follows:

- a likelihood or frequency was assigned to selected tidal inundation scenario model results for each timeframe, using the Frequency scale developed for the main report;
- a consequence from tidal inundation to the different asset classes (including both built and natural assets), then individual assets within each asset class as required, was assigned during a Risk Assessment Workshop conducted specifically for this report; and

- through GIS processing of the tidal inundation "frequency" (i.e. as applied to inundation extent at each timeframe) and "consequence" (i.e. as applied to a GIS database of the various assets), a level of risk for each asset was assigned, then output to risk maps and risk registers as given in Section D.5 below.

Discussion of the values assigned for frequency and consequence is provided in the following sections.

D.3.1 Tidal Inundation Risk Likelihood (Frequency)

For the purpose of assessing tidal inundation risk, the HHWSS tidal plane scenarios for each timeframe were selected because they represent both a higher inundation scenario than compared with MHWS but are also sufficiently frequent (occurring around twice per year) as to be considered too frequent to support most assets or land uses. The scenario of a "decelerated" tidal range increase as modelled by Kumbier et al (2019) was excluded for consideration because there is insufficient evidence to suggest that tidal range will decelerate, and furthermore, the higher inundation extents resulting from this model scenario are likely to be limitation of the modelling, rather than what will be reflected in the future. Therefore, four of the 12 modelled scenarios were adopted to assess tidal inundation risk, see Table D-3.

The frequency of occurrence of a king high tide or HHWSS event at the present day is approximately twice per year. This was considered to be "occasionally" in accordance with the description given in the risk frequency scale of "monthly to seasonal (up to 12 times each year)". At the present day, while sea level rise and tidal range increases have not yet occurred, there are ocean water level and / or rainfall events that may produce an equivalent water level in the Lake. Therefore, the 2040 HHWSS plus SLR and increasing tidal range scenario may occur at the present day, albeit of "infrequent" (i.e. "3-10 years") frequency. Likewise, the 2070 HHWSS plus SLR and increasing tidal range scenario may also occur in the present day in very infrequent circumstances, such as would be considered "almost never", or "generationally (15 to 20 years)".

By 2040, the modelled scenario of HHWSS plus SLR and increasing tidal range for 2040 should now be the typical HHWSS event, and so the frequency for this will increase to "occasionally", in line with the frequency descriptors. Similarly, the 2070 HHWSS plus SLR and increasing tidal range scenario will be occurring with "infrequent" frequency, and the 2100 HHWSS plus SLR and increasing tidal range scenario may also be occurring, albeit "almost never" or generationally. The present day 2016 HHWSS event would be occurring so often as to be considered "often/continual".

Then once again at 2070 and 2100, the equivalent HHWSS scenario for those timeframes would be expected to be the regular king tide level with an "occasional" frequency of occurrence. Lower water level scenarios (e.g. present day, 2040) will be occurring so frequently as to be considered "often/continual", and indeed may be permanently underwater.

In this manner, the gradual increase in tidal water levels is represented in the risk assessment as an event with increasing frequency so as to become almost daily or even permanent. This is representative of the slow, gradual and almost imperceptible change in lake water levels that is occurring due not only to sea level rise, but the increasing tidal range in the Lake due to permanent opening of the Lake's entrance.

Table D-2 Threat Frequency Categories

Scale	Frequency Descriptor	Indicative Timeframe
1	Almost Never	Generationally (15 to 20 years)
2	Infrequent	3 to 10 years
3	Occasionally	Monthly to seasonal (up to 12 times each year)
4	Often / continual	Daily / weekly

Table D-3 Frequency Categories assigned to the Selected Model Scenarios

		Timeframe / Likelihood			
Sim #	Scenario	Present day (2016)	2040	2070	2100
2	HHWSS	**Occasionally**	**Often / Continual**	**Often / Continual**	**Often / Continual**
4	HHWSS + 0.17 m SLR + 12mm/year increase in tidal range (=0.264 m)	**Infrequent**	**Occasionally**	**Often / Continual**	**Often / Continual**
6	HHWSS + 0.50 m SLR + 12mm/year increase in tidal range (=0.624 m)	**Almost never**	**Infrequent**	**Occasionally**	**Often / Continual**
10	HHWSS + 0.98 m SLR + 12mm/year increase in tidal range (=0.984 m)		**Almost never**	**Infrequent**	**Occasionally**

D.3.2 Tidal Inundation Risk Consequence

The risk consequence was considered in terms of the consequence of tidal inundation to built and natural assets, as per the assessments done for Lake Illawarra within Shellharbour LGA (BMT WBM, 2013) and within Wollongong LGA (BMT WBM, 2017). The asset classes and then specific assets within each class were first identified through GIS processing of the assets located around the Lake Illawarra foreshore and potentially affected by the largest inundation extent provided in the tidal inundation modelling.

A Tidal inundation Risk Assessment Workshop was convened on 12th February 2019, and attended by various stakeholders including representatives from the various departments of Wollongong City Council and Shellharbour City Council (e.g. planning, engineering, environmental services, community engagement etc), the state agencies (DPIE - Coasts & Estuaries, DPI Fisheries, DPIE – Crown Lands, TfNSW, PropertyNSW, NPWS) and other stakeholders (Sydney Water, University of Wollongong). The attendees represented both the organisations largely responsible for management of the Lake and its assets, as well as the general community who live, work and play on the Lake and its foreshore.

Using the list of potentially affected assets derived from GIS above, workshop attendees were split into groups and asked to discuss and then agree upon the consequence to an asset in the event that the asset was inundated permanently by the tide, using the consequence scale in Table D-4. Attendees were asked to consider broad categories of assets first, then to identify specific assets with each asset class that may have a different risk level from the group. The interdependencies for the assets in terms of an asset class, an individual asset, or a specific location, were then documented by the attendees through the course of the workshop activities.

The results from the different workshop groups were amalgamated to derive a single consequence level to apply to the asset classes, and specific assets within each asset class as necessary, as given in Table D-5.

As a comparison and cross-check, the overall results from this workshop were compared with the consequence levels for assets in the Lake applied in the *Lake Illawarra Coastal Risk Assessment* (BMT WBM, 2013) and the *Wollongong Coastal Zone Management Plan: Management Study* (BMT WBM, 2017) for coastal (storm) inundation and "permanent" tidal inundation (Shellharbour side only). There was generally good agreement between the results of this assessment and the *Lake Illawarra Coastal Risk Assessment* for tidal inundation.

Key differences are noted between the previous assessments for coastal inundation and this tidal inundation risk assessment. Importantly, the relatively "permanent" nature of the tidal inundation risk was reflected in the assessment of consequence for assets, particularly parks and reserves and other community assets. For such assets, a storm event was considered of lower consequence because the impacts are relatively short-lived and reversible/repairable because the water recedes. In contrast, ongoing, irreversible and virtually permanent inundation by the tides will have a substantial negative impact upon the community where foreshore parks, reserves and other community assets are no longer accessible or usable. In contrast, many of these assets by their very nature need to be adjacent to the foreshore (e.g. boat ramps, jetties) or derive much of their value to the community from their proximity to the foreshore (e.g. parks, reserves, cycleway). In this case, the management actions to facilitate adaptation for these assets must consider how these associated values can be maintained and transitioned.

None of the asset classes were considered to have a "negligible" impact from tidal inundation. Again, this reflects the permanent and irreversible consequences of tidal inundation. In contrast, storm event inundation risks may certainly cause substantial damage, but the damage is reversible and the assets affected can be repaired and used as intended after the event.

Table D-4 Threat Consequence Descriptors

	Consequence Level	Environmental Consequence Descriptor	Social Consequence Descriptor	Economic Consequence Descriptor
1	Negligible	No measurable negative impacts are or will be possible against natural variations	Little to no change to amenity / heritage value	Little to no financial loss (<$20,000) or less than $10,000 ongoing funding costs per year
2	Small but measurable	Small measurable negative impacts outside of natural variation are or will be evident. Any impacts identified have not or will not substantially affect environmental processes	Minor impact to amenity/ heritage value, mainly reversible through management efforts. Access / facilities of a similar nature available nearby	Notable financial loss ($20,000 - $350,000) or ongoing funding costs of $10,000- $50,000 per year
3	Moderate	Moderate measurable and on-going negative impacts are or will be evident in one or more locations, and the level, duration and/or the proportion of area is such that environmental processes are or will be adversely affected. Recovery still possible.	Moderate impact on the amenity / heritage value mainly reversible through management efforts. No similar access points or facilities available nearby for use in the short term.	Moderate to major financial loss ($350,000 - $1m) or ongoing funding costs of $50,000-$100,000 per year
4	Major	Substantial measurable on-going negative impacts in one or more locations are or will be evident that are or will endanger environmental processes and their underlying ecological assets in the long-term	Substantial measurable widespread long-term impacts on the amenity / heritage value – e.g. complete loss of access	Substantial financial loss (>$1m) or ongoing funding costs of $100,000 per year

Table D-5 Consequence Values assigned to Lake Assets (Built and Natural) based upon Workshop Results

Asset Type	Consequence*
COMMUNITY ASSETS	
Parks / Reserves / OpenSpace / Foreshores	Major
Cycleway / Footpath /Shared Access Ways	Moderate
Asset above with different consequence to remainder of the group: Linus Grand Pacific Walk, Lake Foreshore, Lakeside Drive, Berkeley/ Hooka Point, Wollimi Point, walkway under Windang bridge, Lake cycleway	Major
Public / Community Buildings/Playgrounds	Major
Car Parks and supporting utilities	Moderate
Sporting and recreational clubs	Major
WATERWAY INFRASTRUCTURE	
Lake Illawarra Training Walls	Major
Jetties / Wharfs / Boat ramps	Major
Yacht Clubs	Moderate
URBAN DEVELOPMENT	
Residential Development	Major
Industrial Development	Moderate
Commercial Development	Moderate
Heritage	Moderate
Tourist Parks	Moderate
WATER INFRASTRUCTURE	
Stormwater Infrastructure	Major
Potable Water Infrastructure	Major
Sewer Infrastructure	Major
NATURAL ASSETS	
National Parks and Nature Reserves	Major
Environmental Conservation Zoned Land	Major
Saltmarsh	Major
Mangroves	Moderate
Endangered Ecological Communities	Major
TRANSPORT	
Roads - Minor	Moderate
Roads - Major	Moderate
Transport Infrastructure	Moderate
Bridges	Moderate

D.3.3 Level of Risk from Tidal Inundation

The consequences assigned to the various foreshore assets (built and natural) was combined with the frequency assigned to the four tidal inundation scenarios through GIS processing to apply the risk matrix given in Table D-6 below. Specific listing of the risk to assets over time is provided in a risk register given in Table D-9. The level of risk to land and assets around the Lake foreshore is illustrated in Figures 1a to 4d, in Section D.5.

As shown by the risk maps, the most notable areas for impact in terms of inundation extent are Corrungoba Peninsula and Hooka Point, Macquarie Rivulet, and the islands within the Entrance Channel. These landforms are low lying and dynamic in nature as they have formed as part of the tributaries, and channel landscapes of the Lake. As such, they have not generally been used for development, but rather have been preserved as natural areas, reserves or parklands.

The risk registers highlight there are many community assets at risk over time, such as the cycleways, foreshore parks and reserves and associated facilities. There are some relatively small pockets of residential land that may be affected overtime, such as around Primbee, Windang and Lake Heights. Most major and minor roads are not substantially affected, except for some key low-lying sections associated with Hooka Point/Corrungoba Peninsula (Princes Motorway in Kembla Grange), Primbee (Windang Road, Purry Burry Avenue) and Windang (Windang Road).

Not unsurprisingly, many sewer and stormwater assets are also at risk. These assets are necessarily on low lying land, to allow draining of stormwater and collection and pumping of sewage.

Likewise, many of the estuarine fringing habitats and EECs are also at high risk, as these habitats are naturally located on the fringes of waterbodies subject to changing water levels. However, these habitats will have to be carefully managed to ensure their longevity into the future. This may require setting aside land and facilitating the migration of these important habitats overtime. Community assets such as cycleways and even stormwater and sewer assets may also impact upon fringing habitats, depending on how the risks to these assets are managed. Interdependencies that will need to be considered in designing management action are outlined below.

Table D-6 Threat Matrix

		CONSEQUENCE			
		Negligible	Small but measurable	Moderate	Permanent
LIKELIHOOD	Often / continuous	Low	Medium	High	Very High
	Occasionally	Low	Medium	High	High
	Infrequent	Low	Low	Medium	High
	Almost Never	Low	Low	Low	Medium

D.3.3.1 Interdependencies

There are many assets and areas of interdependency for inundation risk. This includes assets that are dependant on other assets to function; assets that are by their very nature necessarily located in low lying land that is at the highest risk; and assets that may be negatively impacted by inappropriate management of inundation risks to adjoining or adjacent assets. Key examples of asset interdependencies that are relevant to Lake Illawarra are explained below.

- **Services to residential developments: roads, sewer, water, stormwater, power etc.** While land use planning can facilitate the filling of land, there must also be a process for raising of roads, and for raising assets over time while still maintaining their functionality, e.g. sewer, water and stormwater.
- **Sewer and stormwater must necessarily be located in low-lying areas to function.** This is problematic where such assets have a very long expected design life (50-100 years) over which the functionality of the asset will be substantially impacted, in turn impacting urban development that is reliant on functioning sewer, water and stormwater drainage systems.
- **Community asset management must also consider access.** Assets such as boat ramps and jetties are necessarily on the waters edge and can be raised over time, and foreshore parks can remain functional even if somewhat smaller overtime. However if these assets cannot be accessed by the community, such as by roads, carparks, footpaths, cycleways etc, they will no longer be viable.
- **Careful planning is needed to avoid unforeseen and damaging impacts from a chosen approach to managing one asset on its neighbouring assets.** There are many examples where protection of one asset has been at the expense (erosion, loss) of a neighbouring asset, which is often a natural or community asset. For example the loss or erosion of a fringing habitat, beach or public foreshore that occurs due to the protection of a stormwater outlet. Asset management planning will need to carefully consider the impact of adaptation action on adjacent assets, and where necessary, undertake an alternative solution. Indeed, where asset management planning is undertaken properly, there are many opportunities to enhance or support adaptation of neighbouring assets. For example, where a cycleway is relocated or raised (via bridge or boardwalk) instead of protected, the former cycleway can be rehabilitated to provide an area for habitat migration and /or community open space.
- **Public foreshore access may be lost to private lands through inundation.** Therefore, ways to maintain public access to the foreshore via strategic planning, and other novel solutions in future, will need to be factored into adaptation planning and the CMP.

D.4 Recommendations for Risk Mitigation and Adaptation

D.4.1 Existing Actions

There are already in place many existing actions that can assist to mitigate or adapt to tidal inundation risks. One of the key actions is the application of the Lake Illawarra Floodplain Risk Management Plan, and which in turn has provided for planning and development controls for flood risk in the LEPs and DCPs; and evacuation planning for the region. It is expected that future updates to flood planning

will including modelling that incorporates combined assessments of ocean water level and rainfall storm event scenarios plus sea level rise and tidal range increases, to deriving flood planning information. The Floodplain Risk Management Plan process is then expected to utilise the latest inundation risk information to update evacuation plans, LEPs and DCPs, and other inundation mitigation activities.

Other actions identified during the workshops included:

- Asset renewal and maintenance programs (although these don't currently factor in future inundation risk);
- Plans of Management and Masterplans for specific areas, e.g. Windang (again, these don't currently factor in future inundation risk);
- Entrance channel investigations are currently underway and shall determine an approach(es) to managing the inundation and erosion risks in the channel;
- Vegetation and other annual surveys to better understand and chart changes to habitats over time; and
- Road, cycleway and footpath closures on an as needs basis during tidal inundation (i.e. "king tide") events.

While such existing actions are important, there remains a need to directly address the inundation risks identified through the CMP process for implementation over the short term and in preparation for managing the long term risks, particularly because the risk from tidal inundation shall occur on such a frequent basis as to be virtually permanent.

D.4.2 Approach to Managing Present and Future Risks

Present day extreme and high risks will need management action as a priority, as per a typical risk tolerance approach as given in Table D-7. For future extreme and high risks, while there is a need to investigate and signal the future management intent in the present timeframe, implementation of these actions can be delayed until impacts are imminent. For future management actions, a trigger is vital, to identify when impacts are imminent but with sufficient time to collate funding, gain approvals and undertake the detailed design for the strategy. This approach to managing inundation risks at present and over future long timeframes is explained in Table D-8.

Table D-7 Typical Tolerance Scale for Treating Risk

Risk Level	Action required	Tolerance
Very High / High	Eliminate or Reduce the risk or Accept the risk provided residual risk level is understood	**Intolerable**
Medium	Reduce the risk or Accept the risk provided residual risk level is understood	**Tolerable**
Low	Accept the risk	**Acceptable**

Table D-8 Approach to Risk Treatment for Present Day to Future Long Timeframe Risks

Timeframe for Extreme / High Risks	Treatment Approach
Present Day	• Implement no regrets actions • Implement site specific management actions as required • Implement land use planning actions to reduce future risk • Implement asset management planning actions, to adequately account for risks during asset replacement and renewal (particularly for assets with high cost and / or long design life) • Implement monitoring of risks, to support the development and measurement of triggers for future adaptation action
2040 to 2100 **2100**	• Confirm preferred actions for managing future risks / assets • Confirm preferred triggers for action implementation (e.g. a depth or frequency of inundation as measured by existing or new water level monitoring gauges or points) • At trigger 1, commence planning, approvals, funding etc to implement preferred action • At trigger 2 (and prior to undesirable impact) implement preferred action

D.4.1 Recommendations for New Actions

As outlined in Table D-8 above, new actions to be implemented over the current timeframe are focussed upon avoiding future risk and improving the ability to manage risks in the future. This essentially involves the following key areas for action.

(1) **Planning.** In the case of tidal inundation, while there exists adequate planning for typical flood risk, there is currently no planning for tidal inundation risks on land where the impacts may be effectively permanent. Such planning could entail a foreshore building line, controls to prevent intensification of development in high risk area, setback or buffer, that allows for habitat migration, community and public land, or public right of access to the foreshore, as required.

(2) **Asset management.** Regular asset renewal and replacement timeframes may offer an excellent opportunity to relocate, redesign or retrofit an existing asset to mitigate future risk. For this to occur, however, asset management plans need to contain risk information, and need to include a process to trigger assessment of this risk when asset replacement is due. Importantly, the approach to managing the risk needs to consider the lifespan of the asset with respect to the expected timeframe of risk impact (e.g. 100 year risk outcomes may not be relevant to a 25 year lifespan asset); and needs to consider the interdependencies of the asset with the function of other assets (e.g. protecting a shoreline for a carpark at the expense of habitat migration, or raising an asset that can no longer be accessed and serviced). Novel approaches to asset replacement are also pivotal, for example, to reducing offsite impacts from risk mitigation e.g. protecting versus relocating assets, and for some assets may be essential (e.g. pumping stations must necessarily be on low-lying ground). However, if done adequately, using regular asset management to implement risk treatments is a highly cost effective and resource efficient approach to managing coastal risk. For example, the approvals, design, engineering, funding etc are already required for asset replacement,

reducing the additional costs of planning for the risk. Similarly, mitigating the risk at asset replacement stage increases the likelihood that the asset will reach the end of its useful life, instead of being impacted by a coastal risk.

(3) **Monitoring.** Understanding the frequency of impact to various assets and features around the Lake, and subsequent impacts from events provides excellent information with which to design triggers (e.g. the frequency of events that can be managed is understood for different asset types) and to understand the risk profile as risk events become more certain in future.

Using the above risk assessment outcomes and information, actions that can be implemented over the next 10 years to manage inundation risks, and thereby improve future responses to these risks have been developed, assessed and documented in the Lake Illawarra CMP.

D.5 Risk Registers and Risk Maps

Table D-9 below lists the assets affected by tidal inundation by 2100, and the level of risk to that asset over current and future timeframes around the Lake Illawarra foreshore. The assets listed are those deemed “at risk” and are not a complete list of assets around the Lake. The risk register simply identifies if the asset is affected it does not indicate the percentage of land affected and furthermore the highest risk level encountered is listed. The risk register is a direct output from the risk maps, the scale at which the risk maps are presented is of a high level such that where small sections of land are affected they will still be listed in the register.

Following Table D-9, a series of risk maps have been created covering the four quadrants (or corners) of Lake Illawarra, in Section . The risk maps display the level of risk to the various assets at each timeframe of interest, namely present (2016), 2040, 2070 and 2100. The risk maps are intended to support the above risk assessment, risk registers and recommendations in the CMP.

D.6 References

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Table D-9 Register of Assets and Level of Risk from Tidal Inundation in Lake Illawarra

Asset Category	Asset Type	Asset Name	Suburb	2016	2040	2070	2100
Community Asset	Carpark\Carpark	Dunsters Reserve Carpark, Albion Park Rail	ALBION PARK RAIL		Low	Medium	High
Community Asset	Carpark\Carpark	Opposite Lake South Public School Carpark	LAKE ILLAWARRA		Low	Medium	High
Community Asset	Carpark\Carpark	Pelican Park (west), Reddall Pde Carpark	LAKE ILLAWARRA		Low	Medium	High
Community Asset	Carpark\Carpark	Reddall Reserve Carpark 5 (View St) Reddall Pde	LAKE ILLAWARRA		Low	Medium	High
Community Asset	Community Building	BOONERAH POINT - SCOUT HALL	MOUNT WARRIGAL	High	Very High	Very High	Very High
Community Asset	Community Building	Windang Memorial Park	Windang		Medium	High	High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	ALBION PARK RAIL	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	Berkeley	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	Kanahooka	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	Koonawarra	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	Lake Heights	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	LAKE ILLAWARRA	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	MOUNT WARRIGAL	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	OAK FLATS	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	Warrawong	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	Waterway	High	Very High	Very High	Very High
Community Asset	Footpath/ Cycleway/ Shared access way	Footpath/ Cycleway/ Shared access way	Windang	High	Very High	Very High	Very High
Community Asset	Open Space and Recreation\Park Furniture\Play Equ*	Play Equipment	LAKE ILLAWARRA	Medium	High	High	Very High
Community Assets	Natural Area	JACKSON AVENUE RESERVE	Warrawong	Medium	High	High	Very High
Community Assets	Natural Area	JACKSON AVENUE RESERVE	Waterway	Medium	High	High	Very High
Community Assets	Natural Area	Natural Area	Kanahooka	High	Very High	Very High	Very High
Community Assets	Natural Area	Natural Area	Primbee	High	Very High	Very High	Very High
Community Assets	Natural Area	Natural Area	Waterway	High	Very High	Very High	Very High
Community Assets	Natural Area	Natural Area	Windang	High	Very High	Very High	Very High
Community Assets	Natural Area	RESERVE BEHIND LAKELINE ESTATE	Kanahooka	High	Very High	Very High	Very High
Community Assets	Natural Area	Reserve between Northcliffe Drive and Cycleway	Lake Heights	High	Very High	Very High	Very High
Community Assets	Natural Area	Windang Beach	Waterway	High	Very High	Very High	Very High
Community Assets	Natural Area	Windang Beach	Windang	High	Very High	Very High	Very High
Community Assets	Natural Area	Windang Surf Club Surrounds	Waterway		Medium	High	High
Community Assets	Natural Area	Windang Surf Club Surrounds	Windang		Medium	High	High
Community Assets	Open Space / Reserves / Parks	Barnes Park	Lake Heights		Medium	High	High
Community Assets	Open Space / Reserves / Parks	Edith Lacey Park Adjoining Lake	Waterway	Medium	High	High	Very High
Community Assets	Open Space / Reserves / Parks	Edith Lacey Park Adjoining Lake	Windang	Medium	High	High	Very High
Community Assets	Open Space / Reserves / Parks	Edith Lacey Park Adjoining Tennis Courts	Windang		Medium	High	High
Community Assets	Open Space / Reserves / Parks	ELEEBANA RESERVE	Kanahooka	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	ELEEBANA RESERVE	Koonawarra	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Fred Finch Park	Berkeley	High	High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Holbom Park West Sctn	Berkeley	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Holbom Park West Sctn	Waterway	High	High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Hooka Point Park	Berkeley	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Hooka Point Park	Waterway	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	JAMES AVENUE RESERVE	Primbee	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Kanahooka Park	Kanahooka	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Kanahooka Park	Waterway	High	High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	KULLY BAY PARK 2	Warrawong	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	KULLY BAY PARK 2	Waterway	High	Very High	Very High	Very High

Table D-9 Register of Assets and Level of Risk from Tidal Inundation in Lake Illawarra

Asset Category	Asset Type	Asset Name	Suburb	2016	2040	2070	2100
Community Assets	Open Space / Reserves / Parks	KULLY BAY PARK Closest to Yatch Club	Warrawong	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	KULLY BAY PARK Closest to Yatch Club	Waterway	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Kully Bay Park Off King st	Warrawong		Medium	High	High
Community Assets	Open Space / Reserves / Parks	Lakeside Drive Reserve	Koonawarra	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Lakeside Drive Reserve	Waterway	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	NORTHCLIFFE/CYCLEWAY RESERVE Adjoining No 37	Lake Heights	Medium	High	High	Very High
Community Assets	Open Space / Reserves / Parks	NORTHCLIFFE/CYCLEWAY RESERVE Adjoining No 87	Lake Heights	Medium	High	High	Very High
Community Assets	Open Space / Reserves / Parks	NORTHCLIFFE/CYCLEWAY RESERVE Adjoining No 87	Waterway	Medium	High	High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	ALBION PARK RAIL	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Berkeley	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Brownsville	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Haywards Bay	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Kanahooka	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Koonawarra	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Lake Heights	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	LAKE ILLAWARRA	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	MOUNT WARRIGAL	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	OAK FLATS	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Primbee	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Warrawong	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Waterway	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Windang	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Open Space / Reserves / Parks	Yallah	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Pine Trees Park	Waterway	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Pine Trees Park	Windang	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	PURRAH BAY RESERVE	Kanahooka	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	PURRAH BAY RESERVE	Waterway	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Purry Burry Point	Primbee	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Purry Burry Point	Waterway	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	William Beach Park	Brownsville	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Windang Foreshore Park 9-15 Judbooley Pde	Windang	Medium	High	High	Very High
Community Assets	Open Space / Reserves / Parks	Windang Foreshore Park adjoining lake	Waterway		Medium	High	High
Community Assets	Open Space / Reserves / Parks	Windang Foreshore Park adjoining lake	Windang	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Windang Foreshore Park up to Windang Rd	Windang	Medium	High	High	Very High
Community Assets	Open Space / Reserves / Parks	Windang Peninsula Heritage Park	Windang	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Wollamai Point	Lake Heights	High	Very High	Very High	Very High
Community Assets	Open Space / Reserves / Parks	Wollamai Point	Waterway	High	Very High	Very High	Very High
Community Assets	Sports Ground / Recreational Clubs	Boronia Oval	Windang		Medium	High	High
Community Assets	Sports Ground / Recreational Clubs	Fred Finch Park Sports	Berkeley	Medium	High	High	Very High
Community Assets	Sports Ground / Recreational Clubs	Fred Finch Park Sports Sth	Berkeley	High	Very High	Very High	Very High
Community Assets	Sports Ground / Recreational Clubs	Holbom Park Sailing Club	Berkeley	High	Very High	Very High	Very High
Community Assets	Sports Ground / Recreational Clubs	Holbom Park Sailing Club	Waterway	High	High	Very High	Very High
Community Assets	Sports Ground / Recreational Clubs	Sports Field Rugby - Cec Glenholmes*	LAKE ILLAWARRA		Medium	High	High
Community Assets	Sports Ground / Recreational Clubs	Sports Field Rugby - Cec Glenholmes*	Waterway	High	High	Very High	Very High
Community Assets	Sports Ground / Recreational Clubs	Sports Ground / Recreational Clubs	Berkeley		Medium	High	High
Community Assets	Sports Ground / Recreational Clubs	Sports Ground / Recreational Clubs	Kanahooka	High	Very High	Very High	Very High

Table D-9 Register of Assets and Level of Risk from Tidal Inundation in Lake Illawarra

Asset Category	Asset Type	Asset Name	Suburb	2016	2040	2070	2100
Community Assets	Sports Ground / Recreational Clubs	Sports Ground / Recreational Clubs	Kembla Grange	High	Very High	Very High	Very High
Community Assets	Sports Ground / Recreational Clubs	Sports Ground / Recreational Clubs	Lake Heights	High	Very High	Very High	Very High
Community Assets	Sports Ground / Recreational Clubs	Sports Ground / Recreational Clubs	Warrawong	High	Very High	Very High	Very High
Community Assets	Sports Ground / Recreational Clubs	Sports Ground / Recreational Clubs	Waterway	High	Very High	Very High	Very High
Community Assets	Sports Ground / Recreational Clubs	Sports Ground / Recreational Clubs	Windang	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Coastal Saltmarsh	ALBION PARK RAIL	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Coastal Saltmarsh	Berkeley	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Coastal Saltmarsh	Haywards Bay	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Coastal Saltmarsh	Koonawarra	High	High	Very High	Very High
Natural Assets	Coastal Wetlands	Coastal Saltmarsh	Lake Heights	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Coastal Saltmarsh	LAKE ILLAWARRA	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Coastal Saltmarsh	OAK FLATS	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Coastal Saltmarsh	Waterway	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Coastal Saltmarsh	Yallah	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Mangrove	LAKE ILLAWARRA	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Saltmarsh	ALBION PARK RAIL	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Saltmarsh	Berkeley	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Saltmarsh	Haywards Bay	High	High	Very High	Very High
Natural Assets	Coastal Wetlands	Saltmarsh	Lake Heights	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Saltmarsh	LAKE ILLAWARRA	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Saltmarsh	Primbee	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Saltmarsh	Warrawong	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Saltmarsh	Waterway	High	Very High	Very High	Very High
Natural Assets	Coastal Wetlands	Saltmarsh	Yallah	High	High	Very High	Very High
Natural Assets	EEC	Freshwater Wetlands on Coastal Floodplains	Berkeley	High	Very High	Very High	Very High
Natural Assets	EEC	Freshwater Wetlands on Coastal Floodplains	Haywards Bay	Medium	High	High	Very High
Natural Assets	EEC	Freshwater Wetlands on Coastal Floodplains	Waterway	Medium	High	High	Very High
Natural Assets	EEC	Freshwater Wetlands on Coastal Floodplains	Yallah		Medium	High	High
Natural Assets	EEC	Illawarra Lowlands Grassy Woodland	Berkeley	High	Very High	Very High	Very High
Natural Assets	EEC	Illawarra Lowlands Grassy Woodland	Brownsville	High	Very High	Very High	Very High
Natural Assets	EEC	Illawarra Lowlands Grassy Woodland	Kembla Grange	Medium	High	High	Very High
Natural Assets	EEC	Illawarra Lowlands Grassy Woodland	OAK FLATS	High	Very High	Very High	Very High
Natural Assets	EEC	Illawarra Lowlands Grassy Woodland	Waterway	High	Very High	Very High	Very High
Natural Assets	EEC	Illawarra Lowlands Grassy Woodland	Yallah	Medium	High	High	Very High
Natural Assets	EEC	Illawarra Subtropical Rainforest	Lake Heights	High	Very High	Very High	Very High
Natural Assets	EEC	Illawarra Subtropical Rainforest	Waterway	High	Very High	Very High	Very High
Natural Assets	EEC	Possible Riverflat Eucalypt Forest	Yallah	High	High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	ALBION PARK RAIL	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Berkeley	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Brownsville	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Calderwood		Medium	High	High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Haywards Bay	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Kanahooka	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Kembla Grange	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Koonawarra	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Lake Heights	Medium	High	High	Very High

Table D-9 Register of Assets and Level of Risk from Tidal Inundation in Lake Illawarra

Asset Category	Asset Type	Asset Name	Suburb	2016	2040	2070	2100
Natural Assets	EEC	Swamp Oak Floodplain Forest	LAKE ILLAWARRA	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	MOUNT WARRIGAL	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	OAK FLATS	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Primbee	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Warrawong	Medium	High	High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Waterway	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Windang	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Oak Floodplain Forest	Yallah	High	Very High	Very High	Very High
Natural Assets	EEC	Swamp Sclerophyll Forest	OAK FLATS	High	High	Very High	Very High
Natural Assets	EEC	Swamp Sclerophyll Forest	Yallah	Medium	High	High	Very High
Natural Assets	EEC	Sydney Freshwater Wetlands	ALBION PARK RAIL	High	Very High	Very High	Very High
Natural Assets	EEC	Sydney Freshwater Wetlands	Berkeley	High	Very High	Very High	Very High
Natural Assets	EEC	Sydney Freshwater Wetlands	Haywards Bay	High	Very High	Very High	Very High
Natural Assets	EEC	Sydney Freshwater Wetlands	LAKE ILLAWARRA	High	Very High	Very High	Very High
Natural Assets	EEC	Sydney Freshwater Wetlands	MOUNT WARRIGAL	High	Very High	Very High	Very High
Natural Assets	EEC	Sydney Freshwater Wetlands	OAK FLATS		Medium	High	High
Natural Assets	EEC	Sydney Freshwater Wetlands	Primbee	High	Very High	Very High	Very High
Natural Assets	EEC	Sydney Freshwater Wetlands	Warrawong	High	High	Very High	Very High
Natural Assets	EEC	Sydney Freshwater Wetlands	Waterway	High	Very High	Very High	Very High
Natural Assets	EEC	Sydney Freshwater Wetlands	Yallah	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	Fred Finch Park Nat Area	Berkeley	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	Fred Finch Park Nat Area	Waterway	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	ALBION PARK RAIL	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	Berkeley	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	Brownsville	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	Haywards Bay	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	Kanahooka	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	LAKE ILLAWARRA	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	Primbee	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	Warrawong	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	Waterway	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	National Parks / Nature Reserves / Natural Areas	Yallah	High	Very High	Very High	Very High
Natural Assets	National Parks / Nature Reserves / Natural Areas	Windang Peninsula Heritage Park Nat Area	Windang	High	High	Very High	Very High
Transport Assets	Minor Bridge	Minor Bridge	ALBION PARK RAIL	Low	Medium	High	High
Transport Assets	Minor Bridge	Minor Bridge	OAK FLATS	Medium	High	High	High
Transport Assets	Railway	Railway	ALBION PARK RAIL	High	High	High	High
Transport Assets	Roads Major	KANAHOOKA RD	Waterway	Low	Medium	High	High
Transport Assets	Roads Major	LAKESIDE DR	Kanahooka	Low	Medium	High	High
Transport Assets	Roads Major	LAKESIDE DR	Koonawarra	High	High	High	High
Transport Assets	Roads Major	NORTHCLIFFE DR	Warrawong		Low	Medium	High
Transport Assets	Roads Major	PRINCES HWY	Dapto	Medium	High	High	High
Transport Assets	Roads Major	PRINCES HWY	Kembla Grange	Low	Medium	High	High
Transport Assets	Roads Major	PRINCES HWY	Yallah	High	High	High	High
Transport Assets	Roads Major	PRINCES MWY	Berkeley	High	High	High	High
Transport Assets	Roads Major	PRINCES MWY	Brownsville	High	High	High	High
Transport Assets	Roads Major	PRINCES MWY	Kembla Grange	Low	Medium	High	High

Table D-9 Register of Assets and Level of Risk from Tidal Inundation in Lake Illawarra

Asset Category	Asset Type	Asset Name	Suburb	2016	2040	2070	2100
Transport Assets	Roads Major	REDDALL PDE	LAKE ILLAWARRA	High	High	High	High
Transport Assets	Roads Major	REDDALL PDE	MOUNT WARRIGAL	High	High	High	High
Transport Assets	Roads Major	WINDANG RD	Waterway	High	High	High	High
Transport Assets	Roads Major	WINDANG RD	Windang	High	High	High	High
Transport Assets	Roads Minor	BORTHWICK ST	Primbee		Low	Medium	High
Transport Assets	Roads Minor	ELEEBANA CR	Koonawarra	Medium	High	High	High
Transport Assets	Roads Minor	FERN ST	Windang	Low	Medium	High	High
Transport Assets	Roads Minor	FISHER ST	OAK FLATS		Low	Medium	High
Transport Assets	Roads Minor	GILBA RD	Waterway	High	High	High	High
Transport Assets	Roads Minor	HOOKA CREEK RD	Berkeley	Medium	High	High	High
Transport Assets	Roads Minor	HOOKA CREEK RD	Waterway	Medium	High	High	High
Transport Assets	Roads Minor	JAMES AVE	Primbee	High	High	High	High
Transport Assets	Roads Minor	JUDBOOLEY PDE	Windang		Low	Medium	High
Transport Assets	Roads Minor	KANAHOOKA ST	ALBION PARK RAIL	Low	Medium	High	High
Transport Assets	Roads Minor	KAROO ST	ALBION PARK RAIL	High	High	High	High
Transport Assets	Roads Minor	KURRAJONG ST	Windang		Low	Medium	High
Transport Assets	Roads Minor	OAKS AVE	Kanahooka		Low	Medium	High
Transport Assets	Roads Minor	OCEAN ST	LAKE ILLAWARRA		Low	Medium	High
Transport Assets	Roads Minor	OVERHILL RD	Primbee	Low	Medium	High	High
Transport Assets	Roads Minor	PURRY BURRY AVE	Primbee	High	High	Very High	Very High
Transport Assets	Roads Minor	PURRY BURRY AVE	Waterway	Medium	High	High	High
Transport Assets	Roads Minor	VIEW ST	LAKE ILLAWARRA		Low	Medium	High
Transport Assets	Roads Minor	WERRANG ST	ALBION PARK RAIL	Low	Medium	High	High
Transport Assets	Roads Minor	WHITEHEATH LANE	Primbee	Low	Medium	High	High
Transport Assets	Roads Minor	WINDANG ST	ALBION PARK RAIL		Low	Medium	High
Transport Assets	Roads Minor	WINDANG ST	LAKE ILLAWARRA		Low	Medium	High
Transport Assets	Roads Minor	WOOROO ST	ALBION PARK RAIL	High	High	High	High
Transport Assets	Roads Minor	YALLAH BAY RD	Yallah	High	High	High	High
Urban Development	Comercial Development	Comercial Development	Yallah	Low	Medium	High	High
Urban Development	Heritage	California Guest House & Tree	LAKE ILLAWARRA		Low	Medium	High
Urban Development	Heritage	Evans Holiday Cottage	OAK FLATS	High	High	High	High
Urban Development	Heritage	Holiday Cottage	OAK FLATS	Low	Medium	High	High
Urban Development	Heritage	Illawarra House jetty relic	OAK FLATS		Low	Medium	High
Urban Development	Heritage	Oak Flats subdivision & road layout	OAK FLATS		Low	Medium	High
Urban Development	Heritage	Queenslander elevated cottage	OAK FLATS	Medium	High	High	High
Urban Development	Heritage	Slater's Bridge	OAK FLATS		Low	Medium	High
Urban Development	Heritage	Slater's Cottage	ALBION PARK RAIL	Medium	High	High	High
Urban Development	Industrail Develpoment	Industrail Develpoment	OAK FLATS		Low	Medium	High
Urban Development	Residental Development	Residental Development	ALBION PARK RAIL	High	Very High	Very High	Very High
Urban Development	Residental Development	Residental Development	Berkeley		Medium	High	High
Urban Development	Residental Development	Residental Development	Kanahooka	High	Very High	Very High	Very High
Urban Development	Residental Development	Residental Development	Koonawarra	High	Very High	Very High	Very High
Urban Development	Residental Development	Residental Development	Lake Heights	High	Very High	Very High	Very High
Urban Development	Residental Development	Residental Development	LAKE ILLAWARRA	Medium	High	High	Very High
Urban Development	Residental Development	Residental Development	MOUNT WARRIGAL	High	Very High	Very High	Very High
Urban Development	Residental Development	Residental Development	OAK FLATS	High	Very High	Very High	Very High

Table D-9 Register of Assets and Level of Risk from Tidal Inundation in Lake Illawarra

Asset Category	Asset Type	Asset Name	Suburb	2016	2040	2070	2100
Urban Development	Residental Development	Residental Development	Primbee	High	Very High	Very High	Very High
Urban Development	Residental Development	Residental Development	Warrawong		Medium	High	High
Urban Development	Residental Development	Residental Development	Waterway	High	Very High	Very High	Very High
Urban Development	Residental Development	Residental Development	Windang	Medium	High	High	Very High
Urban Development	Rural Land	Rural Land	ALBION PARK RAIL	High	High	High	High
Urban Development	Rural Land	Rural Land	Calderwood	Medium	High	High	High
Urban Development	Rural Land	Rural Land	Kanahooka	High	High	High	High
Urban Development	Rural Land	Rural Land	Yallah	Low	Medium	High	High
Urban Development	Tourist Park	Tourist Park	Warrawong	High	High	High	High
Urban Development	Tourist Park	Tourist Park	Windang	High	High	High	High
Urban Development	Tourist Park	Tourist Park	Yallah	Medium	High	High	High
Water Infrastructure	Potable Water Infrastructure	Reticulation	ALBION PARK RAIL	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Reticulation	Berkeley		Medium	High	High
Water Infrastructure	Potable Water Infrastructure	Reticulation	Kanahooka	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Reticulation	Koonawarra	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Reticulation	Lake Heights	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Reticulation	LAKE ILLAWARRA		Medium	High	High
Water Infrastructure	Potable Water Infrastructure	Reticulation	MOUNT WARRIGAL		Medium	High	High
Water Infrastructure	Potable Water Infrastructure	Reticulation	OAK FLATS	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Reticulation	Primbee	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Reticulation	Waterway	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Reticulation	Windang		Medium	High	High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	ALBION PARK RAIL	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	Berkeley		Medium	High	High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	Kanahooka		Medium	High	High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	Kembla Grange	High	High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	LAKE ILLAWARRA	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	MOUNT WARRIGAL		Medium	High	High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	OAK FLATS	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	Primbee	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	Warrawong		Medium	High	High
Water Infrastructure	Potable Water Infrastructure	Service Connection Line	Windang	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	ALBION PARK RAIL	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	Berkeley	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	Brownsville	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	Kanahooka	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	Kembla Grange	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	Koonawarra	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	LAKE ILLAWARRA	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	OAK FLATS	Medium	High	High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	Waterway	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	Windang	High	Very High	Very High	Very High
Water Infrastructure	Potable Water Infrastructure	Trunk	Yallah	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Branch	ALBION PARK RAIL	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Branch	Berkeley	High	High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Branch	Koonawarra	High	Very High	Very High	Very High

Table D-9 Register of Assets and Level of Risk from Tidal Inundation in Lake Illawarra

Asset Category	Asset Type	Asset Name	Suburb	2016	2040	2070	2100
Water Infrastructure	Sewer Infrastructure	Branch	LAKE ILLAWARRA	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Branch	MOUNT WARRIGAL	High	High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Branch	OAK FLATS	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Branch	Primbee	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Branch	Waterway	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Branch	Windang	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Overflow	ALBION PARK RAIL	Medium	High	High	Very High
Water Infrastructure	Sewer Infrastructure	Overflow	Berkeley		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Overflow	Koonawarra	High	High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Overflow	Lake Heights		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Overflow	LAKE ILLAWARRA		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Overflow	OAK FLATS	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Overflow	Warrawong		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Overflow	Windang	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Pressure Main	ALBION PARK RAIL	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Pressure Main	Berkeley		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Pressure Main	Haywards Bay	Medium	High	High	
Water Infrastructure	Sewer Infrastructure	Pressure Main	MOUNT WARRIGAL	Medium	High	High	Very High
Water Infrastructure	Sewer Infrastructure	Pressure Main	OAK FLATS	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Pressure Main	Primbee	Medium	High	High	Very High
Water Infrastructure	Sewer Infrastructure	Pressure Main	Waterway	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Pressure Main	Windang	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Property Connection Sewer	ALBION PARK RAIL	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Property Connection Sewer	Berkeley		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Property Connection Sewer	Lake Heights		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Property Connection Sewer	LAKE ILLAWARRA		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Property Connection Sewer	OAK FLATS	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Property Connection Sewer	Primbee	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Property Connection Sewer	Waterway	High	Very High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Property Connection Sewer	Windang		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Pumping Station - Submersible	ALBION PARK RAIL	Medium	High	High	Very High
Water Infrastructure	Sewer Infrastructure	Relief	Waterway	High	High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Reticulation Low Infiltration Sewer	Windang		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Ventline	ALBION PARK RAIL	Medium	High	High	Very High
Water Infrastructure	Sewer Infrastructure	Ventline	Berkeley	Medium	High	High	Very High
Water Infrastructure	Sewer Infrastructure	Ventline	Brownsville		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Ventline	LAKE ILLAWARRA		Medium	High	High
Water Infrastructure	Sewer Infrastructure	Ventline	OAK FLATS	High	High	Very High	Very High
Water Infrastructure	Sewer Infrastructure	Ventline	Primbee	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	ALBION PARK RAIL	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	Berkeley	High	High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	Kanahooka	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	Koonawarra	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	Lake Heights	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	LAKE ILLAWARRA	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	MOUNT WARRIGAL	Medium	High	High	Very High

Table D-9 Register of Assets and Level of Risk from Tidal Inundation in Lake Illawarra

Asset Category	Asset Type	Asset Name	Suburb	2016	2040	2070	2100
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	OAK FLATS	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	Primbee	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	Warrawong	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	Waterway	High	Very High	Very High	Very High
Water Infrastructure	Stormwater Infrastructure	Stormwater Infrastructure	Windang	High	Very High	Very High	Very High
Waterway Infrastructure	Training Walls	Lake Illawarra Training Walls	LAKE ILLAWARRA	High	Very High	Very High	Very High
Waterway Infrastructure	Training Walls	Lake Illawarra Training Walls	Waterway	Medium	High	High	Very High
Waterway Infrastructure	Training Walls	Lake Illawarra Training Walls	Windang	High	Very High	Very High	Very High
Waterway Infrastructure	Infrastructure\Foreshore Infrastructure\Boat Ramp	Skiway Park Boat Ramp	Waterway		Medium	High	High
Waterways	Natural waterways	Natural waterways	ALBION PARK RAIL	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Berkeley	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Haywards Bay	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Kanahooka	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Koonawarra	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Lake Heights	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	LAKE ILLAWARRA	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	MOUNT WARRIGAL	Low	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	OAK FLATS	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Primbee	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Warrawong	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Waterway	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Windang	Medium	Medium	Medium	Medium
Waterways	Natural waterways	Natural waterways	Yallah	Medium	Medium	Medium	Medium
Waterways	Recreational waterways	Recreational waterways	Berkeley	Medium	Medium	Medium	Medium
Waterways	Recreational waterways	Recreational waterways	Brownsville	Medium	Medium	Medium	Medium
Waterways	Recreational waterways	Recreational waterways	Kanahooka	Medium	Medium	Medium	Medium
Waterways	Recreational waterways	Recreational waterways	Kembla Grange	Medium	Medium	Medium	Medium
Waterways	Recreational waterways	Recreational waterways	LAKE ILLAWARRA	Medium	Medium	Medium	Medium
Waterways	Recreational waterways	Recreational waterways	Warrawong	Medium	Medium	Medium	Medium
Waterways	Recreational waterways	Recreational waterways	Waterway	Medium	Medium	Medium	Medium
Waterways	Recreational waterways	Recreational waterways	Windang	Medium	Medium	Medium	Medium

KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2016.
Lake Illawarra, North West Corner

Figure: 1a

Rev: A

N

0 0.5 1km

Approx. Scale

BMT

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Filepath: "K:\N20606_Lake Illawarra CZMP\GIS\MapInfo\hazard_mapping\2016\2016_hazard_s1_maps.wor"

KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2016.
Lake Illawarra, North East Corner

Figure: 1b

Rev: A

N

0 0.5 1km

Approx. Scale

BMT

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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Tidal Inundation Risk, 2016.
Lake Illawarra, South West Corner

Figure: 1c

Rev: A

N

0 0.5 1km

Approx. Scale

BMT
www.bmt.org

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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2016.
Lake Illawarra, South East Corner

Figure: 1d

Rev: A

N

0 0.5 1km

Approx. Scale

BMT

www.bmt.org

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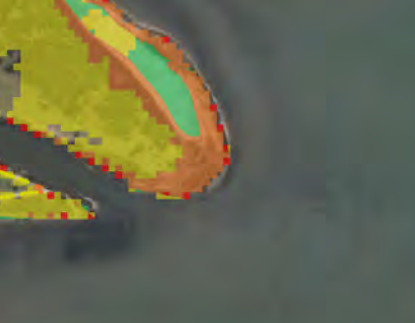
KEY PLAN



LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2040.
Lake Illawarra, North-west Corner

Figure: **2a**

Rev: **A**

N

0 0.5 1km

Approx. Scale

BMT

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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2040.
Lake Illawarra, North-east Corner

Figure: **2b**

Rev: **A**

N

0 0.5 1km

Approx. Scale

BMT

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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Tidal Inundation Risk, 2040.
Lake Illawarra, South-west Corner

Figure: 2c

Rev: A

N

0 0.5 1km

Approx. Scale

BMT

www.bmt.org

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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2040.
Lake Illawarra, South-east Corner

Figure: **2d**

Rev: **A**

N

0 0.5 1km

Approx. Scale

BMT
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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2070.
Lake Illawarra, North-west Corner

Figure: **3a**

Rev: **A**

N

0 0.5 1km

Approx. Scale

BMT

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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2070.
Lake Illawarra, North-east Corner

Figure: **3b**

Rev: **A**

N

0 0.5 1km

Approx. Scale

BMT

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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Tidal Inundation Risk, 2070.
Lake Illawarra, South-west Corner

Figure: 3c

Rev: A

N

0 0.5 1km

Approx. Scale

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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2070.
Lake Illawarra, South-east Corner

Figure: **3d**

Rev: **A**

N

0 0.5 1km

Approx. Scale

BMT
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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2100.
Lake Illawarra, North-west Corner

Figure: **4a**

Rev: **A**

N

0 0.5 1km

Approx. Scale

BMT

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KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2100.
Lake Illawarra, North-east Corner

Figure: **4b**

Rev: **A**

N

0 0.5 1km

Approx. Scale

BMT

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Filepath: "K:\N20606_Lake Illawarra CZMP\GIS\MapInfo\hazard_mapping\2100\2100_hazard_s2_maps.wor"

KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Title:

Tidal Inundation Risk, 2100.
Lake Illawarra, South-west Corner

Figure: **4c**

Rev: **A**

N

0 0.5 1km

Approx. Scale

BMT

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Filepath: "K:\N20606_Lake Illawarra CZMP\GIS\MapInfo\hazard_mapping\2100\2100_hazard_s3_maps.wor"

KEY PLAN

LEGEND

Risk

- Low
- Medium
- High
- Very High

Tidal Inundation Risk, 2100.
Lake Illawarra, South-east Corner

Figure: **4d**

Rev: **A**

N

0 0.5 1km

Approx. Scale

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