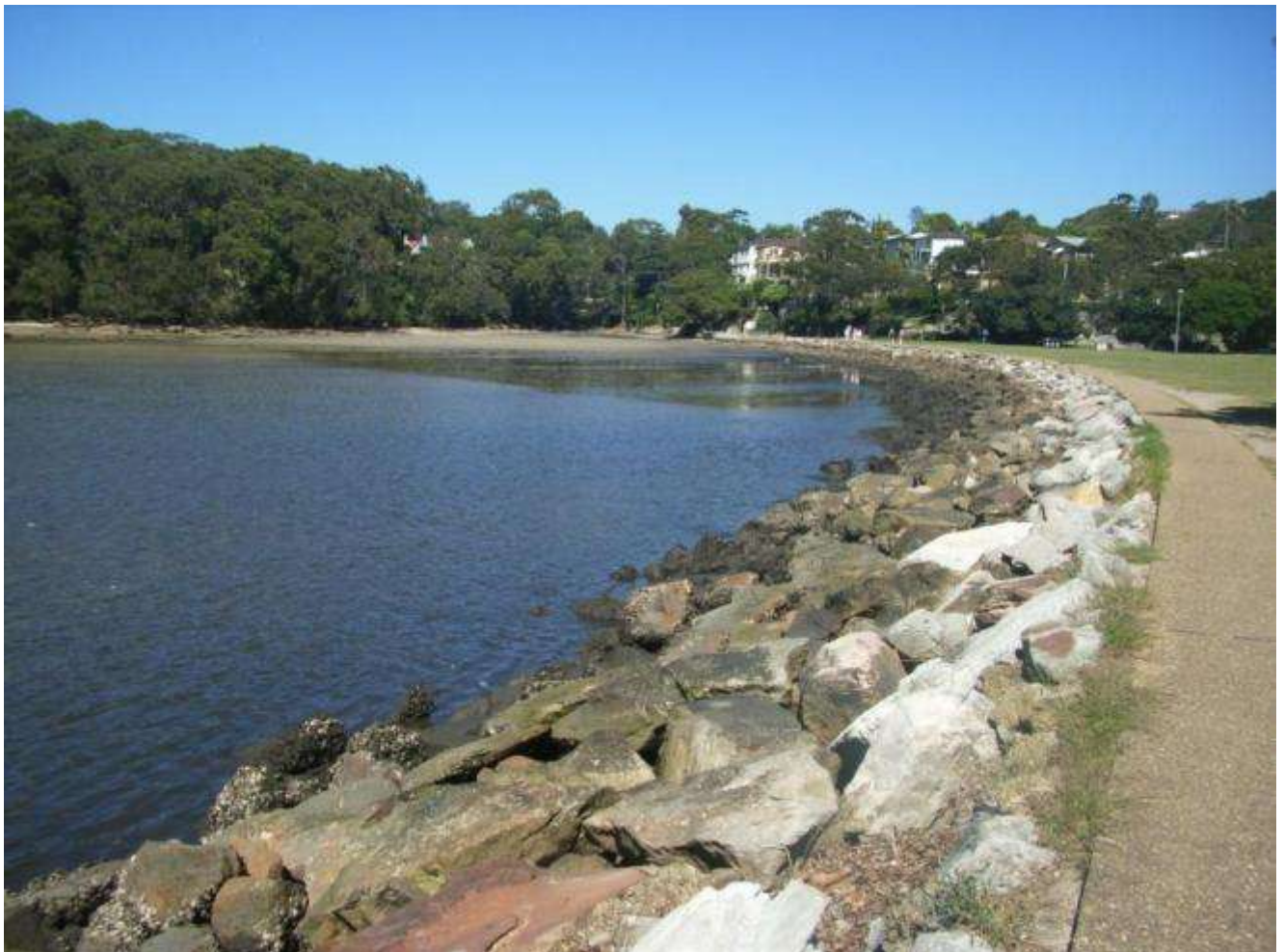




North Harbour

Coastline Management Study

FINAL REPORT



February 2009



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

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i EXECUTIVE SUMMARY

North Harbour Coastline Management Study is intended to present 'baseline condition' of North Harbour study area in relation to land use, land tenure, coastal processes, coastline hazards, climate change impacts, ecological and socio-economic environment. This study identifies all feasible management options to address relevant key issues.

To support this study, a Coastline Hazard Definition Study for the area was completed in April 2004. Also, comprehensive community consultation was conducted during 2006 and 2007.

North Harbour Coastline Management Plan is developed utilising baseline findings and management options proposed in this study

Study Area

North Harbour study area extends both seaward and landward from the shoreline between Federation Point and Wellings Reserve. Included in the study area are rocky intertidal platforms, sandy beaches, grassed reserves, swimming pool, sandstone cliffs, bushland, commercial, retail and residential areas. The study area covers 181 hectares and takes in suburbs of Fairlight, Balgowlah and Balgowlah Heights including Precinct Community Forum areas of Fairlight, North Harbour and Balgowlah Heights.





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Land Use, Tenure & Management

The current land uses within North Harbour study area are predominantly residential development (69.8%), followed by open spaces and parks (16.5%) and road surfaces (12.4%). Manly Scenic Walkway runs through the study area.

Apart from privately owned land, there is a mix of land tenure within the study area including:

- Council owned land: community classification
- Council owned and: operational classification
- Crown land: Council as Trustee
- Energy Australia owned land

There are 10 parcels of community land within the study area. Nine of these parcels are categorised as 'open space'. Plans of Management (PoM) covering these community land are Bareena Park PoM, Geddes Street Bushland Reserve PoM, Brimbecom Park PoM, North Harbour Reserve PoM and Esplanade Park PoM.

The Manly LEP establishes land use zones within the study area as zone 2 – Residential, 3 – Business Zone, 5 – Special Uses Zone and 6 - Open Space. The foreshores and waterways of the study area are designated as W2 (Environment Protection) zone under the Sydney Harbour Regional Environmental Plan.

Significance and Values of North Harbour

North Harbour study area is locally significant in its role as a provider of popular recreational resource for locals and visitors alike and a habitat for native animals and plants. Locals and visitors involve themselves in many recreational pursuits, including swimming, sailing, kayaking, diving, sail boarding, kite-surfing, water skiing and boat and shore fishing. Given its scenic beauty, North Harbour is highly attractive. For these reasons, recreational visitation and use of the waterway is extremely high with significant "flow on" effects for the local and regional economies. Its deep waters are very attractive to the boating community. Because of its scenic beauty and views, foreshores have already become highly sought after residential area.

The study area is rich in Aboriginal cultural heritage giving it significance at the regional and state level. There are five recorded Aboriginal heritage sites within the study area including one rock engraving. European cultural heritage is also an important feature of the study area with numerous heritage listed sites and buildings.

Coastal Processes, Water Quality & Foreshore Structures

The waves, increased water levels and winds associated with storms, together with coastal currents and rivers, set a series of coastal processes and affect human infrastructures such as seawalls and reshape its two beaches, Fairlight & Delwood and shift beach sediments offshore and onshore.

The study area is characterized by natural and cut sandstone cliffs and escarpments with fringing native bushland pockets and landscaped areas along the Esplanade Reserves. The study area has gradual rise to an altitude of 90m with a rapid rise between 40 to 70m.

Storms play an important role in determining the rate and magnitude of shoreline change. The most devastating storm to strike the NSW coastline was the May - June 1974 storm.

Waves occur at Fairlight and Delwood beaches as a result of a combination of ocean swell entering the Harbour during storm events and local wind conditions. Both Fairlight and Delwood Beaches are exposed to wind generated waves, with an open fetch in a 10 degree sector to the south-south-east. Average wave height is established at 80cm, 1.05m with 1 in 10 yr return period and 1.20m with 1 in 50 yr return period.

Longer term sand movements at Fairlight and Delwood Beaches have been examined. In overall terms, for the period 1965 to 1998, Fairlight Beach underwent slight recession, the total loss of sand was approximately 3.2 m³/m. For Delwood Beach, the total gain of sand volume between 1956 and 1998 was approximately 10.6 m³/m.



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Water quality is crucial in overall coastal processes and to protect the health of the North Harbour embayment. The total load of pollutants in stormwater, based on the modelling exercise undertaken for a normal rainfall year, is estimated to be 1,850 kg/year of Total Nitrogen; 220 kg/year of Total Phosphorus; 140 kg/year of Copper, 190 kg/year of Lead, 400 kg/year of Zinc, and 105,300 kg/year of sediment. Roads and residential land-uses deliver the highest loads of almost all pollutants.

DECC routinely measures the two major indicators of bacterial contamination in coastal water, *faecal coliforms* and *enterococci*, at Fairlight Beach site within the study area. Faecal coliform levels complied with swimming guidelines 100% of the time over the last five years between 2002-03 and 2006-07. With the exception of one season, enterococci levels complied 100% of the time over the last five years. There are 3 known sewer overflow locations within the study area.

DPI placed a ban on all commercial fishing within Sydney Harbour, stating the presence of elevated levels of dioxins in fish and crustaceans. Recreational fishing is still permitted, although dietary advice has been issued, stating that limits should be placed on the amount of Harbour caught fish that are consumed.

There are some foreshore structures within the study area. There are two public seawalls: Fairlight Beach Seawall and North Harbour Reserve Rock Revetment Seawall. Total length of seawalls is 0.34km. North Harbour study area has 111 licenses and sites for private moorings and 3 licenses for 91 sites for commercial moorings. Moored boats are usually accessed by dinghies that are stored all along the shores. Treharne's Manly Boat Shed is located within the study area and offers full shipwright services in timber and fibreglass. Davis Marina is located in nearby Forty Basket area. Fairlight pool, located at the eastern end of Fairlight beach, is a well appreciated recreational facility and popular with locals.

Coastline Hazards

Beach erosion is measured in terms of the volume of sand transported offshore and is usually expressed in terms of cubic metres per metre (m^3/m). Beach erosion hazard value of 40 to 60 m^3/m for a 100 year Average Recurrence Interval (ARI) storm event is considered reasonable for both Fairlight & Delwood Beaches.

Excluding the effects of sea level rise, a recession rate of about 0.04 m/yr is adopted for Fairlight Beach. A recession rate of 0.04 m/yr would mean that the beach would reduce in width by 0.8 to 2 m over a period of 20 to 50 years respectively. The current beach width, measured at mean sea level, is approximately 15 m. Similarly, a zero recession rate is adopted for Delwood Beach. It currently has a width, measured at mean sea level, of approximately 8 m.

At present, the hazard posed by drifting sand is generally not significant for Fairlight or Delwood Beaches. There is no historical evidence that inundation has been an issue.

A total of 27 sites with potential geotechnical hazards have been identified. Remediation works at two sites have already been completed.

Climate Change & Adaptations

Sydney's coastal catchments has relatively warm summer, with average maximum January temperatures of approximately 26°C with approximately 3 days above 35°C each year. Winters are cool to mild, with average maximum July temperatures of 17°C. Temperatures rarely fall below 0°C. The catchments receive approximately 1,100 mm of rainfall each year.

Due to impacts of climate change, temperature is projected to rise +0.2 - +1.6°C in 2030 and +0.7 - +4.8°C in 2070. Number of days above 35°C is to increase from 3 to 4-6 days in 2030 and 4-18 days in 2070.

The Sydney Coastal Councils Group has assessed the vulnerability of the SCCG region and its' member Councils to climate change. Manly Council possesses a moderate degree of vulnerability to climate change relative to other Councils. However, due to its coastlines and coastal development, vulnerability to sea-level rise



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and coastal hazards was assessed to be particularly high. In addition, stormwater management may become a challenge in the future due to development and projected increases in future rainfall. The vulnerability of the coastline and the paucity of natural landscapes suggest the Councils' natural ecosystems have a low resilience to the effects of climate change.

Ecological Environment

The ecosystems within the study area are highly fragmented and have signs of the many pressures placed on them through development and high usage.

The marine environment within the study area ranges from rocky intertidal zone to seagrass beds. Three predominant aquatic communities along the foreshore of the study area are 'mixed rocky intertidal & sand', 'sandy beaches' and 'seagrass beds'. The conservation status of these three ecological units is 'high', 'medium' and 'high', respectively. Over 570 species of fish have been recorded in greater Sydney Harbour, and it is likely that a large proportion of these are also present within the study area. The list includes 3 endangered, 5 vulnerable and 18 protected species.

North Harbour Aquatic Reserve lies between an imaginary line from the headlands at North Head and Grotto Point and another line joining Little Manly Point, Manly Point and Forty Baskets Beach. The Reserve extends from the seabed at these outer boundaries up to the mean high water mark between them and covers an area of approximately 260 hectares. There is a proposal to extend this Aquatic Reserve to include total water area of the study area.

The intertidal areas within the North Harbour study area include rocky reefs and platforms, sandy beaches and mudflats and artificial habitat including seawalls, jetties and pontoons. Many types of algae (e.g. - red, green, brown) inhabit the intertidal zone, providing a food source for the many grazing invertebrates. Numerous types of invertebrates, such as worms, crabs and molluscs, can be found in the sediment.

The entire foreshore of Sydney Harbour and its tributaries are protected as an Intertidal Protected Area (IPA) under the *NSW Fisheries Management Act, 1994*, with the exception of waters of North Harbour, north of a line from Manly Point to the South end of Forty Baskets Beach which are excluded. Although the wetland habitat is limited, the NSW State Government has designated large areas in the study area as Wetlands Protection Area (WPA). A total of 62 species are known to be present within intertidal areas. The majority of these species are invertebrates. A small colony of soldier crab is located on the sand bank at the far south west end of North Harbour. This colony surfaces one or two days each year. A small number of Little Penguins are known to use the Federation Point area for breeding and the rocky foreshore and this area is designated as a Wildlife Protection Area.

The terrestrial environment within the study area has experienced the largest change. Bushland reserves occur in a total 9.93 hectares and are scattered throughout the study area. Two reserves have SEPP 19 status under the *NSW Environmental Planning & Assessment Act (EP&A Act 1979)*, requiring preparation of management plans: Nolan Bush (3.00 ha) and West Esplanade Park (4.71ha). Smaller patches of bushland on both public and private land do exist throughout, and in some places provide corridors between the reserves. There are four specific vegetation communities present within these reserves. A total of 3 amphibian, 39 birds, 8 mammal and 9 reptile species have been recorded (Skelton *et.al* 2004). Grey-headed Flying Fox (*Pteropus poliocephalus*) is the only threatened species recorded.

Socio-Economic Environment

Population of the North Harbour study area, according to 2006 census, was only 6,973 increasing from 6,856 in 2001. Number of people who identified themselves as Indigenous was 11 or 0.16% of the population. Manly LGA has a population where 48.7% are males and 51.3% females. Manly's population is ageing with 30.7% of residents over the age of 50.

Manly LGA receives approximately six million visitors annually, of which 75-88% are day visitors attracted to beaches, marine activities and the ferry ride. These visitors mostly are focussed on the Corso and nearby



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beaches. Manly Scenic Walkway attracts many tourists and takes them to more secluded Fairlight Beach and North Harbour Reserve.

Social infrastructure has a direct impact on living conditions, health and potential for economic development. North Harbour Reserve is one of the key social infrastructures in the study area providing many facilities such as BBQs & picnic facilities, and playground, walking paths, toilets, shelters etc. Manly Scenic Walkway is highly used for many activities. There are 4 toilet blocks located within the study area. Two serviced areas with electric BBQs, taps, and garbage bins are located on both ends of the North Harbour Reserve. Children's playgrounds are located on the south side of the North Harbour Reserve, Nanbaree Reserve and Brimbecom Park.

The study area is rich in heritage sites. There are 5 recorded Aboriginal sites within the study area. A number of architectural and archaeological items exist in the study area, built during European settlement period and listed in Manly LEP, Sydney Regional Environmental Plan (Fairlight Pool) and Energy Australia Heritage Registrar.

Community Consultation: Key Issues & Their Management

Structured survey forms were used to obtain community responses on importance, key issues and specific suggestions for inclusion in the Coastline Management Plan. Advertisement in the Manly Daily for community submissions on the 8 October 2005 and temporary display set up in the library foyer explaining the CMP process encouraged community feedback. An item was also included in the relevant Precinct newsletters. Three separate consultation meetings were held.

A total of 167 survey forms were returned throughout the consultation process. Community perceptions on key issues and their management were also assessed through this survey. These can be grouped in six broad based management issues:

- Aquatic/Inter-tidal Habitat Conservation & Management
- Bushland/Terrestrial Habitat Conservation & Management
- Upgrading & Enhancement of Public Facilities
- North Harbour Reserve Improvement
- Hazards & Climate Change
- Heritage Conservation & Management

Community perceptions of managing each of these issues were recorded. These perceptions are the basis for establishing goals, objectives and management options. It appears that there exist certain conflicts between different usage and user groups, especially in relation to dog walking areas, boat storage, cycling on MSW.

Framing Vision, Goals, Management Objectives & Options

Visioning is an important element in any planning process. Setting the future vision ensures strategic long term thinking and is based on the priority areas under the NSW State Plan, targets set by the Natural Resources Commission (NRC) and vision adopted by the Sydney Metropolitan Catchment Management Authority (SMCMA). At local level, the program 'Surfing the Future' provides a direction to aim towards the year 2025 for Manly Local Government Area.

The vision statement, adopted for 'Surfing the Future', has been used in this North Harbour Coastline Management Planning process.

"A thriving community where residents and visitors enjoy a clean, safe and unique natural environment enhanced by heritage and lifestyle"

The vision aims to provide a general statement about the future desired state of the study area. This vision statement, from the onset, establishes importance of visitors, heritage and living in harmony with natural environment and influences setting up of management objectives.



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The vision statement has been followed by six separate issue based goals, elaborated in 21 management objectives. These 21 management objectives were translated into specific and strategic management options. Many of these options have been proposed by community during consultation meetings. Some of the proposed options, before implementation, will be subjected to further consultation with relevant agencies, Precincts and community.

A total of 52 management options are proposed (Table below). Each of the management options are elaborated (Chapter 12) with a description of context, actions, performance target, indicative costs, time frame and responsible agency (ies).

Summary of Key Issues, Goals, Objectives & Management Options

Objectives	Management Options
1.0 Aquatic / Inter-tidal Habitat Conservation & Management <i>Goal: Restore and maintain a healthy and diverse mix of aquatic and intertidal habitats.</i>	
1.1 Establish structured and community led management for an expanded North Harbour Aquatic Reserve.	1.1.1 Submit and pursue a proposal to extend the boundary of North Harbour Aquatic Reserve.
	1.1.2 Prepare the North Harbour Aquatic Reserve Management Plan and implement.
1.2 Ensure all areas of ecological significance are properly protected and conserved.	1.2.1 Pursue & process to declare inter-tidal areas as 'Inter-tidal Protected Area' under the <i>Fisheries Management Act</i> .
	1.2.2 Continue managing Wildlife Protected Area at Federation Point.
	1.2.3 Assess marine biodiversity of North Harbour including Aquatic Reserve.
	1.2.4 Investigate presence of soldier crab colony at the far west end of North Harbour
1.3 Preserve existing seagrass and kelp beds	1.3.1 Encourage NSW DPI to support conservation of seagrass and kelp beds.
	1.3.2 Encourage NSW DPI to implement programmes in line with the 'Control Plan for <i>Caulerpa taxifolia</i> in NSW'.
1.4 Ensure that water quality is suitable for healthy natural habitat conservation	1.4.1 Install Stormwater Quality Improvement Devices (SQIDs) on major stormwater outlets that discharge into North Harbour to ensure healthy aquatic habitat.
	1.4.2 Place screens on minor stormwater outfalls to improve water quality and aquatic health
2.0 Bushland / Terrestrial Habitat Conservation & Management <i>Goal: Protect and enhance urban bushland and native vegetation areas</i>	
2.1 Continue to manage Council's bushland management program	2.1.1 To structure systematic and continued bushland management, prepare a comprehensive management plan and develop a staged implementation programme.
	2.1.2 Prepare site specific management plans for Nolan Bush and West Esplanade Park, the two SEPP 19 bushland, to fulfill statutory requirement.



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Objectives	Management Options
	2.1.3 Initiate processes to obtain SEPP 19 status for Bareena Park & Heathcliff Reserve.
2.2 Undertake systematic program to reduce weed cover in open spaces, reserves and bushland	2.2.1 Continue enhanced weeding program in high weed density areas on a priority basis.
	2.2.2 Investigate sources of rich nutrient discharges at stormwater outlets located in bushland areas and implement appropriate control measures
2.3 Continue to encourage community participation in bush regeneration program and in native plants on public and private lands	2.3.1 Continue Community Bush Care Volunteers programme in the study area.
	2.3.2. Continue publication of 'Bushland News'.
	2.3.3 Continue annual 'Native Plant Giveaway' programme to support residents in maintaining native vegetations on private properties.
	2.3.4 Continue and reassess Council's Street Tree Planting Programme within the study area.
3.0 Upgrading & Enhancement of Public Facilities <i>Goal: Public facilities are upgraded and maintained to facilitate improved social amenity</i>	
3.1 Facilitate improvements to general amenities, traffic and safety at foreshore areas, public reserves and beaches	3.1.1 Enhance general amenities for public use at convenient locations
	3.1.2 Improve and facilitate traffic management around public reserves and beaches
	3.1.3 Install dinghy and kayak storage racks closer to water access within the study area.
	3.1.4 Organise facilities for scuba divers near Fairlight pool.
	3.1.5 Investigate feasibility of constructing a public wharf at North Harbour
3.2 Rationalise mooring places to minimise the impact on ecologically important sea grass beds	3.2.1 Work with NSW Maritime to introduce seagrass friendly moorings
3.3 Ensure safe accessibility to public places including provision of disabled access	3.3.1 Construct paved footpath on both sides of Condamine Street
	3.3.2 Audit disability access of all parks and bays within the study area.
3.4 Facilitate dog walking with better provisions	3.4.1 Review, in consultation with Precincts, off-leash status of North Harbour Reserve.
	3.4.2 Install adequate dog faeces bins, water bowl and bag dispensers.
3.5 Support sustainable recreational fishing	3.5.1 Support continuation of ban on commercial fishing.
	3.5.2 Encourage relevant agencies to continue to monitor Dioxin levels in Sydney Harbour waters.
	3.5.3 Facilitate recreational fishing and work with NSW DPI to educate community about rules and regulations applying to recreational fisher (bag limits, size limits and species types) through NSW Fish care Program



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Objectives	Management Options
4.0 North Harbour Reserve Improvement <i>Goal: Enhance public use of North Harbour Reserve while preserving natural environment and beauty of the Reserve</i>	
4.1 Ascertain health safety issues from landfill and soil of NHR	4.1.1. Carry out necessary investigations to ascertain health risks in soil and sediments at North Harbour Reserve
4.2 Initiate and implement a Masterplan for North Harbour Reserve	4.2.1 Prepare and implement a Landscape Masterplan for North Harbour Reserve, in consultation with Precincts and community
4.3 Assess irrigation options for North Harbour Reserve	4.3.1 Assess recycling of stormwater to irrigate North Harbour Reserve
4.4 Improved (including disable) access in and out of NHR	4.4.1 Widen and upgrade access paths leading to and within North Harbour Reserve.
	4.4.2 Locate and investigate suitability of a graded wheel chair access
	4.4.3 Investigate provision of improved parking facility at North Harbour Reserve.
5.0 Hazards & Climate Change <i>Goal: Assess, minimize and mitigate risks from natural hazards and climate change</i>	
5.1 Reduce to an acceptable level, the risk to property and risk to life as a result of slope and cliff instability identified in the Coastline Hazard Definition Study.	5.1.1 For hazards that are located on private property, owners are contacted, reminded of the identified hazards and recommended to undertake inspections and stabilization works where required.
5.2 Reduce to an acceptable level, the risk of damage as a result of beach erosion and shoreline recession.	5.2.1 Monitor shoreline changes of Fairlight Beach and damage, if any, of foreshore structures
	5.2.2 Ensure future development of Fairlight Beach is compatible with the erosion and recession hazard
	5.2.3 Ensure any protective works minimise impact on beach amenity and access, and where practical improve existing amenity and access
	5.2.4 Encourage DECC to carry out photogrammetric analysis periodically or after major storm events.
5.3 Protect properties and assets from impacts of sea level rise	5.3.1 Assess specific impacts of sea level rise on North Harbour Reserve and devise adaptive measures.
	5.3.2 Assess impact of climate change on areas of ecological significance and devise adaptive measures.
	5.3.3 Work with Sydney Coastal Councils Group to develop regional/ local level climate change model considering protection provided by existing seawalls and rocky foreshores.
5.4 In consultation with community Precinct Forums, undertake adaptation and mitigation measures in	5.4.1 Continue with on-going mitigation and adaptation measures.
	5.4.2 Collect and collate new information and knowledge on climate change



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Objectives	Management Options
relation to climate change impacts	impacts relevant to the study area/ Manly LGA.
	5.4.3 Inform and involve community through Precincts about known impacts of climate change on the study area.
6.0 Heritage Conservation & Management <i>Goal: Ensure that all Aboriginal and European (cultural and natural) heritage areas in the study area are preserved and protected.</i>	
6.1 Ensure that sites of Aboriginal heritage are properly and regularly maintained.	6.1.1 Review Aboriginal Site Management Report for Manly Council (2006) and associated reports to prioritise management needs and develop a plan of implementation.
6.2 Ensure that all sites of non-indigenous heritage are protected under the relevant legislation and in Council planning instruments.	6.2.1. Ensure physical protection and maintenance of all heritage listed items.



ii ABBREVIATIONS

ABS	Australian Bureau of Statistics
AHD	Australian Height Datum
AHO	Aboriginal Heritage Office
CAP	Catchment Action Plan
CCM	Care, Control & Management
CCP	Cities for Climate Protection
CMA	Catchment Management Authority
CMP	Coastline Management Plan
CSIRO	Australia's Commonwealth Scientific and Industrial Research Organisation
DCP	Development Control Plan
DEC	The former NSW Department of Environment and Conservation (at present, DECC)
DECC	NSW Department of Environment and Climate Change
DLWC	The former NSW Department of Land & Water Conservation
DNR	The former NSW Department of Natural Resources (at present, DECC)
DPI	NSW Department of Primary Industries
DWE	NSW Department of Water & Energy
EPA	Environmental Protection Agency (at present, DECC)
EPBC	Environment Protection & Biodiversity Conservation (Act)
EPI	Environmental Planning Instrument (includes LEP, REP and SEPP)
ESD	Ecologically Sustainable Development
GIS	Geographic Information System
GPT	Gross pollution Trap
GSE	Graduate School of Environment, Macquarie University
ICZM	Integrated Coastal Zone Management
IPA	Intertidal Protected Area
IPCC	Inter-Governmental Panel for Climate Change
LEP	Local Environmental Plan
LG	Local Government
LGA	Local Government Area
MC	Manly Council
MEC	Manly Environment Centre
MLALC	Metropolitan Local Aboriginal Land Council
MSL	Mean Sea Level
MSW	Manly Scenic Walkway
MSS	Manly Sustainability Strategy
NH	North Harbour
NHR	North Harbour Reserve
NRC	Natural Resources Commission
NSW	New South Wales
PoM	Plan of Management
REP	Regional Environmental Plan
SAP	Scientific Advisory Panel (of the Manly Council)
SCCG	Sydney Coastal Council Group
SEPP	State Environmental Planning Policy
SES	State Emergency Services
SHOROC	Shore Regional Organisation of Councils
SMCMA	Sydney Metropolitan Catchment Management Authority
SREP	Sydney Regional Environmental Plan
TSC	Threatened Species Conservation (Act)
UWS	University of Western Sydney
WPA	Wetland Protection Area



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1. INTRODUCTION

1.1 COASTLINE MANAGEMENT IN NSW

The coastline is one of the NSW's greatest assets. Beautiful beaches, dunes, estuaries, lakes, lagoons and wetlands attract tourists, support various industries and provide recreation for everyone. However, the coastline is under constant attack from natural forces, and is therefore dynamic and ever-changing. Beaches erode in response to storms, sand dunes migrate inland in response to strong winds, and many sections of the coast are receding due to long-term coastal processes. Climate change is only exacerbating these effects.

Human activities are also causing a host of further problems along the coast. Around 80 per cent of the NSW population lives on the state's coast, with rapid growth projected for the future, generating constant pressure for development.

Department of Environment & Climate Change (DECC) works closely with Catchment Management Authorities (CMAs), local councils and communities to reduce threats from coastal hazards and flooding, and ensure the long term protection, conservation and restoration of coastal and estuarine environments.

DECC manages the NSW Government's Coastal Management Program, which aims to reduce the impact of coastal hazards while accommodating population growth and protecting the coastal environment. Under the program, the NSW Government provides a 50% subsidy, on a dollar-for dollar-basis, to local councils for:

- preparing coastal studies and coastal zone management plans for long-term management of the coastline
- measures to conserve or improve beaches
- investigating, designing and implementing measures to reduce the risk of damage from coastal hazards

During 2007–08, 36 grants totalling \$2.89 million were approved under the Coastal Management Program in 17 local government areas for projects such as hazard mitigation works, dune restoration and enhancement of coastal facilities (DECC 2008a).

1.2 COASTLINE MANAGEMENT IN MANLY

Manly is known distinctively for its iconic beaches and foreshore areas attracting over six million visitors annually. For this reason it is vitally important that waters and natural features around these beaches and foreshores are nurtured and protected. Majority of Manly Local Government Area is bordered by water. Foreshore areas are under constant attack from natural elements such as wind and waves. Manly's coastal and harbour foreshores respond naturally to these processes, however human activities also contribute to modifying them.

In line with efforts of NSW State Government, Manly Council has also embarked on planning and management of coastal and estuarine areas. The importance of coastal and estuarine management has been significantly highlighted in all key policy, vision & strategy documents adopted by Manly Council. One of the key theme areas of the Manly Sustainability Strategy (MC, 2006) is 'A Natural, Sustainable Manly'. The theme adopts the principle '*Recognise the intrinsic value of Manly's geodiversity, biodiversity and natural ecosystems, and protect and restore them*' and includes the 'Coastline and Estuary Management Program'.

Hence, Manly Council has adopted a staged approach to cover the entire Manly lagoons & foreshores under estuary/coastal management plans (**Table 1.2**). The State Government has provided funding to assist Manly Council to prepare and implement these plans. Environment Levy of Council is mainly instrumental in funding these plans.



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Development of the North Harbour Coastline Management Plan (CMP) is on the principles reflected in the NSW Coastal Policy 1997, ongoing advances in coastal management and amendments made in 2002 to the *Coastal Protection Act 1979*. This is an integrated planning approach that incorporates the management of coastal hazards and risk with social economic, aesthetic, recreational and ecological factors. Development of North Harbour CMP is also undertaken to meet requirements for community land management under the *Local Government Act 1993*, and addresses legislative requirements with respect to community land within the study area.

Table 1.2 Formulation statuses of Coastline & Estuary Management Plans

Plans	Status	Remarks
Manly Lagoon Estuary Management Plan	Completed, August 1988	Being implemented
Cabbage Tree Bay Management Plan	Completed, October 2000	Being implemented
Forty Baskets Coastline Management Plan	Completed, May 2004	Being implemented
Little Manly Coastline Management Plan	Completed, May 2004	Being implemented
Manly Ocean Beach Coastline Management Plan	Completed, February 2008	Being implemented
Clontarf/Bantry Bay Estuary Management Plan	Completed, May 2008	Being implemented
Manly Cove Coastline Management Plan	On-going	Coastline Management Study being reviewed
North Harbour Coastline Management Plan	On-going	Coastline Management Study being finalised (this report)

1.3 COASTLINE MANAGEMENT SYSTEM

The coastline management system (**Fig 1.3**) involves a series of steps to establish a committee, identify various coastal processes and hazards, identify land tenure and existing planning controls, environmental features, sensitivity to climate change, assess management options having regard to social, economic, aesthetic, recreational and ecological issues, recommend the best combinations of options and developing a strategy to implement the plan.

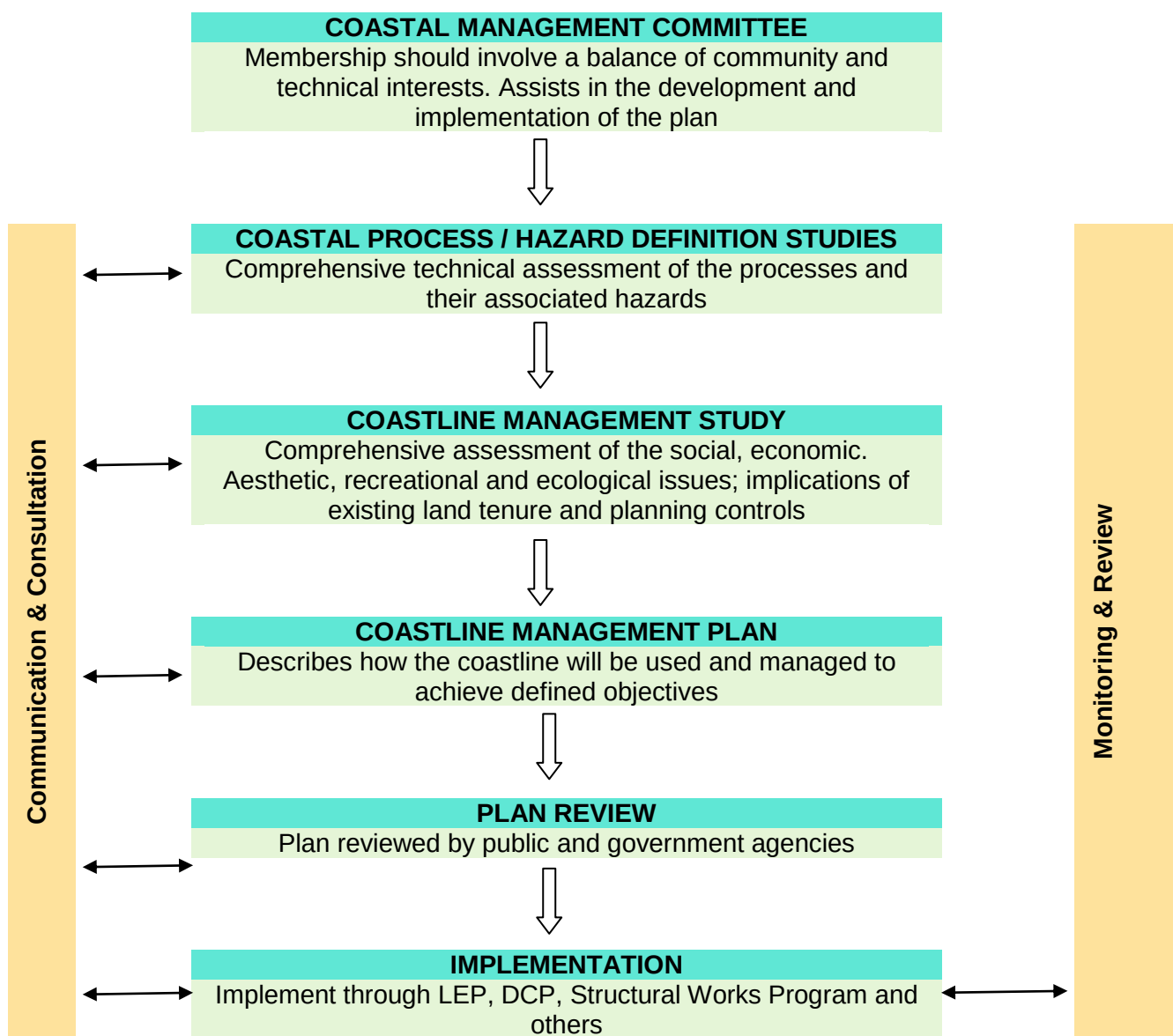
The North Harbour Coastline Management Plan is being developed following steps outlined in Coastline Management Manual (NSW 1990)¹ through the formulation of three key documents as follows:

Formulation of **Coastline Hazard Definition Study** (Patterson, Britton & Partners, 2004), provides sufficient understanding of the coastal processes and their associated hazards. This study has specifically identified hazards threatening the study area

A **Coastline Management Study** assesses the social, economic, aesthetic, recreational and ecological issues associated with land use along the coastline, in addition to coastline hazards, implications of existing land tenure and planning controls. It identifies options relevant to environmental planning and management. The study considers all feasible management options. The study also defines specifically climate change impacts.

¹ DECC was in the process of revising the existing Coastline and Estuary Management Manuals and prepare a combined 'Coastal Zone Management Manual' (DECC 2008b). It is believed that this effort has now been shelved.

Figure 1.3 Elements of the Coastline Management System



Based on information contained in two documents, a **Coastline Management Plan** describes how the coastline will be used and managed to achieve defined objectives. The plan may include:

- a description of the objectives of the plan
- a discussion of issues, problems, special features and values
- a schedule of specific management measures aimed at achieving the objectives
- a description of the means and timing of implementation of these measures.

Coastline management is a multifaceted process that crosses many different disciplines and, to be successful must incorporate a diverse range of skills and expertise.

Community consultation and involvement in decision making are an integral component of the coastline management process. Strong community and stakeholder representation on a coastline management



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committee will assist to promote the widest possible consultation with the community at all stages of the process.

1.4 MANLY HARBOUR FORESHORE MANAGEMENT COMMITTEE

The Manly Harbour Foreshores Management Committee, under the stewardship of Manly Council was established in April 2005 to guide the preparation of a number of plans including the North Harbour Coastline Management Plan. The Committee met bi-monthly. The specific roles of the Committee were to:

- Collectively ensure that the North Harbour CMP project fulfils project brief outcomes;
- Act individually as an initial point of contact and internal reference within respective organisations and agencies;
- Promote the North Harbour CMP project at all levels within respective organisations and agencies to maximise relevant input, participation, eventual endorsement and implementation;
- Facilitate timely exchange of necessary project information to enable project outcomes and milestones to be achieved;
- Contribute or facilitate the provision of specific knowledge and advice in areas of expertise relevant to the project;
- Ensure the integration of current policies, objectives and strategies of relevant organisations and agencies in the North Harbour CMP;
- Provide strategic direction to prepare the Management Plan; and
- To the fullest extent possible ensure the CMP complements concurrent planning for adjacent areas including the Manly Cove and regional planning as gazetted by relevant state government agencies.

The Committee had representations from Manly Council, Precincts, Government organisations, Manly Council's Scientific Advisory Panel and community. The Committee was dissolved in August 2008 before the Local Government Election.

A new committee called 'Manly Coastline & Harbour Foreshore Management Committee' is now being installed and expected to meet in April 2009.

1.5 COASTLINE MANAGEMENT STUDY

Having defined the type, nature and significance of coastline hazards, this **Coastline Management Study** is undertaken, following Coastline Management Manual (NSW 1990), to identify options relevant to the environmental planning and management of the coastal areas. This study is based on a comprehensive assessment of the social, economic, aesthetic, recreational and ecological issues associated with land use along the coastline. The study analyses implications of existing land tenure and planning controls. It identifies options relevant to environmental planning and management and considers all feasible management options. The study defines specifically climate change impacts.

The study is designed to incorporate the principles of Total Catchment Management, and also aims to include issues across the Triple Bottom Line. The Coastline Management Plan (as follow-up of this study) will use the outcomes from this document to adopt a set of agreed management options.

This study has been developed in-house with contribution from an informal 'Coastal Focus Group', consisting of key staff members, under the initial guidance of the 'Manly Harbour Foreshore Management Committee.

Peer review

Review of Preliminary Drafts

Findings from surveys and consultation meetings were presented at the meeting of the Manly Harbour Foreshores Management Committee held on 24 June 2008. A tentative Table of Contents of the North Harbour Coastline Management Study was circulated during the meeting. Broad issues facing North Harbour study area

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were also agreed upon. Executive summary of the preliminary draft was circulated to members of the Manly Harbour Foreshores Management Committee. A presentation of the report was made at the meeting of the Committee on 19 August 2008. As per decision of the Committee, hard copies of the draft report were handed over to representatives of Fairlight and North Harbour Precincts for review.

Review of the Final Draft

A final draft was prepared accommodating comments and suggestions made by members of the Manly Harbour Foreshores Management Committee. A pdf version of the Coastline Management Study was circulated to representatives of relevant state agencies, a member of the Scientific Advisory Panel and key Council staff (Coastal Focus Group) for review and comments. Written comments were received from NSW DPI, NSW DECC, Aboriginal Heritage Office and many members of the Coastal Focus Group. A meeting of the Group was held on 14 January 2009 to present the Study and receive further comments.

The Coastal Focus Group endorsed the final draft pending incorporation of written and verbal comments.

This Final Report accommodates all comments and suggestions received since.

1.6 STUDY AREA

North Harbour study area extends both seaward and landward from the shoreline between Federation Point and Wellings Reserve (**Fig. 1.6**). Included in the study area are rocky intertidal platforms, sandy beaches, grassed reserves, swimming pool, sandstone cliffs, bushland, commercial, retail and residential areas.

Figure 1.6 Aerial view of North Harbour study area





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Seawall backings at Dalwood Beach, Fairlight Beach, Fairlight Pool and North Harbour Reserve as well as sandstone cliff faces and wave cut intertidal platforms and water based developments including Manly Boatshed are all part of the study area.

The study area consists primarily of semi-natural, landscaped and built areas. It is characterized by natural and cut sandstone cliffs and escarpments with fringing native bushland pockets and landscaped areas along the Esplanade Reserves.

The study area borders areas covered by already adopted Forty Basket & Manly Cove Coastline Management Plans.

The study area covers two catchments, North Harbour (with 2 sub-catchments) and Fairlight (with 7 sub-catchments).

North Harbour Aquatic Reserve lies very close to the study area. A new proposal to extend North Harbour Aquatic Reserve to include entire water side of the study area has now been submitted to the Department of Environment & Climate Change for consideration and approval.

North Harbour is a popular location for both visitors and locals alike. The Manly Scenic Walkway, a 10km scenic harbour walking track extending from the Spit Bridge to Manly, directs large numbers of walkers along the length of the study area.

The study area covers approximately 180 hectares and takes in the suburbs of Fairlight, Balgowlah and Balgowlah Heights including Precinct Community Forum areas of Fairlight, North Harbour and Balgowlah Heights.

The entire study area is also part of the Sydney Harbour Foreshores and Waterways Area and Sydney Metropolitan Catchment Management Area. The area, being within Sydney Harbour, is excluded from the legally defined NSW coastal zone. These have implications on administrative and legal management of the study area.



2. COASTLINE MANAGEMENT FRAMEWORK -- INSTITUTIONAL & POLICY ENVIRONMENT

The North Harbour Coastline Management Study has been prepared under the NSW Government's Coastal Management Program. The Program is designed to fulfil the requirements of the NSW Coastal Policy 1997. However, as North Harbour study area comes under the purview of Sydney Harbour catchment, the most important guiding document is the Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 under the *Environmental Planning & Assessment Act 1979*.

The following section identifies relevant commonwealth, state and local legislations and regional planning frameworks and provides a brief outline of applicability of each piece of legislation. This chapter also elaborates on relevant key institutions involved at different levels of the Government.

2.1 RELEVANT COMMONWEALTH POLICIES & ACTS

The following documents are relevant:

Commonwealth Government Coastal Policy 1995

The aim of the Commonwealth Coastal Policy is to promote the ecologically sustainable use of Australia's coastal zone, which house a diverse and interacting mixture of terrestrial, estuarine and marine ecosystems. It presents the Commonwealth's vision for a co-operative, integrated approach to coastal management. While this Policy only applies to those activities for which the Commonwealth has responsibility the document provides some direction in terms of coastal management standards. The Commonwealth Government has no direct responsibility for coastline management of North Harbour; however, many of the best-practice principles (which are mirrored in the NSW Coastal Policy) are being incorporated into the development of the North Harbour CMP.

Environment Protection & Biodiversity Conservation Act 1999

Under the assessment and approval provisions of the *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)*, any action that is likely to have a significant impact on a matter of national environmental significance are subject to an assessment and approval process. Such actions include a project, development, activity or series of activities. The Act applies to North Harbour study area through listed threatened species and ecological communities and potentially through listed migratory species known to inhabit the study area.

Actions that are likely to have a significant impact on the environment of Commonwealth land, and actions taken by the Commonwealth that are likely to have a significant impact on the environment may also require approval under the *EPBC Act*.

National Strategy for the Management of Coastal Acid Sulphate Soils 2000

Acid sulphate soils underlie large areas of Australia's coastline. The impacts of coastal acid sulphate soil runoff come at a significant environmental, economic and social cost to coastal communities. Besides the obvious impact on the environment such as fish kills, acid runoff has been attributed to the decline or failure of fishery and aquaculture industries. The National Strategy for the Management of Coastal Acid Sulphate Soils 2000 proposes a holistic and comprehensive approach to define the problem, prevent it from increasing and encourage remedial actions to reduce existing acid water runoff.

Framework for Integrated Coastal Zone Management 2006

National Cooperative Approach to Integrated Coastal Zone Management (ICZM): Framework & Implementation (2006) provides forward thinking to initiate a nationally cooperative focus on achieving ecologically sustainable development. This sets the scene for national cooperation and provides a strategic tool for guiding national, state, regional and local coastal zone outcomes and adds value to existing initiatives. The major outcomes expected are:

- a) managing coastal issues that are of national scale and scope



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- b) managing coastal issues where complimentary arrangements will work better

The Implementation Plan for the Framework sets out, under strategic priority area, implementation objectives and actions.

Priority Areas	Actions
1. Integration Across the Catchment-Coast-Ocean Continuum	1.1 Research Priorities 1.2 Freshwater Flows 1.3 Communication 1.4 National networks 1.5 State of the Environment Reporting
2. Land and marine-based sources of pollution	2.1 Coastal & estuarine water quality 2.2 Coastal acid sulphate soils 2.3 Marine debris 2.4 Ocean-going commercial vessels waste 2.5 Small commercial and recreational vessel waste 2.6 Dredging
3. Climate Change	3.1 Understanding of climate change 3.2 Managing and adapting to impacts and opportunities
4. Pest plants and animals	4.1 Weeds & feral animals 4.2 Introduced marine pests
5. Planning for population change	5.1 Planning & population
6. Capacity building	6.1 Information 6.2 Education & training 6.3 Incentive measures
7. Monitoring & Evaluation	

2.2 NSW STATE GOVERNMENT ACTS & POLICIES

State Government has developed and promulgated a number of statutory controls, documents and policies which are relevant to the scope of North Harbour study area. These are:

• <i>NSW National Parks and Wildlife Act 1974</i>	• <i>NSW Local Government Act 1993</i>
• <i>NSW Heritage Act 1977</i>	• <i>NSW Fisheries Management Act 1994</i>
• <i>NSW Environmental Planning and Assessment Act 1979 and Environmental Planning and Assessment Amendment Act 2008 No 36</i>	• <i>NSW Threatened Species Conservation Act 1995</i>
• <i>NSW Coastal Protection Act 1979 (amended 2002)</i>	• <i>NSW Coastal Policy 1997</i>
• <i>NSW Coastline Hazard Policy 1988</i>	• <i>NSW Water Management Act 2000</i>
• <i>NSW Crown Lands Act 1989 and Coastal Crown Lands Policy 1991</i>	• <i>NSW Catchment Management Authorities Act 2003</i>
• <i>Estuary Management Policy 1992</i>	•

These are discussed in the following section.



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NSW National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* establishes that the Director-General of DECC is responsible for the care, control and management of all every national park, historic site, state conservation area, regional park, nature reserve, karst conservation reserve and Aboriginal area

The Act provides statutory protection for all Aboriginal objects and places in NSW. Areas are gazetted as Aboriginal places if the Minister is satisfied that there is enough evidence to show the area is, or was, of special significance to Aboriginal culture.

There are a number of key sections in the *NP&W Act*, which are relevant to Aboriginal heritage. These sections deal with the specific protection of:

- particularly significant Aboriginal sites by the Minister for the Environment (s.84),
- the regulation of archaeological activity around Aboriginal sites (s.86-87),
- the legal protection provided to all Aboriginal objects generally (s.90),
- the requirement to notify the Director General when finding a new site (s.91),
- and the Director General's right to issue a stop-work order for actions likely to significantly affect an Aboriginal object or place (s.91AA).

NSW Heritage Act 1977

The *NSW Heritage Act 1977* provides for heritage management by government agencies. Section 170 of the *Heritage Act* outlines the special obligations of government agencies.

The *Heritage Act* protects the State's natural and cultural heritage. Aboriginal and non-indigenous places or objects that are recognized as having high cultural value are listed on the State Heritage Register.

Environmental Planning and Assessment Act 1979 and Environmental Planning and Assessment Amendment Act 2008 No 36

The *Environmental Planning and Assessment Act 1979 (EP&A Act)* sets out the framework for local planning in NSW. The Act, administered by Department of Planning, establishes the framework under which development is assessed and determined by the relevant consent authority for:

- The proper management, development and conservation of natural and artificial resources;
- The planning and co-ordination of development on land and water;
- The sharing of the responsibility for environmental planning between the different levels of government in the state; and
- Achieving ecologically sustainable development on land and water, while promoting orderly and economic development and use on land and water.

To consider the range of possibilities and constraints relating to any proposed development or a particular site, under the *EP&A Act*, a range of planning policies need to be considered. These include the following:

- State Environmental Planning Policies (SEPPs);
- Regional Environmental Plans (REPs);
- Local Environmental Plans (LEPs);
- Development Control Plans (DCPs); and
- Council codes and policies.

SEPPs, REPs and LEPs are collectively referred to as Environmental Planning Instruments (EPIs). The State Government puts SEPPs and REPs in place whereas LEPs are primarily the responsibility of Local Government, although they require the approval of the Minister for Planning.

Under the provisions of the *EP&A Act*, all proposed developments are classified as either:

- Development that needs consent;
- Development that does not need development consent; and
- Development that is prohibited.



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Under recent planning reforms the *EP&A Act* has been amended in a number of respects, more specifically changes to Parts 3 and 4 include:

- Reduction in the number and layers of planning instruments;
- All mandatory controls being placed in the relevant Local Environment Plan (LEP);
- Standardization of LEP's;
- Rationalization and clarification of Development Control Plans (DCP's) and
- Replacing Masterplans with DCP's and staged development applications.

The *Environmental Planning and Assessment Act 1979* provides protection by considering impacts on Aboriginal heritage in land use and planning decisions. The three main areas are:

- planning instruments allow particular uses for land and specify constraints. Aboriginal heritage is a value which should be assessed when determining land use;
- section 90 of the Act lists impacts which must be considered before development approval is granted. Aboriginal heritage is one of these possible impacts;
- State government agencies act as the determining authority on the environmental impacts of proposed activities and must consider a variety of community and cultural factors, including Aboriginal heritage, in their decisions.

There are a number of State Environmental Planning Policies (SEPPs) which operate under the *EP&A Act*. Some of these are detailed below:

SEPP No. 4 - Development Without Consent and Miscellaneous Complying Development

This policy is designed to permit development for a certain purpose which is of minor environmental significance, development for certain purposes by public utility undertakings and development on certain land reserved or dedicated under the *National Parks and Wildlife Act 1974* without the necessity for development consent being obtained.

SEPP No. 14 – Coastal Wetlands

Ensures coastal wetlands are preserved and protected for environmental and economic reasons. The policy applies to local government areas outside the Sydney metropolitan area that front the Pacific Ocean. The policy identifies over 1300 wetlands of high natural value from Tweed Heads to Broken Bay and from Wollongong to Cape Howe. Land clearing, levee construction, drainage work or filling may only be carried out within these wetlands with the consent of the local council and the agreement of the Director General of the Department and Planning. Such development also requires an environmental impact statement to be lodged with a development application. The policy is continually reviewed. It has, for example, been amended to omit or include areas, clarify the definition of the land to which the policy applies and to allow minimal clearing along boundaries for fencing and surveying.

SEPP No. 19 - Bushland in Urban Areas

The general aim of this policy is to protect and preserve bushland within the Greater Sydney area. It requires that bushland not be disturbed without the consent of Council. The SEPP also provides for the preparation of management plans for SEPP 19 Bushland. This policy is integrated into Council's Development Application process.

SEPP 71 – Coastal Protection

The policy has been made to ensure that development in the NSW coastal zone is appropriate and suitably located, to ensure that there is a consistent and strategic approach to coastal planning and management and to ensure there is a clear development assessment framework for the coastal zone.

State Environmental Planning Policy (Major Projects) 2005

This newly created SEPP identifies development that requires consent under the newly created Part 3A of the *EP&A Act*. Development that is considered under Part 3A of the Act is subject to the consent of the Minister for Planning rather than Council. Such development was formerly referred to as *State Significant*



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Development, however, under the new planning reforms is referred to as *Major Projects* and is subject to a different assessment and consent process to development assessed under Part 4 of the *EP&A Act*.

State Environmental Planning Policy (Infrastructure) 2007

Provides a consistent planning regime for infrastructure and the provision of services across NSW, along with providing for consultation with relevant public authorities during the assessment process. The SEPP supports greater flexibility in the location of infrastructure and service facilities along with improved regulatory certainty and efficiency.

Coastal Protection Act 1979

The *NSW Coastal Protection Act 1979* (as amended, 2002) defines the State's 'Coastal Zone'. Under the *Coastal Protection Amendment Act 2002*, North Harbour CMP study area is not included in the coastal zone.

The *NSW Coastal Protection Act 1979* (as amended, 2002) facilitates the carrying out of certain coastal protection works and makes provision to the use and occupation of the coastal zone.

If the Minister has advised a public authority pursuant to Section 38 of the *NSW Coastal Protection Act*, a public authority shall not, without concurrence from the Minister:

- Carry out development in the coastal zone, or
- Grant any right or consent to a person:
 - to use or occupy any part of the coastal zone, or
 - to carry out any development in the coastal zone

Coastline Hazard Policy 1988

The primary objective of the Coastline Hazard Policy is to reduce the impact of coastal hazards on individual owners and occupiers, and to reduce private and public losses resulting from natural coastal forces. Consequently, it is the policy of the NSW Government that:

- the impact of coastal forces on existing developed areas shall be reduced by works and measures and by the purchase of property on a voluntary basis, where appropriate;
- the potential for coastal damage in respect of any proposed coastline development shall be contained by the application of effective planning and development controls by local councils; and
- a merit approach to all development and building decisions which takes account of social, economic and ecological as well as oceanic process considerations, shall be followed by local councils and developers.

This Policy is being implemented through the Coastline Hazard Program. This Policy is proposed to be superseded by the Sea Level rise Policy Statement of 2009.

Crown Lands Act 1989 and Coastal Crown Lands Policy 1991

The *NSW Crown Lands Act 1989* governs the planning, management and use of Crown land, including reservation or dedication for a public purpose, and leasing and licensing.

The *Crown Lands Act 1989* provides for the reservation and dedication of Crown land for a range of public purposes. When land is reserved or dedicated, management of the reserve is mostly undertaken either by:

- The Department of Lands
- A Reserve Trust
- Local Government Councils, by devolvement under the *Local Government Act 1993*.

In the case that Council is appointed as Trustee, Council has the ongoing responsibility to provide care, control and management of Crown land in accordance with the *Crown Lands Act 1989*.



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To ensure that Crown land is managed for the benefit of the people of New South Wales, Council as trustee is required to have regard for the principles of Crown land management. Crown land must be used and managed in accordance those principles under Section 11 of the *Crown Lands Act 1989*. The principles of Crown land management include:

- that environmental protection principles be observed in relation to the management and administration of Crown land,
- that the natural resources of Crown land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible,
- that public use and enjoyment of appropriate Crown land be encouraged,
- that, where appropriate, multiple use of Crown land be encouraged,
- that, where appropriate, Crown land should be used and managed in such a way that both the land and its resources are sustained in perpetuity, and
- that Crown land be occupied, used, sold, leased, licensed or otherwise dealt with in the best interests of the State consistent with the above principles.

A Plan of Management will satisfy the *Crown Lands Act 1989* if the following points are addressed:

- The Plan of Management and its outcomes must incorporate the principles for Crown land management (listed above).
- In addition to incorporating the requirements of Section 36 of the *Local Government Act, 1993* the Plan of Management must address any matters required by the Minister responsible for the *Crown Lands Act* under Section 112 of the Act.
- Any proposed uses, developments and management practices must conform to the public purpose for the reserve.
- The draft Plan of Management is referred to the Department of Lands for comment prior to the public exhibition.
- The draft Plan of Management must be publicly exhibited, including a public notice in the NSW Government Gazette.
- Public submissions regarding the draft Plan of Management are to be referred to both the Minister for Land and Water Conservation and Manly Council as Trust Manager for consideration by the Minister prior to adoption.
- Any alterations to the Plan of Management by the Minister are made.
- Adoption of the Plan of Management by the Minister for Land.
- The Trust must follow the Plan of Management, with all operations being in accordance with the plan.

Coastal Crown Lands Policy

The Coastal Crown Lands Policy issued in 1991 applies to all coastal Crown lands within 1km landward and 3 nautical miles seaward from low water mark. Objectives of the Policy are to:

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

The Policy identifies the assessment of coastal Crown land and the dedication of beaches for a range of public purposes as a high priority to facilitate sound land management of the coastal environment. Where estuary and coastline management plans exist they may form the basis for a land assessment waiver (by the Minister or delegated authority), requiring no formal assessment under the *Crown Lands Act*.

The Policy provides support for the acquisition of unique or environmentally sensitive coastal lands by the State Government, under the Coastal Lands Protection Scheme. Crown lands are identified in the land ownership (Section 3.3) of this Coastline Management Study.



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Estuary Management Policy 1992

The Estuary Management Policy was developed as part of the State Government's recognition of the social and economic importance of estuaries. The specified general goal of the policy is "to achieve an integrated balance responsible and ecologically sustainable use of the State estuaries which form a key component of coastal catchments".

Specific objectives of the policy are:

- Protection of estuarine habitats and ecosystems in the long-term, including maintenance in each estuary of the necessary hydraulic regime;
- Preparation and implementation of a balanced long-term management plan for the sustainable use of each estuary and its catchment, in which all values and uses are considered, and which defines management strategies for:
 - Conservation of aquatic and other wildlife habitats;
 - Conservation of the aesthetic values of estuaries and wetlands;
 - Prevention of further estuary degradation;
 - Repair of damage to the estuarine environment; and
 - Sustainable use of estuarine resources, including commercial uses and recreational uses as appropriate.

An **Estuary Management Manual** has been produced to help develop and implement soundly based Estuary Management Plans.

NSW Local Government Act 1993

Local Government in NSW is established under the *Local Government Act 1993*. This Act conveys a wide range of powers, functions and responsibilities to Local Government, both directly and through other Acts of the NSW Government.

Community Land Plans of Management

Under the *NSW Local Government Act 1993*, Councils are required to prepare Plans of Management (PoM) for all community land. Community land is then required to be managed in accordance with the adopted Plan of Management applying to the land. A PoM may apply to one or more areas of community land (i.e.: a 'generic' PoM) or to just one area (i.e.: a 'specific' PoM). Councils may determine which type of PoM they prepare except in the following cases, for which 'specific' PoMs are required:

- Land declared to be "critical habitat" under the *Threatened Species Conservation Act 1995* (TSC Act) or *Fisheries Management Act 1994*.
- Land directly affected by a recovery plan or threat abatement plan under the *TSC Act* or *FM Act*.
- Land declared by Council to contain 'significant natural features'.
- Land declared by Council to contain an 'area of cultural significance'.

There are additional minimum requirements for 'specific' PoMs described in section 36(3A) of the *LG Act*.

The Coastal Policy 1997 states that where possible joint PoMs will be prepared for foreshore lands where Crown lands and community lands adjoin each other. This Coastline Management Plan includes both Crown and Community Lands where appropriate.

Ecologically Sustainable Development

Under section 7 of the *NSW Local Government Act 1993* Council, Councillors and council employees are required to have regard to the principles of ecologically sustainable development in carrying out their responsibilities.

Section 8 of the *LG Act 1993* defines Council as having the following charter:

"to properly manage, develop, protect, restore, enhance and conserve the environment of the area for which it is responsible, in a manner that is consistent with and promotes the principles of ESD."



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The *NSW LG Act* states that "...ecologically sustainable development requires the effective integration of economic and environmental considerations in decision-making processes. Ecologically sustainable development can be achieved through the implementation of the four principles.

The integration of ESD principles into Council's planning and activities is also required by a number of state and regional policies, strategies and plans. For example ESD is an integral part of the Sydney Regional Coastal Management Strategy, the Sydney Harbour Catchment Blueprint and is required under the NSW Coastal Policy 1997.

Council has sought to integrate ESD into the management decisions and actions identified in this Coastline Management Plan in order to meet its responsibilities under the *LG Act*.

Fisheries Management Act 1994

The *Fisheries Management (FM) Act 1994* and the *Fisheries Management Amendment Acts 1997 and 2001* are developed to conserve, develop and share the fisheries resources of the state for the benefit of present and future generations.

Habitat and species conservation

The Act establishes provisions for NSW Fisheries to conserve fish habitat such as the development of Habitat Protection Plans, the designation of aquatic reserves, regulation of damage to or removal of marine vegetation and the protection of fish spawning areas. Under the *FM Act* approvals are required to dredge and reclaim, harm marine vegetation and restrict the passage of fish.

Threatened Species

The *Fisheries Management Amendment Act 2001* includes new threatened aquatic species provisions including fish and marine vegetation. It also amends the *EP&A Act 1979* and a range of other legislation including the *Threatened Species Conservation Act 1995*.

Marine Protected Areas

The NSW Government is developing a representative system of marine protected areas for NSW Waters in collaboration with the Commonwealth Government's national representative system.

The major aim of NSW protected areas is to manage and conserve marine biodiversity on coastal, estuarine or oceanic areas. Marine protected areas generally fall into the categories of marine parks, aquatic reserves and intertidal protected areas.

The planning process for managing marine protected areas is designed to be flexible to suit local needs and conditions. NSW DECC prepare management plans for marine protected areas, which provide a framework for the development of work programs that meet the objectives of the marine protected area. This is undertaken in consultation with stakeholders and the community.

Aquatic Reserves

The *FM Act* provides for the creation and management of Aquatic Reserves in NSW Waters to conserve the biodiversity of fish and marine vegetation in the area. Any works within this area will require prior approval from NSW DECC.

Intertidal Protected Areas (IPAs)

Intertidal protected areas (IPAs) have been established in nine areas around Sydney to protect selected rocky habitats and intertidal species. The aim is to:

- protect intertidal community biodiversity and structure;
- provide biological reservoirs of breeding stock so exploited areas nearby can be recolonised or sustained; and
- help ensure harvesting of intertidal invertebrates is undertaken at sustainable levels.



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All IPAs extend from the mean high water mark to 10 meters seaward from the mean low water mark. Collecting seashore animals is strictly prohibited in these closures. This includes crabs, snails, cunjevoi, octopus, sea urchins, anemones, pipis, cockles, mussels, oysters, and nippers (saltwater yabbies).

NSW Fisheries Policy & Guidelines: Aquatic Management & Fish Conservation 1998/1999

The Policy and Guidelines apply to all planning and development proposals that affect freshwater, estuarine and marine ecosystems. These documents aim to assist councils and other government agencies in their assessment of proposals and documents such as licenses, development applications and Environment Impact Statements in order to ensure that they are sensitive to, and mitigate impact on, the aquatic environment.

The Policy identifies a number of general Policies for the conservation of fish, marine vegetation and aquatic habitats, which have been considered in the preparation of this Management Plan.

Fish Habitat Protection Plans

To assist in the protection of key fish habitats, the *Fisheries Management Act 1994* enables the creation of Fish Habitat Protection Plans for the protection of any fish habitat. This document presently has two Fish Habitat Protection Plans:

Plan No 1

The Plan applies to the following habitats and features; the quantity and quality of waters, mangroves, seagrass, salt marshes, wetlands (3), mudflats, sand and gravel substrates, rocky reefs, snags (primarily fallen trees and rocks), reed beds and other aquatic plants. This Plan also applies to the following activities: dredging and reclamation, damaging marine vegetation, de-snagging and impeding fish passage.

Plan No 2

This Plan is specific to the protection of seagrass and as a result its primary objective is to “ensure there is no net loss of seagrass within the coastal and estuarine waters of NSW”. The Protection Plan identifies a number of broad strategies for achieving this objective.

The *Fisheries Management Act 1994* states that “A person must not cut, remove, damage or destroy marine vegetation on public water land or an aquaculture lease, or on the foreshore of any land or lease....” Seagrass, mangroves and other types of marine vegetation are included in the definition of marine vegetation. Therefore penalties apply for cutting, removing, damaging or destroying these species without a permit for such activities issued by NSW DPI.

This Plan covers all of NSW’s coastal and estuarine waters. Activities to which this Plan applies include: collection or ‘trimming’ of live seagrass, collection of seagrass from oceanic or estuarine beaches, dredging, reclamation, construction of groynes and breakwaters, construction of jetties, wharves, bridges, ramps and pontoons, moorings, boating and anchoring, fishing, construction and operation of aquaculture facilities, bait digging and collecting and point source pollution. Guidelines for the management of each of these activities are provided in the Plan.

Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995 (TSC Act)* protects all threatened plants and animals native to NSW (with the exception of fish and marine plants, which are covered by the *Fisheries Management Act 1995*). It provides for the identification, conservation and recovery of threatened species, populations and communities. It also aims to reduce the threats faced by those species.

Recovery plans are prepared by the NSW Department of Environment & Climate Change for each threatened species, population and ecological community listed under the *TSC Act*. The Act specifies that Council must not undertake actions that are inconsistent with a recovery plan and must manage the threatened species, population or ecological community in accordance with the relevant recovery plan.



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The *TSC Act* also requires government planners to take account of threatened species before they make environmental plans and policies at a state-wide, regional and local level. The *TSC Act* (and the *EP&A Act*), require that a determining authority cannot carry out or approve an activity that is likely to significantly affect threatened species, populations or ecological communities, or their habitats, unless a Species Impact Statement (SIS), or an EIS has been prepared.

NSW Coastal Policy 1997

The NSW Coastal Policy applies to the NSW Coastal Zone as defined in the *NSW Coastal Protection Act 1979*. As a result, this Policy does not apply to areas of Sydney Harbour including North Harbour CMP study area. However, its principles provide for best practice in minimising the impact of natural coastal forces upon private and public assets.

The NSW Coastal Policy sets a direction for coastal zone management, planning and conservation in NSW. It provides a framework for the balanced and coordinated management of the coast's unique physical, ecological, cultural and economic attributes. The Policy draws into a single document the State's various management policies, programs, standards and plans in order to co-ordinate approach to coastal management.

All NSW State Government agencies and local councils are obliged to take account of the 1997 Coastal Policy in preparation of their own specific policies and programs. The Policy recommends that councils address their implementation of the Policy through the Management Plans, councils are required to prepare under the *NSW Local Government Act 1993*.

NSW Water Management Act 2000

The *Water Management Act 2000* was passed by the NSW Parliament in December 2000 establishing a complete new statutory framework for managing water in NSW. The object of the *Water Management Act 2000* is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The Act is based on the concept of ecologically sustainable development. The Act recognises the need to allocate and provide water for the environmental health of rivers and groundwater systems, while also providing licence holders with more secure access to water and greater opportunities to trade water. The key parts of the legislation are the new arrangements for licensing water and the statutory water sharing plans. Since 1 July 2004 the new licensing and approvals system has been in effect in those areas of NSW covered by operational water sharing plans – these areas cover most of the State's major regulated river systems and therefore the largest areas of water extraction.

The NSW Catchment Management Authorities Act 2003

The *NSW Catchment Management Authorities Act 2003* (CMA Act) provides for the establishment of statutory Catchment Management Authorities, each with a responsible and accountable board. The Act repeals the *Catchment Management Act 1989*.

Catchment Management Authorities were established in January 2004. The functions of a Catchment Management Authority include the following:

- Develop Catchment Action Plans in consultation with Councils and the catchment's communities. These plans will integrate and build on the current Catchment Blueprints.
- Implement Catchment Action Plans through Annual Implementation Programs.
- Provide loans, grants, subsidies or other financial assistance for the purposes of catchment activities and to assist implementation of Catchment Action Plans.
- Provide educational and training courses and materials on natural resource management within the catchment.

A Catchment Action Plan must have regard to the provisions of any environmental planning instrument, other existing natural resource management plans such as Catchment Blueprints, and the need to comply with and promote any State-wide natural resource management standards. These standards are to be developed by the Natural Resources Commission, established under the *Natural Resources Commission Act 2003*.



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A Catchment Management Authority must 'consult widely' during the preparation of a Catchment Action Plan, including with local governments, the catchment's communities and the previous Catchment Management Boards. Public notice of the preparation of a plan must be given and the plan must be placed on public exhibition. In reviewing a draft plan for approval, the Minister must seek the advice of the Natural Resources Commission and must take into account any such advice provided. The Minister may seek and take into account the advice of any other person or body (including Council) in reviewing a draft plan.

North Harbour coastline management area lies within the Sydney Metropolitan Catchment Area. The catchment has an area of 1860 sq.km. and involves 39 LGAs including Manly (further elaboration in 2.5.1).

2.3 REGIONAL PLANS, POLICIES AND STRATEGIES

The study area being located within Sydney Region, following regional plans are relevant for the study area:

- Sydney Regional Environmental Plan - Sydney Harbour Catchments 2005: the Harbour REP
- Sydney Harbour Foreshores and Waterways Area – Development Control Plan 2005
- Sydney Regional Coastal Management Strategy 1998
- Sydney Metropolitan Strategy 2005
- The Northern Sydney Aboriginal Social Plan (NSASP) 2007-2011
- Sydney Metropolitan Catchment Management Action Plan 2008

These are discussed in the following sections.

Sydney Regional Environmental Plan - Sydney Harbour Catchments 2005: the Harbour REP

This is the most important planning document relevant for the North Harbour CMP study area. The plan consolidates and replaces the following instruments: - Sydney Regional Environmental Plan No. 22 - Parramatta River (SREP 22); - Sydney Regional Environmental Plan No. 23 - Sydney and Middle Harbours (SREP 23); and amends State Environmental Planning Policy No. 56 Sydney Harbour Foreshores and Tributaries (SEPP 56).

The Harbour REP covers the area of Sydney Harbour and aims to establish a balance between promoting a prosperous working Harbour, maintaining a healthy and sustainable waterway environment and promoting recreational access to the foreshore and waterways. It establishes planning principles and controls for the catchment as a whole as follows:

- All waterways are classified into one of nine zonings as a mean of identifying appropriate location for a wide variety of uses;
- The working Harbour is preserved by retaining a prosperous working waterfront and an effective transport corridor, including port and maintenance facilities, naval and aviation uses, commercial and marinas and boatsheds.
- The zoning plan aims to improve water safety and amenity by better locating and consolidating certain uses in specific locations. It identifies potential locations for marinas and limits private facilities for residential developments. With these new controls now in place, along with NSW Maritime's new *Landowners Consent Manual*, the NSW Government has lifted the four year ban on large (chiefly commercial) marinas;
- Public access to the foreshore is enhanced, providing for public boat launching ramps, recreational and club facilities and appropriate development controls.

The study area is located in one of the nine zones covered in Harbour REP: W2 (Environment Protection).

Sydney Harbour Foreshores and Waterways Area – Development Control Plan 2005

A Development Control Plan (DCP) has also been prepared to compliment the Harbour Regional Environmental Plan. The DCP provides detailed design guidelines for development and criteria for natural resource protection for the locations identified as Foreshores and Waterways Area. Council will need to consider the Foreshores & Waterways Area DCP in decisions for new developments proposed along the waterfront (up to one street back from the foreshore).



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In this DCP, different landscape character types in and around Sydney Harbour are recognised. These landscape character types provide a statement of character and intent and sets out performance criteria that are to meet for development within each landscape character types. Landscape character type 6 exists in North Harbour CMP study area.

Further, and as part of the DCP of this Harbour REP, Department of Environment & Climate Change has mapped Ecological Communities and Landscape Characteristics. Within the foreshores and waterways area boundary a number of aquatic and terrestrial ecological communities have been identified within North Harbour CMP study area including seagrass beds, mixed rocky intertidal and sand, urban development with scattered trees, grass bed and sandy beaches.

Further details are presented in section 3.7.2

Sydney Regional Coastal Management Strategy 1998

This strategy was prepared by Sydney Coastal Councils Group, representing 15 Local Councils including Manly, to coordinate and integrate relevant coastal planning and management activities, and the responsible organisations, to improve coastal management in Sydney. This strategy applies to the coastal areas between Pittwater local government area and Sutherland local government area, including all areas that were previously excluded from the NSW Coastal Zone.

The primary aim of the present strategy is “to protect and conserve terrestrial and marine ecosystems in the study zone, and to manage the social and economic conditions to achieve this, through the implementation of identified, sustainable coastal planning and management practices.”

At present, the Group is guided by a three-year ‘Strategic Plan 2005-2008’.

Sydney Metropolitan Strategy 2005

The Metropolitan Strategy is a broad framework to secure Sydney's place in the global economy by promoting and managing growth. It is a strategic document that outlines a vision for Sydney over the next 25 years. It is also the start of a process to bring the State Government, local government, stakeholders and the community together to discuss, review and then make decisions to guide the future of Sydney's economy, environment and communities. More detailed planning follows via regional strategies and subregional strategies.

A key objective of the Metropolitan Strategy is to protect Sydney's natural environment from the impacts of growth for dual benefit: our waterways, biodiversity, clean air and heritage are protected; and development processes are streamlined with greater certainty.

This Strategy will contribute to the many initiatives underway to improve the health of Sydney's waterways, by ensuring new development is located and designed to meet the community's aspirations for our rivers, coasts and estuaries.

There will be 10 sub-regional plans, to support Sydney Metropolitan Strategy. The LGAs of Manly Council, along with Pittwater and Warringah constitute under North East Sub-region.

Draft Sub-Regional Strategy: North East Subregion, July 2007. The North East Subregion is well known for its natural environment including coastline, waterways and national parks. Growing sustainability requires managing the environmental impact of development and reducing consumption of natural resources as well as safeguarding assets from natural hazards, which are expected to increase over time with climate change. The strategy includes, among others, actions to: improve the health of waterways, coasts and estuaries; protect the loss of biodiversity; conserve and manage Aboriginal and other cultural heritage; and respond to the risk of climate change and sea level rise. The draft Strategy was on public exhibition till 18 September 2008.

The Northern Sydney Aboriginal Social Plan (NSASP) 2007-2011

The Northern Sydney Aboriginal Social Plan is a document compiled by ten Councils in Northern Sydney Region, including Manly, to address the needs of Aboriginal and Torres Strait Islander people in the area. The aims of the Social Plan are to:



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- Improve outcomes for the Aboriginal community living in Northern Sydney
- Improve coordination and relationships with government on Aboriginal issues
- Increase sharing and co-operation between individuals, groups, and agencies across Northern Sydney

The NSASP identifies 6 key areas of need; collaboration and cooperation, health and wellbeing, education and training, housing, employment and culture and heritage. The first Aboriginal Social Plan (a five year plan) was adopted in 2000.

Sydney Metropolitan Catchment Management Action Plan 2008

The Sydney Metropolitan Catchment Management Authority (SMCMA) is a NSW Government agency responsible for the coordination and management of Sydney's natural resources. In Sydney, natural resources include land, rivers, estuaries and coastal systems. The catchment has an area 1860 square sq. km. (the area extends offshore to include state waters to the three nautical mile limit) accommodating 39 Local Government Areas including Manly. The catchment is divided into eight sub-catchments including North Harbour. Activities of catchment management relates to 5 themes including 'Coastal'.

The Estuary, Coast and Marine theme focuses on a whole of catchment approach to managing impacts on the coastal zone. The unique nature of impacts in estuarine and coastal areas necessitates that the SMCMA encourage partnerships with the community, industry and recreational users in addressing issues of concern. The SMCMA is currently (2009) working on the following projects in this theme:

- Bitou
- Boat Pump Out
- Botany Bay CCI
- Dune Restoration Stages 1 and 2
- From Tide to Table
- Implementation of Estuary Management Plans
- Mapping the In stream Freshwater Vegetation of the Parramatta River
- Marine Pests
- Sydney Harbour Sea Grass and other Estuarine Vegetation (Stages 1 & 2)

The SMCMA drafted a Catchment Action Plan (CAP) in August 2006. The Natural Resources Commission (NRC) has revised the draft CAP and recommended its approval to the NSW Government (June 2008).

The target for the 'Water & Coast &' sub-theme is 'By 2016, there is improvement in the condition of coastal and marine ecosystems'. This target has further been translated into management targets as:

- By 2016 institutional and technical processes are in place to achieve environmentally sustainable management of beach environs.
- By 2016 active management will protect or improve key estuarine and marine habitat areas in partnership with relevant authorities and user groups.
- By 2016 there is an increase in the extent of Marine Protected areas.
- By 2016, the Sydney coastline is covered by a Coastline Management Plan.

2.4 MANLY COUNCIL PLANS & POLICIES

Enforcing the **Local Government** acts, Manly Council has developed many plans and strategies. The following plans & policies are relevant for North Harbour study area:

• Manly Local Environment Plan 1988 (being updated & revised)	• Surfing the Future 2006
• Plans of Management for Community Land 1996	• Manly Sustainability Strategy 2006
• Manly Social Plan 2004-2009	• Manly Plan 2008-2011
• Local Disaster Plan (DISPLAN) 2005	



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Council is responsible for the overall management of the Local Government Area (LGA) and enforcing the requirements of the *NSW Local Government Act 1993*, *Environmental Planning and Assessment Act 1979* and the *Crown Lands Act 1989* (where Council has care and control). The *NSW Local Government Act 1993* requires that Council follows the principles of Ecologically Sustainable Development (ESD) in carrying out its responsibilities. Council is responsible for the preparation and implementation of Plans of Management for community lands (under the *Local Government Act 1993*). Council plays a role in controlling development within the Local Government Area boundary under the *Environmental Planning and Assessment Act 1979*. Council is the consent authority for most land-based developments and activities.

Manly Local Environment Plan 1988

The Manly Local Environment Plan (LEP) establishes Council as the consent authority for all purposes of the LEP and is the main statutory control on development within Manly Local Government Area.

The LEP details the zoning of land within the Manly Council area. It enables Council to make particular Development Control Plans regulating development in any zone and to make provisions for exempt and complying development within Manly.

The LEP also identifies Items of Environmental Heritage, Environmentally Sensitive Areas, Foreshore Scenic Protection Areas and Potential Acid Sulphate Soils and provides planning controls for the ongoing appropriate management of each of these items and areas.

This LEP is now being reviewed and updated in accordance with the NSW Planning Reforms and amended Planning legislation to meet the State government requirement of a new Standardised LEP by 2011.

Plans of Management for Community Land 1996

Under Part 2, Division 2 of the *Local Government Act 1993* as amended; Council is required to prepare Plans of Management for Community Land.

Council has adopted an overarching Plan of Management for Community Lands (1996). The document sets out objectives under four areas.

Natural Environment

- Manage our open spaces on a sustainable basis by addressing ecological systems and biodiversity in conjunction with user needs and demands.
- Integrate local drainage needs into park design and bushland management.

Cultural Environment

- Include heritage conservation and cultural identity matters in design criteria when designing and maintaining our reserves.

Recreation

- Manage all open space land in a flexible manner, and ensure that local needs are met.
- Provide a major open space connection between harbour and ocean foreshores, creek and lagoon edges, and the National Parks.
- Maintain our active sporting areas and manage them to maximize choice.

Open Spaces

- Recognise the role of each open space within the wider community and in relation to other objectives.
- Encourage local participation in design, development and management.
- Provide for user health, safety and enjoyment.
- Retain opportunities to use open space land for special events or projects and for future activities or structures if need becomes apparent.
- Improve management of open space in Manly in order to achieve the objectives of this plan.



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Manly Social Plan 2004-2009

The Manly Social Plan 2004-2009 was adopted by Council in November 2004. The Social Plan was developed on the basis of consultation with the community and service providers, to identify issues affecting the wellbeing of the people in Manly. Needs assessments were conducted targeting women, men, older people, youth, people with a disability, children and families, gay and lesbian communities, culturally and linguistically diverse people and Precincts. This consultation generated a series of priority issues. Action plans to address the priority issues are being implemented as ongoing across Manly Council divisions and in collaboration with external agencies such as the Manly Community Centre, and state level government.

The core objectives of the Manly Social Plan are to assist Council, community groups and health and community service agencies to:

- Understand the local community and the needs of individuals and groups within the community;
- Identify gaps in current service provision;
- Plan for current and future needs;
- Allocate resources in the most effective and equitable way;
- Address the needs of social and cultural diversity in Manly;
- Take a leadership role in community development and the provision of services;
- Establish a framework and process to engage with special needs groups, the wider community and other agencies; and,
- Integrate social and environmental sustainability considerations.

Manly Council's strategic directions, including a focus on social and environmental sustainability provide the context for the Manly Social Plan. North Harbour Coastline Management Plan considers issues and actions addressed in the plan

The Manly, Warringah and Pittwater Councils Local Disaster Plan (DISPLAN) 2005

This Plan has been prepared by the Manly - Warringah - Pittwater Local Emergency Management Committee in accordance with the *State Emergency and Rescue Management Act, 1989* Section 29 (1). The aim is to ensure coordinated and efficient management of the prevention, preparation, response and recovery arrangements for emergencies within Manly, Warringah and Pittwater Local Government Areas. The objectives of this Plan are to:-

- detail responsibilities for the identification, development and implementation of prevention and mitigation strategies;
- define Agency and Functional Area roles and responsibilities in preparation for, response to and recovery from emergencies;
- set out the control, coordination and liaison arrangements at the local level;
- detail activation and alerting arrangements for involved agencies;
- detail arrangements for the acquisition and coordination of resources;
- detail public warning systems and responsibility for implementation;
- detail public information arrangements and public education responsibilities;
- detail arrangements for review, testing, evaluation and maintenance of this plan; and
- detail reporting and information flow arrangements.

Surfing the Future 2006

It is a 'Vision document' for the Manly Local Government Area for 2025. Surfing the Future is a 'road map' for a journey from 2005 to 2025. The six opportunities and challenges to achieve this vision are:

- A Living Manly– inclusive society and culture
- An Affordable Manly – accommodation for our future
- A Well Governed Manly – the role of local government
- A Natural Manly – a sustainable environment
- A Visitor Friendly Manly – a place to stop and stay awhile
- A Moving Manly – transport, access and getting around



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Manly Sustainability Strategy 2006

The Manly Sustainability Strategy (MSS) 2006 is a living and evolving document and builds on MSS 2002. It is a 10 year plan with the following priorities:

- Contributing to the global climate change response
- Securing Manly's waterways and water use
- Reducing our waste
- Maintaining and improving wellbeing and quality of life in Manly
- Protecting and restoring the diversity of species and their habitats in Manly Council

The strategy addresses the vision through the six principles and 10 broad programmes.

The North Harbour Coastline Management Plan contributes to the MSS program: Coastline and Estuary Management Program to achieve the principle C: 'A Natural and Sustainable Manly'. The objective of the Coastline and Estuary Management Program is to manage the terrestrial and marine environment interface to balance environmental conservation and the enjoyment of the areas by user groups and ensure that Manly's coastlines are recognised for their important natural and cultural heritage.

Manly Plan 2008-2011

The Manly Plan 2008-2011, is the key planning document driving the operations of Council. It is a rolling three year plan that identifies a range of objectives and strategies that Council will implement in providing programs, services and facilities to the community made up of those who live, work and visit Manly.

Heritage Review

(under preparation)

In 2007 Council commenced a review of the cultural heritage of Manly. This included the review of over 200 potential items by Heritage Consultants commissioned by Council. This review included public consultation and recommendations to Council for a number of heritage conservation areas in the LGA to provide heritage protection to these areas, as well as strategies for managing Manly's heritage. Council resolved after public consultation not to continue with the proposed conservation areas, but review alternative measures to protect amenity of the areas. The review of potential individual items is being finalised for reporting to Council in 2009.

Manly LGA Climate Change Risk & Adaptation Action Plan

(under preparation)

Council has received funding from the Department of Climate Change (DCC) as part of the DCC's Local Adaptation Pathways Program for the development of a Climate Change Risk and Adaptation Strategy. This will provide a strategic approach to climate change risk management and adaptation for Manly council and community. Elements of the Cardno report will apply.

2.5 INSTITUTIONAL STAKEHOLDERS

Integrated Coastal Zone Management (ICZM) is a management regime defined and directed by broader policy and organisational settings, in turn influenced by the prevailing institutional system. It is important to understand roles and responsibilities, direct and indirect, of institutional stakeholders. Like policy environment, institutional stakeholders also come from three levels of governments.

2.5.1 Local and regional

Manly Council was incorporated as a local government body on 6th January, 1877. Manly Council is a statutory body deriving authority from the *Local Government Act 1993* and other Acts enacted by the Parliament of New South Wales. Council does not have the power to make decisions outside the legislation by which it derives its authority.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Council is responsible for the overall management of the Local Government Area (LGA) and enforcing the requirements of the *NSW Local Government Act 1993*, *Environmental Planning and Assessment Act 1979* and the *Crown Lands Act 1989* (where Council has care and control).

Manly Council is run by 12-member elected Councillors headed by the Mayor. Council is supported by the executive General Manager and staff. Councillors are elected to Council at local government elections, which are held every four years. In Manly local government area, there are no wards, and each Councillor represents the entire Council area. The Mayor is also directly elected by community for a term of 4 years.

The role of Councillors is, as a member of the governing body of Council to:

- direct and control the affairs of Council in accordance with the *Local Government Act*
- participate in the optimum allocation of the Council's resources for the benefit of the area
- play a key role in the creation and review of the Council's policies and objectives and criteria relating to the exercise of the Council's regulatory functions
- review the performance of the Council and its delivery of services, and the management plans and revenue policies of the Council.

The role of Councillors is, as an elected person to:

- represent the interests of residents and ratepayers
- provide leadership and guidance to the community
- facilitate communication between the community and the Council.

The Ordinary meetings of Council and meetings of the principal committees are held on a four (4) weekly cycle on Monday evenings. Agendas & minutes may be accessed via the Business Paper Viewing System, or are available for perusal at the Manly Library on the Friday prior to meetings. Extracts of the agendas and minutes are available from the Customer Service Centre at Council Office.

In all Committee and Council meetings, any member of the public can apply to address Council through the Public Address provision. At Ordinary Meetings, any member of the public can address Council on any matter NOT on the agenda through the Public Forum.

Manly Council is further committed to community consultation, a key component of which is the committee-based **Precinct Community Forums** system. The forum approach was introduced in 1990 to extend the involvement of the community through coordinated consultation and participation. The aim is to involve all property owners, residents and workers in the decisions which affect their local area. Precinct Community Forums are groups of people who live, work or own property in a Precinct area. There are 12 Precinct Community Forums in Manly Council area and Precinct meetings are held monthly. The meetings discuss matters referred by Council for community consultation, and matters of local importance and interest to the community. The decisions of the Precincts are advisory. Their comments are responded to and considered by Council in its statutory decision making role. The Community Forums are organised by the residents. They play a vital role in ensuring that future changes in the local area are taken into account, and are sympathetic to the amenity of the local residents.

Another operational arm of the Council is various issue or topic based Committees and Working Group. They meet as and when needed or at various frequencies. Manly Harbour Foreshore Management Committee is one of these committees, which oversaw initial development of the North Harbour Coastline Management Plan.

SHOROC (the Shore Regional Organisation of Councils) is a cooperative group of Councils on Sydney's Northern Beaches representing Manly, Mosman, Pittwater and Warringah. SHOROC was launched in August 1994 in the belief they had significant shared features that would provide more opportunities for information and resource sharing and joint servicing at a local level. The SHOROC Executive plays a strong role in presenting regional issues effectively to all levels of government. SHOROC operates through a Board, made up of the four Mayors and four General Managers who meet at least quarterly. All member councils make an equal annual contribution to the operating costs of SHOROC and have equal voting rights.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

The SHOROC Board is supported by a Management Committee, a Secretariat and a number of key working groups comprising cross council professional officers. SHOROC projects are diverse and divided between four portfolios – Planning, Environment, Community and Corporate. Publication of 'Regional State of the Environment' Report is one of the key documents produced by SHOROC each year. The Report contains a chapter of 'Land and Coastline'.

The **Sydney Metropolitan Catchment Management Authority (SMCMA)** is a NSW Government agency responsible for the coordination and management of Sydney's natural resources. In Sydney, natural resources include land, rivers, estuaries and coastal systems. The SMCMA was established under the *Catchment Management Authorities Act 2003*. The SMCMA partners with 39 local councils in the metropolitan catchment as well as State and Federal Government departments.

The **Sydney Coastal Councils Group** was established in 1989 to promote co-ordination between member councils on environmental and natural resource management issues relating to the sustainable management of the urban coastal environment.

The Group consists of 15 councils (Botany Bay, Hornsby, Leichhardt, Manly, Mosman, North Sydney, Pittwater, Randwick, Rockdale, Sutherland, City of Sydney, Warringah, Waverley, Willoughby and Woollahra) adjacent to Sydney marine and estuarine environments and associated waterways. The Group represents over 1.3 million Sydneysiders. This area encompasses the waterways of Broken Bay; Pittwater; Port Jackson, the lower Lane Cove River, Middle and North Harbours; Botany Bay, the Lower Georges and Cooks River; and Port Hacking.

The Sydney Coastal Councils Group provides leadership and encourages a coordinated approach to sustainable coastal management undertaken by and in partnership with the member councils to protect and conserve terrestrial and marine ecosystems. The Group facilitates outcomes concerning coastal issues, exceptional to those the member councils could achieve individually.

The Sydney Coastal Councils Group is a Regional Organisation of Councils that provides project facilitation and coordination on environmental and natural resource management issues that relate to the sustainable management of the coastal urban environment. The Group provides strong advocacy and support for its 15 member councils on coastal, climate change and NRM issues. Being a member council also allows council elected and professional staff the opportunity to exchange ideas at a regional level through SCCG forums, presentations, meetings and conferences.

The **Aboriginal Heritage Office** is a joint initiative by Lane Cove, North Sydney, Manly, Warringah, Willoughby, Ku-ring-gai and Pittwater councils, in a progressive move to protect Aboriginal Heritage in these areas. Part of the work of the Aboriginal Heritage office is to monitor Aboriginal Sites on a day to day basis and long term management reports are developed to ensure their preservation and protection.

Another key role of the Aboriginal Heritage office is to give the Aboriginal people and non-aboriginal people involved with these council areas an avenue of approach to discuss issues or concerns they may have. The office is in direct contact with the Metropolitan Local Aboriginal Land Council and its many resources.

An important part of the role is to communicate with school and other groups and teach children an ethos of understanding to appreciate the unique culture of the Aboriginal people. In association with the local councils, talks, walks and activities are planned to enhance appreciation of Aboriginal culture in the wider community. A selection of information leaflets on various Aboriginal Heritage topics are available to download.

2.5.2 State

Department of Environment and Climate Change (DECC) emerged in April 2007 from the Department of Environment and Conservation. The NSW Government's aim was to build a broader organisation able to respond to the challenges presented by climate change and further progress reforms in the sustainable management of our land and water resources.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

DECC is building on the strengths and cultures of its constituent agencies by combining knowledge, innovation, regulatory and field experience to tackle priority environmental, climate change, natural resource and cultural heritage issues for NSW. In doing so, DECC contributes towards achieving its corporate vision through:

- working towards a healthy environment cared for and enjoyed by the whole NSW community
- managing the state's natural resources, including biodiversity, soils and natural vegetation
- managing natural and cultural heritage across the state's land and waters
- acting to minimise the impacts of climate change
- promoting sustainable consumption, resource use and waste management
- regulating activities to protect the environment
- conducting biodiversity, environmental and cultural heritage research to improve decision-making.

NSW DECC serves a number of key functions including:

- The management of natural and cultural heritage;
- Promotion of sustainable consumption, resource use and waste management;
- Regulation of activities to protect the environment; and
- The undertaking of biodiversity, plant, environmental and cultural heritage research to improve decision making.

DECC provides financial and technical assistance to councils to help develop and implement sustainable coastline management plans through the Coastal Management Program. Under the program, the NSW Government provides a 50% subsidy to local government for:

- Preparation of coastal studies and coastline management plans aimed at ensuring balanced long term management of the coastline;
- Construction of works for the conservation and/or improvement of beaches and public reserves; and
- Investigation, design and implementation of management measures and works to reduce potential damage from coastal processes in existing developed areas.

Similarly, DECC also provides financial and technical assistance to councils to help develop and implement sustainable estuary management plans through the Estuary Management Program. The Program was commenced in 1992 to assist local government to better manage estuaries through a strategic process outlined in the NSW Estuary Management Manual.

The NSW National Parks and Wildlife Service (NPWS), which forms part of the Department of Environment & Climate Change, is responsible for protecting the State's flora and fauna, and for managing and maintaining National Parks and Nature Reserves. The NPWS is also responsible for Aboriginal Heritage and sites.

DECC has responsibilities and powers under many NSW environmental legislation. Only relevant ones are mentioned here:

- *Soil Conservation Act 1938*
- *National Parks and Wildlife Act 1974*
- *Coastal Protection Act 1979*
- *Fisheries Management Act 1994*
Note: DECC only administers Part 7 Division 2 of this Act and s227 so far as it relates to that Division and ss 243 & 245 so far as is required in relation to this Division.
- *National Environment Protection Council (New South Wales) Act 1995*
- *Threatened Species Conservation Act 1995*
- *Contaminated Land Management Act 1997*
- *Marine Parks Act 1997*
- *Environmental Trust Act 1998*
- *Forestry and National Park Estate Act 1998*
- *Nature Conservation Trust Act 2001*
- *Catchment Management Authorities Act 2003*



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

NSW Maritime (formerly Waterways Authority) is a statutory State Government body classified by NSW Treasury as a non-budget dependent general government agency. NSW Maritime is a self-funding entity.

NSW Maritime is responsible for the on-water management of all NSW navigable waters, including coastal areas, estuaries, rivers, lakes and dams to three nautical miles offshore. On-water management responsibilities include the management of safety, the protection of the marine environment from degradation by vessels, the provision of waterways infrastructure for vessels, the licensing of vessel operators, commercial vessels, on-water events, and mooring management.

NSW Maritime the government body which owns the seabed of Sydney Harbour, North Harbour and Middle Harbour and all related tidal bays, rivers and their tributaries. Under the *Ports Corporatisation and Waterways Management Act 1995 (PC&WM Act 1995)* the Waterways Authority is the landowner of Sydney Harbour and its tributaries and therefore controls Sydney Harbour.

NSW Maritime is therefore responsible for management of waterways and the sea bed from mean high water mark (MHWM) seaward. As owner of the bed of Sydney Harbour, Waterways is the consent and determining authority for a variety of water-based developments and activities. Waterways are now also responsible for the investigation of on-water pollution incidents and issuing clean-up and prevention notices in relation to vessels (in navigable waters that are not required to have a pilot).

NSW Maritime is the State's maritime regulator and administers a number of Acts of Parliament and the Regulations made there under. Only relevant ones are mentioned here:

- *Navigation Act 1901*
- *Maritime Services Act 1935*
- *Marine Pollution Act 1987*
- *Ports and Maritime Administration Act 1995*
- *Marine Safety Act 1998*

NSW Maritime also has responsibilities relating to the marine environment under:

- *Environmental Planning and Assessment Act 1979*
- *Protection of the Environment Operations Act 1997*

From Monday 4 February 2008 most DAs lodged with NSW Maritime seeking consent for water based development under Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 are likely to be 'integrated development applications' because the development is likely to require a controlled activity approval under the *Water Management Act 2000*.

The change in the DA requirements is a result of the repeal of the *River and Foreshores Improvement Act 1948* and commencement of the controlled activity provisions of the *Water Management Act 2000*.

Under the *Water Management Act 2000*, controlled activities include the erection of a building or the carrying out of a work or the removal or deposition of material and approval and approval is required where the work is carried out in, on or over the bed of any river, lake or estuary.

Once lodged with NSW Maritime, special advertising and notification procedures apply to these DAs under the *Environmental Planning and Assessment Act 1979*. These require a minimum public display period of 30 days, a public notice in a local newspaper and notifications to relevant public authorities and neighbours.

NSW Maritime's DA form has been updated so that the integrated referral(s) requirement can be identified. If relevant, other integrated approvals may also continue to be required, for instance, approvals required under the *Fisheries Management Act 1994*.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

The **NSW Department of Lands** (Lands) is the primary Government agency responsible for managing state-owned land. It is the guardians of all land information in NSW. It operates through a number of Divisions, only relevant ones are described below:

- Services of the Land and Property Information (LPI) Division include land title registration, property information, valuation, surveying and mapping.
- Crown Lands Division practices sustainable management of state-owned lands for the benefit of the people of NSW managing a total area of approximately 12.7 million hectares. In a number of cases however, Council manages Crown Land in accordance with the *Crown Lands Act 1989*
- Soil Conservation Service is established as the authority in planning, design and construction of soil conservation earthworks, rehabilitation and revegetation, and training in conservation earthmoving, urban erosion and sediment control.

Department of Lands has responsibilities and powers under much NSW environmental legislation. Only relevant ones are mentioned here:

- *Valuation of Land Act 1916 No 2*
- *Transfer of Records Act 1923 No 14*
- *Land Sales Act 1964 No 12*
- *Crown Lands (Validation of Revocations) Act 1983 No 55*
- *Community Land Development Act 1989 No 201*
- *Crown Lands Act 1989 No 6 (except parts, Minister for the Environment)*
- *Crown Lands (Continued Tenures) Act 1989 No 7*
- *Roads Act 1993 No 33, (part)*
- *Surveying Act 2002 No 83*

NSW Department of Primary Industries (DPI) acts to foster profitable and sustainable development of primary industries in New South Wales. The department was formed in July 2004 with the amalgamation of Mineral Resources NSW, NSW Agriculture, NSW Fisheries and State Forests NSW. One of the seven Divisions, Fisheries, Compliance and Regional Relations, deal with the management of sustainable, commercial and recreational use of NSW fisheries' resources, and the protection of the aquatic environment.

The Division has jurisdiction over all fish and marine vegetation in all waters of the state (including all private and public waters and permanent and intermittent waters) extending to 3 nautical miles offshore (and to 80Nm offshore in those fisheries for which it has jurisdiction under the Offshore Constitutional Settlement). This means that it has management responsibility for all aquatic animals (with the exception of aquatic mammals, reptiles, amphibians and birds, which are managed by the NSW Department of Environment & Climate Change) and responsibility for all marine vegetation and key aquatic habitats including seagrass, mangroves, gravel beds and snags. It has also management and research responsibilities related to threatened fish species, populations and ecological communities.

While DPI is responsible for the management of all aquatic animals, the department is a state government authority with limited on-the-ground staff to effectively regulate the management of aquatic environments. As a result Manly Council's rangers are presently licensed as DPI officers to assist Fisheries with some of their on-the-ground 'localised' regulation functions.

Relevant to coastal management, the Department of Primary Industries administers the following acts:

- *Fisheries Act 1935*
- *Noxious Weeds Act 1993*
- *Fisheries Management Act 1994*
Except Part 7 (Divisions 1 and 2) and Part 7A, jointly the Minister for Climate Change, Environment and Water and the Minister Assisting the Minister for Climate Change, Environment and Water (Water).



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

The Department of Planning was established in August 2005, following the de-amalgamation of the former Department of Infrastructure, Planning and Natural Resources. In March 2006, the NSW Heritage Office was incorporated into the department. The functionality of the Department is run through the following 7 divisions:

- Cities and Centers
- Corporate Governance and Support Services
- Heritage Office
- Major Project Assessments
- Metropolitan Planning
- Rural and Regional Planning
- Strategic Sites and Urban Renewals.

In developing its roles and responsibilities, the Department identifies the following five major goals:

1. Sustainable growth in the right locations
2. Improved investor and community confidence
3. Effective management of natural, environmental and cultural resources and values
4. Diverse, equitable and pleasant neighbourhoods which reflect community needs and aspirations
5. Integrated delivery of regional infrastructure and government activities

Planning and development is carried out under:

- *Environmental Planning and Assessment Act 1979*
- *Environmental Planning and Assessment Regulation 2000*
- *Coastal Protection Act 1979 (as amended 2002).*

Environmental planning instruments (State environmental planning policies, regional environmental plans and local environmental plans) are legal documents that regulate land use and development. Local environmental plans prepared by councils guide planning decisions for local government areas. Through zoning and development controls, they allow councils to supervise the ways in which land is used. Development control plans, prepared in accordance with the *Environmental Planning and Assessment Act*, are also used to help achieve the objectives of the local plan by providing specific, comprehensive requirements for certain types of development or locations e.g. for urban design, and heritage Precincts and properties.

Planning and development within the NSW Coastal Zone (as declared under the *Coastal Protection Act 1979*) is now subject to a Ministerial direction for coastal protection, NSW Coastal Policy, SEPP 71 - Coastal Protection, and the Major Projects SEPP (which identifies coastal development that will need the approval of the Minister for Planning). The NSW Government in June 2001 announced its \$11.7 million Coastal Protection Package to protect the State's beaches, headlands and other coastal features for generations to come.

Comprehensive Coastal Assessment is another key element of the NSW Government's Coastal Protection Package. A Comprehensive Coastal Assessment toolkit is now available to help local councils, government agencies and others undertake important strategic land use planning. The toolkit represents a whole-of-government three-year investment in identifying, analysing and assessing data and information on the physical, biological, social and economic values of the State's coastline.

The Coastal Lands Protection Scheme is used to bring significant coastal lands into public ownership and provides for their long term management and care. The Department administers the Scheme which receives an annual budget allocation of \$3 million for acquisitions. The Scheme, which commenced in 1973, identified certain lands to be protected and acquired. These lands usually included features such as headlands, dunes, hinterland, coastal lagoons and lakes, particularly where the original vegetation was still dominant. Since the Scheme commenced approximately 15,336 hectares at a total cost of \$67.87 million have been acquired (as at March 2008).



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

The **Department of Water and Energy (DWE)** was created on Friday April 27 2007, which incorporates most of the functions of the former Department of Energy, Utilities and Sustainability (DEUS) and the water-related functions of the former Department of Natural Resources as well as the Metropolitan Water Directorate from the former NSW Cabinet Office.

Some of the functions of the former DEUS, such as the Energy and Water Savings Funds and Action Plans have been transferred to the new Department of Environment and Climate Change. The Accredited Service Provider program was also transferred to the Office of Fair Trading.

Sydney Water, a statutory State owned corporation, wholly owned by the New South Wales Government has three equal, principal objectives:

- to protect public health
- to protect the environment
- to be a successful business.

Sydney Water provides drinking water, recycled water, wastewater services and some stormwater services to more than four million people in Sydney, Illawarra and the Blue Mountains. Drinking water is sourced from a network of dams managed by the Sydney Catchment Authority, then treated and delivered to customers' homes and businesses by Sydney Water. Sydney Water is governed, among others, by

- *Sydney Water Act 1994*
- *Sydney Water Regulation 2006*

Sydney Water has Memoranda of understanding with

- Memorandum of Understanding with the Department of Environment and Climate Change
- Memorandum of Understanding with NSW Health

There exists a Sydney Water & Manly Council partnership arrangement

The **Natural Resources Commission (NRC)** was created by the *Natural Resources Commission Act 2003*. The NRC provides independent advice to the NSW Government on a range of natural resource management issues. The NRC reports to the Premier, reflecting its independent nature. The Government has adopted the NRC recommended Standard for Quality Natural Resource Management and state-wide targets for NRM. The targets now form priority E4 of the NSW Government's State Plan. The NRC contributes to priority E4 by:

- reporting on progress towards the targets, and advising Government on resolving issues that are restricting progress
- auditing the effectiveness of CMAs' implementation of their Catchment Action Plan in terms of compliance with the Standard and contribution to the targets
- reviewing technical issues to provide a sound scientific basis for decisions on specific NRM issues
- developing and revising the Standard and targets and facilitating their use by natural resource managers across NSW to drive adaptive management towards targets
- conducting reviews on natural resource issues as requested by the Government.

The standard and targets provide a quality assurance framework and clear goals to ensure that the investments of the NSW and Australian Governments and others in the activities of catchment management authorities are cost effective, protect and improve high value natural resource assets, and maximise integrated NRM outcomes from the property scale to the state scale. The standard and targets support flexible and innovative regional planning, investment and decision-making while ensuring consistency, rigour and accountability for NRM in NSW. The NRC follows, at present, the Strategic Plan 2008-2011.

The **State Emergency Service** is an emergency and rescue service dedicated to assisting the community. It is made up almost entirely of volunteers, with 232 Units located throughout New South Wales. The Units comprise of more than 10,000 volunteer members, who are easily identified by their distinctive orange overalls.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Though major responsibilities are for flood and storm operations, the SES also provides the majority of general rescue effort in the rural parts of the state. This includes road accident rescue, vertical rescue, bush search and rescue, evidence searches (both metropolitan and rural) and other forms of specialist rescue that may be required due to local threats. The Service's trained rescuers also support the full-time emergency services during major disasters.

The SES also assists other emergency services when they are performing major operations. These services include the NSW Police Service, the NSW Rural Fire Service, the NSW Fire Brigade and the Ambulance Service of NSW.

2.5.3 Commonwealth

The Australian Government **Department of the Environment, Water, Heritage and the Arts** (formerly the Department of the Environment and Water Resources) develops and implements national policy, programs and legislation to protect and conserve Australia's environment and heritage. The Department, among others, deals with coasts and ocean issues.

The Department sets the scene for national cooperation in managing coastal issues and ensuring effective and complementary arrangements within and across jurisdictions, and to better reflect the interests of coastal stakeholders through the Framework for a National Cooperative Approach to Integrated Coastal Zone Management. The implementation of the Framework is managed through the Intergovernmental Coastal Advisory Group (ICAG), comprised of representatives from the Australian Government, each state government, the Northern Territory Government and the Australian Local Government Association (ALGA). ICAG members meet several times a year to share experiences and to work on Framework implementation.

Another program, the Coastal Catchments Initiative aims to achieve target reductions in pollutant discharges to coastal water quality hotspots. This is being done through the development and implementation of Water Quality Improvement Plans, prepared in accordance with the Australian Government's Framework for Marine and Estuarine Water Quality Protection.

The **Department of Climate Change** was established on 3 December 2007 as part of the Prime Minister and Cabinet Portfolio. The Government takes the challenge of climate change seriously. The approach is to:

- reduce greenhouse pollution in Australia in the short and long term
- work with the international community to develop a global response that is effective and fair
- prepare for the climate change that we cannot avoid.

The *White Paper, Carbon Pollution Reduction Scheme: Australia's Low Pollution Future*, was released on 15 December 2008. The paper outlines the final design of the Carbon Pollution Reduction Scheme and decisions on other significant climate change programs

A number of initiatives to address climate change such as National Climate Change Adaptation Framework, the National Climate Change Adaptation Programme, the Climate Change Adaptation Actions for Local Government are also relevant for coastline management.



3. LAND USE, TENURE & MANAGEMENT

North Harbour study area consists primarily of semi-natural, landscaped and built areas. It is characterized by natural and cut sandstone cliffs and escarpments with fringing native bushland pockets and landscaped areas along the Esplanade Reserves.

The study area covers two catchments, North Harbour (with 2 sub-catchments) and Fairlight (with 7 sub-catchments).

3.1 PRESENT LAND USES

The current land use is predominantly residential (Table 3.1). This is followed by open spaces and parks (16.5%) and road surfaces (12.4%). Long stretches of parkland (Esplanade Park) separate residential blocks from shoreline except behind King Avenue and North Harbour Street where residential properties border shoreline.

Table 3.1 Current land use within the North Harbour study area

Catchment Name	Area (sq m)	Land use Breakdown (%)			
		Residential	Open Space	Roads	Other*
North Harbour	1,367,339	69.2	17.1	12.1	1.6
Fairlight	440,809	71.7	14.6	13.0	0.7
Study Area	1,808,148	69.8	16.5	12.4	1.3
Manly LGA		37.2	30.9	14.6	17.3

* includes commercial, special use property and unzoned

Reserves and parks occur scattered throughout the area with North Harbour Reserve providing space for many passive activities. Wellings Reserve, a SEPP 19 bushland, occurs in neighbouring Forty Basket CMP area. Manly Scenic Walkway runs through the study area.

3.2 BEACHES & CREEKS

Fairlight beach is long and narrow and backed by a small reserve and picnic area. It is a popular beach with local residents. A 25-metre pool that is filled with water from the harbour is adjacent to the beach. It has disabled accessed toilet facilities. Fairlight is favourite snorkelling and scuba diving spot.

Delwood beach is a small and secluded beach and a great place to snorkel. Five bench seats are scattered along the grassy area behind the beach.

There is no existing **natural creek** in this highly urban area. However, two natural water creeks existed previously as shown on a 1913 map (Figures 3.2a and b). Creeks used to reach the tidal flat underneath a bridge on the Condamine Street. Sections of creeks still exist as drain. The bridge does not exist anymore.

3.3 LAND TENURE

Ownership and management responsibilities for the land and seabed within the study area are shared by a number of government agencies and Manly Council. In general, land of North Harbour CMP study area consists of private, Crown, Manly Council and Energy Australia owned and administered land, with Crown land representing by far the major public land holding. As the study area is located within Sydney Harbour, NSW Maritime is responsible for management of both seabed and waterways.

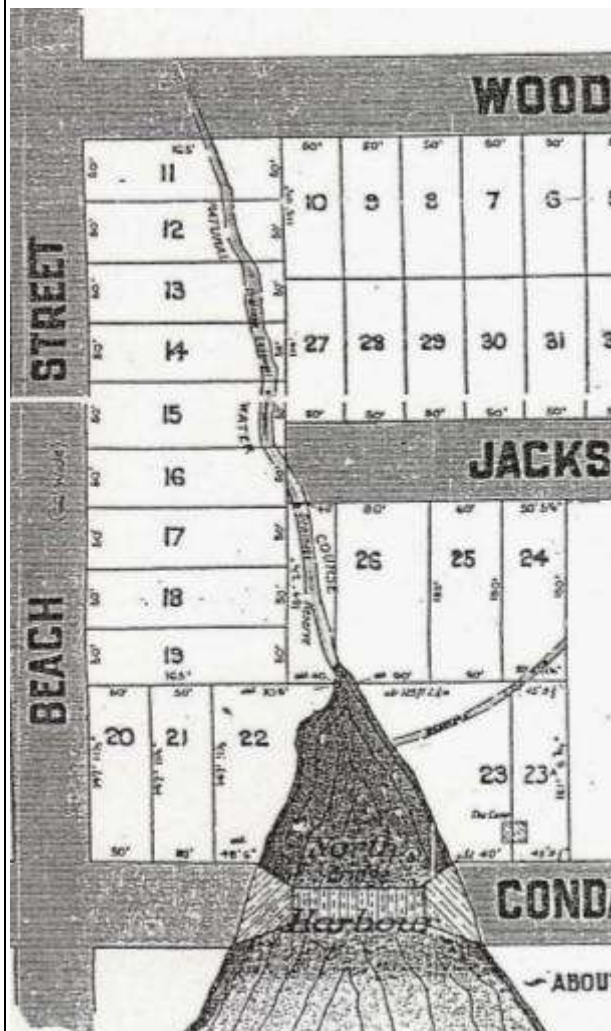
Ownership of land within North Harbour CMP study area is identified in Figure 3.3 – North Harbour Land Ownership map.

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Figure 3.2a: 1913 map showing a natural creek near North Harbour



Figure 3.2b: Section enlarged of the 1913 map



As indicated by Figure 3.3 there is a mix of land tenure within the study area including:

- Council owned land: community classification
- Council owned land: operational classification
- Crown land: Council as Trustee
- Energy Australia owned land

Council owned land: community classification

Manly Council owns a total of 17,201 sq.m of land under community classification in 10 different parcels. All these parcels are zoned as 'open space' except one parcel yet to be zoned. These land parcels are used either as reserve, parks, path or drainage reserve and include Bareena Park, Brimbcom Park and others. Further details are in section 3.2.

Council owned land: operational classification

Manly Council owns a total of 15,573 sq.m of land under operational classification in 20 different parcels. Ten of these parcels are presently disused and were used to house Balgowlah Women's Bowling Club. Two are vacant. Other parcels of lands are used as drainage reserve, car park, lane, path and house.

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Figure 3.3 Land ownership within North Harbour study area



Crown Land: Council as Trustee

Manly Council acts as trustee of a total of 97,282 sq.m of Crown land. These are occurring in 13 parcels of land covering North Harbour Reserve, Esplanade Park, Nolans Bush, Bareena Park and Glenside Street Reserve.

Energy Australia Owned Land

Energy Australia owns a parcel of land of 40 sq.m of land in Glenside Street, Fairlight.

3.4 LAND MANAGEMENT REQUIREMENTS

Crown Land Requirements

The *NSW Crown Lands Act 1989* governs the planning, management and use of Crown land, including reservation or dedication for a public purpose, and leasing and licensing.

The Department of Lands is the principal NSW Government agency responsible for managing state-owned land together with the Reserve Trusts appointed by the Minister. The *Crown Lands Act 1989* provides for the reservation and dedication of Crown land for a range of public purposes. When land is reserved or dedicated, management of the Reserve is mostly undertaken either by:

- the Department of Lands;
- a Reserve Trust; or
- Local Government councils, by devolvement under the *Local Government Act 1993*.

In the case where Council is appointed as Trustee or management is devolved to Council, Council has the ongoing responsibility to provide care, control and management of Crown land in accordance with the *Crown Lands Act 1989*.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

To ensure that Crown land is managed for the benefit of the people, Council is required to have regard for the principles of Crown land management. Crown land must be used and managed in accordance with those principles under Section 11 of the *Crown Lands Act 1989*.

The principles of Crown land management include:

- that environmental protection principles be observed in relation to the management and administration of Crown land;
- that the natural resources of Crown land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible;
- that public use and enjoyment of appropriate Crown land be encouraged;
- that, where appropriate, multiple use of Crown land be encouraged;
- that, where appropriate, Crown land should be used and managed in such a way that both the land and its resources are sustained in perpetuity; and
- that Crown land be occupied, used, sold, leased, licensed or otherwise dealt with in the best interests of the State consistent with the above principles;

The North Harbour CMP will satisfy the *Crown Lands Act 1989* if the following points are addressed:

- The CMP and its outcomes must incorporate the principles for Crown Land management (listed above).
- In addition to incorporating the requirements of Section 36 of the *Local Government Act 1993*, the CMP must address any matters required by the Minister responsible for the *Crown Lands Act 1989* under Section 112 of the Act.
- Any proposed uses, developments and management practices must conform to the public purpose for the Reserve.
- The draft CMP is referred to the Department of Lands for comment prior to the public exhibition of the draft CMP.
- The draft CMP must be publicly exhibited, including a public notice in the NSW Government Gazette.
- Public submissions regarding the draft CMP are to be referred to both the Minister responsible for the *Crown Lands Act 1989* and Manly Council as Trust Manager for consideration by the Minister prior to adoption.
- Any alterations to the CMP by the Minister under Section 114 are made.
- Adoption of the CMP by the Minister responsible for the *Crown Lands Act 1989*.
- The Trust must follow the CMP, with all operations being in accordance with the Plan.

This CMP has been developed to meet these requirements.

Community land management requirements

Community land cannot be sold, exchanged or otherwise disposed of (except when adding the land to Crown Reserve or to a protected area under the *National Parks & Wildlife Act 1974*). Community land cannot be leased, licensed or any other estate granted over the land for more than 21 years.

Under section 36 of the *Local Government Act 1993*, a plan of management for community land must be prepared for the land and that plan must categorise the land. For community land that is not owned by Council the *Local Government Act 1993* requires that, where Council controls but does not own the land, the plan of management must:

- identify the owner of the land;
- state whether the land is subject to any trust estate, interest, dedication, condition, restriction or covenant; and
- state whether the use or management of the land is subject to any condition or restriction imposed by the owner.

3.5 COMMUNITY LANDS

3.5.1 Land Identification

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

There are 10 parcels of Council owned community lands within the study area (**Fig 3.5.1**). Nine of these parcels are zoned as 'open space' and one parcel yet to be zoned (**Table 3.5.1**). These lands are used either as reserve, parks, path or drainage reserve and include Bareena Park, Brimbekom Park and others.

Figure 3.5.1 Location of Council owned community lands within the study area

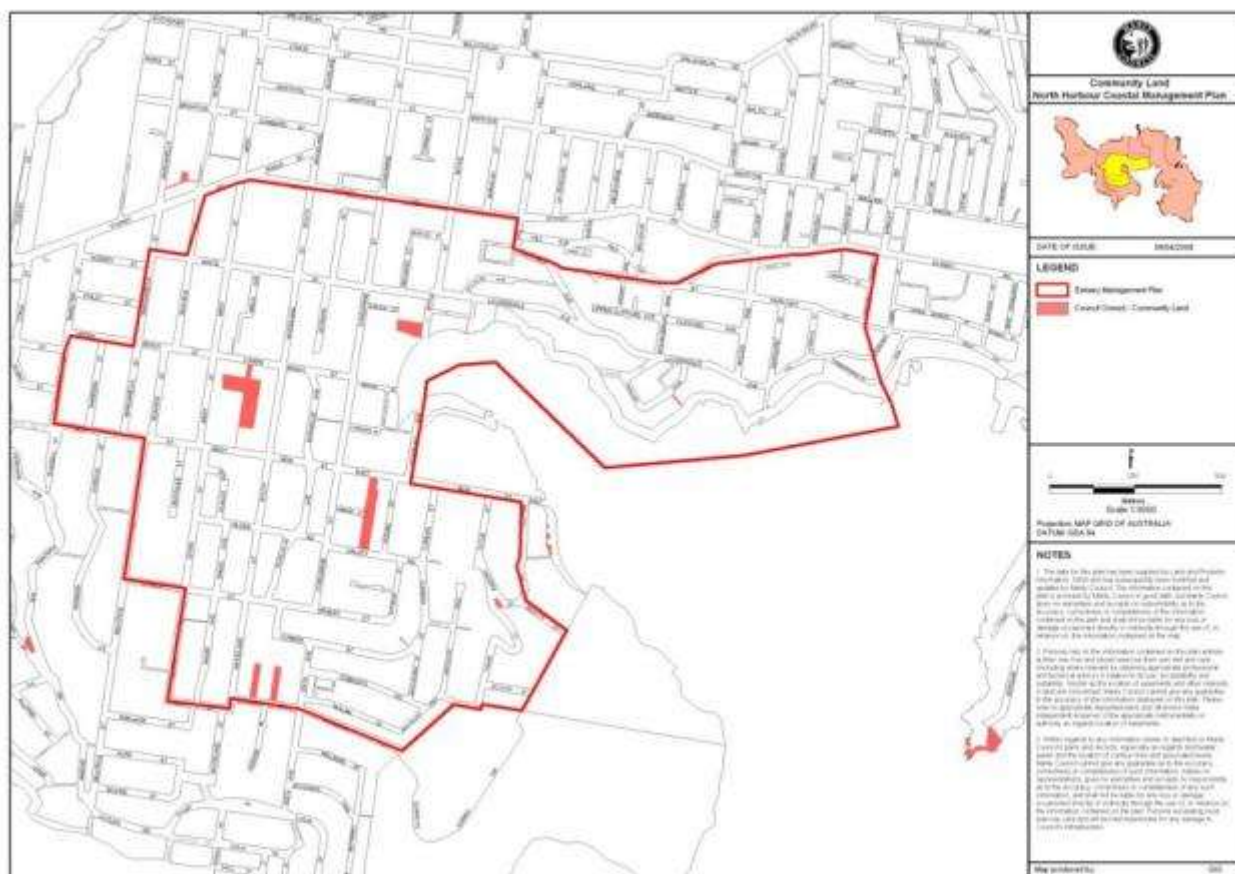


Table 3.5.1 Details of Council owned community lands within the study area

Title No.	Address	Suburb	Land Use	Area (sq. m)	Zoning (LEP)	Comments
1424/752038	Bareena Drive	Balgowlah Heights	Bareena Park	2023	Open Space	Lease 2006/4 to Balgowlah Bowling Club
1427/752038	Bareena Drive	Balgowlah Heights	Bareena Park	2056	Open Space	
72/9202	Geddes Street	Balgowlah Heights	Public Reserve	480	Open Space	
103/555215	New Street	Balgowlah	Brimbecom Park	145	Open Space	
6/25542	Lower Beach Street	Balgowlah	Brimbecom Park	6981	Open Space	
203/537569	West Street	Balgowlah	Brimbecom Park	1246	Open Space	
204/537569	West Street	Balgowlah	Brimbecom Park	1148	Open Space	
1/115707	North Harbour Reserve	Balgowlah	Drainage Reserve	2751	Open Space	



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Title No.	Address	Suburb	Land Use	Area (sq. m)	Zoning (LEP)	Comments
1/569379	King Avenue Reserve	Balgowlah	Public Reserve	121	Open Space	
1/1060275	Fairlight Crescent	Fairlight	Path	250	NOT ZONED	Formerly Arlington Drive, closed through a Gazette dated 26/3/2004

3.5.2 Plans of Management

As mentioned above, under section 36 of the *NSW Local Government Act 1993*, a plan of management for community land must be prepared for the land and that plan must categorise the land. Manly Council has prepared Plans of Management for all nine community land parcels (MC 1996). The following Plans of Management (PoM) cover all parcels of community lands:

Bareena Park PoM: Covers both land titles 1424/752038 and 1427/752038 of Bareena Park. Land is categorised sports ground (in part) and park (in part). These have been last leased to Balgowlah Bowling Club in 2006.

Bushland Reserve, Geddes Street PoM: Covers land title 79/9202. This is a steep triangular shaped reserve separating Fisher & Geddes Street. Land is categorised as natural area – bushland.

Brimbecom Park PoM: Covers land titles 6/25542, 103/555215, 203/537569 and 204/537569 of Brimbecom Park. Land is categorised as a park, general community use and natural area – bushland.

North Harbour Reserve PoM: Covers land title 1/115707. Land is categorised as a park and natural area – foreshore and bushland.

Esplanade Park PoM: Covers, among others, land title 1/569379. Land is categorised as natural area – foreshore.

No PoM has yet been prepared for the land parcel 1/1060275 on Fairlight Crescent, Fairlight (photo). This is formerly Arlington Drive, closed through a Gazette dated 26/3/2004. Manly Council has classified the land parcel as community land but no zoning has been done yet. This land parcel is proposed to be categorised as 'general community use', subject to specific process of public hearing.



This Coastline Management Plan serves as the Community Land Plan of Management for community lands within the study area.

3.6 LAND USE PLANNING

The North Harbour CMP study area consists of land, foreshore and waterways areas. Land use planning of the study area is governed by two documents, the Manly Local Environment Plan 1988 (Manly LEP) and the Sydney Regional Environmental Plan - Sydney Harbour Catchments 2005 or simply the Harbour REP, both enacted under the *Environmental Planning and Assessment Act 1979*.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

The Manly Local Environment Plan 1988 (Manly LEP) is the main statutory control over local development within Manly Local Government Area and applies to all land including North Harbour CMP study area. The Clause 9 of the Manly LEP establishes land use zones (presented in section 3.6.1). The LEP also identifies Items of Environmental Heritage, Environmentally Sensitive Areas, Foreshore Scenic Protection Areas and Potential Acid Sulphate Soils.

The Sydney Regional Environmental Plan - Sydney Harbour Catchments 2005 applies to the hydrological catchment of the Harbour. It also defines and contains specific provisions for the 'Foreshores and Waterways Area' (which is generally the area 'one-street back' from the foreshore), strategic foreshore sites, heritage items and wetlands protection areas. Council is the consent authority for land-based development and land-water interface development. The Minister administering the *Ports and Maritime Administration Act 1995* is the consent authority for water-based development. The Minister for Planning is the consent authority only where development is state significant or if any Environmental Planning Instrument nominates the Minister as the consent authority (whether within or outside of a council's Local Government Area (see Clause 5).

The Sydney Regional Environmental Plan - Sydney Harbour Catchments 2005 contains a set of planning principles relating to land within Sydney Harbour catchment, land within the Foreshores and Waterways Area and heritage conservation. The planning principles need to be taken into consideration in the preparation of environmental planning instruments and development control plans under Part 3 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the preparation of environmental studies and Masterplans for the purposes of the Act. This will ensure that all strategic land use decisions with the potential to impact on the harbour are made having regard to such impacts. The catchment planning principles include a number of natural resource management principles that relate to water quality and quantity, implementation of the actions outlined in the Sydney Harbour Catchment Blueprint (Department of Land and Water Conservation, 2003), soil management (salinity and acid sulphate soils) and the protection and rehabilitation of wetlands, remnant native vegetation (including riparian vegetation) and the enhancement of ecological connectivity.

3.6.1 Land Zoning

Land within the study area is zoned under the Manly LEP as zone 2 – Residential, 3 – Business Zone, 5 – Special Uses Zone and 6 - Open Space (including areas to be acquired), as shown in Figure 3.6.1. The objectives of each of the zone need to be addressed in any of the proposed management options that represent development under the LEP. Those objectives, described separately for each zone, are as follows:

Zone 2 Residential

- (a) to set aside land to be used for the purposes of housing and associated facilities;
- (b) to delineate, by means of development control in the supporting material, the nature and intended future of the residential areas within the Municipality;
- (c) to allow a variety of housing types while maintaining the existing character of residential areas throughout the Manly Council area;
- (d) to ensure that building form, including alterations and additions, does not degrade the amenity of surrounding residents or the existing quality of the environment;
- (e) to improve the quality of the residential areas by encouraging landscaping and permitting greater flexibility of design in both new development and renovations;
- (f) to allow development for purposes other than housing within the zone only if it is compatible with the character and amenity of the locality;
- (g) to ensure full and efficient use of existing social and physical infrastructure and the future provisions of services and facilities to meet any increased demand;
- (h) to encourage the revitalisation of residential areas by rehabilitation and suitable redevelopment; and
- (i) to encourage the provision and retention of tourist accommodation that enhances the role of Manly as an international tourist destination, and particularly in relation to the land to which Manly Local Environmental Plan 1988 (Amendment No 57) applies.

North Harbour Coastline Management Plan Zoning

DATE OF ISSUE: 21/09/2005

LEGEND

- Coastline Management Area
- Residential Zone
- Business Zone
- Industrial Zone
- Special Uses Zone
- Open Open Space
- Open Open Space to be acquired by Council
- Open Open Space to be acquired by Council
- National Parks to be acquired by Council
- National Parks to be acquired by Council

0 200 400 600
Metres
Scale 1:12500

Projection: MAP GRID OF AUSTRALIA
DATUM: MGA 84

NOTES

- The data for this map has been taken from the Land and Planning Information System (LIPIS) and the Sydney Water Corporation (SWC) and is subject to change without notice. The map is intended for general information only and should not be used for any purpose other than that for which it was prepared. The map is not a guarantee of accuracy and is not a substitute for a professional survey.
- Wherever possible, the information contained on this map is intended to be accurate and up-to-date. However, the map is not a guarantee of accuracy and is not a substitute for a professional survey.
- Wherever possible, the information contained on this map is intended to be accurate and up-to-date. However, the map is not a guarantee of accuracy and is not a substitute for a professional survey.

- (a) to provide for and encourage the development and expansion of business activities which will contribute to the economic growth and employment opportunities within the Manly Council area;
- (b) to accommodate retail, commercial and professional services in established locations in the residential neighbourhoods where such development is compatible with the amenity of the surrounding areas;
- (c) to ensure there is adequate provision for car parking in future development in the business areas; and
- (d) to minimise conflicts between pedestrians and vehicular movement systems within the business areas.

(a) in case of land shown unhatched on the map, is now owned or used for public or community purposes; or
(b) in the case of land shown hatched on the map, will be acquired by a public authority for the particular public or community purpose shown on the map.

- a) to ensure there is provision of adequate open space areas to meet the needs of all residents and provide opportunities to enhance the total environmental quality of the Council;
- b) to encourage a diversity of recreation activities suitable for youths and adults;
- c) to identify, protect and preserve land which is environmentally sensitive, visually exposed to waters of Middle Harbour, North Harbour and the Pacific Ocean and of natural or aesthetic significance at the water edge;
- d) to facilitate access to open areas, particularly along the foreshore, to achieve desired environmental, social and recreational benefits;
- e) to conserve the landscape, particularly at the foreshore and visually exposed locations, while allowing recreational uses for those areas; and'

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

f) to identify areas which:

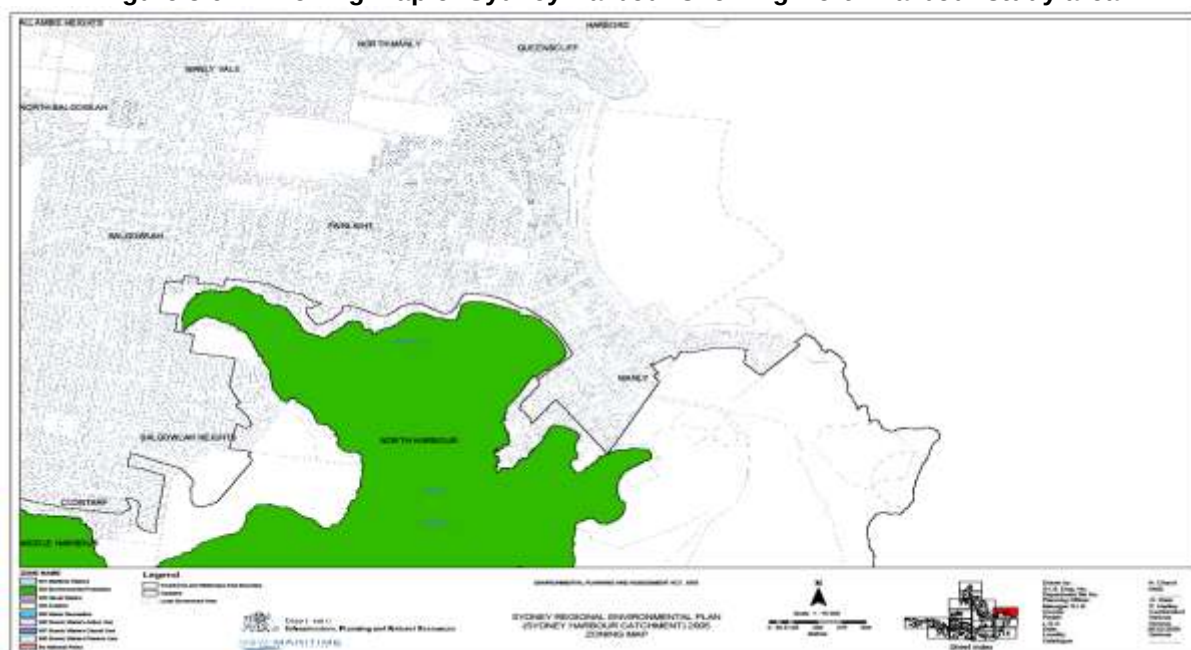
- i. in the case of areas shown unhatched on the map are now used for open space purposes, and
- ii. in the case of land shown hatched on the map are proposed for open space purposes.

3.6.2 Foreshore & Waterways Area Zoning

Under the Sydney Regional Environmental Plan - Sydney Harbour Catchments 2005, the entire waterways of the harbour and its tributaries are classified into nine zones: W1 (Maritime Waters), W2 (Environment Protection), W3 (Naval Protection), W4 (Aviation), W5 (Water Recreation), W6 (Scenic Waters – Active Use), W7 (Scenic Water Casual Use), W8 (Scenic Waters – Passive Use) and W8a (National Parks). These waterways zones have been specifically tailored to suit the differing environmental characteristics and land uses of the Harbour. This has resulted in a system that provides greater clarity and certainty for applicants and consent authorities in development considerations and applications.

Foreshores & waterways of the entire North Harbour study area is classed in W2 (Environment Protection) zone.

Figure 3.6.2 – Zoning map of Sydney Harbour showing North Harbour study area



Zone W2 – Environment Protection

The zone provides for the protection, rehabilitation and long term management of the natural and cultural values of the waterways and adjoining foreshores.

The objectives of this zone are as follows:

- (a) to protect the natural and cultural values of waters in this zone,
- (b) to prevent damage or the possibility of longer term detrimental impacts to the natural and cultural values of waters in this zone and adjoining foreshores,
- (c) to give preference to enhancing and rehabilitating the natural and cultural values of waters in this zone and adjoining foreshores,
- (d) to provide for the long-term management of the natural and cultural values of waters in this zone and adjoining foreshores.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

3.7 DEVELOPMENT CONTROL PLANS

3.7.1 Manly LEP 1988

The Manly Local Environment Plan 1988 (Manly LEP)² is the main statutory control over local development within Manly Local Government Area and applies to all land including North Harbour CMP study area.

The Manly Local Environment Plan (LEP) establishes Council as the consent authority for all purposes of the LEP. Clause 10 of the Manly LEP establishes that in order for consent to be granted for development, the Consent Authority must be of the opinion that the proposed development is consistent with the objectives of the relevant zone. Clause 10 also identifies the types of development that are permissible without development consent (item 2), permissible with development consent (item 3) and development that is prohibited (item 4) within each of the land use zones (Table 3.7.1a).

Table 3.7.1a Development controls within 4 land zones in North Harbour CMP study area

Zones	Without Development Consent (Item 2)	Only with Development Consent (item 3)	Prohibited (Item 4)
Zone 2 – Residential zone	Bed and breakfast accommodation; home occupations.	Any purpose other than a purpose included in item 2 or 4.	Advertising structures; amusement centres; bulk stores; car repair stations; backpacker accommodation; clubs; hotels; motels; refreshment rooms; service stations and tourist facilities (other than backpacker accommodation; clubs, hotels, motels, refreshment rooms, service stations and tourist facilities in the Tourist Area); commercial premises; gas holders; generating works; heliports; industries other than home industries; institutions; junk yards; liquid fuel depots; mines; motor show rooms; public buildings; retail plant nurseries; roadside stalls; sawmills; service stations; shops other than small shops; transport terminals; warehouses.
Zone 3 - Business zone	Bed and breakfast accommodation, home occupations.	Any purpose other than a purpose included in item 2 or 4.	Bulk stores; bus depots; car repair stations; dwelling-houses; fuel depots; gas holders; generating works; heliports; purposes specified in Schedule 3; junk yards; liquid fuel depots; mines; road transport terminals; roadside stalls; sawmills; warehouses.
Zone 5 – Special Uses Zone	Nil	The particular purpose indicated by red lettering on the map; child care centres and other child care facilities; drainage; educational	Any purpose other than those included in item 3.

² The present version of the Manly LEP 1988 is updated and amended in December 2008. Simultaneously, work is going on to revise the present LEP into the standard LEP template by 2011.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Zones	Without Development Consent (Item 2)	Only with Development Consent (item 3)	Prohibited (Item 4)
		establishments; landscaping; roads; telecommunications facilities; utility installations other than generating works or gas holders.	
Zone 6 - open space zone	Works for the purpose of landscaping, gardening or bush fire hazard reduction.	Agriculture; boating facilities; car parking ancillary to a use permitted in this item; child care centres; drainage; forestry; golf courses; marinas; parks; public baths; public dressing pavilions; race courses; recreation areas; refreshments rooms; roads; sports clubs; sports grounds; surf life saving clubs; telecommunications facilities; tennis courts; utility installations other than gas holders or generating works or both.	Any purpose other than a purpose included in items 2 or 3.

The LEP also identifies Items of Access land, Foreshore Scenic Protection Areas, Environmental Heritage, vicinity of Aboriginal Relics (Objects) and Potential Acid Sulphate Soils and provides planning controls for the ongoing appropriate management of each of these items and areas.

Open Space Land Owned by Council or Public Authority

Under Clause 16 of the Manly LEP, Council shall not consent to an application to carry out development on land which is zoned 6 and owned by Council or another public authority unless it has made an assessment of:

- the need for the proposed development on that land;*
- the impact of the proposed development on the existing or likely future use of the land; and*
- the need to retain the land for its existing or likely future use.*

Foreshore Scenic Protection Area

A Foreshore Scenic Protection Area has been established by the Manly LEP.

Manly LEP (Clause 17) establishes that the Council shall not grant consent to the carrying out of development unless it is satisfied that the development will not have a detrimental effect on the amenity of the Foreshore Scenic Protection Area.

Items of Environmental Heritage

The Manly LEP identifies a number of specific items, including many within North Harbour study area, listed as being of Environmental Heritage Value. Clauses 18 and 19 of the Manly LEP identifies the restrictions on development of or adjacent to items of Environmental Heritage. The Council shall not grant consent to a development application to carry out development in the vicinity of an item of the environmental heritage unless it has made an assessment of the effect which the carrying out of that development will have on the historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance of the item of the environmental heritage and its setting.

Acid Sulphate Soils

Clause 33 of the Manly LEP relates to the development of land identified on potential Acid Sulphate Soils (ASS). Mapping of ASS has been undertaken across Manly LGA and areas subsequently placed into 5 separate Classes. The study area is identified as Class 2 (North Harbour Reserve) or Class 5 land. Unless



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

otherwise indicated by Council, consent is required for the carrying out works, as described in Table 3.7.1b. A person must not, without the consent of the council, carry out works described in the following table on land of the class specified for those works, except as provided by sub clause (3).

Table 3.7.1b Detail of land categorization for potential Acid Sulphate Soils

Class of Land	Works
2	works below natural ground surface works by which the water table is likely to be lowered
5	Works within 500 metres of adjacent Class 1, 2, 3 or 4 lands which are likely to lower the water table below 1 metre AHD on adjacent Class 1, 2, 3 or 4 lands.

3.7.2 DCP for Sydney Regional Environmental Plan – Sydney Harbour Catchments (2005)

Council is the responsible authority for land/water interface development under the provisions of the Sydney Regional Environmental Plan -Sydney Harbour Catchments (2005).

Land/water interface development consists of boating industry facilities; boat launching ramps; boardwalks; large marinas; marinas; public water transport facilities; water based restaurants and entertainment facilities; water recreational facilities; development for the purposes of dwellings of any type (inc serviced apartments), commercial premises, tourist facilities, shops and retailing, restaurants, recreation facilities, car parking when carried out wholly or partly in the waterway.

The Development Control Plan (DCP) of the Sydney Regional Environmental Plan - Sydney Harbour Catchments (2005) sets out in detail Council's town planning controls and guidelines on key development factors. As mentioned already, the study area is entirely located in W2 (Environment Protection) zone.

Activities that may be carried out without development consent

Aids to navigation, demolition (other than demolition of a heritage item), general restoration works, naval activities and single mooring (other than associated with a commercial marina or a boating industry facility).

Activities that may be carried out only with development consent

Boat launching ramps (Public), community facilities, dredging, flora and fauna enclosures, maintenance dredging, private landing steps, public boardwalks, public water recreational facilities, public water transport facilities, recreational or club facilities and telecommunications facilities

Development activities that is prohibited

Advertisements, advertising structures, aviation facilities, boat lifts (other than boat lifts for storage of vessels above water, boat lifts for the storage of vessels above water, boat repair facilities, boat sheds (private), charter and tourism facilities, commercial marinas, commercial port facilities, houseboats, intertidal dredging, mooring pens, private landing facilities, private marinas, reclamation works, residential development, skids, slipways, swimming enclosures (private), swimming pools, tourist facilities, water-based restaurants and entertainment facilities and waterfront access stairs.

However, special provision clause 34 applies to existing boat repair facilities called Manly Boatshed whereby development can be carried out only with development consent. Further, special provision clause 37 allows a consent authority may grant development consent to the development of land that is within 20 metres of the boundary of zone no. W2 and another zone for a purpose for which development may be carried out in either Zone No. W2 or the adjoining zone.

In this DCP, different landscape character types in and around Sydney Harbour are recognised. These landscape character types provide a statement of character and intent and sets out performance criteria that are to be met for development within each landscape character types. Landscape character type 6 exists in North Harbour CMP study area.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

LANDSCAPE CHARACTER TYPE 6

Statement of Character and Intent: The key features of these areas are the uninterrupted sandy beaches and headlands where the backdrop of development is interspersed with vegetation. While development is suitable in parts of these areas, the key natural features should be retained and protected. Each bay has key beaches and headlands that contain significant vegetation and rocky outcrops which should be preserved. The leafy nature of the upper slopes and ridgelines provides an important contribution to the visual character.

Performance Criteria: Any development within this landscape is to satisfy the following criteria:

- headlands, points and shorelines are retained in their current, generally undeveloped, state;
- it is sited and designed to maintain the visual character of shorelines and to maximise retention of existing vegetation;
- visual continuity of elements such as beaches is not lost or broken by development;
- the scale of the built form of development is consistent with predominantly low density residential;
- it is sited so that it follows the topography and minimises cut and fill of slopes; and
- overall colours should match native vegetation as closely as possible with trim colours drawn from natural elements such as tree trunks and stone.

3.7.3 DCP for Residential Zone 2007 – Amendment 1

This DCP provides controls, considerations and requirements for development in the Residential Zone under the Manly LEP 1988. It applies to all forms of residential development in the zone with the objectives of this Plan also applying to residential development in other zones and non-residential development in the Residential Zone. This has established standard for dwelling density, floor space ratio, building height, setbacks, open spaces and landscaping, swimming pools, car parking and access.

The residential zone is divided into 7 density sub-zones with the study area designated within sub-zones 2 (with minimum allotment size of 250 m²), 3 (with minimum allotment size of 250 m²), 4 (with minimum allotment size of 300 m²), 5 (with minimum allotment size of 500 m²) and 7 (with minimum allotment size of 750 1150 m² at different slopes)

This DCP establishes following foreshore setbacks and existing foreshore building lines:

- a) Development on any property having frontage to the foreshore shall be setback a minimum of either 15m from mean high water mark, or the maximum wall height of the proposed building on the foreshore frontage, whichever is the greater.
- b) In residential areas which have been subject to foreshore building lines set by Council at less than 15m from mean high water mark, the setback will be determined individually taking into account the terrain, the adjoining development and the Council's existing and any future foreshore walkway.

3.7.4 DCP for Access 1996

This DCP is pursuant to Section 72 of the *Environmental Planning and Assessment Act* 1979 and applies to the entirety of Manly Council area. It sets out in detail Council's controls and guidelines to provide for an environment accessible to all people (including those with disabilities) in order to assist in achieving the aims and objectives and the policies and strategies of the LEP.

The DCP incorporates those parts of Manly Council Access Policy relating to development and building. This policy applies to public car parking provision, signage, audible access, footpaths and ramps, paving and public toilet facilities.

3.7.5 DCP for Landslip and Subsidence 2001

This DCP (updated March 2003) is designed to ensure that Council and the Community is aware, and responds appropriately to all identified potential hazards as a result of landslip and subsidence. It is also intended to



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

address the range of major risks to public safety, including risks to life, health, private and public property, the economy and the environment.

The DCP aims to provide a framework for identification, assessment, treatment and monitoring of landslip and subsidence risk and assists Council in the Development Application process. The study area contains land which fall under all four Zones A, B, C and D. Further details on each zone are provided in Table 3.7.5.

Table 3.7.5 Summary of Land Slip and Subsidence in the North Harbour study area

Zone	Location	Description	Slope Angle	Council requirement
A	Generally areas behind Zone B	Ridge crests, major spur slopes and dissected plateau areas.	< 15°	Geotechnical assessment may be required
B	Generally areas behind Zone C all along the foreshore	Flanking Slopes	15°-25°	Geotechnical assessment may be required
C	All foreshores of the study area	Steeper slopes, generally near coastal or harbour side areas	> 25°	Geotechnical assessment is required
D	North Harbour Reserve & beaches	Beach foredune and alluvial flats	< 5°	Should follow good engineering practice

3.7.6 DCP for Energy Efficiency Buildings 1998

This DCP (updated March 2003) encourages the design and development of energy efficient housing in the Manly Council area. It reflects Council's concern for the conservation of the environment, possible climate changes due to the Greenhouse Effect and Council's support for the ecologically sustainable development. The guidelines and specific controls apply to the assessment of residential, commercial and industrial development.

3.7.7 DCP for Waste Minimisation and Management 2000

The DCP (updated March 2003) for Waste Minimisation and Management 2000 encourages development applicants to consider waste management issues during the planning stage.

The DCP reflects Council's emphasis on the principles of ecologically sustainable development and a desire to reduce the amount of waste disposed of at landfill, in recognition of State and Federal Government targets. Waste avoidance is imperative to achieving this goal and is central to the requirements of this DCP.

Key controls in this DCP require developers lodging a development application to:

- Complete a waste management plan prior to the issuing of a construction certificate
- Include waste facilities in the development that support source separation and efficient waste collection.

3.7.8 DCP for Advertising Signs 1993

This plan (updated March 2003) aims to control the use of advertising structures and signs, so as to retain the uniqueness and natural beauty, and the architectural and historic significance of the LGA environment.

3.7.9 Other Council Plans & Policies

Described in detail in Chapter 2.



4. SIGNIFICANCE & VALUES OF NORTH HARBOUR

This section summarises the special features and unique qualities of North Harbour study area that make it significant from local, regional, and national levels. This is based on the feedback from community consultation, as well as the research and data collection collated for this study.

4.1 SIGNIFICANCE

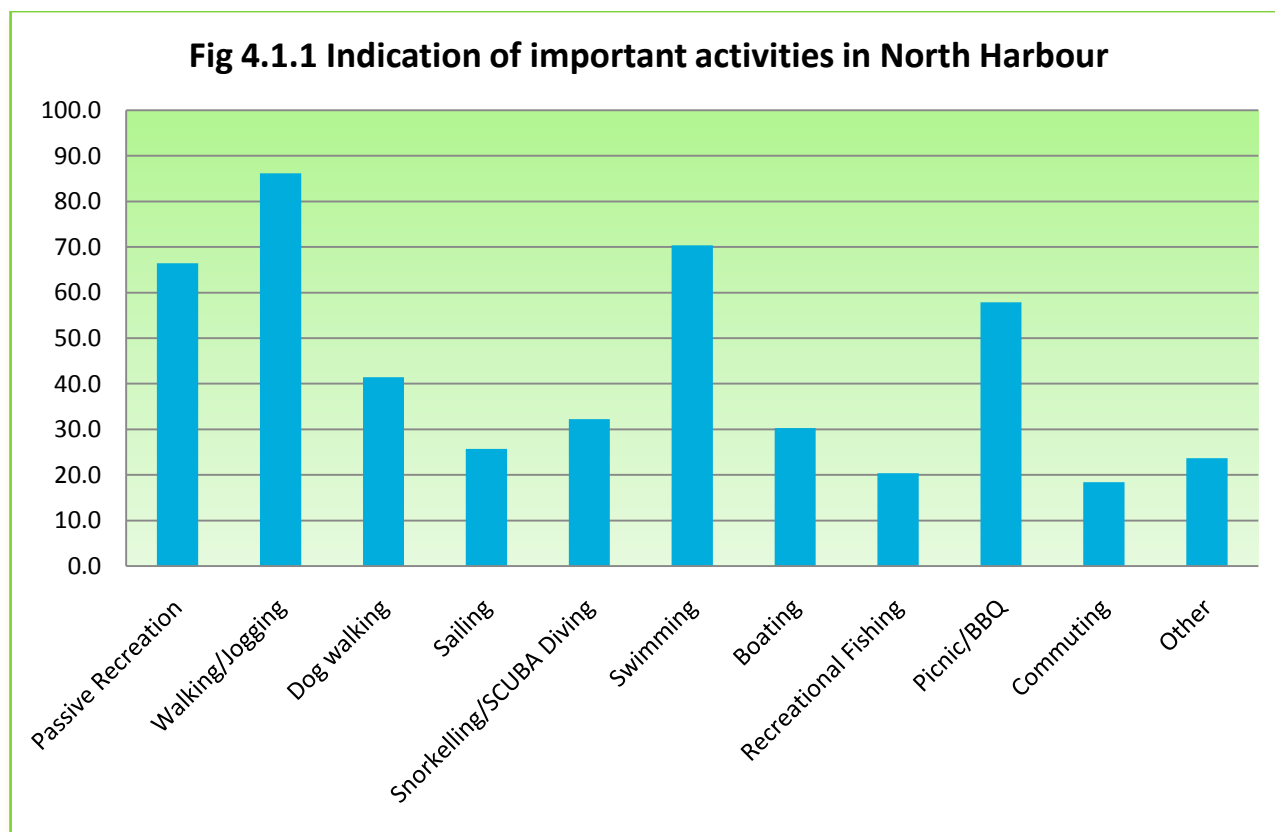
The identified characteristics indicate significance of the study area which is of existing and perceived future local or regional significance.

4.1.1 Local Significance

North Harbour study area is locally significant in its role as a habitat for native animals and plants, a provider of popular recreational resource for locals and visitors alike. The attraction of North Harbour is enhanced by its generally good water quality. This results in numerous primary and secondary contact recreational pursuits, including swimming, sailing, kayaking, diving, sail boarding, kite-surfing, water skiing and boat and shore fishing, which are immense value to locals and visitors alike.

During community consultation, respondents were requested to indicate leisure time activities important to them among 10 specified activities. Respondents indicated, on an average, 4.7 activities important to them. Results (Fig. 4.1.1) showed that the five most important activities carried out by residents in North Harbour are walking/jogging (86.2%), swimming (70.4%), passive recreation (66.4%), picnic/BBQ (57.9%) and dog walking (41.4%).

Fig 4.1.1 Indication of important activities in North Harbour





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Respondents have indicated cycling, kayaking, rowing/canoeing, group exercise, bird/wildlife watching, sight-seeing with visitors, bush generation and playing with children as other activities.

North Harbour Reserve is the central to all key activities. Other key locations that are reasons for many activities are:

- The Manly Scenic Walkway makes the area most popular for walkers, joggers and dog walkers.
- Fairlight pool and small harbour beaches provide great access for swimmers.
- Grassed areas and sandy beaches of Fairlight & Delwood provide areas for passive recreation.
- Sheltered sea conditions and the presence of nearby Davis Marina attracts boating and sailing to North Harbour area.
- Fairlight is favourite snorkelling and scuba diving spot.

Given its scenic beauty, North Harbour is highly attractive and people want to be near it, look at it, or be on it. For these reasons, recreational visitation and use of the waterway is extremely high with significant “flow on” effects for the local and regional economies. Its deep waters are very attractive to the boating community.

Because of its scenic beauty and views, foreshores have already become highly sought after residential area. At present, 70% of the foreshore is under residential land use compared to 37% within the whole Manly LGA.

4.1.2 State and Regional Significance

The study area is rich in Aboriginal cultural heritage giving it significance at the regional and state level. The Aboriginal Heritage Office (AHO) has recorded 5 Aboriginal sites within the study area (AHO & MC 2006a) including one rock engraving. European cultural heritage is also an important feature of the study area with numerous heritage listed sites and buildings including Fairlight Pool.

At the regional level, the study area has significance for its natural habitat. In recognition of the diverse array of habitat types that are still found in North Harbour, the NSW State Government, under its Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005, has zoned entire waterways of the study area as Environmental Protection, which aims to “provide for the protection, rehabilitation and long term management of the natural and cultural values of the waterways and adjoining foreshores (NSW Department of Planning, 2005). Large areas of the study area have also been designated as Wetlands Protection Area (WPA) by the NSW State Government. This area is designed to allow for future growth, as well as preserving and protecting the existing populations (NSW Department of Planning, 2005).

North Harbour Aquatic Reserve lies very close to the study area. Council has recently submitted a new proposal to extend North Harbour Aquatic Reserve to include entire water side of the study area for consideration by the Department of Environment & Climate Change.

There are several flora and fauna recorded as threatened, making the study area important. The entire study area has regional significance as it is covered within the Sydney Harbour Foreshores and Waterways Area and the Sydney Metropolitan Catchment Management Area.

4.2 VALUES OF THE AREA

It is also important to gain an appreciation of the multiple features and values of the area. The following values reflect attributes, activities and processes that are of importance to the community, and are the qualities on which the study area depends for its attractiveness, desirability, liveability and use. These values were derived from the community consultation that were undertaken during March-April 2006 and March 2007, to assist in the development of North Harbour Coastline Management Plan.

4.2.1 Historical Values

Aboriginal Occupation: The entire North Harbour study area was used extensively by the Aboriginals, known locally as the Gayemal clan of the Guringai tribe, who spent much of their time on the foreshores of Sydney



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Harbour (AHO, 2008). At that time, North Harbour was known as *Kunn-na*, *Kunna* or *Cannae* (Living Harbour 2008). The Guringai people lived a self-sufficient and harmonious life. A large amount of leisure time allowed them to develop a rich and complex culture that included trade with other tribes and ceremonies (AHO, 2008). Fishing is an important part of Aboriginal culture. Indigenous fishing is undertaken using a variety of methods and equipment, including hand gathering, lines, rods and reels, nets, traps and spears. Indigenous fishing targets a range of species of fish, shellfish, crabs and worms that are used for food, medicine or bait. Target species include (but are not limited to) mullet, flathead, whiting, tailor, bream, blackfish, mud crab, oysters, pipis, prawns, beach worms and river worms. Beach worming and shellfish gathering are recognised as an important part of the Aboriginal fisheries.

It is important to note however that while the Gai-marigal clan did occupy Northern Sydney region, the Metropolitan Local Aboriginal Land Council has previously stated that there are no known traditional Aboriginal owners of the North Shore peninsular (MLALC, 2003). More recently MLALC has recognised Bob Waterer as a traditional owner of Guringai country following the discovery of birth certificates proving that his great great grandmother was Motora, the wife of Bungaree.

The Gai-marigal clan was comprised of six major family groups. The Gatlay family group was associated with the Manly LGA and consisted of two smaller groups: the Boregal and Gorualgal people (Foley 2001).

The North Harbour study area provided shelter in all weather conditions in the various bays and valleys, with the extensive sandstone outcrops providing an abundance of overhangs and caves. There was also an abundance of food resources and fresh water, as evidenced by the many and extensive middens that can be found throughout. In excess of 1500 Aboriginal middens have been recorded along the coast, primarily as open sites (Sullivan 1988). Many middens are situated in rock shelters, reflective of relative abundance of cavernous overhangs to the shoreline. Middens are observed to be of varying size and length. Mounded middens are also found on the south coast. Estuarine shell fish species comprise approximately 50% of the shell in middens along the coast. Oyster is the dominant shell fish throughout the deposit. Most midden sites are within 200 meters of a water supply.

Many midden sites have been destroyed by European land uses, with substantial destruction in the early years of colonisation when middens were exploited as a source of lime (NSW Fisheries 2001). Every seaside beach was believed to contain midden areas, as did the populated bays on the harbour foreshore. These bays included that of the North Harbour area, in which middens can be found today, for example the grassed area of Esplanade Reserve.

Much of the evidence of indigenous occupation and lifestyle has been lost due to extensive land modification and urban development since European arrival. However, some artefacts still exist.

These existing artefacts, particularly middens, face further risk of being inundated through projected climate change impacts. Currie *et al.* (2007) carried out an investigation on Aboriginal sites located within Willoughby City Council on Middle Harbour and found that 30 (of the 148 currently recorded sites) will be inundated with a sea level rise of 0.59 meter. Fifty six sites will be affected that are within a one metre buffer zone.

European Arrival: Lieutenant James Cook arrived in 1770, declared that the land as uninhabited and named as New South Wales, to be the property of Britain's King George III. Captain Arthur Phillip then arrived in January of 1788 with orders to establish a penal colony, and take control of the land for settlement. The first European land ownership was granted only four days after this arrival, when a group of men began clearing land to gain access to fresh water. Though Captain Philip raised the flag for the first settlement at Sydney Cove on 26 January 1788, records show that he visited North Harbour either on 21 January 1788 (pictured Plaque) or 23 January 1788 (Balgowlah 150 Committee 1991).

The arrival of the Europeans resulted in numerous armed conflicts with the Guringai people contributing to the demise of the local population. Along with the conflict, the Guringai people also began to suffer from a shortage of food as the much larger white population depleted fish and kangaroo stocks through unsustainable netting and hunting, cleared the land and polluted the water.

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Exotic diseases from Europe were introduced with the invasion, for which the isolated Aboriginal people had no immunity. Over half the Aboriginal population of the Sydney basin died from small pox in less than one year. The remaining population was displaced from the land as the Europeans cleared it for farming and settlement. These brought to an end of traditional lifestyles of Aboriginal population in this area. Aboriginal people continue to live in the area, although very little traditional knowledge has survived.

European Settlement: After European settlement began in 1788 the study area slowly became populated, with several regionally important farms established. An early map of about 1822 shows a plan of a proposed township of Manly at North Harbour as quiet waters of North Harbour would have afforded greater protection for the small boats that were the only link with Sydney during that period. From the early 1820s scattered settlement began in the Manly Cove and North Harbour areas.



Major Thomas Livingstone Mitchell drew a plan of North Harbour in 1828, with 31 allotments laid out in rectangular grid to form the streets, and looked as an amphitheatre, watered by streams and a sheltered harbour. John Fincham, Robert Tiffen, James Jenkins are some of the early convict settlers of North Harbour. Robert Tiffen lived in North Harbour since 1817. Jenkins made a road in 1826 between North Harbour to Pittwater with thirteen bridges at a cost of 300 pounds and made North Harbour a gateway to Sydney long before connection through Ellery's Punt at the Spit. Thirty one allotments were large rural blocks ranging from 30 to 380 acres intended for farming purposes only. In 1850 land was sold for as little as \$4 an acre.

Henry Gilbert Smith, an English businessman living in Sydney, saw that Manly - with an ocean beach on one side and fine sandy cove on the other - could provide a great "watering place" for the people of Sydney, as Brighton did for Londoners. He started acquiring land in the area in the 1850s.

The home of first Prime Minister – Sir Edmund Barton is situated here and was probably built in 1870's. Situated near the corner of Boyle Street and Lauderdale Avenue, the Lookout was a local landmark. North Harbour Park, before it was reclaimed, was a sandy shallow area where children swam and splashed, fishermen netted and one could canoe under the wooden bridge on Condamine Street to the bottom of the waterfall that began near the dairy. Eventually a four lane road replaced the wooden bridge. In November 1880, residents applied for the establishment of a school for 26 pupils.

4.2.2 Social Values

Social values are linked community's willingness to participate in consultation. More than 150 survey forms were returned with comments, suggestions for the desired management of North Harbour. People recognise the area as public land for the enjoyment of the local community and visitors and value being able to provide input into the future direction and management of the area.

4.2.3 Cultural Values

Cultural values associated with the area's indigenous and non-indigenous heritage and the identification of significant Aboriginal sites. The entire North Harbour study area was used extensively by Aboriginals, known



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locally as the Gayemal clan of the Guringai tribe, who spent much of their time on the foreshores of Sydney Harbour (AHO, 2008). There are five recorded Aboriginal heritage sites within the study area.

A list of heritage items of the study area is presented in Section 9.4.

4.2.4 Ecological Values

Ecological values associated with the protection and improvement of aquatic, inter-tidal and terrestrial environments. These include marine habitat, intertidal habitat, mixed rocky intertidal with sand, sandy beaches, sea grass beds, urban bushland and reserves and wetlands. The consultation process identified that the community highly values the preservation of natural bushland, seagrass and water quality. North Harbour supports habitats of regional and state conservation value including species and communities listed under the *Threatened Species Conservation Act 1995*, *Environment Protection and Biodiversity Conservation Act 1999*, *Fisheries Management Act 1994*, and/or State Environmental Planning Policies.

4.2.5 Aesthetic Values

Aesthetic values associated with a pleasant, appropriate and 'green' landscape character. For example the consultation process identified that the community values the more natural characteristics of the area. Areas that hold specific scenic value include: North Harbour Reserve and Esplanade Park

4.2.6 Recreational Values

Recreational values associated with an enjoyable environment for all users, visitors and local residents. For example people value being able to undertake various recreational activities in public places, both on land and on water. The attraction of North Harbour is enhanced by its generally good water quality. This results in numerous primary and secondary contact recreational pursuits, including swimming, sailing, kayaking, diving, sail boarding, and shore fishing. The foreshores around are also used for numerous recreational pursuits, including walking / jogging, dog exercise, bird watching, scenic enjoyment / nature appreciation and picnicking. North Harbour Reserve is a popular recreational area.

4.2.7 Economic Values

Economic values associated with a number of economic activities. The area is important to a range of stakeholders, ranging from local retailers to commercial tourism operators, boating services, marinas and support industries.

Manly is a visitor's destination in Australia and attracts approximately 6 million visitors per year to its beaches and water. It has very positive impact on local economy. Economic valuation of Manly beaches is currently being estimated. Recently, attention has been drawn towards ecotourism to market natural, heritage and cultural showcases existing in Manly and selling 'Manly – more than a beach'. North Harbour area offers many opportunities for touristic visitation.

Commercial fishing had been one of the key economic activities of the study area but has remained banned since October 2006. However, recreation fishing is allowed with some restrictions. NSW DPI has carried out a recreational fishing survey (NSW DPI, 2002), which indicates that there are almost half a million recreational anglers in Sydney, many of whom would utilise the area from time to time. Total expenditure of Sydney recreational anglers could be in the order of \$150 - \$250 million per year.

4.2.8 Physical Values

Physical values associated with coastal foreshore and processes. For example, residents and visitors value ability to access and experience the foreshore and associated views. Values associated with effectively



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maintained infrastructure and services. For example people identify that well maintained facilities and services contribute to the experience of the area.

4.2.9 Sustainable Use Values

Values associated with the sustainable use and management of resources, land and the marine area. The consultation identified that the community would like to ensure that the area be used and managed in a way that will ensure that these values are preserved in the future.

4.2.10 Accessibility Values

Accessibility values associated with convenient access to all public areas. For example people value the ability for all people to access and enjoy the area.

4.2.11 Lifestyle Values

Lifestyle values associated with a safe environment. For example people value being able to enjoy the area knowing that it is safe and will not affect their health



5. COASTAL PROCESSES

Coastal land is exposed to never ending attack by the sea, the atmosphere and coastal rivers. The waves, increased water levels and winds associated with storms, together with coastal currents and rivers debouching into coastal waters, reshape beaches and shift beach sediments offshore, onshore and atmosphere. This section looks at various coastal processes along with background information on geological settings.

5.1 GEOLOGICAL SETTING & SOILS

Sydney Harbour is made up of mostly sandstone and shale formed during the Triassic period (about 220 million years ago). These formations were later raised to their present heights by earth movements, starting in the Jurassic period, (200 million years ago). During this time great cracks formed and molten lava rose up through the rocks to form volcanic vents, these then cooled and hardened to form dykes of basalt. Remains of basalt dykes can still be found around North Head.

North Harbour area is predominantly Hawkesbury sandstone. Sandstone is a very hard rock that tends to break away in large blocks leaving the boulders and vertical cliffs that characterises Sydney coastline.

Along some parts of the Harbour there are some low lying areas of sand that has been deposited by water (alluvium) running between hills of sandstone. Particularly high areas such as North Head and South Head which were once islands are now joined to the mainland by sand spits such as the Corso area of Manly.

The sandstone and clays of Sydney Basin were deposited as sediments during Permian and Triassic times, 275 to 180 million years ago. About 90 million years ago (Late Cretaceous), Sydney Basin was uplifted and erosion of the softer top layers began, exposing the lower beds of sandstones. Sydney Harbour was once a valley formed by stream erosion and subsequently inundated when sea level rose by 100 metres at the end of the last Ice Age. Since that time the Harbour has been gradually filling with deposits of mud, sand and silt.

The soils of the study Area are a result of weathering of the Hawkesbury and Narrabeen sandstone bedrock marine deposition and Aboriginal shell middens. These landscapes are Hawkesbury Colluvial (ha), Gynea Erosional (gy) and Woy Woy (ww). Mapping of the 1:100 000 map sheet by the Soil Conservation Service of NSW in 1989 identified three basic soil landscapes. These are described below (Skelton & White 2004).

Hawkesbury Colluvial (ha)

These soils cover the majority (approximately 85 %) of the terrestrial part of the study area. These soils are characterised by shallow, discontinuous lithosols/siliceous sands associated with rock outcrops, earthy sands, yellow earths and some yellow podsol soils on inside of rocky benches and along joints and fractures, localised yellow and red podsol soils associated with shale lenses, siliceous sands and secondary yellow earths along drainage lines. These soils are typically vulnerable to extreme soil erosion hazard, mass movement (rock fall) hazard, steep slopes, rock outcrops, shallow, stony, highly permeable soil and low soil fertility (Chapman and Murphy 1989).

Gynea Erosional (gy)

These soils occur on the northwest corner of the study area and cover approximately 10 %. These soils are characterised by shallow to moderately deep yellow earths and earthy sands on crests and inside of rocky benches, shallow siliceous sands on leading edges of rocky benches, localised gleyed podzolic soils on shale lenses, shallow to moderately deep siliceous sands and leached sands along drainage lines (Chapman and Murphy 1989). These soils are typically vulnerable to localised steep slopes, high soil erosion hazard, rock outcrop, shallow highly permeable soil and very low soil fertility.

Woy Woy (ww)

These soils are characterised by deep Siliceous Sands and occasional Podzols on sandy rises, Humus Podzols in poorly drained areas, Calcareous Sands near beaches (Chapman and Murphy 1989). These soils are

5.2 ACID SULPHATE SOILS

Presence of Class 2 acid sulphate soil, according to Manly LEP, is located at North Harbour Reserve and surrounds (**Figure 5.2**). Acid sulphate soils occur when soils containing naturally occurring iron sulphide are dried and exposed to the air, usually as a result of human activity. In air, iron sulphides are oxidised and sulphuric acid is produced. This sulphuric acid has the potential to leach into the surrounding environment, where it can affect the health of waterways, groundwater, aquatic and terrestrial plants and animals, and also causes damage to engineering structures. In another study, Skelton & White (2004) did not find presence of acid sulphate soil from core samples of North Harbour Reserve.

Figure 5.2 Potential Acid Sulphate Soils within North Harbour Study Area



Soil cores were obtained from the North Harbour Reserve using a 2-man borer with an auger gauge of 100mm on 7 May 2003 (Skelton & White 2004). Samples from each horizon were also analysed. The soil types and clay content were identified and any inclusions noted. The samples were analysed for acid sulphate soil potential. Cores were drilled until bedrock was reached or to a maximum depth of 2 meters. Results are presented in **Table 5.3**.



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Table 5.3 Results from soil samples within the North Harbour Reserve

Depth of Core	Location	Description of soil layers	pH
0.4m	This core was drilled towards the road side of the reserve.	The topsoil consisted of a rich, organic, black loam, free of rock or shell inclusions, to a depth of 17 cm. This indicates imported soil for lawn covering. The following soil horizon consists of sand with shell fragments and entire shell casings, to the depth of 40 cm. Sandstone was encountered at the depth of 40 cm.	8.5 - 9
2.0m	The second core was drilled towards the road side of the reserve	The topsoil consisted of a rich, organic, black loam, free of rock or shell inclusions, to a depth of 17 cm. This indicates imported soil for lawn covering. The following soil horizon from 18 cm to 60 cm depth, consisted of a loamy sand with clay inclusions (2-5 cm in diameter). This soil layer likely to be fill material. The remainder of the soil core consisted of sand with shell fragments and sandstone inclusions (1-2 cm in diameter).	8.5 - 9
2.0m	This core was drilled towards the seawall. Soil that was found consisted of topsoil to the depth of 11 cm followed by sand with shells.	The topsoil consisted of a rich, organic, black loam, free of rock or shell inclusions, to a depth of 11 cm. This indicates imported soil for lawn covering. The following soil horizon from 11 cm to 1 m depth, consists of a marine sand, with unbroken shell inclusions (unlikely to be a midden), characteristic of shallow marine substrata.	8.5 - 9
2.0m	The core was drilled towards the seawall side of the reserve. This soil profile was very similar to the hole at GPS 7. Topsoil was to a depth of 15 cm, followed by marine sand with shell inclusions.	The topsoil consisted of a rich, organic, black loam, free of rock or shell inclusions, to a depth of 15 cm. This indicates imported soil for lawn covering. The following soil horizon from 15 cm to 1 m deep, consists of a marine sand, with unbroken shell inclusions (unlikely to be a midden), characteristic of shallow to medium depth marine substrata.	8.5 - 9

Source: Skelton and White (2004)

Recommendations

- No acid sulphate soil was found so no precautions need to be taken during excavation in regard to acid sulphate soils.
- No potentially contaminated fill was found.
- The soil is suitable for planting.

5.4 TOPOGRAPHY & BATHYMETRY

The study area is characterized by natural and cut sandstone cliffs and escarpments with fringing native bushland pockets and landscaped areas along the Esplanade Reserves. The study area has gradual rise to an altitude of 90m with a rapid rise between 40 to 70m. This terrain has implications for stormwater management, public access to foreshores, erosion, and the potential for land slip

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Figure 5.4a Topography of the North Harbour study area

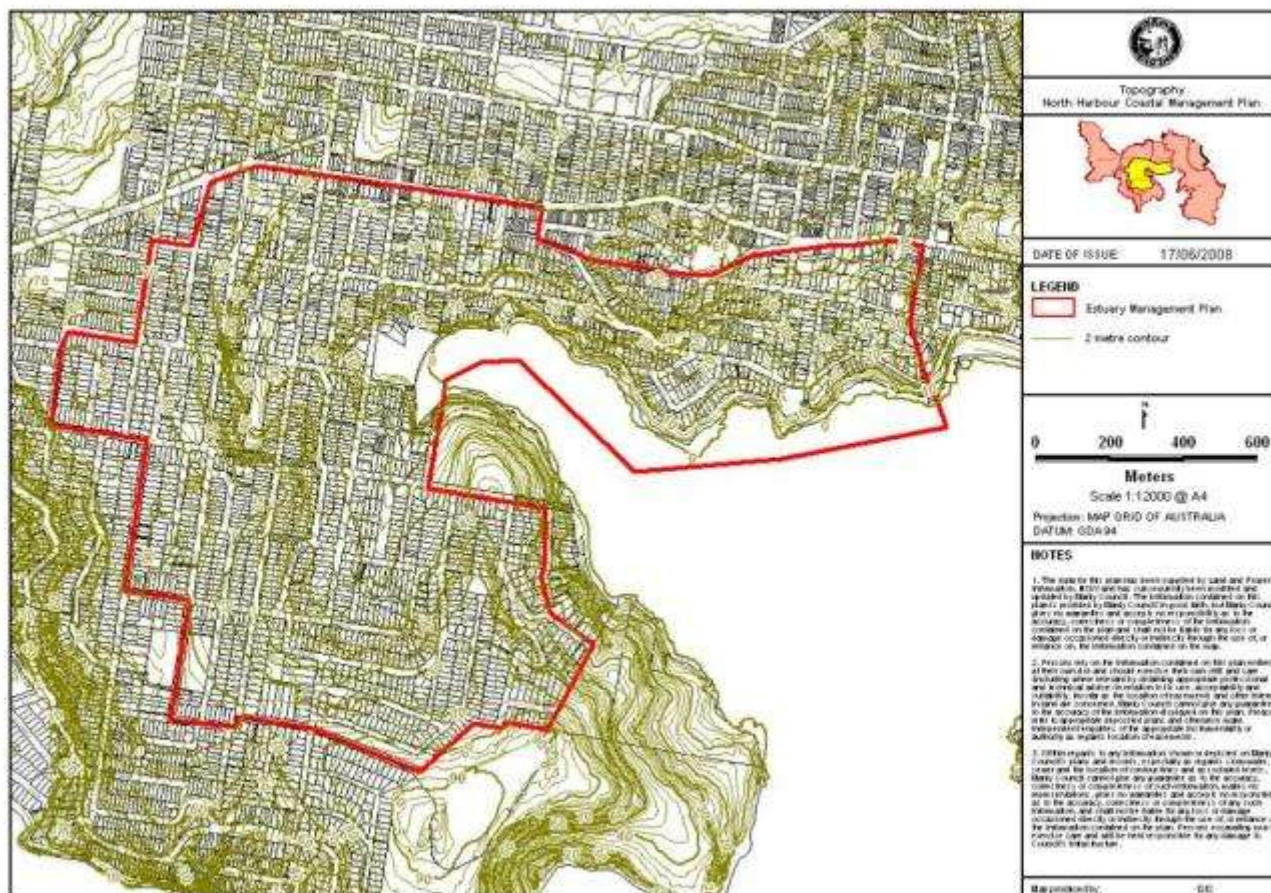


Figure 5.4b – Bathymetry of the North Harbour



5.5 STORMS

Storms play an important role in determining the rate and magnitude of shoreline change. The most devastating storms to strike the NSW coastline since records began, in terms of erosion damage, is likely to be the May - June 1974 storms. The 1974 storm washed the boats over North Harbour Reserve and Condamine Street into the parking area on the western side of Condamine. Because of many broken boats, a bonfire was done.

PWD (1985) provides a history of the storms affecting the NSW coast between 1880 and 1980 and categorises storms in terms of offshore significant wave height and damage caused. Two categories of storms result in substantial coastal erosion; these are so-called categories X and A (**Table 5.5**). Category X storms are extreme events that have significant offshore wave heights of greater than 6 m and are characterised by damage to coastal installations, severe erosion and disruption to shipping (PWD, 1985). Category A storms have significant offshore wave heights of between 5 and 6 m and are also characterised by erosion and damage to coastal installations and disruption to shipping (PWD, 1985).

Table 5.5 Category A and X Storms over the period 1972-1975

Date	Category
23 June 1972	A
20-21 February 1974	A
25-26 May 1974	X
8-14 June 1974	A
21-23 June 1975	A

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5.6 ELEVATED WATER LEVELS

The still water level that occurs during a storm can be much higher than that experienced during calm weather. Other than astronomical tide, there are three components that can contribute to an elevated still water level during a storm; namely barometric setup, wind setup and wave setup.

Barometric setup is a localised rise in ocean level due to a reduction in atmospheric pressure. Wind setup is a result of strong onshore winds causing water to “pile-up” along the coast. Barometric setup and wind setup are collectively referred to as storm surge. Wave setup is an increase in still water level in the surf zone, i.e. inshore of where the waves break, due to a conversion of some of the kinetic energy of waves to potential energy. Individual waves cause temporary water level increases above the still water level due to the process

of wave run up or uprush. The above components of elevated water levels at the times of storms are illustrated in **Figure 5.6**.

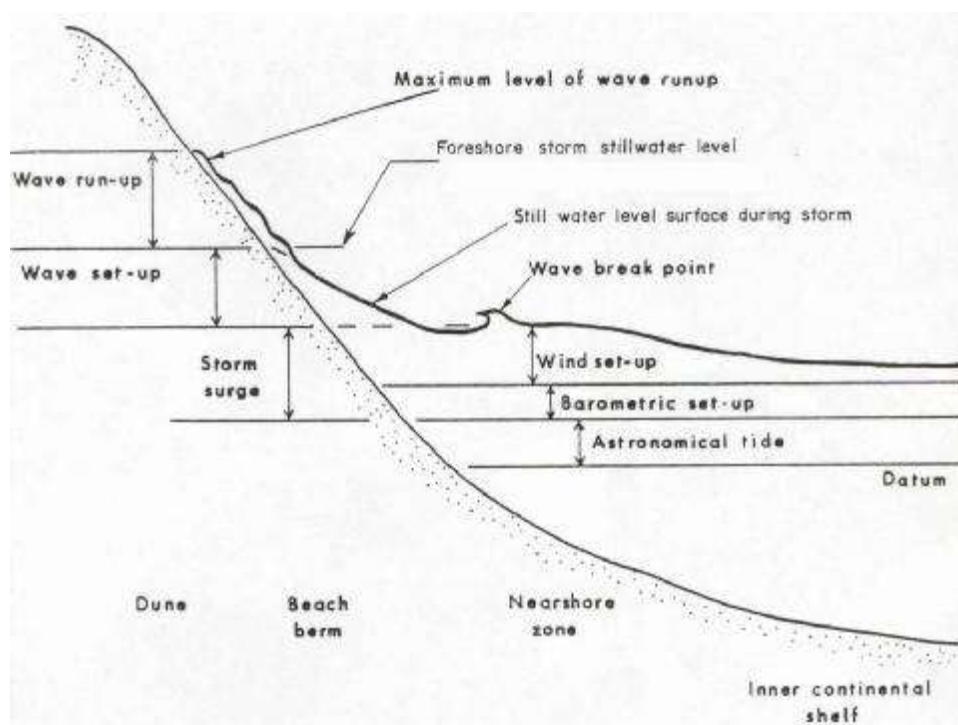


Figure 5.6 Components of elevated still water levels during storms

Source: Public Works Department

Barometric setup, wind setup and wave setup are interrelated but are all independent of astronomical tide. Whether the peak of the storm coincides with high tide or low tide is a very significant factor in determining the level of erosion damage.

Tidal anomaly exceedances for Sydney for a range of Average Recurrence Intervals (ARIs) as reported in WRL (2003) are set out in **Table 5.6**. Tidal anomaly refers to the difference between the actual recorded water level at a tidal gauge and the predicted astronomical tide. It is a measure of storm surge (*where the tidal gauge is situated such as not to be influenced by wave setup*). In this case the tidal anomalies are based on analysis of 76 to 88 years of data from the Fort Denison tide gauge.

Using the refraction diagram presented in Foster *et al.* (1975) to determine a refraction coefficient for the swell wave penetration to Fairlight Beach, and the Shore Protection Manual to estimate a shoaling coefficient it is expected that the wave coefficient value would be approximately 0.35 in a water depth of approximately 5 m. This value has been used to determine the wave setup at Fairlight Beach and thus the extreme water levels in **Table 5.6**. The wave refraction study reported in Lawson and Treloar (1988) determined a wave coefficient of 0.1 for the Little Manly Beach boat ramp area. Due to the more exposed nature of Fairlight Beach, these values are considered comparable.

The predicted extreme water level therefore expected in a 100 ARI event including astronomical tide, storm surge and wave setup, and is approximately 2.0 m above Australian Height Datum (AHD). AHD corresponds approximately to Mean Sea Level.



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Table 5.6 Extreme Water Level and Tidal Anomaly Exceedances

ARI (yrs)	Positive Tidal Anomaly (m)	Water Level (m AHD) excluding wave setup	Offshore Hs (m)	Hs at Fairlight Beach (m)*	Wave setup based on 15% of Hs (m)	Water Level (m AHD) including 15% wave setup
1	0.48	1.28	5.8	2.03	0.30	1.58
2	0.52	1.31	6.4	2.24	0.34	1.65
5	0.54	1.36	7.2	2.52	0.38	1.74
10	0.56	1.39	7.8	2.73	0.41	1.80
20	0.57	1.43	8.4	2.94	0.44	1.87
50	0.59	1.47	9.3	3.26	0.49	1.96
100	0.61	1.50	9.8	3.43	0.51	2.01

Source: WRL (2003) for tidal anomaly and offshore significant wave height.; * Based on a refraction coefficient of 0.35

5.7 WAVE CLIMATE

The wave climates at Fairlight Beach and Delwood Beach are composed of a combination of wind and boat generated waves and swell penetrating from the ocean.

5.7.1 Wind Waves

Wind waves result from wind blowing across the water surface. The height and period are dependent upon speed, duration and direction of wind, length of water or fetch over which the wind blows, and the water depth.

Both Fairlight Beach and Delwood Beach are generally fairly exposed to wind generated waves, with an open fetch in a 10 degree sector to the south-south-east.

Based on the Shore Protection Manual wave hindcasting methods (*US Army Corp of Engineers, 1984*), and using an estimated fetch distance to South Head, the following wave climate data has been established.

Table 5.7.1 Wind Generated Significant Wave Heights

Direction of Wind	Fetch Length (km)	Significant Wave Height (m)		
		Return Period		
		Annual	1 in 10 yr	1 in 50 yr
South-south-east	3.6	0.8	1.05	1.2

5.7.2 Boat Generated Waves

Boat wakes are generated by vessels sailing or steaming across the harbour and bay. The size of the wave generated at the site is a function of the speed of travel of the vessel, displacement and hull shape of the vessel, and the distance of the site from the vessel's sailing line.

Field measurements of boat wakes for various types of vessels have been recorded by the Water Research Laboratory of the University of New South Wales, the Sydney Ports Corporation, and Patterson Britton and Partners (*PBP*) at various locations in New South Wales. A summary of the maximum wave height and corresponding wave period measured close to the vessels' sailing lines are summarised in **Table 5.7.2**.

Based on measurements collected by Patterson Britton, the maximum wave height generated by these vessels would, typically, not be expected to exceed 0.6 m at a distance of 50 m from the sailing line.

The predominant vessel wave action experienced along the foreshore from the point east of Delwood Beach may therefore be from the Manly Jet Cats (*also confirmed by pers comm with Bruce Davis of Davis Marina*). At

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its closest point, the Jet Cat route is approximately 600 m from Fairlight Beach. The vessel generated wave height would reduce significantly over this distance and is therefore not expected to exceed 0.3 m.

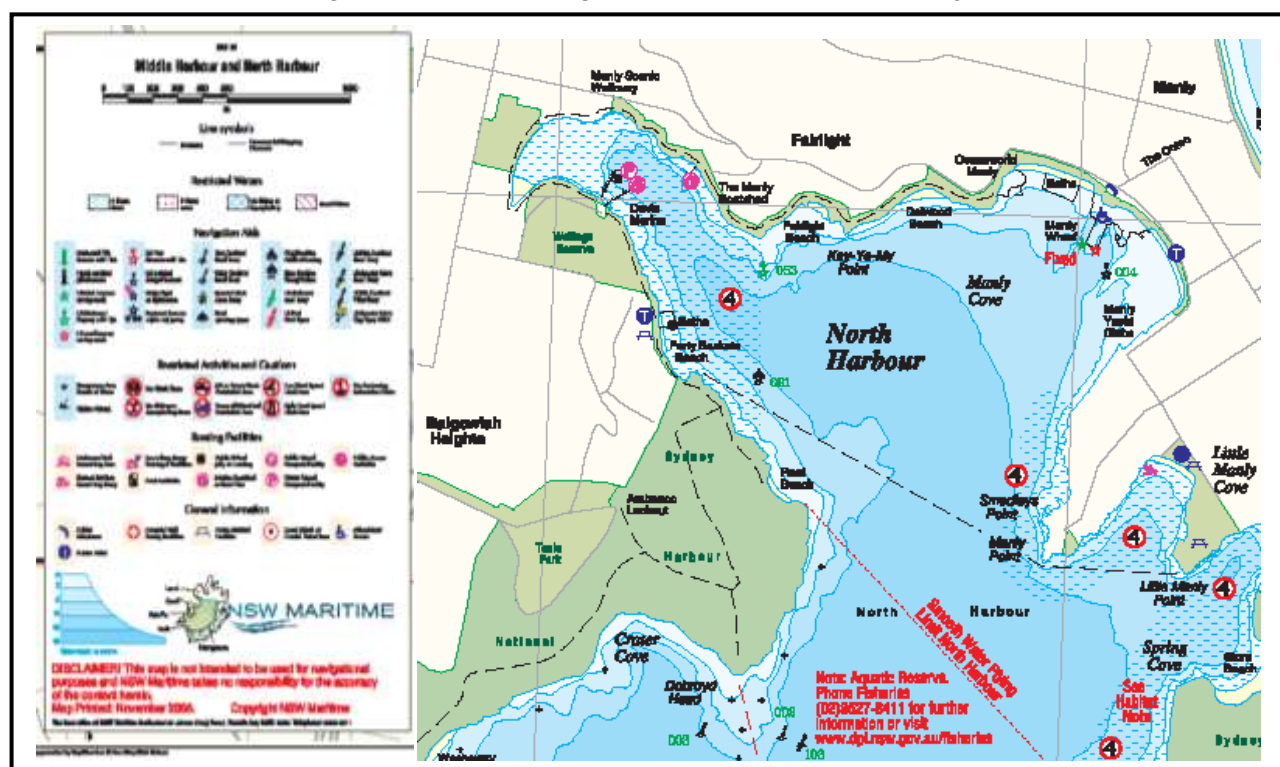
Table 5.7.2 Measured Boat Wake Waves for Various Vessel Types

Vessel Type	Maximum Wave Height (m)	Wave Period (sec)
Sydney Ferries (excluding catamaran type)	0.4	2.2
Rivercat	0.3	7.0
Water Taxis	0.5	2.2
15m Motor Cruiser	0.8	3.6
13m Tug	0.8	1.4
Power Boat	0.4	2.0

To manage this large amount of boat traffic, there is boating restrictions in place (see Figure 5.7.2) that in theory should minimise the effects of boat generated waves for certain parts of the study area.

A 4 knot speed limit zone is in place in North Harbour. Speed limit zones are designated purely for safety reasons. Safety is a concern in this area because of the large amount of traffic using the waterway. No boating restrictions apply for any parts of the study area, apart from the generic regulations that apply in all waterways.

Figure 5.7.2 Boating Restrictions within the Study Area



Source: NSW Maritime, 2006

5.7.3 Ocean Swell Waves

Fairlight Beach is directly affected by refracted ocean swells through Sydney Heads. During extreme events, elevated ocean levels due to storm surge in combination with wave diffraction (*i.e. bending of waves around an island or headland*) and refraction can result in low height long wave period ocean swells.



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Foster *et al.* (1975) noted that a feature of the May-June 1974 storms was the severe damage experienced within Sydney Harbour at Balmoral and Manly Cove. They argued that the wave climate could not have resulted from short period seas generated within the harbour, yet theoretical analysis (*which at the time did not allow for the combination of refraction and diffraction around a headland*) could not predict the conditions that must have occurred. Through analysis of vertical aerial photographs taken during subsequent storms in August 1974 they were able to construct refraction/diffraction diagrams for Sydney Harbour. This analysis showed significantly higher wave heights in the lee of the headlands as a result of wave diffraction and refraction acting together.

In **Table 5.6** it was noted that the 100 year ARI significant wave height offshore is 9.8 m (WRL, 2003). If a wave coefficient of 0.35 is taken for Fairlight Beach, as discussed in **Section 5.6**, the 100 year ARI significant wave height offshore of Fairlight Beach is predicted to be about 3.4 m. The wave height at Fairlight Beach would therefore be depth limited i.e. the maximum wave height in a certain depth is limited because the wave would break. Similarly, based on numerical modelling of swell wave climate at Little Manly Cove (Lawson & Treloar, 1987), and considering the relative magnitude of the wave coefficients between Little Manly Cove and Fairlight Beach, the following frequency of swell wave heights would be expected at Fairlight Beach (**Table 5.7.3**).

Table 5.7.3 Frequency of swell wave heights at Fairlight beach

Total no. of days/annum wave height exceeded	Significant Wave height (m)
1	1.59
5	1.21
10	1.06
20	0.91
50	0.72

5.7.4 Overall Wave Climate

Waves may occur at Fairlight and Delwood Beaches as a result of combination of ocean swell entering the harbour during storm events and local wind conditions generating wind waves from the south-south-east direction.

There is no joint probability data on the combined occurrence of both wind and swell waves in the harbour. It would be overly conservative to combine a rare wind wave event and rare swell wave event. Based on experience it would be expected that a combined wind wave and swell wave having a return period of about 100 years would have a wave height in the order of 4 m. For beach erosion considerations, the more severe combination would be large ocean swell and a moderate wind wave.

5.8 WAVE INDUCED CURRENTS

The most common forms of wave induced currents are longshore and rip currents.

Longshore currents occur within the breaker zone and move essentially parallel to the shoreline, they are usually generated by waves breaking at an angle to the shoreline. These currents cause movement of sediment along the shoreline, commonly referred to as littoral drift. Due to variability in wave approach direction at most open coast beaches, there may be times when the littoral drift is in one direction and at other times when it is in the opposite direction. At Harbour beaches subject to ocean swell, such as Fairlight Beach, the degree of filtering of wave approach direction is such that a wide range of wave approach directions is not possible.

Rip currents are strong currents which flow seaward from the shore. They comprise the return movement of water which is "piled up" on the shore by incoming waves and wind. The rip consists of three parts : the feeder currents flowing parallel to shore inside the breakers; the neck, where the feeder currents converge and flow through the breakers in a narrow band or "rip"; and the head where the current widens and slackens outside the Breaker line.

As the "rip" is a locally deeper channel through the sand bars, larger waves can reach the shoreline at the location of rips, i.e. opposite rip heads. Accordingly, it is common to distinguish the higher storm erosion



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demand which can occur at rip heads and the lower storm erosion demand which prevails away from the location of rips. Due to the extent of sheltering at Fairlight Beach, significant rip formation is probably limited to times of storms.

Anecdotal evidence from Mr Bruce Davis (*of Davis Marina*) indicates that there can be a strong current circulating in North Harbour which could potentially transport sediment, particularly during storm events. According to Mr Davis these currents generally travel north along the eastern shore up to the seawall at the head of the harbour then travel back out along the southern side. The existence of a large scale anticlockwise circulation in North Harbour may be due to the effects of wind or due to differences in wave setup across the waterway. The amount of sand transported by this local mechanism would not be expected to be significant.

5.9 SEDIMENT BUDGET

Although no detailed coastal processes study has been carried out for Fairlight Beach or Delwood Beach it is likely these beaches are largely closed sediment systems based on a number of factors:

- Fairlight and Delwood Beaches have rocky points at both ends of the beach that extend approximately 100m out from the beach, hence it is unlikely there is any significant littoral sand supply or loss;
- Fairlight Beach is truncated by a concrete seawall, and Delwood by an undercut sandstone rock face along the full length of the beach. As there are no dune systems, there is consequently no significant loss or gain of sand across the back beach boundaries;
- the results of the photogrammetric analysis of historical vertical aerial photography indicate that there have been generally only minor changes in beach volume over the period 1965 to 1998. The results of the photogrammetry are discussed in **Sections 5.10.2 and 6.2**.

The primary beach dynamic is therefore thought to be sand moving generally offshore during storm activity and onshore in calmer weather.

5.10 SHORT TERM ONSHORE/OFFSHORE SAND MOVEMENT – STORM DEMAND

5.10.1 General

Onshore/offshore sand movement is caused by natural variations in the wave climate. The offshore movement of sand is usually referred to as storm erosion. This onshore/offshore movement of sand results in short term fluctuations in the width of the beach profile. At open coast beaches and even harbour beaches the onshore/offshore movement of sand was dramatically highlighted during the severe May-June 1974 storms.

During storms, the beach is cut by storm waves with beach sand moving offshore to form bars in the surf zone. This process typically occurs over a period of hours to days. When extended periods of calmer waves occur, the material held in these bars migrates onshore to re-build the beach berm. Depending on the magnitude of the preceding storm, this beach building process can occur over a time scale of days to years.

The depth of the active profile or closure depth is the discernible offshore limit of significant bathymetric change. For a sheltered harbour beach subject to ocean swell, the closure depth is probably in the order of about -3 m AHD (*e.g. Jimmys Beach, Port Stephens*). Fairlight Beach is quite exposed, the closure depth may be in the order of about -4 m AHD. As Delwood is slightly more protected than Fairlight Beach, the closure depth may be in the order of -3 m AHD. Significant onshore/offshore movement of sediment is restricted to shallower depths above this contour.

The amount of sand which can be removed from the beach during a storm event is referred to as the "storm demand". This quantity is measured above 0 m AHD (*approximately Mean Sea Level*) and is usually expressed as a volume per metre run of beach (*m³/m*). Knowledge of storm demand for a beach allows estimation of the amount of material required to be held in reserve for a storm in order to protect a given asset. It also allows estimation of the degree to which a beach would be eroded in a storm for a given pre-storm beach profile.



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The reason that the storm demand is measured above 0 m AHD reflects the way in which the data to describe storm demand has been obtained, being typically from survey or photogrammetric techniques where only that portion of the beach above Mean Sea Level is either considered or is visible.

At any location at any point in time, the storm demand is dependent on a number of variables including:

- wave height and period as well as the duration of the storm;
- state of the beach before the storm;
- direction of the storm relative to the orientation of the beach;
- magnitude of the storm surge accompanying the event;
- the amount of wave setup and run up on the beach during and immediately following the storm;
- tidal range at the time of the storm; and
- state of the tide at the peak of the storm.

Because the actual storm demand is a complex function of these variables, it is usual to express the storm demand in terms of an average recurrence interval, i.e. storm demand for a 1 in 50 year event, 1 in 100 year event and the like.

5.10.2 Fairlight and Delwood Beaches

A Profile Area Volume (PAV) analysis of the historical beach profiles established by photogrammetry³ was undertaken by the then Department of Land and Water Conservation (DLWC) and supplied to Patterson Britton for interpretation as part of this hazard definition study.

Interpretation of DLWC PAV Analysis

By comparing the sub aerial beach volumes, i.e. volumes above 0 m AHD, before and after the 1974 storms it is possible to make some assessment of the storm demand in extreme events. Variations in storm demand along the beach can also be determined in this manner. It needs to be recognised of course that photography is not always available immediately before and immediately after a storm. Hence some judgement is applied to measure erosion volumes before design values are adopted for storm demand.

The date of photography used for the 'before' analysis for Blocks 9 and 10 was 28/4/1972. The date of photography used for the 'after' analysis was 6/8/75 (*over a year after May-June 1974 storm event*).

A summary of the storm demand calculated on a block average basis in the PAV analysis is presented below in **Table 5.10.2**. The maximum storm demand calculated at an individual beach profile is also given.

Table 5.10.2 1974 Storm Demand Calculated from PAV Photogrammetric Analysis

Location	Block	Dates	Average Storm Demand (m ³ /m)	Maximum Storm Demand (m ³ /m)
Fairlight Beach	9	1972-1975	-1.7*	-2.9*
Delwood Beach	10	1972-1975	5.1	13.4

*minus indicates a sand volume gain

The storm demands found for Delwood Beach based on the available dates of photography are generally low. A slight accretion was actually found for Fairlight Beach based on the available dates of photography. Whilst this is surprising, a contributing factor in this result may be the relatively eroded state of the beach in 1972 indicating that this particular beach may have been worst effected in the storms of 1972 and though still in a relatively eroded state in 1974, appeared to have 'recovered' slightly.

³ The photogrammetric plotting for Fairlight Beach and Delwood Beach was undertaken by the then Department of Land and Water Conservation using vertical aerial photography dating from 1956 to 1998. At Fairlight Beach, cross-shore beach profiles were prepared at eight locations (*10 m centres*). These eight profiles are known as Block 9. At Delwood Beach, cross-shore beach profiles were prepared at ten locations (*10 m centres*). These ten profiles are known as Block 10.



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In arriving at recommended values for storm demand it is useful to determine the “available beach volume” along Fairlight and Delwood Beaches. In certain circumstances, this volume can be used to infer limits on the storm demand, e.g.:

- in situations where a seawall exists which could fail if all the sand was lost but which has not done so in the available historical record (*inclusive of severe storms*). This could suggest the storm demand is less than the available sand volume on the beach determined from the historical record;
- in situations where historical photographs exist showing evidence of all sand being lost from a beach after severe storms, for example underlying bedrock exposed. This could suggest the available sand volume on the beach is less than the storm demand.

There is a seawall at the back of Fairlight Beach which is believed to have been constructed in the early 1900s. There is no known history of failure of the seawall, suggesting the available beach volume exceeds the storm demand, however, it has been established that the seawall is generally founded on a sandstone rock platform and therefore would not generally be susceptible to failure even if all the sand was lost from the beach.

At both Fairlight Beach and Delwood Beach there are rock shelves situated at relatively small depths below the sand surface, which have become exposed in past severe storms. Accordingly, this suggests that the storm demand exceeds the available beach volume.

The available beach volume can be determined from the DLWC PAV analysis. If the sand volume data for relatively “beach full” conditions only are considered, the typical available sand volume is approximately 20 m³/m for Fairlight Beach and approximately 15 m³/m for Delwood Beach.

A reasonable design storm demand for Fairlight Beach and for Delwood Beach is considered to be in the range of 40 to 60 m³/m for a 100 year average recurrent interval event, having regard to the following:

- typical available sand volumes of approximately 20 m³/m for Fairlight Beach and 15 m³/m for Delwood Beach, which are known to have been exceeded by erosion loss in severe storms based on historical photography;
- adopted design storm demands for other beaches in the Manly Local Government Area where more extensive data sets have been available, including both Harbour beaches and open coast beaches, and taking into account the relative wave exposure of these beaches.

5.11 LONGER TERM SAND MOVEMENT

5.11.1 General

Longer term sand movement at Fairlight and Delwood Beaches has been examined using the results of the DLWC Profile Area Volume (PAV) analysis, by considering the changes in volume of sand above AHD on the beaches over time between the first and last dates of photography.

The interpretation of the information is subject to a number of factors; for example, the relatively short period of the historical data (*it is implicitly assumed that coastal processes over this period are representative of the longer term situation*), the frequency and severity of storms over the time span for which the volume changes were measured, the fluctuations in sand volumes due to storms which can often mask longer term trends, and the influence of sea level rise which causes a reduction in the volume of sand above AHD and which has been operative over the period of the photographic record.

5.11.2 Interpretation of PAV Analysis

The plot for Fairlight Beach shows erosion in 1972 with a small increase in volume to 1975, followed by a phase of beach recovery until 1978. As noted previously, it is surprising that there was actually slight accretion following the storms of 1974 at this location. A contributing factor in this pattern may be the relatively eroded state of the beach in 1972 indicating that this particular beach may have been worst effected in the storms of



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1972 and though still in a relatively eroded state in 1974, appeared to have 'recovered' slightly. Between 1978 and 1998 further erosion has occurred. In overall terms, for the period 1965 to 1998, Block 9 underwent slight recession. The total loss of sand between 1965 and 1998 was approximately $3.2 \text{ m}^3/\text{m}$ based on Profiles 4, 5, 6 and 7 (total length of beach 40 m).

The magnitude of this recession suggests that there was only a relatively small longer term total beach volume change over the period 1965 to 1998.

The general apparent stability of Fairlight Beach is consistent with its appearance as a sheltered beach with a likely closed sediment system. Long term sediment losses or gains would not be expected to be significant.

The plot for Delwood Beach shows erosion in the May-June storms of 1974 followed by a period of significant recovery between 1974 and 1978, followed by a more gradual trend of recovery until 1998. In overall terms, for the period 1956 to 1998, Block 10 underwent accretion. The total gain of sand volume between 1956 and 1998 was approximately $10.6 \text{ m}^3/\text{m}$.

This accretion result is somewhat unusual in light of the erosion experienced on nearby Fairlight Beach. It suggests some possible mechanism for longer term sand supply to the beach though there is no readily identifiable mechanism. It may reflect ongoing recovery from a relatively depleted beach state at the commencement of the photogrammetric assessment. It is important to appreciate that most or all of the sand volume on the beach can be eroded offshore in a severe storm event, exposing the rock platforms that are situated only a shallow depth below the sand surface.

5.12 AEOLIAN (WIND) SAND MOVEMENT

Aeolian sand movement occurs when dry sand is entrained by aeolian (*wind*) processes and transported into the back beach area. Fairlight Beach is generally well sheltered from most directions with the exception of winds emanating from the south-eastern sector. The beach is backed by a low seawall (*maximum height above sand is currently about 1 m*) and a grassed berm varying in height from approximately 0.5 to 2 m above the seawall crest. Delwood Beach is quite exposed to the south but is backed by an undercut sandstone cliff face approximately 3 to 4 m high. There would appear to be negligible sand loss from either of these beaches through aeolian sand movement.

5.13 STORMWATER RUNOFF

Stormwater within the study area flows through artificial drainage networks. The hard artificial surfaces that stormwater travels over and through in urban environments greatly increases its velocity. These high velocity concentrated flows are then directed and released into bushland, watercourses or the foreshore. Often the end of the pipe is surrounded by soft surface material such as soil or sand, which is easily eroded by the large volumes of high velocity rainwater during a storm.

There are two stormwater catchments in the study area: North Harbour and Fairlight. Some characteristics of these catchments are presented in Table 5.13.

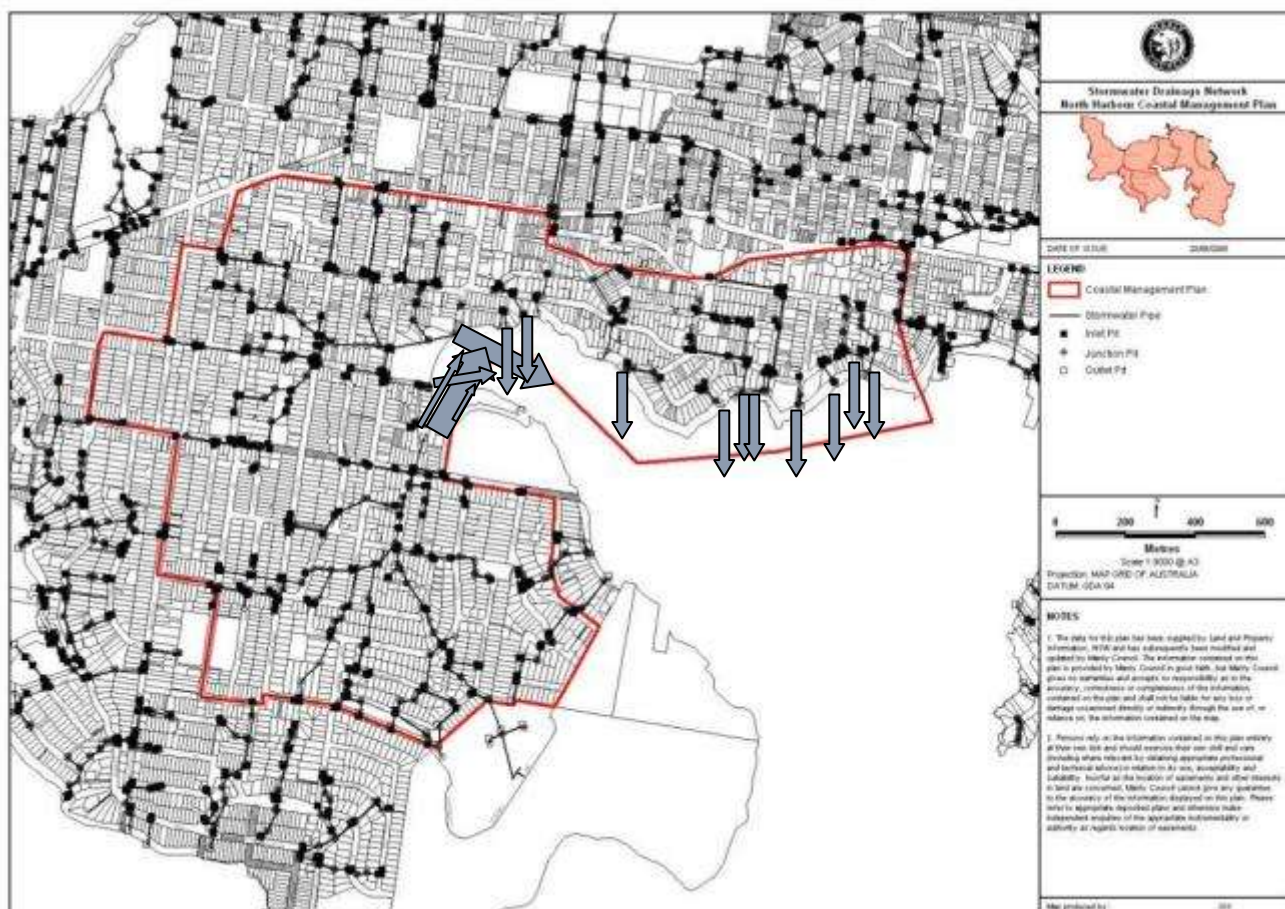
In the study area, the relatively narrow and steep catchment means that nearly all of the major stormwater pipes extend right to North Harbour, and discharge either onto the foreshore or directly into the water (see Figure 5.13). Some of the pipes direct flows over rock, which provides a stable surface.

Table 5.13 Stormwater catchments in the study area

Catchment Name	Area (ha)	Artificial drainage network length (km)	Number of Outfalls	
			Major	Minor
North Harbour	136.73	10.62	2	3
Fairlight	44.08	3.48	1	10
Total	180.81	14.10	3	13

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Figure 5.13 Stormwater Drainage Networks and Outfalls within the North Harbour study area.



5.14 WATER QUALITY

5.14.1 Overview of Water Quality

Maintaining water quality is crucial to protect the health of North Harbour embayment. The primary source of pollution inflows into North Harbour, which control water quality and environmental health in the embayment, is stormwater runoff derived from the surrounding residential areas of Balgowlah Heights, Balgowlah, and Fairlight.

North Harbour is a sheltered harbour embayment located to the north of Sydney Harbour. It is located to the west of Manly Cove, reasonably protected from ocean swells by the headlands of Dobroyd Head, and North Head. North Harbour receives large inflows of freshwater during rainfall from an urbanised catchment to the west of the embayment, consisting of extensive artificial stormwater drainage networks.

Despite reported improvements in water quality recently, pollution is still evident, particularly in times of rain when stormwater transports terrestrial pollutants. Other point sources of pollution (e.g.- boats, foreshore industry) also still contribute to the pollution problem. Table 5.14.1 provides a summary of the common pollutants that are likely to enter North Harbour, as well as their likely sources, and impacts on the environment.

Anecdotal evidence is important in helping to understand the history of water quality in a catchment, however a more detailed understanding is necessary to ensure appropriate management actions can be implemented. There are two methods of estimating water quality in a catchment – modelling and monitoring. Both have been undertaken within the study area, and are described below. The modelling described in section 5.14.2 provides



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information on the pollutant loads produced by the terrestrial catchments, and the monitoring described in section 5.14.3 provides information on measured water quality within North Harbour study area itself.

Table 5.14.1 Pollutants Likely to Enter North Harbour

Pollutant Group	Examples	Sources	Impacts
Gross Pollutants	Plastic bags, bottles	Littering, Illegal dumping	Ingestion by marine fauna
Oxygen Demanding Substances	Leaves, twigs	Bushland, roads, residential gardens, stormwater	Reduced dissolved oxygen, marine flora and fauna cannot survive
Oils, greases & hydrocarbons	Car oil, petrol, lubricants	Roads, industrial areas marinas, boats	Marine fauna smothered and/or poisoned
Nutrients	Fertilisers, detergents, sewage	Residential gardens, sports fields, golf courses, sewage leaks/overflows	Algal blooms
Heavy Metals	Lead, copper, zinc	Industrial areas, roads, marinas, boats	Bioaccumulation of heavy metals through the food chain
Pathogens	Faecal coliforms, enterococci	Sewage leaks/overflows, animal faeces	Human infection as a result of pathogens
Sediments	Sand, silt	Construction sites, residential gardens	Smothering of marine flora and fauna; reduced light penetration and ability for marine plants to photosynthesise

5.14.2 Modelled Pollution

Estimation of annual pollutant loads transported into North Harbour through the stormwater drainage systems was undertaken for the most common and priority pollutants identified to occur in stormwater. These were identified from local research undertaken in Manly (Smith, P.G., 2006; Galloway, M.J., 2005a), and through literature review of national and international studies (USEPA, 1983; Galloway, M.J., 2005b). Pollutants identified were: Total Nitrogen (TN), Total Phosphorus (TP), Copper (Cu), Lead (Pb), Zinc (Zn), and Sediment.

Modelling was commissioned to estimate the total annual loads (in kg) of these pollutants entering North Harbour. This desktop study was undertaken through assigning a runoff coefficient to each land-use identified in the nine sub-catchments (a percentage of rainfall that will runoff and enter stormwater), adopting annual recorded rainfall in Manly, and adopting assumed average stormwater pollutant concentrations for stormwater runoff for each land-use. Values were selected to be site-specific to North Harbour conditions.

Manly Councils Water Cycle Management Team modelled the nine catchments within the study area. For this modelling an alternative comparable system had to be used for stormwater pollutant concentration data, due to a lack of data available for the study area. Stormwater pollutant concentrations were attributed from those measured in adjacent catchments in Manly LGA with similar identified land-uses, for which detailed sampling and analysis has already been undertaken. Extrapolation of these results through the modelling process for North Harbour study area, along with known rainfall figures, then provided modelled total pollutant loads.

The combined total load of pollutants in stormwater estimated from both North Harbour and Fairlight catchments based on the modelling exercise undertaken, for a normal rainfall year, was approximately 1,850 kg/year of Total Nitrogen; 220 kg/year of Total Phosphorus; 140 kg/year of Copper, 190 kg/year of Lead, 400 kg/year of Zinc, and 105,300 kg/year of Sediment (Tables 5.14.2a and b). Only two variables in the modelling undertaken strongly influence these results. These are: (1) the adopted runoff coefficients, and (2) the adopted stormwater pollutant concentrations. Consideration of research undertaken in other Manly sub-catchments to date, site-specific considerations in North Harbour catchment; and research publications in other urban



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catchments was made in determination of these values. Thus, while margin of error of annual pollutant loads is possible, results are likely to be generally representative of current pollutant loads into North Harbour waters.

Table 5.14.2a Estimated annual loads of pollutants likely to enter North Harbour from catchments and sub-catchments of the study area

Catchment Name	Pollutant loads (kg/year)					
	Total Nitrogen	Total Phosphorus	Copper	Lead	Zinc	Sediment
North Harbour						
NT-01	659.11	75.54	53.39	69.71	146.45	37410.00
NT-02	670.33	77.63	55.35	72.28	150.48	39038.00
Total	1329.44	153.17	108.74	141.99	296.93	76448.00
Fairlight						
FA-01	21.50	2.78	1.32	1.71	3.93	1211.00
FA-02	54.83	7.64	2.78	3.57	8.98	2769.00
FA-03	32.67	4.19	2.02	2.62	6.03	1795.00
FA-04	231.16	26.43	17.68	23.12	49.47	12977.00
FA-05	69.21	8.92	4.34	5.65	12.86	3887.00
FA-06	45.77	5.57	3.11	4.05	8.99	2584.00
FA-07	67.36	8.11	4.85	6.32	13.83	3664.00
Total	522.50	63.64	36.10	47.04	104.06	28887.00
Study Area	1851.94	216.81	144.84	189.03	400.99	105335.00

Table 5.14.2b Estimated annual loads of pollutants likely to enter North Harbour by land uses

Land use	Pollution Load (kg/year)					Sediment (kg/year)
	TN	TP	Cu	Pb	Zn	
North Harbour Catchment						
Residential	647.20	111.46	12.43	14.55	66.74	26967
Open Space	11.99	2.39	0.13	0.27	0.13	2664
Roads	569.41	9.49	94.90	126.54	221.44	44921
Other	100.84	29.29	1.28	0.63	8.62	1897
Total	1329.44	153.17	108.74	141.99	296.93	76448
Fairlight Catchment						
Residential	333.21	57.39	6.40	7.49	34.36	13884
Open Space	3.88	0.95	0.04	0.09	0.04	862
Roads	177.33	2.96	29.56	39.41	68.96	13990
Other	8.08	2.35	0.10	0.05	0.69	152
Total	522.50	63.64	36.10	47.04	104.06	28887

The greatest contributing land-uses emergent from the modelling were roads and residential land-uses. These land-uses delivered the highest loads of almost all pollutants. Results were similar for both catchments, North Harbour and Fairlight. In particular, in both the catchments, roads were estimated to produce highest loads for Copper, Lead, Zinc and Sediment, with residential the second greatest. However, residential land-uses were estimated to produce the highest loads of nutrients (TN and TP). Suggested sources include vehicle traffic and corrosion of road surfaces (delivering heavy metals, and sediment into stormwater); deciduous trees (delivering nutrients); residential buildings (delivering heavy metals including Cu, Pb, Zn from corrugated roof surfaces into stormwater), construction sites and disturbed sites (delivering high levels of sediment), and residential gardens and vegetative matter through lawn mowing (delivering nutrients and sediment).



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5.14.3 Measured Pollution

Measured pollution refers to data that has been obtained through taking water samples and analysing them to estimate pollution within a water body. This method of estimating pollutant loads is clearly more accurate than desktop modelling; however, it still has limitations. Firstly, water sampling is undertaken at discreet locations, and these may not be representative of the greater water body within which each sampling location lies. Secondly, the water sampling is only undertaken at a given point in time, and this may not be representative of the average pollutant loads in the given water body.

The most comprehensive measured water quality data identified was through the Harbour watch program, run by the Department of Environment and Climate Change (DECC). The Harbour watch program's key concern is human health relating to the use of harbour waters, and as a result it focuses primarily on bacterial pollution (DECC, 2008). Hence, the two major indicators of bacterial contamination, *faecal coliforms* and *enterococci*, are measured at various harbour swimming locations. Faecal coliforms and Enterococci are found naturally in the intestines of humans and therefore also in the sewerage system, so are used to indicate the presence of sewage pollution. Sampling location within the study area is Fairlight Beach.

Sampling is undertaken by the DECC at the site every six days. A monthly median of the samples from the site is then determined, and monthly reporting indicates if the median was below or above ANZECC guidelines for primary contact (e.g.- swimming). Faecal coliform levels complied with swimming guidelines 100% of the time over the last five years between 2002-03 and 2006-07. With the exception of one season, enterococci levels complied 100% of the time over the last five years. This generally indicates good performance with minor sewage impact.

Faecal coliform and enterococci densities generally increased with increasing rainfall. Faecal coliform densities occasionally exceeded the median guideline limit in response to 20 millimetres of rain or more in the previous 24 hours. Enterococci densities occasionally exceeded the median guideline limit in response to light rain in the previous 24 hours.

5.14.4 Known Designed Sewer Outlet Locations

There are 3 known designed sewer outlet locations (Figure 5.14.4) within the study area. Detail information of locations is presented in Table 5.14.4.

Table 5.14.4: Details of known designed sewage overflow points in North Harbour Catchment

Overflow No.	Catchment	Address	Location	Suburb
SNNH10F01	North Harbour	4 New Street East	-	Balgowlah
SNNS10F01	North Harbour	4 Jackson Street	Private	Balgowlah
SNNS10F02	North Harbour	133 Woodland Street	In-road	Balgowlah

Source: GIS system, Manly Council

5.14.5 Possible Stormwater Quality Improvement Measures

A number of stormwater treatment options are currently applied by Council in the Manly LGA. One or more of these may be appropriate for targeted application in specific sub-catchments to reduce stormwater pollution entering North Harbour, and improve water quality in the North Harbour embayment.

Treatment options currently practiced in other areas of Manly include: Council street sweeping, installation of Gross Pollutant Traps (GPTs) to capture coarse pollution and litter, installation of pit insert (traps) on stormwater drains, and targeted community education.

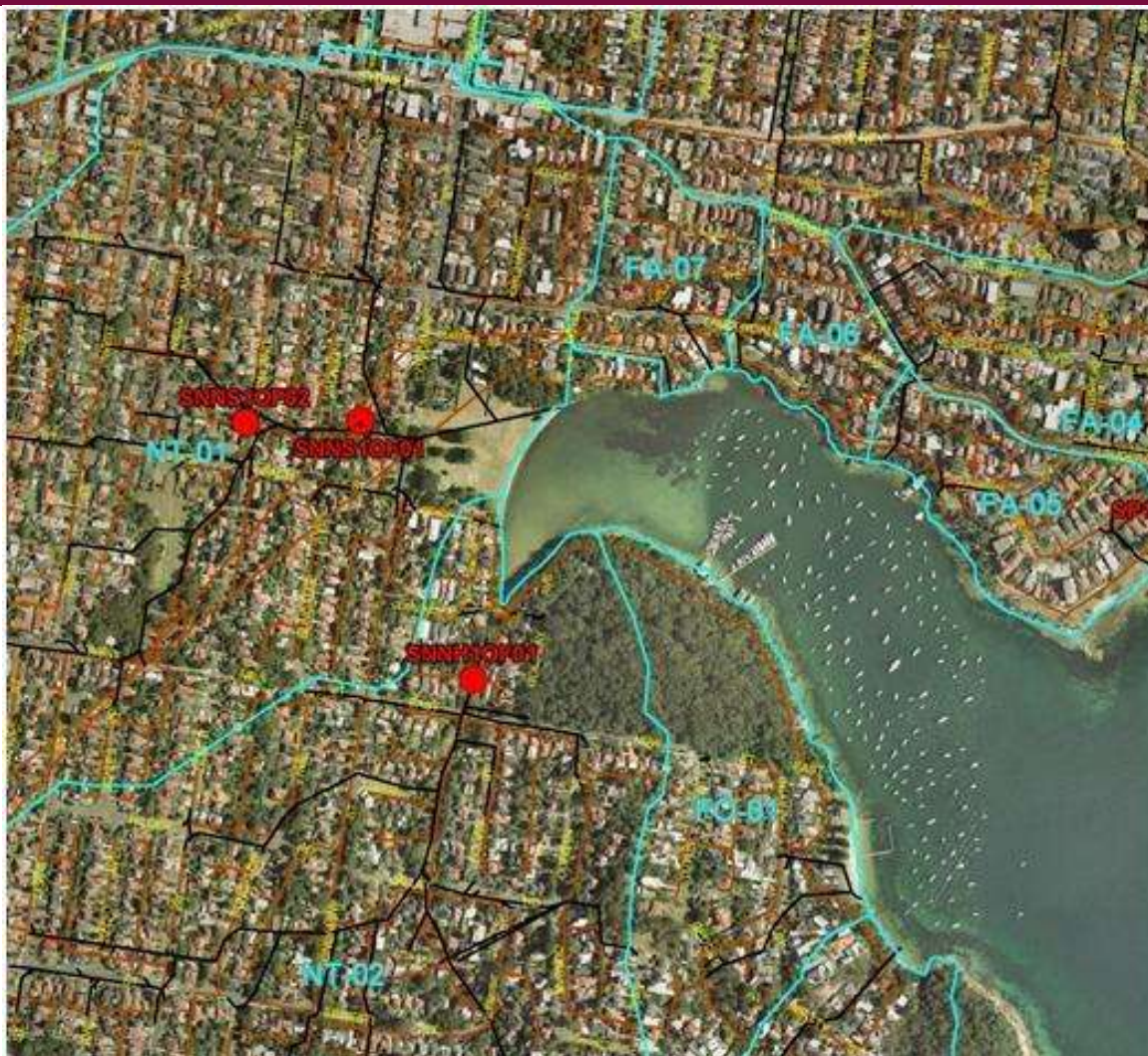


Figure 5.14.4 Sewage overflow points in North Harbour Catchment

Council Street Sweeping

Street sweeping using sweeper and vacuum trucks is currently carried out year round by Council staff within the Manly LGA overall, with areas and Precincts of greater concern swept at the greatest frequency. In the North Harbour catchments, sweeping of individual streets is done on an average once every six weeks.

Strengths:

1. Sweeping management (sweeping frequency) is flexible and can be modified at a later date subject to further catchment research or demonstrated needs.
2. Roads were estimated to be the highest source of Copper, Lead, Zinc, and sediment in NT-01 and NT-02. Increased frequency of road sweeping would thus likely significantly reduce these loads.
3. Research in other Precincts of the Manly area has demonstrated the success of street sweeping.

Total annual pollutant loads (kg/year) captured throughout the Manly LGA by street sweeping in

Street Sweeping estimated pollutant prevention in Manly Council (2005/06) (kg)

TN	4,463.7
TP	847.8
Cu	81.1
Pb	62.1
Zn	232.4
Sediment	580,840.6
Algal growth prevented	25,434.1



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2005/06, based on monitoring research was estimated. This included over 580 tonnes of sediment, and over 4 tonnes of nutrients. Independent research conducted in Manly has also demonstrated street sweeping to capture and prevent 1-50% of total annual pollutant loads of nutrients (Total Nitrogen and Total Phosphorus) and heavy metals (Copper, Lead, Zinc); and between 7-63% of total annual pollutant loads of sediment from entering waterways (variation due to differences between results in different catchments studied, and differences in frequency of street sweeping application in those catchments).

Weaknesses:

1. Street sweeping only captures pollutant loads on road surfaces. Pollutants accumulating on building rooves, driveways, paths, open space, and other premises will not be targeted or prevented by street sweeping, and will continue to be transported into the stormwater system.
2. Street sweeping is restricted by a maximum capture size range of target pollutants. Pollutants below a certain size (depends on sweeping vehicle type) may not be able to be captured from road surfaces.
3. Street sweeping is currently carried out relatively infrequently in this area

Gross Pollutant Traps

Fourteen inline GPTs are currently installed in a range of priority catchments throughout Manly, together with 9 stormwater pollution nets/litter booms. GPTs primarily serve the function of reducing coarse pollutants such as sediment (which also provides some pollutant capture for heavy metals and/or nutrients bound to sediment); and litter. Stormwater pollution control nets primarily serve the function of capturing litter (such as plastic bags, bottles, rubbish) and preventing these from entering waterways. At present, no GPTs exist in study area.

GPT estimated pollutant prevention in Manly Council (2005/06) (kg)

TN	625.7
TP	80.0
Cu	9.9
Pb	10.4
Zn	54.6
Sediment	108,550.7
Algal growth prevented	2,399.2

Strengths:

1. Because GPTs are installed at the base of sub-catchments at drainage concentration points, pollutants from all sources in the sub-catchment will be directed through them (compared with street sweeping, which only treats pollutants stored on road surfaces).
2. Research in other Precincts of the Manly area has demonstrated success of GPTs. Total annual pollutant loads captured within Manly by GPTs in 2005/06 were estimated. This included over 108 tonnes of sediment, and 0.6 tonnes of nutrients. Independent research conducted in Manly has also demonstrated GPTs to capture and prevent 5-35% for nutrients (Total Nitrogen and Total Phosphorus) and heavy metals (Copper, Lead, Zinc), and between 29-74% of sediment loads (variation depending on catchment studied and GPT model design).
3. NT-01 and NT-02 are estimated to produce a very large volume of sediment (over 76 tonnes a year in total). If sediment capture rates of between 29-74% were achieved in North Harbour (similar to other GPTs in Manly), this would result in between 22-56 tonnes of sediment a year being prevented from entering North Harbour, and reduced impact on ecosystem health.

Weaknesses:

1. GPTs are fixed in location, capture screen aperture, and storage volume once installed, and can be difficult to modify at a later date.
2. GPT performance is only as good as the maintenance (cleaning) regime which is imposed on them. If not adequately cleaned, pollutants stored within a GPT will undergo biological and chemical reaction (breakdown), become re-suspended in subsequent rainfall events, and be delivered into waterways. Maintenance incurs an increased and ongoing cost.
3. As with street sweeping, GPTs are restricted by a maximum capture size range of target pollutants. GPTs typically do not treat very fine pollutants such as dissolved and fine-sediment suspended heavy



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metals and nutrients, and these will pass through untreated. This maximum size limit is also much greater than street sweeping.

Education Programs

Education campaigns to target behaviour in individual residences have been conducted in the past in many Precincts in Manly. In particular the Sea change education program for residents has targeted residents to achieve behavioural change outcomes, and reduce pollution from individual premises.

Pit Inserts in Stormwater Drains

Pit inserts, consisting of fine mesh, can be installed at stormwater pit locations and drains to prevent catchment pollution entering stormwater drains and mixing with stormwater where it will become more difficult and costly to treat. However, pit inserts must be installed at many locations throughout the catchment, will require ongoing maintenance, have limited storage capacity, and can often fill fast during a storm event. These can contribute to blockage of stormwater flow into the harbour, increasing the chance of localised flooding.

Increased residential uptake of rainwater tanks to reduce stormwater flows

Increased community installation of rainwater tanks at an individual residential scale, would greatly reduce the volume of polluted stormwater entering North Harbour, through disconnecting the large roof areas of residential properties' from the stormwater network. This would decrease the proportion of stormwater swept off-site from residential properties, and the capacity of stormwater to entrain and transport pollution into the North Harbour embayment. In particular it would also decrease the pollution load from residential land-uses in the catchment through containing nutrient and other pollution on-site. Residential land-uses were estimated to be the greatest source of nutrients and the second-greatest source of heavy metals and sediment in North Harbour. Manly Council would encourage residents to consider installation of residential rainwater tanks as a means to reduce stormwater flows into North Harbour, and establish an alternate water source for their gardens and/or properties.

Manly Council's Guidelines on the Installation of Rainwater Tanks are available at Council's website: www.manly.nsw.gov.au under "DA Fact Sheets" in the "Planning and Development" menu.

5.15 SEDIMENT CONTAMINATION

Although the water quality in the greater Sydney Harbour has improved in recent years and is now relatively good, the sediments in parts of the Harbour floor are of extreme concern. Sediments are not as easily flushed of contaminants as water quality, and pollutants tend to accumulate in them over time. Certain pollutants can actually bind or attach to fine sediment (mud) particles, making their dispersal and flushing even more difficult. Decades of unregulated heavy foreshore industry and poor stormwater management practices have resulted in a toxic array of pollutants finding their way into the Harbour. In 2004 Birch & Taylor published a comprehensive book about the contamination of sediments throughout all areas of Sydney Harbour. They concluded that Sydney Harbour's sediments contain mean concentrations of pollutants such as heavy metals, organochlorin compounds, and polycyclic aromatic hydrocarbons that are among the highest in the world.

Luckily, however, the highest concentrations of these contaminants are not found in the study area. The areas of most concern in Sydney Harbour are the upper reaches of embayment and tributaries, especially those upstream of the Harbour Bridge. Although the study area does contain muddy sediments (which have an affinity for attaching pollutants), it is not close to any major tributary or source of contamination, and is relatively well flushed by tides and currents.

Although the study area has relatively low sediment contamination, the other areas of contamination are still of concern for the study area.

Bioaccumulation refers to the ingestion of substances by fauna, and subsequent transfer of those substances up the food chain. Invertebrates living within the sediments, such as yabbies and worms, play an important



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function in turning and cleaning the sediments, known as bioturbation. When elevated levels of toxins are found within the sediments, these are ingested by the invertebrates, and then passed up the food chain as they are consumed by predatory fish, and those fish are in turn consumed by larger fish. Birch and Taylor (2004) suggest that toxic chemicals are enriched in fish species within Sydney Harbour due to the contamination of sediments. As fishes move throughout the greater Harbour, this means that affected fish will be found within the study area. In 2006, probably as a result of the release of the findings by Birch & Taylor, testing was undertaken on some common fish species in Sydney Harbour by the NSW Food Authority to determine if toxins were present. They were, and DPI placed a ban on all commercial fishing within Sydney Harbour, stating the presence of elevated levels of dioxins in fish and crustaceans in the Harbour as the reason. Recreational fishing is still permitted, although dietary advice has been issued, stating that limits should be placed on the amount of Harbour caught fish that are consumed. The advice also states that fish caught west of the Harbour Bridge should not be consumed at all (DPI, 2008). The worst affected fish species were generally found where Birch and Taylor (2004) measured the highest levels of sediment contamination. Table 6.2 provides a summary of the dietary advice provided by DPI, regarding the consumption of Harbour caught fish.

Table 5.15 Recommended maximum intake based on eating a single species caught east of the Sydney Harbour Bridge

Species	Number of 150 gram serves	Amounts per month
Prawns	4 per month	600 g
Crab	5 per month	750 g
Bream	1 per month	150 g
Flounder	12 per month	1800 g
Kingfish	12 per month	1800 g
Luderick	12 per month	1800 g
Sand Whiting	8 per month	1200 g
Sea Mullet	1 every 3 months	50 g
Silver Biddie	1 per month	150 g
Silver Trevally	5 per month	750 g
Tailor	1 per month	150 g
Trumpeter Whiting	12 per month	1800 g
Yellowtail Scad	8 per month	1200 g
Squid	4 per month	600 g

Source: NSW Department of Primary Industries, 2008

5.16 FORESHORE DEVELOPMENTS

Development of the foreshore has been extensive in the study area. Some of these are described below:

5.16.1 Seawalls

Seawalls, both public and private, exist throughout the study area. They are now common features of landscape in shallow coastal waters of urbanised areas. In some areas, they have replaced considerable portions of natural habitats, such as natural rocky shores or beaches. In Sydney Harbour, approximately 50% of the shore is composed of retaining seawalls or other built habitats (Chapman & Bulleri 2003). Total length of seawalls within North Harbour is only 0.34km. Two prominent seawalls are Fairlight Beach Seawall & North Harbour Reserve Rock Revetment Seawall.

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Fairlight Beach Seawall: The seawall at Fairlight Beach is believed to have been constructed in the early 1900's. A plan drawing provided by Council, dated 20.9.26, shows the seawall along the same alignment as it is today. No detail or cross sectional drawings of the seawall were available.

The seawall appears to be of concrete construction and is approximately 90 m long (Photograph). Two staircases descend through the seawall towards the western end of the beach and a third at the eastern end.

The portion of the wall west of the westernmost steps is also of concrete construction but has a façade of sandstone rocks embedded into its front face. The seawall is currently up to 1.0m high above beach level with slight variation at different places.

The back-slope behind the wall varies from relatively flat at the western end to a grassed slope of approximately 15 to 30 degrees from the middle of the beach to the eastern end. There are drainage provisions at some points along the length of the wall (Fig 5.16.1a).



Fig 5.16.1a: Drainage provision in the Fairlight seawall, May 2008



Fig 5.16.1b: Drainage culvert at western end of Fairlight Beach



The western portion of the seawall (*approximately 25 m length*) comprised a box culvert approximately 1 m square internal dimension that outlets onto the wave cut platform at its south-western end (Fig 5.16.1b). The roof slab was between 0.15 m and 0.2 m thick. The seaward wall of the culvert was approximately 0.3 m thick at the outlet. Two pipes of diameter approximately 0.1 m and 0.5 m were observed to outlet through the northern wall of the culvert.

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The seawall was generally in reasonable condition. No historical account of any significant seawall damage at Fairlight Beach was identified in the available background information.

North Harbour Reserve Rock Revetment Seawall: The foreshore adjacent to North Harbour Reserve comprises a rock revetment seawall (Photograph). Most of the information regarding this seawall was obtained from Drawing No. 1-464, dated April 1986, titled 'North Harbour Seawall Stabilising Plan and Details' which was provided by Council. This drawing includes a typical cross section of the seawall showing the original stepped seawall covered by a layer of geofabric, overlain by smaller rocks (*to protect the filter cloth*), then by larger armour stones.



Seawalls are designed to protect properties against storm waves and surge, rather than against long term estuary processes, so it is important that they are sufficiently stable to protect against the severe storm conditions that can be experienced in North Harbour (Piorewicz, 2002).

Anecdotal reports suggest that the seawalls within the study area have adequately protected foreshore properties from storm waves in recent years. Erosion has taken place at the base of the walls in times of higher wave activity and large stormwater flows (see section 6.1), although there have been no obvious signs that the integrity of the walls have been compromised.

Risk Assessment

Based on the results of the test pit investigation, it is considered that the likelihood of any portion of the Fairlight beach seawall failing is 'unlikely'. However, should the potential hazard occur, the consequence to property (*the seawall and/or existing stormwater and sewer lines*) would be medium and the qualitative risk to property would therefore be 'low to moderate'.

The North Harbour Reserve rock revetment seawall was assessed to pose a minimal risk to life or property in its present state. However, there is some minor disrepair that could potentially allow further deterioration of the seawall to occur more rapidly than it would otherwise, affecting the durability and longevity of the structure.

Recommendations

Whilst it is not considered that any major stabilising or reconstruction works are necessary in the immediate term, it is recommended that the walls be monitored on a regular basis and after heavy rainfall and storm events, to assess the required timing and nature of any future stabilising or reconstruction works. Meantime, some minor maintenance works is carried out to replace the torn geofabric on the North Harbour Reserve rock revetment seawall and replace the displaced armour rock to cover the exposed geofabric.

5.16.2 Moorings & Marinas

Boat storage facilities within study area consist predominantly of private swing moorings and commercial marinas. The study area is popular offering relatively calm and secure condition. North Harbour has 111 licenses and sites for private moorings and 3 licenses for 91 sites for commercial moorings, as on 17 June, 2008. Moored boats are usually accessed by dinghies that are stored all along the shores.



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Most of the moorings in North Harbour are swing moorings, with chains dragging across the seafloor damaging the seagrass beds within their range. Swing moorings have resulted in bare patches within the seagrass beds.

In 2004 NSW Maritime and the NSW Department of Planning prepared a Boat Storage Policy for Sydney Harbour. The policy aims to provide a more strategic and certain approach to regulating boat storage facilities on the harbour and outlines the NSW Government's policy for achieving a balance between promoting a prosperous working harbour, maintaining a healthy waterway and promoting recreational uses of the foreshores and waterways.

Davis Marina

Davis Marina is located at the vicinity of the study area, within the Forty Baskets CMP area. It offers many services and facilities for residents and visiting crafts. The marina consists of two fixed jetties with a total of 33 berths extending off either side, there are two slipways.

The marina supplies and maintains the mooring lines, lighting, power and water on the jetties.

Fifty-one (51) conventional swing moorings are licensed to Davis Marina by NSW Maritime. These moorings are regularly checked and maintained by Davis Marina.

Part of the western jetty consists of work berths for maintenance and repair of boats. Shallow water at low tide which restricts access, lack of pontoon access and safety issues were identified by Davis Marina as issues associated with the use of this section of the jetty for boat maintenance work.

Fuel bowzers are located at the end of the western jetty for refuelling as well as pick up and drop off. A dinghy pontoon is also provided at the marina. A fleet of six Marina dinghies is available to use 24 hours.

Davis Marina has a waste removal contract with Council and has established a Pollution Prevention Plan, which they are presently working towards. Waste facilities at the marina include 1 large skip bin and segregated recycling facilities for marina patrons. The skip bin is also utilised by the community for general waste and disposal of dog wastes.

Disabled access to boating activities is not available at Davis Marina however, it is provided at the Manly Yacht Club located in Manly Cove.

Parking in the vicinity of Davis Marina consists of twenty seven (27) 90⁰ angled parking bays at the end of Gourlay Avenue. An access ramp of steep gradient extends down to the marina however it is restrictive in terms of the number of vehicles it can cater for and the turning capability of the vehicles.

Treharne's Manly Boat Shed

It is a family establishment since 1948. It offers full shipwright services in timber and fibreglass. Services offered are:

- Engine repairs and servicing
- Electrical repairs and servicing
- Engineering repairs and servicing
- Rigging repairs and servicing
- Mechanical repairs and servicing
- Mooring repairs and servicing
- New moorings laid



Thirty-nine (39) conventional swing moorings are licensed to Manly Boatshed by NSW Maritime.

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5.16.3 Sailing & Yacht Clubs

There is one small club, North Harbour Sailing Club, sailing in mixed divisions over six courses on Sundays in an area of North Harbour from Forty Baskets down to Obelisk Bay-Lady Bay.

The club contributes to economic use of the area through a number of events including racing, training etc.

5.16.4 Fairlight Pool

The pool is located at the eastern end of Fairlight beach. Access to the pool is either via the park or a walkway which leads down from Lauderdale Avenue.



HISTORY: For some years residents bathed in a small pool which had been voluntarily built. This pool had been located close to the present site but like most `volunteer` pools it was small and inadequate. After agitation of ratepayers in the Fairlight Hill area, it was reported in 1922 that the Manly Council had resolved to construct concrete baths which was originally intended to include a two storey structure for dressing and for spectators. However, the lease from the Sydney Harbour Trust was not granted until 1928. Prior to this time both the residents (Fairlight Improvements Association) and Manly Council had commissioned consulting engineers, Hardy, Busby and Norman to prepare plans, so when approval was granted work commenced soon after. The final date of completion is not known, however, records indicate the pool was completed by 1931.

DESCRIPTION: The pool has been formed by the construction of two mass concrete walls on an excavated rock shelf to the south and west with the remainder of the pool being formed by the rock itself. It would seem that at some later stage, a broad concrete concourse was laid to the pool's western side below the nearby cliff face to provide a generous sitting and sun-baking area. The pool is essentially rectangular in shape having the approximate dimensions of 50 x 30m. A smaller wading pool has been created at the pool's northern end by installing another concrete wall which helps to retain water in a natural depression in the rock shelf. Water is pumped into the pool via a pump house which is well concealed by the rocks of the cliff. A sluice valve has located in the southern corner of the pool to enable it to be periodically emptied. The pool shares facilities with those provided in the park which includes a 1950s/60s red brick amenities building with a concrete roof that doubles as a viewing platform. The pool is well maintained with regular maintenance occurring.



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The pool has significance for the following reasons: it has high aesthetic value resulting from the juxtaposition that is created between the still waters of the pool and the dynamic interference patterns of the harbour, it is the only rock and concrete pool within the harbour area (rock and concrete construction is more commonly associated with coastal sites), and it has social importance as its origins lie in the actions of local residents and it still remains a well appreciated recreational facility.

Like Delwood it too is a great place to snorkel. Remember though sharks have been sighted in Sydney harbour though attacks are rare. The pool is popular with early morning locals and there are toilets nearby.



6. COASTLINE HAZARDS

Following NSW Coastline Management Manual, Patterson Britton & Partners (2004) has completed a Coastline Hazard Definition Study for North Harbour and Manly Cove covering the section of shoreline from the Davis Marina to Manly Point including North Harbour Reserve, Fairlight Beach, Delwood Beach and Manly Cove. This study provided a sufficient understanding of the coastal processes and their associated hazards. This study has specifically identified hazards threatening the area and quantified these hazards and their effects. The report assessed beach erosion, shoreline recession, sand drift, coastal inundation, stormwater erosion, slope and cliff instability, climate change including an assessment of the existing seawalls.

Local Disaster Plan (DISPLAN) identifies following hazards which could affect the area.

Table 6.0 Hazards and threat levels identified in local DISPLAN

Hazards	Threat Level		Comments
	Probability	Consequence	
Severe Storms/Floods	High	Major	General threat throughout the District.
Earthquake	Remote	Major	General threat throughout Area
Coastal Erosion	High	Major	Refer to Coastal Erosion Sub-Plan (to be developed)
Tsunami/Storm	Remote	Major	Threat to Coastal Areas
Landslip	High	Major	Councils have identified potential slip areas.

Source: The Manly, Warringah and Pittwater Councils Local Disaster Plan (DISPLAN)

Some of these and hazards from oil spills are described here. Climate Change is addressed in Chapter 7.

6.1 BEACH EROSION HAZARDS

During storms, large waves, elevated water levels and strong winds can cause severe erosion to sandy beaches (NSW Government, 1990). The hazard of beach erosion relates to the limit of erosion that could be expected due to a severe storm or from the effects of a series of closely spaced storms.

The erosion can be measured in terms of the volume of sand transported offshore or in terms of the landward movement of a significant beach feature. The volume is usually expressed in terms of cubic metres per metre run of beach (m^3/m), as measured above Mean Sea Level (MSL) or Australian Height Datum (AHD). The significant beach feature is usually taken to be the back beach erosion escarpment.

The beach erosion hazard is analogous to the “storm demand” discussed in Section 5.9.2. In that section it has been established, based on a photogrammetric analysis carried out as part of this hazard study, the available sand volumes on Fairlight Beach and Delwood Beach, and experience, that a storm demand or beach erosion hazard value of 40 to 60 m^3/m for a 100 year Average Recurrence Interval (ARI) storm event is considered reasonable for both of these beaches.

6.2 SHORELINE RECESSION HAZARDS

The hazard of shoreline recession is the progressive landward shift in the average long term position of the coastline. The two causes of shoreline recession are sediment loss and an increase in sea level.

Sediment Loss - Recession of a sandy beach is the result of a long term and continuing net loss of sand from the beach system. According to the sediment budget concept, this occurs when more sand is leaving than entering the beach compartment. Recession tends to occur when, for example:

- the outgoing longshore transport from a beach compartment is greater than the incoming longshore transport;



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- offshore transport processes move sand to offshore “sinks” from which it does not return to the beach; and
- there is a landward loss of sediment by windborne transport.

While it is convenient to express shoreline recession due to sediment loss as a rate (*metres per year*) the process of recession is not uniform over time but is associated generally with storm activity.

Sea Level Rise - A progressive rise in sea level will result in shoreline recession through two mechanisms: first, by drowning low lying coastal land, and second, by shoreline readjustment to the new higher coastal water levels. The second mechanism is probably the more important: deeper offshore waters expose the coast to attack by larger waves; the near shore refraction and diffraction behaviour of waves will change; a significant volume of sediment will move offshore as the beach seeks its new equilibrium profile. Sea level rise is discussed in more detail under Chapter 7.

Shoreline recession is typically a long term process which in some cases is imperceptible. Its effect on a beach is often masked by the more rapid and dramatic erosion and accretion that accompanies storm events. Consequently, it can be difficult to identify recession from historical data, even if it extends over many years.

Trends in shoreline recession can be estimated in two ways:

- by assessment of changes over time in the volume of sand contained within the beach and dune system (*sediment budget approach*); and
- by measurements over time of the position of various beach features, such as the position of the back beach erosion escarpment or the position in plan of certain “cut” level through the foredune.

For Fairlight and Delwood Beaches the most appropriate method of determining any long term shoreline recession is by an assessment of the change in volume of sand on the beach (*an assessment based on the position of the back beach erosion escarpment is not appropriate as the beach is backed by a seawall or undercut sandstone cliffs*).

This assessment has been undertaken in Section 5.10. In summary, the findings were that Fairlight Beach underwent slight recession over the period 1965 to 1998. This was possibly due to a loss of sand offshore during severe storms which did not fully return to the beach in calmer swell periods.

The total loss of sand from Fairlight Beach between 1965 and 1998 was $3.2 \text{ m}^3/\text{m}$ (*based on Profiles 4, 5, 6 and 7 – total length of beach 40 m*). Therefore a total volume of some 130 m^3 of sand was eroded from Fairlight Beach between 1965 and 1998 or about $0.1 \text{ m}^3/\text{m}$ per year. If the average height of sand on the back beach is taken to be about 2.2 m AHD (*based on photogrammetric data*) this would correspond to a landward shoreline movement of about 0.04 m/year (*volume/(height x length x no. years)*).

In summary Fairlight Beach has undergone relatively minor longer term sand loss.

The PAV analysis suggests that Delwood Beach underwent accretion over the period 1956 to 1998. The total gain of sand on Delwood Beach between 1956 and 1998 was $10.6 \text{ m}^3/\text{m}$ (*based on profiles 2 to 10 - total length of beach of 90 m*). Therefore a total volume of some 954 m^3 of sand was deposited on Delwood Beach between 1956 and 1998 or about 22.7 m^3 per year.

As there is no clear mechanism, however, for sand supply onto Delwood Beach, the minor accretion could possibly be attributed to the particular start and finish dates of the photogrammetric analysis. It is therefore considered reasonable (*and conservative*) to assume that Delwood Beach has undergone zero sand gain over the long term.

It is important to note that any volume changes determined from historical data will contain some influence of sea level rise which occurred in the period of the historical record, i.e. in this case from 1956 to 1998 for Delwood Beach and 1965 to 1998 for Fairlight Beach. The assessment of the contribution of sea level rise to



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historical beach behaviour over the analysis period can be estimated using the so-called “Bruun Rule”⁴ (Bruun, 1983). If this contribution is significant, historical recession rates are adjusted (*discounted*) to represent recession due to sediment loss only since, in the prediction of the future behaviour of the coastline, shoreline recession due to sediment loss and shoreline recession due to sea level rise are calculated separately.

The Bruun Rule allows prediction of shoreline recession due to sea level rise by the following formulation:

$$R = \frac{rX}{h + d_c}$$

where ‘R’ is the horizontal recession in metres, ‘r’ is the sea level rise, ‘X’ is the horizontal distance between ‘h’ and ‘d_c’ in metres, ‘h’ is the active dune/berm height in metres, and ‘d_c’ is the profile closure depth in metres.

For Fairlight Beach, a representative conservative value for X/(h+d_c) of 18 has been determined, assuming a closure depth d_c = -4m AHD, average berm height h = 2.0m AHD and value for X = 110m (*based on available hydrographic data from Aus Chart 201*). Accordingly, the recession due to sea level rise becomes: R = 18r.

For Delwood Beach, a representative conservative value for X/(h+d_c) of 8 has been determined, assuming a closure depth d_c = -3 m AHD, average berm height h = 2.0 m AHD and value for X = 40 m (*based on available hydrographic data from Aus Chart 201*). Accordingly, the recession due to sea level rise becomes: R = 8r.

The New South Wales Government's Coastline Management Manual (NSW Government, 1990) provides some indication of historical sea level rise in the Sydney area based on analysis of average annual mean tide levels for the Fort Denison tide recorder. This analysis indicates that the average sea level rise over the last 100 years has been 0.5 mm/year. WRL (2003) noted based on studies by the Royal Australian Navy (1998) that the long term average rate of sea level rise at Fort Denison between 1910 and 1999 was 0.86 mm/yr.

The shoreline recession rates which would apply due to sea level rise over the historical period covered by the photogrammetric analysis, based on the Bruun Rule, for the two rates of sea level rise referred to above are summarised in **Table 6.2**. These recession rates are small.

Table 6.2 Estimated Shoreline Recession Rates Due to Historical Sea Level Rise Using the Bruun Rule

Block	Analysis period	Adopted Rate of Historical Sea Level Rise	Estimated Shoreline Recession Rate
9	1965 - 1998	0.50 mm/yr	0.009 m/yr
		0.86 mm/yr	0.015 m/yr
10	1956 - 1998	0.50 mm/yr	0.004 m/yr
		0.86 mm/yr	0.007 m/yr

Due to the predicted low recession rates as a result of historical sea level rise, together with the uncertainties in the Bruun analysis and PAV analysis, no discounting of measured sand losses where recession has been observed, or increase in estimated sand gain where accretion has occurred, to account for sea level rise influences, is considered warranted.

Accordingly, adoption of a recession rate of about 0.04 m/yr is recommended for Fairlight Beach, excluding the effects of sea level rise which should be separately accounted for (refer Section 7. 2.). A recession rate of 0.04 m/yr would mean that the beach would reduce in width by 0.8 to 2 m over a period of 20 to 50 years respectively. The current beach width, measured at mean sea level, is approximately 15 m.

⁴ The use of the standard Bruun Rule to provide a single recession value has been deemed inadequate for future coastal management (Ranasinghe *et al.*, 2007). The standard Bruun Rule makes a number of assumptions which are largely not appropriate for the NSW coast. For example, the Bruun Rule is two-dimensional, so does not account for coastal features (e.g. headlands) or longshore sediment transport. An improved model for assessing long term recession due to sea level rise has been developed by Cowell *et al* 2006, R, termed the Shoreface Translation Model. In short, the model uses a fourth order solution to the Bruun Rule to determine the likely shoreline position under a future sea level.



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Similarly, no discount in measured sand volume changes is considered warranted for Delwood Beach. Adoption of a zero recession rate, excluding the effects of sea level rise, is recommended. Delwood Beach currently has a width, measured at mean sea level, of approximately 8 m.

6.3 SAND DRIFT HAZARDS

Sand drift is a result of the aeolian movement of beach sediment (refer Section 5.11) and as such can be controlled to a large extent by the existence of a well vegetated foredune. Sand drift leads to a number of hazards depending on the volume of sand involved. At one extreme, sand drift is only of nuisance value while at the other extreme it can represent a permanent loss of sand from the active beach system, thereby causing shoreline recession, and can result in the inundation of coastal developments (NSW Government, 1990).

At present, the hazard posed by drifting sand is generally not significant for Fairlight or Delwood Beaches because of the existence of a seawall and a well grassed berm at Fairlight and a high undercut sandstone rock face at Delwood that prevent the loss of any significant volumes of sand by aeolian processes.

6.4 COASTAL INUNDATION HAZARDS

Coastal inundation is the flooding of coastal lands by ocean waters, which is generally caused by large waves and elevated water levels associated with severe storms. Severe inundation is an infrequent event and is normally of short duration, but it can result in significant damage to both public and private property.

The components which give rise to elevated still water levels at times of storms have been referred to in Section 5.5 and illustrated in Figure 5.5. Individual waves cause further temporary water level increases above the still water level due to the process of wave run up or uprush.

The height of wave run up on beaches depends on many factors that include wave height and period, the slope, shape and permeability of the beach, the roughness of the foreshore area, and wave regularity. Wave run up can be difficult to predict accurately due to the many factors involved. Anecdotal evidence and the surveying of debris lines following a storm event usually provide the best information on wave run up levels.

Wave run up levels in storms would be expected to overtop the Fairlight Beach seawall which has a crest level varying between approximately 2 and 3 m AHD. This overtopping in combination with scour effects at the toe of the seawall could potentially act to destabilise the seawall in an extreme event, however, there is no historical evidence that inundation has been an issue.

Actual wave run up levels behind Delwood Beach are limited by the undercut rock face (*with a minimum height of approximately 2 m above the beach level i.e. 4 m AHD*) which backs the entire length of the beach. Wave run up levels in extreme events would be expected to be below the crest of the rock face, hence overtopping and coastal inundation would not be expected to pose a significant hazard in this area.

6.5 STORMWATER EROSION HAZARDS

During major stormwater runoff events, stormwater collected from back beach areas and discharging into coastal waters can cause significant erosion to the beach berm (NSW Government, 1990). This in turn can allow larger waves to attack the beach and can cause migration of the stormwater discharge entrance (NSW Government, 1990).

There are two stormwater outlets which discharge in the vicinity of Fairlight Beach (**Figures 6.5a and 6.5b**). The main outlet is enclosed in a box culvert at the western end of the beach. The second outlet is a small conduit pipe west of the beach which discharges onto a grassed area above the rock platforms. Neither of these stormwater outlets poses a potential threat to the beach in terms of erosion as they both discharge onto rock platform areas.

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There are four stormwater outlets which discharge in the vicinity of Delwood Beach. One is located near the western end of the beach, and three are located on top of the rocky outcrop/face at the back of the beach or in the grassed area behind these rocks about halfway along the beach (refer **Figures 6.5 c - e**).

Fig 6.5a: Stormwater box culvert at western end of Fairlight beach



Fig 6.5b : Outlet within box culvert at western end of Fairlight beach



Fig 6.5c: Stormwater outlet at western end of Delwood beach



Fig 6.5d: Stormwater outlet on top of rock outcrop on Delwood Beach (just east of stairs)



Fig 6.5e: Stormwater outlet on top of rock outcrop on Delwood beach further east.





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The westernmost outlet discharges directly onto a rock platform area and would therefore have minimal erosive potential. The two stormwater outlets, one shown in Photograph 6.5d, located just east of the steps, could potentially cause some beach erosion as the water drops from the pipe level down to the sand, a fall of approximately 2 m. The vegetation currently growing at the base of the rocky outcrop would limit this erosive potential by providing a binder for the sand and reducing the impact of the falling water.

In general the stormwater outlets have the potential to cause minimal impact on sand levels as they discharge onto rocky or grassed areas.

6.6 SLOPE & CLIFF INSTABILITY HAZARDS

In coastal environments, where the processes of wind, waves, storms and erosion are evident, there is a constant risk that slopes and cliffs may become unstable. The consequences of landslips and rock falls can be extreme, with risks to both property and life. Although the rocky foreshores in the study area have been described as relatively stable in relation to shorter term coastal processes, long term processes such as rock erosion can make slopes and cliffs unstable, to the point of collapse. Further, erosion and water logging from terrestrial processes (e.g.- stormwater flows) can also undermine slopes to the point of collapse.

An investigation was conducted in November 2003 for the section of foreshore between Davis Marina and Delwood Beach. The purpose of the investigation was to identify potential slope and cliff instability hazards and the likely consequences should a hazard occur.

These investigations involved surface observations of the topographic, surface drainage and geological conditions of the subject study area along the foreshore and along the footpath above the foreshore cliff line. Investigations were carried out from a boat and on foot.

Qualitative 'risk to property' and 'risk to life' assessments were undertaken based on the framework outlined in the 'Landslide Risk Management Concepts and Guidelines' presented in *Geomechanics*, Vol 35, No. 1, 2000. The assessment methodology involved rating the 'likelihood' of a hazard occurring and rating the 'consequence to property' of the hazard occurring. These ratings when combined determined the 'Risk Level Implication' which range from 'very low risk' to 'very high risk'.

A summary of the findings of the investigation are presented below.

6.6.1 Site Description

The study area is approximately 1.5 km in length and can be broadly described as follows:

- the small inlet feature bound between Gourlay Avenue (*eastern side*) and Harbour Street (*western side*) generally comprises the rear yard of residences with a timber footbridge crossing over the inlet. The rear yards step and slope down to the east and west to the foreshore below. The steps are retained by concrete and sandstone masonry walls of between about 1 and 2.5m height;
- the foreshore adjacent to the flat grass surfaced North Harbour Reserve comprised a rock revetment seawall. Most of the information regarding this seawall was obtained from Drawing no. 1-464, dated April 1986, titled 'North Harbour Seawall Stabilising Plan and Details' which was provided by Council. This drawing includes a typical cross section of the seawall showing the original stepped seawall covered by a layer of geofabric, overlain by smaller rocks (*to protect the filter cloth*), then by larger armour stones. Observations of the revetment seawall revealed exposed and torn geofabric where the smaller rocks have been displaced. No obvious signs of major instability were noted over the length of the seawall or the flat concrete paved and grass surfaced area above.
- from below King Avenue to Esplanade Park, the coastline extends to the east and comprises limited outcrops of sandstone bedrock (*of between 0.5 and 1.5m height*) and concrete and sandstone masonry seawalls, which range in height from about 1 to 2.5 m.



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- Esplanade Park comprises a grass surfaced area that slopes down to the south to the foreshore at grades of between 10° and 30°. The coastal path is located at the top of the slope.
- from the eastern end of Esplanade Park to Delwood Beach the foreshore generally comprises a sandstone cliff face, which ranges in height from 1 to 6m. Based on the 1:100,000 Geological Map of Sydney, the cliff line comprises Hawkesbury Sandstone. The coastal path extends along the top of the cliff line and is generally set-back at least 5 m from the edge of the cliff and is lined by the rear yards and walls of the adjoining properties above (*typically to the north*).

The cliff line zigzags along the orthogonal jointing in the rock mass. At the base of the cliff line is a sandstone wave cut platform, where there is an abundance of detached blocks up to 1.5m x 1.5m from previous rock falls, particularly within the inlet feature (*between Gourlay Avenue and Harbour Street*) and along the foreshore to the east of Esplanade Park.

6.6.2 Potential Geotechnical Hazards

The main potential geotechnical hazards identified within the study area can be summarised as follows:

- localised erosion of undercuts and overhangs with subsequent rock falls from parts of the cliff line;
- toppling (*or forward rotation*) of blocks/overhangs from the top part of the cliff line;

In addition, the following potential hazards were identified in specific locations:

- collapse of overhang or undercut feature within the cliff line causing collapse of rear yards, retaining walls, footbridge and/or staircases above and consequently impacting on coastal path. Fig trees growing over cliff line or outcrop also possibly de-stabilised.
- collapse of dilapidated structures including retaining walls and staircases impacting on coastal path above or below structure.
- collapse of existing piers, underpins and/or sandstone masonry walls etc supporting overhangs and undercuts within the cliff line or detached blocks, causing collapse or the above portion of cliff line or detached block.
- earth slide of the existing fill slopes adjacent to foreshore;
- earth slide of over-steep excavation batters;
- earth slide of over-steep existing colluvial slopes.

More specifically, the following potential geotechnical hazards were identified (**Table 6.6.2; Figure 6.6.2 for location of items**):

Table 6.6.2: Summary of potential risks to locations of geotechnical hazards

Item No.	Potential Geotechnical hazard	Assessed likelihood	Assessed consequences	Risk to property	Risk to life	Recommendations
6.	Collapse of wall &/or colluvial slope below	Possible	Minor to medium (depending whether collapse destabilises significant portions of rear yard and wall)	Low to moderate to moderate	Acceptable	Wall reconstruction.
7	Collapse of overhang and wall above	Possible	Minor	Low to moderate	Acceptable	Concrete or masonry piers to support overhang. Possible wall re-construction
8	Collapse of overhang & footbridge above	Possible	Minor to medium (depending whether collapse destabilises significant portions of footbridge)	Low to moderate to moderate	Tolerable to acceptable	Concrete or masonry piers to support overhang.
9	Collapse of undercut & wall above	Possible	Minor to medium (depending whether collapse destabilises	Low to moderate to	Acceptable	Reconstruction of part of wall



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Item No.	Potential Geotechnical hazard	Assessed likelihood	Assessed consequences	Risk to property	Risk to life	Recommendations
			significant portions of rear yard)	moderate		
12	Collapse of Steps	Possible	minor	Low to moderate		Hand rail to line side of steps. Post warning sign.
14	Collapse of Piers	Possible	Medium	Moderate	Tolerable to Acceptable	Concrete or masonry piers
16	Collapse of Wall	Possible	Minor	Low to moderate	Acceptable	Reconstruction of part of wall
17	Collapse of Fill batter	Possible	Minor	Low to moderate	Acceptable	Reconstruction of fill batter
19	Collapse of walls	Likely (concrete wall) Unlikely (brick wall)	Minor minor	Moderate Very low to Low	Tolerable to unacceptable	Wall reconstruction, removal of vegetation
20	Collapse of Fill batter	Possible	Minor (path) Moderate (if car parked at time of collapse)	Low to moderate to moderate	Acceptable	Reconstruction of fill batter
22	Collapse of portion of access ramp to unit building	Unlikely	Minor to Medium (depending whether collapse destabilizes significant portions of ramp)	Very low to Low to Low to Moderate	Tolerable to unacceptable	Concrete or masonry underpins/piers
23	Earth side of fill or natural soil batter	Possible	Minor (coastal path) Moderate (boat sheds below) Minor (steps and storm water pipe)	Low to moderate to Moderate Very low to Low to Low to Moderate		Concrete or masonry piers
30	Overhung or undercut collapse due to failure of pier				Tolerable to acceptable	REMEDIATION WORK COMPLETED
32	Collapse of undercut below timber steps and stormwater pipe. Boats stored beneath undercut)	Possible to unlikely	Major (boats)	Moderate to High	Acceptable	Move boats and/or post warning sign REMEDIATION WORK COMPLETED

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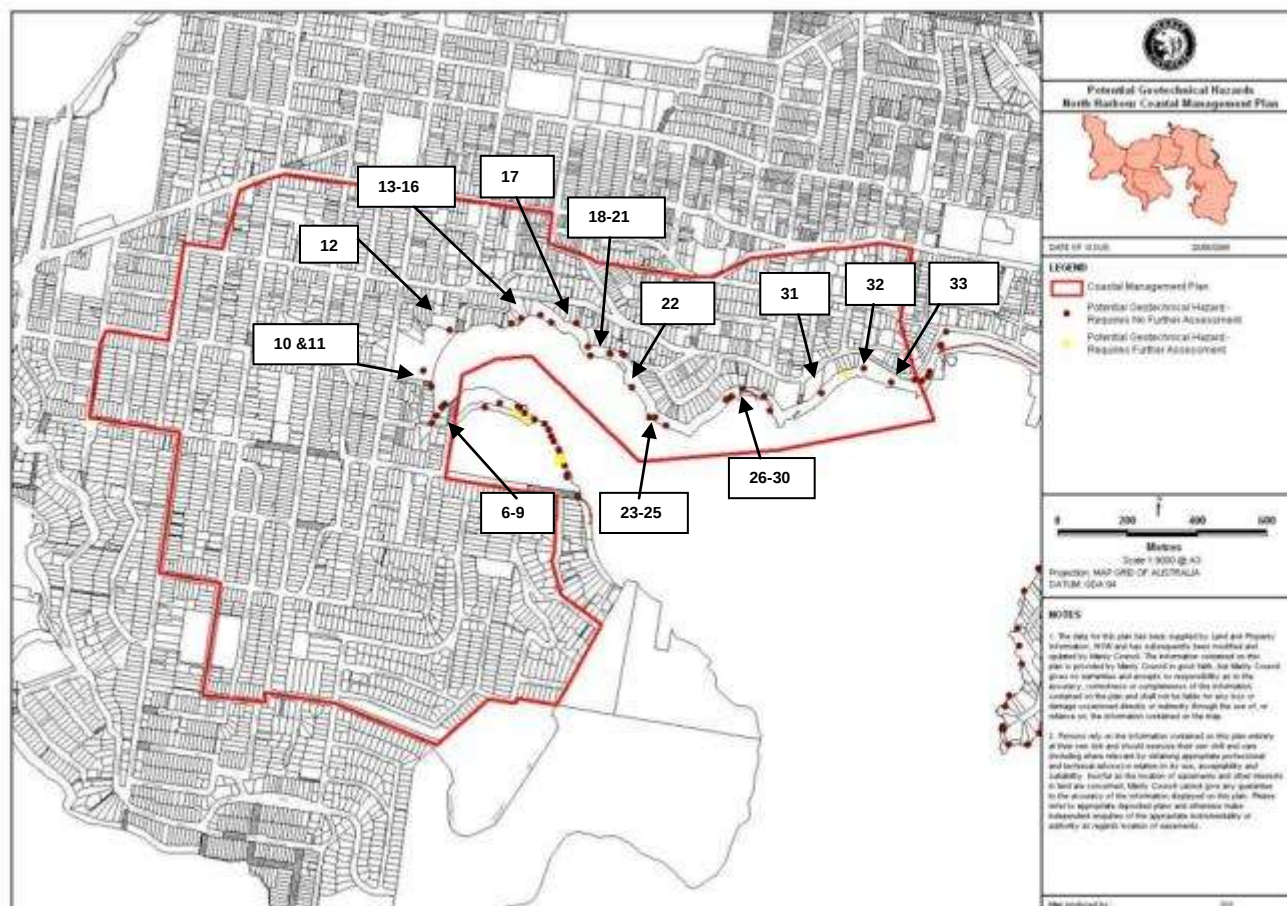


Figure 6.6.2 Location of geotechnical hazards within the study area.

6.6.3 Risk Assessment

Risk to Property

An assessment of the risk to property was undertaken for the Items listed above. Other items were not considered to represent a risk to property. The assessed risk to property ranged from 'very low to low' to 'moderate to high'. The following items had the higher risk ratings of 'moderate' (*Items 14 and 19*) and 'moderate to high' (*Item 32*).

Item 14 – Collapse of piers – location approximately corresponding to Numbers 1 to 5 King Avenue. The rear yard and sandstone block wall appear to be founded on top of a sandstone overhang of about 2 m height and extending back about 2 m. The overhang is supported by a curved sandstone masonry pier approximately 0.3 m square. Immediately west a two level weatherboard house is supported on concrete piers about 2 m high and about 0.5 m square. Below the piers the rear yard appears to be supported by a dry sandstone wall that is founded on sandstone bedrock and appears to be in good condition.

Item 19 – A concrete retaining wall supporting the rear yards to existing residences lining the northern side of the coastal path was noted to be leaning out and cracked.

Item 32 – The sandstone cliff line at Delwood Beach contains overhang and undercut features of 0.5 to 1.5 m horizontal depth and 0.5 to 1.5 m height. A stormwater pipe discharges over the cliff edge and timber steps lead down to the beach from the top of the cliff.

Generally the hazards with assessed 'moderate to high' risk to property would be considered to be unacceptable in their current condition. Hazards with assessed 'low to moderate' risk would be considered



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tolerable in their current condition. Hazards with 'very low to low' risk would be considered acceptable in their current condition.

Risk to Life

Risk to life was also determined, using indicative probabilities associated with the assessed likelihood. Where appropriate it has been assumed that collapse of the overhang undermines the rear yard above, and that a person was in the yard and/or a person was below the overhang, either on the beach or the wave cut platform.

The majority of the potential hazards creating a risk to life were existing slopes, with an assessed risk ranging from 1×10^{-5} to 3×10^{-8} , which is considered to be acceptable. Other potential hazards were assessed to have 'tolerable' to 'unacceptable' risk levels and are discussed below:

Item 8 – collapse of overhang on which the existing footbridge is founded is considered 'possible'. The assessed risk to life for the person most at risk was 6×10^{-5} which is considered 'tolerable' to 'acceptable'.

Items 14 & 30 – collapse of existing piers supporting overhangs and rear yards above is considered 'possible'. The risk to life for the person most at risk is therefore between 1×10^{-5} to 2×10^{-5} which is considered to be 'tolerable' to 'acceptable'.

Item 19 – the likelihood of collapse of the dilapidated concrete wall lining the coastal path, is considered 'likely'. The resulting risk calculation determined that the risk to life for a person on the path was therefore about 6×10^{-5} which is considered to be 'tolerable' to 'unacceptable'.

6.6.4 Recommendations

It was recommended that the specific hazards discussed above (*Items 8, 14, 19, 30 and 32*) be further assessed so that the risk to life and property can be further considered together with risk treatment options to reduce risks to an acceptable level.

In the interim, it was recommended that a warning sign be erected on the path and foreshore area adjacent to the overhang (*Item 32*).

Likely stabilisation measures for overhangs were considered to be concrete or masonry piers, or removal of the overhangs. Likely stabilisation measures for the steep excavation batters adjacent to the path were considered to be regrading of the slopes to an angle of about 30° to the horizontal, installation of an anchored shotcrete facing or construction of a toe retaining wall.

It was recommended that further geotechnical inspection (*and possibly subsurface investigation*) be undertaken in order to provide information to enable a detailed design of the likely stabilisation measures.

For hazards that are located on private property it is recommended that owners be contacted and made aware of the hazards and that further assessment of each hazard be undertaken (*Items 14 and 19*).

6.6.5 Remediation Works

Remediation works on Item 8 were completed earlier providing concrete or masonry piers to support overhang. During 2008, two remediation works were completed:

Item 30 (Fairlight pool). Construction of nine concrete/ masonry blade underpinning walls beneath the rock overhang

Item 32 (Delwood Beach). Construction of five concrete/ masonry blade underpinning walls beneath the rock overhang

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Item 30 (Fairlight pool)



Item 32 (Delwood Beach)



6.7 OIL SPILLS HAZARDS

Given the volumes of oil that are transported worldwide on a daily basis, a realistic strategy must recognise that a major spillage could occur at any time or place in our estuarine or coastal waters. In fact, Sydney Harbour has experienced a number of oil spills over the last decade. On 3 August 1999 the Laura D'Amato, a 96 121 DWT Italian registered oil tanker, an estimated 250 to 300 tonnes of cargo was pumped into Sydney Harbour. This was the largest ship sourced oil spill in Sydney Harbour.

A Coastal Resource Atlas for Oil Spills in Port Jackson was published in 1994 (EPA 1994). The Atlas assesses resources at risk in three groupings: ecological resources; socio-economic resources and cultural resources. Each resource is assigned to one of four categories relating to the sensitivity of that resource to an oil spill. The categories are: extreme, high, moderate and low.

North Harbour study area is shown to have moderate to high levels of sensitivity to an oil spill.

However, the value of coastal resource atlases is demonstrated by the recent development of a National Oil Spill Response Atlas (OSRA) as part of the National Plan to Combat Pollution of the Sea by Oil. The atlas will provide a uniform national oil spill response atlas in a computerised Geographic Information System (GIS).



7. CLIMATE CHANGE & ADAPTATIONS

7.1 THE HAZARDS OF CLIMATE CHANGE

Over the past 200 years, human activities have significantly altered the world's atmosphere. While much progress in understanding the climate change issue has been made, uncertainties continue to exist about aspects of the climate change science, and regarding societal developments that will affect the extent of future climate change and societal vulnerability. Some impacts of climate change are now inevitable. However, more certainty and understanding is needed to guide decision-makers towards the most effective and cost-efficient means to adapt to climate changes in the near-term (next decade), and to avoid unacceptably large climate changes in the longer term (multi-decades to centuries) through emissions reductions measures (Australian Greenhouse Office, 2007).

The Intergovernmental Panel on Climate Change (IPCC) has released its Fourth Assessment Report in early 2007 with the following key conclusions on climatic patterns on a global scale:

- warming of the climatic system is unequivocal;
- most of (>50%) of the observed increase in global average temperatures since the mid-20th century is very likely (confidence level >90%) due to the observed increase in anthropogenic (human) greenhouse gas concentrations;
- hotter temperatures and rises in sea level "would continue for centuries" even if greenhouse gas levels are stabilised, although the likely amount of temperature and sea level rise varies greatly depending on the fossil intensity of human activity during the next century
- the probability that this is caused by natural processes alone is less than 5%;
- World temperature could rise by between 1.1 and 6.4°C during the 21st century and that:
 - Sea levels would probably rise by 18 to 59 cm
 - there will be more frequent dry spells, heat waves and heavy rainfall (at a confidence level >90%);
 - there will be an increase in droughts, tropical cyclones and extreme high tides (at a confidence level >66%).
- Both past and future anthropogenic carbon dioxide emissions will continue to contribute to warming and sea level rise for more than a millennium;

The projected global SLR, however, does not include the inputs due to melting of terrestrial ice sheets, as the climate science community could not agree on the magnitude or timing of this contribution. The IPCC estimates this will add approximately 10-20cm to global SLR (IPCC 2007).

Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values over the past 650,000 years.

Climate change is likely to have significant impacts on Australia (Preston & Jones 2006). From 1910 to 2004, the Australian-average maximum temperature rose 0.6°C and the minimum temperature rose 1.2°C, mostly since 1950 (Nicholls and Collins 2006).

A key federal initiative of early action on climate change is the National Climate Change Adaptation Framework endorsed by the Council of Australian Governments in April 2007. This framework, intended to guide actions by all levels of government over the next five to seven years, identifies coastal zone vulnerability to climate change as a priority area for action (COAG, 2007). Governments at all levels recognise climate change as a major pressure on the sustainable management of the social, economic and environmental well-being of coastal areas (Natural Resource Management Ministerial Council, 2006; COAG, 2007).



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The National Climate Change Adaptation Programme, a federal Govt. programme, costing some \$14 million over four years is being made available to help Australia start to address the adaptation challenge. Partnerships with industries, research bodies, communities and governments will commence work towards practical solutions. Guidelines, planning tools and information about climate change impacts form the basis of the Programme. One of the recent outputs is Climate Change Adaptation Actions for Local Government.

Climate Change in New South Wales

Hennessy *et al.* (2004) found that between 1950–2003, NSW became 0.9°C warmer, with more hot days/nights and fewer cold days/nights. Annual total rainfall declined by an average of 14 mm per decade, with the largest declines in rainfall near the coast due to an increase in El Niño years since the mid-1970s. Extreme daily rainfall intensity and frequency have also decreased throughout much of the State.

CSIRO (2006) has studied impacts of climate change through simplified scenarios for ten regions of Australia, including NSW. These scenarios for 2030 are suitable for the purpose of an initial assessment of risks and are presented as changes relative to 1990.

Table 7.1a: Changes in climate for New South Wales by 2030, relative to 1990

Feature	Low Global Warming Scenario		High Global Warming Scenario	
	Estimate of change	Uncertainty	Estimate of change	Uncertainty
Annual average temperature	+0.6°C	±0.2°C	+1.3 °C	±0.6°C
Average sea level	+3cm		+17cm	
Average annual rainfall	0%	±6.5%	0%	±15%
Seasonal average rainfall				
Summer	+ 1.5%	±8%	+ 3.5%	±18.5%
Autumn	+1.5%	±8%	+ 3.5%	±18.5%
Winter	-3%	±6.5%	-7%	±15%
Spring	-3%	±6.5%	-7%	±15%
Annual average potential evaporation	+2.4%	±1.9%	+5.6%	±4.4%
Annual average number of hot days (>35°C)	+1 day		+25 days	
Annual average number of cold nights (<0°C)	-5 days		-30 days	

Source: CSIRO, 2006

NSW is likely to become warmer, with more hot days and fewer cold nights. For example, the number of days above 35°C could average 4-7 in Sydney (now 3). In cities, changes in average climate and sea level will affect building design, standards and performance, energy and water demand and coastal planning. Increases in extreme weather events are likely to lead to increased flash flooding, strains on sewerage and drainage systems, greater insurance losses, possible black-outs and challenges for emergency services.

Action 2.6 of the NSW Greenhouse Plan 2005⁵ relevant to coastal communities is to “research likely coastal impacts and investigate the feasibility of a coastal adaptation program”. The NSW Government’s Climate Change Impact and Adaptation Program provide new funding to address key actions of the NSW Greenhouse Plan. Under this Program, “High resolution terrain mapping of the New South Wales Central and Hunter Coasts for land use planning assessments of potential climate change impacts on coastal communities” is being implemented.

In a recent study, regional variability of SLR estimate from the global average has been further refined. In the case of South-Eastern Australia, strengthening of the East Australian Current is likely to lead to a contribution of around 12cm of additional SLR, relative to the global average (McInnes *et al.* 2007). These additional amounts bring the upper end of the SLR projection envelope for the New South Wales coast to around 91cms. Whilst there is currently no guidance from the State or Federal Governments on the SLR figures which should be used for future planning and climate change adaptation purposes, the NSW Floodplain Risk Management Guideline:

⁵ This plan is scheduled to be replaced by NSW Climate Change Action Plan in April 2009.



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Practical Consideration of Climate Change suggests the figure of 91cm be used as the upper boundary for sensitivity testing of flood models (DECC 2007). In fact, Lake Macquarie City Council has resolved to publicly exhibit a proposal to adopt the upper sea level rise figure for the year 2100 of 91 cm as the basis for Council staff to proceed with risk assessment, policy development, community empowerment, and other planning and development decisions (Farrell *et al.* 2008).

The NSW Government is, at present (October 2008), working with the University of NSW (UNSW) to develop regional climate change projections. The Government is assessing the projected impacts of these changes on a regional basis across in NSW. In the regional assessment project, the Department of Environment and Climate Change (DECC) and the Department of Water and Energy (DWE) are working together to assess the likely effects of climate change on physical environment. In particular, the project is looking at the effects of climate change in specific NSW regions on: sea level, runoff and floods. The project is then examining the impacts of these changes on land, coastal hazards and flood risk, and natural ecosystems across NSW. It will provide a basic integrated assessment of possible biophysical changes in NSW by 2050 (and possible changes to coastal hazards by 2050 and 2100). Interim report of Sydney region is yet to be prepared.

The NSW Government has released (February 2009) a draft Sea Level Rise Policy Statement for public consultation. The primary objective of this Sea Level Rise Policy Statement is to minimise the social disruption, economic costs and environmental impacts resulting from long-term sea level rise. To achieve these objectives, the NSW Government will:

1. promote an adaptive risk-based approach to managing sea level rise impacts
2. provide guidance to local councils to support their sea level rise adaptation planning
3. encourage appropriate development on land projected to be at risk from sea level rise
4. continue to provide emergency management support to coastal communities during times of floods and storms
5. continue to provide updated information to the public about sea level rise and its impacts.

The Climate of the Sydney Metropolitan Catchments

Summers in the Sydney Metropolitan Catchments are relatively warm, with average maximum January temperatures of approximately 26°C (Table 7.1b). However, the catchments do experience approximately 3 days above 35°C each year. Winters are cool to mild, with average maximum July temperatures of 17°C. Temperatures rarely fall below 0°C. The catchments receive approximately 1,100 mm of rainfall each year. Peak precipitation occurs between January and March, and the variability in rainfall from one year to the next is high. Hail storms are common, the worst being the April 1999 event which cost \$2.3 billion (IDRO, 2006). Bushfires are also common, often occurring near residential properties.

Since 1950, the region has experienced warming of around 0.8°C. This is likely to be partly due to human activities. The catchments have also experienced a significant drop in annual rainfall at a rate of approximately 55 mm per decade. The contribution of human activities to this rainfall decline is hard to distinguish from natural variability (CSIRO, 2004).

The future climate of the Sydney Metropolitan Catchments is likely to be warmer and drier. Such trends would also increase evaporation, heat waves, extreme winds and fire risk. Nevertheless, despite this trend toward drier conditions, the possibility of increases in extreme rainfall events remains.

Further details about these changes are described in table 7.1b, which compares average conditions for the present climate with ranges of potential change in 2030 and 2070 (CSIRO, 2007). When considering projections identified in Table 7.1b it can be noted that a warming of 1.0°C and a 5% decrease in rainfall (a moderate scenario for 2030) would make the climate of Sydney similar to the current climate of Paterson to the north west of Newcastle.



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Table 7.1b - Current and projected climate change in the Sydney Metropolitan Catchment

Climate Features	Present (1990) ¹	Projected Changes	
		2030	2070
Temperature			
Average	17-26 C ²	+0.2 - +1.6C	+0.7 - +4.8C
No. of days below 0C	0	0	0
No. of days above 35C	3	4-6	4-18
No. of days above 40C	0	0-1	1-4
Rainfall			
Annual Average	1094mm	-13 - +7%	-40 - +20%
Extreme Rainfall ³		-3 - +12%	-7 - +10%
Evaporation		+1 - +8%	+2 - +24%
No. of droughts per decade ⁴	3	2-5	1-9
Extreme Winds		-5 - +8%	-16 - +24%
No. of Fire Days ⁵	9	9-11	10-15

Source: CSIRO, 2007

¹ Present day conditions for temperature and rainfall represent long-term averages from the Bureau of Meteorology. For extreme temperatures, the present average is based on 1964-2003. For fire danger, the present average is based on 1974-2003. For drought, the present average is for a period centred on 1990.

² Range represents average July and January maximum temperature.

³ Defined as 1 in 40 year 1 day rainfall total. Values represent the range in seasonal projections from a limited set of climate models for central eastern NSW. However, given the strong spatial gradients in extreme rainfall projections, these regional results may not be applicable to Sydney.

⁴ The values for drought represent average monthly drought frequencies, based upon the Bureau of Meteorology's criteria for serious rainfall deficiency.

⁵ Number of days annually with a "very high" or "extreme" fire danger index. Changes are for 2020 and 2050 respectively.

7.2 IMPACTS OF CLIMATE CHANGE IN THE SYDNEY REGION

Although changes in average temperature, rainfall and evaporation will have long-term consequences for the catchments, the impacts of climate change are more likely to be felt through extreme weather events. Projections suggest there will be more hot days, bushfires, droughts and intense storms. These can all place human life, property and natural ecosystems at increased risk. Additional details regarding climate change impacts to various activities and assets in the catchments are discussed below.

Water

Changes in rainfall and higher evaporation rates are likely to lead to less water for streams and rivers in the Sydney Metropolitan Catchments, which will have downstream consequences for storages and place strains on water resources. In addition, much of Sydney Metro's water resources are sourced from the neighbouring Hawkesbury-Nepean Catchment, where a number of key storages are also at less than 50% capacity. In fact, the main impacts of climate change on Sydney's water supply may result from effects in upstream catchments.

Various studies of stream flows in NSW indicate that climate change is likely to reduce flows in the future (Hassall and Associates, 1998; Jones and Page, 2001; Beare and Heaney, 2002; Bates *et al.*, 2003; Warner, 2003). Under the National Water Initiative, the Commonwealth, State and Territory Governments have agreed that water users should bear the risk of such reductions in water availability. Other modelling studies have also indicated the potential for increased flooding in catchments upstream from Sydney (Schneider *et al.*, 2000).

Lower flows and higher temperatures may also reduce water quality within the catchments. For example, low flows, higher temperatures and elevated nutrients create a more favourable environment for potentially harmful algal blooms. Greater fire activity could contaminate water catchments with sediment and ash. Salinity problems in the catchments may be exacerbated by changes in rainfall, temperature and stream flows (Beare



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and Heaney, 2002). In addition to effects on surface water, the quality of coastal groundwater aquifers may be adversely affected by rising sea levels and salt-water infiltration.

Biodiversity

Changes to the climate will have significant effects on the catchment's plants and animals. Currently, 149 species, nine populations and 21 ecological communities (i.e., collections of species or habitat) in the Sydney Metropolitan Catchments are classified as threatened or endangered (DECC 2006). Although current threats to the catchment's biodiversity are largely a product of historical land clearing, alterations of river flows and water extraction, climate change is likely to heighten the need for conservation efforts.

The geographic distribution of a species is often defined by its 'climate envelope,' reflecting species-specific tolerances to extremes of temperature and moisture. Climate change is likely to drive changes in the distribution of some plant and animal species, driving some species out of the catchments or enabling invaders to move in. Meanwhile, even those species capable of coping with climate change alone may succumb to the cumulative effects of multiple stressors. Despite such impacts, little is actually known regarding how climate change may affect the catchments' rich biodiversity or ecosystems.

Other risks to biodiversity in the Sydney Metropolitan Catchments include:

Reductions in stream flows are likely to have a negative impact on aquatic biodiversity and wetland ecosystems;

- Plants and animals may become 'stranded' in isolated remnants of vegetation due to changing climate and continued development within the catchments;
- More frequent droughts and fires are likely to increase stress on plants and animals.
- Sea-level rise is likely to inundate coastal wetlands and alter the discharge of freshwater into estuaries, with potential adverse effects on coastal wetland habitat.

Human Health

Warmer winters are likely to reduce cold-related illnesses, but warmer summers are likely to increase the risk of heat-related health problems, especially in the elderly (McMichael, 2003).

For example, climate change and population growth and ageing may increase annual heat-related deaths in those aged over 65 in Sydney from 176 at present, to 364–417 by the year 2020, and 717–1,312 by 2050 (McMichael *et al.*, 2003). Warmer temperatures may also contribute to the spread of infectious diseases, although the spread of tropical diseases such as dengue fever into the Sydney Metropolitan Catchments remains unlikely.

Built infrastructure

The built environment is also vulnerable to climate change. A recent study by the Academy of Technological Sciences and Engineering concludes that the impacts of current climate change projections have the potential to significantly challenge the capacity of elements of Australia's physical infrastructure and that action needs to be taken at the national level to ensure that appropriate adaptation measures can be implemented to meet these challenges (Stevens, 2008). Changes in average climate will affect building design and performance, including structural standards and cooling and heating demand (PIA, 2004). Higher summer temperatures, for example, may induce an evaluation of building design and standards to ensure thermal comfort at minimal cost, while potential increases in extreme winds may necessitate more robust construction. In addition, a study by Austroads (2004) concluded that climate change would contribute to increases in road maintenance costs in NSW of up to 25% by 2100, largely due to assumptions about the effects of climate change and population growth on traffic volumes.

Given increases in the intensity of the heaviest rainfall events, flash flooding and strains on water infrastructure such as sewerage and drainage systems would rise, particularly in population centres. For example, a study by Minnery and Smith (1996) found that climate change may double flood-related damages in urban areas of NSW, although more recent modelling suggests that extreme rainfall events along the NSW coastline may



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decline, but increase further inland (Hennessey *et al.*, 2004b). Regardless of changes in such extremes, higher temperatures and lower average rainfall are likely to lead to increased pressure on urban water and energy supplies, unless moderated by demand management measures. For example, McDonald (2006) estimated that per capita water demand in Sydney would have to decline by 54% by 2030 in order to remain within sustainable yields. Higher temperatures would increase summer peak energy demand for air-conditioning (Howden and Crimp, 2001), increasing the risk of black-outs.

The risk of property loss due to bushfire is likely to increase. For example, on average Sydney is likely to experience 0–2 more days with a fire danger index of “very high” or “extreme” by 2020 and 1–6 more days by 2050 (Hennessey *et al.*, 2005). Given large number of properties in bushland and the exposure of critical infrastructure, this would pose challenges for emergency management. As a consequence, insurance risk assessments and premiums are likely to be affected.

Aboriginal Heritage

Research into the impact of climate change on cultural heritage sites, in particular indigenous heritage sites, is very limited. Middens are described as being highly susceptible to erosion. Accelerated climate change is likely to result in an increase in the exposure and disappearance of sites. Currie *et al.* (2007) carried out an investigation on Aboriginal sites located within Willoughby City Council on Middle Harbour. Of the 148 Aboriginal heritage sites, there are currently 12 sites that are underwater or partly underwater during high tides, which occur twice a day in the study area. An additional 18 sites will be inundated with a sea level rise of 0.59 meter. A further 26 sites will be within a one metre buffer of the predicted sea level rise. There will be 12 sites within a two metre zone of the new sea level height. As the distance from the shoreline increases, there is an increase in the number of engravings and shelters with art that will be affected. There will be ten sites within a three metre buffer of the projected sea level height. The remainder of the sites (70 sites or 48% of the sites) will be outside a three metre buffer of the projected sea level rise.

Other Impacts

Cyclone intensities may be expected to increase with temperature, however climate models give no consistent indication of whether tropical storms will increase or decrease in frequency or intensity with increasing temperature.

Mid latitude storms, unlike tropical cyclones, may actually decrease in intensity and frequency with global warming due to a reduction in equator to pole temperature gradients, however as with tropical cyclones, climate modelling at present lacks the resolution to accurately predict changes associated with global warming.

Given the above uncertainty, no specific account can be taken of any potential changes to storm frequency and intensity or changes in wave directions. However, this uncertainty should be taken into consideration when assessing the risk and consequences of recession occurring in the future. The potential for a climate change related recession needs to be continually reviewed as more information comes from the scientific community.

Climate change also has the potential to impact on other coastline hazards such as the coastal inundation hazard and the slope and cliff instability hazard. An increase in sea level, for example, would directly impact on (*increase*) the magnitude of the coastal inundation hazard. There are, in addition, indirect impacts on this hazard due to sea level rise, since the heights of waves which reach the shoreline and influence the wave setup and wave run up components of elevated water levels are a function of the available water depth, which in turn would be affected by any increase in sea level.

In some cases, the magnitude of the slope and cliff instability hazard, and the design of stabilisation measures, would be influenced by climate change such as an increase in sea level and greater storminess, e.g. where the slope and cliff instability is due to wave undercutting.

It is difficult to be precise about the potential effects of climate change on these other coastline hazards. For these reasons it is important to monitor shoreline behaviour, monitor trends in climate change predictions, and



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take into account up-to-date predictions in the assessment of management options and the design of any mitigation or stabilisation measures.

7.3 CLIMATE CHANGE WITHIN MANLY LGA

7.3.1 General

On October 29, 2006 Council's Manly Environment Centre conducted a Climate Change Forum titled 'Weathering the Storm'. During this session many views were expressed about what climate change will mean for Manly and some of the management options were outlined.

At Council's Ordinary Meeting of 20 November 2006, Council resolved to adopt a Mayoral Minute entitled Global Warming: Local Solutions - Time for Action, which requires the establishment of a "Climate Change Working Group" to identify likely impacts of climate change and to provide advice on prevention and mitigation strategies.

In 2006, Council established a Climate Change Working Party to formulate recommendations for action to manage, and to respond to the likely impacts of Climate Change. Cardno (2008) has made an assessment of the likely effects of climate change. A preliminary mapping has also been prepared. North Harbour Reserve and its surrounds have been indicated to be affected by sea level rise.

Prior to this, Manly Council has remained a leading member of the (inter) national Cities for Climate Protection Programme (CCP) since 1998. CCP is a program delivered by ICLEI in collaboration with the Australian Greenhouse Office and is aimed to help local governments and their communities to reduce greenhouse gas emissions and their impact on the environment. Manly Council was the second Council in the State to complete all five milestones of the program and move on to CCP Plus, the advanced programme.

Through this program Manly Council has undertaken several greenhouse projects including education programs, energy efficient lighting and retrofits of public amenities (including the beachfront and several sports fields), installation of a solar hot water at Swim Centre and energy efficient equipment in our offices. Through these and other actions Manly Council to date has achieved over 1600 tonnes of greenhouse gas abatement in the corporate sector and over 26,600 tonnes of greenhouse gas abatement in the community sector.

7.3.2 Vulnerability

Vulnerability is the degree to which a system is susceptible to, or able to cope with, adverse effects of climate change, including climate variability and extremes (IPCC 2001). The Sydney Coastal Councils Group has undertaken research on regional approaches to managing climate vulnerability on the Sydney region (Preston *et al.* 2008).

During the first stage of this project, an assessment of the vulnerability of the SCCG region and its' member Councils to climate change was conducted. In conducting these assessments, simple conceptual models identifying the key processes and assumptions were developed for each of the above impact areas. These models were subsequently utilized to select a broad range of climate, landscape, household and Council indicators reflecting the three components of vulnerability: exposure, sensitivity and adaptive capacity. Each of the indicators identified above were subsequently scored, mapped and then integrated within a GIS to develop spatial representations of vulnerability to different impacts at the regional level. The results were then averaged over each local government area.

This assessment (Preston *et al.* 2008) indicated that, on average, Manly Council possesses a moderate degree of vulnerability to climate change relative to other Councils within the SCCG Region (Table 7.3.2). However, due to its coastlines and coastal development, vulnerability to sea-level rise and coastal hazards was assessed to be particularly high. In addition, Stormwater management may become a challenge in the future due to development and projected increases in future rainfall. The vulnerability of the coastline and the paucity of natural landscapes suggest the Councils' natural ecosystems have a low resilience to the effects of climate



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change. Meanwhile, bushfire vulnerability was assessed to be particularly low. Despite these broad generalizations, vulnerability in general varied significantly throughout the Council.

Table 7.3.2 - Climate Variability Scores for Manly Council

Impact Area	Extreme Heat & human health effects	Sea-level Rise & coastal management	Extreme Rainfall & stormwater management	Bushfire	Natural Ecosystems & Assets	Overall
Vulnerability Score*	5	8	8	1	7	6

*Vulnerability was scored on a scale from 1-9, with 1 indicating low and 9 indicating high vulnerability

Source: Preston *et al.* 2008

It is important to note that although significant focus is often placed on the climatological and biophysical hazards associated with climate change (e.g. temperature extremes or storm events), factors such as demographics, socio-economic conditions and human agency and decision-making are often equally, if not more important in dictating vulnerability. Such factors frequently determine the sensitivity of a given sector or location to climate change. They also influence adaptive capacity through their association with financial and social capital as well as institutional processes and relationships.

7.3.3 Adaptations

Climate change will obviously affect many natural and human systems and activities. However, the impact of a given climate change on a particular system or activity depends on its vulnerability and adaptability. If a system or activity does not adapt to the change, the impacts will be larger. Adaption may be automatic, or it may be conscious and planned. Automatic adaption tends to occur in natural systems, such as the migration of flora and fauna to more suitable environmental regions. Planned adaption tends to occur in human systems (Greenhouse Office 2003).

Adaptation is a risk management strategy involving actions to reduce the negative impacts of climate change and take advantage of new opportunities that may arise. The types of adaptation measures adopted will vary from region-to-region. Because some of the decisions will have lasting implications for future climate vulnerability, one must start planning adaptive responses now. These will help to lessen some of the environmental, economic and social costs of climate change (CSIRO, 2007).

Some examples of potential adaptation measures may include:

- Improving water-use efficiency, recycling and public education about water usage.
- Enhancing water supplies through groundwater extractions and desalination, subject to environmental impact assessments.
- Implementing early-warning and public communication systems for heat waves.
- Designing energy efficient buildings.
- Retrofitting old and designing new, infrastructure to cope with climate change.
- Reviewing flood and fire management arrangements.
- Reviewing coastal zone management practices.
- Maintaining green spaces and ecological refuge in urban areas.

Making sure the catchment has the necessary capacity to implement such adaptation measures means continually expanding research, education and communication. It is the intention of the North Harbour Coastline Management Plan to identify measures which facilitate adaptive approaches in the planned future management of climate change within the study area.



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7.3.4 Council's Current Programs

In terms of greenhouse emissions and climate change education, Manly Council has taken an active role in making our community become more aware of these highly important issues. The Manly Environment Centre (MEC) is a shop front on Belgrave Street staffed with trained environmental educators on hand to provide education material (including brochures, education kits & media clippings) to the general public.

Manly Council works with local businesses to improve energy management through a number of programs. The Sea Change for Sustainable Tourism Project is aimed at making Manly's local tourism industry more sustainable through a number of environmental management practices including energy management, and the annual Green Business Awards incorporates energy management education.

Manly Council has pledged to reduce emissions by 25 per cent by 2010. To help reduce community greenhouse gas emissions, the following programs for residents and businesses have been implemented:

- Enviro Saver energy audits gives residents and business the opportunity to install free energy efficient light globes, water efficient showerheads, as well as obtain advice on the installation of other energy efficient products.
- The Fridge Buyback scheme provided a financial reward and free pick-up for the old, second fridges.
- The Manly Appliance Rebate Program (MARP) provided up to \$200 for residents who installed a more energy efficient air conditioner, or switched from electric heating or cook tops to gas. Grant funding for MARP was provided by the Demand Management Planning Project.
- In the past year posters, displays and materials helped raise awareness and promote Green Power at community events and in the quarterly rate notices. In addition, a Green Power competition was held with the winner receiving "Green Power for a year".

Council is working with the local surf clubs to install solar hot water and solar panels. These solar technologies will help local surf clubs reduce energy and operating costs as well as promote greater acceptance and awareness of solar technologies in the wider community. Council is preparing a new action plan that will identify priorities and strategies for reducing council and community greenhouse gas emissions. This action plan will be prepared with the assistance of the Climate Change Working Group, that provides a forum for integrative discussion and recommendations for prioritised action on climate change reduction and adaptation.

In 2008, *Cardno*, a multi-disciplinary firm of consultants, was commissioned to carry out an independent analysis of the likely impacts of Climate Change on the Manly LGA and to establish a set of objective criteria for advising Council on an appropriate range of response measures (and their relative priority) for implementation within the framework of an integrated strategy to deal with likely effects of Climate Change on the Manly Community.

In order to affect the measures identified in the *Cardno Analysis Report*, Council needs the support of its ratepayer for a special levy. In this regard, Council gauged the level of support of the community for such a levy at the September 08 local government election. Only 38% of voter supported such a move.

In addition, Council is in the process to undertake a full review and risk assessment. It is expected that this process will be conducted through a workshop process and a review panel using the recently published guidelines from the Australian Greenhouse Office.

In July 2008, Manly Council led the SHOROC Councils - Manly, Warringah, Pittwater and Mosman to investigate to install solar-powered street lights, an Australian first. The solar plan roll-out will involve replacing 30,000 existing lights and adding approximately 10,000 additional lights to those areas which currently have substandard lighting. A full investigation and report into the scheme is expected in six months, while installation of solar lights may take 2-3 years.

7.4 SPECIFIC INFORMATION FOR THE STUDY AREA

The study area will experience many of the impacts of climate change, with the low lying areas close to the foreshore likely to be subject to more of the impacts than the elevated areas. These impacts are likely to



MANLY COUNCIL RESPONSE RE: CLIMATE CHANGE ADAPTATION ACTIONS

Council developed a “Manly Sustainability Strategy” in 2006. This Strategy provides overarching guidance for climate change adaptation and mitigation within the Manly LGA

Mitigation & Adaptation

Climate Change Actions for Manly LGA (Cardno Report) – September 2008

A report prepared for Council identifying and mapping preliminary predictions of specific climate change impacts upon the LGA with respect to sea level rise, catchment flooding and oceanic inundation. Specific mitigation measures and preventative/adaption measures were proposed and a prioritized action list prepared. This report provides excellent background information to the Climate Change Risk and Adaptation Project (CCAP) and for responding to climate change impacts - see below. The report is available on Manly Council's website.

Climate Change Strategy

Council plans to develop a Climate Change Strategy which will provide an umbrella framework for Climate Change management and issues in Council. It will provide a strategic approach to climate change, drawing together various initiatives such as Carbon Neutral Plan, Climate Change Risk Adaptation Action Plan, Climate Change Education Strategy outlined below.

Mitigation

Carbon Neutral Plan

Manly Council resolved to become Carbon Neutral by 2010 at its meeting of 21 July 2008. Staffs are currently establishing a project to achieve this target following the energy hierarchy of avoiding energy consumption, increasing energy efficiency, fuel switching, renewable energy and carbon offsetting. The project has gone to seek EoI for the development of a Carbon Neutral Plan for 2010 and beyond.

Cities for Climate Protection Plus (Local Air Quality & Greenhouse Action Plan / Carbon Neutral Plan)

Council has been a part of the CCP program since 1998 and the CCP Plus program since about 2006. This project is concerned with preparing a new Carbon Neutral Plan (as per Council resolution for 2010) for Council corporate and Local Air Quality & Greenhouse Action Plan for the community (provides strategic direction to mitigation).

Manly Council: Renewable Energy Generator Scoping Study

Council staffs are preparing a scoping study to investigate the feasibility of Manly Council generating considerable solar power for Council's own supply to reduce carbon emissions. This involves the placement of PV solar panels on available roof space in the Manly LGA. This is in response to a Council resolution of 10 November 2008.

Adaptation

Climate Change Risk and Adaptation Project

Council has received funding from the Department of Climate Change (DCC) as part of the DCC's Local Adaptation Pathways Program for the development of a Climate Change Risk and Adaptation Strategy. This will provide a strategic approach to climate change risk management and adaptation for Manly council and community. Elements of the Cardno report will apply.

Integration of Climate Change in the Development of Coastline Management Plans

Since 1997 Manly Council has been developing Management Plans (CMPs) in response to legislative requirements and community issues. This approach encourages current best practice for the management of coastal and estuary foreshores in line with the Coastline Management Manual (1990).



MANLY COUNCIL RESPONSE RE: CLIMATE CHANGE ADAPTATION ACTIONS (CONTINUED)

Emergency Management Plan for coastal Erosion (EMP)

Manly Council has developed an Emergency Management Plan for Coastal Erosion (EMP) for Manly Ocean Beach.

Development of GIS tool to assess Vulnerability of coastal Infrastructure and building to catastrophic Marine Floods

Council has partnered with the SCCG and UNSW Natural Hazards Research Lab to undertake a research project that will apply and test a newly developed and highly novel GIS tool to assess the vulnerability of coastal infrastructure and buildings to catastrophic marine floods. The outputs of the assessment aid council in making decisions about long-term strategic planning and development. Comprehensive GIS mapping identifying vulnerability of individual buildings throughout the low lying areas of Manly CBD and Lagoon catchments has been incorporated into Councils management processes.

Integration of Climate Change into Planning processes

General information is provided on the section 149(5) on the potential for some properties to be impacted by climate change.

The Environmental Planning and Assessment Regulation (2000) (Item 7 of Schedule 4) requires that the following information be disclosed in a Section 149(2) Certificate:

Whether or not the land is affected by a policy:

(a) adopted by the council, or

(b) adopted by any other public authority and notified to the council for the express purpose of its adoption by that authority being referred to in planning certificates issued by the council, that restricts the development of the land because of the likelihood of land slip, bushfire, flooding, tidal inundation, subsidence, acid sulphate soils or any other risk.

Therefore to include the potential hazards information relating to specific private properties on the relevant Section 149(2) certificates, Council was required to adopt the Coastline Hazard Definition Study reports 'as Council Policy'.

LEP Review

Council is currently amending the LEP/DCP in line with the NSW Government's Planning Reforms. The NSW government has not included any climate change provisions in the new LEP template, however, Council is attempting to build the consideration of climate change into the objectives etc.

Climate Change Education Strategy

Currently being developed to address community education with respect to climate change mitigation and adaptation.

Community Energy and Water Saving Technology Uptake Program

Discussions have been held with representatives of Mosman, Warringah and Pittwater Council's to introduce a SHOROC project to increase solar system uptake in the community. The concept came from a presentation by John Larkin "Solar Up". Manly Council's Senior management has recently approved the project, however it has not commenced.

Climate Change Ambassadors Group (Gas Busters)

Council's Volunteer Coordinator is creating a community volunteer group whose primary objective is to inform the general public about climate change issues (adaptation and mitigation) and encourage people to reduce their emissions and impact on the environment.



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include: sea level rise; increases in extreme weather events; temperature increases; reductions in water availability; altered hydrology and increased flash flooding (Hennessy *et al.*, 2006).

At a few pockets of the study area contains properties that extend right to the foreshore. Sea levels are expected to rise, but they only need to rise marginally for low lying properties to be at risk of inundation.

Predictions estimate that for sandy beaches the coastline could retreat 50 – 100 times the distance of the vertical sea level rise (Australian Greenhouse Office, 2007). This sandy beach shoreline recession would also be exacerbated by the expected increase in severe weather events (e.g. - storm surge), to make the threat of inundation for relevant foreshore properties within the study area even more severe. Areas with stable rocky shores will not experience the same shoreline recession, however the frequency of rock falls may increase and the width of the intertidal rock platforms will decrease as the sea migrates inland (Manly Council Scientific Advisory Panel, 2005).

Temperature increases will affect the ability of some ecosystems to function as they currently do. Slight increases in temperature may be enough to change the balance of some vegetation communities, which can then have flow-on effects to the entire surrounding ecosystem. The temperature increases will also affect water availability. Changes in rainfall are expected, and with higher evaporation demand (due to increased temperatures) this will lead to a tendency for fewer run-offs into waterways (Hennessy *et al.*, 2006).

Although there will be a net decrease in water run-off into waterways, the increase in extreme weather events means that the rainfall we do receive will be more intense, and is predicted to lead to more frequent flash flooding, erosion and strains on water infrastructure. The stormwater system is under capacity now, and is broadly designed to cope with 1 in 20 year storms, but these same storms may become as frequent as 1 in 7 year events. Sewer overflows will also become more frequent as a result of the higher intensity storms. Again it will be the low lying parts of the study area that will be most affected by this impact (Manly Council Scientific Advisory Panel, 2005).

Patterson & Britton (2004) have calculated shoreline recession resulting from sea level rise using the “Bruun Rule”, as described in **Section 6.2**. In essence, the shoreline recession allowance is calculated by multiplying the predicted sea level rise amount by the slope of the active beach profile.

For Fairlight and Delwood Beaches, the slope of the active beach profile has been conservatively estimated to be 18 and 8 respectively. Accordingly, the shoreline recession allowances for 50 year and 100 year planning time frames for these beaches are summarised in **Table 7.4**.

Table 7.4. Estimation of Shoreline Recession allowances for beaches within the study area.

Location	Planning Period (yrs)	Sea Level Rise (m)*	Shoreline Recession Allowance (m)
Fairlight Beach	50	0.19	4
	100	0.47	9
Delwood Beach	50	0.19	2
	100	0.47	4

* Mr. Mark Moratti, DECC, based on available information in 2003.

The shoreline recession allowances in **Table 7.4** are additive to the shoreline recession allowance due to sediment loss in severe storms discussed in **Section 6.2**, i.e. 0.04 m/yr recession for Fairlight Beach and 0.0 m/yr movement for Delwood Beach. Accordingly, the predicted overall loss in beach width over the next 20 to 50 years due to sediment loss in severe storms and accelerated sea level rise is in the order of 3 to 6m for Fairlight Beach and 1 to 2 m for Delwood Beach. These values are expected to be conservatively high.

As Fairlight and Delwood Beaches currently have widths, measured at mean sea level, of approximately 15 and 8 m, respectively, the effects of severe storms and sea level rise could cause significant loss of the beach width over the 20 to 50 year time frame. The loss of beach width would lead to a greater risk of damage to the existing seawall at Fairlight Beach during severe storms and would also impact adversely on beach amenity.



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Monitoring of the Fairlight Beach seawall and monitoring of beach width is recommended. Should the reduction in beach width become a concern in regard to increased risk of damage to the seawall, several options are available:

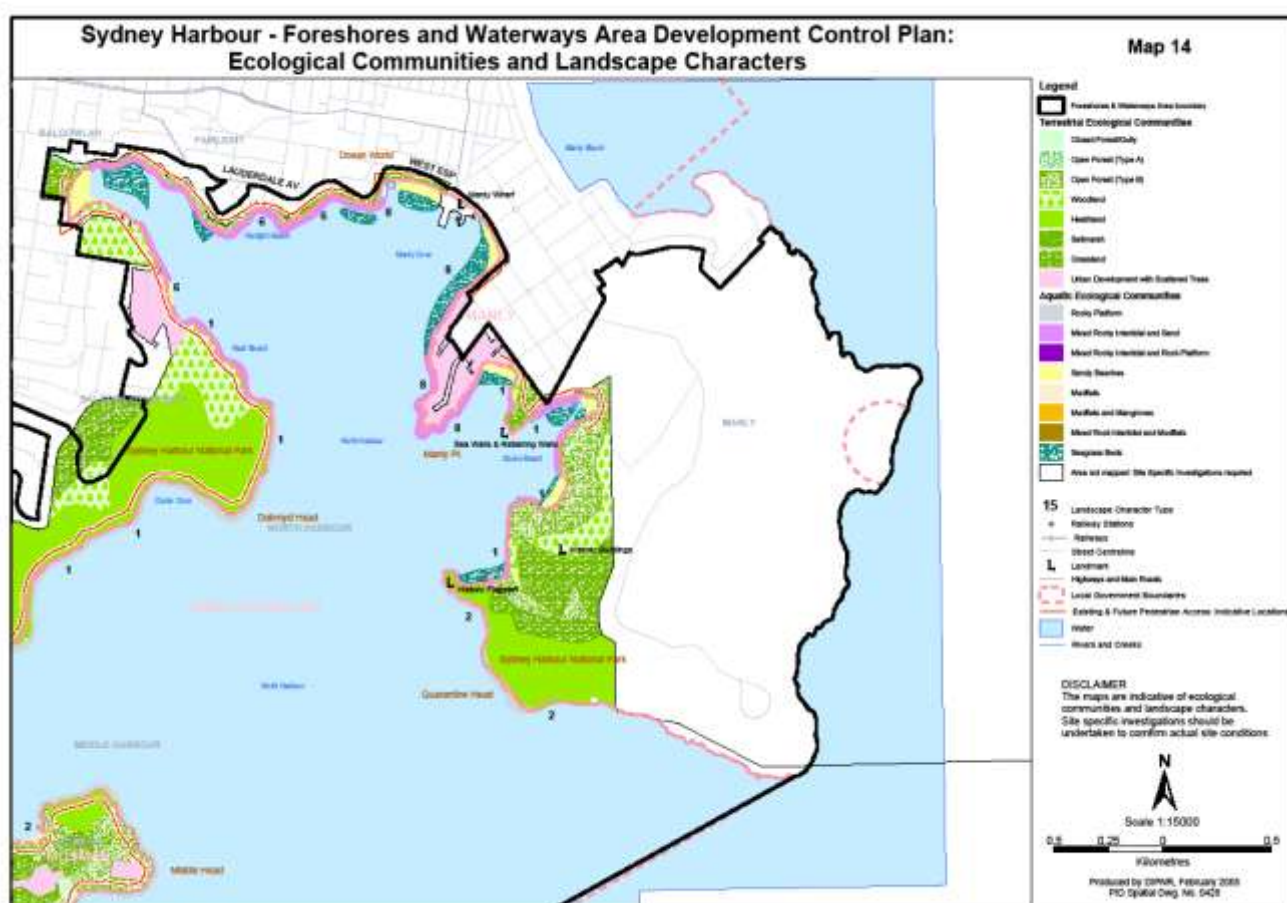
- do nothing, and repair/reconstruct the seawall in the event of damage;
- undertake stabilisation works to prevent or minimise damage to the seawall in the event of a severe storm;
- undertake beach nourishment to restore the volume of sand on the beach so that the seawall would not be damaged in the event of a severe storm.

The last option has the advantage of also improving beach amenity, should the reduction in beach width due to shoreline recession also become a concern in this regard.

8. ECOLOGICAL ENVIRONMENT

The ecosystems within the study area are highly fragmented and likely to only represent a selection of the ecosystem/habitat types that would have been present prior to development of the area. The different habitat types have signs of the many pressures placed on them through development and high usage. **Figure 8.0** (below) provides an overview of the ecological communities present within the study area, while the following sections look at each component in more detail.

Figure 8.0 Overview of Ecological Communities within the Study Area



Source: Department of Planning, 2005

8.1 MARINE ECOLOGY

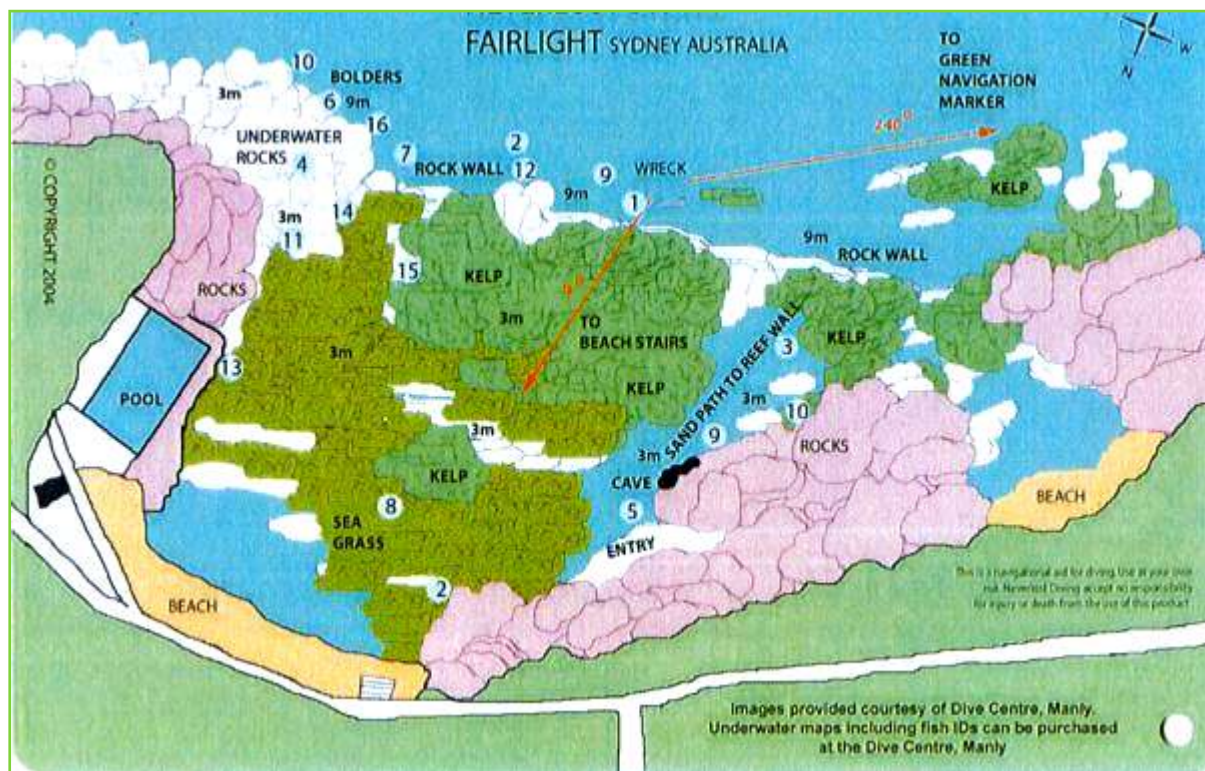
North Harbour exhibits a diversity of habitat with a wide range of substrata, vegetation, depths, exposures and their combinations with aquatic plant communities being among the most abundant and conspicuous habitats of sub-tidal reefs in Sydney Harbour (Fig 8.1).

Sydney Harbour is subject to a variety of stresses from human activities that have the potential to decrease species diversity and abundance. Understanding the various physical and biological processes that influence the structure of marine ecosystems in the study area is important, therefore, because it will allow for improved predictions on the changes that are likely to occur under certain conditions and allow managers to make informed decisions about the conservation and management of these systems.

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Very few published studies have been undertaken to describe and assess the ecological characteristics of these waters. Those studies that have been undertaken are specific to assessing particular aspects of the marine environment or the impact of a particular activity on the area's aquatic ecology.

Figure 8.1: Underwater reef structure in front of Fairlight Beach



It is important to note that the management of the area's marine ecology is primarily the responsibility of Department of Primary Industries. Council's control over aquatic issues is therefore limited to the impact that the Local Government Area has on the marine environment and the important regulatory and educational role.

8.1.1 Habitat & Flora

North Harbour houses a diverse marine environment which ranges from rocky intertidal zone to the seagrass beds. Three predominant aquatic communities were classified along the foreshore of the study area; 'mixed rocky intertidal & sand', 'sandy beaches' and 'seagrass beds'. The conservation status of these three ecological units is 'high', 'medium' and 'high' respectively as described in Table 8.1.1.

Table 8.1.1 Conservation status of ecological communities in North Harbour

Habitat	Description	Conservation Status
Mixed Rocky Intertidal & Sand	Intertidal rock shelf gradually changing into a sub tidal sandy beach away from the shoreline.	High
Sandy Intertidal	Sandy beach occupying both intertidal and sub tidal.	Medium
Seagrass Beds	Seagrass beds in intertidal and sub tidal areas. Well defined from surrounding unvegetated areas. A number of species of seagrasses occur and these form several types of seagrass communities.	High

Source: Dept of Planning 2005

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Mixed Rocky Intertidal

Rocky shores provide, on a very restricted spatial scale, an enormous diversity of plants and animals living in close proximity while being subjected to obvious patterns of physical and environmental factors. In the management of such environments it is important to understand the complex interactions occurring between species known to colonise this habitat type. The reefs provide valuable shelter, such as caves and crevices, and also a food supply, for various marine species. Crustaceans and invertebrates live on the rocks, and fishes that feed on them live in the surrounds. These rocky areas also contain patches of kelp beds, which provide vertical underwater structure and much valuable habitat and also a source of food for certain marine species. Kelp is a form of macro-algae, with anchors to hold it onto the rocks rather than a formal root system.



Rocky foreshores also provide an important recreational resource for many visitors and residents. The foreshores are predominantly made up of intertidal wavecut platforms composed of the Hawkesbury Sandstone formation forming extensive horizontal surfaces that suit many species of intertidal flora and fauna.

Sandy Beaches

Sandy beaches, such as those in Fairlight, Dalwood and the western tip of North Harbour, occupy a dynamic position between sea and land. Despite lack of site specific data, such environments are known to hold a large number and diversity of animals such as crabs, pipis and worms living in or on the upper sand layers. A large number of microscopic animals live between the sand grains. Few attached plants are found in these environments due to the dynamics of sand movement and the lack of protection from wave energy.

Upper Beach Zone: The upper intertidal zone is the most terrestrial of the beach environments and, therefore exhibits the widest variation of heat and cold. As a result, desiccation is a significant problem for marine organisms in the summer and cool temperatures a problem in the winter. Fresh water, both surface water from rainfall and subsurface flow, can also impact populations. Because of the limited inundation time, marine food resources are limited.

In times of rough weather, dislodged seaweed is often found to accumulate in the upper beach zone. These seaweed deposits, also known as wrack, provide important ecological functions through the provision of shelter and food as well as in the nutrient cycle. A recent study confirmed that wrack represents a vital link in a complex food chain based on near shore primary production so its accumulation is important to beach and near shore communities (Fairweather & Henry 2003). Most wrack is returned to the sea by high tide with the remainder entering interstitial and macro-faunal food chains. The wrack that is returned to the surf zone off a beach can provide important shelter and indirect food source for juvenile fishes. It provides food for semi-terrestrial crustaceans and insects, washed up carrion is important for aquatic crustaceans and scavenging gastropods and filter feeders rely on suspended particles and surf-zone diatoms (Brown & McLachlan 1990). The dry upper beach zone is typically inhabited by several species of amphipods, isopods, insects and ghost crabs (Brown and McLachlan 1990, in Barros 2001).

Mid Zone: The mid-littoral zone is characterized by a moderate inundation time, but is subject to many of the same rigors as the upper zone (temperature extremes, fresh water). The mid zone is more subject to rapid sediment removal during winter storms, requiring extreme mobility of its fauna.

Swash Zone: The swash zone, where wave breaking and run-up often occurs, is characterized by the highest water movement, so consequently has a high degree of mechanical stress. It remains inundated over half the time, and so is less subject to extremes of temperature and salinity. The number of species and abundance of individuals has been found to be greater in the swash zone than upper areas of the beach (James and Fairweather, 1996). Debate exists as to whether there are unique assemblages of species in different parts of



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the swash zone or whether the whole assemblage simply alters position with the tide. Physical and chemical factors are thought to explain many patterns observed for in fauna on beaches and predation is claimed to be the most important biotic factor (Reise 1985, in Jones and Short 1995).

Low Intertidal: The low intertidal zone, extending into the shallow sub tidal, is almost fully marine, being aerially exposed for short periods only on the lowest tides. The low intertidal is subject to almost constant wave action, requiring that the inhabitants be either rapid burrowers or protected against mechanical damage. It houses the most diverse faunal assemblage of the beach zones.

Seagrass

Seagrass is a flowering plant that provides food and shelter that is critical to the survival to a wide range of aquatic biota. Under the *Fisheries Management Act, 1994*, all seagrass is protected, and must not be damaged or collected (NSW DPI, 2007).

Seagrass beds provide extremely important aquatic habitat by providing food and shelter for a variety of juvenile fish and invertebrate species, many of which settle into seagrass beds at the end of their planktonic stage. Many such species are of considerable value to recreational and commercial fishing industries.

Seagrasses grow fast, producing a great amount of organic material with a single hectare of seagrass meadow producing up to 20 tonnes of leaf material each year (NSW DPI). The main grazers of seagrasses in temperate regions are sea urchins and small crustaceans. However, most of the organic material produced by seagrasses enters the food chain as particle-sized detritus through the breakdown of organic material and subsequent consumption by various organisms.

This breakdown of organic matter also drives nutrient cycling which promotes the growth of bacteria and protozoans which in turn are consumed by planktonic invertebrates with biomass being transferred as animals higher in the food chain feed on this food source. The surface of seagrass leaves and stems also provide opportunities for colonization by epiphytes which are plants which grow on the surface of other plants. Epiphytes themselves are then grazed upon by a variety of fish and invertebrate species (NSW DPI, 2006).

Seagrass Species & Distribution

Seagrass beds are found within the study area growing in shallow sub tidal areas along the foreshore, in depths where sunlight is available for photosynthesis. Of the 6 species known to colonise the NSW coast two native species of seagrass have been identified within the study area, these being:

- *Posidonia australis* or strapweed is the largest with straplike leaves, 6-14 mm wide and 30-60 cm long;
- *Zostera capricorni* or eelgrass which has narrower straplike leaves, 1-5 mm by up to 50 cm; and

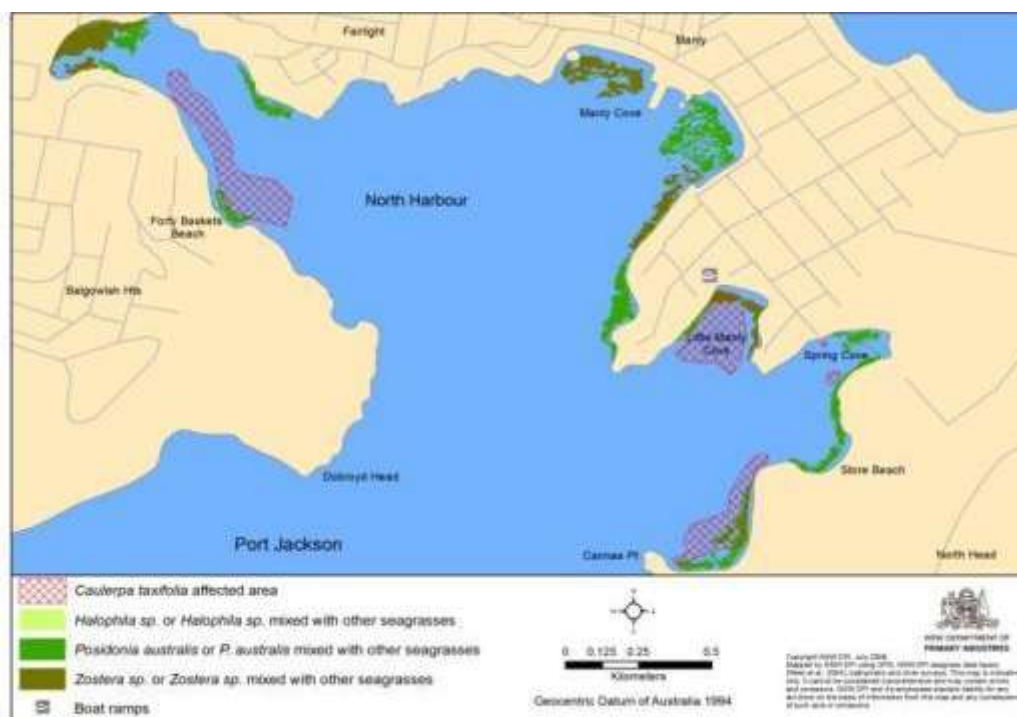
The total seagrass bed within the study area is 2.79ha. Seagrass beds exist in front of North Harbour tidal flat and also in areas between the Manly Boatshed and southern tip in front of Esplanade Park (Figure 8.1.1a).

Anecdotal evidence, received from sources such as Manly Environment Centre, suggests large losses in seagrass in the area. In the early 2000s, an interim statement on changes in the cover of seagrass for some NSW estuaries was generated. Of the 22 estuaries for which data were produced, large losses were seen in nine and small losses in six, while large gains and small gains were found in three and three estuaries, respectively. It is evident that seagrass is variable in its cover, with extent expanding or contracting over time and/or disappearing from one site and being found at an adjacent one. Similar factual information of North harbour seagrass area is absent. However West & Williams (2008) have mapped lands suitable for seagrass beds within North Harbour. This area is undoubtedly larger than the existing coverage.

Seagrasses are fragile ecosystems which can be easily destroyed. The re-establishment of seagrasses following disturbance can vary between seagrass species. In particular, the re-establishment of the slow growing, in-frequently seeding *Posidonia australis*, is very slow.

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Figure 8.1.1a: Distribution of seagrass and *Caulerpa taxifolia* areas in North Harbour in 2003-06



Caulerpa taxifolia

In 2003 *Caulerpa taxifolia* was identified in the waters of Sydney Harbour including a number of locations within North Harbour (Figure 8.1.1a). It must be noted that the distribution and density of *Caulerpa* can change markedly over time, either expanding or contracting.

Caulerpa taxifolia is a green alga with regularly-spaced feather-like fronds growing along a running stolon that is attached to the bottom. The fronds vary in length but can reach 60 cm or more. It can colonise most kinds of substrates including rock, sand, mud and seagrass beds. It has been found in depths ranging from less than 1 m to over 100 m and is capable of rapid growth.

Caulerpa taxifolia is normally only found in warm tropical waters. It has been widely used as a decorative plant in the marine aquarium trade. The 'aquarium strains' can invade cool temperate waters, and *Caulerpa taxifolia* has become established in several waterways along the NSW east coast. Research by NSW DPI has indicated that the strain of *Caulerpa* found in NSW is the same (as far as anyone has been able to demonstrate so far) as that occurring naturally in coastal Queensland.

Reproduction of the invasive strain is asexual and dispersal occurs through fragmentation. It has been demonstrated in laboratory experiments that a fragment as small as 1 mm can settle and start growing. Growth rates are greatest in the summer months and lowest during winter.

Caulerpa taxifolia has been declared a Class 1 noxious species under the *Fisheries Management Act 1994*. It is illegal to possess or sell the seaweed; and fines of up to \$11,000 apply. The noxious listing also provides NSW DPI with the power to seize and destroy *Caulerpa taxifolia*, or require its destruction.

Management of *Caulerpa taxifolia* in Sydney Harbour

It is usually extremely difficult to eliminate aquatic weeds once they have become established. It is therefore vital to prevent *Caulerpa taxifolia* from spreading further within and between waterways.

NSW DPI has trialled a variety of control methods, including dredging, smothering and applying salt and



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determined that for smaller infestations salt treatment is the most efficient control method. When swimming pool salt is put on *Caulerpa* the salinity rises to a point where the weed is killed in a matter of hours. A major limitation to the technique, because *Caulerpa* reproduces asexually from tiny fragments, is that salting needs to kill all fragments in order to eradicate the seaweed.

In response to the identification of *Caulerpa taxifolia* within North Harbour, NSW DPI has undertaken initial salt treatment work to contain the invasive species, however they have reported that isolated plants and small patches of *Caulerpa* may still exist in the area. Handpicking has not proved an effective treatment method due to the potential for dispersal and colonisation of fragments during the activity and the time intensity required undertaking the exercise.

At this stage no fishing or boating restrictions have been gazetted for areas within North Harbour, however users are recommended to:

- Avoid boating near *Caulerpa taxifolia* outbreaks. Propellers cut the plant into many fragments that can drift into areas only to grow into new outbreaks.
- Inspect anchors, ropes and chains before leaving an area.
- Inspect fishing equipment; nets, traps and fishing lines before use.
- Inspect dive gear such as wetsuits bags and other equipment before use.
- Collect fragments of *Caulerpa* you have accidentally picked up. Seal the pieces in a plastic bag and dispose of them in a bin where they cannot re-enter a waterway.
- Collect information on where you have seen *Caulerpa*. Accurate maps, size of the outbreak, depth, habitat type (seagrass, bare sand, rocky reef) are important details.

In March 2004 Department of Primary Industries (NSW DPI) adopted a *Caulerpa* Control Plan, which is being implemented in association with relevant agencies and the Local government. NSW DPI is currently reviewing this plan to reflect the Department's current knowledge of *Caulerpa*, and management directions for the prevention of further spread of this species. The application of salt negatively impacts *Posidonia*, a native seagrass, and so it is not possible to apply salt to *Caulerpa* which invades *Posidonia* (DPI 2008).

Contrary to initial public concern and media reports from the Mediterranean, NSW DPI research has to date found minimal effects of *Caulerpa* on seagrasses. Research on the effects of *Caulerpa* on fish populations (by the University of Technology in conjunction with NSW DPI) indicates some differences in the types of species in *Caulerpa* compared to native seagrasses (*Posidonia* and *Zostera*), with seahorses and pipefishes being rare in *Caulerpa* compared to seagrass. Work done by researchers at other NSW universities indicates that *Caulerpa* may have some negative effects on the reproduction and distribution an estuarine cockle. No large-scale impacts of *Caulerpa* on marine biodiversity have been documented in NSW or elsewhere. All these factors make it difficult to justify a large-scale control program for *Caulerpa* in NSW. Consequently, NSW DPI has shifted the focus to small-scale control work, vector management, community education and ongoing research.

Ongoing monitoring and maintenance of the weed along with the implementation of education programs targeting local boat and fishing enthusiasts will assist in the management of this introduced species. Council will endeavour to work collaboratively with the Sydney Coastal Councils Group, Department of Primary Industries, NSW Maritime and other key user groups to identify, develop and implement effective management strategies.

Kelp

Kelp (*Ecklonia radiata*) beds are present on rocky substrate on the eastern side of the study area through from Federation Point and extended southern tip in front of Esplanade Park. Rock/kelp occurs on 4.32 ha area within the study area (Figure 8.1.1b).

Kelp is known to anchor itself to rock substrata with a root-like organ, which differs to the roots of terrestrial plants. They form dense communities, sometimes called 'forests', and exhibit a distinct zonation. In the intertidal zone, green algae are predominant. Below this zone, brown algae are found. These include bladderwrack and knotted wrack, which rely on gas-filled pods for buoyancy and to stay upright in the water. Below the brown algae, red algae occur in the lowest intertidal zone, and far below them come the large kelp species such as blade kelp. Every algae zone is a distinct habitat type, with a typical assemblage of flora and fauna species.

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Kelp forests and beds are highly productive and provide a special habitat for a host of marine organisms. However, no more than an estimated 10% of the algae biomasses produced find its way into the food web via plant consumers. The vast majority only becomes available for consumption as detritus or dissolved organic matter (Hammond & Synnot, 1994). Marine pollution occurring from terrestrial and water based sources has caused a decline in species and promoted more resilient species to the detriment of others.

Figure 8.1.1b Distribution of Kelp areas in North Harbour



Beach Accumulation of Macro algae (Wrack)

Beach wrack is an important yet poorly studied component of marine ecology and greater effort is required to better understand the ecological effects of wrack on sandy beaches (Fairweather & Henry, 2003). Beach wrack is an essential component to a healthy and diverse sandy beach ecosystem, as it acts as a direct food source and shelter for many species living above the sand (and potentially fish) and provides nutrients to fauna living in the sand (The Ecology Lab, 2006).

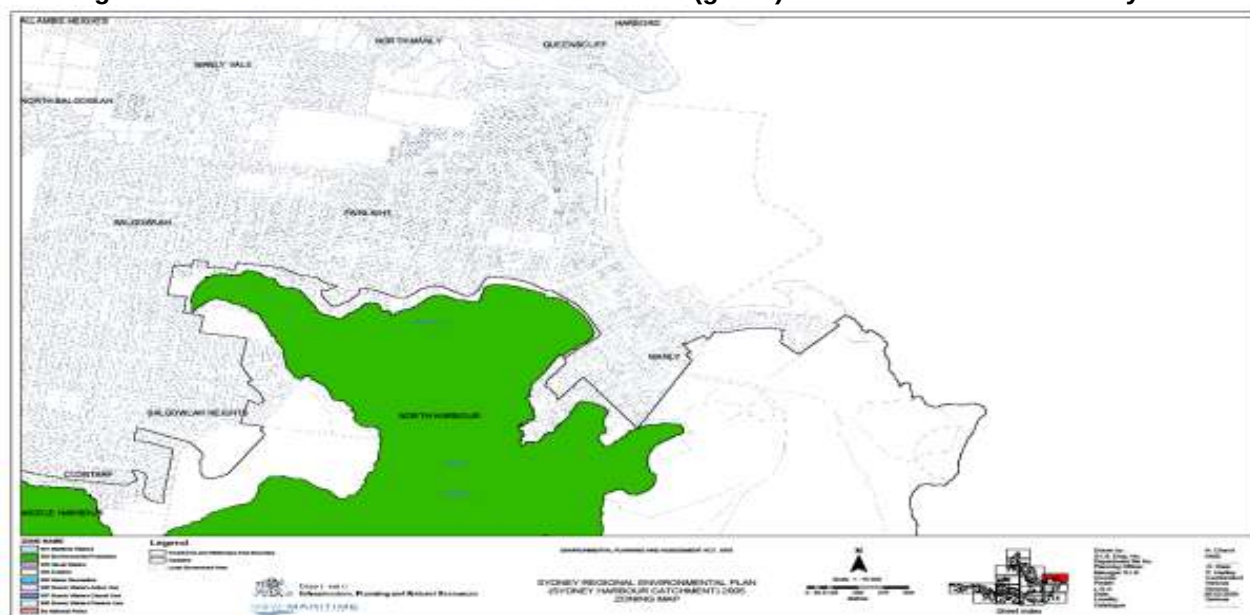
Wrack represents a vital link in a complex food chain based on near shore primary production so its accumulation is important to beach and near shore communities (Fairweather & Henry, 2003). Most wrack is returned to the sea by high tide with the remainder entering interstitial and macro-faunal food chains. The wrack that is returned to the surf zone off a beach can provide important shelter and indirect food source for juvenile fishes. It provides food for semi-terrestrial crustaceans and insects, washed up carrion is important for aquatic crustaceans and scavenging gastropods and filter feeders (clam *Donax*) rely on suspended particles and surf-zone diatoms. Freshly deposited wrack on a beach can be colonised by a number of macro-faunal species within 24 hours. Thus wrack is an essential component to a thriving and diverse sandy beach ecosystem attracting terrestrial and marine species.

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Environmental Protection Area

To protect the existing range of habitat available in North Harbour, the NSW State Government, under its Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005, has zoned large parts of the study area as Environmental Protection (Figure 8.1.1c). The aim of this zoning is to “provide for the protection, rehabilitation and long term management of the natural and cultural values of the waterways and adjoining foreshores (NSW Department of Planning, 2005).

Figure 8.1.1c The Environmental Protection Area (green) within North Harbour Study Area



Source: Department of Planning, 2005

Habitats on Artificial structures

A proportion of the North Harbour foreshore has been modified with seawalls and boatshed. Understanding the ecological role of artificial structures in shallow coastal waters is necessary in order to plan sound strategies of conservation and management of natural habitats (Bulleri *et al.* 2005).

Most traditional foreshore protection structures tend to be vertical, as opposed to natural shorelines, which tend to be flatter. As a consequence, traditional structures have very little intertidal area and the surfaces are often smooth, providing few different sorts of microhabitats (Chapman & Bulleri, 2003).

Previous research has shown that many animals found on rocky shores also live on seawalls. Some species, however, show differences in density and size between rocky shores and seawalls. Additionally, some animals, such as several species of sea anemones, whelks and starfish, are not found on seawalls. It is therefore reasonable to conclude that seawalls do not provide a suitable habitat for the whole suite of organisms living on natural rocky shores (Moreira, 2006).

Results of recent studies indicated that mid-shore assemblages on seawalls were different from those on rocky shores, but this was not the case at low-shore levels. Few taxa were unique to either habitat. Cover of common species of algae and sessile animals and abundances of mobile grazers were variable with few consistent patterns. Variability at the scales sampled differed between habitats and heights on the shore. Seawalls and rocky shores, in general, supported a similar suite of species, but patterns of abundance and variation differed among locations and from height to height in each habitat. The implications of these findings for the future management of seawalls must be considered in the development of this Plan.



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8.1.2 Fauna

The aquatic environment within the study area is home to an extremely diverse range of fauna despite the intensity of its usage. Sydney Harbour, despite its problems, is one of the world's richest and most diverse marine environments in an urban setting. Over 570 species of fish have been recorded in greater Sydney Harbour, and it is likely that a large proportion of these are also present within the study area (Australia Museum, 2007). The diversity is most likely due to the broad range of habitat that is available. Recently, Sydney Institute of Marine Sciences has observed Mourning Cuttlefish living in groups in about two meters of water, rare for cuttlefish (Smith 2008).

Appendix C1 details a species list that was prepared by the Australian Museum (2007) on the fishes found within Sydney Harbour. The list details out species for which the Australian Museum Fish Collection holds a specimen from Sydney Harbour. Although Sydney Harbour incorporates much more than just the study area, it is likely that many fishes from throughout the Harbour may at some stage be present within the study area. Hence, it has been included as a likely species list for the study area. It is worth mentioning here that (unlike many terrestrial species) there are no barriers to recruitment from other areas.

Appendix C2 details other fauna species (not just fishes) that have been recorded within the study area or Sydney Harbour. It is again assumed that species recorded in other parts of Sydney Harbour are likely to have at some stage visited the study area if their preferred habitat type is represented here.

The species present within the study area changes throughout the year. Many species will be present throughout the year; however some species will only be present seasonally. Whales, for example, will only be present at the start of winter when they pass Sydney on their way north to warmer waters, and at the start of summer, when they return south. Many of the pelagic species are also seasonal, with fish such as Kingfish preferring the warmer months, and fish such as Silver Trevally preferring the cooler months.

Threatened Species that have been recorded in the above-mentioned species lists are named below.

Endangered Species:

- Green sawfish (*Pristis zijsron*)⁶
- Grey nurse shark (*Carcharias taurus*)
- Dugong (*Dugong dugon*)

Vulnerable Species:

- Great White Shark (*Carcharodon carcharias*)
- Black Cod (*Epinephelus daemeli*)
- Australian Fur Seal (*Arctocephalus pusillus doriferus*)
- Sperm Whale (*Physeter macrocephalus*)
- Humpback Whale (*Megaptera novaeangliae*)

Protected Species:

- Seahorse (*Hippocampus* sp)
- Big belly Seahorse (*Hippocampus abdominalis*)
- White's Seahorse (*Hippocampus whitei*)
- Crested Pipefish (*Histiogamphelus briggsii*)
- Girdled Pipefish (*Festucalex cinctus*)
- Hairy Pipefish (*Urocampus carinirostris*)
- Javelin Pipefish (*Lissocampus runa*)
- Mother-of-Pearl Pipefish (*Lissocampus runa*)
- Ornate Ghost pipefish (*Solenostomus paradoxus*)
- Red Pipefish (*Notiocampus ruber*)
- Robust Ghost Pipefish (*Solenostomus cyanopterus*)
- Sawtooth Pipefish (*Maroubra perserrata*)
- Spiny Pipe horse (*Solegnathus spinosissimus*)

⁶ According to NSW DPI, this is listed as 'Presumed Extinct'

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- Spotted Pipefish (*Stigmatopora argus*)
- Stick Pipefish (*Trachyrhamphus bicoarctatus*)
- Tiger Pipefish (*Filicampus tigris*)
- Upside Down Pipefish (*Heraldia nocturna*)
- Wide-body Pipefish (*Stigmatopora nigra*)

8.1.3 North Harbour Aquatic Reserve

Aquatic reserves have been established to protect biodiversity and provide representative samples of varied marine life and habitats. New South Wales currently has 12 aquatic reserves declared under the *Fisheries Management Act 1994*. Although aquatic reserves are generally small compared with marine parks, they play a significant role in the NSW marine protected area system. Apart from protecting important habitat, nursery areas and vulnerable and threatened species, aquatic reserves also have valuable research and educational roles. Community involvement is critical in the management of aquatic reserves. Through public involvement in management planning processes, the government seeks to achieve community partnership in these important places, providing ongoing protection for the future.

North (Sydney) Harbour Aquatic Reserve lies between an imaginary line from the headlands at North Head and Grotto Point and another line joining Little Manly Point, Manly Point and Forty Baskets Beach (Figure 8.1.3). The reserve extends from the seabed at these outer boundaries up to the mean high water mark between them and covers an area of approximately 260 hectares.

At the Ordinary Meeting of 17 March 2008, Manly Council moved a resolution to extend the boundaries of the North Harbour Aquatic Reserve to include both Little Manly Cove and North Harbour (Figure 8.1.3). A formal proposal has now been submitted to DECC for its review and approval.



Figure 8.1.3 North Harbour Aquatic Reserve



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The reserve's intertidal rock pools provide homes for many invertebrates, including anemones, worms, sponges, shrimps, crabs and molluscs. Sheltered bays and inlets provide seagrass and algal habitats for species, including seahorses and sea dragons. In summer, tropical fish are a common sight, carried from the Great Barrier Reef by the East Australian Current. The rocky reefs and kelp are also home to both invertebrates and fish. Read about the marine life of Sydney's rocky shores.

Within the reserve, line fishing is allowed only for fish with fins. Otherwise, the collection or disturbance of marine life or habitat is prohibited. This includes collecting shellfish, pumping for worms, spear fishing and collecting dead or empty shells.

Baseline data on diversity and abundance of marine and estuarine species within the Reserve can be viewed at: <http://www.urgdiveclub.org.au/Research/NHARProject/tabid/71/Default.aspx>

The NSW Department of Environment and Climate Change (DECC) is responsible for the administration and management of all Aquatic Reserves.

8.2 INTERTIDAL ECOLOGY

This refers to:

1. the area between the mean high water and mean low water marks, and
2. flora and fauna that occurs in both the marine and terrestrial environment

8.2.1 Habitat & Flora

The intertidal area within the study area has a range of habitats, which play a vital role in the overall ecosystem.

The rocky habitat, mentioned in section 8.1.1, extends in parts into the terrestrial zone, creating an intertidal zone in between. This rocky intertidal zone is an exceptionally harsh environment, with organisms having to tolerate long periods of drying under the full summer sun, large changes in salinity levels as rock pools full of salt water dry up or are flushed with rainwater, and perhaps even frosts in winter (Edgar, 2001).

The rocky outcrops and headlands are predominantly sandstone and shale, with a mixture of flat shelves and boulders. Despite the harsh environment, the weathered sandstone, with its many cracks and crevices, along with the boulders and flat surfaces, provides significant habitat for many intertidal species. Many types of algae (e.g. - red, green, brown) also inhabit the intertidal zone, providing a food source for the many grazing invertebrates. These algae generally differ from those in the marine zone, as they are never submerged to any great depth, and hence do not grow as tall. Encrusting algae that form dense mat-like layers over the surface of rocks are very common (Edgar, 2001).

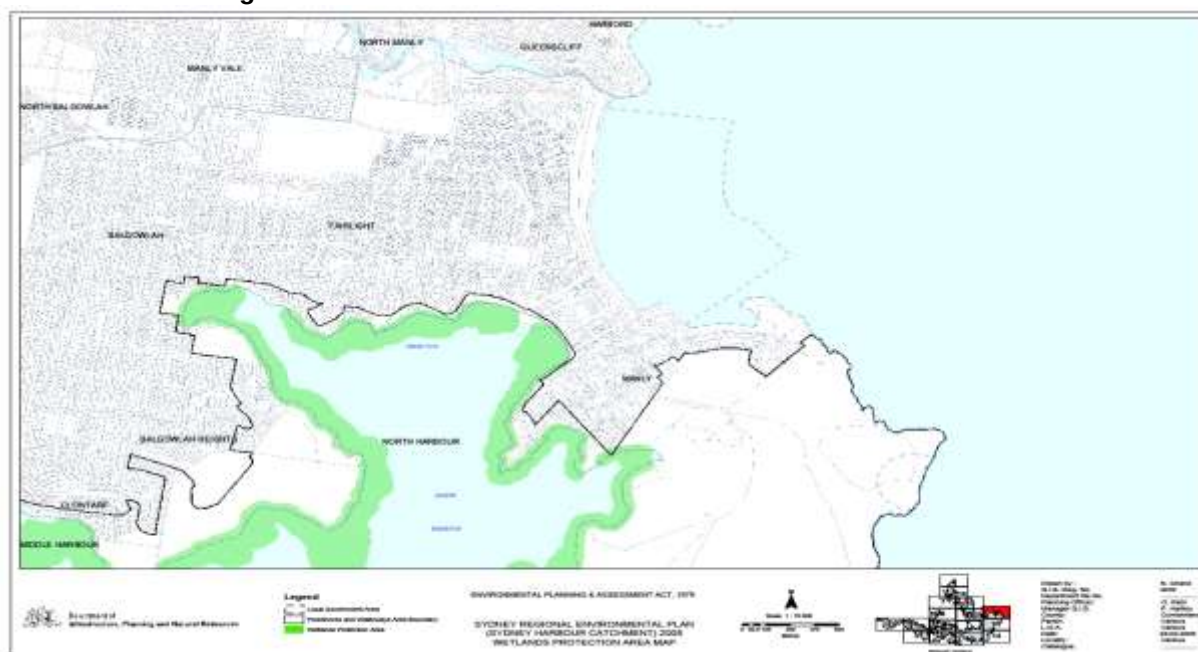
The sand flat at the tip of North Harbour provides extensive areas of habitat, with the steeper sandy beaches, Fairlight and Delwood beaches providing smaller areas of similar habitat. The many layers of sediments within sandy flats and beaches, and the resulting changes in amounts of organic material, moisture, oxygen levels and bacteria, provide a range of habitat in what often appears to be a barren environment. Numerous types of invertebrates, such as worms, crabs and molluscs, can be found in the sediment. Some are surviving through filtering food from their surrounds and others through predation. Washed up seaweed and seagrass are extremely important on sand flats and beaches, with many invertebrates at the base of the food chain dependant on it as a source of food for survival (Edgar, 2001).

Although the extent of wetland habitat in the study area is limited, large areas have been designated as Wetlands Protection Area (WPA) by the NSW State Government (Figure 8.2.1). This area is designed to allow for future growth, as well as preserving and protecting the existing population (NSW Department of Planning, 2005).

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Though the entire foreshores of the Sydney Harbour and its all tributaries are protected as Intertidal Protected Area (IPA)⁷ under the Fisheries Management Act, 1994, waters of North Harbour which are north of a line from Manly Point to the South end of Forty Baskets beach are excluded.

Figure 8.2.1 The Wetlands Protection Area in North Harbour



Source: Department of Planning, 2005

8.2.2 Fauna

Information on flora within the intertidal zone of the study area is extremely limited, although information about fauna in the general North Harbour intertidal zone provides some detail. Table C5 in the Appendix lists species that are known to be present in or directly adjacent to (and hence expected to also be in) the study area. The majority of these species are invertebrates. There are also likely to be many species that live in the sediments of the beaches and sand flats (see section 8.2.1) that are not represented within the list. The majority of these species are also invertebrates, ranging from those visible to the naked eye, to microscopic species. Although they are not represented in the species list, they are extremely important to the ecology of the intertidal zone (Edgar, 2001). A small colony of soldier crabs is located on the sand bank at the far south west end of North Harbour. This colony surfaces one or two days each year. However, pedestrians and dogs are threat to these soldier crabs. Mud flat, before it was reclaimed as the North Harbour Reserve in 1938, was a well-known habitat of the little soldier crabs (Wellings 1950).

The Little Penguin is included in this list, as it feeds in the estuary during the day and nests on land during the night. It is unknown whether the Little Penguins that are often sighted near Treharne Boatshed (as per community consultation for the CMP) are from the Endangered North Head Population, or whether they are separate and nesting somewhere in North Harbour.

⁷ The IPA extends from the mean high water mark to 10 metres seaward from the mean low water mark, and collecting seashore animals is strictly prohibited in this area (DPI, 2007). IPA's are created to protect selected rocky habitats and intertidal species, and aim to:

- protect intertidal community biodiversity and structure;
- provide biological reservoirs of breeding stock so exploited areas nearby can be recolonised or sustained; and
- help ensure harvesting of intertidal invertebrates is undertaken at sustainable levels.



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The fauna in the intertidal zone plays an extremely important role in the greater ecosystem. Invertebrates on the rocks feed on the surrounding algae, ensuring it does not over colonise, while they provide a food source for many marine fishes at high tide. Invertebrates within the sand on beaches and flats clean the sand by filtering it for food, and again themselves provide a food source for marine fishes at high tide. Both of these groups of invertebrates also provide a vital source of food for terrestrial fauna, such as wader birds.

8.2.3 Federation Point Wildlife Protection Area

In response to community concern, requests from the Department of Environment and Climate Change (DECC) and Council's responsibility for the conservation of Manly's Endangered Population of Little Penguins, Council designated the foreshore area of Federation Point a Wildlife Protection Area (WPA). The WPA includes the rocky foreshore area from the mean high water mark landward to the cliff top and extends from the tip of Federation Point east along the foreshore behind Manly Pier Restaurant.

Administered under the *Companions Animals Act 1998*, the designation of the WPA precludes dogs and cats from the foreshore. To coincide with the designation of the WPA the stairs and boardwalk/walkway around to Ocean World has been made a dog 'on leash area'. Signage has also been installed.

8.3 TERRESTRIAL ECOLOGY

8.3.1 Habitat & Flora – Urban Bushland

Manly has a rich diversity of natural landscapes protected in around 55 hectares of bushland reserves, ranging in size from Wellings Reserve (7 hectares) to Fisher and Geddes which is about the size of an average house block. Manly's bushland contains a variety of vegetation types, supporting a wide diversity of native plants, mammals, birds and reptiles. In addition to the biodiversity values of Manly's bushland, these areas are valuable resources, providing residents and visitors with:

- areas for recreational use
- a better urban environment in which to live
- habitat for native birds and animals
- preservation of native flora
- an educational resource

Nearly 90% of Manly's natural environment has been degraded to some extent due to human activities (Manly Council 1997). The impacts of urban development can tip the balance - native vegetation is gradually replaced by weeds, resulting in a loss of biodiversity. Some of the impacts and causes of degradation in urban bushland are:

- increased levels of high nutrient stormwater runoff entering bushland, creating ideal conditions for weed growth
- dumped garden refuse and rubbish.
- altered fire regimes - some native plants rely on fire for regeneration
- urban encroachment on reserves
- the impact of domestic pets on flora and fauna
- poisoning trees for views

The fragmentation of natural bushland areas in Manly has reduced the viability of habitat in many bushland reserves to support populations of native flora and fauna.

Skelton *et al.* (2004) classified and named all bushland reserves in Manly in a report, titled *Flora and Fauna: Manly Councils Bushland Reserves* and for simplicity these names have been adopted for the relevant reserves within the North Harbour study area.

Bushland reserves occur in a total 9.93 hectares and are scattered throughout the study area. Smaller patches on both public and private land do exist throughout, and often act as corridors between the reserves.



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According to Skelton *et al.* (2004), there are extensive shelter resources available for fauna within the reserves. These include: tree-hollows and stags; canopy foliage; groundcover vegetation; leaf litter; logs; woody debris; rock outcrops; dense shrubs and thicket; cliff lines and sandstone rock features; creek lines; and seeps.

Skelton *et al.* (2004) indicates that there are four specific vegetation communities present within the study area reserves, which can be grouped into two broad types of vegetation communities. The communities described are largely based on a classification system developed by Benson and Howell (1994), but were modified slightly by Skelton *et al.* (2004) to suit local conditions in Manly. The vegetation communities contain an array of different species. This range of communities offers a range of habitat, which provides suitable conditions for many different species of fauna. They are detailed in Table 8.3.1a.

Table 8.3.1a - Vegetation Communities within the North Harbour Study Area	
Subcategory Description	Broad Vegetation Community
Low Open-forest of <i>Casurina glauca</i> and <i>Baumea juncea</i>	Estuarine Complex
Coastal Banksia - Eucalypt Woodland	Sydney Sandstone Gully Forest
Creek line Rainforest	Sydney Sandstone Gully Forest
Woodland/Low woodland: <i>Corymbia gummifera</i> - <i>Eucalyptus haemastoma</i>	Sydney Sandstone Ridgetop Woodland
Source: Skelton <i>et al.</i> 2004	

A combined native and exotic flora species list for all of the reserves and communities in the study area is presented in Appendix B (Tables B10, B11). A total of 196 native and 139 exotic species have been identified (Table 8.3.1b).

Table 8.3.1b: Total number of species per habitat type located within the North Harbour study area

Vegetation Type	Native	Exotic
Fern	14	1
Grass	13	13
Grass Tree	3	0
Herb	36	56
Palm	1	2
Rush	4	0
Scrambler	1	1
Sedge	11	0
Shrub	65	31
Tree	35	23
Vine	13	12
Total	196	139

Further information on the vegetation communities and the flora species specific to each reserve within the study area can be found in section 8.3.2.

Threatened Flora species

The term 'threatened species' describes plant species listed as either vulnerable or endangered on the Schedules of the NSW *TSC Act 1995* and/or Commonwealth *EPBC Act 1999*. There are no endangered plant species but two vulnerable plant species (*TSC Act 1995*, *EPBC Act 1999*) were recorded.

Scientific name	Common Name	Status*	Reserve (s)
<i>Eucalyptus nicholii</i>	Narrow-leaved Peppermint	TSC 2	Nolan Bush
<i>Syzygium paniculatum</i>	Magenta Lillypilly	TSC2	Fisher and Geddes Reserve, West Esplanade Park

*TSC2 = Vulnerable, *TSC Act 1995*



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SEPP 19 Bushland

SEPP No. 19 - Bushland in Urban Areas is one of State Environmental Planning Policies (SEPPs) which operate under the *EP&A Act*. The general aim of this policy is to protect and preserve bushland within the Greater Sydney area. It requires that bushland not be disturbed without the consent of Council. The SEPP also provides for the preparation of management plans for SEPP 19 Bushland. This Policy is integrated into Council's Development Application process. The following two reserves within the study area have the State Environmental Planning Policy No.19 (SEPP 19) status:

- Nolan Bush (3.00 ha)
- West Esplanade Park (4.71ha)

Skelton *et al.* (2004) classified additional two reserves within the study area that meets the definition of SEPP 19 status and recommended formalisation of their approval. These are Bareena Park Bushland (0.21ha) and part of Heathcliff Reserve (0.37ha).

8.3.2 Parks & Reserves

Parks & reserves within the study area (Figure 8.3.2) are described below, following Skelton *et al.* (2004):

Nanbaree Reserve (0.62ha): The reserve is long and narrow in shape and does not support representative natural bushland, but contains a number of planted trees with a grassy understorey. The reserve retains its natural landform, consisting basically of a natural drainage line. The reserve contains a number of park benches and stormwater drain entry points. There is also children's playground area and swing set. The vegetation in this reserve is open parkland and consists mostly of planted species. The vegetation has been highly modified. A total of 9 bird species, 3 mammal, 3 native species of reptile and no amphibians recorded in this reserve. The main native canopy trees are *Melaleuca quinquinervia*, *Casuarina glauca* and *Eucalyptus sclerophylla*. Individuals of *Eucalyptus nicholii* were recorded in this reserve. This species is listed as vulnerable on the *TSC Act 1995*. Nutrients from dog faeces and litter are threats to this bushland.

North Harbour Reserve: The reserve is an open grassy area with mature exotic and native trees used for active and passive recreational activities. The Reserve was reclaimed on a tidal flat during the mid 1930's by the construction of a sandstone retaining wall and landfill. Further details are elaborated in 9.3.1

Nolan Bush Reserve (3.0ha): The bushland has a large edge: area ratio. The reserve is characterised by a shallow soil layer, sandstone platforms and outcrops and low soil phosphorus. The vegetation is coastal heath and is close to other remnant bushland and Tania Park. A total of 1 amphibian species, 16 bird species, 4 mammal and 5 native species of reptile recorded in this reserve. Red-Crowned toadlet (vulnerable, *TSC Act 1995*) and Grey-headed Flying Fox (vulnerable, *TSC Act 1995* and *EPBC Act 1999*) have been recorded in this reserve. *Lomandra brevis*, a rare small grass-like herb, occurs on the site. The average canopy height is 3m. Increased soil nutrients levels, weed infestation, dumping and feral animals are threats to this bushland.

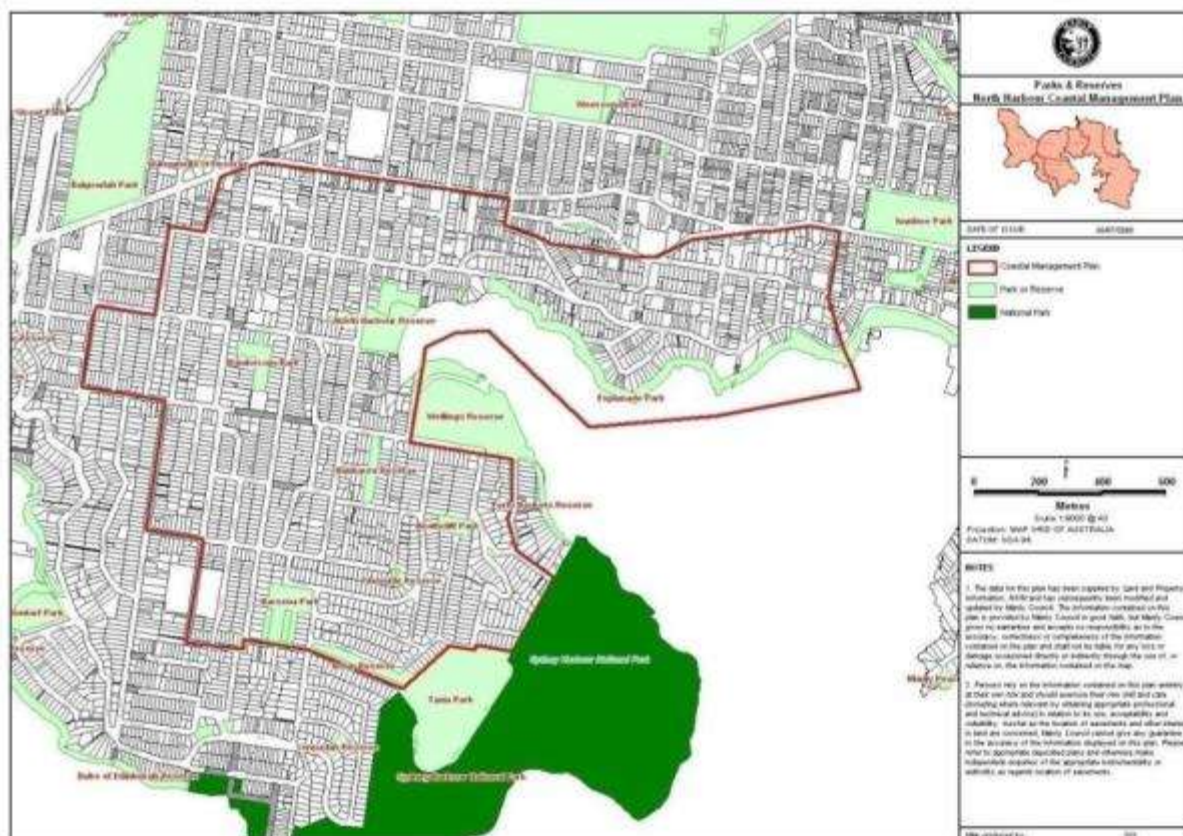
Bareena Park (0.21ha): This reserve is located near Nolan Bush. The vegetation within the site is classified as Sydney Sandstone Ridgetop Woodland, Open forest/woodland. The canopy cover on the site is less than 30%, with the vegetation forming a woodland community with an upper canopy approaching 7m. in height. The dominant canopy species are *Eucalyptus haemastoma*, *Corymbia gummifera*, *Allocasuarina littoralis* and *Pittosporum undulatum*. No threatened species were recorded. There are no formal man-made structures but many bike trails. Dog-walking occurs in this reserve. There are a large number of rock features in this small reserve. Weed infestations/garden escapes, access/disturbance, dumping of garden refuse, absence of fire and maintenance procedures (especially mowing) are threats to this bushland.

Heathcliff Park (0.55ha): The reserve encompasses a relatively small area of ridgetop vegetation, bordered mainly by private residential property. There are many rock features throughout the reserve and the shallow sandy soil is generally well drained. A basketball hoop has been placed on the grassy area and there is a stormwater drain. A total of 1 amphibian species, 14 bird species, 2 mammal and 3 native species of reptile recorded in this reserve. The vegetation within the site is classified as Sydney Sandstone Ridgetop Woodland with a strong coastal element. The average canopy height is 12m. The dominant canopy species are

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Eucalyptus haemastoma, *Corymbia gummifera*, *Glochidion ferdinandi*, *Angophora costata*, *Angophora floribunda*, *Banksia serrata*, *Pittosporum undulatum*, *Banksia ericifolia*, *Eleocarpus reticularis* and *Kunzea ambigua*. No threatened species were recorded. Weed invasion, inappropriate fire interval and dumping of garden refuse and grass clippings are threats to this bushland.

Figure 8.3.2 Parks and reserves within the study area



Brimbecom Park (0.18ha): This small, isolated patch of remnant bushland is located to one side of the cleared parkland of Brimbecom Park. Cleared parkland contains picnic tables, swings and play equipment. The bushland in this park has scenic value and should be maintained. A total of 9 bird species, 4 mammal and 2 native species of reptile recorded in this reserve. Grey-headed Flying-foxes were recorded in this reserve. The remnant vegetation is comprised of low woodland. The dominant canopy species are *Cynnamomum camphora*, *Angophora costata*, *Eucalyptus paperita*, *Allocasurina littoralis*, *Callicoma serratifolia*, *Ligustrum sinense*, *Pittosporum undulatum*, *Lomandra longifolia*, *Nephrolepis cordifolia* and *Protasparagus aethiopicus*. Weed infestation and inappropriate fire regime are threats to this bushland.

Esplanade Park (4.71ha): This is a narrow foreshore stripe of public land. The park contains grassy lawn areas with isolated native trees and remnant patches of bushland. Exotic plants and small gardens have been planted in some parts of the reserve. The reserve has high recreational and scenic values. Manly Scenic Walkway runs the entire length of the park. There are facilities and man-made structures, including garbage bins, park benches, signage, a swimming pool, public toilets, a bin for dog faeces, footpath and streetlights. The reserve is a popular dog off-leash area. A total of 19 bird species, 4 mammal and 2 native species of reptile recorded in this reserve. The vulnerable Grey-headed Flying-foxes were recorded in this reserve. The dominant canopy species are Norfolk Island pines and *Banksia integrifolia*. Extremely high visitor use, sewer leaks, weed infestation, encroachment of exotic plant species and eutrophication from dog faeces are threats to this bushland.



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Burton's Bush (0.35ha): The vegetation consists of remnant coastal woodland with established coastal rainforest species. The upper canopy is composed of largely senescent *Angophora costata*, *Ficus rubiginosa*, *Glochidion ferdinandi* and *Cinnamomum camphora* and it is subject to bush regeneration activity. Manly Scenic Walkway runs through this reserve. There are two streetlamps lighting the concrete pathway near the steps. The adjacent North Harbour Reserve has facilities like rubbish bins, water taps, BBQs, a basketball hoop and children's play equipment. A total of 9 bird species, 8 mammal and 3 native species of reptile recorded in this reserve. The threatened Grey-headed Flying-fox was seen foraging within this reserve. The vegetation community was classified as Sydney Sandstone Ridgetop Woodland. The upper canopy varies in height from 10-14m and the cover density is up to 60%. The dominant canopy species are *Banksia ericifolia*, *Ficus rubiginosa*, *Glochidion ferdinandi* and *Cinnamomum camphora*. Unofficial access paths, weed infestation, garden escapes and dogs are threats to this bushland.

Fisher and Geddes Reserve (0.035ha): This reserve is very small and wedge shaped. There is an electricity substation located towards the southern end of the site off Geddes Street. A total of 7 bird species, 1 mammal and 4 native species of reptile recorded in this reserve. Two individuals of the threatened species *Syzygium paniculatum* (Magenta Lillypilly) were recorded in the reserve. The bushland is best classified as Sydney Sandstone Ridgetop Woodland with the dominant canopy species being *Angophora costata*, *Eucalyptus gummifera* and *Allocasurina littoralis*. The canopy varies in height from 8-15m and the cover density ranges from 25-50%. Establishment of weed propagules – particularly bird dispersed species and inappropriate fire frequency is threats to this bushland.

Glenside Reserve (0.11ha): This very small is situated in a small gully between residential properties. An electricity sub-station is located on this site. A total of 9 bird species, 2 mammal and 2 native species of reptile recorded in this reserve. No threatened species were recorded on this site. The vegetation type, typically associated with creek lines such as this, is closed forest. The reserve contains tall rainforest trees with a dense canopy in patches. Increased nutrient levels, weed infestations and garden escapes are threats to this bushland.

Jackson Reserve (0.16ha): This is one of the smallest bushland reserves. The reserve is quite narrow running uphill from Condamine Street to Jackson Street along the path of a modified natural drainage line. The creek line is naturally rocky. The reserve is surrounded by residential properties and contains a rough pathway and a large stormwater drain culvert. A total of 1 amphibian species, 11 bird species, 2 mammal and 3 native species of reptile recorded in this reserve. There is no clear vegetation type in this reserve. The dominant canopy species are *Erythrina Xsykesii*, *Eucalyptus piperita*, *Angophora costata*, *Bamboo*, *Lantan camara*, *Tradescantia albiflora* and *Commelina cyanea*. No threatened species were recorded. Dumping of garden refuse, garden escapes, establishment of weed propagules, high nutrient loading of stormwater, car parking – soil compaction are threats to this bushland.

King Avenue Reserve (0.012ha): This is a narrow strip in between two residential blocks connecting King Avenue and foreshore of North Harbour Bay.

8.3.3 Fauna

There is still a significant amount of native terrestrial fauna within the study area, despite the many evident pressures, such as encroachment, high usage of bushland areas, and presence of introduced species. Skelton *et al.* (2004) recorded:

- 3 native amphibian species
- 34 native and 5 introduced bird species
- 4 native and 4 introduced mammal species
- 9 reptile species

See Table C6 in Appendix C for the full species list of fauna recorded within the study area.

There has also been one threatened species recorded in the study area, the Grey-headed Flying Fox (*Pteropus poliocephalus*). The Grey-headed flying fox is listed as Vulnerable on Schedule 2 of the NSW *Threatened*



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Species Conservation Act, 1995, and Endangered on the Commonwealth Environmental Protection and Biodiversity Conservation Act, 1999.

There has been recent (August 2008) sighting of an endangered Bush Stone Curlew (*Burhinus grallarius*) in Curban St Balgowlah Heights opposite Bareena Park. This is listed as threatened under both *NSW Threatened Species (TSC) Act* and *Commonwealth threatened species (EPBC Act)*.

8.4 ECOLOGICAL IMPACTS

8.4.1 Marine

As noted in section 8.1 the marine environment within the study area has a diverse range of habitats, many of which are in relatively reasonable condition. However, there are still many human activities that adversely impact on its health.

Fishing is possibly the most common recreational activity undertaken within the study area. Fisher people are required to obtain a licence from DPI, with revenue rose being used to improve recreational fishing. Various bag and size limits also apply to recreational fisher people for most common fish species. DPI scientists undertake research into the various species and determine the appropriate bag and size limits to ensure the sustainability of populations. However, not everyone adheres to these regulations, and DPI field officers are required to undertake patrols to enforce the bag and size limits. The impact of the occasional breach of regulations is not likely to be significant, but continued breaches within one locality (i.e. – the study area) could potentially threaten local fish stocks.

Recreational fishing is still permitted despite a ban on all commercial fishing within Sydney Harbour, although dietary advice has been issued, stating that limits should be placed on the amount of Harbour caught fish that are consumed. The advice also states that fish caught west of the Harbour Bridge should not be consumed at all (NSW DPI, 2007).

Serious health problems are emerging in the children of families exposed to dangerous dioxins from eating poisoned fish out of Sydney Harbour. Two years after commercial fishing ban, children are suffering from gum disease, rotten teeth and retarded development (McDougall 2008).

Littering and gross pollutants from stormwater can impact on aquatic life directly e.g. choking on plastic bags, and indirectly through lowering of water quality e.g. garden wastes in stormwater.

Boating is also an extremely popular recreational activity within the study area, but unfortunately it can have detrimental impacts on the marine environment. Anchors, moorings, propellers and hulls can all damage the seafloor and associated seagrass. Also, boating can contribute to water pollution which also degrades the marine environment.

Boat users can potentially impact on many other areas and users of an estuary besides just creating waves. For example, boat generated waves over time can weaken sea walls leading to their collapse; they cause foreshore erosion and can impact on habitat. Boating can impact on water quality via spills, anti-foul paints, littering from boats and from marinas where boats are washed and fixed etc.

Moorings are fixed in place with a heavy anchor weight with a chain, rope and buoy attached. The chain drags along the bottom with the current in a circular motion around the anchor, and has the effect of scouring the sea floor. If the mooring is located in a seagrass bed, the scouring will damage or destroy the seagrass within the limit of the chain. There are currently over 200 permanent moorings within the study area and its vicinity. Seagrass friendly moorings are currently being trialled by NSW Maritime, although none are located within the study area.



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8.4.2 Intertidal Area

Urban development has probably had the greatest impact on the intertidal environment within the study area. Losses of habitat from seawall and foreshore modification such as marinas etc have a big impact on intertidal ecology in the study area.

Water pollution has historically had detrimental effects on invertebrates on rocky shores within the study area. As water pollution is still evident within North Harbour, it is possible that invertebrate populations are still being affected. However, the limited data available suggests that populations of invertebrates in the intertidal zone may be increasing, regardless of pollution still being evident.

Harvesting species within the intertidal zone may also have impacted on its ecology, although data is not available to confirm this. The entire foreshore of the study area is an Intertidal Protected Area (IPA), and harvesting is not permitted. It is not known whether other harvesting (e.g. - oysters from the rocks) is taking place. Education and enforcement may be needed.

Marine debris such as seagrass wrack (not rubbish) washed up on the shore provides an important source of food for a diverse range of invertebrate species, which are an important part of the intertidal food chain.

8.4.3 Terrestrial

Urban development has been the single largest threat to the terrestrial environment within the study area. Development such as the construction of houses, roads, utilities and recreational facilities removes natural habitat in the footprint of each development.

The loss of natural habitat within the study area has been extreme, with the majority of the study area now developed at the cost of the native habitat such as vegetation, rock shelters, mulch, soil and creek lines (see section 5.3.1). Further, some existing properties within the study area are encroaching into the remaining habitat through the extension of lawns and outdoor living areas. The loss of habitat has greatly reduced the carrying capacity of the study area for native wildlife, and natural ecological processes and biodiversity have been threatened (Skelton *et al.* 2004). The fragmentation of natural bushland areas in Manly has reduced the viability of habitat in many bushland reserves to support populations of native fauna.

Impact of high nutrient storm water on Manly Bushland Reserves has been specifically investigated (Skelton *et al.* 2002). Fifty outlets in 16 reserves, 19 in the study area, were investigated. High nutrient loads were found to occur only at 5 of 19 sites located all over the study area (Table 8.4.3). The source of nutrients was not investigated but possible cause included sewage leaks, incorrect use of lawn and garden fertilizer, disposal of dog faeces down the drain etc. (Skelton *et al.* 2000).

There are also many secondary impacts as a result of the development within the study area. The invasion of exotic species is the most notable of these impacts. As indicated in Appendix C, there were 335 species of flora recorded within the study area, and 139 (approximately 41%) of them are exotic. These species have reached bushland areas through escaping from gardens, illegal dumping of garden refuses, dispersion by fauna (e.g. - birds eating seeds) and illegal plantings. The spread of exotic fauna has also been exacerbated by nutrient pollution from stormwater and sewage overflows, and the dumping of garden soil.

Fire is a natural part of the environment, and many species are dependent on regularly spaced fires. Inappropriate fire frequency has also impacted on the terrestrial environment within the study area. Fire is important in many aspects of ecosystem functioning, such as seed germination, nutrient cycling and control of species diversity. Residential development around the bushland reserves means that fires are suppressed, rather than allowed to occur naturally. Back burning takes place in some reserves to reduce the fuel load and reduce the bushfire potential, although this rarely mimics the frequency and intensity of natural fires (Skelton *et al.*, 2004).



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Table 8.4.3: Impact of high nutrient storm water on bushland at 19 outlets

Reserve	Outlet Reference No.	Outlet Catchment size	litter	Nutrients in Water	Weed Cover	Weed Ecological Severity Score	Deposition Below Outlet	Weeds 5m radius	Severity of Impact on Bushland
		1=small, 10=large	1=absence, 10=presence	1=low 10=very high	1=no weeds, 10=complete cover	1=no problem weeds 40=many ecologically damaging weeds	1=none, 4=heavily silted	1=degraded bushland' 5=good bushland	High value looks bad
West Esplanade Park	1	2	10	1	2	2	1	1	1.3
	2	2	1	1	2	7	2	4	1.5
	3	4	10	3	2	23	1	1	2.1
	4	8	10	3	2	5	1	4	1.7
	5	2	1	1	2	2	2	1	0.9
	6	2	10	7	8	7	4	1	2.7
	7	4	1	1	1	1	1	5	0.7
	8	4	10	3	4	9	1	3	1.8
	9	8	10	1	1	-	1	5	2.2
	10	4	10	1	4	2	1	3	2.4
	11	2	1	1	3	2	1	1	0.9
	12	2	1	7	8	19	1	1	1.7
	13	4	10	3	2	22	1	4	2.1
	14	2	1	1	1	-	1	5	1.2
	15	8	1	1	1	-	1	5	1.6
	16	8	10	7	10	28	-	1	3.6
Nolan's Bush	22	4	10	7	4	18	2	3	1.9
	23	2	1	7	4	25	2	3	1.2
Bareena Park Bushland	24	2	1	10	10	36	2	1	2.8

Source: Skelton *et al.* 2002

Introduced fauna (see Table C7 in Appendix C) have also impacted on the native fauna within the study area. The introduced birds, particularly the Common Myna, have most likely displaced native birds to some degree, although the extent is not known. Displacement occurs through competition for food and nesting sites, and aggressiveness of introduced birds towards natives (Australian Museum, 2007).

Cats were recorded throughout the study area reserves. Cats are renowned as predators of native fauna, and have a preference for mammals and birds around the weight of 200g, although they will also take other species such as reptiles and frogs. Even when a cat attack does not directly kill the intended prey, they carry a disease, *toxoplasmosis* that usually results in death of its opponent through blindness, central nervous system damage or respiratory failure (Skelton *et al.* 2004).

Domestic dogs were sighted in most of the study area reserves. Dogs impact on native fauna directly by predation and attack when unleashed, but they can also have indirect impacts. The smell of domestic dogs reduces the habitat potential of an area, as native animals become stressed and avoid the areas where the smell is present (Skelton *et al.* 2004). Parts of the study area, particularly the Manly Scenic Walkway and surrounds, are frequented by dogs being walked, meaning their scent would be nearly always present. North Harbour sand flat is also regularly used to exercise dogs off leash, which would impact on populations of shore birds that would normally hunt on the sand flat at low tide for food.

Rabbits were recorded in some of the study area reserves. Rabbits cause a myriad of problems, both to other fauna and the environment around them. Rabbits compete with, and often out compete, many native ground dwelling animals for food and shelter. They are extremely mobile and can reproduce rapidly, placing huge pressure on the more territorial and slow reproducing natives. Rabbits eat the seedlings of native plants, reducing the ability of the bush to regenerate, and they also graze on mature plants and damage its protective bark. They create erosion through digging burrows, which can also exacerbate any existing erosion (Skelton *et al.* 2004).



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8.5 ECOSYSTEM HEALTH ASSESSMENT

In conclusion, an assessment has been made in tabular form that allows for an overview of the ecosystem health. Key indicators were chosen from the topics covered in this report. These findings will assist in developing appropriate management actions.

Indicator	Assessment
Water Quality – Aquatic Ecosystem Health Values	??
Water Quality – Recreational Ecosystem Health Values	Good. Sample Site showing 100% compliance with the <i>faecal coliform</i> guidelines over the last 5 years and 100% compliance with the <i>enterococci</i> guidelines on four of the five years.
Erosion	not a problem
Sedimentation	stable sedimentary environment,
Wetlands (mangroves and salt marsh)	None
Seagrasses	Medium sized meadows of seagrass; exotic species exist
Urban bushland	scattered, some larger reserves, exotic species, high density of weed
Fish & fisheries	large number of fish species (fishing banned at present)
Habitat on foreshore structures	selective (poor?) habitats with extensive growth of some species
Phytoplankton	smaller areas
Zooplankton	??
Benthic Macro invertebrates	??
Terrestrial fauna	significant number and species

?? No data to make a judgement on the indicator



9. SOCIO-ECONOMIC ENVIRONMENT

9.1 DEMOGRAPHY

Australia's coastal regions continue to undergo transition as traditional land uses decline and new land uses evolve. Many regions have changed from quiet rural coastal communities with declining agricultural or industrial sectors into popular tourist localities and, in some cases, have grown into large urban or suburban settlements. Other regions have also changed because of easy commuting distances to major cities (Smith & Doherty 2006). An understanding of the population is important in coastline management.

Existing Population

The 2006 Estimated Resident Population (ERP) of Manly is 39,214 excluding overseas visitors. The total population counted in the 2006 Census was 37,110 people based on place of residence and of these, 18,066 were males and 19,044 were females. The population density in Manly is estimated at 2,451 persons/km².

Based on the Census data, the population growth rate, over the last three Census periods, has slowed down from 3.93% during 1991-1996 to 3.64% during 1996-2001 and 1.54% during 2001-2006.

However, population of the North Harbour study area, according to 2006 census, is only 6,973 increasing from only 6,856 in 2001. The population density in Manly is estimated at 3,852 persons/km².

Aboriginal Population

In 2006, the number of people who identified themselves as Indigenous in Manly LGA was 93 or 0.3% of the population, consistent with the previous Census figures. Only 11 people are identified in the study area. Although the population is small, Aboriginal people have a significant spiritual, cultural, social and economic interest in the area.

Projected Population

The latest ABS projection for Manly LGA population is 40,630 for 2011 and 41,440 for 2016 (Figure 9.1).

Gender & Age Structure

Manly LGA has a population where 48.7% are males and 51.3% females.

Of the total, 17.5% were children aged between 0-14 years, and 24.8% were persons aged 55 years and over. The median age of persons was 37 years, compared with 37 years for persons in Australia.

Manly population is ageing with 30.7% of residents (or 11,375 people) over the age of 50. The ageing trend of the population is also evident in the declining proportion of young people. The proportion of people aged 15-24 years declined from 12.6% in 1996 to 10.4 % in 2006. There was a slight increase in the proportion of young children under 14 years of age but decline in the next two age groups between 15-29 years. The most significant changes in the age structure of Manly population indicating clear ageing trend are:

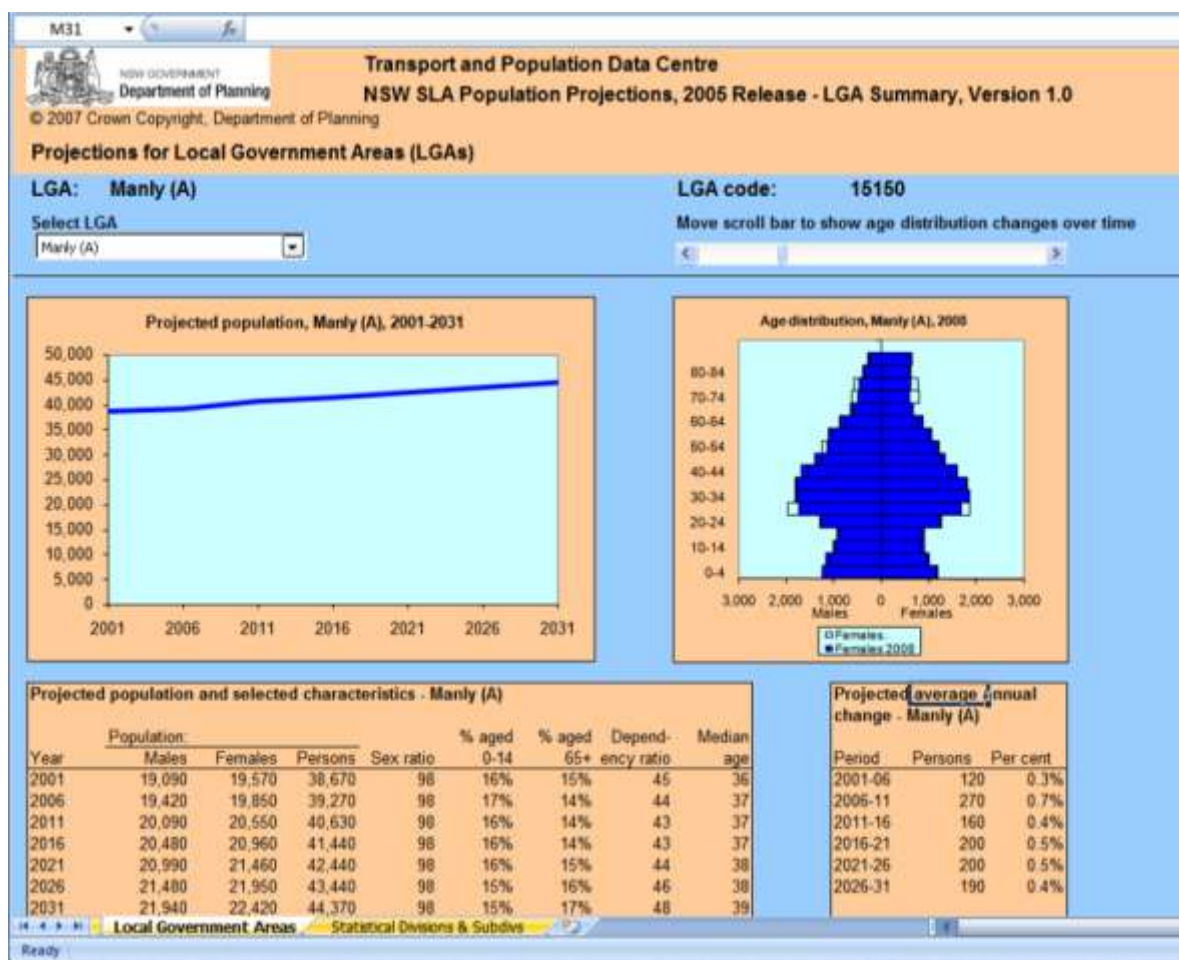
- steady decline in the proportion of young people aged 15-29 years.
- steady increase in most age groups over 40 years.

According to ABS projections for Manly between 2001 to 2019, the only age groups forecast to increase are those aged 25 years and over. The proportion of children aged 0-11 years are forecast to decline in numbers and the proportion of young people aged 12-24 years remains static.

Aged and Disability

On 30 June 2006, in Manly there were 187 aged care residents and 107 people received Community Aged Care Packages (ABS, *NSW Regional Statistics*, 2007). Based on 2006 Census, the number of people with a disability, long term health condition or old age who needed assistance with self-care, mobility and communication was 896. A total of 2,847 carers provided unpaid assistance to people with disabilities.

Figure 9.1 Population projections for Manly LGA area



Household formation

The Manly community is characterised by atypical family and household structures with significantly less people living in a family household and more lone person, group and other households compared to Australia. In Manly, there are proportionally less married people, more people that never married, less couple families with children, more couples without children, and less single parent families than nationwide.

The household and family composition presented in the figures above is based on the 2006 Census. There were 9,279 family households in Manly, 3,814 lone person households and 934 group households. In terms of household family structure, since 2001, the balance has shifted in favour of couples with children and there were less

Dwelling construction

Manly is distinct of Sydney in its high concentration of flats with more than double the Sydney wide figure. Of all the occupied private dwellings in Manly, there has been no real increase in the number of separate houses. However, since 1991 there has been a steady increase in the number of flats, units or apartments and semi-detached, row or terrace houses and townhouses.

The majority of occupied dwellings in Manly are flats, units or apartments (48.3%), followed by separate houses (40.7%) and semi-detached houses (10.3%). The occupancy rate is 1.1 persons per bedroom or 2.4 persons per household, lower than the neighbouring Warringah (2.6) or Pittwater (2.7).

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Economic structure

The gross weekly household income gives an indication of population socio-economic status. Manly residents earn significantly more than both residents of the Sydney region and the Northern Beaches. The median weekly individual income of Manly residents in 2006 was \$790 and the median weekly household income was \$1,705, with 44.4% of households earning \$1,700 or more a week.

9.2 TOURIST VISITATION

Established in the 1850's as Australia's first seaside resort, Manly has a long history of tourism. Today Manly is a Mecca for tourists all year round. It is estimated that approximately 6 million people currently visit the area each year and this figure is predicted to increase by up to 6.2% per year. Of them, 75-88% is day visitors attracted to beaches, marine activities and the ferry ride (UWS 2005). These visitors mostly are focussed on the Corso and nearby beaches. Manly Scenic Walkway, runs through the study area, attracts many tourists and takes them to more secluded Fairlight beach and North Harbour Reserve.

In order to cater to additional demand, Council needs to create additional provision of public facilities. These include beach & street cleaning, shade, picnic tables, waste disposal, toilets & showers, signage, visitor information and maps. In line with community aspirations, Manly is being promoted as a place of ecotourism as a means to ensure care for natural and social fabric.

Manly Council is committed to managing the impacts of tourism in order to protect the local environment and residential amenity. In 2005 Council introduced *Sea Change for Sustainable Tourism*, an education program for tourism business operators that is designed to improve social and environmental business performance.

9.3 SOCIAL INFRASTRUCTURE

Infrastructure provision, more specifically social infrastructure provision are important to people. The presence of these kinds of infrastructure has a direct impact on living conditions, health and potential for economic development. Social infrastructure are usually considered services, such as health care facilities, public toilets, schools, neighbourhood centres, parks, and open space etc. Some of these are described here:

9.3.1 North Harbour Reserve

It is an open harbour foreshore reserve situated on level terrain around North Harbour Bay (Details from Nikolov A. 2005). It has scenic harbour and marine views. The Reserve is suitable for picnics, dog walking, exercise, and ball games.

Historically, North Harbour area is one of the oldest parts of Manly, dating back to the arrival of the First Fleet in 1788. Manly derives its name from Captain Arthur Phillip's description of the 'manly natives' that greeted him, and a subsequent map by Captain John Hunter placed Manly Cove off North Harbour Reserve. Surveyor John Oxley noted in 1827 that the land in North Harbour had "long been pointed out as a proper situation to be reserved for the site of a village". It was particularly attractive because three fresh water streams could supply the potential village and one of them, the waterfall flowing beneath the bridge at Gourlay Avenue, can still be seen. The village was laid out in 1828 but the area had attracted settlement well before then. Improved roads and reliable motor transport in the 1920s contributed significantly to the changes



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that turned the Village of North Harbour into the suburb of Balgowlah. In 1938 the large sandy bay which had originally extended to Condamine Street was reclaimed and made into the present park.

The Reserve was reclaimed by the construction of a sandstone retaining wall and landfill on a tidal flat during the mid 1930's. There is no beach in front but a sandy flat. There is sealed wide path around the rocky bank.

Access:

Pedestrian: The reserve is part of the North Harbour Walk connected via stairs to both Burton St at the northern end and to Lower Beach St. at the southern end. The best point of entry for people with disabilities using the Reserve is the kerb ramp at the pedestrian crossing on Condamine St. (see picture above).

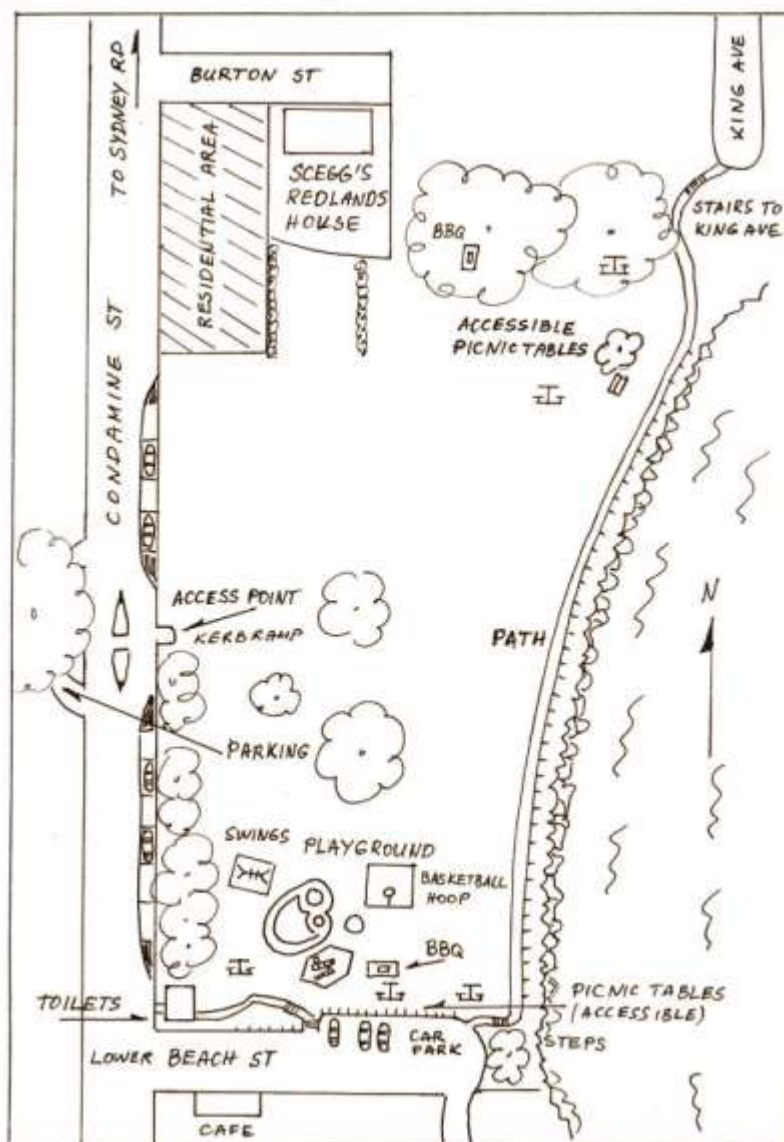
Vehicle: Parallel parking in Condamine St for 10 cars on the side of the Reserve. More parking (around 30 spaces) is available across Condamine St under a large fig tree opposite the kerb ramp access point. Designated car park with 90° to the kerb spaces for 20 cars in Lower Beach St. via steps.

Public transport: Public buses and taxis from Manly Wharf. Nearest bus stop is at the corner of Condamine St & White St, Balgowlah, 300m north-west.

Facilities:

- **Toilets:** Male and female toilets both with steps to the entrance. These are not accessible.
- **Shelter:** Shade is provided by the large trees. Shade cloth over the playground.
- **Seating & Tables:** Bench seats and picnic tables are set on concrete and are accessible over the grass, as indicated on the map.
- **Picnic areas:** Two serviced areas with electric BBQs, taps, and garbage bins are located on both ends of the Reserve.
- **Playground:** Located on the south side of the reserve, 60m from the accessible entry point, as indicated on the map. Shaded by large fig tree and shade cloth, it offers lots of children's equipment, swings, and children's cycleway. A court with one basketball hoop is east of the playground.
- **Telephones:** Two telephone booths, 250m north in Condamine St near Sydney Rd.
- **Shops:** Coffee shop & take-away/general store in Lower Beach St, 70m from end of parking.

Improvements of North Harbour Reserve have been undertaken on adhoc basis, in the absence of any Masterplan.



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9.3.2 Manly Scenic Walkway

As presented in section 4.1.1, walking/jogging has been indicated as the most preferred usage of the study area. Manly Scenic Walkway is used extensively by both visitors and residents.

Manly Scenic Walkway (MSW) was opened in 1988 and is jointly managed by the Manly Council and the National Parks and Wildlife Service of the DECC. It is almost 10 km long starting from Manly and reaching up to the Spit Bridge with approximately 1.6 km within the study area. There are couple of entrance points to allow shorter walks. All flora, fauna, Aboriginal sites, rock formations and historic structures are protected on the walk. Of the 23 points of interest (MSW Brochure), the following two points are within the study area.

Figure 9.3.2 – Route of the Manly Scenic Walkway within the Study area



- Fairlight: Named after Fairlight House, built in 1854 by Henry Gilbert Smith, a great benefactor of Manly. Remnants of the garden – a stone wall and three Norfolk Island Pines – can still be seen. The Promenade to Manly Wharf is very popular and suitable for wheelchairs.
- North Harbour Reserve: Large picnic area with open playing space, situated on 2 hectares of land reclaimed in 1938. The original road from Manly to Sydney, known as 'Jenkins Road', started nearby.

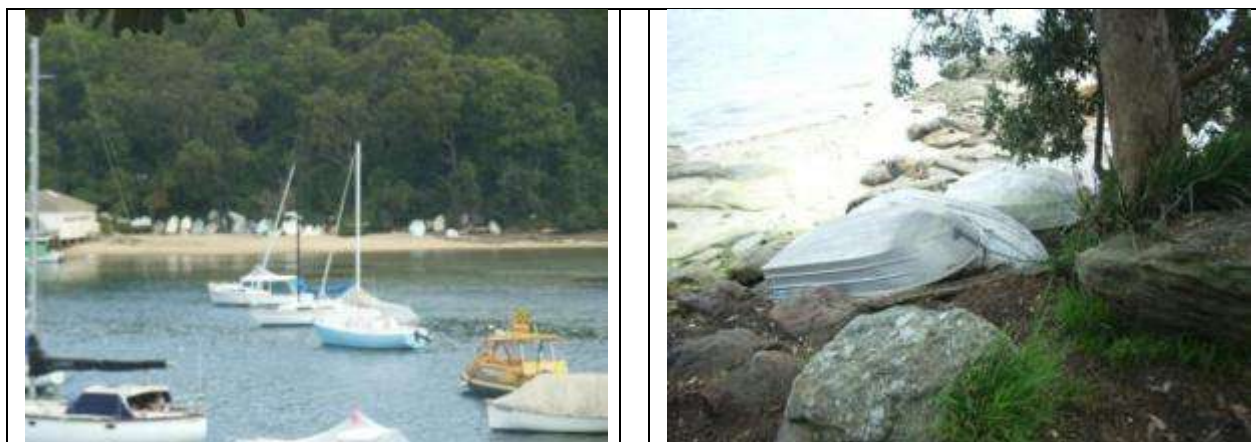
9.3.3 Dinghy/Kayak Storage Facility

North Harbour study area offers excellent site for boating and kayaking. North Harbour and surrounds are part of 8-km kayaking loop (Photo). However, there is no dinghy and kayak storage facility in the study area. There is one dinghy storage rack at nearby Forty Baskets. Dinghies are now stored along the foreshore on both sides of Manly Boatshed and in front of



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Wellings Reserve. The presence of dinghies along the foreshore has been found to damage tree bark and numerous informal tracks have been formed due to inappropriate dinghy storage and access.



However, there is conflicting opinion among community on the need of dinghy storage. One group sees that current haphazard storage of dinghies adds charm and character to the natural environment of shoreline. It helps in maintaining the natural appeal of the area. Others believe that dinghies on shores are dangerous and unsightly. Dinghies destroy trees.

9.3.4 Amenities/Toilet Block

There are 4 toilet blocks located within the study area (map), with two, Fairlight & Condamine Street, toilets being wheel chair accessible:

- Fairlight beach (Location 10)
- Condamine Street, corner of Sydney Road (Location 21)
- North Harbour Reserve on Condamine Street, near Lower Beach Street (Location 23)
- Bareena Park corner of Bareena Drive & Vista Street (Location 25)

The existing facilities at Fairlight beach consist of separate male and female sections each with toilets, a shower and wash basin.

Toilet at North Harbour Reserve has recently been repaired and upgraded.



9.3.5 BBQ

Two serviced areas with electric BBQs, taps, and garbage bins are located on both ends of North Harbour Reserve. The BBQ facility consists of a single burner atop a solid brick working/serving bench. BBQ use is free of charge. Bench seats and picnic tables are set on concrete and are accessible over the grass,

Throughout the consultation process over-utilisation of the BBQ facilities at North Harbour Reserve was identified as an issue to be addressed in the development of this management plan. During summer this has reportedly resulted in the utilisation of portable BBQs by patrons. Community has asked for two more stainless steel BBQs within the Reserve area.

Another issue that was identified in the consultation process was that of general maintenance. Manly Council is responsible for the maintenance of such facilities however maintenance work is undertaken on a needs basis when community members report such issues to Council.

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9.3.6 Shelter

With the exception of the amenities block, no man-made structures exist within the study area to provide shelter to patrons. However, the natural/planted tree canopy provides some shelter and shade. There is shade cloth over the playground at North Harbour Reserve. There is lack of shading from trees at and near Fairlight pool.

9.3.7 Playground

Children's playgrounds are located on the south side of North Harbour Reserve, Nanbaree Reserve and Brimbecom Park. Located 60m from the accessible entry point at North Harbour Reserve, it offers lots of children's equipment, swings, climbing frame and children's cycleway. The play ground is shaded by large fig tree and shade cloth. Swings and play equipment exist in cleared parklands of Brimbecom Park and Nanbaree Reserve.

Basketball hoops has been placed on the grassy area of Heathcliff Park and on east of the playground at North Harbour Reserve. During community consultation, people requested a second basketball hoop at a lower height for younger children.

A number of issues associate with the playground facilities were identified in the consultation process. Issues were primarily associated with safety, the upgrading of facilities and insufficient facilities to cater for user needs.

Manly Council undertook an assessment of all playground facilities within the local government area. The aim of this study was to determine what facilities currently exist, to conduct a safety assessment, determine actions required to address any identified issues and determine a priority rating for all playgrounds within the LGA. In preparing the assessment report attention was focused on safety, structural soundness of the facility and user satisfaction. Findings from the report noted that there were safety issues that needed to be addressed.

9.3.8 Pay Phone Booths

There are five Payphone booths in and around the study area:

- 108 Condamine Street, Balgowlah,
- 394 Sydney Road, Balgowlah
- 71 New Street, Balgowlah Height
- 70 Wanganella St Balgowlah and
- 80 West Esplanade, Manly (wheel-chair accessible)

These are maintained by Telstra.

9.3.9 Lighting

Issues related to lighting were identified as being of concern to local residents and visitors of North Harbour study area, more specifically the lack of lighting. The community perceived this to present a safety issue to those wishing to utilise the area of an evening or at night. It has also been suggested that the lack of lighting attracts hooligans and encourages vandalism in the area.

9.3.10 Steps

There are a number of steps providing access to North Harbour Reserve, North Harbour sandy flat, Delwood and Fairlight Beaches. Issues related to the steps have been of concern to local residents and visitors of North Harbour for some time. A number of steps are narrow and pose risk to users. These need to be replaced and/or rebuilt with railings fitted.

Council continually addresses the maintenance of stairs located in the study area to ensure compliance with Manly Council's Development Control Plan for Access and to ensure the safety of visitors and residents.



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9.3.11 Kiosk

There is a coffee shop & take-away/general store in Lower Beach St, 70m from end of parking near North Harbour Reserve.

9.3.12 Dog Exercise Area

Dog exercising is a popular activity for many members of the community. There are a number of leash-free areas along the foreshores that are frequented by the public and their companion animals.

Dogs are allowed on a leash in Fairlight Beach & West Esplanade Park. Dogs are allowed off the leash in most of Council's reserves. North Harbour Reserve has been identified as an ideal location. One must still ensure that the dog is under control, doesn't annoy or attack anybody or animals. The dog must be 10 metres away from children's play areas, BBQ's and picnic areas.

Dogs are not permitted on any beaches or in swimming enclosures.

9.3.13 Cycleway

Bicycle data point to the strength of cycling in the area. In particular, the Cycling in Sydney Report (Transport NSW, 2003) found that residents who live on the northern beaches have the third highest bicycle ownership per household of any area in Sydney. Also, the Northern Beaches has the third highest proportion of residents who use their bicycle to travel to and from work. The only locations with a higher proportion are Sydney CBD and the Eastern Suburbs.

The Manly Cycleway Network is extensive, consisting of both on-road and off-road cycle paths catering for the commuter and recreational cyclist (Figure 9.3.13a). However, there are distinct impediments to improving links in the cycleway network, namely the hilly topography and road carriageways that are too narrow to provide cycle paths (unless at the expense of on-street parking or changing roads to a single direction of traffic). Following the approval of the Manly Cycleway Plan Study (1997), Manly Council has embarked on a Cycleway Improvement Program.

Fig 9.3.13a: Cycle way within the study area



Figure 9.3.13b: Upgraded East-West Cycleway



A key proposal in the Study (1997) is a cycleway link between Commonwealth Parade and King Avenue, and the Scenic Walkway is identified as the potential location to provide this link. This link would provide a safe connection to recreational facilities such as North Harbour Reserve and Fairlight Beach. The strength of demand for an east-west cycle route is assessed in the Manly Bicycle Plan Study (1997). Demand for the east-



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west link is therefore from both recreational cyclists — who would like to ride safely to recreational attractors such as parks and the wharf — and from commuter cyclists — who need a safe route to and from Manly wharf. This would be to provide a cycleway in the Lauderdale Avenue corridor, ideally between King Avenue Balgowlah and extending all the way to Federation Point in Manly.

The Manly East-West Cycleway, now being upgraded (Figure 9.3.13b), provides cyclists, joggers and walkers with a pleasant way to exercise and enjoy the beautiful surroundings between where the Corso meets the oceanfront and the nearby suburb of Seaforth. This is approximately 8 km in length one way.

Manly Council also celebrates bike week each year to further encourage community to make use of extensive cycle ways through our exceptional scenery of bush, beach and lagoon. Council has recently approved plans for an East-West corridor that will link existing bike networks and provide greater options for cyclists and commuters.

9.3.14 Public Transport

The study area is serviced by public buses and taxis. Nearest bus stop to and from North Harbour Reserve is at the corner of Condamine St & White St, Balgowlah, 300m north-west.

9.3.15 Community Bus Service

The Hop, Skip & Jump is a community bus service, operated by Manly Council and proudly sponsored by Stockland & NRMA. The mini buses are running on 4 routes 7 days a week, including the study area, which interchange in Condamine Street, at the Totem Shopping Centre in Balgowlah, and run to Manly, to Seaforth, to Balgowlah Heights and to Warringah Mall. The four-bus fleet provides 7,500 passenger journeys a week.

9.3.16 Access

Providing adequate access to and within public areas of the Manly LGA is performed under the guidelines of the Manly Access DCP.

The aims and objectives of the Access DCP (MMC, 1996) are:

- to provide an environment which is accessible to all people, including those with disabilities;
- all community members have the right to full access to participate in all aspects of community life; and
- policies should aim to ensure Manly becomes accessible to all people regardless of abilities / disabilities.

Key objectives of the Access DCP that are relevant to the North Harbour study area are:

- to ensure access throughout the pedestrian network in the Council area including footpaths, through-site links, public arcades, overpasses and underpasses; and
- to provide convenient access to all public open space including parks, reserves, malls, plazas and squares.

Having regard to Council's Policy and Australian Standards AS1428.2, Council seeks to improve the accessibility of public open space and facilities by addressing matters such as signage, ramps, parking and toilet facilities.

Access to North Harbour Reserve is via four possible routes:

1. King Avenue, Balgowlah

Access from King Avenue cul-de-sac is via access steps. This access route forms part of the Manly Scenic Walkway and follows the line of the foreshore.

2. Beach Street, Balgowlah – Eastern end of the road



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Access from the Eastern end of Beach Street is via a narrow stone stepped walkway, which also forms part of the Manly Scenic Walkway.

3. Condamine Street, Balgowlah

Access is direct from footpath on Condamine Street.

4. Corner of Beach Street and Condamine Street, Balgowlah

Access from the corner of Beach Street and Condamine Street beside the toilet block is via a narrow concrete walkway that goes directly to children's playground. People with prams usually use this access.

Disabled & Aged Access

Disabled and aged access within North Harbour Reserve area is limited. Of the four access ways that currently exist, only limited disabled and aged access is provided from footpath on Condamine Street.

Council's Access Policy (MMC, 1996) aims for the progressive improvement in accessibility of all facilities operated by Council. Provisions for disabled parking spaces in Beach Street were suggested as a management recommendation in the community consultation process as none currently exists in close proximity to the Reserve.

Pedestrian access

Pedestrian access within the study area is adequate. Access is available from all four of the above listed access ways. The Manly Scenic Walkway, a highly utilised scenic foreshore walk extending from The Spit to Manly, directs large numbers of pedestrians from the Esplanade Park across North Harbour Reserve and through Wellings Reserve.

There are currently a number of properties on King Avenue and North Harbour Street with direct access to the North Harbour water/sand flat.

Boating access

Access to Manly Boatshed is through Bolingbroke Parade and access to nearby Davis Marina is via Gourlay Avenue.

9.4 HERITAGE SITES / ITEMS

An item / site with historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic history and importance have a heritage value. These are, very often, specified in an inventory of heritage items made by different authorities and for different purposes. These can have global to local significance.

The NSW *Heritage Act 1977* provides for heritage management by government agencies. Section 170 of the Heritage Act outlines the special obligations of government agencies.

In relation to conservation of local heritage, Manly Council is also committed:

- (i) to promote the Manly Council area's environmental heritage and celebrate its diverse environment, including architecture, Aboriginal archaeology, industrial archaeology and landscape;
- (ii) to set a good example with the Manly Council area's heritage and guide, encourage and educate others to further the appropriate conservation of the heritage items they own or administer; and
- (iii) to continue an active program of public information and participation in heritage and conservation matters; and



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9.4.1 Aboriginal Heritage

Aboriginal places and objects are an important part of the rich heritage of Manly and are of great significance to Aboriginal communities, providing links to culture, environment and knowledge. The oldest Aboriginal site known in the Manly LGA is dated to about 4100 years before present. European development has had great impact on Aboriginal heritage in these areas. It is important to protect these special places for future generations. Coastal and foreshore areas are generally considered to have very high potential for Aboriginal sites. Sites can be found immediately above the tidal zone, on slopes above foreshore areas, and on ridge tops.

Manly Council, jointly with 6 councils, has established the Aboriginal Heritage Office (AHO) in a progressive move to protect Aboriginal Heritage in these areas. The office has prepared 3 volumes Aboriginal Site Management Report for Manly Council (2006). Part of the work of the Aboriginal Heritage office is to monitor these Aboriginal sites on a day to day basis. There are a total of 107 sites for Manly, of which 62 are considered to be within Council's direct or indirect planning and assessment responsibility. As information about some places is restricted by cultural protocols and relevant legislative regulations (*NSW Heritage Office* guidelines, *NPWS Act* and Aboriginal Heritage Information Management System database: *AHIMS*), the information offered must not be made public.

There are five recorded Aboriginal heritage sites within the study area (AHO & MC 2006). This includes the following types (there can be more than one feature at one site):

- 1 Shelter with midden
- 3 open middens
- 1 Rock Engraving

Within the study area, middens are located in North Harbour Reserve, West Esplanade Park, and in Burton Bush:

- A midden is located in North Harbour Reserve. Midden material (broken and dispersed) appears to be oyster, cockle, hairy mussel and Hercules whalk. Ballistic stone fragments appear within the deposit. Midden dimensions may have been 40meters x 15 meters.
- Two middens are located at Burton Bush. Sites are disturbed middens as walking tracks bisect them. Majority of the shell deposit is on the uphill side and has an area of 5 meters along track.
- A rock shelter with shell middens is located at West Esplanade Reserve. The midden contains cockle, mussel, limpet and black Nerita shells.
- Rock engravings are located within the vicinity of Balgowlah Heights Infants School. There are two fish engravings of heavily weathered grooves, each about 3 meters long. They are arranged nose to tail.

However, due to potential sensitivities in mapping specific sites and locations of Aboriginal significance, maps and detailed descriptions have not been included in this report. It is likely that further sites will be present in areas that have not been surveyed or where they are not visible at the surface. Aboriginal sites are vulnerable to many of the same processes that affect other assets, such as encroachments, development and earthworks, pedestrian traffic, graffiti and so on.

Based on landscapes or physical setting, the likely range of cultural evidence associated with the landscape and the landscape history, AHO & MC (2006) has identified Heathcliff Reserve to be extremely high potential area to find further Aboriginal sites, Bareena Park Reserve, Balgowlah Public School, North Harbour Reserve, Burtons Bush Reserve and Esplanade Park as high potential area and Nanbaree Reserve as moderate potential areas within the study area.

9.4.2 Built Heritage (European)

A list of architectural and archaeological items existing in the study area, built during European settlement period, as listed in different documents, is presented in Table 9.4.2.



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Table 9.4.2 – Items of the architectural and archaeological items in the North Harbour study area

ITEM	ADDRESS
Listed under Sydney Regional Environmental Plan	
Fairlight Pool	Lauderdale Avenue, Fairlight
Listed under Energy Australia Heritage Register	
Electricity Substation 15151	Condamine Street, Balgowlah
Listed under Manly Local Environmental Plan	
House	2 Boyle Street, Balgowlah
House	10 The Crescent, Fairlight
House	155 Condamine Street, Balgowlah
House	169 Condamine Street, Balgowlah
Residential Flat Building	Cumberland, 32 The Crescent, Fairlight
Manly Reservoir	Corner Fairlight Street & Ashley Parade, Fairlight
Group of 3 houses	21-25 Fairlight Street, Fairlight
House	1 Hill Street, Fairlight
House (Inter-War California Bungalow)	17 Jackson Street, Balgowlah
House	19-21 Jackson Street, Balgowlah
House	13 King Avenue, Balgowlah
Margaret Street (from Lauderdale Avenue to Fairlight Street)	Fairlight
Group of houses	303, 305 & 307 Sydney Road, Balgowlah
Catholic Church	Corner White and Wanganella Streets, Balgowlah
House (Inter-War California Bungalow style house)	Corner White and Jackson Streets (28 White Street), Balgowlah
House	Corner White and Woodland Streets (37 White Street), Balgowlah

Source: Schedule 4 of Manly LEP 1988 (updated October 2008) (*Refer Clause 7*)

At present, Manly Council is reviewing its LEP to include additional items in the heritage list, being identified through Manly's Heritage Review.

Fairlight House, the home of Henry Gilbert Smith (1802-1886). He first saw the potential of Manly as a seaside resort and laid out central Manly much as it is today. He commissioned the eminent Colonial architect, Edmund Thomas Blacket, and local builder Alexander Dean, to design and build Fairlight House. Erected in local sandstone, it was of classic rectangular Georgian design, two storeys high, five windows and ten shutters wide. The ground floor of the house had verandas on the front and one side. The name 'Fairlight' had strong emotional ties for Smith. It was the name of the village in Sussex, England, where his first wife, Eleanor Whistler had once lived. The house was first occupied around 1860. The 36 acres (15 hectares) estate stood just behind the pine trees, extending half a kilometre northwards to Hilltop Crescent. Smith's second wife, Anne Margaret, died of tuberculosis in April 1866 and is buried in Manly Cemetery. The family enjoyed Fairlight House for only six years, after which the family left for England. The tower and portico in the photograph were added by subsequent owners. The house was demolished in 1939. There was a 100 foot reservation dedicated to public recreation on the harbour foreshore of the estate's southern boundary. The stone wall and pine trees are all that remain at present.

James Jenkins Trailblazer was constructed around 1826. This became a gateway to Pittwater, a short cut to Sydney long before Ellery's Punt or the Steamer.

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Brighton College, Manly was one of the first private schools for girls to be established in the State of new South Wales. Its origins probably date back to 1880, when a girls' school was set up in Wentworth Street, under the principalship of Miss Milne. However, 1889 is widely regarded as the birth-date of the school that was to become Brighton College, as direct links can be made historically to that date. In its early years it was situated in Wood Street, Fairlight Street and James Street. In 1903 it was first called "Brighton" under its then principal, Miss Hayes-Williams. The school closed in 1960. During the eighty years of its existence its pupils made a significant contribution to the cultural life of Manly and the community at large.

Home of the First Prime Minister of Australia, Sir Edmund Barton is also located within the study area.



Brighton College



9.4.3 Natural Heritage

Landscape items, as listed in Manly LEP, are declared as heritage items and are presented in Table 9.4.3.



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Table 9.4.3 – Landscape items, as environmental heritage, in North Harbour study area

ITEM	ADDRESS
Landscape Items	
Esplanade Park	Fairlight foreshore, North Harbour
Waterfall	North Harbour, Balgowlah
Moreton Bay Fig Tree (<i>Ficus Macrophylla</i>)	North Harbour Reserve, Balgowlah
Row of palm tree (<i>Washingtonia robusta</i>)	137 Woodland Street, Balgowlah
Governor Phillip Monument Garden	"Whitehall" corner White & Woodland Streets, Balgowlah
Margaret Street (from Lauderdale Avenue to Fairlight Street)	Fairlight
Seaview Street (from New Street to Upper Beach Street)	Balgowlah
Harbour Foreshores	Boundary of Municipality adjacent to the Harbour

Source: Schedule 4 of Manly LEP 1988 (updated October 2008) (*Refer Clause 7*)

9.4.4 Heritage Management

The Indigenous heritage of Manly is being managed by the Aboriginal Heritage Office and the AHO provided Council with a report in 2006 on the indigenous heritage sites in Manly. The Natural heritage of Manly was covered very well in the 1986 Heritage Study and as part of the on-going Heritage Review the study will be included on the Manly website. The inventory sheets for all existing items (including natural heritage) are being updated as relevant information becomes available with the aim of providing greater understanding of an item's significance.

Any Aboriginal conservation works must be undertaken with the full co-operation and consent of the Metropolitan Local Aboriginal Lands Council. Bush regeneration works must be undertaken only after advice from Aboriginal Heritage Office who is available to conduct field assessments.

Where there are grassed surfaces adjacent then the management practice should include periodic slashing in favour of mowing, tilling or planting of large shrubs or trees. This method means that sites are not interfered with and that sufficient flora exists to retain stormwater and prevent erosion and movement of material down slope.

Retention of sufficient vegetation over a deposit site is a prerequisite for preventing stormwater erosion or movement of deposit down slope. Many sites have only several centimetres of soil or vegetation protection and the retention of five to ten metres of cartilage protects sites from the majority of stormwater events.

AHO & MC (2006) made further two sets of recommendations:

Education & Training

1. Provide a Council Public Education Kit outlining information for residents and developers on the following:

- Aboriginal culture of the North Shore
- Significance of Aboriginal heritage
- Site Identification
- The Metropolitan Local Aboriginal Land Council
- The National Parks & Wildlife Service (Aboriginal Heritage Division)
- Information for developers regarding restrictions and legislations
- Information for Residents on issues relating to their land
- Cultural Walks in Manly



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- General information on Manly
2. Education programs to school and the wider community
 3. Implement training in site & heritage awareness for Council and Bush care teams
 4. Train contractors working in bush generation or any work that involves weed removal and replanting in Aboriginal site identification and cultural awareness

Site Protection

- Keep site from general public knowledge
- Site may need regular monitoring
- No water or soil to be dumped near site
- Note site is of a high priority and should be protected at all costs
- Signage to be erected notifying of NPW legislation
- Signage showing some interpretation
- Fence off site
- Removal of graffiti and rubbish from area of site
- Bush care should not remove any plants from site
- Stop campers and day picnickers from using site
- Further education about the significance of this site
- Fire Management is implemented
- Consultation with the MLALC
- Site is a PAD and should be fully tested before works in this area
- If the site within private property, notify owner of the site as to the protection of the site under the NPW Act (refer to Section 149 certificate mechanism). Additional protection works may be undertaken around site to ensure its conservation during any works in a given area



10. COMMUNITY CONSULTATION: KEY ISSUES & THEIR MANAGEMENT

A vital part in the coastal management planning process is community involvement and action. Hence, the coastal management planning process requires widespread community awareness, cooperation and action. This section provides an outline of community perceptions on issues and their management identified through the consultation process undertaken in the development of North Harbour Coastline Management Plan.

10.1 COMMUNITY CONSULTATION

The support and knowledge of local community is essential for the success of North Harbour Coastline Management Plan. The Council dynamically involved community representatives in the preparation and review of North Harbour Plan through the Manly Harbour Foreshores Management Committee and submissions from community consultation events and submissions at Council.

Structured survey forms were prepared and distributed to obtain community responses on importance, key issues and specific suggestions for inclusion in the Coastline Management Plan. Advertisement in the Manly Daily for community submissions on the 8 October 2005 and temporary display set up in the library foyer explaining the CMP process encouraged community feedback. An item was also included in the relevant Precinct newsletters

Three separate consultation meetings were held:

- North Harbour Reserve 9 am -12 noon; Sunday 19 February 2006.
- Fairlight Pool 8-10 am; Sunday 4 March 2007.
- North Harbour Reserve 10.15 am-12.30pm; Sunday 4 March 2007.

Fairlight, North Harbour and Balgowlah Heights Precincts were consulted through those representatives of the Manly Harbour Foreshores Management Committee, through written correspondence and calls for submissions in local media and the Manly Council Website.

A total of 167 survey forms were returned from community and community consultation events. Among them, 152 were from Manly residents who visit North Harbour area regularly. Only forms submitted by residents were analysed.

Comments on Community Consultation

- *“ Good that this is being done to get our views”*
- *“More community consultation and feedback; great to see Council’s efforts”*
- *“This survey should be in electronic form for submission to Council. It would significantly increase the response rate; why are we still using hard copy and snail mail”*
- *Consolidate feedback of result of this and similar consultation initiatives. Put on website with summary of most mentioned issues” [placed on Council website]*

10.2 IMPORTANT ISSUES

A total of 14 issues were indicated on the questionnaire. Respondents were requested to identify issues of importance within the study area from among these 14 identified issues. Respondents identified, on an average 8.8 issues as important. The five most frequent responses to issues included:

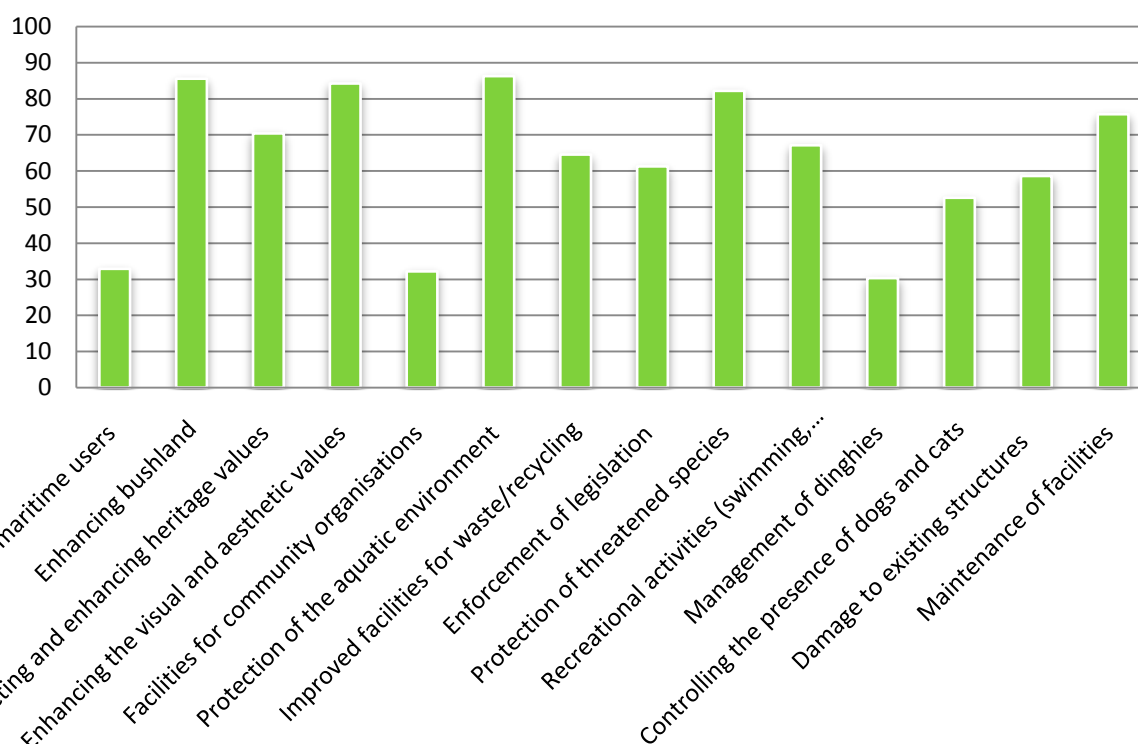
- Protection of aquatic environment (86.2%),
- Protection & enhancing bushland including wildlife corridors (85.5%),
- Protection & enhancing the visual & aesthetic values of the area (84.2%),
- Protection of threatened species (82.2%) and
- Maintenance of facilities (75.7%).

The high indication for the protection of the aquatic environment, protection of threatened species and protection and enhancement of bushland shows the community are aware and keen to preserve their surrounding environment.

The high visual aesthetics of the study area and the presence of the Manly Scenic Walkway had respondents show their preference for protecting and maintaining the current level of the landscape.

Maintaining existing areas for recreation is important to the community.

Fig 10.2 Important Issues in Management of North Harbour



A full compilations of specific comments recorded within the questionnaires is provided in **Appendix A**.



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10.3 KEY MANAGEMENT ISSUES

A long list of management issues was identified mainly from filled in survey forms (**Appendix A**). Further, specific local issues were derived during three community consultation field days. These issues are presented and discussed at the Harbour Foreshore Management Committee meeting on 24th June 2008 and are summarised under six key broad based management issues, as given below., These headings have been retained throughout this report.

- Aquatic/Inter-tidal Habitat Conservation & Management
- Bushland/Terrestrial Habitat Conservation & Management
- Upgrading & Enhancement of Public Facilities
- North Harbour Reserve Improvement
- Hazards & Climate Change
- Heritage Conservation & Management

10.4 MANAGING KEY ISSUES

Community's perceptions of managing these six key issues are presented below. These were discussed in detail at the 'Harbour Foreshores Management Committee' meetings. Possible solutions offered by community through survey forms are presented in boxes. These will form the basis for identifying management options/actions.

Aquatic/Inter-tidal Habitat Conservation & Management

Protection of endangered species is an important issue for the community. There is a concern over spread of exotic invasive marine pest, *Caulerpa taxifolia* probably from boating activity. People desire mangrove plants in the area. North Harbour Aquatic Reserve must be better managed.

People have observed a new Penguin colony near Treharne moorings. A small colony of soldier crab is located on the sand bank at the far south west end of North Harbour. This colony surfaces one or two days each year. However, pedestrians and dogs are threat to these soldier crabs.

Pumping for yabbies on the sandbank should not be allowed as Pelicans look for food.

Improved water quality is essential for aquatic ecosystem health.

COMMUNITY RECOMMENDATIONS

- Protect endangered species, such as seahorses and Little Penguins.
- Protect the community of soldier crabs at the far south west end of North Harbour,
- Re-establish mangrove plants
- Investigate presence of a new Penguin colony near Treharne moorings and implement measures to protect this habitat
- Introduce 'No Take' zone to protect aquatic species

Bushland/Terrestrial Habitat Conservation & Management

There is wide support to maintain as much bushland as possible within the study area. There is need for conservation of native vegetation and weed control through bush regeneration activities. Address the causes of weed infestations rather than spraying weeds with chemicals. Weed reduction works, so far, have been successful but there is need to continue good works. Do not plant anymore Coastal Rosemary. Concerns were expressed that bushland has many exotic species. Dogs threaten protected species, lizards, and wading birds.



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COMMUNITY RECOMMENDATIONS

- Plant more judicious low growing plants for birds & small animal habitat.
- Enhance habitat for birdlife between Condamine St and Forty Baskets
- Maintain the open-space for passive recreation and the bushland setting

Upgrading & enhancement of public facilities

This is a special area and one of the few passive recreational areas in Manly. Increasing popularity of the area is considered as a problem by residents. Hence, there is need for upgrading and maintenance of various types of public facilities to cater for all users.

Landscape improvement & view maintenance: Don't over develop the area. Reef and Shelly Beaches have lost their charm with un-sympathetic development. There is no need for additional structures such as paths or concrete around waterfront. However, there is need to ensure proper maintenance of existing structures. Retain low key appearance of bridge between Clarence St and Gourlay Ave.

All tall trees (not the NI Pines) and shrubs between Federation Point and Delwood beach are excessive and are blocking the view. It is difficult to view water, at some places, as one walks the path.

Consider allowing 2-storied, maximum 3-storied buildings on waterfront.

COMMUNITY RECOMMENDATIONS

- Better manage erosion of foreshore areas
- Upgrade of existing stone seawall to improve stability and appearance
- Dredging needs in North Harbour western sand areas/foreshore
- Footbridge from Clarence Street to Gourley Ave should be kept and maintained, not left to decay.
- Upgrade Esplanade Park to shared path status providing a safe link for cyclists to Manly Wharf.
- Remove or thin some tall trees & shrubs between Federation Point and Delwood Beach

Fishing: It is heartening to see fish returning into the bay more plentifully since the netting of fish has stopped. Therefore, there is more food for penguins, pelicans and more big bream around the Marinas. However, there occur illegal fishing practices, improper rubbish disposal, over harvesting of intertidal species for bait, undersized fish catching, removal of shellfish and other items from rocks.

COMMUNITY RECOMMENDATIONS

- Educate recreational fishers
- More monitoring of catches by National Parks & Reserves
- Restrict fishing on rocks

Boating: There is overall community support for passive boating such as sailing, rowing or paddling. There is concern for overcrowding of boats and dinghies which cause pollution in waterways and noise during high use periods. Moorings are taking up too much of the Harbour leaving less open area. Power boats go dangerously close to snorkers off Fairlight.

Community feels that existing boating facilities are either adequate or in excess for the area. Two commercial boatshed businesses are located, one in a residential area the other on a pedestrian strip (end of Gourlay Avenue). People are both supportive and opposed to the development of the Trehearne boatshed. People prefer improved public access to boating and kayak activities. Manly needs a public wharf (there are three in Mosman Bay) and North Harbour would be ideal.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

COMMUNITY RECOMMENDATIONS

- Construct a public wharf at North Harbour
- Create kayak facilities such as ramp
- Control mooring numbers

Access for Walkers & Disabled: Walking has been identified as an important activity in the study area. Many sections of these walkways lack signage, handrails, lighting. Better lighting is needed to deter vandalism. Walking track along foreshore needs widening and some more shade trees. No provision for people with disabilities. Footpaths, curb ramps are not wheel chair or scooter friendly.

Community is divided in its support and opposition for the provision of board walk along foreshores.

Steps down from The Crescent to Delwood Beach are too steep and difficult for people with prams, toddlers and the elderly.

COMMUNITY RECOMMENDATIONS

- Construct a footpath on both sides (exists on one side now) of Condamine Street
- Improve signage, lighting on walkways, place handrails on some sections.
- Find an innovative way to get wheelchair access.
- Encourage walkers to use the low tide sand route rather than clashing with local traffic when heading between Davis Marina and North Harbour Reserve.
- Provide a boardwalk beside/over the shoreline to keep walkers on the foreshores rather than on backstreets.
- Investigate possibility of water level board walks below King Avenue.
- Make steps from the Crescent to Delwood Beach user friendly to elderly, toddlers and people with prams.

Waste Management: Amount of rubbish and cigarette butts around is depressing. Lots of rubbish (paper, plastic, timber) washed up from Fairlight to North Harbour. People should be fined for littering. Beaches are not cleaned daily. Tourists often leave rubbish in bushes and on walkways. Pollution from dog faeces is increasing.

COMMUNITY RECOMMENDATIONS

- More rubbish bins to help litter problem. Recycling bins needed at Delwood & Fairlight Beaches.
- Daily cleaning of harbour beaches should be done so that rubbish does not get carried out to sea. Extra provisions in summer months.
- Provision of rubbish barge to clean up plastic from water during summer months (when north eastern blows).
- Provision for more dog waste bags

Stormwater Pollution: Pollution has been identified as a key issue. The amount of pollution that enters the Harbour after heavy rain needs to be addressed, particularly from the storm water outlet under the footbridge to Gourlay Ave. Stormwater drain that flows into North Harbour needs to be cleaned up regularly to preserve water quality in the area. This is more important near swimming areas.

COMMUNITY RECOMMENDATIONS

- Prioritise storm water recycling rather than discharge
- Screens on stormwater pipes to prevent rubbish deposit on sand and harbour
- Provision of treatment devices on each stormwater pipe that discharges into North Harbour



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Manly Scenic Walkway: It is a world class walkway. The walkway needs improvement at some sections (from Esplanade to North Harbour Reserve), especially trimming of grass on pathways, removal of dead branches of trees and palms. There is difference of opinion on the need of cycleway on the walkway.

COMMUNITY RECOMMENDATIONS

- Place signage depicting key points of environmental interest (i.e. Fairy penguin colony, etc).
- Detailed map/leaflet with clearer walkway direction.
- Provide a variety of items for users to look at along the walkway e.g. sculpture
- Provide additional shade along Manly Scenic Walkway

Fairlight pool & beach: One respondent has criticised that no consultation was done before installation of fence at the pool.

COMMUNITY RECOMMENDATIONS

- Maintain water quality of Fairlight pool.
- Continuous pumping of water into/out of pool is needed.
- Existing shower to have automatic cut off
- Better access for wheelchairs & prams
- Bike rack at Fairlight Beach (near access lane)
- No dogs on beaches
- Plant fast growing trees to afford shelter from sun at the pool. Plant palms (like that at Shelly Beach).
- New turf needed above Fairlight Pool (prepare ground well first)

Traffic Management: Parking is a huge issue to residents...Traffic needs to be slowed down on Condamine Street for safety of kids. Traffic restrictions on Condamine Street adjacent to NH Reserve are not effective at present. 2-hr parking permits are not monitored routinely.

COMMUNITY RECOMMENDATIONS

- Control the spread of cars in shared streets and car parks around reserve areas
- Provision of better parking for North Harbour Reserve
- Enforcement of 2hr. parking in residential area
- Lower speed limits on Condamine Street for safety of kids
- Arrange speed humps in Fairlight Crescent to avoid fatal accidents from speeding vehicles.
- One way flow of traffic through Lower Beach Street and North Harbour Street

North Harbour Reserve Improvement

The beauty and environmental aspects of the North Harbour Reserve (NHR) should be preserved. The Reserve being the central recreation area, there is need and room for its overall further improvement. NHR improvement has been identified as one of the main issues for consideration in North Harbour CMP.

Steps to NHR are uneven and quite dangerous. The original Bicentenary Walkway plan included a ramp pathway for wheelchair or stroller access to NHR. This has not been installed. The footpaths along the water in NH Reserve is absurdly narrow leading to major erosion – needs widening to at least 2.5m

Rocks supporting North Harbour seawall pose risk to some. One elderly lady stumbled and fell onto rocks. At least two children chasing balls have gone over the edge onto the rocks.

The toilets at NHR are very dark and dingy, need upgrade. Present toilet facilities –really disgraceful, very old & inadequate systems (cisterns) [This has been upgraded in recent months].

No dinghy storage should be constructed within NHR.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

There is a need for fencing around the play area because of the issue dogs and interaction with children, however some suggested fencing all around the park. Others consider fencing the area would be a drastic action spoiling the look of the reserve.

Historical information in the south-eastern corner of the reserve has been vandalized and needs replacing.

There is doubt about the possible health risk from sand/soil near the North Harbour waterfall and the North Harbour in general. Sand near the water fall or the cut through is black/blue –it smells.

Make the park out of bounds at night.

COMMUNITY RECOMMENDATIONS

- A wide path from King Ave end of North Harbour Reserve to enable better access for prams and walkers, especially during wet periods. The footpaths along the water need widening to at least 2.5m.
- There should be a graded path (not steps) from NH Reserve to King Ave. for parents with strollers, the disabled and cyclists
- Provision of better parking for North Harbour Reserve.
- Upgrade toilets with solar powered lights and light coloured paint to interior
- Additional seating/tables under trees for picnickers. Place rubber matting/improve bases of picnic tables and seats.
- Install at least two more stainless steel BBQs.
- More dog poo bags across the park
- More bins in picnic areas
- A small shelter at NHR
- A second basketball hoop at a lower height for younger children
- Fencing the whole NHR or at least children's play area.
- Establish a small garden for wedding parties and photography, emphasise planting of native trees.
- Bike/scooter track around the perimeter of the park
- More dog poo bag dispensers across the park.
- Box of dog toys to use (near the equipment)
- Carry out an investigation of soil/core samples of NHR fill and sand near North Harbour waterfall
- Rubbish trap on drain at north/east of NHR
- A system of recycling water from the creek flowing into the North Harbour from Clarence Street (near wooden bridge) can be examined to irrigate NHR

Hazards& climate change

Seawall maintenance is critical as it protects properties. Climate change has been identified as one of the main issues for consideration in North Harbour CMP. Unless we address the root causes of global warming, such as excessive car use, efforts to mitigate the results will be wasted.

COMMUNITY RECOMMENDATIONS

- Repair seawalls, replace large rocks
- Provide real active transport infrastructure that will encourage people to walk & cycle more

Conservation of heritage

Knowledge on indigenous or post-European heritage is very valuable and gives a better appreciation of the area as a whole.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

COMMUNITY RECOMMENDATIONS

- Protect heritage areas particularly the Aboriginal sites
- Continue efforts to protect older (pre 1960's) buildings/structures along the Scenic Walkway
- Preserve maritime heritage in North Harbour (Boatshed)
- Preservation of coastline natural features (geoheritage)

10.5 PRECINCT'S FEEDBACK

North Harbour Precinct has identified a number of broad issues, as elaborated below, to be addressed and acted upon accordingly as part of the North Harbour Coastal Management Plan. These are consistent with Issues and activities identified in "Community Consultation and Key Concerns".

Protection of the aquatic environment

- remedy the stormwater pollution, other pollution and erosion problems
- stop infrastructures being built along the foreshores
- review the current health of the aquatic environment and remedy pollution problems
- replant native seagrasses and other aquatic flora as appropriate
- for the collection of rubbish in areas where existing road access is not available, waste removal to be collected by barge to prevent foreshore, bushland or land based erosion. For example, the beach area below Number 1 King Avenue where the rubbish is collected by Maritime NSW collects the rubbish.

Bushland conservation, regeneration and enhancement and Enhancing aesthetic values

- conservation of existing bushland
- continuation and expansion of efforts for bush regeneration
- stopping erosion
- no more built structures along the foreshores or in bush areas
- no more sea walls
- no more boat ramps (with exception of existing ones in the areas on southern shore near Davis Marina)
- no boats, dinghies, canoes or surfboards to be stored in North Harbour Reserve or immediate surrounding areas or bushland
- all dinghies, canoes, surfboards to remain on southern side of shore lines near the Davis Marina area
- any storage infrastructure near Davis Marina to have minimal bulk and profile; e.g. horizontal dinghy storage at 40 Baskets beach.

Protection of threatened species

- Maintain bushland including shrubs and the variety of trees, including dead trees as these provide habitat for many species
- Protect fauna and flora in the littoral zones
- Minimise infrastructure such as hard roads, fix poor drainage such as that near the Sailing Club, install environmentally friendly pathways to minimise erosion of surrounding areas.

Protecting and enhancing heritage values

- ensure Aboriginal middens and other areas protected
- no new infrastructure or installations.

Recreational activities

- optimal opportunities for walking, jogging, picnicking, swimming and other family or individual activities



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

- maintain pleasant and unstructured environment
- review “off the leash” dog rules.

Maintenance of facilities and Improve facilities for waste recycling

- Explore the capture of, and use for, stormwater especially near the western side of Condamine Street
- Explore underground stormwater tanks to collect water for re use in park, toilets,

Enforcement of legislation

- More patrolling especially at Federation Point

North Harbour Reserve – specific recommendations

- Preserve and nurture existing trees and avoid loss of mature trees, as has happened in Hyde Park and the Domain.
- Improve the pathway along the eastern edge of the park
 - explore planting hardy native grasses (no more than 50 cm tall) along western edge of the pathway to help regenerate the grass in the park, reduce erosion and protect existing grass
 - if pathway is to be widened, ensure that it is keeping with the ambience of the park
- Hand rails on steps on northern and southern steps
- No boat storage in the park and immediate surrounds
- Maintain minimal infrastructure in park
- Toilets being upgraded
- Noise issues from the Basketball hoop and backboard on southern side of park – either remove whole structure or the backboard. There is constant use of this structure in the middle of the night and early hours of the morning. This generates significant noise for the neighbouring homes. Explore options to solve this noise pollution problem.
- Dogs off the leash in the park
 - review limiting “off the leash” activities
 - explore possible time zones for “off the leash” and feasibility of introducing session times such as morning session and late afternoon session.
- Cats present in the park at night to trapped and impounded.

10.6 CONFLICTING ISSUES

From community consultation, it appeared that there exist certain conflicts between different usage and user groups. In this section, only the conflicts are highlighted. It is important to balance between interests of residents, visitors, commercial activities (i.e. boatyards) with respect to the fragile environment. Possible compromises, where possible, have also been discussed. One respondent suggested effective communication between different user groups considering all issues overlap.

Dog walking: North Harbour Reserve is a dog off-leash area while West Esplanade Park is a dog on-leash area. Population of dogs (more 2-dog owners) exercised in the area is increasing. There is conflicting concern regarding dog walking facilities available in the study area. While one group sees dogs not being a problem, others believe that dogs should be banned from all parks. Then there is concern over dogs swimming and running around on tidal flats at North Harbour. Dog owners complain that they are never consulted in decisions. They like to ensure that off-leash access for dogs to North Harbour Reserve is continued undisturbed. Dog walkers form a core group who use the area at least once or twice a day. Plenty of dog exercise area is needed. There is even request for a designated doggy beach at North Harbour. Off-leash dogs in NH Reserve are danger to toddlers and elderly. Some dog owners do not pick up dog poo. Some owners ignore on-leash signage (notably on Manly Scenic Walkway at Commonwealth Parade). Enforcement by Rangers is needed to oversee responsible dog management. No dogs should be allowed on or near Fairlight & Delwood Beaches. In addition, Provision of more dog waste containers needed in the park



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Dinghy/Kayak Storage: One group sees that current haphazard storage of dinghies adds charm and character to the natural environment of shoreline. It helps in maintaining the natural appeal of the area. Others believe that dinghies on shores are dangerous and unsightly. Dinghies destroy trees. The group supports storage stacks for dinghies and kayaks on shoreline between Delwood & North Harbour. There is strong objection of constructing dinghy storage within North Harbour Reserve. All agree that there are old, broken and abandoned boats and suggest removal preferably by joint action with community stakeholders.

Cycling on the MSW: There are groups strongly for and against keeping bikes on the Manly Scenic Walkway. It would be disastrous to allow bikes on the same path as walkers, joggers with or without dogs. Compromised suggestions include a cycleway adjacent to the walkway or the path being made accessible to bike riders early in the morning and after 8pm or no cycling on Sundays. Further, there is suggestion to stop proposed cycleway along Lauderdale Avenue on grounds of safety problems.

Other conflicts are related to suggested boardwalk ways along foreshores and development of the Trehearne boatshed.



11. FRAMING VISION, GOALS, MANAGEMENT OBJECTIVES & OPTIONS

This section presents vision (Section 11.1), a set of goals and management objectives for each key issue (Section 11.2) and objectives translated into specific and strategic management options (Section 11.3).

11.1 VISION FRAMEWORK

Visioning is an important element in any planning process. Setting the future vision ensures strategic long term thinking and avoids focus on daily issues.

State & Regional Levels

NSW Government released the State Plan on 14 November 2006. It is tipped as 'A New Direction for NSW'. The Plan reflects the hopes and goals of people across NSW and the priorities for the public sector. The Plan sets out clear targets for improved outcomes and service delivery. The Plan contains 14 long term social, economic and environmental goals and 34 priority areas for action for NSW. The Priority E4 of the State Plan is

"Better outcomes for native vegetation, biodiversity, land, rivers and coastal waterways".

This has been translated into state-wide targets (Box) by the Natural Resources Commission (NRC) and adopted by the Government in the State Plan.

NRC targets adopted in the State Plan

Biodiversity

1. By 2015 there is an increase in native vegetation and an improvement in native vegetation condition
2. By 2015 there is an increase in the number of sustainable populations of a range of native fauna species
3. By 2015 there is an increase in the recovery of threatened species, populations and ecological communities
4. By 2015 there is a reduction in the impact of invasive species

Water and Coast

5. By 2015 there is an improvement in the condition of riverine ecosystems
6. By 2015 there is an improvement in the ability of groundwater systems to support groundwater dependent ecosystems and designated beneficial uses
7. By 2015 there is no decline in the condition of marine waters and ecosystems
8. By 2015 there is an improvement in the condition of important wetlands, and the extent of those wetlands is maintained
9. By 2015 there is an improvement in the condition of estuaries and coastal lake ecosystems

Land

10. By 2015 there is an improvement in soil condition
11. By 2015 there is an increase in the area of land that is managed within its capability

Community

12. Natural resource decisions contribute to improving or maintaining economic sustainability and social well-being
13. There is an increase in the capacity of natural resource managers to contribute to regionally relevant natural resource management

At regional level, the Sydney Metropolitan Catchment Management Authority (SMCMA), responsible for the coordination and management of Sydney's natural resources, adopted the following vision:

"The Sydney community has the knowledge and skill to achieve healthy waterways and bushland that all Sydneysiders can enjoy, now and in the future."



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

The SMCMA has completed its Catchment Action Plan (CAP). The CAP will guide the activities of the SMCMA while forming the basis for partnerships with the community, business, industry and government. The CAP will assist the SMCMA in ensuring that natural resource management projects are undertaken in priority areas within the catchment, and that these projects lead to the best outcomes for the environment and the community. There are four themes: biodiversity, water & coast, land and community. Under each of these, there are Catchment Targets (Box), Management Targets and Actions. One of the key Catchment Target is shown, as an example, translated into Management Targets and Actions (diagram).

SMCMA Catchment Targets

Biodiversity

Enhance ecological resilience and connectivity of bushland and aquatic habitats

- CTB1 By 2016 the extent and condition of terrestrial native vegetation in all landscapes is maintained or improved.
- CTB3 By 2016 there is an increase in the connectivity of terrestrial native vegetation.
- CTB4 By 2016 aquatic and terrestrial threatened species and Endangered Ecological Communities (EECs) and endangered populations are better conserved by implementing actions identified in the Priorities Action Statement.
- CTB5 By 2016 the impact of terrestrial and aquatic invasive species on biodiversity is reduced by decreasing the number, distribution and impact of invasive weeds, pest animals and pathogens.

Water

Enhance the positive connectivity of aquatic processes

- CTW1 By 2016 there is a net improvement in the health of modified waterways and riparian corridors and conservation of natural waterways.
- CTW2 By 2016 there is an improvement in the condition and extent of wetlands.
- CTW3 By 2016 there is measurable progress towards achieving the Water Quality and River Flow Objectives adopted for each waterway.
- CTW4 By 2016 there is an improvement in the quality and sustainable use of groundwater systems so that they are able to support groundwater dependent ecosystems and designated beneficial uses.
- CTECM1 By 2016 there is an improvement in the condition of estuaries and coastal lakes.
- CTECM2 By 2016 there is an improvement in the condition of coastal and marine ecosystems.

Land

Reduce the negative edge effects of urban expansion

- CTLD1 By 2016 there is an increase in the amount of land managed within its capability.
- CTLD2 By 2016 implement actions under the Sydney Metropolitan Strategy that recognise, protect and improve key natural resources.
- CTLD 3 By 2016 Indigenous cultural landscape values are identified, acknowledged and incorporated into all natural resource management activities and land use planning.

Community

Improve community and institutional connections between natural resources, strong communities and robust economy

- CTC1 By 2016 more people, communities and organisations have increased capacity to engage in practices that contribute to improved natural resource management.
- CTC2 By 2016 there is improved focus and collaboration between organisations that act in or influence natural resource management.
- CTC3 By 2016 there is a framework for monitoring, evaluating and reporting natural resource indicators.
- CTC4 By 2016 there is improved recognition across the community of the contribution of healthy natural resources to valued social and economic activities in the region.
- CTC5 By 2016 there is improved awareness and willingness to adopt adaptive and mitigating strategies for climate change impacts on natural resource values.

CATCHMENT TARGET

CTECM2 *By 2016, there is improvement in the condition of coastal and marine ecosystems.*

MANAGEMENT TARGETS

- MTECM2.1 By 2016 all vegetation in dune areas on public land is rehabilitated to reduce weed cover by 20% from the June 2007 baseline.
- MTECM2.2 By 2016 institutional and technical processes are in place to achieve environmentally sustainable management of beach environs.
- MTECM2.3 By 2016 active management will protect or improve key estuarine and marine habitat areas in partnership with relevant authorities and user groups.
- MTECM2.4 By 2016 there is an increase in the extent of Marine Protected areas.
- MTECM2.5 By 2016 the Sydney coastline is covered by a Coastline Management Plan.

ACTIONS

- Map aquatic habitats.
- Map barriers to fish passage and aquatic habitat connectivity.
- Prepare Estuary Management and Coastline Management Plans.
- Guidelines and regulations for structures.

Local level

Manly Council has routinely, for the last two decades, involved community in setting vision through programs like myManly, Futures Forum and Surfing the Future. Surfing the Future provides a direction to aim towards for the year 2025 for Manly Local Government Area. It establishes a 'road map' and identifies major themes. The Social Plan (MC 2004) and Manly Sustainability Strategy (MC 2006), short-term strategy documents, are developed based on themes established under Surfing the Future. The following vision statement has been adopted for 'Surfing the Future':

"A thriving community where residents and visitors enjoy a clean, safe and unique natural environment enhanced by heritage and lifestyle"

The same vision statement has been adopted in preparation of this North Harbour Coastline Management Planning process. The vision aims to provide a general statement about the future desired state of the study area. This vision statement, from the onset, establishes importance of visitors, heritage and living in harmony with natural environment and influences setting up of management objectives.

11.2 MANAGEMENT GOALS & OBJECTIVES

The Coastline Management Plan is a tool for integrating the needs and values of the environment within the development-based planning framework of local and state government. Therefore, the focus of the plan should be on addressing environmental concerns through a series of management options that are both effective and easy to implement.

The basis for the Coastline Management Plan needs to be Ecologically Sustainable Development (ESD). ESD is development that aims to meet the needs of the present, while conserving our ecosystems for the benefit of future generations. By following the principles of ESD, we should be able to reduce the likelihood of serious environmental impacts arising from our present day economic activities.

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

11.2.1 Principles of ESD

There are four basic principles of Ecologically Sustainable Development (ESD):

1. Conservation of biological diversity and ecological integrity;
2. Social equity, including inter-generational equity;
3. Improved valuation, pricing and incentive mechanisms; and
4. The precautionary principle.

These principles form the basis in deciding whether projects are consistent with ecologically sustainable objectives.

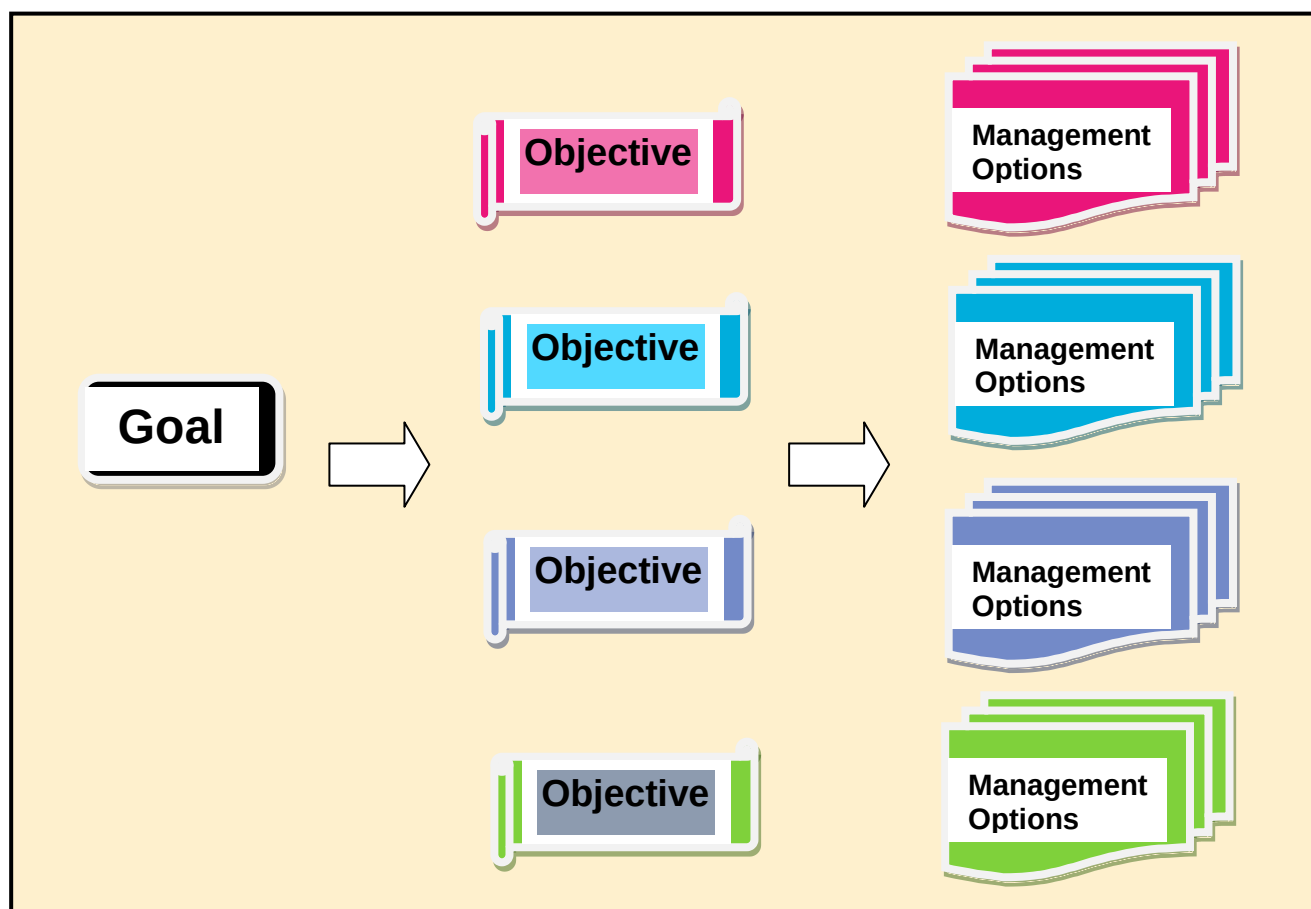
11.2.2 Formulation of Goals and Management Objectives

A series of goals and objectives for the future management of the North Harbour study area were developed on the basis of information received through the community and stakeholder consultation, input from the Harbour Foreshore Management Committee and a sound appreciation of coastal processes and human interactions.

Management Objectives provide the 'goal posts' towards which future management of the North Harbour study area should be directed. In short, the objectives aim to rectify the problems or issues facing the study area, whilst preserving and enhancing its inherent values.

Goals and objectives have been defined under a series of key management issues, as described in Section 10.3. For each management issue a goal has been defined, along with a range of management objectives that will be further partitioned into management options in the next section (**Figure 11.2.2**).

Figure 11.2.2 – Management Framework





NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Goals define aspirations of community and future direction for management with respect to the environmental, social recreational and economic sustainability and viability of North Harbour. For each goal, a series of specific objectives have been defined, which describe the requirements for specific aspects, necessary to achieve the goals. Linkages to existing policies, plan documents have been made. Coastline Management framework is detailed in **Chapter 2**.

The goals and their related objectives for North Harbour study area are presented below. In general, set goals and objectives relate to the general goal of the NSW Coastal Policy 1997, Coastal Protection Act 1979, Water Management Act 2000 and management principles described in relevant regional plans (Sydney Regional Environmental Plan – Sydney Harbour Catchment 2005, Draft Subregional Strategy: North East Subregion, July 2007), Sydney Metropolitan Catchment Management Action Plan 2008 and also Manly Local Environmental Plans and different strategy documents (details in Chapter 2).

11.3 MANAGEMENT OPTIONS

Management Options for North Harbour study area have been developed based on ESD principles and a number of practical considerations:

- options that require little or no additional out-of-pocket expenditure, with works/actions being done by Council staff, or in-kind contributions from other organisations, volunteers etc;
- innovative ideas and non-standard approaches to natural resource management;
- easy to implement on-ground works; and
- options that are scientifically defensible.

Management options are presented under each of management objectives categorized under key management issues. Brief titles of options are provided in this Chapter. Many of these options have been proposed by community during consultation meetings. Some of the proposed options, before implementation, will be subjected for further consultation with relevant agencies, Precincts and community. Detailed descriptions of each of the options are presented in the next Chapter 12.

1. AQUATIC / INTER-TIDAL HABITAT CONSERVATION AND MANAGEMENT

The key habitat management priority for the study area is to protect habitats of high ecological and coastal value. It is more cost effective to protect these areas now than to rehabilitate them in the future if habitats are allowed to deteriorate.

Four strategic objectives have been set to achieve the following defined goal:

Goal: Restore and maintain a healthy and diverse mix of aquatic and intertidal habitats	
<i>Objectives</i>	
1.1	Establish structured and community led management for an expanded North Harbour Aquatic Reserve.
1.2	Ensure all areas of ecological significance are properly protected and conserved.
1.3	Preserve existing seagrass and kelp beds.
1.4	Ensure that water quality is suitable for healthy natural habitat conservation

These objectives are consistent with aims and objectives of the Council's Local Environmental Plan (1988) and Sustainability Strategy (2006), which seek to have a positive impact on biodiversity within the study area. On a regional scale, these are complementing planning principles of the Sydney Regional Environmental Plan



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

(Sydney Harbour Catchment) 2005 and targets of the Sydney Metropolitan Catchment Management Action Plan 2008. On state level, these objectives complement NSW Coastal Policy 1997, *Coastal Protection Act 1979*, *Water Management Act 2000* and Fisheries Policy & Guidelines: Aquatic Management & Fish Conservation 1998/99.

The strategic objectives are expanded below and translated into management options:

1.1 Establish structured and community led management for an expanded North Harbour Aquatic Reserve.

North (Sydney) Harbour Aquatic Reserve lies between an imaginary line from the headlands at North Head and Grotto Point and another line joining Little Manly Point, Manly Point and Forty Baskets Beach. A formal proposal is being prepared to extend the boundaries of North Harbour Aquatic Reserve to include Manly Cove, Little Manly Cove and North Harbour.

If formally extended, it is recommended that DECC is pursued to work with Council and other key stakeholders to prepare and implement a management plan for the aquatic reserve. Community user group involvement is critical in the management of aquatic reserves. Public involvement in the management planning processes is a mechanism by which government seeks to achieve community partnership in these important places, enabling ongoing protection into the future.

Management Options:

- 1.1.1 Submit and pursue a proposal to extend the boundary of North Harbour Aquatic Reserve.
- 1.1.2 Prepare North Harbour Aquatic Reserve Management Plan and implement.

1.2 Ensure all areas of ecological significance are properly protected and conserved

North Harbour Bay supports habitats of regional, state and national conservation value including species and communities listed under different Acts. These include: 'mixed rocky intertidal & sand', 'sandy beaches' and 'seagrass beds'. Many of these ecologically important habitats are being threatened due to urban development and other external pressures. Moreover, though the whole foreshores of Sydney Harbour and all its tributaries are protected under Intertidal Protected Area (IPA), yet foreshores of North Harbour are excluded.

Management Options:

- 1.2.1 Pursue & process to declare inter-tidal areas as 'Inter-tidal Protected Area' under the *Fisheries Management Act*.
- 1.2.2 Continue managing Wildlife Protected Area at Federation Point.
- 1.2.3 Assess marine biodiversity of North Harbour including Aquatic Reserve.
- 1.2.4. Investigate presence of soldier crab colony at the far west end of North Harbour

1.3 Preserve existing seagrass and kelp beds.

Seagrass beds exist in front of North Harbour tidal flat and also in areas between the Manly Boatshed and extended southern tip in front of Esplanade Park. Anecdotal evidence suggests that the area have experienced large losses in seagrass cover. Under the *Fisheries Management Act, 1994*, all seagrass is protected, and must not be damaged or collected (DPI, 2007).

Similarly kelp beds exist throughout from Federation Point and extended southern tip in front of Esplanade Park. Kelp beds provide food, shelter and habitat to a host of other members of marine ecosystem.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

There are weed species (including *Caulerpa taxifolia*) within and around the North Harbour study area. *Caulerpa taxifolia* has been declared a Class 1 noxious species in all NSW waters under the *Fisheries Management Act 1994*.

The NSW Government has developed a comprehensive control program for *Caulerpa taxifolia* (NSW Fisheries 2004). The program includes removing the weed from sale in the aquarium trade, controlling infestations in priority areas and eradicating them where possible, educating the public and restricting the use of fishing gear to help stop the weed spreading.

Management Options:

1.3.1 Encourage DPI to support conservation of seagrass and kelp beds.

1.3.2 Encourage DPI to implement programmes in line with the 'Control Plan for *Caulerpa taxifolia* in NSW'.

1.4 Ensure that water quality is suitable for healthy natural habitat conservation

High water quality is important for natural and healthy aquatic habitat. Pollution has often been identified as a key issue. The amount of pollution that enters the Harbour after heavy rain needs to be addressed, particularly from the storm water outlet under the footbridge to Gourlay Ave. and stormwater drain that flows into North Harbour.

Management Options:

1.4.1 Install Stormwater Quality Improvement Devices (SQIDs) on major stormwater outlets that discharge into North Harbour to ensure healthy aquatic habitat.

1.4.2 Place screens on minor stormwater outfalls to improve water quality and aquatic health

2. BUSHLAND / TERRESTRIAL HABITAT CONSERVATION & MANAGEMENT

Bushland reserves occur in a total 9.93 hectares and are scattered throughout the study area. Smaller patches of bushland on both public and private land do exist throughout, and in some places provide corridors between the reserves.

Some of the impacts and causes of degradation in urban bushland are:

- increased levels of high nutrient stormwater runoff entering bushland, creating ideal conditions for weed growth
- dumped garden refuse and rubbish.
- altered fire regimes – some native plants rely on fire for regeneration
- urban encroachment on reserves
- the impact of domestic pets on flora and fauna
- poisoning trees for views

The fragmentation of natural bushland areas in Manly has reduced the viability of habitat in many bushland reserves to support populations of native fauna.

Three strategic objectives have been set to achieve the following defined goal:



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Goal: Protect and enhance urban bushland and native vegetation areas

Objectives

2.1	Continue to manage Council's Bushland Management Program.
2.2	Undertake systematic program to reduce weed cover in open spaces, reserves and bushland
2.3	Continue to encourage community participation in bush regeneration program and in native plants on public and private lands

These objectives are consistent with aims and objectives of the Council's Local Environmental Plan (1988) and Sustainability Strategy (2006), which seek to have a positive impact on biodiversity within the study area. On a regional scale, these are complementing planning principles of the Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 and targets of the Sydney Metro Catchment Management Action Plan 2008. On state level, these objectives complement SEPP19 of EP & A Act 1979 and NSW Coastal Policy 1997.

The strategic objectives are expanded below and translated into management options:

2.1 Continue to manage Council's Bushland Management Program.

The State Environmental Planning Policy (SEPP) No. 19 – Bushland in Urban Areas is targeted to protect and preserve bushland within the Greater Sydney area. It also provides for the preparation of management plans for SEPP 19 Bushland. Reserves within the study area that have been declared under the State Environmental Planning Policy No.19 (SEPP 19) are:

Bushland with SEPP 19 status

- Nolan Bush (3.00ha)
- West Esplanade Park (4.71 ha)

Recommended for SEPP 19 status (Skelton 2004)

- Bareena Park (0.21ha)
- Heathcliff Reserve (0.37 ha)

Management Options:

- 2.1.1. To structure systematic and continued bushland management, prepare a comprehensive management plan and develop a staged implementation programme.
- 2.1.2 Prepare site specific management plans for Nolan Bush and West Esplanade Park, the two SEPP 19 bushland, to fulfill statutory requirement.
- 2.1.3. Initiate processes to obtain SEPP 19 status for Bareena Park & Heathcliff Reserve.

2.2 Undertake systematic program to reduce weed cover in open spaces, reserves and bushland

A total of 41% of species within the study area's bushland are exotic. These species have reached bushland areas through escaping from gardens, illegal dumping of garden refuses, dispersion by fauna (e.g. - birds eating seeds) and illegal plantings. Impact of high nutrient stormwater on Manly Bushland Reserves was investigated (Skelton et al. 2002). High nutrient loads were found to occur at 5 of 19 sites located all over the study area. It is felt that recommendations of this study are further reviewed based on the present condition. The largest area of high density weeds is in western side of West Esplanade Park. Other high density sites are Bareena Park, Geddes Road Reserve, Brimbecom Park and Jackson Reserve.

Management Options:

- 2.2.1. Continue enhanced weeding program at high weed density areas on a priority basis.
- 2.2.2. Investigate sources of rich nutrient discharges at stormwater outlets located in bushland and implement appropriate control measures.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

2.3 Continue to encourage community participation in bush regeneration program and in native plants on public and private lands

Bush regeneration is the rehabilitation of bushland from a weed infested or otherwise degraded plant community to a healthy community comprised of endemic plants. Council has an active bush regeneration programme, working to protect and restore Manly's valuable urban bushland assisted by community bush care volunteers. This unique program is designed to allow residents greater involvement in the care of local bushland through either volunteer work or voluntary financial contribution.

Council's *Bush Friendly Neighbour* programme encourages the community to participate in creating an appropriate environment in private gardens by following some simple tips:

- choose native plants that provide food and habitat for native animals
- conserve water by mulching garden and choosing drought tolerant plants
- responsible pet care – keep dogs on a leash and cats indoors at night
- user friendly pesticides and fertilisers – natural deterrents like the native Blue Tongue lizard eliminate pests like snails, slugs and bugs.
- remove weeds from garden or other plants that invade bushland.

Manly Council also publishes 'Bushland News' quarterly.

Management Options:

- 2.3.1. Continue Community Bush Care Volunteers programme in the study area.
- 2.3.2. Continue publication of 'Bushland News'.
- 2.3.3. Continue annual 'Native Plant Giveaway' programme to support residents in maintaining native vegetations on private properties.
- 2.3.4. Continue and reassess Council's Street Tree Planting Programme within the study area.

3. UPGRADING & ENHANCEMENT OF PUBLIC FACILITIES

Infrastructure provision, more specifically social infrastructure provision is important to people. The presence of these kinds of infrastructure has a direct impact on living conditions, health and potential for economic development. Social infrastructure is usually considered as services, such as health care facilities, public toilets, schools, neighbourhood centres, parks, and opens space but also includes access to a variety of community services.

Five strategic objectives have been set to achieve the following defined goal:

Goal: Public facilities are upgraded and maintained to facilitate improved social amenity	
Objectives	
3.1	Facilitate improvements to general amenities, traffic and safety within foreshore areas, public reserves and beaches
3.2	Rationalise mooring places to minimise the impact on ecologically important sea grass beds
3.3	Ensure safe accessibility to public places including provision of disabled access
3.4	Facilitate dog walking with better provisions
3.5	Support sustainable recreational fishing



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

These objectives are consistent with aims and objectives of the Council's Local Environmental Plan (1988) and Sustainability Strategy (2006), which target the sustainable management of land within the catchment, and improved public facilities within the study area. On a regional scale, these are complementing planning principles of the Sharing Sydney Harbour Access Plan 2003, Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005, Sydney Metropolitan Strategy 2005, and targets of the Sydney Metro Catchment Management Action Plan 2008.

The strategic objectives are expanded below and translated into management options:

3.1 Facilitate improvements to general amenities, traffic and safety at foreshore areas, public reserves and beaches

Public reserves and beaches in the study area are used extensively year round for many purposes. It is important that taps, bubblers, shade, rain shelters, rails on steps, telephones, toilets, accessible toilets / showers / seating / pathways / parking / ramps / rails are maintained routinely. Graffiti on sewer structure, signage and public toilets is a problem. Though crime is not a significant issue, vandalism to facilities is problem. Parking is a huge issue to residents. Traffic needs to be slowed down on Condamine Street for safety of kids. Traffic management of the area needs a further review.

Management Options:

- 3.1.1 Enhance general amenities for public use at convenient locations
- 3.1.2 Improve and facilitate traffic management around public reserves and beaches
- 3.1.3 Install dinghy and kayak storage racks including water access within the study area.
- 3.1.4 Organise facilities for Scuba divers near Fairlight pool.
- 3.1.5 Investigate feasibility of constructing a public wharf at North Harbour

3.2 Rationalise mooring places to minimise the impact on ecologically important sea grass beds.

The study area is popular and has many mooring locations, offering convenient locations in relatively calm and secure conditions. All moorings are licensed by NSW Maritime. Moored boats are usually accessed by dinghies that are often stored in the adjacent foreshore areas. There is concern for overcrowding of boats and dinghies which cause pollution in waterways and noise during high use periods. Moorings occupy a large area of the harbour leaving less open harbour. Moorings in North Harbour encourage boats across shallow areas where there are reasonable stands of seagrass. Boat propellers act like harvesters resulting in significant damage of seagrass plants and other aquatic flora. Boat anchoring can have a similar effect on aquatic flora.

NSW Maritime is currently trialling seagrass friendly moorings in an attempt to minimise the impact of boating on seagrass beds and the aquatic environment.

Management Options:

- 3.2.1 Work with NSW Maritime to introduce seagrass friendly moorings

3.3 Ensure safe accessibility to public places including provisions of disabled access.

Walking has been identified as an important activity in the study area. A number of walking tracks along foreshore areas need widening.

Steps down from The Crescent to Delwood beach are too steep and difficult for people with prams, toddlers and the elderly.

In general, there is lack of provisions for people with disabilities. Footpaths, curb ramps are not wheel chair or scooter friendly. People (residents) with a disability raised the need for better access ways in the Manly LGA, specially increased disabled access to parks and bays.



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Management Options:

- 3.3.1 Construct paved footpath on both sides of Condamine Street
- 3.3.2 Audit disability access of all parks and bays within the study area.

3.4 Facilitate dog-walking with better provisions.

The issue of companion animals' access is very important. Dog exercising is a popular activity for many members of the community. There are number of off-leash areas along North Harbour foreshores that are frequented by the public and their companion animals. North Harbour Reserve is a dog off-leash area while West Esplanade Park including Wildlife Protection Area at Federation Point is dog on-leash area. Off-leash dogs in NH Reserve may pose danger to toddlers and elderly. The number of dogs (more 2-dog owners) exercised in the area is increasing. There is conflicting concern regarding dog walking facilities in the study area. Dogs are not permitted on any beaches or in swimming enclosures, however are commonly observed on sandflats and sandy areas between North Harbour Reserve and Davis Marina.

Management Options:

- 3.4.1 Review, in consultation with Precincts, off-leash status of the North Harbour Reserve.
- 3.4.2 Install adequate dog faeces bins, water bowl and bag dispensers.

3.5 Support sustainable recreational fishing

A total of 17% of the NSW population participate in recreational fishing. This is almost 24% of the NSW male and 10% of female population. Sydney has the largest number of recreational fishers with almost half the State's recreational fishers reside in Sydney. Recreational fishing in saltwater (offshore, coastal and estuarine waters) accounted for 76% of the NSW recreational fishing effort.

Commercial fishing used to be the largest commercial activity. However, fishing was banned throughout all of Sydney Harbour for five years, from 10 February 2006 to 9 February 2011, unless sooner amended or revoked (NSW DPI, 2006). The ban was based on the existence of Dioxins found in Sydney Harbour fish, due to contaminated sediments at various locations within the Harbour.

Management Options:

- 3.5.1 Support continuation of ban on commercial fishing.
- 3.5.2 Encourage relevant agencies to continue to monitor Dioxin levels in Sydney Harbour waters.
- 3.5.3 Facilitate recreational fishing and work with NSW DPI to educate community about rules and regulations applying to recreational fisher (bag limits, size limits and species types) through NSW Fishcare Program.

4. NORTH HARBOUR RESERVE IMPROVEMENT

North Harbour Reserve is an open harbour foreshore reserve situated on low lying reclaimed land to the east of North Harbour Bay. It has scenic harbour and marine views. The reserve is suitable for picnics, dog walking, exercise, and ball games. The Reserve is the centre piece of the study area and used extensively by residents and visitors.

Four strategic objectives have been set to achieve the following defined goal:



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Goal: Enhance safe public use of North Harbour Reserve (NHR) while preserving natural environment and beauty of the Reserve

Objectives

- | | |
|-----|---|
| 4.1 | Ascertain health safety issues from landfill and soil of NHR |
| 4.2 | Initiate and implement a Masterplan for North Harbour Reserve |
| 4.3 | Assess irrigation options for North Harbour Reserve |
| 4.4 | Improve (including disable) access in and out of NHR |

These objectives are consistent with a number of aims and objectives of the Council's Local Environmental Plan (1988) and Sustainability Strategy (2006), which target the sustainable management of land within the catchment, and improved public facilities within the study area. On a regional scale, these are complementing planning principles of the Sharing Sydney Harbour Access Plan 2003, Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005, Sydney Metropolitan Strategy 2005, and targets of the Sydney Metro Catchment Management Action Plan 2008.

The strategic objectives are expanded below and translated into management options:

4.1 Ascertain health safety issues from landfill and soil of NHR

North Harbour Reserve is established on a sandy bay which was reclaimed in 1938. Respondents during community consultation expressed concern about the possible health risk from sand/soil near the North Harbour waterfall and North Harbour Reserve in general. Accumulated sediment near upstream water fall is black/blue in colour and produces a distinct odour. North Harbour Reserve, as identified in the Manly LEP, contains potential acid sulphate soil.

Management Options:

- 4.1.1. Carry out necessary investigations to ascertain any health risk in soil and sediments at North Harbour Reserve.

4.2 Initiate and implement a Masterplan for North Harbour Reserve

Improvements in North Harbour Reserve have been made, so far, as on *ad hoc* basis. Since NH Reserve has intensive use, it is desirable that a detailed Landscape Masterplan is prepared. This Masterplan should consider suggestions made during community consultation by different user groups. Improvements should, in no way, compromise natural beauty of the Reserve.

Management Options:

- 4.2.1 Prepare and implement a Landscape Masterplan for North Harbour Reserve, in consultation with Precincts and community.

4.3 Assess irrigation options for North Harbour Reserve

North Harbour Reserve has an irrigation system but unfortunately with water restrictions, the system has not been used since it was introduced. The Reserve is located on potential acid sulphate soil. Recycling of stormwater can be considered as an option to irrigate NHR. There are two major stormwater outfalls located near NHR.



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Management Options:

- 4.3.1 Assess recycling of stormwater to irrigate North Harbour Reserve.

4.4 Improve (including disable) access in and out of NHR

Access to North Harbour Reserve is via four possible routes. All these access are narrow and pose risk to pedestrians. People with prams usually use access from the corner of Beach Street and Condamine Street, beside the toilet block via a narrow concrete walkway that goes directly to children's playground. There is also an opportunity to improve parking facilities to facilitate access.

Management Options:

- 4.4.1 Widen and upgrade access paths leading to and within North Harbour Reserve.
4.4.2 Locate and investigate suitability of graded wheel chair access
4.4.3 Investigate provision of improved parking facility at North Harbour Reserve.

5. HAZARDS AND CLIMATE CHANGE

As identified in the Davis Marina to Manly Point Hazard Definition Study, North Harbour study area is subjected to a number of hazards including beach erosion, shoreline recession, sand drift, inundation, stormwater erosion and slope & cliff instability. A number of sites have been identified as exhibiting potential risks.

Climate change is likely to have significant impacts on the region including the study area. Since 1950, Sydney region has experienced warming of around 0.8°C. The region has also experienced a significant drop in annual rainfall at a rate of approximately 55 mm per decade.

Manly Council possesses a moderate degree of vulnerability to climate change relative to other Councils within the SCCG Region. However, due to its coastlines and coastal development, vulnerability to sea-level rise and coastal hazards was assessed to be particularly high. The vulnerability of the coastline and the paucity of natural landscapes suggest the Councils' natural ecosystems have a low resilience to the effects of climate change.

Four strategic objectives have been set to achieve the following defined goal:

Goal: Assess, minimize and mitigate risks from coastline hazards and climate change

Objectives

5.1	Reduce to an acceptable level, the risk to property and risk to life as a result of slope and cliff instability identified in the Coastline Hazard Definition Study.
5.2	Reduce to an acceptable level, the risk of damage as a result of beach erosion and shoreline recession.
5.3	Protect properties and assets from the impacts of sea level rise
5.4	In consultation with Community Precinct Forums, undertake adaptation and mitigation measures in relation to climate change impacts



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These objectives are consistent with a number of aims and objectives of the Council's Local Environmental Plan (1988) and Sustainability Strategy (2006), which seeks to have a positive impact on hazard management within the study area. On state level, these objectives complement NSW Greenhouse Plan (2005) and on Commonwealth level, *Plan for Collaborative Action on Climate Change* (2006).

The strategic objectives are expanded below and translated into management options:

5.1 Reduce to an acceptable level, the risk to property and risk to life as a result of slope and cliff instability identified in the Coastline Hazard Definition Study.

A Hazard Definition Study was conducted in November 2003 for the section of foreshore between Davis Marina and Delwood Beach. The purpose of the investigation was to identify, among others, potential slope and cliff instability hazards and the likely consequences should a hazard occur. The main potential geotechnical hazards identified within the study area can be summarised as follows:

- a) localised erosion of undercuts and overhangs with subsequent rock falls from parts of the cliff line;
- b) toppling (*or forward rotation*) of blocks/overhangs from the top part of the cliff line;

A total of 14 potential risk sites have been identified. Of these, five sites, three on public and two on private land, exhibit risk to life. Manly Council has already undertaken remediation works on all three sites. The remaining two sites, sites 14 and 19 are located on private property.

Management Options:

- 5.1.1 For hazards that are located on private property, owners are contacted, reminded of the identified hazards and recommended to undertake inspections and stabilization works where required.

5.2 Reduce to an acceptable level, the risk of damage as a result of beach erosion and shoreline recession.

During storms, large waves, elevated water levels and strong winds can cause severe erosion to sandy beaches. The erosion is measured in terms of the volume of sand transported offshore or in terms of the landward movement of a significant beach feature. The current width of Fairlight Beach, measured at mean sea level, is approximately 15 m. This beach has shown a recession rate of about 0.04 m/yr which would mean that the beach would reduce in width by 0.8 to 2 m over a period of 20 to 50 years respectively. On the other hand, Delwood Beach currently has a width, measured at mean sea level, of approximately 8 m. This beach has experienced no recession over a limited study period. As these are popular beaches, it is necessary to monitor recession due both to storms and sea level rise.

Management Options:

- 5.2.1 Monitor shoreline changes of Fairlight Beach and damage, if any, of foreshore structures
- 5.2.2 Ensure future development of Fairlight Beach is compatible with erosion and recession hazards
- 5.2.3 Ensure any protective works minimise impact on beach amenity and access, and where practical improve existing amenity and access
- 5.2.4 Encourage DECC to carry out photogrammetric analysis periodically or after major storm events.

5.3 Protect properties and assets from impacts of sea level rise

It is well accepted now that Manly including the North Harbour study area will experience impacts of sea level rise. However, possible impacts at specific locations are not known. Increased sea level rise will mean that specific foreshores and intertidal areas may be permanently or intermittently inundated. This is likely to have some flow on effects on a variety of human based infrastructure, to existing vegetative communities, estuarine morphology. North Harbour Reserve poses likely risk of inundation though a definite study is yet to be made. It



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will also allow for tides to propagate up and thereby affect existing salinity regimes, which will have impacts on existing vegetative communities. During flood events the ocean surge levels may also be heightened, potentially increasing flood levels and extent. Also potential for low lying stormwater outlets being inundated leading to upstream flooding.

Potential impacts can, at present, be addressed through appropriate forward planning. Hence, future development and redevelopment at foreshores need to accommodate potential risks. This is particularly pertinent to foreshore structures such as seawalls, boat ramps, swimming enclosures.

Management Options:

- 5.3.1 Assess specific impacts of sea level rise on North Harbour Reserve and devise adaptive measures.
- 5.3.2 Assess impact of climate change on areas of ecological significance and devise adaptive measures.
- 5.3.3 Work with Sydney Coastal Councils Group to develop regional/ local level climate change model considering protection provided by existing seawalls and rocky foreshores.

5.4 In consultation with Community Precinct Forums, undertake adaptation and mitigation measures in relation to climate change impacts

Adaptation is a risk management strategy involving actions to reduce the negative impacts of climate change. Manly Council continues to undertake and support mitigation measures in relation to climate change impacts. Manly Council has pledged to reduce emissions by 25 per cent by 2010.

In 2008, Manly Council commissioned an independent analysis of the likely impacts of Climate Change on the Manly LGA and to set an appropriate range of response measures for implementation. In order to affect the measures identified in the Report, Council proposed for a special climate change levy, which failed to receive community support in a poll conducted with 2008 local government election.

Council has recently received funding from the Department of Environment & Climate Change (DECC) as part of the DECC's Local Adaptation Pathways Program for the development of a Climate Change Risk and Adaptation Strategy. This will provide a strategic approach to climate change risk management and adaptation for Manly Council and community.

Management Options:

- 5.4.1 Continue with on-going climate change mitigation and adaptation measures.
- 5.4.2 Collect and collate new information and knowledge on climate change impacts relevant to the study area/ Manly LGA.
- 5.4.3 Inform and involve community through Precincts about known impacts of climate change on the study area.

6. HERITAGE CONSERVATION & MANAGEMENT

The entire North Harbour study area was used extensively by the Aboriginals, known locally as the Gayemal clan of the Guringai tribe, who spent much of their time on the foreshores of Sydney Harbour (Aboriginal Heritage Office, 2007). The oldest Aboriginal site known in the Manly LGA is dated to about 4100 years before present' although it is expected that older sites will be discovered. There are 5 known Aboriginal sites in the study area. The area is considered to have high potential for further unrecorded sites. Therefore, seemingly unused shelters and vantage points may actually contain archaeological evidence of past Aboriginal occupation. These and other landscapes have cultural significance for generations of Aboriginal people and make up an important part of Australia's heritage.



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However, the entire study area has been populated by Europeans since soon after European settlement in 1788. Areas such as North Harbour (then called Balgowlah) became popular destination for picnic. James Jenkins Trailblazer was constructed around 1827s. This became a gateway to Pittwater, a short cut to Sydney long before Ellery's Punt or the Steamer. Home of the First Prime Minister of Australia, Sir Edmund Barton is also located within the study area.

Two strategic objectives have been set to achieve the following defined goal:

Goal: Ensure that all Aboriginal and European (cultural and natural) heritage areas in the study area are preserved and protected.	
<i>Objectives</i>	
6.1	Ensure that sites of Aboriginal heritage are protected under relevant legislations and appropriately and regularly maintained.
6.2	Ensure that all sites of non-indigenous heritage are protected under relevant legislations and in Council planning instruments.

These objectives are consistent with aims and objectives of the Council's Local Environmental Plan (1988), Social Plan (2004) and Sustainability Strategy (2006), which target conservation of environmental heritage within the study area. These are also consistent with Aboriginal Heritage Office's Manly Aboriginal Site Plan (2006), Foreshores Aboriginal Heritage Promotion, Sydney Northern Region, Site Conservation: Aboriginal Sites Works Program 2007 and Aboriginal Site Signage Report 2007. On regional scale, these complement planning principles of the Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005. On state level, these objectives complement *National Parks and Wildlife Act 1974* and *NSW Heritage Act 1997*.

The strategic objectives are expanded below and translated into management options:

6.1 Ensure that sites of Aboriginal heritage are protected under relevant legislations and appropriately and regularly maintained.

There are significant number of Aboriginal heritage items and areas within the bounds of the study area. These sites need to be protected. Aboriginal people are cultural owners and managers of information relating to their heritage. Information relating to Aboriginal history and heritage provided by members of any Aboriginal community must be treated with respect and any agreement regarding access and/or confidentiality should be honoured.

The Aboriginal Heritage office has recorded one shelter with middens, three open middens and one rock engraving within the study area (AHO & MC 2006). Within the study area, middens are located in North Harbour Reserve, West Esplanade Reserve and within Burton Bush. Middens are observed to be of varying size and length. Most midden sites are within 200 meters of a water supply. Many midden sites have been destroyed by European land uses, with substantial destruction in the early years of colonisation when middens were exploited as a source of lime (NSW Fisheries 2001).

Based on landscapes or physical setting, AHO & MC (2006) identified Heathcliff Reserve to exhibit extremely high and Bareena Park Reserve, North Harbour Reserve, Burtons Bush Reserve and Esplanade Park as high potential area to find further Aboriginal sites.

Management Options:

- 6.1.1 Review Aboriginal Site Management Report for Manly Council (2006) and associated reports to prioritise management needs and develop a plan of implementation.



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6.2 Ensure that all sites of non-indigenous heritage are protected under relevant legislations and in Council planning instruments.

There are a significant number of European built heritage items and areas within the bounds of the study area. These sites should be protected according to their level of significance. Many sites are already listed in Manly Council's LEP, Energy Australia Heritage Register and Sydney Regional Environmental Plan. It is important that due care is taken to avoid damage to known cultural sites and sites that may be culturally significant.

Management Options:

6.2.1. Ensure physical protection and maintenance of all heritage listed items.



12. DESCRIPTION OF STRATEGIC MANAGEMENT OPTIONS

Each of the management options are elaborated in this chapter with a description of context, actions, performance target, indicative costs, time frame and responsible agency (ies).

With regard to **indicative cost**, high costs are typically more than \$50,000, medium costs are between \$10,000 and \$50,000, while low costs are less than \$10,000. Many low cost options actually have minimal expenditure, as these options would be implemented by existing staff as part of normal duties.

Timeframe for Implementation: The Coastline Management Plan (once completed and adopted) will be reviewed regularly (in the course of preparing Council's Management Plan) and updated periodically. Therefore, it has been tentatively described as:

- Continued – to be implemented as part of on-going program
- Immediate – to be implemented shortly after adoption of the CMP
- Short term – to be implemented within 2 years of adoption of the CMP
- Medium term – to be implemented within 3-4 years after adoption of the CMP
- Long term – to be implemented within year 5 and beyond after adoption of the CMP

Responsibilities: Agencies and respective branches with Manly Council responsible for implementing the option have been indicated. A brief description of Agencies and their mandates are presented in **Chapter 2**.

Attributes such as performance targets, indicative costs, time frame and responsible agencies for each of the management options have also been summarised in Table 13.7.

12.1 OPTIONS ADDRESSING AQUATIC/INTER-TIDAL HABITAT CONSERVATION & MANAGEMENT

1.1.1 Submit and pursue a proposal to extend the boundary of North Harbour Aquatic Reserve.

Context: North (Sydney) Harbour Aquatic Reserve lies between an imaginary line from the headlands at North Head and Grotto Point and another line joining Little Manly Point, Manly Point and Forty Baskets Beach. The reserve extends from the seabed at these outer boundaries up to the mean high water mark between them and covers an area of approximately 260 hectares.

At the Ordinary Meeting of 17 March 2008, Manly Council moved a resolution to extend the boundaries of North Harbour Aquatic Reserve to include both Little Manly Cove and North Harbour. A formal proposal is now being prepared for submission to DECC for its approval.

Actions:

- Seek letters of support from community user groups, NGOs, research organisations, relevant agencies and Precincts
- Prepare a proposal for expansion of North Harbour Aquatic Reserve and submit to DECC and pursue for consideration

Advantages: Area under aquatic reserve will increase. Biodiversity of the area will be enhanced through expanded regulation and improved management. This will be achieved through a collaborative approach to management, education and compliance.

Disadvantages: Lack of ability for State Government to enable compliance activity

Objectives addressed:



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Performance Target: North Harbour Aquatic Reserve expanded
Indicative Cost: Staff Cost
Time Frame: Immediate
Responsible Agency: Manly Council – NR, DECC, DPI and other institutional partners

1.1.2 Prepare the North Harbour Aquatic Reserve Management Plan and implement.

Context: NSW Department of Environment and Climate Change (DECC) is currently responsible for the administration and management of NSW Aquatic Reserves. NSW Aquatic Reserves are managed under the Fisheries Management Act 1994 and the Fisheries Management (Aquatic Reserves) Regulation 2002. Under s197.A of the Fisheries Management Act 1994 the Minister for Environment and Climate Change may make arrangements for the preparation of a Management Plan for an Aquatic Reserve.

DECC has already agreed in principle to prepare North Harbour Aquatic Reserve Management Plan. A MoU to effect this between DECC and Manly Council has been formalized.

Community involvement is critical in the management of aquatic reserves. Through public involvement in management planning processes and in implementation, the Government and Council seek to achieve community partnership, providing ongoing protection for the future.

Actions:

- Establish a multi-stakeholder Working Group ensuring wider community representations.
- Assess the current health (including pollution status) of the reserve and take appropriate measures
- Carry out User's Survey
- Conduct community consultation and seek input in identifying management options
- Identify management options in consultation with the Working Group
- Implement the Management Plan and encourage community monitoring during implementation

Advantages: This will guide measures to protect biodiversity and varied marine life and habitats of North Harbour Aquatic Reserve.

Disadvantages: Restrict all types of fishing in all or part of the reserve

Objectives addressed:

Performance Target: Management Plan prepared and implemented

Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: DECC and Manly Council – NR

1.2.1 Pursue & process to declare inter-tidal areas as 'Inter-tidal Protected Area' under the Fisheries Management Act.

Context: Foreshores of Sydney Harbour and all its tributaries are protected under Intertidal Protected Area (IPA) excluding foreshores of North Harbour. Excluded areas are foreshores north of a line from Manly Point to the south end of Forty Baskets beach.

There are currently nine IPAs in NSW. These are temporary fishing enclosures and complement the NSW marine protected area system by protecting rocky shore intertidal invertebrates. IPAs extend from the mean high water mark to 10 meters seaward from the mean low water mark. IPAs are declared



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under the Fisheries Management Act 1994 and are managed by NSW DPI. The aim of these IPAs is to minimize threats and to ensure the sustainability of rocky shore animals and plants.

Actions:

- Prepare a background paper and proposal for declaring rocky foreshores of North Harbour as IPA.
- Collect and collate letter of support from relevant agencies and Precincts
- Submit the proposal to DPI and pursue for its approval

Advantages: Area under IPA will increase. Biodiversity of the area will be protected.

Disadvantages:

Objectives addressed:

Performance Target: Proposed intertidal areas declared as IPA.

Indicative Cost: Staff Cost

Time Frame: Immediate

Responsible Agency: Manly Council – NR, and DPI

1.2.2 Continue managing Wildlife Protection Area (WPA) at Federation Point.

Context: A small colony of Little Penguin has nested at Federation Point east along the foreshore behind Manly Pier. For the conservation of Manly's endangered population of Little Penguins, Council designated the foreshore area of Federation Point a Wildlife Protection Area (WPA). Administered under the Companion Animals Act 1998, the designation of the WPA precludes dogs and cats from the foreshore. To coincide with the designation of the WPA the stairs and boardwalk/walkway around to Ocean World has been made a dog 'on leash area'. Signage has also been installed.

During community consultation, some local residents have reported sighting of Little Penguin near Treharne boatshed. This should be investigated.

Actions:

- support continuation of the WPA.
- support Penguin Wardens to patrol the area
- improve educational/interpretive signage
- improve fencing to restrict companion animal interactions with Little Penguin
- Investigate existence of Little Penguins near Treharne boatshed.

Advantages: Little penguin habitat protected and population size increased.

Disadvantages:

Objectives addressed:

Performance Target: WPA maintained and continued

Indicative Cost: Low

Time Frame: Continued

Responsible Agency: Manly Council – Natural Resources, Precincts

1.2.3 Assess marine biodiversity of North Harbour including Aquatic Reserve.

Context: North Harbour Aquatic Reserve has been established to protect biodiversity and representative samples of varied marine life and habitats. Baseline data on diversity and abundance of marine and estuarine species within the Reserve was collected in 2003/04 and can be viewed at:

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<http://www.urgdiveclub.org.au/Research/NHARProject/tabid/71/Default.aspx>

The baseline study was designed following a reproducible methodology permitting subsequent analyses of changes in the Reserve's ecology. Methodology for the North Harbour Biodiversity Research can be viewed at:

<http://urgdiveclub.org.au.85.seekdotnet.com/Portals/0/Research/Page3/EnvirofundNHARProcess.pdf>



Action: The option involves organising follow-up survey in 2009-10 following the methodology used during baseline study.

Advantages: This will identify possible changes and status of biodiversity. Results will be used to take appropriate management interventions.

Disadvantages:

Objectives addressed:

Performance Target: Investigation completed

Indicative Cost: Medium

Time Frame: Medium term

Responsible Agency: Manly Council – Natural Resources & DECC

1.2.4. Investigate presence of soldier crab colony at the far west end of North Harbour

Context: Soldier crabs are listed as endangered population. If present, it is important that the colony is protected. During community consultation, some local residents have reported sighting of soldier crab colony on sand flats of North Harbour.

Action: The option involves further investigation to locate soldier crab colony in order to facilitate their protection.

Advantages: This will identify possibly identify soldier crab colony within the study area and help in implementing protection measures.

Disadvantages: -

Objectives addressed:

Performance Target: Investigation completed

Indicative Cost: Low

Time Frame: Medium term

Responsible Agency: Manly Council – Natural Resources, Precincts

1.3.1 Encourage NSW DPI to support conservation of seagrass and kelp beds.

Context: The total seagrass bed within the study area is 2.79ha. Seagrass beds exist in front of North Harbour tidal flat and also in areas between the Manly Boatshed and extended southern tip in front of



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Esplanade Park. Kelp (Ecklonia radiata) beds are present on rocky substrate on the eastern side of the study area and occur on 4.32 ha area.

Seagrass and Kelp beds provide extremely important aquatic habitat by providing food and shelter for a variety of juvenile fish and invertebrate species. Many such species are of considerable value to recreational and commercial fishing industries. Hence, it is important to conserve existing beds. These areas are identified as Wetlands Protected Area under Sydney Regional Environmental Plan (Sydney Harbour Catchment), 2005.

Actions:

- Periodic updates of macrophyte distribution map within the study area.
- Facilitate measures to remove/ reduce threats to seagrass so as to foster natural re-establishment e.g. seagrass friendly moorings, water sensitive urban design.
- Conserve seagrass beds through community education and compliance monitoring.
- Ensure water based development does not negatively impact on marine vegetation.

Advantages: Continued conservation of these ecologically valuable habitats.

Disadvantages:

Objectives addressed:

Performance Target: Areas of seagrass and kelp beds maintained.

Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: NSW DPI, Manly Council – NR, NSW Maritime, SMCMA

1.3.2 Encourage NSW DPI to implement programmes as elaborated in ‘Control Plan for *Caulerpa taxifolia* in NSW’.

Context: *Caulerpa taxifolia* is currently being managed by NSW Department of Primary Industries, who are involved in the research and application of a range of methods to control this noxious aquatic weed. Various methods of control have been trialled, including:

- Salt Treatment – smothering outbreaks with thick layers of salt to poison the plant
- Matting – covering outbreaks with matting to remove its ability to photosynthesise
- Hand picking – divers remove outbreaks by hand

*The various methods have had limited success, although none have proven to be completely effective in all situations, and *Caulerpa* continues to be a component of the marine environment within the study area. Handpicking has not proved an effective treatment method due to the potential for dispersal and colonisation of fragments during the activity and the time intensity required undertaking the exercise.*

*Council, NSW Maritime and the SMCMA should support DPI in their endeavours to manage this species from North Harbour study area, particularly by way of community education programs and implementation of the NSW *Caulerpa* Control Plan (2004). This Plan is currently being reviewed.*

Action: The option involves implementation of the *Caulerpa* Control Plan. In addition, encourage community including estuary users to report sightings of *Caulerpa taxifolia*.

Objectives addressed:

Performance Target: Control Plan implemented

Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: DPI (Fisheries), SMCMA, SCCG, Manly Council – NR

1.4.1 Investigate feasibility of installing Stormwater Quality Improvement Devices (SQIDs) on major stormwater outlets that discharge into North Harbour to ensure healthy aquatic habitat.

Context: High water quality is important for healthy aquatic habitat. However with all nine sub-catchments within the study area draining directly into the waters of North Harbour, water quality may deteriorate following rainfall. Manly Council is committed to contribute to improving stormwater quality to protect the health of harbour waterways.

Further, there is strong community demand to install Stormwater Quality Improvement Devices (SQIDs) including GPTs on all major stormwater outlets where feasible. It is essential that installation of new SQIDs is based on current best practice technologies.



Actions:

- Assess current best practice technologies
- Prioritise installation of SQIDs based on modelled pollutant loads and available funding resources.
- Liaise with Sydney Water and other relevant agencies.

Advantages: With new SQIDs, significant improvements to the water quality could be expected particularly through solids, litter, sediment and nutrient capture. This would in turn improve the aquatic habitat, possibly resulting in more abundant or diverse aquatic fauna.

Disadvantages: Increased cost; cannot be implemented if funding is not secured.

Objectives addressed:

Performance Target: SQIDs installed

Indicative Cost: High

Time Frame: Medium term

Responsible Agency: Manly Council – Natural Resources & Urban Services

1.4.2 Place screen/gully pit devices on minor stormwater outfalls to improve water quality and aquatic health

Context: There are three major and 13 minor outfalls discharging stormwater directly into the waters of North Harbour. Manly Council is committed to contribute to improving stormwater quality to protect the health of harbour waterways.

Discharged water, apart from carrying pollution loads, also deposits rubbish. Screens placed on minor outfalls can prevent the deposit of rubbish into water.

Actions:

- Assess current best practice technologies
- Place screen/gully pit devices on minor outfalls.
- Clean devices periodically.



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Advantages: Removes gross pollutants from stormwater, which otherwise will pollute water of North Harbour

Disadvantages: System clogs if not regularly cleaned. Increased cost

Objectives addressed:

Performance Target: Screen / gully pit devices installed, Decreased volume of gross pollutants entering Harbour from study area catchments.

Indicative Cost: Medium

Time Frame: Medium term

Responsible Agency: Manly Council – Natural Resources & Urban Services

12.2 OPTIONS ADDRESSING BUSHLAND/TERRESTRIAL HABITAT CONSERVATION & MANAGEMENT

2.1.1 To structure systematic and continued bushland management, prepare a comprehensive management plan and develop a staged implementation programme.

Context: Manly has a rich diversity of natural landscapes protected in around 55 hectares of bushland reserves. Nearly 90% of Manly's natural environment has been degraded to some extent due to human activities (Manly Council 1997).

The Local Government Act 1993 requires that all Councils establish Plans of Management for their Parks and Reserves. The management of bushland areas within Manly are covered by a number of plans and programs. Plans of Management that cover bushland areas have the objectives of ensuring the ongoing ecological viability and biodiversity of the land, protection of aesthetic and scientific values, restoration of degraded bushland and to protect landforms and bushland as a natural stabiliser of the soil surface. Whilst these plans and programs satisfy the requirements of the Local Government Act 1993 (as amended), there is merit in preparing a Bushland Management Plan for Manly to encompass all the bushland areas.

A Bushland Management Plan would focus on preserving and regenerating Manly's bushland areas. The Plan would detail the staging, appropriate techniques and methodology for implementation of bushland restoration, various site specific Plans of Management, Threatened Species Conservation Act 1995 and the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999.

Actions: The preparation of a Bushland Management Plan would be undertaken by Council's Bushland Management staff in consultation with the various volunteer bush care groups and the community. The plan should address regular regeneration, weeding, view maintenance, bushfire management and storm water runoff issues. The aims and objectives of the plan would be to:

- manage bushland for its aesthetic, recreational, educational and scientific value to the community, and to maximise these values as part of Manly's natural heritage
- manage bushland in a way that maintains biodiversity of indigenous species in the long term
- fulfil Council's responsibilities under other community and Government plans and programs, NSW legislation.

Advantages: Provides a holistic approach to bushland management of the area. The report will provide more structured and prioritized actions considering all options.

Disadvantages: Plan preparation is time consuming and costly. Value of the Plan is lost if not implemented readily.

Objectives addressed:

Performance Target: Bushland Management Plan prepared

Indicative Cost: Medium



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Time Frame: Medium term
Responsible Agency: Manly Council- Parks & Reserves

2.1.2 Prepare site specific management plans for Nolan Bush and West Esplanade Park, the two SEPP 19 bushland, to fulfill statutory requirement.

Context: The general aim of SEPP No. 19 – Bushland in Urban Areas is to protect and preserve bushland within the Greater Sydney area. It requires that bushland not be disturbed without the consent of Council. The SEPP also identifies the need to prepare management plans for SEPP 19 Bushland areas. This Policy is integrated into Council's Development Application process. The following two reserves within the study area have State Environmental Planning Policy No.19 (SEPP 19) status:

- Nolan Bush (3.00 ha)
- West Esplanade Park (4.71 ha)

Action: The option involves preparation of site specific management plans for these bushland parcels.

Advantages: Statutory requirement is fulfilled. These bushland will be subjected to planned and structured management.

Disadvantages:

Objectives addressed:

Performance Target: Management Plans prepared

Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: Manly Council – Parks & Reserves

2.1.3 Initiate processes to obtain SEPP 19 status for Bareena Park & Heathcliff Reserve.

Context: Skelton et.al. (2004) classified two additional reserves within the study area that meets the definition of SEPP 19 status and recommended formalisation of their approval. These are:

- Bareena Park Bushland (0.21ha) and
- part of Heathcliff Reserve (0.37ha).

The general aim of SEPP No. 19 – Bushland in Urban Areas is to protect and preserve bushland within the Greater Sydney area.

Action: The option involves Council seeking SEPP 19 status for these two bushland parcels.

Advantages: SEPP19 status will ensure these important bushland parcels are provided with legislative protection.

Disadvantages: Attention has to be diverted from other bushland areas

Objectives addressed:

Performance Target: SEPP19 status obtained

Indicative Cost: Staff time

Time Frame: Short term

Responsible Agency: Manly Council – Parks & Reserves



2.2.1 Continue enhanced weeding program in high weed density areas on a priority basis.

Context: There are 139 weed species recorded within the study area. These species have reached bushland areas by escaping from gardens, illegal dumping of garden refuses, dispersion by fauna (e.g. - birds eating seeds) and illegal plantings. The largest area of high density weeds is in western portion of West Esplanade Park. Weed management will involve seasonally prioritised strategies.

Actions:

- Provide priority attention to weed growth in West Esplanade Park
- Control weeds using appropriate bush regeneration methods to minimise disturbance to the environment.
- Take steps to prevent dispersal of weeds
- Follow Weed Management Strategy 2007-11 for Sydney Metropolitan CMA.

Advantages: Contributes in healthy native vegetation

Disadvantages: Labour intensive, must ensure sufficient maintenance

Objectives addressed:

Performance Target: Weed density lowered

Indicative Cost: Low

Time Frame: Short term

Responsible Agency: Manly Council – Parks & Reserves

2.2.2 Investigate sources of rich nutrient discharges at stormwater outlets located in bushland areas and implement appropriate control measures.

Context: Impact of high nutrient stormwater on Manly Bushland Reserves was investigated (Skelton et al. 2002). High nutrient loads were found to occur at 5 of 19 sites located within the study area. The source of nutrients was not investigated but possible causes include sewage leaks, incorrect use of lawn and garden fertilizer and disposal of dog faeces down the drain (Skelton et al. 2000).

Actions:

- Inspect all sites and record any observable sources of contamination
- Investigate leakage by CCTV, dye testing or other measures
- Implement appropriate control measures at sources
- Liaise with Sydney Water to minimize sewage leaks & illegal connections within the study area.

Objectives addressed:

Performance Target: Control measures implemented, improved water quality

Indicative Cost: Medium

Time Frame: Long term

Responsible Agency: Manly Council- Parks & Reserves, Natural Resources

2.3.1 Continue Community Bush Care Volunteers programme in the study area

Context: The Manly Council Bushcare Programme encourages the community to get involved in the protection and restoration of precious urban bushland. Bushcare groups work each week in a variety of bushland areas.



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Bushcare activities include

- *encouraging natural bushland regeneration by removing weeds*
- *native plant and weed species identification*
- *recreating bushland by planting native species*
- *erosion control and mulching*
- *recreating habitat.*

Council supports the bush care programme by providing qualified supervisors, tools and gloves to use on site, plants and mulch as needed along with additional support.

Action: *The option involves continuation of the program encouraging wider community participation.*

Objectives addressed:

Performance Target: *Program supported & continued with increased volunteer participation*

Indicative Cost: *Low*

Time Frame: *Continued*

Responsible Agency: *Manly Council- Parks & Reserves*

2.3.2 Continue publication of 'Bushland News'

Context: *Manly Council publishes Bushland News regularly and circulates the publication widely among community. It contains information about bush care activities, council initiatives, technical information and other relevant stories. This newsletter is popular among readers.*

Action: *The option involves continuation of the newsletter.*

Objectives addressed:

Performance Target: *Publication continued*

Indicative Cost: *Low*

Time Frame: *Continued*

Responsible Agency: *Manly Council- Parks & Reserves*

2.3.3 Continue 'Native Plant Giveaway' programme to support residents in maintaining native vegetations on private properties.

Context: *Manly Council organises 'Native Plant Giveaway' program annually. This program is very popular. Council also continues Plant Giveaway program through community events i.e. consultation, citizenship ceremonies etc.*

Actions:

- *Continuation of the program.*
- *Initiate community education regarding the environmental value of native vegetation. New plantings should be accompanied by information about the maximum height of the vegetation and penalties for unauthorised removal.*

Advantages: *Support restoration of native vegetation, especially on privately owned backyards.*

Disadvantages: -

Objectives addressed:

Performance Target: *Program continued*



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Indicative Cost: Low
Time Frame: Continued
Responsible Agency: Manly Council- Parks & Reserves, CEP

2.3.4 Review & Continue Council's Street Tree Planting Programme within the study area.

Context: Manly Council's policy is to maintain the attractiveness, appeal and amenity of the area by preserving healthy trees in recognition of the value and importance of trees held by the community. Trees play an important part in maintaining the health of our environment, they help to protect soil and water supplies, provide shade, provide habitat, food, shelter and protection for wildlife. Trees in urban areas act as extensions of and links between core bushland, also known as bushland corridors. However, there exists no list of recommended trees within the Council.

The Manly Council Tree Preservation Order 2001 applies to all trees in the Manly LGA. It is illegal to remove or prune any trees on public land, parks, bushland reserves or foreshore areas.

Consider reviewing the landscape section of the 1986 Manly Heritage Study for background into any culturally significant tree plantings in the area; and conserve and enhance any existing listed street tree plantings.

Actions:

- Review the present programme of tree plantation
- Develop a comprehensive list of site specific recommended and appropriate trees
- Accommodate view eminence by selecting suitable plant type

Objectives addressed:

Performance Target: Recommended list prepared & program continued

Indicative Cost: Low

Time Frame: Continued

Responsible Agency: Manly Council-Parks & Reserves

12.3 OPTIONS ADDRESSING UPGRADING & ENHANCEMENT OF PUBLIC FACILITIES

3.1.1 Enhance general amenities for public use at convenient locations.

Context: North Harbour Reserve and other reserves near beaches are popular places for both local and visiting families. It is important that general amenities are not only maintained but also enhanced and upgraded. There are four public toilets well spread throughout the study area. Telephone booths are few and none exists near North Harbour Reserve. It is desired that additional telephone booths are located conveniently for general and emergency use. Lights are also upgraded in reserves.

Actions: The option involves auditing of existing public facilities and in consultation with Precincts, encourages relevant agencies to establish additional toilet, telephone and street light facilities.

Objectives addressed:

Performance Target: Facilities enhanced

Indicative Cost: High

Time Frame: Continued

Responsible Agency: Manly Council – Urban Services

3.1.2 Improve and facilitate traffic management around public reserves and beaches

Context: According to community consultation, traffic management is an important issue to residents. Traffic needs to be slowed down on Condamine Street for safety of kids. Traffic restrictions on Condamine Street adjacent to NH Reserve are not effective at present. 2-hour parking permits are not monitored routinely.

Actions:

- Enforcement of 2-hour parking in residential area
- Lower speed limits on Condamine Street for safety of kids
- Investigate installation of speed humps in Fairlight Crescent to avoid fatal accidents from speeding vehicles.
- Investigate possible arrangement of one- way flow of traffic through Lower Beach Street and North Harbour Street

Objectives addressed:

Performance Target: Improved traffic management

Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: Manly Council – Urban Services, RTA, Risk Manager

3.1.3 Install dinghy and kayak storage racks closer to water access within the study area.

Context: Lack of dinghy and kayak storage was identified as a key issue. Historically dinghies have been stored along the foreshore of Wellings Reserve and North Harbour Bay. The extensive number and random storage of dinghies and other boats impact on the aesthetic and environmental quality of the area. Dinghies have been found to damage tree bark At places, Aboriginal midden sites have been affected.



Installation of horizontal dinghy storage is proposed for safety, park maintenance and liability reasons. In determining dinghy storage arrangements in the area, Council has already provided dinghy storage facilities at nearby Forty Baskets Reserve. This option should be explored in light of the space limitations within the reserve areas. Similar to Council facilitated formal dinghy storage facilities at

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Little Manly and Forty Basket, new storage is also subject to registration and 'boat storage fee' charged per annum.

Actions:

- Investigate appropriate design and location for dinghy and kayak storage facilities within or near the North Harbour Reserve including area near Davis Marina.
- Seek community and Precinct feedback
- Introduce a dinghy registration/licensing system to establish improved storage.
- Regulate dinghy storage to ensure vessels are consolidated into identified dinghy storage facility
- Investigate options to improve water access for dinghy and kayak users

Objectives addressed:

Performance Target: Storage rack installed

Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: Manly Council – Urban Services, Design & Technical Group

3.1.4 Organise facilities for scuba divers near Fairlight pool.

Context: Among many attractive sites around Sydney, Fairlight boasts a diversity of sea life including fish, invertebrates, algae. Scuba divers visit the site regularly. The entry point is off an exposed rock platform (low tide) - they swim approx 50 metres to the drop off which runs parallel to the shore. Here one will find small overhangs, small boulders & caves. The depth ranges to a depth of about 6 metres and is an excellent night dive. However, there is no diving preparatory deck or table (as with Shelly Beach, Little Manly). Hence, the divers use the grassy reserve to the north west of the pool. Uncontrolled storage of dive equipments impacts on enjoyment and use of the site.



Actions:

- Install divers corralling platforms (low-level table) for preparation prior to diving.

Objectives addressed:

Performance Target: Tables installed

Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: Manly Council – Urban Services, Design & Technical Group

3.1.5 Investigate feasibility of constructing a public wharf at North Harbour

Context: Pontoons and jetties within the study area are commercially owned. There is no public pontoon/jetty. During community consultation, people have requested a public wharf at North Harbour



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for boat owners, nearby residents and the general public. There are a significant number of boat moorings in North Harbour Bay which will benefit from this new access.

Actions:

- Consult NSW Maritime
- Identify alternative locations considering public demand through a feasibility study of alternative sites
- Seek financial support to build a public wharf within the study area.

Objectives addressed:

Performance Target: Assessment made

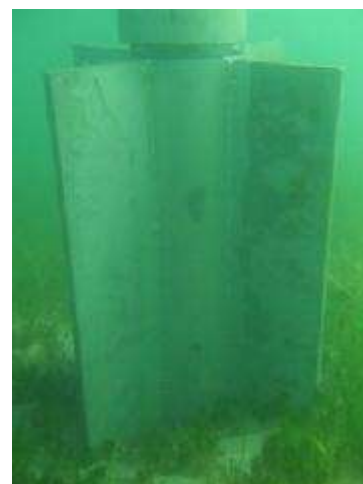
Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: NSW Maritime, Manly Council – Urban Services

3.2.1 Work with NSW Maritime to introduce seagrass friendly moorings

Context: The NSW Maritime is currently trialing seagrass friendly moorings in an attempt to minimise the impact of boating on seagrass beds. Many private companies have patented and marketed seagrass friendly mooring designs. One of such mooring system uses a single point screwed into place mooring post as the anchor point. Attached to the mooring post just below the sea bed is a set of load spreaders to stabilize the post. This is then attached to shock absorber to the swivel head and run a hawser rope from the shock absorber to a surface buoy.



Actions: The option involves working with NSW Maritime to introduce seagrass friendly moorings throughout the study area.

Objectives addressed:

Performance Target: Moorings introduced

Indicative Cost: Medium

Time Frame: Medium term

Responsible Agency: NSW Maritime, NSW DPI, SCCG, SMCMA

3.3.1 Construct paved footpath on both sides of Condamine Street

Context: Condamine Street is one of the more heavily used roads in Manly and connects important landmarks such as North Harbour Reserve and Balgowlah Shopping Centre. Many people use footpaths for recreational walking or jogging. Parents with children go to schools. At present, there is a paved footpath on only one side of the road. This creates difficulty for users to walk with prams and poses risks to walkers.

Actions:

- Investigate feasibility of constructing paved footpaths
- Consult with relevant Precincts
- Design and construct paved footpath.



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Objectives addressed:

Performance Target: Footpath designed and constructed

Indicative Cost: High

Time Frame: Long term

Responsible Agency: Manly Council

3.3.2 Audit disability access of all parks and bays within the study area.

Context: People with disability identified problems with wheelchair access to theatres, libraries, parks, shops, doctors' surgeries and banks. They have identified the supply of accessible transport services including taxis for the disabled, transport for medical appointments in an emergency, and wheelchair friendly public transport as a high priority need for Manly residents.

An audit is required to plan improving facilities for persons with disabilities and seniors through the provision of enhanced infrastructure and facilities. This will allow them easy access to reserves and where possible to bays and water fronts. The need for an audit is in line with the federal Disability Discrimination Act 1992 and also Manly Council's Social Plan 2004.

Actions:

- Undertake Access Audit for North Harbour Reserve & Fairlight Beach reserve areas.
- Discuss the proposal with the Access Committee, Manly Council
- Implement disability access at these priority locations.

Objectives addressed:

Performance Target: Audit completed

Indicative Cost: Low

Time Frame: Short term

Responsible Agency: Manly Council – Planning & Strategy

3.4.1 Review, in consultation with Precincts, off-leash status of North Harbour Reserve.

Context: Dog exercising is a popular activity for many members of the community. There are a number of off-leash areas along the foreshores that are frequented by the public and their companion animals. Dogs are allowed off the leash in most of Council's reserves including North Harbour Reserve. Off-leash dogs in NH Reserve are considered by many to pose a danger to toddlers and elderly.

Dogs are not permitted on any beaches or in swimming enclosures. However, dogs are regularly seen both on and off the leash on North Harbour tidal flat. Hence, a compromise is proposed whereby North Harbour Reserve could be dog on-leash area and North Harbour tidal flat could be dog off-leash area. NSW Maritime need to be consulted before considering the proposal.

Actions:

- Obtain further community feedback on this sensitive issue
- Analyse feed back if a change in status supported
- If supported, redesignate North Harbour Reserve as dog on-leash area and North Harbour tidal flat as off-leash dog area with appropriate signage
- Alternatively explore possible time zones for 'off-the-leash' and feasibility of introducing session times such as morning session and late afternoon session
- Enforce controls in other areas through education and increased patrols.



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Objectives addressed:

Performance Target: Off-leash dog area declared

Indicative Cost: Low

Time Frame: Short term

Responsible Agency: Manly Council – Planning & Strategy, NSW Maritime, Rangers, Precincts

3.4.2 Install adequate dog faeces bins, water bowls and bag dispensers.

Context: Dogs are valued part of community. However, dog faeces contribute to the pollution of estuary and bushland, as they are washed into the stormwater system after rain. Dog faeces are a source of nutrients and a potential source of pathogens.

Manly Council is participating in the DECC supported Community Watch-dog Project to set up a system so dog owners could be responsible for their pets' waste and dispose of it thoughtfully. Councils recruited volunteers, many of whom were dog owners. Volunteers were trained to inform other pet owners about stormwater pollution from dog faeces and provide them with Pooch Pouches.

In addition, Manly Council has already made a number of dog faeces bins, water bowl and dog dispensers at key locations. These are not regarded as adequate.

Actions:

- run a systematic education program focussed on dog owners and water pollution
- Install additional dog faeces bins, water bowls and bag dispensers
- Schedule regular and frequent collections from these facilities
- Install regulatory signs advising dog owners of appropriate conduct and penalties associated with non-compliance through increased patrol.

Objectives addressed:

Performance Target: Facilities established

Indicative Cost: Low

Time Frame: Continued

Responsible Agency: Manly Council – Waste Services

3.5.1 Support continuation of ban on commercial fishing.

Context: A ban has been placed on commercial fishing as a precautionary measure following the release of test results which revealed elevated levels of dioxins in fish and crustaceans across the Harbour, including Parramatta River and other connected tidal waterways. This fishing closure took effect on 10 February 2006 and to remain in effect until 9 Feb 2011, unless sooner amended or revoked.

Anecdotal reports indicate that fish species abundance and distribution in Sydney Harbour has increased since the ban.

Action: The option involves continuation of the ban.

Objectives addressed:

Performance Target: Ban maintained

Indicative Cost: Low

Time Frame: Continued

Responsible Agency: DPI-Fisheries, SCCG, SMCMA, MC (NR)



3.5.2 Encourage relevant agencies to continue to monitor Dioxin levels in Sydney Harbour waters.

Context: There are many agencies involved in addressing the issue of Dioxin level in Sydney Harbour waters. The Department of Environment and Climate Change advises the Department of Primary Industries on ecosystem contamination issues. The Department of Primary Industries acts on advice from NSW Health and the NSW Food Authority on fish contamination issues. When advised by these agencies, the Department of Primary Industries takes action by implementing fishing closures where appropriate, communicating health warnings where appropriate, and assisting these agencies with sampling of fish.

About 1200 fish have been tested in total as part of the comprehensive testing regime till December 2007 (Department of Food Authority 2007). Some good news for the State's anglers with several recreational fish species caught east of the Sydney Harbour Bridge found to be relatively free of dioxin. Unfortunately, the tests for commercial species such as Bream, Prawns and Squid are so high as to make it unlikely for commercial fishing to return to the Harbour in the foreseeable future.

Action: The option involves continuation of monitoring of dioxin levels.

Objectives addressed:

Performance Target: Dioxin level monitored

Indicative Cost: Low

Time Frame: Short term

Responsible Agency: DECC, Department of Food Authority, NSW DPI, NSW Health, SMCMA

3.5.3 Facilitate recreational fishing and educate community about rules and regulations applying to recreational fisher (bag limits, size limits and species types) through NSW Fishcare Program.

Context: Fishing is one of the most common recreational activity undertaken within the study area. A total of 17% of the NSW population participate in recreational fishing. This is almost 24% of the NSW male and 10% of female population. Almost half the State's recreational fishers lived in Sydney.

Various bag and size limits apply to recreational fishers for most common fish species. However, not everyone adheres to these regulations. A number of changes to size limits, bag limits and fishing methods were introduced in September 2007.

Actions: The option involves working with NSW DPI to improve recreational fishing practices through educational programs. Fish care Volunteers talk to anglers about fishing rules and responsible fishing and help in a range of activities, such as fishing clinics, catch surveys and community fishing events.

Objectives addressed:

Performance Target: Education program implemented

Indicative Cost: Low

Time Frame: Short term

Responsible Agency: Manly Council - CEP, DPI - Fisheries



12.4 OPTIONS ADDRESSING NORTH HARBOUR RESERVE IMPROVEMENT

4.1.1 Carry out necessary investigations to ascertain health risks in soil and sediments at North Harbour Reserve

Context: During community consultation, people expressed concerns about the possible health risks from sand/soil near North Harbour waterfall and North Harbour Reserve in general. Accumulated sediment near upstream water fall is black/blue in colour and produces distinct odour.

Further, according to Manly LEP (1988), Class 2 acid sulphate soil is located at North Harbour Reserve (NHR) and surrounds. Acid sulphate soils occur when soils containing naturally occurring iron sulphide are dried and exposed to the air, usually as a result of human activity. In air, iron sulphides are oxidised and sulphuric acid is produced. This sulphuric acid has the potential to leach into the surrounding environment, where it can affect the health of waterways, groundwater, aquatic and terrestrial plants and animals, and also causes damage to engineering structures. However, Skelton & White (2004) did not find any indication of acid sulphate soil from core samples of North Harbour Reserve and thereby risks from potential acid sulphate soil is minimized, if not eliminated.

Actions:

- Conduct sediment sampling and water testing immediately below waterfall.
- Take precautionary measures, if needed, based on test results.
- Alternatively, inform community to dispel concerns if no health risks exist.

Advantages: Improved protection of human and ecosystem health

Disadvantages: -

Objectives addressed:

Performance Target: Health risks assessed

Indicative Cost: Low

Time Frame: Immediate

Responsible Agency: Manly Council-PS, Parks & Reserves

4.2.1 Prepare and implement a Landscape Masterplan for North Harbour Reserve, in consultation with Precincts and community.

Context: North Harbour Reserve is the central recreational spot of the study area and used extensively by residents and visitors. Improvements in North Harbour Reserve have been made, so far, on an ad hoc basis. With the increasing use of the Reserve, it has become necessary to prepare a detailed Landscape Masterplan.

The Masterplan should seek to distribute appropriately the various functions of the reserve and to maximise the opportunities presented by the foreshore setting and by the arrangement of the elements within it. Principles, to prepare the Masterplan, are:

- recognition of value of the existing open spaces and landscape;
- reinforcement of the existing native and indigenous planting and bushland;
- further establishment of safe, quiet and planted seating and picnic areas around the edges;
- recognition of existing play area with upgraded play equipments;
- consideration of noise issue
- measures for child safety as the Reserve is also a dog off-leash area; and
- emphasis of the historic past with signage and other interpretative and informative features.



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This Masterplan should consider and analyse suggestions made during community consultation by different user groups. Among others, considerations should be given for:

- Widening of footpath in front of rock revetment sea wall.
- A new walking trail around the Reserve or only on north and south sides of the reserve
- Removal of hedges located near Redlands house
- A dinghy and kayak storage facility with water access at suitable location within or near the North Harbour Reserve
- Exploring possibility of an extended observation deck on water front.
- Solar panel on already upgraded toilet block
- Improvement of seating, BBQ, recycling bins and other facilities
- Formalisation of the important pedestrian entrance and exit (including disabled access and use of prams) from King Street, north and south sides of Beach Street and Condamine Street;
- Improvement of parking spaces across Condamine St opposite the kerb ramp access point.

Actions:

- Commission a Landscape Masterplan preparation of North Harbour Reserve
- Consult Precincts and community before and after plan preparation
- Implement the adopted Masterplan gradually.

Advantages: A planned improvement of North Harbour Reserve will satisfy user needs

Disadvantages: -

Objectives addressed:

Performance Target: Masterplan prepared, adopted and implemented

Indicative Cost: Medium/High

Time Frame: Medium term

Responsible Agency: Manly Council-NR, Urban Services

4.3.1 Assess recycling of stormwater to irrigate North Harbour Reserve.

Context: North Harbour Reserve has an irrigation system but unfortunately with water restrictions, the system has not been used since they were introduced. In the current water shortage in Sydney, Manly Council is turning to alternative water supplies, such as stormwater, to maintain public parks and reserves.

There are two possibilities. Creek water from Clarence Street (near wooden bridge) can be diverted to irrigate North Harbour Reserve. Alternatively, stormwater can be diverted from Jackson Street Drainage Reserve.

Actions:

- Assess stormwater recycling options and their feasibility
- Utilise current best practice technologies
- Compare cost benefit from both sources
- If found feasible, prepare detailed engineering design
- Implement, if found acceptable and economical.

Advantages: Efficient use of stormwater

Disadvantages: Huge investment cost; cannot be implemented if funding is not secured.

Objectives addressed:

Performance Target: stormwater recycled

Indicative Cost: High

Time Frame: Medium term



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Responsible Agency: Manly Council – Natural Resources, Parks & Reserves & Urban Services

4.4.1 Widen and upgrade access paths leading to and within North Harbour Reserve.

Context: Access to North Harbour Reserve is via four possible routes. All these accesses are narrow and pose risk to pedestrians. Of the four access ways, only limited disabled and aged access is provided from footpath on Condamine Street. People with prams usually use access from the corner of Beach Street and Condamine Street, beside the toilet block via a narrow concrete walkway that goes directly to children's playground.

It is recommended that these access ways are widened to meet required standards and improve user safety and aesthetics.

Actions:

- Assess present condition of all four access paths
- Design wider paths with railings
- Implement designed wider access paths.

Advantages: Access to and from North Harbour Reserve is improved to enhance user safety

Disadvantages: cost prohibitive

Objectives addressed:

Performance Target: Access paths are widened

Indicative Cost: Medium

Time Frame: Medium term

Responsible Agency: Manly Council-NR, Urban Services

4.4.2 Locate and investigate suitability of a graded wheel chair access.

Context: Access in or out of North Harbour Reserve is via four possible routes. Of the four access ways, only limited disabled and aged access is provided from kerbside on Condamine Street. This limits the use of the Reserve by elderly and disabled. Wider graded disabled access paths can be constructed either through Burton's bushland on northern side of the Reserve from King Avenue or from southern side from Beach Street near toilet blocks. Beach Street is near to parking lot.

Actions:

- Compare advantages of two alternative locations and discuss with Precincts
- Design a graded wheel chair access
- Implement designed wheel chair access.

Advantages: Access to and from North Harbour Reserve is facilitated

Disadvantages: -

Objectives addressed:

Performance Target: Wheel chair access constructed

Indicative Cost: Medium

Time Frame: Medium term

Responsible Agency: Manly Council-NR, Urban Services

4.4.3 Investigate provision of improved parking facility at North Harbour Reserve

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Context: Community consultation identified that traffic management is an important issue to residents. The current situation deteriorates over weekends around North Harbour Reserve. At present, cars are parked in a haphazard manner at an open space (Crown land) on opposite side of Condamine Street. A marked metered parking would accommodate more cars in a systematic fashion.

Actions:

- Landscape the area for a car park
- Make provisions for vehicle movement and parked cars
- Make provisions for meters

Objectives addressed:

Performance Target: Improved parking facility

Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: Manly Council – Urban Services



12.5 OPTIONS ADDRESSING HAZARDS & CLIMATE CHANGE

5.1.1 For hazards that are located on private property, owners be contacted, reminded of the identified hazards and recommended to undertake inspections and stabilization works where required.

Context: A total of 14 potential risk sites have been identified. Of these, five sites, three on public and two on private lands, poses risks to life. Manly Council has already undertaken remediation works on all three public sites. The remaining two sites, sites 14 and 19 are located on private property and have risks to property and life.

Actions:

- Contact owners
- Detailed geotechnical inspection of piers and rear yards (for item 14) and concrete walls (item 19).
- Stabilization works may comprise concrete or masonry piers (for item 14) and wall reconstruction (item 19).

Objectives addressed:

Performance Target: Stabilization works completed

Indicative Cost: Staff time

Time Frame: -

Responsible Agency: Property owners

5.2.1 Monitor shoreline changes of Fairlight Beach and damage, if any, of foreshore structures

Context: Fairlight Beach underwent slight recession over the period 1965 to 1998. This was possibly due to a loss of sand offshore during severe storms which did not fully return to the beach in calmer swell periods.



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The total loss of sand from Fairlight Beach between 1965 and 1998 was $3.2 \text{ m}^3/\text{m}$. Therefore a total volume of some 130 m^3 of sand was eroded from Fairlight Beach between 1965 and 1998 or about $0.1 \text{ m}^3/\text{m}$ per year. If the average height of sand on the back beach is taken to be about 2.2 m AHD, this would correspond to a landward shoreline movement of about 0.04 m/year.

Actions:

- Develop and implement a natural shoreline and shoreline structure monitoring program for Fairlight beach
- Revise the assessment of coastline hazards as required based on the findings of monitoring program
- Consider beach nourishment to restore the volume of sand so that the seawall would not be damaged
- Should the risk of damage to the existing seawall in the future become unacceptable, repair/reconstruct the seawall or seawall stabilization works to prevent damage

Objectives addressed:

Performance Target: Monitoring program initiated

Indicative Cost: staff time

Time Frame: -

Responsible Agency: Manly Council

5.2.2 Ensure future development of Fairlight Beach is compatible with erosion and recession hazards

Context: Fairlight is one of the popular local beaches. Fairlight beach underwent slight recession over the period 1965 to 1998. This was possibly due to a loss of sand offshore during severe storms. This requires that future development of the beach accommodates safety from these hazards.

Actions:

- Control new development so that it is appropriately sited and is not adversely affected by the erosion and recession hazard over a suitable planning time frame (minimum 50 years)
- Ensure any redevelopment and public facilities are compatible with the erosion and recession hazard and do not adversely affect coastal processes
- Develop design guidelines for any structures located within areas subject to coastline hazards, which address matters such as, siting, foundation design and materials.

Objectives addressed:

Performance Target: Erosion, recession hazards taken into account prior to any works

Indicative Cost: staff time

Time Frame: -

Responsible Agency: Manly Council

5.2.3 Ensure any protective works minimise impact on beach amenity and access, and where practical improve existing amenity and access

Context: The current width of Fairlight beach, measured at mean sea level, is approximately 15 m. This beach has shown a recession rate of about 0.04 m/yr which would mean that the beach would reduce in width by 0.8 to 2 m over a period of 20 to 50 years respectively. Hence, all protective works should at least maintain existing amenities and access.

Actions:



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- Design any future stabilization works or new seawall at Fairlight beach to minimise impact on coastal processes, minimise impact on beach amenity and access, and where practical improve existing amenity and access and takes into account impacts of climate change
- Ensure any new seawall is as landward as practicable
- Ensure any stabilization works involve the minimum encroachment on the beach and/or rock platform in front of the seawall
- Consider inclusion of steps and/or access ramp, and seating, in the design of any new seawall
- Consider use of coloured concrete for any new seawall to match the colour of the beach sand or rock platform.

Objectives addressed:

Performance Target: Designs made

Indicative Cost: staff time

Time Frame: Long term

Responsible Agency: Manly Council

5.2.4 Encourage DECC to carry out photogrammetric analysis periodically or after major storm events.

Context: Photogrammetry is the practice of obtaining information about physical objects through the process of recording, measuring, and interpreting photographic images. Photogrammetric measurements of erosion or accretion of Fairlight & Delwood beaches were done with relatively short period of the historical data and may have affected the result. It is proposed that routine data are collected at different points covering the entire LGA. Flights should be undertaken annually and close to the same dates and tidal conditions to allow easy comparison. Clear weather and good light are required for best results. Tide levels should be below mean low water to allow important process information to be derived for the beach.

Actions:

- Encourage DECC to take out routine photographic images
- Analyse these images every 4-5 years or immediately after major storm events to monitor trend in changes in beach profiles.
- Use results to undertake mitigation measures

Objectives addressed:

Performance Target: Photographic images collected

Indicative Cost: High

Time Frame: Short term

Responsible Agency: DECC, Manly Council – GIS

5.3.1 Assess specific impacts of sea level rise on North Harbour Reserve and devise adaptive measures.

Context: Cardno (2008) has made an assessment of the likely effects of climate change. A preliminary mapping has been prepared using Digital Elevation Model (DEM) to provide a broad indication of the likely spatial effects of climate change. North Harbour Reserve and its surrounds are likely to be affected by sea level rise.

North Harbour Reserve and surrounds are also likely to be inundated with 100 year flooding. This together with 30% increase in rainfall and sea level rise will exacerbate the situation further.



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Actions:

- Assess specific impacts of sea level rise to identify risk to public and private properties and infrastructure
- Develop possible mitigation and adaptation measures.
- Consider raising the bed level of Condamine Street as protective wall against projected sea level rise
- Maintain and upgrade sea walls

Objectives addressed:

Performance Target: Mitigation and adaptation measures identified

Indicative Cost: Medium

Time Frame: Short term

Responsible Agency: Manly Council – Corporate Planning & Strategy

5.3.2 Assess impact of climate change on areas of ecological significance and devise adaptive measures.

Context: In a preliminary assessment, the study area is expected to face high vulnerability to ecosystems due to impacts of climate change. However, this has not yet been specified. It is believed that natural ecosystems have low resilience to the effects of climate change. Hence, there is need to plan and implement adaptive measures to prevent further damage to critical ecosystem of the study area.

Actions: Overlay map of areas of ecological significance (Fig. 8.0) on climate change impact area map (to be prepared), define vulnerable ecosystems and devise adaptation measures.

Advantages: Impacts on ecosystems of the area will be specified. Adaptive measures will prevent further damage to critical ecosystems.

Disadvantages: -

Objectives addressed:

Performance Target: Ecological impact maps

Indicative Cost: Low

Time Fame: Medium term

Responsible Agency: Manly Council – NR, SCCG

5.3.3 Work with Sydney Coastal Councils Group to develop regional/ local level climate change model considering protection provided by existing seawalls and rocky foreshores

Context: Manly Council is collaborating with the Sydney Coastal Councils Group (SCCG) to better understand the implications of climate change at regional level through participation in susceptibility modeling. In a preliminary assessment, Manly LGA has been found to possess a moderate degree of vulnerability to climate change. The study area, however, faces high vulnerability to sea level rise, ecosystems and extreme rainfall and subsequent stormwater management. This collaboration has already proved to be fruitful. It has been indicated that modeling does not consider the level of protection provided by existing seawalls. At a later stage, the model results have to be refined by inclusion of the parameter.

Action: The option involves continuation of collaboration.

Objectives addressed:

Performance Target: Model Results & Impact Report

Indicative Cost: High



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Time Frame: Short term
Responsible Agency: SCCG, DECC, NSW GO, Manly Council- NR

5.4.1 Continue with on-going climate change mitigation and adaptation measures.

Context: Manly Council has undertaken several greenhouse projects including education programs, energy efficient lighting and retrofits of public amenities (including the beachfront and several sports fields), installation of a solar hot water at Swim Centre and energy efficient equipment in offices. Council has also initiated Climate Change Risk and Adaptation Action Strategy.

Council is also implementing a few adaptation measures including:

- Improving water-use efficiency, recycling and public education about water usage.
- Developing and gradually implementing coastal zone and estuary management plans.
- Maintaining green spaces (parks and bushland) in urban areas.

Actions:

- Completion of Manly LGA Climate Change Risk and Adaptation Action Strategy.
- Modify on-going mitigation and adaptation measures based on periodic assessment and also accommodating new knowledge
- Identify opportunities to install water and energy efficient systems on public facilities throughout the study area.

Objectives addressed:

Performance Target: Positive measurable impacts achieved

Indicative Cost: High

Time Frame: Short term

Responsible Agency: Manly Council – Corporate Planning & Strategy

5.4.2 Collect and collate new information and knowledge on climate change impacts relevant to the study area/ Manly LGA.

Context: Knowledge of possible impacts of climate change is always growing. Research at global, regional, national and local levels is feeding into knowledge on climate change impacts. It is sometimes difficult to synthesize information/knowledge relevant for the study area. A structured effort should be made to collect and collate relevant information.

Actions:

- Information for the community on Climate Change in the Manly LGA will be provided through and following the development of the Climate Change Strategy, Climate Change Education Strategy and the Climate Change Risk and Adaptation Strategy.
- In addition, prepare an e-book with relevant information on climate change impacts of Manly LGA including information on on-going mitigation and adaptation measures
- Host this e-book on Manly website
- Revise periodically

Objectives addressed:

Performance Target: Strategic documents and e-book published and hosted

Indicative Cost: staff time

Time Frame: Short term

Responsible Agency: Manly Council – CEP



5.4.3 Inform and involve community through Precincts about known impacts of climate change on the study area.

Context: Knowledge of possible impacts of climate change is always growing. Community is often confused with information reaching to them from media. Community needs to receive relevant and structured information. Precincts can facilitate in disseminating knowledge and community involvement.

Actions:

- Prepare a booklet on key climate change impacts on Manly LGA including information on on-going mitigation and adaptation measures (a combination of Cardno, SCCG and Risk/Mitigation Assessment reports)
- Publish and distribute the booklet through Precincts

Objectives addressed:

Performance Target: Booklet published and distributed

Indicative Cost: Medium

Time Frame: Medium term

Responsible Agency: Manly Council – CEP

12.6 OPTIONS ADDRESSING HERITAGE CONSERVATION & MANAGEMENT

6.1.1 Review Aboriginal Site Management Report for Manly Council (2006) and associated reports to prioritize management needs and develop a plan of implementation.

Context: The Aboriginal Heritage office (AHO) has prepared the Aboriginal Site Management Report (2006) for Manly Council. This report has been reviewed. While many sites are in good to reasonable condition, others show signs of degrees of degradation because of exposure to a variety of uses including lack of understanding in the community. Two of the sites are located on the Manly Scenic Walkway. This report has been used to prioritize management needs.

Action: The option involves continuation of Aboriginal site management through formulation of Works program. Consult and maintain liaison and seek approval with the Metropolitan Aboriginal Lands Council and Aboriginal Heritage Office.

Objectives addressed:

Performance Target: Prioritisation done

Indicative Cost: Low

Time Frame: Short term

Responsible Agency: AHO, Manly Council – Planning & Strategy

6.2.1. Ensure physical protection and maintenance of all heritage listed items.

Context: It is likely that many sites of historical significance (primarily European heritage) have become degraded with time. Some of these sites are still used on a regular basis (e.g. swimming enclosures and seawalls) and in some cases, may represent a public risk.

Action: This option involves Council, with assistance of AHO, carrying out repairs to these structures to ensure their integrity, or possibly restoring currently degraded structures / sites as show-pieces of former usage and estuary based activities.



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Council would primarily be responsible for the repairs and restoration of historical items / structures under its control.

Objectives addressed:

Performance Target: *Maintained & cleaned*

Indicative Cost: *Low*

Time Frame: *Immediate*

Responsible Agency: *Manly Council – Urban Services*



13. ASSESSMENT OF OPTIONS

All identified management options are investigated through an open and transparent evaluation process. The aim of this process is to enable staff, community and stakeholders to choose the particular combination of management responses that best meet the vision, goals and objectives set for the study area. The evaluation process, thus, reflect the emerging principle of 'community right to know'. This expresses the community's right to access all information that may affect their quality of life. It acknowledges community demands for more information and increased transparency in decision-making.

Evaluation Criteria

Options are evaluated according to explicit criteria that reflect a wide range of social, economic, environmental and financial considerations. The most favorable options are those that best satisfy the criteria. The following criteria are used for evaluation management options.

- **Sustainability:** the option is consistent with the principles of ecologically sustainable development (ESD) and other relevant principles.
- **Consistency with vision and goals:** the option promotes achievement of adopted goals and objectives.
- **Likely impacts:** the social, economic and environmental impacts are acceptable to the community.
- **Public domain:** the option protects or enhances the public domain, particularly, the public's right to access and enjoy foreshore reserves, beaches, waterways and the estuary
- **Cultural:** the option respects and promotes the cultural, social or spiritual value of coastal environment
- **Acceptable risk:** the level of risk to life, property and the environment is accessible
- **Indicative Cost-benefit:** the cost-benefit of the option is positive and is superior to alternative options
- **Financial:** the option can be adequately finances, both initially and in the long-term
- **Legal and regulatory:** the option is compatible with legal and regulatory constrains, including land tenure issues and approvals by Commonwealth and state agencies
- **Community support:** the community understands and supports the option.

+ indicates positive and – negative results. Number of +es or –es show the degree of results.

A preferred management option is the option that best meets the evaluation criteria. It may include a number of actions.

PRIORITISATION OF MANAGEMENT OPTIONS

The prioritisation process is an important step in focusing activities and funding towards addressing those issues which will potentially provide benefit. Typically the highest priorities for implementation are those, which have the greatest potential to bring about required change within the study area.

The process of prioritising the management options is complex. The reasons for this include:

- There are many different aspects of the study area which can be improved, and it can be difficult to determine whether commercial benefits are more important than ecosystem benefits, etc; and
- The likely level of benefit of some strategies is difficult to estimate. This is often a function of how easy or how well implemented the objective is.

As the new Committee is yet to be installed after the LG election, prioritisation of management options has been deferred to plan preparation stage.



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Table 13.1: Evaluation of Management Options

Management Options	Sustain-ability	Consistency with goals/ objectives	Likely Impact			Public Domain	Cultural	Risks	Indicative cost-benefit	Financial acceptability	Community Support
			Social	Economic	Environ-mental						
1.0 Aquatic / Inter-tidal Habitat Conservation & Management <i>Goal: Restore and maintain a healthy and diverse mix of aquatic and intertidal habitats that will maintain and improve biodiversity and ecological functions of the North Harbour.</i>											
1.1.1 Submit and pursue a proposal to extend the boundary of the North Harbour Aquatic Reserve.	High	Yes	+++	N/A	+++	Yes	N/A	N/A	N/A	N/A	+++
1.1.2 Prepare the North Harbour Aquatic Reserve Management Plan and implement.	High	Yes	++	N/A	+++	Yes	N/A	N/A	N/A	N/A	+++
1.2.1 Pursue & process to declare inter-tidal areas as 'Inter-tidal Protected Area' under the <i>Fisheries Management Act</i> .	High	Yes	+	N/A	+++	Yes	N/A	N/A	N/A	N/A	+++
1.2.2 Continue managing Wildlife Protected Area at Federation Point.	High	Yes	+	N/A	+++	Yes	N/A	N/A	N/A	N/A	+++
1.2.3 Assess marine biodiversity of North Harbour including Aquatic Reserve.	N/A	Yes	+	N/A	+++	Yes	N/A	N/A	N/A	N/A	++
1.2.4 Investigate possible soldier crabs colony at the far west end of North harbour	N/A	Yes	N/A	N/A	+++	Yes	N/A	N/A	N/A	N/A	+++
1.3.1 Encourage DPI to support conservation of seagrass and kelp beds.	Medium	Yes	N/A	N/A	+++	Yes	N/A	N/A	Medium	+	++
1.3.2 Encourage DPI to implement programmes as elaborated in 'Control Plan for <i>Caulerpa taxifolia</i> in NSW'.	High	Yes	++	+	+++	Yes	N/A	N/A	Low	+	++
1.4.1 Install Stormwater Quality Improvement Devices (SQIDs) on major stormwater pipes that discharge into North Harbour to ensure healthy aquatic habitat.	High	Yes	++	++	+++	Yes	N/A	Medium	++	+	++
1.4.2 Place screens on minor stormwater outfalls to improve water quality and aquatic health	Medium	Yes	++	++	+++	Yes	N/A	Low	+	++	++
2.0 Bushland / Terrestrial Habitat Conservation & Management <i>Goal: Protect and enhance urban bushland and native vegetation areas</i>											



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Management Options	Sustain-ability	Consistency with goals/ objectives	Likely Impact			Public Domain	Cultural	Risks	Indicative cost-benefit	Financial acceptability	Community Support
			Social	Economic	Environ-mental						
2.1.1 To structure systematic and continued bushland management, prepare a comprehensive management plan and develop a staged implementation programme.	High	Yes	N/A	+	++	Yes	++	N/A	N/A	+++	++
2.1.2 Prepare site specific management plans for Nolan Bush and West Esplanade Park, the two SEPP 19 bushland, to fulfill statutory requirement.	High	Yes	N/A	+	++	Yes	+	N/A	N/A	++	++
2.1.3 Initiate processes to obtain SEPP 19 status for Bareena Park & Heathcliff Reserve.	Medium	Yes	++	N/A	++	Yes	N/A	N/A	N/A	++	++
2.2.1 Continue enhanced weeding program in high weed density areas on a priority basis.	Medium	Yes	N/A	N/A	++	Yes	N/A	N/A	N/A	N/A	N/A
2.2.2 Investigate sources of rich nutrient discharges at stormwater outlets located in bushland areas and implement appropriate control measures	Medium	Yes	N/A	N/A	++	Yes	N/A	N/A	N/A	N/A	N/A
2.3.1 Continue Community Bush Care Volunteers programme in the study area.	High	Yes	+++	++	++	Yes	N/A	N/A	Medium	N/A	+++
2.3.2. Continue publication of 'Bushland News'.	Medium	Yes	N/A	N/A	N/A	Yes	N/A	N/A	Medium	N/A	++
2.3.3 Continue annual 'Native Plant Giveaway' programme to support residents in maintaining native vegetations on private properties.	High	Yes	+++	++	++	Yes	N/A	N/A	High	++	++
2.3.4 Continue to reassess Council's Street Tree Planting Programme within the study area.	Medium	Yes	++	++	++	Yes	++	N/A	++	++	++
3.0 Upgrading & Enhancement of Public Facilities											
<i>Goal: Public facilities are upgraded and maintained to facilitate improved social amenity</i>											
3.1.1 Enhance general amenities for public use at convenient locations	Medium	Yes	+++	+	+	Yes	++	N/A	Medium	++	+++
3.1.2 Improve and facilitate traffic management around public reserves and beaches	Medium	Yes	++	++	+	Yes	++	Low	Medium	++	++
3.1.3 Install dinghy and kayak storage racks closer to water access within the study area.	Medium	Yes	+	++	+	Yes	++	High	High	++	??



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Management Options	Sustain-ability	Consistency with goals/ objectives	Likely Impact			Public Domain	Cultural	Risks	Indicative cost-benefit	Financial acceptability	Community Support
			Social	Economic	Environ-mental						
3.1.4 Organise facilities for Scuba divers near Fairlight pool.	Medium	Yes	++	++	+	Yes	++	Medium	Medium	+	++
3.1.5 Investigate feasibility of constructing a public wharf at North Harbour	Low	Yes	++	++	+	Yes	N/A	High	Low	+	+
3.2.1 Work with NSW Maritime to introduce seagrass friendly moorings	High	Yes	+	+	+++	Yes	N/A	Low	Medium	++	++
3.3.1 Construct paved footpath on both sides of Condamine Street	Medium	Yes	++	++	+	Yes	N/A	Medium	Low	++	++
3.3.2 Audit disability access of all parks and bays within the study area.	High	Yes	+++	+	+	Yes	N/A	N/A	N/A	N/A	++
3.4.1 Review, in consultation with Precincts, off-leash status of the North Harbour Reserve.	Low	Yes	??	N/A	N/A	Yes	N/A	High	N/A	N/A	??
3.4.2 Install adequate dog faeces bins, water bowl and bag dispensers.	Medium	Yes	+++	N/A	++	Yes	+	None	++	+++	++
3.5.1 Support continuation of ban on commercial fishing.	High	Yes	++	+	+++	Yes	N/A	Medium	++	N/A	+++
3.5.2 Encourage relevant agencies to continue to monitor Dioxin levels in Sydney Harbour waters.	High	Yes	+++	+	++	Yes	N/A	Medium	++	+++	++
3.5.3 Facilitate recreational fishing and educate community about rules and regulations applying to recreational fisher (bag limits, size limits and species types) through NSW Fish care Program.	High	Yes	+++	++	+++	Yes	++	None	+++	N/A	++
4.0 North Harbour Reserve Improvement											
<i>Goal: Enhance public use of the North Harbour Reserve while preserving natural environment and beauty of the Reserve</i>											
4.1.1. Carry out necessary investigations to ascertain health risks in soil and sediments at North Harbour Reserve	High	Yes	++	N/A	++	Yes	N/A	High	+++	++	++
4.2.1 Prepare and implement a Landscape Masterplan for North Harbour Reserve, in consultation with Precincts and community	High	Yes	+	++	+++	Yes	++	None	++	+	+



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Management Options	Sustain-ability	Consistency with goals/ objectives	Likely Impact			Public Domain	Cultural	Risks	Indicative cost-benefit	Financial acceptability	Community Support
			Social	Economic	Environ-mental						
4.3.1 Assess recycling of stormwater to irrigate the North Harbour Reserve	Medium	Yes	++	++	+++	Yes	N/A	Medium	++	+	++
4.4.1 Widen and upgrade access paths leading to and within the North Harbour Reserve.	++	Yes	++	+	+	Yes	N/A	Low	++	++	+++
4.4.2 Locate and investigate suitability of a graded wheel chair access	++	Yes	+++	+	N/A	Yes	N/A	Medium	++	++	+++
4.4.3 Investigate provision of improved parking facility at North Harbour Reserve.	High	Yes	+++	+++	+	Yes	+	Medium	Medium	++	++
5.0 Hazards & Climate Change											
<i>Goal: Assess, minimize and mitigate risks from natural hazards and climate change</i>											
5.1.1 For hazards that are located on private property, owners are contacted, made aware of the hazards and recommended to undertake inspection and stabilization works where required.	++	Yes	+++	N/A	+	No	N/A	High	N/A	N/A	++
5.2.1 Monitor shoreline changes of Fairlight beach and damage, if any, of foreshore structures	++	Yes	++	+	++	Yes	N/A	None	+++	+++	++
5.2.2 Ensure future development is compatible with the erosion and recession hazards	++	Yes	N/A	++	++	Yes	N/A	Medium	++	+	+
5.2.3 Ensure any protective works minimise impact on beach amenity and access, and where practical improve existing amenity and access	++	Yes	++	+	++	Yes	N/A	Medium	++	+	++
5.2.4 Encourage DECC to carry out photogrammetric analysis periodically or after major storm events.	N/A	Yes	N/A	N/A	++	Yes	N/A	Medium	+++	++	N/A
5.3.1 Assess specific impacts of sea level rise on North Harbour Reserve and devise adaptive measures.	+++	Yes	++	++	+++	Yes	N/A	Medium	N/A	++	++
5.3.2 Assess impact of climate change on areas of ecological significance and devise adaptive measures.	+++	Yes	N/A	+	+++	Yes	N/A	Medium	++	++	+



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Management Options	Sustain-ability	Consistency with goals/ objectives	Likely Impact			Public Domain	Cultural	Risks	Indicative cost-benefit	Financial acceptability	Community Support
			Social	Economic	Environ-mental						
5.3.3 Work with Sydney Coastal Councils Group to develop regional/ local level climate change model considering protection provided by existing seawalls and rocky foreshores.	+++	Yes	+	++	+++	Yes	N/A	None	+++	++	++
5.4.1 Continue with on-going mitigation and adaptation measures.	High	Yes	++	++	+++	Yes	N/A	Medium	+++	+	++
5.4.2 Collect and collate new information and knowledge on climate change impacts relevant to the study area/ Manly LGA.	High	Yes	++	+	+++	Yes	N/A	None	++	++	++
5.4.3 Inform and involve community through Precincts about known impacts of climate change on the study area.	High	Yes	++	+	+++	Yes	++	None	++	+++	+++
6.0 Heritage Conservation & Management											
<i>Goal: Ensure that all Aboriginal and European (cultural and natural) heritage areas in the study area are preserved and protected.</i>											
6.1.1 Review Aboriginal Site Management Report for Manly Council (2006) and associated reports to prioritize management needs and develop a plan of implementation.	N/A	Yes	++	N/A	N/A	Yes	N/A	++	N/A	N/A	++
6.2.1. Ensure physical protection and maintenance of all heritage listed items.	High	Yes	+++	++	++	Yes	+++	Low	++	+	++



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15. GLOSSARY

Accreted Profile	The profile of a sandy beach that develops in the "calm" periods between major storm events. During such periods, swell waves move sediment from the offshore bar back onto the beach to rebuild the beach form.
Accretion	A build up of sand which may cause or be associated with a seaward movement of the beach profile.
Aeolian Transport	Transport (of sand) by wind.
Bathymetry	Description of the shape of the ocean bed (underwater contours etc.). The measurement of depths of water.
Beach Erosion	The offshore movement of sand from the sub-aerial beach during storms.
Beach Profile	A cross-section of a beach, generally normal to the water line, showing the elevation of the surface relative to some datum. It may also extend some distance offshore.
Benthic ²	Pertaining to the seafloor (or bottom) of a river, coastal waterway, or ocean.
Berm	The relatively flat section of the beach profile between the top of the swash zone and the toe of the erosion escarpment or frontal dune.
Bluff	Vertical or near vertical cliff face (relatively erosion resistant rock) or moderate to steep slope (less erosion resistant rock or soils perched on rock strata).
Breaker Zone	That area of coastal waters where shoaling effects cause swell waves to break. This typically occurs in the shallower waters over an offshore bar.
Breaking Waves	As waves increase in height through the shoaling process, the crest of the wave tends to speed up relative to the rest of the wave. Waves break when the speed of the crest exceeds the speed of advance of wave as a whole. Waves can break in three modes: spilling, surging and plunging.
Breakwater	Structure protecting a shoreline, harbor, anchorage or basin from ocean waves.
Buffer Zone	An appropriately managed and unalienated zone of unconsolidated land between beach and development, within which coastline fluctuations and hazards can be accommodated in order to minimise damage to the development.
Catchment	The area of land which collects and transfers rainwater into a waterway.
Coastal Process	The active forcing functions (waves, winds, currents etc.) and their interaction with and effects on the coastal environment (sediments, beach and cliff erosion etc.)
Coastal Structures	Those structures on the coastline designed to protect and rebuild the coastline and/or enhance coastal amenity and use.
Coastal Zone	The zone affected by coastal processes and its immediate hinterland.
Corridor	Lines of native vegetation connecting separate habitat areas that are essential for maintaining biodiversity. Corridors enable fauna to access larger habitats by



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	encouraging mobility between areas. Corridors may also assist native plant species to spread and colonise new areas over time.
Diffraction	The “spreading” of waves into the lee of obstacles such as breakwaters by the transfer of wave energy along wave crests. Diffracted waves are lower in height than the incident waves.
Erosion	The depletion of the land mass by natural forces, such as the reduction of a beach by waves and/or wind. Commonly perceived as the landward movement of an erosion escarpment during storm events.
Erosion Escarpment	A near vertical step formed by wave erosion at the back of a beach. Usually indicates the landward extent of wave incursion during recent storm events.
Estuary (definition 1)	The tidal portions of river mouths, bays and coastal lagoons, irrespective of whether they are dominated by hyper saline, marine or fresh water conditions
Estuary (definition 2)	a semi enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage
Flushing	Exchange of water between an estuary or coastal waterway and the ocean.
Frictional Attenuation	As applied to water waves, the reduction in wave energy as a result of resistant to water particle movement at the sea bed (bottom friction).
Groynes	Low walls built perpendicular to a shoreline to trap longshore sediment. Typically, sediment build up on the up drift side of a groyne is offset by erosion on the down drift side.
Intertidal	The environment between the level of high tide and low tide.
Littoral Drift	The sedimentary material which is moved in the littoral zone by waves and currents.
Littoral Transport	The movement of littoral drift.
Littoral Zone	Extends from the onshore dune system to the seaward limit of the offshore zone and possibly beyond.
Longshore Currents	Currents flowing parallel to the shore within the inshore and nearshore zones. Longshore currents are typically caused by waves approaching the beach at an angle. The “feeder” currents to rip cells are another example of longshore currents.
Longshore Transport	Synonymous with LITTORAL TRANSPORT.
Mud	Fine sedimentary material, typically comprising both inorganic (mineral) and organic material.
Nearshore Zone	Coastal waters between the offshore bar and the 60 m depth contour.
Net	With respect to sediment transport is the resultant difference of the volume of transport in all directions, i.e. the time averaged resultant effect.



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Nourishment	The replenishment of a beach with sand. Commonly used to increase the beach width after erosion.
Offshore Bar	Submerged sandbar formed offshore by the process of beach erosion and accretion. Typically, swell waves break on the offshore bar. Also known as longshore bar.
Offshore Zone	Coastal waters to the seaward of the nearshore zone.
Onshore/Offshore Transport	The process whereby sediment is moved onshore and offshore by wave, current and wind action.
Organic Material	Once-living material (typically with high carbon content), mostly of plant origin.
Refraction	The tendency of wave crests to become parallel to bottom contours as waves move into shallower waters. This effect is caused by the shoaling process which slows down waves in shallower waters.
Rip Currents	Concentrated currents flowing back to sea perpendicular to the shoreline. Rip currents are caused by wave action piling up water on the beach. Feeder currents running parallel to the shore (longshore currents) deliver water to the rip current.
Seagrass	Marine flowering plants which generally attach to the substrate with roots.
Seawalls	Walls built parallel to the shoreline to limit shoreline recession.
Sediment Budget	An accounting of the rate of sediment supply from all sources (credits) and the rate of sediment loss to all sinks (debits) from an area of coastline to obtain the net sediment supply/loss.
Sediments	Unconsolidated detrital material consisting of organic and/or inorganic fragments. The composition and textural characteristics (gravel, sand, mud) vary with sediment source (local, fluvial, marine) and the transporting medium.
Semi-diurnal Tide	Tides with a period, or time interval between two successive high or low waters, of about 12.5 hours. Tides along the New South Wales coast are semi-diurnal.
Shoreline Recession	A net long term landward movement of the shoreline caused by a net loss in the sediment budget.
Spilling Waves	The wave crest breaks gradually as the wave travels to the shore. Characterised by the appearance of white water at the crest.
Spring Tide	A tide greater than the mean tidal range. Occurs about every two weeks, when the Moon is full or new.
Storm Bar	An offshore bar formed by sediments eroded from the beach during storm conditions.
Storm Profile	The profile of a sandy beach that develops in response to storm wave attack. Considerable volumes of sediment form the beach berm, the incipient dune and the foredune can be eroded and deposited offshore. The landward limit of the storm profile is typically defined by a backbeach erosion escarpment.



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Storm Surge	The increase in coastal water level caused by the effects of storms. Storm surge consists of two components: the increase in water level caused by the reduction in barometric pressure (barometric setup) and the increase in water level caused by the action of wind blowing over the sea surface (wind setup).
Subaerial	That section of the beach which is above the waterline.
Subaqueous	The portion of the beach profile below the water surface.
Surging Waves	The wave does not "break" but maintains its basic shape as it moves towards the shore, where it surges up the beach. Very little white water is evident before surging waves reach the shore.
Swell	Wind-generated waves that have travelled out of their generating area. Swell characteristically exhibits a more regular shape and longer period than the sea (c.f. SEA).
Swell Waves	Wind waves remote from the area of generation (fetch) having a uniform and orderly appearance characterised by regularly spaced wave crests.
Turbidity	The condition resulting from the presence of suspended particles in the water column which attenuate or reduce light penetration.
Wave Height	The vertical distance between a wave trough and the following wave crest.
Wave Period	The time taken for consecutive wave crests or wave troughs to pass a fixed point.
Wavelength	The distance between consecutive wave crests or wave troughs.
Wind Waves	The waves initially formed by the action of wind blowing over the sea surface. Wind waves are characterised by a range of heights, periods and wavelengths. As they leave the area of generation (fetch), wind waves develop a more ordered and uniform appearance and are referred to as swell or swell waves.



APPENDIX A

Community Consultation Summary



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AQUATIC ISSUES

Issues	Statements	Suggestions
Aquatic Habitat and Flora	- Concern over spread of exotic invasive marine pest <i>Caulerpa Taxifolia</i> - Ensure improved water quality for aquatic ecosystem health	- Protect endangered species - Remove invasive exotic weeds surfacing - Bring back mangroves (intertidal)
Aquatic fauna	- Small colony of soldier crabs on the sand bank at the far south west end of North Harbour, being destroyed by pedestrians and dogs. This colony surface one or two days each year. - Penguins are starting a new colony near Treharne moorings. Please investigate and protect if possible	- Protect sea horses and Little penguins - Protect the penguin critical habitat - Do something about the oysters and the slime
North Harbour Aquatic Reserve	- Aquatic reserves must be better managed - Would you like to see North Harbour designated as a "No Take" aquatic reserve?	- Protect aquatic species through 'no take' zones - Ensure that the area becomes controlled and managed as an environmental protection zone.
Boating	- Overcrowding of boats and dinghies - Noise emanating from vessels in North Harbour a problem during high use periods - Power boats go dangerously close to snorkers off Fairlight - Pollution from boating & boat maintenance - Pollution from pressure washing of anti-fouling paint from boats	- Control amount of boats in area - Pollution from boats must be minimized - Incentives for "passive" boating e.g. sailing, rowing, paddling - Investigate wave action as a result of doubling of boat numbers in past 12 years
Dinghy & Kayak	- Don't want to see North Harbour over regulated. Part of its charm is the dinghies on the beaches and natural environment. - Dinghy arrangement adds character to the shoreline - Dinghies are dangerous and unsightly - Change the dinghy arrangements e.g. dinghy's up against trees destroys them - Dinghies to remain on foreshore but culled by joint action with community stakeholders. - Need for improved access to water for kayakers	- Tidy up dingy storage and remove old& abandoned ones - Remove dinghies that are not used - Storage stacks for dinghies on shoreline. - Broken dinghies and canoes need to be cleared up. Should be some areas for dinghy storage for locals between Delwood & North harbour - Provide a form of dinghy racking to reduce the visual impact of dinghy's on the shoreline. - Create kayak facilities - Ramp for Kayakers/canoers
Boating facilities and organizations	- Boatsheds are adequate for the number of craft at present in the North Harbour - Too many boating facilities - Extra motor vehicle traffic created by the	- Manly needs a public wharf (there are three in Mosman Bay) and North Harbour would be ideal. - Control/reduce number of mooring



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Issues	Statements	Suggestions
	two commercial boatshed businesses, one in a residential area the other on a pedestrian strip (end of Gourlay Avenue) • If boat racks are approved then ensure they are located in areas sympathetic to coasts. • Boat ramp is not a good idea • Lack of boat ramps and public wharf facilities • The Trehearne operation is, I believe, planning expansion. I am opposed to any such changes	within North Harbour with little “open” harbour left • Improve public access to boating activities • The proposed expansion of the Trehearne boatshed should be stopped , especially the proposed driveway from Bolingbroke • Stop development of the Trehearne boatshed •
Fisheries & Fishing	• Since the netting of fish has stopped, it is heartening to see fish returning into our bay more plentifully. Therefore more food for penguins, pelicans and more big bream around the Marinas. • Educate recreational fishers on the impacts they have upon the marine environment (improper rubbish disposal, over harvesting of intertidal species for bait) • Noticed a lot of undersized fish caught by adult anglers. More monitoring of catches by National Parks& Reserves • People taking shellfish, other items from rocks and catching small fish and killing them	• Educate recreational fishers on the impacts they have upon the marine environment (improper rubbish disposal, over harvesting of intertidal species for bait) • Target illegal fishing practices • Restrict fishing on rocks

TERRESTRIAL ISSUES

Issues	Statements	Suggestions
Terrestrial Flora	• Exotic species in the bush	• Conservation of native vegetation and weed control through bush regeneration activities • Do not plant anymore Coastal Rosemary. • More judicious low growing plants for birds & small animal habitat
Terrestrial Fauna	• Dogs threaten protected species, lizards, wading birds	• Enhance habitat for birdlife between Condamine St and Forty Baskets
View Maintenance	• All tall trees (not the NI Pines) and shrubs between Federation Point and Delwood beach are excessive and are blocking the view. Please remove some of them.	• Ensure that larger, ageing trees are properly maintained • Thinning of trees so that water can be viewed as one walks to Manly
Landscapes	• No additional structures such as paths or concrete around waterfront, ensure	• Upgrade of existing stone seawall to improve stability and appearance



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Issues	Statements	Suggestions
	proper maintenance of existing structures. Better manage erosion of the foreshore area	- Retain low key appearance of bridge between Clarence St and Goulray Ave. - Esplanade Park should be upgraded to shared path status providing a safe link for cyclists to Manly Wharf.
Manly Scenic Walkway	- The MSW is world class except where it diverts (onto Lauderdale & King Aves etc) away from the harbour - Improved signage for walkway. - More detailed map/leaflet with clearer walkway direction (visitors get lost) - Improve walkway along coast from Esplanade to North Harbour Reserve - Need for additional shade along Manly Scenic Walkway - Never make the path available to bikes	- Signage on walkway depicting key points of environmental interest (i.e. Fairy penguin colony, etc). - Provide a variety of items for users to look at along the walkway e.g. sculpture - Trimming of grass on pathways, removal of dead branches of trees and palms - That the end of MSW at Lauderdale Ave be restored to the footpath beside the road instead of being turned onto the driveway from No.93 Lauderdale Ave for safety reasons. - Provide a cycleway adjacent to the walkway - Removing cycling from Manly Scenic Walkway. - Keep bikes off the MSW - I would like to see the path being accessible to bike riders early in the morning and after 8pm Allow bike riding along the foreshore park to Manly. My kids are under 7 and it's ridiculous that they can't use the pathway to ride bikes to Manly.
North Harbour Reserve	- Preserving the beauty and environmental aspects of the park <u>Access to Park</u> - Steps to NHR are uneven and quite dangerous - The original Bicentenary Walkway plan included a ramp pathway for wheelchair or stroller access to NHR. This has not been installed. - Wheelchair pathway for wheelchair or stroller access to/within. It is impossible for people to access the reserve from King Ave. <u>Facilities</u> - The toilets at NHR are very dark and dingy, need upgrade - Present toilet facilities –really	<u>Access to Park</u> - Need to widen path to enable better access for prams and walkers, especially during wet periods. - An access point from King Ave end of North Harbour Reserve – wheelchair, prams etc but retain bush remnant - A ramp from King avenue to North Harbour Reserve is required to accommodate prams and wheel chairs. - There should be a graded path (not steps) from NH Reserve to King Ave. for parents with strollers, the disabled and cyclists <u>Facilities</u> - Toilet facility at North Harbour Reserve needs upgrading - Upgrade toilets with solar powered lights



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Issues	Statements	Suggestions
	disgraceful, very old & inadequate systems (cisterns) - Better toilets at North Harbour Reserve - Some additional seating/tables under trees in NHR would be nice - Improved tables, better bins and care of grassed area. - Shade clothes over enclosed kids area - May be a small shelter at NHR - I strongly disagree with putting dinghy storage in NH Reserve, there is no car access and I feel will create more problems than it will solve. <u>Fencing issue</u> - Enclosure of park at North Harbour. <u>Parking</u> - Better parking for North Harbour Reserve. - Cars driven into park only encourage others to park in reserve. This should be stopped by laying telegraphic poles along edge of the park <u>Trees</u> - Need for more shade trees in North Harbour Reserve <u>Others</u> - Historical information in the south-eastern corner of the reserve has been vandalized and needs replacing - The footpaths along the water in NH Reserve is absurdly narrow leading to major erosion – needs widening to at least 2.5m - Sand near the water fall or the cut through, is black/blue –it smells - To irrigate the NHR, a system of recycling water from the creek flowing into the North Harbour from Clarence Street (near wooden bridge)	a d light coloured paint to interior - More seating at NH Reserve - Place rubber matting/improve bases of picnic tables and seats - Stainless steel BBQ's, dog waste containers in park - Increase number of BBQ (at least two more) - Shade clothes over enclosed kids area - More dog poo bags across the park - More bins in picnic areas - A second basketball hoop at a lower height for younger children would be welcome <u>Fencing issue</u> - NO fence around North Harbour. - Fence around the play area would be appreciated because of the issue dogs and interaction with children - Fence around playground - Fence the park area (to include lots of grass) so that kids are never threatened by dogs <u>Parking</u> - Cars parking in North Harbour Reserve. <u>Trees</u> - Increase native plantation in reserve - Small garden for wedding parties and photography <u>Others</u> - Bike/scooter track around the whole park - Box of dog toys to use (near the equipment) - Please take soil/core samples of NHR fill - Investigate the quality of sand near the North Harbour waterfall and remove if it exhibits a health risk - Rubbish trap on drain at north/east of NHR



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Issues	Statements	Suggestions
Conservation Management	• Preservation of coastline natural features (geoheritage) • Do not do anything to change the existing use except maintain current management of area. • Balancing the interest between residents, visitors, commercial activities (i.e. boatyards) with respect to the fragile environment.	• Maintain the open-space for passive recreation and the bushland setting
Access	• Need for improved access to water area. • Better access to the walkway from higher streets • People to keep to marked pathways • No provision for people with disabilities, footpaths, curb ramps not wheel chair or scooter friendly need disability facilities in toilet block. • Cycleway – encouraging more cycling in the area • Provision of safe bicycle access round the foreshore to Manly CBD • Provision for bike riders early in the morning and after 8pm?	• Improve signage on walkways • Handrails needed • Improve lighting on walkway • Find an innovative way to get wheelchair access • Provision of better access, encouraging walkers to use the low tide sand route rather than clashing with local traffic when heading between Davis Marina and North Harbour Reserve. • Walking track along foreshore needs widening and some more shade trees • Investigation of water level board walks below King Avenue. • Provision of safe bicycle access round the foreshore to Manly CBD • Provision for bike riders early in the morning and after 8pm?
Waste Management	• Recyclables to improve • Tourists leaving rubbish in bushes and on walkways • Amount of rubbish and cigarette butts around is depressing • Lot of rubbish (paper, plastic, timber) washed up from Fairlight to North Harbour, Lots of oysters & slime • No daily cleaning is done • Dog pollution increasing	• Removing waste that has accumulated along the shore line • Daily beach cleaning of harbour beaches so that rubbish does not get carried out to sea. • Bins including recycling at Delwood Beach • More rubbish bins to help litter problem. • Extra provision in summer months including recycling bins on Fairlight beach. • During summer months (when north eastern blows) send rubbish barge to clean up plastic. • Dog waste bags to be accessible

OTHER ISSUES

Issues	Statements	Suggestions
Companion Animals	• Dog owners are not being consulted in any changes and non-dog walkers	• Please prevent dogs being able to swim in water



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Issues	Statements	Suggestions
	getting preference - Don't see dogs being a problem - The area is totally spoiled by dogs. When off-leash, they are danger to toddlers and elderly - Not all dog owners pick up doggy doo – could a ranger be seen now and then? - Ranger patrols in late afternoon for dogs on the beaches. - Make sure to have plenty of exercise areas for dogs - Retain no leash area as it allows sense of community - Please ensure access to North Harbour Reserve off-leash for dogs is continued undisturbed.	- Control of dogs on paths and water - If dogs are allowed to run off the leash in NH Reserve, then Rangers need to be employed to police it - Control dogs in Park or ban dogs all together - Improved enforcement of no dogs on beach - Enforcement of dog leash area – Federation Point To North Harbour park - Stop dogs swimming and pooing in water and sand - Provide a designated doggy beach at North Harbour - Make sure to have plenty of exercise areas for dogs - Provision of more dog waste containers in the park
Heritage	I think knowledge (whether indigenous or post-European) of our heritage is very valuable and gives us all a better appreciation of the area as a whole.	- Protect the heritage areas particularly the Aboriginal sites - Continued efforts to protect older (pre 1960's) buildings/structures along the Manly Scenic Walkway - Preserve maritime heritage in North Harbour
Infrastructure	- Don't over develop the area. Reef and Shelly beaches have lost their charm with un-sympathetic development. - Balancing development and nature. Restraining incursions by residents. - Do not do anything to change existing use, maintenance. - Some development of marine facilities to ensure that marine use is effective and limits side effects. - Avoid overdevelopment of natural areas (Manly Council has done this very well in other parts e.g. Shelly beach).	Footbridge from Clarence Street to Gourlay Ave should be kept and maintained, not left to decay so that we need something new and dramatically different to the existing structure
Traffic Management	- Control the spread of cars in shared streets and car parks around reserve areas 2hr parking permits not monitored - Better control of parking – enforcement of 2hr. residential area	- Traffic needs to be slowed down on Condamine street for safety of kids - Speed humps in Fairlight Crescent - One way flow of traffic through Lower Beach Street and North harbour Street
Interpretation & Signage	- More signs along walkway - Clear and appropriate signage, especially in relation to care and protection of this very special	The historical information in the North Harbour Reserve south-eastern corner of the park has been vandalized and needs replacing.



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Issues	Statements	Suggestions
	environment, both terrestrial and aquatic.	
Safety & Crime Prevention	- Increased frequency of policing by Council Rangers and/or Police specially on the weekends - Better lighting to deter vandalism - Controlling behaviour in parks - Keep walkway safe - Make people more responsible for their actions	- Put up a first aid sign as there are many sea urchins and not many people know how to treat them if they step on one. - Stop vandals damage - Repair seawalls, replace large rocks
Stormwater & Water Quality	- Issues with water quality, especially after rain. Need for improved controls on Stormwater pollution - Control of pollution/rain run-off. Stormwater drainage traps required - Address water quality issues in swimming areas - Storm water runoff and boat use based water pollution	- Prioritise storm water recycling rather than discharge - Regularly clean the stormwater drains which at the moment are not attended to - Screens on stormwater pipes to prevent rubbish deposit on sand and harbour - The stormwater drain that flows into North Harbour needs to be cleaned up to preserve water quality in the area - Provision of treatment devices on each stormwater pipe that discharges into North Harbour - The amount of pollution that enters the harbour after heavy rain needs to be addressed, particularly from the storm water outlet under the footbridge to Gourlay Ave.
Community facilities	- Lack of toilet facilities between Fairlight Pool & Spit - Lack of playground equipment between Federation point and Davis Marina - New toilet facilities - Improve toilet facilities and signage	- Shower at Delwood beach - Provision of small playground equipment for young children between Federation point and Davis Marina
Fairlight Pool/ beach	- Maintain water quality of Fairlight pool. - Needs continuous pumping of water into/out of pool. - Better access for wheelchairs & prams - Bike rack at Fairlight beach (near access lane) - No dogs on beaches - I feel that Fairlight beach could perhaps have some palms (like that at Shelly beach)	- Existing shower to have automatic cut off on Fairlight beach - Bike rack at Fairlight beach (near access lane) - Plant fast growing trees to afford shelter from sun at the Fairlight pool. - Install some shade areas at Fairlight beach - New turf needed above Fairlight Pool (prepare ground well first)



APPENDIX B

PRINCIPLES OF ECOLOGICALLY SUSTAINABLE DEVELOPMENT (ESD)



DETAILED DESCRIPTIONS OF THE ESD PRINCIPLES

Precautionary Principle

The precautionary principle reinforces a 'risk averse' approach to development. Acknowledging that the predictive process of Environmental Impact Assessments is imperfect, the precautionary principle ensures that the uncertainty and the associated level of risk is considered in the decision making process by adopting a worst case scenario (DUAP, 1995). Absolute proof that environmental harm will occur should not be necessary for precautionary measures to be adopted. The onus of proof of environmental damage (or lack thereof) should be borne by the developer, rather than the public or the decision maker.

Inter-generational Equity

Social equity, incorporating inter-generational equity, embraces value concepts of justice and fairness, so that the basic needs of all sectors of society are met, and there is a fair distribution of costs and benefits. Inter-generational equity refers to the present generation ensuring that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. Intra-generational equity refers to the present generation ensuring that improved well-being and welfare are accessible to all sectors of society within Australia, and that improved welfare within Australia does not result in decreased welfare in other nations (DUAP, 1995).

Inter-generational equity is about the needs of future generations being considered in current projects, and ensuring that such projects do not limit the ability of future generations to attain quality of life at least equal to the current generation. Future generations should not be responsible for repairing environmental damage created by projects today.

Conservation of Diversity

The conservation of biological diversity and ecological integrity relates to the protection of biodiversity and the maintenance of ecological processes and systems. The loss of biodiversity is in most cases irreversible.

Biodiversity is usually considered at three levels: genetic diversity; species diversity; and ecosystem diversity. Ecological integrity is maintained when the productivity, stability and resilience of the ecosystem are sustained. Maintaining biodiversity and ecological integrity is important for both anthropocentric and ecocentric reasons. Anthropocentric justification relates to the needs of society to maintain food, medicine, building materials and other life support resources. It also provides significant cultural, economic, educational, recreational, scientific and social benefits. Ecocentric justifications relate to rights of plants, animals and the non-living elements of the planet to existence irrespective of human needs or wants (DUAP, 1995).

Improved Valuation and Pricing

Natural resources have often been misconstrued as being "free" or under priced. This has led to their wasteful use and consequent degradation in the past. Natural resources have historically been subjected to the same monetary market place economic analysis as general commodities. Based on supply and demand, for items that are plentiful, such as air and water, the value of the resource is low. This principle is based on ensuring that there is a broader approach to valuation, including ecological function values and other environmental factors.

In essence, this principle strives for *polluter pays* schemes, whereby those who generate pollution and waste should bear the cost of containment, avoidance or abatement, and *user pays* schemes, whereby consumers should pay prices based on the full life cycle costs, including the use of natural resources and assets, and the ultimate disposal of any wastes (DUAP, 1995).

References

DUAP – Department of Urban Affairs and Planning (1995) *Principles of Ecologically Sustainable Development* Appendix Q, Standard Brief Conditions, Provision of Project Management Services



APPENDIX C

SPECIES LISTS



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Table C1 – Fishes of Sydney Harbour

Common name	Scientific name	Common name	Scientific name
Amberjack	<i>Seriola dumerili</i>	Mackerel Tuna	<i>Euthynnus affinis</i>
Arrow Dartgoby	<i>Ptereleotris evides</i>	Magpie Morwong	<i>Cheilodactylus gibbosus</i>
Australian anchovy	<i>Engraulis australis</i>	Mangrove Jack	<i>Lutjanus argentimaculatus</i>
Australian Angelshark	<i>Squatina australis</i>	Manta Ray	<i>Manta birostris</i>
Australian Bandfish	<i>Cepola australis</i>	Manyband Sole	<i>Zebrias scalaris</i>
Australian Bonito	<i>Sarda australis</i>	Many-host Cling-Goby	<i>Pleurosicya mossambica</i>
Australian Damsel	<i>Pomacentrus australis</i>	Maori Wrasse	<i>Ophthalmolepis lineolatus</i>
Australian Herring	<i>Arripis georgianus</i>	Maray	<i>Etrumeus teres</i>
Australian Mado	<i>Atypichthys strigatus</i>	Marble Dragonet	<i>Neosynchiropus ocellatus</i>
Australian Pilchard	<i>Sardinops sagax</i>	Marbled Flathead	<i>Platycephalus marmoratus</i>
Australian Rainbow Wrasse	<i>Suezichthys devisi</i>	Messmate Fish	<i>Echiodon rendahli</i>
Australian Smelt	<i>Retropinna semoni</i>	Milkfish	<i>Chanos chanos</i>
Axilspot Hogfish	<i>Bodianus axillaris</i>	Mimic Leatherjacket	<i>Paraluteres prionurus</i>
banded bellowsfish	<i>Centriscoops humerosus</i>	Miracle Threefin	<i>Enneapterygius mirabilis</i>
Banded Morwong	<i>Cheilodactylus spectabilis</i>	Mirrorwing Flyingfish	<i>Hirundichthys speculiger</i>
Banded Rockcod	<i>Epinephelus ergastularius</i>	Moon Wrasse	<i>Thalassoma lunare</i>
Banded Scat	<i>Selenotoca multifasciata</i>	Moorish Idol	<i>Zanclus cornutus</i>
Banded Seaperch	<i>Hypoplectrodes nigroruber</i>	Mosaic Leatherjacket	<i>Eubalichthys mosaicus</i>
Barracouta	<i>Thyrstites atun</i>	Moses Perch	<i>Lutjanus russelli</i>
Barred Longtom	<i>Ablennes hians</i>	Mother-of-Pearl Pipefish (P)	<i>Vanacampus margaritifer</i>
Barred Soapfish	<i>Diploprion bifasciatum</i>	Mud Flathead	<i>Ambiserrula jugosa</i>
Barred Threefin	<i>Brachynectes fasciatus</i>	Mulloway	<i>Argyrosomus japonicus</i>
Bar-tailed Goatfish	<i>Upeneus tragula</i>	Nannygai	<i>Centroberyx affinis</i>
Bastard Red Cod	<i>Pseudophycis breviuscula</i>	Narrow-Banded Sergeant Major	<i>Abudefduf bengalensis</i>
Bastard Trumpeter	<i>Latridopsis forsteri</i>	Narrow-banded Sole	<i>Aseraggodes macleayanus</i>
Beaked Coralfish	<i>Chelmon rostratus</i>	Narrow-barred Spanish Mackerel	<i>Scomberomorus commerson</i>
Beaked Salmon	<i>Gonorynchus greyi</i>	Nebulous Wrasse	<i>Halichoeres nebulosus</i>
Bearded Rock Cod	<i>Pseudophycis barbata</i>	Numbfish	<i>Hypnos monopterygium</i>
Beardie	<i>Lotella rhacina</i>	Oarfish	<i>Regalecus glesne</i>
Bicolour Goatfish	<i>Parupeneus barberinoides</i>	Ocean Jacket	<i>Nelussetta ayraudi</i>
Bigbelly Seahorse (P)	<i>Hippocampus abdominalis</i>	Ocellate Butterflyfish	<i>Parachaetodon ocellatus</i>
Bigeye Trevally	<i>Caranx sexfasciatus</i>	Ogilby's Hardyhead	<i>Atherinomorus vaiigiensis</i>
Bigscale Scalyfin	<i>Parma oligolepis</i>	Ogilby's weedfish	<i>Heteroclinus heptaeolus</i>
Bigscale Soldierfish	<i>Myripristis berndti</i>	Old Wife	<i>Enoplosus armatus</i>
Bigtooth Twin-spot Flounder	<i>Pseudorhombus duplici-cellatus</i>	One-spot Puller	<i>Chromis hypsilepis</i>
Black Kingfish	<i>Rachycentron canadum</i>	Orangeband Surgeonfish	<i>Acanthurus olivaceus</i>
Black Leopard-Wrasse	<i>Macropharyngodon negrosensis</i>	Orangebar Threefin	<i>Ceratobregma helenae</i>
Black Rockcod (V)	<i>Epinephelus daemeli</i>	Orangeline Cardinalfish	<i>Apogon cyanosoma</i>
Black Sole	<i>Brachirus nigra</i>	Orange-line Wrasse	<i>Halichoeres hartzfeldi</i>
Black Spinefoot	<i>Siganus fuscescens</i>	Orangelined Wirrah	<i>Acanthistius paxtoni</i>
Black Triggerfish	<i>Sufflamen chrysopteron</i>	Ornate Ghostpipefish (P)	<i>Solenostomus paradoxus</i>
Blackback Butterflyfish	<i>Chaetodon melanotus</i>	Ornate Wobbegong	<i>Orectolobus ornatus</i>
Blackbanded Seaperch	<i>Hypoplectrodes annulatus</i>	Oxeye Herring	<i>Megalops cyprinoides</i>
Blackhead Leatherjacket	<i>Pervagor melanocephalus</i>	Oyster Blenny	<i>Omobranchus anolius</i>
Black-head Threefin	<i>Enneapterygius larsonae</i>	Pacific Blue-eye	<i>Pseudomugil signifer</i>
Black-lined Sleeper Goby	<i>Valenciennaea helsdingenii</i>	Pacific Rockcod	<i>Trachypoma macracanthus</i>



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Table C1 – Fishes of Sydney Harbour

Common name	Scientific name	Common name	Scientific name
Blackmargin Dartfish	<i>Parioglossus marginalis</i>	Painted Lizardfish	<i>Trachinocephalus myops</i>
Blackmargin Maori Wrasse	<i>Oxycheilinus nigromarginatus</i>	Painted Rainbow Wrasse	<i>Suezichthys arquatus</i>
Blackspot Boarfish	<i>Zanclistius elevatus</i>	Painted Stinkfish	<i>Eocallionymus papilio</i>
Black-spot Goatfish	<i>Parupeneus spilurus</i>	Painted Sweetlips	<i>Diagramma pictum</i>
Blackspot Gurnard	<i>Lepidotrigla umbrosa</i>	Peacock Rockskipper	<i>Istiblennius meleagris</i>
Black-spot Mangrove-goby	<i>Mugilogobius stigmaticus</i>	Peacock Sole	<i>Pardachirus pavoninus</i>
Blackspot Snapper	<i>Lutjanus fulviflamma</i>	Pearl Perch	<i>Glaucosoma scapulare</i>
Black-spotted Porcupinefish	<i>Diodon hystrix</i>	Pennantfish	<i>Alectis ciliaris</i>
Black-spotted Wrasse	<i>Austrolabrus maculatus</i>	Piano Fangblenny	<i>Plagiotremus tapeinosoma</i>
Blacktail Snapper	<i>Lutjanus fulvus</i>	Pigfish	<i>Bodianus unimaculatus</i>
Black-tipped Bullseye	<i>Pempheris affinis</i>	Pike	<i>Sphyaena novaehollandiae</i>
Black-tipped Fusilier	<i>Pterocaesio digramma</i>	Pilotfish	<i>Naucrates ductor</i>
Blindshark	<i>Brachaelurus waddi</i>	Pineapplefish	<i>Cleidopus gloriamaris</i>
Blotched Hawkfish	<i>Cirrhitichthys aprinus</i>	pink clingfish	<i>Aspasmogaster costatus</i>
Blue Angelfish	<i>Pomacanthus semicirculatus</i>	Pink-banded Grubfish	<i>Parapercis nebulosa</i>
Blue Damsel	<i>Pomacentrus coelestis</i>	Pinkbreast Siphonfish	<i>Siphamia roseigaster</i>
Blue Groper	<i>Achoerodus viridis</i>	Pink-lined Wrasse	<i>Coris dorsomacula</i>
Blue Mackerel	<i>Scomber australasicus</i>	Port Jackson glassfish	<i>Ambassis jacksoniensis</i>
Blue Morwong	<i>Nemadactylus douglasii</i>	Port Jackson Shark	<i>Heterodontus portusjacksoni</i>
Blue Sprat	<i>Spratelloides robustus</i>	Premature Floater	<i>Schindleria praematura</i>
Blue Warehou	<i>Seriotelele brama</i>	Purple Flying Gurnard	<i>Dactyloptena orientalis</i>
Blue-barred Parrotfish	<i>Scarus ghobban</i>	Purple Rockcod	<i>Epinephelus cyanopodus</i>
Bluebottle-fish	<i>Nomeus gronovii</i>	Purple Tuskfish	<i>Choerodon cephalotes</i>
Bluefish	<i>Girella cyanea</i>	Pygmy Scorpionfish	<i>Scorpaenodes scaber</i>
Blue-lined Goatfish	<i>Upeneichthys lineatus</i>	Queensland Yellowtail Angelfish	<i>Chaetodontoplus meredithi</i>
Blue-spot Goby	<i>Pseudogobius sp 9</i>	Raccoon Butterflyfish	<i>Chaetodon lunula</i>
Blue-spotted Parrotfish	<i>Leptoscarus vaigiensis</i>	Ragged-finned Firefish	<i>Pterois antennata</i>
Bluestripe Seaperch	<i>Lutjanus kasmira</i>	Rainbow Cale	<i>Odax acroptilus</i>
Bluestriped Fangblenny	<i>Plagiotremus rhinorhynchus</i>	Rainbow Monocle-bream	<i>Scolopsis monogramma</i>
Bluntheaded Wrasse	<i>Thalassoma amblycephalum</i>	Red Firefish	<i>Pterois volitans</i>
Bony Flyingfish	<i>Hirundichthys oxycephalus</i>	Red Gurnard	<i>Chelidonichthys kumu</i>
Bridled Goby	<i>Arenigobius bifrenatus</i>	Red Morwong	<i>Cheilodactylus fuscus</i>
Bridled Leatherjacket	<i>Acanthaluteres spilomelanurus</i>	Red Pipefish (P)	<i>Notiocampus ruber</i>
Bridled Monocle Bream	<i>Scolopsis bilineatus</i>	Red Rockcod	<i>Scorpaena cardinalis</i>
Bridled Triggerfish	<i>Sufflamen fraenatum</i>	Redbanded Grubfish	<i>Parapercis binivirgata</i>
Broadhead Goosefish	<i>Lophiomus setigerus</i>	Redspot Wrasse	<i>Stethojulis bandanensis</i>
Broadnosed Sevengill Shark	<i>Notorynchus cepedianus</i>	Remora	<i>Remora remora</i>
Broadstripe Cardinalfish	<i>Apogon angustatus</i>	Ribbonfish	<i>Trachipterus arawatae</i>
Brokenline Wrasse	<i>Stethojulis interrupta</i>	Ring-scale Triplefin	<i>Enneapterygius atrogulare</i>
Bronze Whaler	<i>Carcharhinus brachyurus</i>	River Garfish	<i>Hyporhamphus regularis</i>
Brown Sabretooth Blenny	<i>Petroscirtes lupus</i>	Robust Ghost Pipefish (P)	<i>Solenostomus cyanopterus</i>
Brown Sweetlips	<i>Plectorhynchus gibbosus</i>	Rock Blackfish	<i>Girella elevata</i>
Bull Shark	<i>Carcharhinus leucas</i>	Rock Cale	<i>Aplodactylus lophodon</i>
Bullrout	<i>Notesthes robusta</i>	Rock Flathead	<i>Thysanophrys cirronasus</i>
Butterfly Perch	<i>Caesioperca lepidoptera</i>	rosy perch	<i>Callanthias allporti</i>
Capricorn Cardinalfish	<i>Apogon capricornis</i>	Rosy Weedfish	<i>Heteroclinus roseus</i>



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Common name	Scientific name	Common name	Scientific name
Carp	<i>Cyprinus carpio</i>	Rotund Blenny	<i>Omobranchus rotundiceps</i>
Checkerboard Wrasse	<i>Halichoeres hortulanus</i>	Rough Flutemouth	<i>Fistularia petimba</i>
Clouded Saury	<i>Saurida nebulosa</i>	Rough Leatherjacket	<i>Scobinichthys granulatus</i>
Coastal Cubehead	<i>Cubiceps whiteleggi</i>	Rough-head Dragonet	<i>Repomucenus limiceps</i>
Cockatoo Waspfish	<i>Ablabys taenianotus</i>	Roundbelly Cowfish	<i>Lactoria diaphana</i>
Cockerel Wrasse	<i>Pteragogus enneacanthus</i>	Roundsnout Gurnard	<i>Lepidotrigla mulhali</i>
Cocos Frillgoby	<i>Bathygobius cocosensis</i>	Ruby Cardinalfish	<i>Apogon coccineus</i>
Comb Wrasse	<i>Coris picta</i>	Saddled Puffer	<i>Canthigaster valentini</i>
Common Bullseye	<i>Pempheris multiradiata</i>	Sailfin Goby	<i>Nesogobius pulchellus</i>
Common Dolphinfish	<i>Coryphaena hippurus</i>	Samson fish	<i>Seriola hippos</i>
Common Galaxias	<i>Galaxias maculatus</i>	Sand Flathead	<i>Platycephalus bassensis</i>
Common Jack Mackerel	<i>Trachurus declivis</i>	Sand Mullet	<i>Myxus elongatus</i>
common name unknown	<i>Gymnothorax kidako</i>	Sand Whiting	<i>Sillago ciliata</i>
Common Pike Eel	<i>Muraenesox bagio</i>	Sandy Sprat	<i>Hyperlophus vittatus</i>
Common Saury	<i>Saurida tumbil</i>	Sandyback Stingaree	<i>Urolophus bucculentus</i>
Common Sawshark	<i>Pristiophorus cirratus</i>	Sargassum Anglerfish	<i>Histrio histrio</i>
Common Shore-eel	<i>Alabes dorsalis</i>	Sawtail Surgeonfish	<i>Prionurus microlepidotus</i>
Common Silverbiddy	<i>Gerres subfasciatus</i>	Saw-tooth Moray	<i>Gymnothorax prionodon</i>
Common Stingaree	<i>Trygonoptera testacea</i>	Sawtooth Pipefish (P)	<i>Maroubra perserrata</i>
Common Stinkfish	<i>Foetorepus calauropomus</i>	Scalloped Hammerhead	<i>Sphyrna lewini</i>
Common Threefin	<i>Trinorfolkia clarkei</i>	Scalytail Toadfish	<i>Torquigener squamicauda</i>
Common Toadfish	<i>Tetractenos hamiltoni</i>	School Mackerel	<i>Scomberomorus queenslandicus</i>
Convict Surgeonfish	<i>Acanthurus triostegus</i>	School Shark	<i>Galeorhinus galeus</i>
Coral Sea Gregory	<i>Stegastes gascoynei</i>	Schooling Bannerfish	<i>Heniochus diphreutes</i>
Cottonmouth Trevally	<i>Uraspis secunda</i>	Scissortail Sergeant	<i>Abudefduf sexfasciatus</i>
Cox's Gudgeon	<i>Gobiomorphus coxii</i>	Scribbled Leatherjacket	<i>Aluterus scripta</i>
Crescent Perch	<i>Terapon jarbua</i>	Scribbled Rockcod	<i>Epinephelus undulatostratus</i>
Crested Flounder	<i>Lophonectes gallus</i>	Scribbled Wrasse	<i>Anampses geographicus</i>
Crested Horn shark	<i>Heterodontus galeatus</i>	Sea Mullet	<i>Mugil cephalus</i>
Crested Oyster Goby	<i>Cryptocentroides gobioides</i>	Seagrass Ghost-goby	<i>Pleurosicya bilobata</i>
Crested Pipefish (P)	<i>Histiogamphelus briggsii</i>	Senator Wrasse	<i>Pictilabus laticlavus</i>
Crested Weedfish	<i>Cristiceps australis</i>	Sergeant Baker	<i>Aulopus purpurissatus</i>
Crimsonband Wrasse	<i>Notolabrus gymnogenis</i>	Serpent Eel	<i>Ophisurus serpens</i>
Crowned Puffer	<i>Canthigaster coronata</i>	Sharpnose Grubfish	<i>Parapercis cylindrica</i>
Darkbar Flyingfish	<i>Cypselurus hexazona</i>	Shortfin Eel	<i>Anquilla australis</i>
Dash-dot Goatfish	<i>Parupeneus barberinus</i>	Shortfin Worm Eel	<i>Scolecenchelys australis</i>
Diamond Wrasse	<i>Anampses caeruleopunctatus</i>	Shorthead Lamprey	<i>Mordacia mordax</i>
Diamondfish	<i>Monodactylus argenteus</i>	Shorthead Worm Eel	<i>Scolecenchelys breviceps</i>
Diamondscale Goatfish	<i>Parupeneus ciliatus</i>	Shoulder-spot Sandgoby	<i>Gnatholepis anjerensis</i>
Doublesaddle Butterflyfish	<i>Chaetodon ulietensis</i>	Shoulderspot Wrasse	<i>Leptojulis cyanopleura</i>
Dusky Butterflyfish	<i>Chaetodon flavirostris</i>	Sieve-patterned Moray	<i>Gymnothorax cribroris</i>
Dusky Flathead	<i>Platycephalus fuscus</i>	Silver Sweep	<i>Scorpius lineolata</i>
Dusky Morwong	<i>Dactylophora nigricans</i>	Silver Toadfish	<i>Lagocephalus sceleratus</i>
Dusky Shark	<i>Carcharhinus obscurus</i>	Silver Trevally	<i>Pseudocaranx dentex</i>
Dusky Wrasse	<i>Halichoeres marginatus</i>	Silverline Cardinalfish	<i>Apogon hartzfeldi</i>
Dwarf Hawkfish	<i>Cirrhitichthys falco</i>	Silverside Weedfish	<i>Cristiceps argyroleura</i>



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Common name	Scientific name	Common name	Scientific name
Dwarf Lionfish	<i>Dendrochirus brachypterus</i>	Silverstreak Wrasse	<i>Stethojulis strigiventer</i>
Eastern Australian Salmon	<i>Arripis trutta</i>	Six-spine Leatherjacket	<i>Meuschenia freycineti</i>
Eastern Blue Devil	<i>Paraplesiops bleekeri</i>	Skipjack Tuna	<i>Katsuwonus pelamis</i>
Eastern Blue-spotted Flathead	<i>Platycephalus caeruleopunctatus</i>	Slender Flounder	<i>Pseudorhombus tenuirastrum</i>
Eastern Cleaner-clingfish	<i>Cochleocephalus orientalis</i>	Slender Longtom	<i>Strongylura leiura</i>
Eastern Conger	<i>Conger wilsoni</i>	Slender Rainbow Wrasse	<i>Suezichthys gracilis</i>
Eastern Fiddler Ray	<i>Trygonorrhina sp a</i>	Slender Roughy	<i>Optivus agastos</i>
Eastern Frogfish	<i>Batrachomoeus dubius</i>	Slender Sandburrer	<i>Creedia haswelli</i>
Eastern Gambusia	<i>Gambusia holbrooki</i>	Slender Seamothe (P)	<i>Pegasus volitans</i>
Eastern Gobbleguts	<i>Vincentia novaehollandiae</i>	Slender Suckerfish	<i>Echeneis naucrates</i>
Eastern Hulafish	<i>Trachinops taeniatus</i>	Slimy Cuskeel	<i>Brommophyciops pautzkei</i>
Eastern Jumping Blenny	<i>Lepidoblennius haplodactylus</i>	Small-head Sole	<i>Soleichthys microcephalus</i>
Eastern King Wrasse	<i>Coris sandeyeri</i>	Smallmouth Hardyhead	<i>Atherinosoma microstoma</i>
Eastern Longfin-goby	<i>Favonigobius lentiginosus</i>	Small-scale Bullseye	<i>Pempheris compressa</i>
Eastern Pomfred	<i>Schuettea scalaripinnis</i>	Smallscale Hardyhead	<i>Atherinason hepsetoides</i>
Eastern School Whiting	<i>Sillago flindersi</i>	Smallspot Dart	<i>Trachinotus bailloni</i>
Eastern Sea Garfish	<i>Hyporhamphus australis</i>	Smalltooth Flounder	<i>Pseudorhombus jenynsii</i>
Eastern Shovelnose Ray	<i>Aptychotrema rostrata</i>	Smooth Flutemouth	<i>Fistularia commersonii</i>
Eastern Smooth Boxfish	<i>Anoplocapros inermis</i>	Smooth Golden Pufferfish	<i>Lagocephalus inermis</i>
Eastern Stargazer	<i>Kathetostoma laevis</i>	Smooth Hammerhead	<i>Sphyrna zygaena</i>
Eastern Striped Trumpeter	<i>Pelates sexlineatus</i>	Smooth Stingray	<i>Dasyatis brevicaudata</i>
Eastern Talma	<i>Chelmonops truncatus</i>	Smooth Toadfish	<i>Tetractenos glaber</i>
Eastern Wirrah	<i>Acanthistius ocellatus</i>	Snakeskin Wrasse	<i>Eupetrichthys angustipes</i>
Eastern Yellow Blindfish	<i>Dermatopsis macrodon</i>	Snapper	<i>Pagrus auratus</i>
Elegant Wrasse	<i>Anampses elegans</i>	Snubnose Dart	<i>Trachinotus blochii</i>
Elephantfish	<i>Callorhynchus milii</i>	snubnose Garfish	<i>Arrhamphus sclerolepis</i>
Empire Gudgeon	<i>Hypseleotris compressa</i>	Southern Conger	<i>Conger verreauxi</i>
Epaulette Shark	<i>Hemiscyllium ocellatum</i>	Southern Demoiselle	<i>Chrysiptera notialis</i>
Estuary Catfish	<i>Cnidogobius macrocephalus</i>	Southern Eagle Ray	<i>Myliobatis australis</i>
Estuary Perch	<i>Macquaria colonorum</i>	Southern Fanfish	<i>Pteraclis velifera</i>
Estuary Perchlet	<i>Ambassis marianus</i>	Southern Peacock Sole	<i>Pardachirus hedleyi</i>
Estuary Stingray	<i>Dasyatis fluviorum</i>	Southern Pygmy Leatherjacket	<i>Brachaluteres jacksonianus</i>
Exquisite Sandgoby	<i>Favonigobius eximius</i>	Southern Red Scorpionfish	<i>Scorpaena papillosus</i>
Eye Gurnard	<i>Lepidotrigla argus</i>	Southern Roughy	<i>Trachichthys australis</i>
Eyestripe Surgeonfish	<i>Acanthurus dussumieri</i>	Southern Silver Drummer	<i>Kyphosus sydneyanus</i>
False Cleanerfish	<i>Aspidontus taeniatus</i>	Southern Smiler	<i>Opistognathus jacksoniensis</i>
False Fusilier	<i>Paracaesio xanthura</i>	Southern Sprat	<i>Herklotsichthys castelnaui</i>
False Kelpfish	<i>Sebastiscus marmoratus</i>	Spangled emperor	<i>Lethrinus nebulosus</i>
Fan-bellied Leatherjacket	<i>Monacanthus chinensis</i>	Sparse Eviota	<i>Eviota sparsa</i>
Fantail Mullet	<i>Valamugil georgii</i>	Spikey Dogfish	<i>Squalus megalops</i>
Fine-spotted Wrasse	<i>Cirrhitilabrus punctatus</i>	Spineless Toadfish	<i>Torquigener perlevis</i>
Finny Scad	<i>Megalaspis cordyla</i>	Spiny Gurnard	<i>Lepidotrigla papilio</i>
Firetailed Gudgeon	<i>Hypseleotris galii</i>	Spiny Pipehorse (P)	<i>Solegnathus spinosissimus</i>
Fisons Flounder	<i>Arnoglossus fisoni</i>	Spinyeye Cardinalfish	<i>Apogon fraenatus</i>
Five-line Snapper	<i>Lutjanus quinquelineatus</i>	Spinytooth Parrotfish	<i>Calotomus spinidens</i>
Five-lined Cardinalfish	<i>Cheilodipterus quinquelineatus</i>	Spot-tail wide-eye Flounder	<i>Engyprosopon grandisquama</i>



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Common name	Scientific name	Common name	Scientific name
Flag-tail Flathead	<i>Platycephalus arenarius</i>	Spotted Bigeye	<i>Priacanthus macracanthus</i>
Flat-backed Mangrove-goby	<i>Mugilogobius platynotus</i>	Spotted Butterfish	<i>Scatophagus argus</i>
Flathead Goby	<i>Callogobius depressus</i>	Spotted Dragonet	<i>Repomucenus calcaratus</i>
Flathead Gudgeon	<i>Philypnodon grandiceps</i>	Spotted Grubfish	<i>Parapercis ramsayi</i>
Flathead Sandfish	<i>Lesueurina platycephala</i>	Spotted Pipefish (P)	<i>Stigmatopora argus</i>
Flat-tail Mullet	<i>Liza argentea</i>	Spotted Sawtail	<i>Prionurus maculatus</i>
Fortescue	<i>Centropogon australis</i>	Spotted Wobbegong	<i>Orectolobus maculatus</i>
Fourline Cardinalfish	<i>Apogon doederleini</i>	Starck's Demoiselle	<i>Chrysiptera starcki</i>
Foxfish	<i>Bodianus frenchii</i>	Starry Goby	<i>Asterropteryx semipunctatus</i>
Freckled Porcupinefish	<i>Diodon holocanthus</i>	Starry Pufferfish	<i>Arothron stellatus</i>
Freshwater Catfish	<i>Tandanus tandanus</i>	Starry Toadfish	<i>Arothron firmamentum</i>
Freshwater Herring	<i>Potamalosa richmondia</i>	Stars and Stripes Leatherjacket	<i>Meuschenia venusta</i>
Frigate Mackerel	<i>Auxis thazard</i>	Stars and Stripes Toadfish	<i>Arothron hispidus</i>
Fringed Stargazer	<i>Ichthyoscopus barbatus</i>	Stick Pipefish (P)	<i>Trachyrhamphus bicoarctatus</i>
Frostfish	<i>Lepidopus caudatus</i>	Stout Longtom	<i>Tylosurus gavioloides</i>
Gelatinous Cardinalfish	<i>Pseudamia gelatinosa</i>	Stout Whiting	<i>Sillago robusta</i>
Giant Anglerfish	<i>Antennarius commersoni</i>	Striped Anglerfish	<i>Antennarius striatus</i>
Giant Boarfish	<i>Paristiopterus labiosus</i>	Striped Cardinalfish	<i>Apogon fasciatus</i>
Giant Herring	<i>Elops hawaiiensis</i>	Striped Catfish	<i>Plotosus lineatus</i>
Giant Sea Catfish	<i>Arius thalassinus</i>	Striped Cleaner Wrasse	<i>Labroides dimidiatus</i>
Giant Squirrelfish	<i>Ostichthys japonicus</i>	Striped Gudgeon	<i>Gobiomorphus australis</i>
Giant Trevally	<i>Caranx ignobilis</i>	Striped Sandgoby	<i>Acentrogobius pflaumii</i>
Girdled Parma	<i>Parma unifasciata</i>	Striped Seapike	<i>Sphyrna obtusata</i>
Girdled Pipefish (P)	<i>Festucalex cinctus</i>	Stripey	<i>Microcanthus strigatus</i>
Girdled Reef-goby	<i>Priolepis cincta</i>	Surge Demoiselle	<i>Chrysiptera brownriggii</i>
Glassgoby	<i>Gobiopterus semivestitus</i>	Sweetlip Emperor	<i>Lethrinus miniatus</i>
Glassy Sprat	<i>Hyperlophus translucidus</i>	Sydney Cardinalfish	<i>Apogon limenus</i>
Goblinfish	<i>Glyptauchen panduratus</i>	Sydney Scorpionfish	<i>Scorpaenopsis insperatus</i>
Goldband Fusilier	<i>Caesio caerulaurea</i>	Sydney Skate	<i>Dipturus australis</i>
Golden Weedfish	<i>Cristiceps aurantiacus</i>	Tailor	<i>Pomatomus saltatrix</i>
Goldfish	<i>Carassius auratus</i>	Tallfin Flyingfish	<i>Cheilopogon pinnatibarbus</i>
Goldlined Wrasse	<i>Coris aurlineata</i>	Tamar Goby	<i>Afurcagobius tamarensis</i>
Goldspot Pigfish	<i>Bodianus perditio</i>	Tarwhine	<i>Rhabdosargus sarba</i>
Gold-spotted Sweetlips	<i>Plectorhinchus flavomaculatus</i>	Tasmanian Blenny	<i>Parablennius tasmanianus</i>
Grass Whiting	<i>Haletta semifasciata</i>	Tasmanian clingfish	<i>Aspasmogaster tasmaniensis</i>
Green Moray	<i>Gymnothorax prasinus</i>	Tasmanian numbfish	<i>Narcine tasmaniensis</i>
Green Sawfish (E)	<i>Pristis zijsron</i>	Tasselled Leatherjacket	<i>Chaetodermis penicilligera</i>
Greenback Stingaree	<i>Urolophus viridis</i>	Teira Batfish	<i>Platax teira</i>
Greeneye Dartgoby	<i>Ptereleotris microlepis</i>	Temperate Scad	<i>Decapterus muroadsi</i>
Grey Nurse Shark (E)	<i>Carcharias taurus</i>	Teraglin	<i>Atractoscion aequidens</i>
Grey Spotted Catshark	<i>Asymbolus analis</i>	Theodore's Threadfin-bream	<i>Nemipterus theodorei</i>
Gulf Damsel	<i>Pristotis obtusirostris</i>	Thicklip Trevally	<i>Carangoides orthogrammus</i>
Gummy Shark	<i>Mustelus antarcticus</i>	Thicklip Wrasse	<i>Hemigymnus melapterus</i>
Günther's Butterflyfish	<i>Chaetodon guentheri</i>	Thorny-back Cowfish	<i>Lactoria fornasini</i>
Gunther's wrasse	<i>Pseudolabrus guentheri</i>	Threadfin Butterflyfish	<i>Chaetodon auriga</i>
Hairy Pipefish (P)	<i>Urocampus carinirostris</i>	Threadfin Emperor	<i>Lethrinus genivittatus</i>



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Common name	Scientific name	Common name	Scientific name
Halfband Cardinalfish	<i>Apogon semiornatus</i>	Threadfin Leatherjacket	<i>Paramonacanthus filicauda</i>
Halfband Snake Eel	<i>Malvoliophis pinguis</i>	Threadfin Reef-goby	<i>Priolepis nuchifasciata</i>
Half-banded Seaperch	<i>Hypoplectrodes maccullochi</i>	Thread-tail Dartgoby	<i>Ptereleotris hanae</i>
Half-bridled Goby	<i>Arenigobius frenatus</i>	Threeband Demoiselle	<i>Chrysiptera tricolor</i>
Half-scale Sandburrer	<i>Creedia partimsquamigera</i>	Three-bar Porcupinefish	<i>Dicotylichthys punctulatus</i>
Halstead's Toadfish	<i>Reicheltia halsteadii</i>	Three-by-two Garfish	<i>Hemiramphus robustus</i>
Hasselt's Flaphead Goby	<i>Callogobius hasseltii</i>	Three-spot Dascyllus	<i>Dascyllus trimaculatus</i>
Herring Cale	<i>Odax cyanomelas</i>	Tiger Cardinalfish	<i>Cheilodipterus macrodon</i>
Highfin Toadfish	<i>Torquigener altipinnis</i>	Tiger Flathead	<i>Platycephalus richardsoni</i>
Hoesse's Sandgoby	<i>Istigobius hoessei</i>	Tiger Pipefish (P)	<i>Filicampus tigris</i>
Horned Blenny	<i>Parablennius intermedius</i>	Tiger Shark	<i>Galeocerdo cuvier</i>
Hussar	<i>Lutjanus adetii</i>	Tommyfish	<i>Limnichthys fasciatus</i>
Immaculate Damsel	<i>Mecaenichthys immaculatus</i>	Toothbrush Leatherjacket	<i>Acanthaluteres vittiger</i>
Indo-Pacific sergeant	<i>Abudefduf vaigiensis</i>	Trident Goby	<i>Tridentiger trigonocephalus</i>
Jameson's Seaperch	<i>Hypoplectrodes jamesoni</i>	Tripletail	<i>Lobotes surinamensis</i>
Javelin Pipefish (P)	<i>Lissocampus runa</i>	Trumpeter Whiting	<i>Sillago maculata</i>
John Dory	<i>Zeus faber</i>	Turretfish	<i>Tetrosomus reipublicae</i>
Keel-head Razorfish	<i>Xyrichtys jacksonensis</i>	Two-eye Cardinalfish	<i>Apogon nigripinnis</i>
Kelpfish	<i>Chironemus marmoratus</i>	Two-spine Angelfish	<i>Centropyge bispinosa</i>
keyhole angelfish	<i>Centropyge tibicen</i>	Twospot Maori Wrasse	<i>Oxycheilinus bimaculatus</i>
King Gar	<i>Scomberesox saurus</i>	Twotone Wrasse	<i>Halichoeres prosopoeion</i>
Klein's Butterflyfish	<i>Chaetodon kleinii</i>	Unicorn Leatherjacket	<i>Aluterus monoceros</i>
Kreff's Frillgoby	<i>Bathygobius krefftii</i>	Upside Down Pipefish (P)	<i>Heraldia nocturna</i>
Kuiter's Goby	<i>Valenciennesia immaculata</i>	Variegated Lizardfish	<i>Synodus variegatus</i>
Kuiter's Wrasse	<i>Macropharyngodon kuiteri</i>	Velvetfish	<i>Aploactisoma milesii</i>
Lance Blenny	<i>Aspidontus dussumieri</i>	Waite's Seapike	<i>Sphyrna waitii</i>
Largehead Hairtail	<i>Trichiurus lepturus</i>	Ward's Damsel	<i>Pomacentrus wardi</i>
Largemouth Goby	<i>Redigobius macrostoma</i>	Weedy Seadragon (P)	<i>Phyllopteryx taeniolatus</i>
Largenose Weedfish	<i>Heteroclinus nasutus</i>	Weeping Toado	<i>Torquigener pleurogramma</i>
Largescale Saury	<i>Saurida undosquamis</i>	White Shark (V)	<i>Carcharodon carcharias</i>
Largespotted Herring	<i>Herklotsichthys koningsbergeri</i>	White-barred Goby	<i>Amblygobius phalaena</i>
Large-tooth Flounder	<i>Pseudorhombus arsius</i>	White-Ear	<i>Parma microlepis</i>
Latchet	<i>Pterygotrigla polyommata</i>	Whiteleg's Weedfish	<i>Heteroclinus whiteleggii</i>
Leaf Scorpionfish	<i>Taenianotus triacanthus</i>	Whiteline Eviota	<i>Eviota albolineata</i>
Leaping Bonito	<i>Cybiosarda elegans</i>	White's Seahorse (P)	<i>Hippocampus whitei</i>
Lemon Tongue-sole	<i>Paraplagusia bilineata</i>	Whitespotted Guitarfish	<i>Rhynchobatus australiae</i>
Leopard Shark	<i>Stegostoma fasciatum</i>	Whitetail Angelfish	<i>Centropyge flavicauda</i>
Lesser Moray	<i>Gymnothorax minor</i>	Wide-body Pipefish (P)	<i>Stigmatopora nigra</i>
Little Conger	<i>Gnathopis longicaudatus</i>	Woods Siphonfish	<i>Siphania cephalotes</i>
Little Dragonfish	<i>Eurypegasus draconis</i>	Yellow Boxfish	<i>Ostracion cubicus</i>
Little Weed Whiting	<i>Neodax balteatus</i>	Yellow Tang	<i>Zebrasoma flavescens</i>
Long Green Wrasse	<i>Pseudojuloides elongatus</i>	Yellowback Bream	<i>Dentex tumifrons</i>
Longfin Bannerfish	<i>Heniochus acuminatus</i>	Yellow-back Puller	<i>Chromis nitida</i>
Longfinned Eel	<i>Anguilla reinhardtii</i>	Yellowband Fusilier	<i>Pterocaesio chrysozona</i>
Long-finned Perch	<i>Caprodon longimanus</i>	Yellowedge Lyretail	<i>Variola louti</i>
Long-finned Pike	<i>Dinolestes lewini</i>	Yellowfin Bream	<i>Acanthopagrus australis</i>



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Table C1 – Fishes of Sydney Harbour

Common name	Scientific name	Common name	Scientific name
Longhorn Cowfish	<i>Lactoria cornuta</i>	Yellowfin Goby	<i>Acanthogobius flavimanus</i>
Longsnout Flounder	<i>Ammotretis rostratus</i>	Yellowfin Pigfish	<i>Bodianus flavipinnis</i>
Longspine Flathead	<i>Platycephalus longispinis</i>	Yellow-finned Leatherjacket	<i>Meuschenia trachylepis</i>
Longtail Catfish	<i>Euristhmus lepturus</i>	Yellow-striped Leatherjacket	<i>Meuschenia flavolineata</i>
Lowe's Leatherjacket	<i>Paramonacanthus lowei</i>	Yellowtail Demoiselle	<i>Neopomacentrus azysron</i>
Luculentus Wrasse	<i>Pseudolabrus luculentus</i>	Yellowtail Kingfish	<i>Seriola lalandi</i>
Luderick	<i>Girella tricuspidata</i>	Yellowtail Scad	<i>Trachurus novaezelandiae</i>
Lyre-tail Hawkfish	<i>Cyprinocirrhites polyactis</i>	Zebra Lionfish	<i>Dendrochirus zebra</i>
		Zebra Sole	<i>Zebrias quagga</i>
		Zebrafish	<i>Girella zebra</i>
		Zig-zag Ponyfish	<i>Leiognathus moretoniensis</i>
P = Protected Species, Fisheries Management Act, 2004			
E = Endangered Species, Fisheries Management Act, 1994			
V = Vulnerable, Fisheries Management Act, 1994			
Source: Australian Museum, 2007			

Table C2 – Other Marine Fauna Species Recorded in the Study Area & Sydney Harbour

Common Name	Scientific Name	Where Observed	Source of Information
Australian Fur Seal (V1)	<i>Arctocephalus pusillus doriferus</i>	Sydney Harbour	Australian Museum, 2007
Blue Swimmer Crab	<i>Portunus pelagicus</i>	Manly Wharf	Scott Machar*
Bottlenose Dolphin	<i>Tursiops truncatus</i>	Sydney Harbour	Australian Museum, 2007
Common Dolphin	<i>Delphinus delphis</i>	Sydney Harbour	Australian Museum, 2007
Crab-eater Seal	<i>Lobodon carcinophagus</i>	Sydney Harbour	Australian Museum, 2007
Dugong (E1)	<i>Dugong dugon</i>	Sydney Harbour	Australian Museum, 2007
Green Turtle	<i>Chelonia mydas</i>	Sydney Harbour	Australian Museum, 2007
Humpback Whale (V1)	<i>Megaptera novaeangliae</i>	Sydney Harbour	Scott Machar*
Killer Whale	<i>Orcinus orca</i>	Sydney Harbour	Australian Museum, 2007
Leatherback Turtle	<i>Dermochelys coriacea</i>	Sydney Harbour	Australian Museum, 2007
Leopard Seal	<i>Hydrurga leptonyx</i>	Sydney Harbour	Australian Museum, 2007
Loggerhead Turtle	<i>Caretta caretta</i>	Sydney Harbour	Australian Museum, 2007
Pygmy Sperm Whale	<i>Kogia breviceps</i>	Sydney Harbour	Australian Museum, 2007
Risso's Dolphin	<i>Grampus griseus</i>	Sydney Harbour	Australian Museum, 2007
Southern Calamari	<i>Sepioteuthis australis</i>	Adjacent to Balmoral Beach	Scott Machar*
Southern Elephant Seal	<i>Mirounga leonina</i>	Sydney Harbour	Australian Museum, 2007
Sperm Whale (V1)	<i>Physeter macrocephalus</i>	Sydney Harbour	Australian Museum, 2007
Spotted Dolphin	<i>Stenella attenuata</i>	Sydney Harbour	Australian Museum, 2007
Yellow-bellied Sea Snake	<i>Pelamis platurus</i>	Sydney Harbour	Australian Museum, 2007
E1 = Endangered Species, NSW Threatened Species Conservation Act, 1995			
V1 = Vulnerable Species, NSW Threatened Species Conservation Act, 1995			
* = species observed by Scott Machar, former Estuary Management Officer, Manly Council			



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Table C3 – Estuarine Flora Species within the Study Area	
Common Name	Scientific Name
Caulerpa*	<i>Caulerpa taxifolia</i>
Eelgrass	<i>Zostera capricorni</i>
Halophila	<i>Paddleweed</i>
Kelp / Algae	<i>Various / Unknown</i>
Strapweed	<i>Posidonia australis</i>
* Class 1 Noxious Marine Vegetation on Fisheries Management Act, 1994	
Source: DPI, 2006	

Table C4
Port Survey for Introduced Marine Species – Sydney Harbour
Schedule 1 Target Introduced Pest Species <i>Alexandrium catenella</i> <i>Alexandrium tamarense</i>
Schedule 2 Marine Species that Pose a Threat to Australia <i>Mytilus galloprovincialis</i>
Schedule 3 Known or Likely Exotic Marine Species in Australian Waters <i>Euchone limnicola</i> <i>Hydroides elegans</i> <i>Ficopomatus enigmaticus</i> <i>Pseudopolydora paucibranchiata</i> <i>Megabalanus rosa</i> <i>Notomegabalanus algicola</i> <i>Cirolana harfordi</i> <i>Eurylana arcuata</i> <i>Limnoria lignorum</i> <i>Limnoria quadripunctata</i> <i>Limnoria tripunctata</i> <i>Paracerceis sculpta</i> <i>Sphaeroma walkeri</i> <i>Botrylloides leachi</i> <i>Botryllus schlosseri</i> <i>Ciona intestinalis</i> <i>Styela plicata</i> <i>Tridentiger trigonocephalus</i> <i>Bugula flabellata</i> <i>Bugula neritina</i> <i>Conopeum tenuissimum</i> <i>Schizoporella unicornis</i> <i>Teredo navalis</i> <i>Theora lubrica</i> <i>Polycera hedgpethi</i> <i>Zeacumantus subcarinatus</i>



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Table C4
Port Survey for Introduced Marine Species – Sydney Harbour
<i>Caulerpa filiformis</i>
Source: Australian Museum Business Services, 2002

Table C5 – Intertidal Species Within the Study Area	
Common Name or Taxon	Scientific Name
Austrocochlea	<i>Austrocochlea constricta</i> ¹
Barnacle	<i>Austrobalanus imperator</i>
Barnacle	<i>Balanus variegates / amphitrite</i>
Barnacle	<i>Chthamalus antennatus</i>
Barnacle	<i>Elminius coarctatus</i>
Barnacle	<i>Ibla quadrivalvis</i>
Barnacle	<i>Tessieropora rosea</i>
Barnacle	<i>Tetraclitella purpurea</i>
Bembicium	Unknown
Chiton	<i>Chiton pelliserpentis</i>
Chiton	Chiton sp.
Crab	<i>Cyclograpsus audouinii</i>
Crab	<i>Helograpsus haswellianus</i>
Cunjevoi	<i>Pyura stolonifera</i> ¹
Galeolaria	<i>Galeolaria caespitosa</i> ¹
Gastropoda (limpets, slugs, snails)	<i>Aplysia</i> sp.
Gastropoda (limpets, slugs, snails)	<i>Cf. Agnewia tritoniformis</i>
Gastropoda (limpets, slugs, snails)	<i>Austrocochlea concamerata</i>
Gastropoda (limpets, slugs, snails)	<i>Austrocochlea porcata</i>
Gastropoda (limpets, slugs, snails)	<i>Batillaria australis</i>
Gastropoda (limpets, slugs, snails)	<i>Bembicium nanum</i>
Gastropoda (limpets, slugs, snails)	<i>Bembicium melanostomum</i>
Gastropoda (limpets, slugs, snails)	<i>Cellana tramoserica</i>
Gastropoda (limpets, slugs, snails)	<i>Littoraria luteola</i>
Gastropoda (limpets, slugs, snails)	<i>Morula marginalba</i>
Gastropoda (limpets, slugs, snails)	<i>Nerita atramentosa</i>
Gastropoda (limpets, slugs, snails)	<i>Nodilittorina unifasciata</i>
Gastropoda (limpets, slugs, snails)	<i>Nodilittorina pyramidalis</i>
Gastropoda (limpets, slugs, snails)	<i>Notoacmea</i>
Gastropoda (limpets, slugs, snails)	<i>Onchidella/Onchidina</i>
Gastropoda (limpets, slugs, snails)	Opisthobranchia sp.1
Gastropoda (limpets, slugs, snails)	Opisthobranchia sp. 2
Gastropoda (limpets, slugs, snails)	<i>Patelloida</i>
Gastropoda (limpets, slugs, snails)	<i>Siphonaria</i>
Gastropoda (limpets, slugs, snails)	<i>Umbraculum sinicum</i>
Green Algae	Unknown
Limpets	<i>Cellana tramoserica</i> ¹
Little Penguin	<i>Eudyptula minor</i>



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Table C5 – Intertidal Species Within the Study Area	
Common Name or Taxon	Scientific Name
Marine Worm	<i>Galeolaria caespitose</i>
Marine Worm	Nereidae
Marine Worm	Terebellidae
Marine Worm	Polynoidae
Mollusca	<i>Crassostrea gigas</i>
Mollusca	<i>Lasaea australis</i>
Mollusca	<i>Mytilus</i>
Mollusca	<i>Saccostrea glomerata</i>
Mollusca	<i>Trichomya hirsuta</i>
Morula	<i>Morula marginalba</i> ¹
Mussels	Unknown
Nerita	Unknown
Onchidium	Unknown
Oyster Limpet	Unknown
Oysters	Unknown
Pyrazus	<i>Pyrazus ebeninus</i> ¹
Red Algae	Unknown
Sea Squirt	Ascidacea sp.
Sea Squirt	<i>Pyura stolonifera</i>
Seastar	<i>Patiriella exigua</i>
Slater	<i>Cirolana</i>
Slater	Ligiidae
Soldier Crab	<i>Mictyris longicarpus</i>
Yabby (Saltwater)	<i>Trypaea australiensis</i>
species were observed in Sydney Harbour and are therefore expected to also be present within the study area	
¹ Scientific names were obtained through various websites, and are assumed to be the correct scientific names of the species observed by Sydney Water	

Table C6 – Terrestrial Native Fauna Species within the Study Area		
Group	Common Name	Scientific Name
Amphibian	Common Eastern Froglet	<i>Crinia signifera</i>
Amphibian	Brown-striped Frog	<i>Limnodynastes peronii</i>
Amphibian	Red-Crowned Toadlet	<i>Pseudophyrne australis</i>
Bird	Australian Magpie	<i>Gymnorhina tibicen</i>
Bird	Australian Raven	<i>Corvus coronoides</i>
Bird	Australian Wood Duck	<i>Chenonetta jubata</i>
Bird	Brown Gerygone	<i>Gerygone mouki</i>
Bird	Bush Stone Curlew (T2 & E2)*	<i>Burhinus grallarius</i>
Bird	Channel-billed Cuckoo	<i>Scythrops novaehollandiae</i>
Bird	Crested Pigeon	<i>Ocyphaps lophotes</i>



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Table C6 – Terrestrial Native Fauna Species within the Study Area

Group	Common Name	Scientific Name
Bird	Crimson Rosella	<i>Platycercus elegans</i>
Bird	Diamond Firetail	<i>Stagonopleura guttata</i>
Bird	Eastern Whipbird	<i>Psophodes olivaceus</i>
Bird	Eastern Yellow Robin	<i>Eopsaltria australis</i>
Bird	Galah	<i>Cacatua roseicapilla</i>
Bird	Grey Butcherbird	<i>Cracticus torquatus</i>
Bird	Grey Fantail	<i>Rhipidura fuliginosa</i>
Bird	Laughing Kookaburra	<i>Dacelo novaeguineae</i>
Bird	Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>
Bird	Little Wattlebird	<i>Anthochaera chrysoptera</i>
Bird	Magpie-lark	<i>Grallina cyanoleuca</i>
Bird	Masked Lapwing	<i>Vanellus miles</i>
Bird	Noisy Miner	<i>Manorina melanocephala</i>
Bird	Pied Cormorant	<i>Phalacrocorax varius</i>
Bird	Pied Currawong	<i>Strepera graculina</i>
Bird	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>
Bird	Red Wattlebird	<i>Anthochaera carunculata</i>
Bird	Sacred Kingfisher	<i>Todiramphus sanctus</i>
Bird	Silver Gull	<i>Larus novaehollandiae</i>
Bird	Southern Leaf-tailed Gecko	<i>Phyllurus platurus</i>
Bird	Sulphur-crested Cockatoo	<i>Cacatua galerita</i>
Bird	Superb Fairy-wren	<i>Malurus cyaneus</i>
Bird	Tawny Frogmouth	<i>Podargus strigoides</i>
Bird	Variiegated Fairy-wren	<i>Malurus lamberti</i>
Bird	Welcome Swallow	<i>Hirundo neoxena</i>
Bird	White-browed Scrubwren	<i>Sericornis frontalis</i>
Bird	Willie Wagtail	<i>Rhipidura leucophrys</i>
Bird	Yellow Thornbill	<i>Acanthiza nana</i>
Mammal	Common Brushtail Possum	<i>Trichosurus vulpecula</i>
Mammal	Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>
Mammal	Grey-headed Flying-fox (T2 & E2)	<i>Pteropus poliocephalus</i>
Mammal	Water Rat	<i>Hydromys chrysogaster</i>
Reptile	Copper-tailed Skink	<i>Ctenotus taeniolatus</i>
Reptile	Dark-flecked Garden Sunskink	<i>Lampropholis delicata</i>
Reptile	Eastern Blue-tongued Lizard	<i>Tiliqua scincoides</i>
Reptile	Eastern Water-skink	<i>Eulamprus quoyii</i>
Reptile	Golden Crowned Snake	<i>Cacophis squamulosus</i>
Reptile	Pale-flecked Garden Sunskink	<i>Lampropholis guichenoti</i>
Reptile	Robust Ctenotus	<i>Ctenotus robustus</i>
Reptile	Yellow-bellied Three-toed Skink	<i>Saiphos equalis</i>
Reptile	Weasel Skink	<i>Saproscincus mustelinus</i>
T2 = Vulnerable on Schedule 2, NSW Threatened Species Conservation Act, 1995 E2 = Endangered on Commonwealth Environmental Protection and Biodiversity Conservation Act, 1999		
Source: Skelton et al, 2004 *Sighted recently (August 2008) within the study area		



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Table C7 – Terrestrial Exotic Fauna Species within the Study Area		
Group	Common Name	Scientific Name
Bird	Spotted Turtle-Dove	<i>Streptopelia chinensis</i>
Bird	Common Myna	<i>Acridotheres tristis</i>
Bird	Common Starling	<i>Sturnus vulgaris</i>
Bird	House Sparrow	<i>Passer domesticus</i>
Bird	Rock Dove	<i>Columbia livia</i>
Mammal	Black Rat	<i>Rattus rattus</i>
Mammal	Cat	<i>Felis catus</i>
Mammal	Dog	<i>Canis familiaris</i>
Mammal	Rabbit	<i>Oryctolagus cuniculus</i>
Source: Skelton et al, 2004		

Table C8 – Terrestrial Native Flora Species within the Study Area		
Habit	Common Name	Scientific Name
Fern	Batswing Fern	<i>Histiopteris incisa</i>
Fern	Birds Nest Fern	<i>Asplenium australasicum</i>
Fern	Bracken	<i>Pteridium esculentum</i>
Fern	Christella	<i>Christella dentata</i>
Fern	Creeping Shield Fern	<i>Lastreopsis microsora</i>
Fern	False Bracken Fern	<i>Calochlaena dubia</i>
Fern	Giant Club Moss	<i>Lycopodium deuterodensum</i>
Fern	Hares Foot Fern (rare)	<i>Davallia pyxidata</i>
Fern	King Fern	<i>Todea barbara</i>
Fern	Lacy Wedge Fern	<i>Lindsaea microphylla</i>
Fern	Maidenhair Fern	<i>Adiantum aethiopicum</i>
Fern	Pouched Coral Fern	<i>Gleichenia dicarpa</i>
Fern	Screw Fern	<i>Lindsaea linearis</i>
Fern	Straw Tree Fern	<i>Cyathea cooperi</i>
Grass	Basket Grass	<i>Oplismenus aemulus</i>
Grass	Basket Grass	<i>Oplismenus imbecillis</i>
Grass	Blady Grass	<i>Imperata cylindrica</i> var. <i>major</i>
Grass	Common Couch	<i>Cyanodon dactylon</i>
Grass	Indian Cupscale Grass	<i>Sacciolepis indica</i>
Grass	Kangaroo Grass	<i>Themeda australis</i>
Grass	Kikuyu	<i>Pennisetum clandestinum</i>
Grass	Sand Couch	<i>Sporobolus virginicus</i>
Grass	Unknown	<i>Cymbopogon refractus</i>
Grass	Unknown	<i>Danthonia</i> sp.
Grass	Unknown	<i>Eragrostis brownii</i>
Grass	Weeping Grass	<i>Microlaena stipoides</i> var. <i>stipoides</i>
Grass	Wiry Panic	<i>Entolasia stricta</i>
Grass Tree	Broad-leaved Grass Tree	<i>Xanthorrhoea arborea</i>
Grass Tree	Forest Grass Tree	<i>Xanthorrhoea media/resinifera</i>



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Table C8 – Terrestrial Native Flora Species within the Study Area		
Habit	Common Name	Scientific Name
Grass Tree	Grass Tree	<i>Xanthorrhoea minor ssp. minor</i>
Herb	Bearded Orchid	<i>Calochilus sp.</i>
Herb	Blue Flax Lily	<i>Dianella caerulea</i>
Herb	Bush Pea	<i>Pultanea stipularis</i>
Herb	Carrot Tops	<i>Platysace linearifolia</i>
Herb	Centella	<i>Centella asiatica</i>
Herb	Cockspur Flowers	<i>Plectranthus parviflorus</i>
Herb	Common Chloanthos	<i>Chloanthos stoechadis</i>
Herb	Common Stinkweed	<i>Opercularia aspera</i>
Herb	Creeping Christian	<i>Commelina cyanea</i>
Herb	Cup Orchid	<i>Cryptostylis erecta</i>
Herb	Daisy-bush	<i>Olearia tomentosa</i>
Herb	Fish Bones	<i>Lomandra obliqua</i>
Herb	Flannel Flower	<i>Actinotus helianthi</i>
Herb	Geranium	<i>Geranium homeanum</i>
Herb	Germander Raspwort	<i>Gonocarpus teucroides</i>
Herb	Lesser Flannel Flower	<i>Actinotus minor</i>
Herb	Lesser joy weed	<i>Alternanthera denticulata</i>
Herb	Mitre Weed	<i>Mitrasacme polymorpha</i>
Herb	Native Bluebell	<i>Wahlenbergia gracilis</i>
Herb	Native Parsnip	<i>Platysace lanceolata</i>
Herb	Native Violet	<i>Viola hederacea</i>
Herb	Pale Mat-rush	<i>Lomandra glauca</i>
Herb	Pomax	<i>Pomax umbellata</i>
Herb	Spiny-headed Mat-rush	<i>Lomandra longifolia</i>
Herb	Stephenson's Platysace	<i>Platysace stephensonii</i>
Herb	Swamp Lilly	<i>Crinum pedunculatum</i>
Herb	Tongue Orchid	<i>Dendrobium linguiforme</i>
Herb	Tuft Mat-rush	<i>Lomandra brevis</i>
Herb	Unknown	<i>Apium Prostratum</i>
Herb	Unknown	<i>Hydrocotyle peduncularis</i>
Herb	Unknown (rare)	<i>Schelhammera undulate</i>
Herb	Unknown	<i>Veronica plebeia</i>
Herb	Warrigal Greens	<i>Tetragonia tetragonoides</i>
Herb	Wattle Mat-rush	<i>Lomandra filiformis ssp. filiformis</i>
Herb	White Root	<i>Pratia purpurascens</i>
Herb	Wooly Xanthosia	<i>Xanthosia pilosa</i>
Palm	Cabbage Tree Palm	<i>Livistona australis</i>
Rush	Cord Rush	<i>Restio dimorphus</i>
Rush	Cord Rush	<i>Restio tetraphyllus ssp. meiostachyus</i>
Rush	Scale-rush	<i>Lepyrodia scariosa</i>
Rush	Tassel Rush	<i>Restio fastigiatus</i>
Scrambler	Native Raspberry	<i>Rubus parvifolius</i>
Sedge	Bog-rush	<i>Schoenus sp.</i>
Sedge	Carex	<i>Carex sp.</i>



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Table C8 – Terrestrial Native Flora Species within the Study Area		
Habit	Common Name	Scientific Name
Sedge	Caustis	<i>Caustis pentandra</i>
Sedge	Cut Grass	<i>Gahnia aspera</i>
Sedge	Cut Grass	<i>Gahnia sp.</i>
Sedge	Cyathochaeta	<i>Cyathochaeta diandra</i>
Sedge	Knobby Club-rush	<i>Isolepis nodosa</i>
Sedge	Rush	<i>Juncus usitatus</i>
Sedge	Unknown	<i>Lepidosperma filiforme</i>
Sedge	Unknown	<i>Ptilothrix deusta</i>
Sedge	Variable Sword Edge	<i>Lepidosperma laterale</i>
Shrub	Ball Honeymyrtle	<i>Melaleuca nodosa</i>
Shrub	Banksia	<i>Banksia oblongifolia</i>
Shrub	Bleeding Heart	<i>Omalanthus populifolius</i>
Shrub	Bossiaea	<i>Bossiaea heterophylla</i>
Shrub	Box-leaved Wax Flower	<i>Eriostemon buxifolius</i> spp. obovatus
Shrub	Breynia	<i>Breynia oblongifolia</i>
Shrub	Bush Pea	<i>Pultenaea elliptica</i>
Shrub	Bushy Needlebush	<i>Hakea sericea</i>
Shrub	Crimson Bottlebrush	<i>Callistemon citrinus</i>
Shrub	Coastal Rosemary	<i>Westringia fruticosa</i>
Shrub	Coastal Tea-tree	<i>Leptospermum laevigatum</i>
Shrub	Coastal Wattle	<i>Acacia longifolia</i> var. <i>sophorae</i>
Shrub	Conesticks	<i>Petrophile pulchella</i>
Shrub	Coral Heath	<i>Epacris microphylla</i> var. <i>microphylla</i>
Shrub	Crinkle Bush	<i>Lomatia silaifolia</i>
Shrub	Crowea	<i>Crowea saligna</i>
Shrub	Dagger Hakea	<i>Hakea teretifolia</i>
Shrub	Darwinia	<i>Darwinia fascicularis</i> spp. <i>fascicularis</i>
Shrub	Dog Rose	<i>Bauera capitata</i>
Shrub	Drumsticks	<i>Isopogon anethifolius</i>
Shrub	Eggs and Bacon	<i>Dillwynia retorta</i>
Shrub	Elderberry Panax	<i>Polyscias sambucifolia</i>
Shrub	Flax-leaved Wattle	<i>Acacia linifolia</i>
Shrub	Fuchsia Heath	<i>Epacris longiflora</i>
Shrub	Grey Spider Flower	<i>Grevillea buxifolia</i> ssp. <i>buxifolia</i>
Shrub	Hairy Zieria	<i>Zieria pilosa</i>
Shrub	Hakea	<i>Hakea gibbosa</i>
Shrub	Heath Leaved Banksia	<i>Banksia ericifolia</i> var. <i>ericifolia</i>
Shrub	Hop Bush	<i>Dodonaea triquetra</i>
Shrub	Lance-leaved Geebung	<i>Persoonia lanceolata</i>
Shrub	Lemon Scented Tea Tree	<i>Leptospermum polygalifolium</i>
Shrub	Mock Olive	<i>Notelaea ovata</i>
Shrub	Mountain Devil	<i>Lambertia formosa</i>
Shrub	Narrow-leaved Bottlebrush	<i>Callistemon linearis</i>
Shrub	Narrow-leaved Geebung	<i>Persoonia linearis</i>
Shrub	Paperbark	<i>Melaleuca hypericifolia</i>



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Table C8 – Terrestrial Native Flora Species within the Study Area

Habit	Common Name	Scientific Name
Shrub	Paperbark Tea Tree	<i>Leptospermum trinervium</i>
Shrub	Pink Kunzea	<i>Kunzea ambigua</i>
Shrub	Pink Spider Flower	<i>Grevillea sericea</i>
Shrub	Prickly Broom-heath	<i>Monotoca scoparia</i>
Shrub	Prickly-leaved Paperbark	<i>Melaleuca styphelioides</i>
Shrub	Prickly Moses	<i>Acacia ulicifolia</i>
Shrub	Red Spider Flower	<i>Grevillea speciosa</i>
Shrub	Rice Flower	<i>Pimelea linifolia</i> ssp. <i>linifolia</i>
Shrub	Sandfly Zieria	<i>Zieria smithii</i>
Shrub	Scrub She-oak	<i>Allocasuarina distyla</i>
Shrub	Small-leaved White Beard	<i>Leucopogon microphyllus</i>
Shrub	Smooth Geebung	<i>Persoonia levis</i>
Shrub	Smooth Parrot-pea	<i>Dillwynia glaberrima</i>
Shrub	Snow Wreath	<i>Woolfsia pungens</i>
Shrub	Stiff Bottlebrush	<i>Callistemon rigidus</i>
Shrub	Sunshine Wattle	<i>Acacia terminalis</i>
Shrub	Swamp Banksia	<i>Banksia robur</i>
Shrub	Swamp Paperbark	<i>Melaleuca ericifolia</i>
Shrub	Sweet Scented Wattle	<i>Acacia suaveolens</i>
Shrub	Sydney Golden Wattle	<i>Acacia longifolia</i>
Shrub	Tick Bush	<i>Kunzea ambigua</i>
Shrub	Twining Guinea Flower	<i>Hibbertia dentata</i>
Shrub	Two-veined Hickory	<i>Acacia binervata</i>
Shrub	Unknown	<i>Hovea</i> sp.
Shrub	Unknown	<i>Omalanthus nutans</i>
Shrub	Unknown	<i>Petrophile sessilis</i>
Shrub	Unknown	<i>Philotheca salsolifolia</i>
Shrub	White Spider Flower	<i>Grevillea linearifolia</i>
Shrub	Willow Bottlebrush	<i>Callistemon salignus</i>
Shrub	Willow-leaved Hakea	<i>Hakea salicifolia</i>
Tree	Bangalay	<i>Eucalyptus botryoides</i>
Tree	Bastard Mahogany	<i>Eucalyptus umbra</i>
Tree	Black She-oak	<i>Allocasuarina littoralis</i>
Tree	Black Wattle	<i>Callicoma serratifolia</i>
Tree	Bloodwood	<i>Corymbia gummifera</i>
Tree	Blueberry Ash	<i>Elaeocarpus reticulatus</i>
Tree	Blue Lillypilly	<i>Syzygium olesum</i>
Tree	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>
Tree	Brown Stringy Bark	<i>Eucalyptus capitellata</i>
Tree	Cheese Tree	<i>Glochidion ferdinandi</i> var. <i>ferdinandi</i>
Tree	Coastal Banksia	<i>Banksia integrifolia</i> ssp. <i>integrifolia</i>
Tree	Dwarf Apple	<i>Angophora hispida</i>
Tree	Hard Leaved Scribbly Gum	<i>Eucalyptus sclerophylla</i>
Tree	Forest She-oak	<i>Allocasuarina torulosa</i>
Tree	Grey Gum	<i>Eucalyptus punctata</i>



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Table C8 – Terrestrial Native Flora Species within the Study Area		
Habit	Common Name	Scientific Name
Tree	Lily Pilly	<i>Acmena smithii</i>
Tree	Magenta Lillypilly	<i>Syzygium paniculatum</i>
Tree	Mountain Cedar Wattle	<i>Acacia elata</i>
Tree	Muttonwood	<i>Rapanea variabilis</i>
Tree	NSW Christmas Bush	<i>Ceratopetalum gummiferum</i>
Tree	Old Man Banksia	<i>Banksia serrata</i>
Tree	Parramatta Green Wattle	<i>Acacia parramattensis</i>
Tree	Port Jackson Fig	<i>Ficus rubiginosa</i>
Tree	River Oak	<i>Casuarina cunninghamiana</i>
Tree	Rough-fruit Pittosporum	<i>Pittosporum revolutum</i>
Tree	Scribbly Gum	<i>Eucalyptus haemastoma</i>
Tree	Scrub She-oak	<i>Allocasuarina distyla</i>
Tree	Smooth-barked Apple	<i>Angophora costata</i>
Tree	Spotted Gum	<i>Corymbia maculata</i>
Tree	Swamp Sheoak	<i>Casuarina glauca</i>
Tree	Sweet Pittosporum	<i>Pittosporum undulatum</i>
Tree	Sydney Blue Gum	<i>Eucalyptus saligna</i>
Tree	Sydney Peppermint	<i>Eucalyptus piperita</i>
Tree	Unknown	<i>Angophora Bakeri ssp. bakeri</i>
Tree	Water Gum	<i>Tristaniopsis laurina</i>
Vine	Apple Berry, Dumplings	<i>Billardiera scandens</i>
Vine	Dusky Coral-pea	<i>Kennedia rubicunda</i>
Vine	Golden Guinea Flower	<i>Hibbertia scandens</i>
Vine	Hairy Devil's Twine	<i>Cassytha pubescens</i>
Vine	Lawyer Vine	<i>Smilax australis</i>
Vine	Mistletoe	<i>Amyema congener ssp. congener</i>
Vine	Native Sarsaparilla	<i>Smilax glycyphylla</i>
Vine	Scrambling Lily	<i>Geitonoplesium cymosum</i>
Vine	Smooth Devil's Twine	<i>Cassytha glabella</i>
Vine	Snake Vine	<i>Stephania japonica var. discolor</i>
Vine	Unknown	<i>Marsdenia sp.</i>
Vine	Wombat Berry	<i>Eustrephus latifolius</i>
Vine	Wonga Wonga Vine	<i>Pandorea pandorana</i>
Source: Skelton et al, 2004		

Table C9 - Terrestrial Exotic Flora Species within the Study Area			
Habit	Common Name	Scientific Name	Status
Fern	Fishbone Fern	<i>Nephrolepis cordifolia</i>	
Grass	Buffalo Grass	<i>Stenotaphrum secundatum</i>	
Grass	Giant Reed / Elephant Grass	<i>Arundo donax</i>	Noxious Class 4a
Grass	Kikuyu	<i>Pennisetum clandestinum</i>	
Grass	Palm Grass	<i>Setaria palmifolia</i>	
Grass	Pampas Grass	<i>Cortaderia sp.</i>	Nox W2
Grass	Parramatta Grass	<i>Sporobolus africanus</i>	



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Table C9 - Terrestrial Exotic Flora Species within the Study Area

Habit	Common Name	Scientific Name	Status
Grass	Paspalum	<i>Paspalum dilatatum</i>	
Grass	Rhizomatous Bamboo	<i>Phyllostachys</i> sp.	Noxious Class W4a
Grass	Summer Grass	<i>Digitaria sanguinalis</i>	
Grass	Unknown	<i>Paspalum radiatum</i>	
Grass	Veldt Grass	<i>Ehrharta</i> sp.	
Grass	Whiskey Grass	<i>Andropogon virginicus</i>	
Grass	Winter Grass	<i>Poa annua</i>	
Herb	Agapanthus	<i>Agapanthus orientalis</i>	
Herb	American Cactus	<i>Agave americana</i>	
Herb	Asparagus Fern	<i>Asparagus aethiopicus</i>	
Herb	Asthma Weed, Pellitory	<i>Parietaria judaica</i>	Noxious Class W3
Herb	Balsam	<i>Impatiens walleriana</i>	
Herb	Banana	<i>Musa</i> sp.	
Herb	Beefsteak Plant	<i>Acalypha wilkesiana</i>	
Herb	Bindii	<i>Solvia pterosperma</i>	
Herb	Black-berry Nightshade	<i>Solanum nigrum</i>	
Herb	Canna Lily	<i>Canna indica</i>	
Herb	Cast Iron Plant	<i>Aspidistra elatior</i>	
Herb	Climbing Asparagus	<i>Asparagus plumosus</i>	Noxious Class W4c
Herb	Clover	<i>Trifolium</i> sp.	
Herb	Cobbler's Pegs, Pitchforks	<i>Bidens pilosa</i>	
Herb	Coreopsis	<i>Coreopsis lanceolata</i>	
Herb	Creeping Buttercup	<i>Ranunculus repens</i>	
Herb	Crofton Weed	<i>Ageratina adenophora</i>	Nox W3
Herb	Crucifix Orchid	<i>Epidendrum ibaguense</i>	
Herb	Cud Weed	<i>Gnaphalium</i> sp.	
Herb	Dandelion	<i>Teraxacum Officinale</i>	
Herb	Dietes	<i>Dietes</i> sp.	
Herb	Fairy Crassula	<i>Crassula multicava</i>	
Herb	Fennel	<i>Foeniculum vulgare</i>	
Herb	Fire Weed	<i>Senecio madagascariensis</i>	
Herb	Flatweed	<i>Hypochaeris radicata</i>	
Herb	Fleabane	<i>Conyza</i> sp.	
Herb	Freesia	<i>Freesia refracta</i>	
Herb	Gazania	<i>Gazania rigens</i>	
Herb	Ginger	<i>Zingiber officinale</i>	
Herb	Ginger Lily	<i>Hedychium gardnerianum</i>	
Herb	Hydrangea	<i>Hydrangea macrophylla</i>	
Herb	Japanese Knotweed	<i>Polygonum capitatum</i>	
Herb	Kaffir Lily	<i>Clivea miniata</i>	
Herb	Kurnell Curse	<i>Hydrocotyle Bonariensis</i>	
Herb	Lamb's Tongues, Plantain	<i>Plantago lanceolata</i>	
Herb	Mistflower	<i>Ageratina riparia</i>	
Herb	Mother-of-millions	<i>Bryophyllum delagoense</i>	
Herb	Mouse Ear Chick Weed	<i>Cerastium glomeratum</i>	



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Table C9 - Terrestrial Exotic Flora Species within the Study Area

Habit	Common Name	Scientific Name	Status
Herb	New Zealand Christmas Bell	<i>Alstroemeria psittacina</i>	
Herb	New Zealand Flax	<i>Phormium tenax</i>	
Herb	Onion Weed	<i>Nothoscordum gracile</i>	
Herb	Ornamental Ginger	<i>Alpinia sp.</i>	
Herb	Paddy's Lucerne	<i>Sida rhombifolia</i>	
Herb	Petty Spurge	<i>Euphorbia peplus</i>	
Herb	Poinsettia	<i>Euphorbia pulcherrima</i>	
Herb	Potato Weed	<i>Galinsoga parviflora</i>	
Herb	Roadside Lilly	<i>Lilium formosum</i>	
Herb	Slender Celery	<i>Ciclospermum leptophyllum</i>	
Herb	Smooth Cats Ear	<i>Hypochaeris glabra</i>	
Herb	Spider Plant	<i>Chlorophytum comosum</i>	
Herb	Swiss Cheese Plant	<i>Monstera deliciosa</i>	
Herb	Taro	<i>Colocasia esculenta</i>	
Herb	Unknown	<i>Senecio milkanioides</i>	
Herb	Wandering Jew	<i>Tradescantia albiflora</i> syn. <i>fluminensis</i>	
Herb	Wild Watsonia, Bugle Lily	<i>Watsonia meriana</i> cv. <i>bulbillifera</i>	
Palm	Canary Island Palm	<i>Phoenix canariensis</i>	
Palm	Cocos Palm, Queen Palm	<i>Syagrus romanzoffiana</i>	
Scrambler	Blackberry	<i>Rubus fruticosus</i>	Noxious Class 4
Shrub	African Olive	<i>Olea europaea</i> ssp. <i>africana</i>	
Shrub	Bird of Paradise	<i>Strelitzia reginae</i>	
Shrub	Boneseed	<i>Chrysanthemoides monilifera</i> spp. <i>monilifera</i>	Nox W3
Shrub	Bottlebrush	<i>Callistemon sp.</i>	
Shrub	Bracelet Honey Myrtle	<i>Melaleuca armillaris</i>	
Shrub	Cassia	<i>Senna floribunda</i>	
Shrub	Cassia / Senna	<i>Senna pendula</i>	Noxious Class 4b
Shrub	Cootamundra Wattle	<i>Acacia baileyana</i>	
Shrub	Cotoneaster	<i>Cotoneaster pannosus</i>	
Shrub	Fleabane	<i>Conyza albida</i>	
Shrub	Golden Wreath Wattle	<i>Acacia saligna</i>	
Shrub	Green Cestrum	<i>Cestrum parqui</i>	Noxious Class W2
Shrub	Hibiscus	<i>Hibiscus sp.</i>	
Shrub	Jade Plant	<i>Portulacaria afra</i>	
Shrub	Lantana	<i>Lantana camara</i>	Noxious Class W2
Shrub	Looking-glass Bush	<i>Coprosma repens</i>	
Shrub	Ochna, Mickey Mouse Plant	<i>Ochna serrulata</i>	Noxious Class 4
Shrub	Oleander	<i>Nerium oleander</i>	
Shrub	Orange Firethorn	<i>Pyracantha angustifolia</i>	
Shrub	Pink Pavonia	<i>Pavonia hastata</i>	
Shrub	Plumbago	<i>Plumbago sp.</i>	
Shrub	Polygala	<i>Polygala myrtifolia</i>	
Shrub	Privet – broad leaved	<i>Ligustrum lucidum</i>	Noxious Class W4b
Shrub	Privet – narrow leaved	<i>Ligustrum sinense</i>	Noxious Class W4b
Shrub	Rhus Tree	<i>Toxicodendron succedaneum</i>	Noxious Class W2



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Table C9 - Terrestrial Exotic Flora Species within the Study Area

Habit	Common Name	Scientific Name	Status
Shrub	Scotch/English Broom	<i>Cytisus scoparius</i>	
Shrub	Silky Oak	<i>Grevillea robusta</i>	
Shrub	Snowbell Tree	<i>Viburnum tinus</i>	
Shrub	Tibouchina, Lasiandra	<i>Tibouchina sp.</i>	
Shrub	Umbrella Tree	<i>Brassaia actinophylla</i>	
Shrub	Wild Tobacco Tree	<i>Solanum mauritianum</i>	
Tree	Bauhinia	<i>Bauhinia sp.</i>	
Tree	Black Bean	<i>Castanospermum australe</i>	
Tree	Brush Box	<i>Lophostemon confertus</i>	
Tree	Camphora Laurel	<i>Cinnamomum camphora</i>	
Tree	Climbing Fig	<i>Ficus pumila</i>	
Tree	Coral Tree	<i>Erythrina X sykesii</i>	
Tree	Draceana	<i>Dracaena marginata</i>	
Tree	Flame Tree	<i>Brachychiton acerifolius</i>	
Tree	Grey Box	<i>Eucalyptus moluccana</i>	
Tree	Jacaranda	<i>Jacaranda mimosifolia</i>	
Tree	Liquidamber	<i>Liquidamber orientalis</i>	
Tree	Lombardy Poplar	<i>Populus sp.</i>	
Tree	Morton Bay Fig	<i>Ficus macrophylla</i>	
Tree	Narrow-leaved Peppermint	<i>Eucalyptus nicholii</i>	
Tree	New Zealand Cordyline	<i>Cordyline australis</i>	
Tree	Norfolk Island Pine	<i>Araucaria heterophylla</i>	
Tree	Pine	<i>Pinus sp.</i>	
Tree	Stonefruit	<i>Prunus sp.</i>	
Tree	Tortured Willow	<i>Salix matsudana</i>	
Tree	Weeping Willow	<i>Salix babylonica</i>	Noxious Class 4
Tree	White Cedar	<i>Melia azedarach</i>	
Tree	White Mulberry	<i>Morus alba</i>	
Tree	Willow Gum	<i>Eucalyptus scoparia</i>	
Vine	Balloon Vine	<i>Cardiospermum grandiflorum</i>	Noxious Class W4c
Vine	Cape Ivy	<i>Delairea odorata</i>	Noxious Class W4d
Vine	Cat's Claw Creeper	<i>Macfadyena unguis-cati</i>	Nox W4c
Vine	English Ivy	<i>Hedera helix</i>	
Vine	Japanese Honeysuckle	<i>Lonicera japonica</i>	
Vine	Madeira Vine	<i>Anredera cordifolia</i>	Noxious Class W4c
Vine	Morning Glory	<i>Ipomea cairica</i>	Noxious Class W4c
Vine	Moth Vine	<i>Araujia sericifera</i>	
Vine	Passionfruit	<i>Passiflora edulis</i>	
Vine	Turkey Rhubarb	<i>Acetosa sagittata</i>	
Vine	Unknown	<i>Cissus rhombifolia</i>	
Vine	Wistaria	<i>Wistaria sinensis</i>	
Source: Skelton et al, 2004			
Status Definitions			
Noxious Class 1	State Prohibited Weeds - The plant must be eradicated from the land and the land must be kept free of the plant.		



NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Table C9 - Terrestrial Exotic Flora Species within the Study Area			
Habit	Common Name	Scientific Name	Status
Noxious Class 2	Regionally Prohibited Weeds - The plant must be eradicated from the land and the land must be kept free of the plant.		
Noxious Class 3	Regionally Controlled Weeds - The plant must be fully and continuously suppressed and destroyed.		
Noxious Class 4	Locally Controlled Weeds - The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed.		
Noxious Class 5	Restricted Plants - The requirements in the Noxious Weed Act 1993 for a notifiable weed must be complied with.		



APPENDIX D

NORTH HARBOUR – A PHOTO STORY

Historical photographs are from Manly Council Library (Local Studies)

North Harbour through Ages	
Aerial View of North Harbour	North Harbour (19.9.1936)
	
	January 1956
	
28 – 10 - 2008	12 -5- 2008
	

Land Reclamation (North Harbour Reserve)

Tidal Flat (19.09.1936)



Construction (14.6.1938)



Sea wall construction (14.6.1938)



Construction and land fill (7.10.1938)



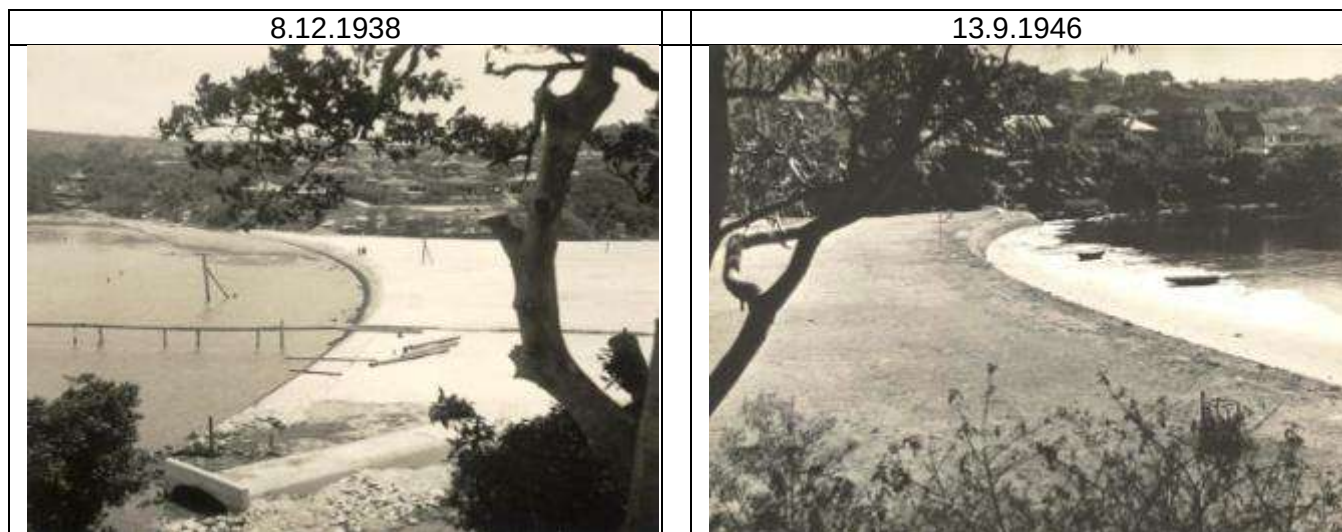
Construction of outfall drain (22.07.1938)



Construction (22.07.1938)



NORTH HARBOUR COASTLINE MANAGEMENT STUDY



Features	
Beach	Bush
	
Rocky Coastline	View
	

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Heritage	Manly Scenic Walkway
	
Urbanization	Boat
	
Tidal Sandy flat	North Harbour Reserve
	

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Waterfall	Bridge
	
Manly Boatshed	
	

Uses	
Kayaking	Dog walking
	

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Diving 	Relaxing 
Fishing 	Snorkeling 
Parasailing 	Sun & Sand (Fairlight beach) 

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Issues & Concerns	
Narrow access way (NHR)	Narrow & risky access way (NHR)
	
Picnic table (NHR)	Saucepan as dog water bowl (NHR)
	
Cliff instability	Empty poo bag dispenser
	

NORTH HARBOUR COASTLINE MANAGEMENT STUDY

Pollution & stormwater outfall	Lack of boat storage facility
	
Narrow NHR walkway	
	

Completed / On-going Improvements	
Renovation of toilet (NHR)	Remediation works
	