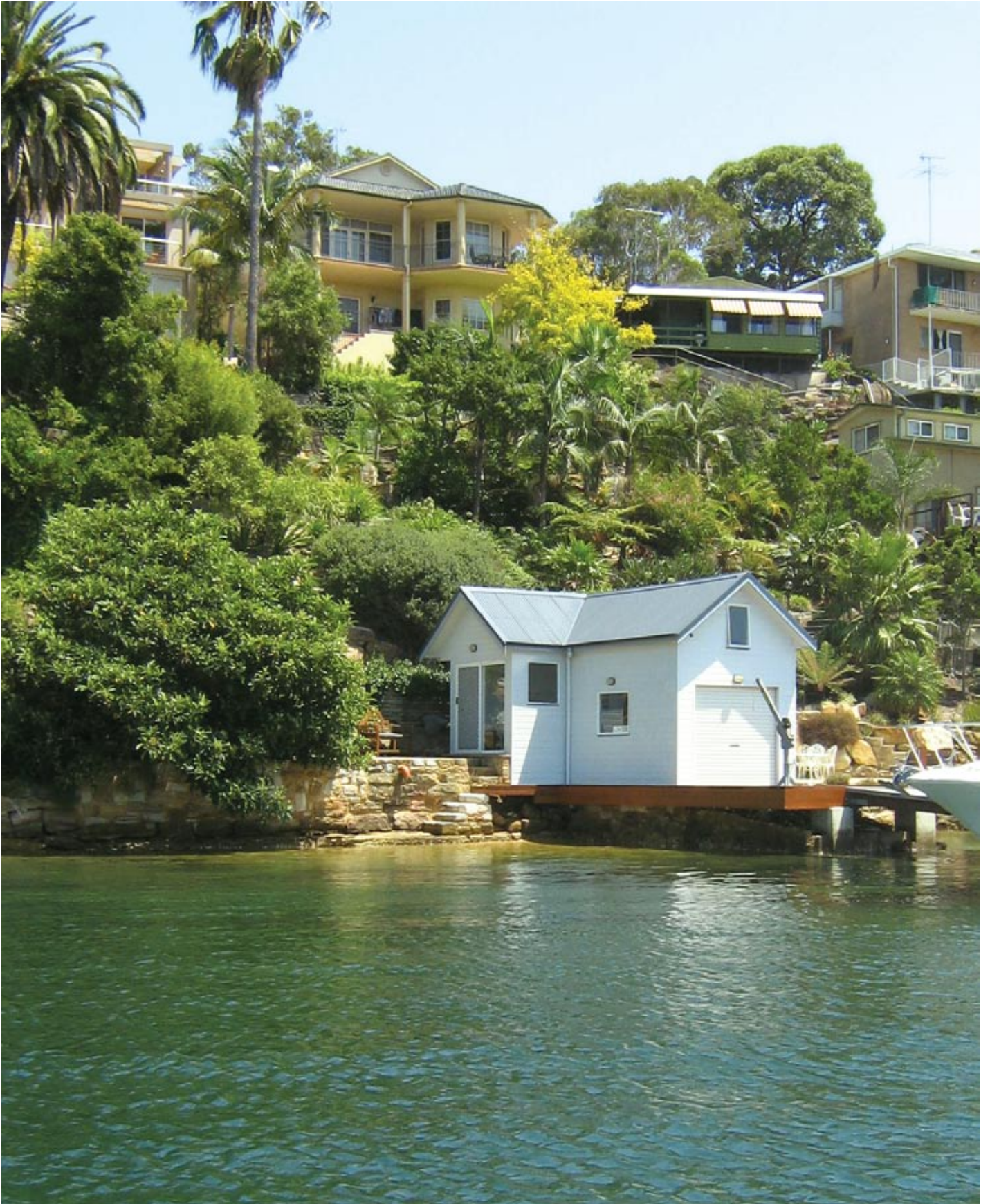


PORT HACKING INTEGRATED ENVIRONMENTAL MANAGEMENT PLAN



Prepared by the Strategic Planning Unit of Sutherland Shire Council for the Port Hacking Catchment Management Panel. Accompanies report titled *Port Hacking: Past and Present* prepared by Associate Professor A.D Albani and G. Cotsis

Update 2007 - 2012



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TABLE OF CONTENTS

Acknowledgements	4	4. WHERE TO NEXT?	26
Foreword by Associate Professor Alberto Albani and Professor Paul Martin	5	5. CHANNELS AND MARKERS – BACKGROUND AND SCIENTIFIC INFORMATION.....	27
1. BACKGROUND AND OVERVIEW	6	5.1. Overview	27
1.1 Introduction	6	5.2. Description of the Catchment, Issues and Challenges	28
1.2 Locating the Port Hacking Catchment	6	5.2.1 Aesthetic and heritage issues.....	30
1.3 Then and Now... Changes Since 1992	8	5.2.2 Social issues	31
1.4 Governance	9	5.2.3 Economic issues.....	39
1.4.1 The Port Hacking Management Panel ...	10	5.2.4 Ecological issues	41
1.4.2 Selected Regulatory Tools.....	10	6. APPENDICES.....	59
1.5 Community Consultation.....	10	REFERENCES	74
1.5.1 Mapping of Community Values.....	11	GLOSSARY – ACRONYMS AND DEFINITIONS	76
1.5.2 Mapping of Community Issues	11	 Bibliography included on CD version only.	
1.6 Structure of the Plan	12		
2. THE PLAN	13		
2.1 Aims	13		
2.2 Objectives and Strategies.....	13		
2.3 Investment Strategy	17		
2.3.1 Issues	17		
2.3.2 Time Frame	17		
3. IMPLEMENTATION AND MONITORING.....	23		
3.1 What is an Indicator?	23		
3.2 Implementation Monitoring	23		
3.3 Ecosystem Monitoring Pilot Project	23		
3.4 Data Sources.....	25		

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FOREWORD

Port Hacking is a place of natural beauty and enjoyment for many people. However, human use itself can modify and often damage the natural beauty and the diversity of this estuary. This is reflected in the loss of seagrass beds, increased sedimentation, shifts in the sediment distribution, loss of foreshore vegetation and overdevelopment. Preventing further harm, whilst maintaining opportunities for people to enjoy the Port, is the focus of this plan.

Since 1984 Port Hacking and its catchment has been the object of broad environmental and social evaluations. The pressures of urbanisation, environmental degradation and, at the same time, growing recreational demands resulted in the Port Hacking Plan of Management. It involved all the government bodies with responsibilities for the Port in a pioneering attempt to achieve integrated strategic management. Its target was sustainability at a time when the concept was little understood.

Adopted by Sutherland Shire Council in 1992, the Plan of Management encapsulated our understanding of the natural processes, the human-induced modifications and the aspiration of the community for the use and the preservation of this unique environment for our future generations.

Now, 15 years after its adoption, the Plan of Management has been updated to reflect the latest research and to address some new challenges, such as climate change. It provides a blueprint for decision-making and will assist the community to meet the challenges of balancing use with protection of this Port that we love.

We have both been deeply involved in prior studies and community action since the time of the first Management Panel (and long before). We have been committed to the concept of 'totality' and to the priority of scientific understanding. Our collective involvements have been in research, public communications and in the development and implementation of plans and strategies. We have seen both the successes, and the failures, of past plans. The one ingredient that is essential, which cannot be provided by planning alone, is the genuine commitment of the community to protect this unique natural resource. When this ingredient has been present, the results have been heartening. When it is lacking, no plan can prevent damage to the environment or the erosion of the interests of those who are passive.

We feel a strong responsibility to pass on to future generations the best legacy possible so that our children, and our grandchildren, will enjoy this magnificent asset long after we are gone. Whether they will inherit it in an excellent, or a much reduced state, depends on the community.

It is therefore with gratitude, with humility and a sense of responsibility that we strongly commend this updated plan in the belief that it gives us the possibility of a healthy legacy for future generations.

Alberto Albani
Paul Martin

Members of the Port Hacking Management Panel Working Party



1. BACKGROUND AND OVERVIEW

1.1 INTRODUCTION

The Port Hacking Integrated Environmental Management Plan 2007 – 2012 (PHIEMP) is an implementation tool to sustainably manage change in Port Hacking and its catchment.

Anyone connected to Port Hacking will know the beauty and special nature of this catchment, but there needs to be an holistic approach to management of this vital area. Throughout this plan attention needs to be focused, not just on the visual aspects of the Port, headwaters and special places, but on all of the issues at hand because this environment is under pressure.

In 1992 the first Port Hacking Plan of Management (POM) was adopted by Sutherland Shire Council (SSC). This groundbreaking work recognised the pressures faced within the catchment and sought to provide a means of integrating management to protect its natural beauty for future generations. A considerable number of people invested many hours to bring together a holistic plan. The 2007 PHIEMP shares this commitment.

The 2007 PHIEMP has been developed through joint funding from SSC and the Department of Environment and Climate Change (DECC). The Port Hacking Management Plan Working Group (PHWG) was established to take on the role of directing the preparation of the plan. A sub-group of the Port Hacking Management Panel (PHMP), the PHWG has representatives with diverse interests, including members from state and local government authorities, community and environmental representatives.

The plan provides a framework for managing the catchment, recognising the changes since 1992, and looks to the future to anticipate new threats, such as global warming and the impacts of climate change. The plan is designed for use by state and local governments, land management groups, schools, community and recreation groups and individual community members.

The responsibility and mechanisms for implementing change will rest with those people and agencies responsible for the separate components within the system. It is important each person and agency works co-operatively to bring to the table information with which to monitor and action the plan.

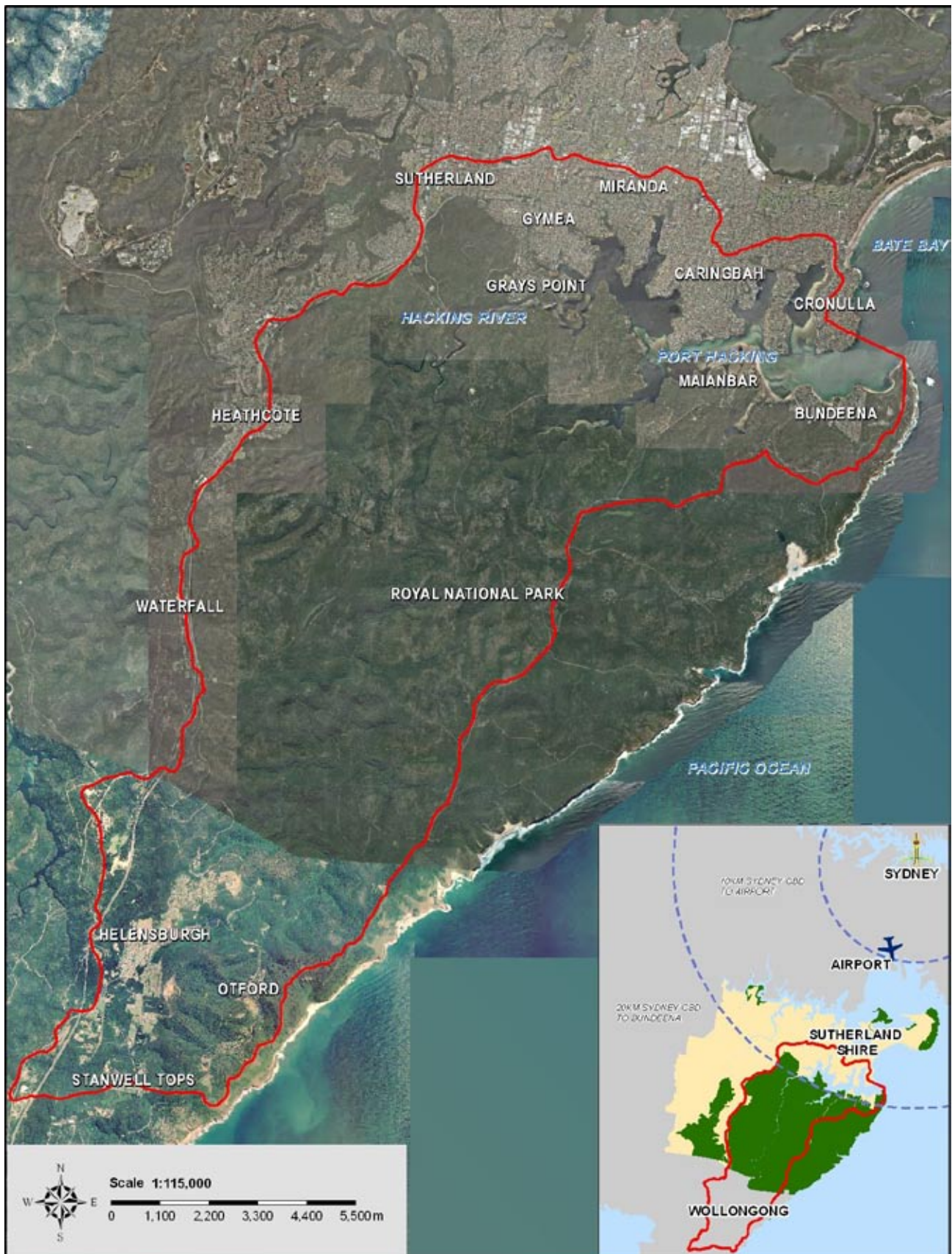
1.2 LOCATING THE PORT HACKING CATCHMENT

Port Hacking catchment is located 30 kilometres south of the Sydney CBD. The Hacking River commences in the upper regions of Otford and travels 27 kilometres where it meets the Port Hacking estuary, which covers an area of approximately 11 square kilometres. The total catchment area covers approximately 208 square kilometres, with the headwaters near Otford. Approximately 60 per cent of this area is natural bushland. Since the catchment is considered to be the most unpolluted of Sydney's major river catchments, the maintenance of high water quality is therefore a high priority.

The Port Hacking catchment and its location are shown in Figure 1.1



Figure 1.1
Port Hacking Catchment



1.3 THEN AND NOW – 15 YEARS ON FROM THE 1992 POM

Since the completion of the 1992 POM, there have been local changes in the Port and the catchment within a context of broader change, just as community expectations and demands upon the Port Hacking catchment have changed. It is necessary to update the actions taken to manage the Port Hacking catchment.

Changes since 1992, that were not considered in the original POM, but are now important for future management include:

- Infestation of the Port with *Caulerpa taxifolia*
- Increased intensity of water based activities and changing recreation patterns
- Several ecological communities, populations and species within the catchment are now considered

endangered and under threat from extinction and have been listed under the provisions of the Threatened Species Conservation Act

- Availability of additional scientific information to provide updated information on the state of the Port Hacking catchment environment, including an inventory and prioritisation of pollution sources carried out by Knowles (1996)
- Changes in water quality and the availability of comprehensive water quality data
- Climate change impacts (including sea-level rise).

Pressure on the Port Hacking catchment has continued. Increasing population, additional housing and increased boating activities are some of the changes. Selected changes between 1992 and 2007 to the Port Hacking catchment planning environment are summarised in Table 1.1.

Table 1.1
Selected changes between 1992 and 2007

Change element	1992	2007
Sutherland Shire resident population	190,000	213,636
Boat moorings	1241	1284
Boat berths	136	207
Riverkeeper	No Riverkeeper	Full-time position
<i>Caulerpa taxifolia</i>	Not identified	Present
Threatened species and endangered ecological communities	Not identified	Present
Stormwater management	Ad hoc response to improved water quality with a focus on flooding	Active program for improvement of water quality through stormwater levy
Port Hacking Catchment Panel	Present	Present
Catchment Management Committee/ Authority	Catchment Management Committee	Catchment Management Authority
Personal watercraft	Not specifically recorded as present	Present
Bundeena sewage infrastructure	Not sewered	Sewered
Sutherland Shire Local Environment Plan	The Port Hacking Management Plan was adopted prior to the adoption of SSLEP 1993	Review of LEP in accordance with DOP LEP template within 2 years

As detailed in Table 1.1, there have been a number of management achievements in the Port Hacking catchment following on from the 1992 POM, including:

- An active program for improvement of water quality through a stormwater levy (see section 5.2.4)
- The implementation of sewerage to Bundeena
- The continuation of the Sydney Metro Catchment Management Authority
- Environmental data collection and the development of Estuary Management Plans for Gunnamatta, Gymea and Yowie Bays.

Some issues identified in the original 1992 Plan may have continued to worsen, including:

- Increased conflict between users
- Continued foreshore development that detracts from the natural quality of the Port as evident in the results of Foreshore Visual Study (2002)
- Continued destruction of Aboriginal heritage sites
- Continued net loss of seagrass.

1.4 GOVERNANCE

Governance for the Port Hacking catchment is shared between a number of agencies, including:

- Sutherland Shire Council (SSC)
- Wollongong City Council (WCC)
- Department of Environment and Climate Change (DECC), including the National Parks and Wildlife Service, Estuary Management Program
- Department of Primary Industries (Fisheries)
- Department of Planning (DOP)
- NSW Maritime
- Natural Resources Commission (NRC)
- Sydney Metropolitan Catchment Management Authority (SMCA)
- Sydney Coastal Councils' Group (SCCG)
- Port Hacking Management Panel (PHMP).

The challenge of integrating agency, legislative activities and differing community expectations is not small. The legislative environment is complex and changing as a number of pieces of legislation apply within the Port Hacking catchment, as detailed in Part 5 - Background and Scientific Information. Many of the actions detailed in the PHIEMP are required by legislation and individual investment decisions by agencies will be based on the strategic directions found in the plan.

A planning and legislation review as part of the Draft Scientific Data Review in 2005 did not identify any direct conflict between the various statutory and non-statutory bodies considered. However, many pressures continue to impact upon the Port Hacking catchment. The continuation of these pressures indicates that work needs to continue on developing an understanding of the catchment while promoting an ability to address the pressures. The plan and its supporting documentation go some way to drawing together the views of the stakeholders to ensure that the Port Hacking catchment is improved for the future.

The actions recommended in this plan are implemented utilising a number of tools, for example the Sutherland Shire LEP 2006 (SSLEP 2006), the implementation of water quality improvement projects through the SSC stormwater levy and through incentives such as the funding of community based initiatives from a variety of sources. State agencies also provide incentives through joint funding for the preparation and implementation of plans, such as this plan. Infrastructure funding, like the NSW Metropolitan Greenspace Program, is available and statutory control is exercised through licensing requirements and development approvals.

Implementation of the plan will rely on regulatory, educational and incentive mechanisms to provide advice and information for diverse stakeholders within the catchment. The plan complements the existing work and location-specific plans such as the Yowie Bay, Gymea Bay and Gunnamatta Bay Estuary Management Plans. This is in addition to management plans that will be available as developed in the future, for example Bundeena Creek and Audley in the Royal National Park (RNP).

1.4.1 The Port Hacking Management Panel

The role of the PHMP is to advise SSC through the Environment and Health Committee (EHC) on all matters related to the preservation, maintenance, sustainable development and use of Port Hacking, which includes ensuring that the POM is contemporary and relevant. This charter was adopted by SSC on 10 May 1999 and is found in the SSC report CCL062-99.

Members of the PHMP who are eligible to vote on motions include SSC councillors, a commercial operators' representative, a Waterfront Owners Association representative, a Waterways User Group representative, two environmental representatives and up to seven community representatives.

Non-voting members include a Department of Primary Industries representative, a NSW Maritime Authority representative, three DECC representatives (representing the National Parks and Wildlife Service, the Estuary Management Program and the former Environment Protection Authority) and two SSC staff.

To direct the plan a sub-group of the PHMP, the PHWG was established with members who represent diverse interests across the Port Hacking catchment. Membership includes the chair of the PHMP, SSC's representative to the Sydney Metropolitan Catchment Management Authority (SMCMA), one community and one environmental representative, the chair of the SMCMA Board, two DECC representatives from the National Parks and Wildlife Service and Estuary Management Program, SSC's Parks and Waterways manager, and state and local government representatives, as required. In practice, all members of the PHMP have been invited to attend all PHWG meetings.

As monitoring of the plan will be essential to ensure implementation, the PHMP will develop a three-year program for inclusion in the SSC Management Plan and will be reported annually in the SSC Annual Report.

1.4.2 Selected regulatory tools

There are a number of pieces of legislation that apply within the catchment and these are detailed in Appendix 3. Of local importance are the:

- Sutherland Shire LEP 2006 (SSLEP 2006)
- Wollongong LEP (1990)
- Threatened Species Conservation Act 1995
- Contaminated Land Management Act 1997
- Fisheries Management Act 1979
- National Parks and Wildlife Act 1974
- Aboriginal Land Rights Act 1983
- Heritage Act 1977
- Native Title Act (NSW) 1994.

The SSLEP 2006 is the plan currently in force for the Sutherland Shire LGA. This LEP was gazetted by the Minister for Planning on 16 November 2006.

The SSLEP is to be reviewed in accordance with the Department of Planning requirements to prepare a Standard Instrument LEP. The new LEP is to be implemented in 2011.

Wollongong's LEP is the principal planning instrument for its LGA. The LEP zones land for particular uses, including residential, commercial, industrial and open spaces, as well as protection of areas of environmental, social and cultural heritage. The LEP is currently undergoing a major review in line with state government requirements. DECC utilises the Aboriginal Heritage Information Management System (AHIMS) to ensure protection of Aboriginal heritage items.

1.5 COMMUNITY CONSULTATION

The natural values and setting of Port Hacking enriches the lives of the people who are fortunate to live, work and play in the catchment. The development of this plan included a program of community consultation that utilised community questionnaires, briefings and stakeholder meetings.

Information on community values and concerns also has been drawn from secondary sources, for example the NSW Maritime Authority, 1999; Port Hacking Protection Society, undated; and SSC surveys and research, 2002, 2003, 2007 (see Appendix 2). These consultations and data collection processes have determined the community values and concerns that have been incorporated into the plan.

Key community stakeholders are those people who have an interest in or influence on what happens in the catchment, and are generally people or groups who are adversely or positively impacted by activities in Port Hacking catchment, including:

- Catchment residents
- Informal user groups, including boat owners and recreational fishers
- Formal user groups, such as Sutherland Shire Marine Association
- Commercial users, such as tourism operators
- Environmental protection groups, such as Bushcare groups.

1.5.1 Mapping of community values

[See CD ROM]

The locations and activities of community value in the Port Hacking catchment have been mapped and can be seen in Appendices 2 and 3. Some of these values overlap, while others may be in conflict, and are summarised in the following themes:

Aesthetic and heritage values

- Balance use demands and development impacts since the land and waterways are important for natural and cultural heritage values.
- Protect visual beauty and conserve the Port's scenic quality.

Social values

- Maximise the opportunities for sustainable recreation and tourism use of Port Hacking and its surrounds.

Economic values

- Protect land values adjacent to the waterways.
- Balance usage demands and the development impacts of commercial activities.

Ecological values

- Enhance the diverse vegetation as important habitats for indigenous plant and animal species.
- Maintain water quality as suitable for ecology and recreation.
- Take a custodian approach to anticipate and protect against future threats.

1.5.2 Mapping of community issues

[See CD ROM]

The locations of issues identified by the community in the Port Hacking catchment have been mapped and can be seen in Appendices 4 and 5. Some of these issues are not confined to a single location and may be systemic, and are summarised in the following themes:

Aesthetic and heritage Issues

- Development on the waterfront impacts on visual beauty and ecological values, as well as failing to protect rocky shore aquatic habitats from modification.
- Heritage protection and conservation, as well as the prevention of destruction of Aboriginal heritage sites.

Social issues

- Competition for limited space from tourism activities and user groups. In some locations there is conflict between users, such as motorised and non-motorised watercraft, impact from personal watercraft and a shortage of boating facilities on the southern side of Port Hacking.
- One overarching issue is the need to manage the catchment in a holistic way.

Economic issues

- Boating safety and maintenance of the navigation channel.
- Management of shoaling within the Port.

- The need to prepare for future threats and develop a risk assessment for factors, such as climate change and sea-level rise.

Ecological Issues

- The perception of diminishing water quality from bacterial contamination, stormwater run-off, catchment run-off, illegal disposal of material in the catchment and waterway, lack of reticulated sewage systems and the impacts of expanding urban development in the Helensburgh area.
- Impacts of sedimentation from stormwater run-off, sedimentation of bays and basins, contaminated sediments and sedimentation processes apparent in the area above the Audley weir on the Hacking River.
- Flora and fauna protection focused on endangered ecological communities and prevent further spread of *C. taxifolia* and the decline in saltmarsh and seagrass.

1.6 STRUCTURE OF THE PLAN

The preparation of this plan follows the process outlined in the NSW Estuary Management Manual (DECC, 1992) and builds on the existing

POM and its subsequent implementation by the PHMP. Further, it draws from the sub-catchment Estuary Management Plans for Yowie, Gunnamatta and Gynea Bays and the Bundeena Creek study also prepared under the NSW Estuary Management Policy.

This plan will therefore act as an Integrated Environmental Management Plan for Port Hacking and its catchment. Benefits of this approach include a holistic approach to management of the catchment and achieving associated economies of scale and avoidance of duplication. The plan contains objectives and strategies, including an investment strategy outlining the priority actions over the short, medium and long term. It also describes the implementation and monitoring tools and processes.

Part 5 provides a background and overview of the many considerations in addition to more detailed scientific information within the catchment. Additional information may be accessed through the references list.

Now that the background considerations and an overview of current conditions and threats have been explained, it is timely to describe the tools and processes available to achieve the vision for the Port Hacking catchment.



2. THE PLAN

The plan is a management tool that will assist to address the issues and protect the future of the Port Hacking catchment. To do this there are planning tools outlined in this section that include:

Aims – anticipated outcomes that are intended or guide the planned objectives

Objectives – specific, measurable targets that flow on from the aims

Strategies – the way to achieve objectives

Implementation – implementation of the plan will not rest with one body, rather this will rely on the activities of local, state and federal governments in conjunction with community and business initiatives. (Section 3)

Monitoring – how to check that the objectives have been achieved. (Section 3)

FIGURE 2.1
HOW THE REPORT WORKS



2.1 AIMS

The PHIEMP will provide the basis for the co-ordinated management of the entire Port Hacking catchment to achieve the following aims:

1. Protect biodiversity of terrestrial and aquatic ecosystems.
2. Preserve the ecological and aesthetic values of Port Hacking and its catchment.
3. Acknowledge indigenous custodians and preserve Aboriginal heritage.
4. Protect natural features and scenic values.
5. Provide sustainable recreation activities that promote environmental, heritage and scenic values.
6. Promote education and research to improve understanding of natural processes and develop greater community awareness of natural and heritage values.
7. Ensure through holistic management appropriate development and protection of the environment.
8. Manage the impacts of climate change.

2.2 OBJECTIVES AND STRATEGIES

The following table 2.1 outlines the management objectives for the Port Hacking catchment. These management objectives are contained in 6 groups as follows:

- Ecology
- Governance and management
- Hydrology including water quality
- Human influence
- Sedimentation
- Climate change.

The glossary contains the list of acronyms for agencies listed.

Table 2.1 – Objectives and strategies

Group	Objectives	Strategies	Monitoring tools	Agency
Ecology	Manage RNP to conserve biodiversity, maintain ecosystem function and catchment values	<ul style="list-style-type: none"> Activities are consistent with national park POM Improved access to RNP 	State of the Parks Reporting Annual Regional Achievement Reports	DECC
	Minimise the impact of development on aquatic environment and natural areas	<ul style="list-style-type: none"> Implement SSLEP 2006 and SSDCP 2006 Implement WCC LEP 1990 	SSC/WCC SOE Reports Visual assessment survey	SSC WCC
	Conserve and rehabilitate habitat for aquatic flora/fauna and substrate on which the flora/fauna depend	<ul style="list-style-type: none"> Reduce sediment inflows Rehabilitate natural environments Restrict access in vulnerable areas 	SSC/WCC SOE Reports DPI (Fisheries) Sea Grass Mapping	SSC WCC DPI (Fisheries)
	Minimal impact of commercial uses on the natural environment of the waterway	<ul style="list-style-type: none"> Monitoring of waterway and land based activities SSLEP LEP 2006 consistent with state provisions and EPA standards Economic Development Committee takes active role in promoting sustainable marine activities 	Riverkeeper and SSC CRMS	Riverkeeper SSC
	Minimal impacts on the aquatic environment from structural works	<ul style="list-style-type: none"> Preparation and compliance with consent and review of environmental factors 	Riverkeeper and SSC CRMS	Riverkeeper SSC Department of Lands
	Maintain recognised fishing grounds	<ul style="list-style-type: none"> Jibbon and Salmon Haul monitored 	Catch return records for Jibbon and Salmon Haul beaches (recognised fishing grounds)	DPI (Fisheries)
	Conserve and rehabilitate Port Hacking catchment and its tributaries to provide opportunities for threatened and protected species	<ul style="list-style-type: none"> Minimise spread of introduced aquatic and terrestrial species List and protect species and locations as required Management of feral animal species 	Threatened Species reporting in SOE Mapping of the extent of bushland vegetation and habitat Record feral animal culls	SSC DECC WCC SRA
Governance and Management	Maintain a joint administrative body for Port Hacking catchment comprising relevant NSW authorities headed by SSC	<ul style="list-style-type: none"> The PHMP continues to meet regularly Liaison with the CMA 	Monitor progress of plan implementation Monitoring of NRC indicators as available	SSC and representative agencies CMA NRC
	Ensure PHIEMP remains relevant to the needs of the Port Hacking catchment	<ul style="list-style-type: none"> Ongoing review of the objectives and policies of this plan, with review in 3-5 years Develop a dredging protocol 	Reporting through the SOE and SOS	SSC and representative agencies

Table 2.1 – Objectives and strategies (Cont.)

Group	Objectives	Strategies	Monitoring tools	Agency
Hydrology including water quality	Water quality is to comply with the ANZECC aquatic ecosystem and recreational guidelines for water quality	<ul style="list-style-type: none"> • Manage stormwater to ensure that the volume and quality discharged to the estuary minimises negative impacts on aquatic life and human contact • Installation and maintenance of landscape and engineering works to reduce sediment and other pollutants • Implement BASIX through the DA process • Implement WSUD at an individual household level for new and existing development 	SWAMP program and Beachwatch data Sydney Water data SOS water quality improvements	SSC WCC DECC RNP – water quality monitoring Sydney Water
Human influence	Involve stakeholders in PHC activities	<ul style="list-style-type: none"> • Involve stakeholders in day to day participation as well as at a policy level • Maritime events 	Management Plan Bushcare and volunteer groups RNP volunteers Maritime NSW aquatic event licences	SSC DECC (RNP) WCC Maritime NSW
	Enhanced landscape elements within the residential foreshore, riparian zone and in the visual landscapes	<ul style="list-style-type: none"> • Identify and list for protection identified landscape elements • Landscape heritage items included in SSLEP 2006 • Protect riparian zones from inappropriate development through DCP controls • Protection from deer and people 	LEP Review NPWS Riverkeeper	SSC DECC (RNP) Maritime NSW (Riverkeeper)
	Commercial facilities to meet existing and future demands including that for visitors and tourism	<ul style="list-style-type: none"> • Assess current and future tourism needs • Mitigate negative impacts of tourism and promote eco-tourism • Establish sustainability parameters 	Coastal Recreational 2007/2008 Fish survey from Port Macquarie to Wollongong Vessel registration, ferry passengers and eco tourism participants	SSC NSW Tourism DECC (RNP) DPI (fisheries) Maritime NSW
	A foreshore with maximum opportunities for public access having regard to residential amenity, environmental impact and constraints	<ul style="list-style-type: none"> • Improve access and public facilities at the waterfront, including use of heritage items • Restrict access in vulnerable areas 	SOS reporting on waterfront access in Sutherland Shire	SSC WCC DOP DECC (RNP) WCC
	Protection and conservation of Aboriginal and other heritage, cultural locations and artefacts	<ul style="list-style-type: none"> • Ongoing protection by national parks and SSC • Improved awareness of the need for protection • Use of heritage items such as wharves etc in such a manner as to conserve them 	Listed in LEP and by NPWS	SSC DECC WCC Department of Planning (NSW Heritage Office)

Table 2.1 – Objectives and strategies (Cont.)

Group	Objectives	Strategies	Monitoring tools	Agency
Human influence (Cont.)	A waterway safe for all users	<ul style="list-style-type: none"> • Encourage safe and equitable use of the Port with minimal conflict and overlapping of activities • Activity zones established and clearly marked (eg. boating and swimming) • Provision of directional and information signs • Develop educational and promotional materials and make these available on the internet 	Incidents reporting Infringements	SSC Maritime NSW
Sedimentation	Sediment inputs to achieve near stable conditions accommodating changing natural and human processes	<ul style="list-style-type: none"> • Monitor port movements • Establish baseline data in port movements • Establish Protocol for Heads of Bay • Assess changes in water transport energy due to sea level changes. Mathematical models in transport energy 	Volume of sediment by catchment and material type Sediment quality Geochemical load Benthic Biota	SSC
	Maintain a safe navigation channel (refer to Appendix 6)	<ul style="list-style-type: none"> • Dredging of navigation channel as required as per protocol developed and Memorandum of Understanding • Prepare/plan for future requirements • Defining navigation channel with channel markers 	Incident and infringement reporting Review of Environmental Factors Benching and testing Annual hydrographical studies	Maritime NSW DECC SSC
	Minimal impact on aquatic environment from dredging and reclamation	<ul style="list-style-type: none"> • Compliance with existing agency requirements and SSLEP 2006 	2007 Dredging Review of Environmental Factors fish audits and sea grass audits as undertaken	All agencies including DECC – Fisheries SSC CMA
Climate Change	Consider climate change in the development of activities and projects in the estuary.	Update and review planning controls and policies (LEP & DCP) and Council's data to respond to climate change concerns	The integration of climate change in policies and decision making	SSC DECC SSGC Department of Planning
	Respond to the sea level change risks	<ul style="list-style-type: none"> • Develop a strategy and policy to manage the impacts of sea level change • Map effects of sea level rise 	SSLEP 2006 and DCP 2006 reviews Sea level rise policy endorsed by SSC	SSC DOP SCCG

2.3 INVESTMENT STRATEGY

The catchment aims and objectives outlined in Section 2 and community and stakeholder values for the catchment have created the need to identify priority actions for investment. A long term investment strategy is required to respond to and address these actions and manage the future of the Port Hacking catchment.

Whilst the funds available for projects are often uncertain from budget to budget, it is possible to identify projects for consideration from work already completed and from discussions during the preparation of the plan. These include actions from the Gymea Bay EMP, Gunnamatta Bay EMP, Yowie Bay EMP, the 1992 POM, the Audley Masterplan and the Bundeena Creek EMP.

There were more than 60 actions listed in the 1992 POM, some of which have been addressed, but are still relevant and require ongoing management. Agencies have identified priorities from within the planning processes. Where practical these projects have been carried across to provide a single information source.

2.3.1 Issues

To achieve the objectives listed in Section 2, Table 2.1, specific projects have been allocated to an issues category. The projects cross these categories and address the multiple challenges within the Port Hacking catchment. Column 1 in Table 2.2 indicates the issue to be addressed by that investment strategy. These issues are identified and discussed in Part 5 – Background and Scientific Information, but it should be remembered that the issues are from across the spectrum – aesthetic and heritage issues, social, economic and ecological issues. The following abbreviations are used to identify the category of issue to be addressed by the plan:

Aesthetic and heritage issues

H = Heritage, culture and tourism

D = Development

Social issues

CS = Competition for space

HM = Holistic management

Economic issues

MS = Management of shoaling

FT = Future threats

B = Boating safety

S = Sedimentation

Ecological issues

WQ = Water quality

FF = Flora and fauna conservation

Climate change

SL=Sea level rise

2.3.2 Time frame

Time frames are applied to these projects based on a combination of need, available funding and ease with which the project may be undertaken. The following descriptions apply to the priority and time frame for undertaking projects:

- Immediate (I) is a project that is imminent, underway or is recommended to commence in the next six months
- Short Term (ST) is a project that will commence in the next 12 months
- Medium Term (MT) is a project that will commence from 12 months to three years
- Long Term (LT) is a project that will commence in three years or more.



Table 2.2 – Project list

Issue	Project/ Actions	Description	Contact	Cost (\$000)	Source of project	Benefits	Time frame
WQ	Bundeena Creek Management Plan	Develop Bundeena Creek Management Plan	SSC Eng	80	DECC	Improved management of Bundeena Creek	I
WQ	Water quality	Assessment of priority areas for treatment of the urbanised catchment	SSC Eng	NC	SSC	Improved water quality including a reduction of sediment	ST
WQ	Coastal processes study of eastern shore of Gunnamatta Bay	Unfunded SSC resolution	SSC (P&W)	50	SSC request	Develop renourishment strategies including soft engineering options	ST
WQ	Water quality monitoring in WCC area	Investigate opportunities to monitor water quality in the Hacking River area and consider catchment sources	WCC	NC	PHMP	Monitoring of water quality in the Hacking River	ST
WQ	Yowie Bay stormwater treatment	Improve stormwater quality by upgrading existing GPT, Implementation of items from the Yowie Bay Estuaries Management program (including Wonga Rd)	SSC Eng	250	Yowie Bay EMP	Improved water quality including a reduction of sediment	ST
WQ	GyMEA Bay Water Quality Improvements	Implementation of items from the GyMEA Bay Estuaries Management program (inc. dredging consents, Burraneer Bay Rd. GPT)	SSC Eng	NC	GyMEA Bay EMP	Improved water quality including a reduction of sediment	ST
WQ	GUNNAMATTA Bay Water Quality Improvements	Implementation of items from the GUNNAMATTA Bay Estuaries Management program	SSC Eng	30	GUNNAMATTA Bay EMP	Improved water quality including a reduction of sediment	ST
WQ	Restoration of Kareena Creek (inc. Stage iv)	Restore open stormwater drain, stabilise banks and vegetation rehabilitation	SSC Eng	200	Yowie Bay EMP	Improved environmental and recreation outcomes for popular picnic locality	ST/MT
WQ	Saville's Creek Wetland/GPT	Install GPT and construct nutrient wetland Saville's Creek	Riverkeeper/ SSC Eng	10	SSC	Removal of nutrients and cleaning of water prior to entering the Hacking estuary	MT
WQ	Kelly's Creek	Investigation of GPT	WCC	NC	PHMP	Improvement of water quality discharging to Hacking River	MT
D	Rehabilitate Hacking River Erosion	Rehabilitate the eroded shoreline of prioritised sites	RNP, WCC	30	PHMP	Environmental improvement, reduce riverbank erosion	MT

Table 2.2 – Project list (Cont.)

Issue	Project/ Actions	Description	Contact	Cost (\$000)	Source of project	Benefits	Time frame
D	Waterways Visual Survey update	Repeat visual survey of foreshore to examine impacts of development	SSC Planning	NC	PHMP	Monitoring of visual impacts of development	LT
CS	The impact of boat users on the Sutherland Shire marine infrastructure and the Shire's marine industry	Conduct surveys to measure demand and supply issues of Sydney boat users; measure impact on SSC' marine infrastructure; measure impact on the marine industry in SSC.	Dr Elias Sanidas (School of Economics, UOW)	26	PHMP	Timely and adequate improvements of boat ramps and other marine facilities in SSC; assisting marine business in the SSC to prosper.	I
CS	Yowie Bay Wharf and parking upgrade	Upgrade of boating and recreation facilities	SSC (P&W)	300	SSMA	Better management of infrastructure	I/ST
CS	Lugarno Street Wharf upgrade	Upgrade of boating and recreation facilities	SSC (P&W)	300	SSMA	Improved infrastructure	I/ST
CS	Boating education program	Boating etiquette and information on impacts of boats	SSC (P&W) Maritime NSW	2	Maritime NSW	Social benefits from sharing of resources, reduced bank erosion and improved safety	ST
CS	Fisherman and Hospital Bay wharf	Identify ownership and management approach to these two wharves	Riverkeeper	NC	GB EMP	Address access and safety considerations	ST
CS	Waterways facilities audit	Compliance with AASA standards, structural assessment and user perceptions	SSC (P&W)	NC	PHMP	Improved management of Shire infrastructure	ST
CS	Upgrade of Lilli Pilli Baths	Structural assessment and review access	SSC (P&W)	10	SSC	Targeted works for infrastructure	ST
CS	Upgrade of Gynea Baths	Structural assessment and review of access	SSC (P&W)	10	SSC	Targeted works for infrastructure	ST
CS	Grays Point Masterplan	Access, reserve, heritage values, endangered species and conservation values Swallow Rock water quality and amenity improvements	SSC (P&W) SSC Planning	50 120	SSMA	More integrated planning and design for important parks asset	ST/MT

Table 2.2 – Project list (Cont.)

Issue	Project/Actions	Description	Contact	Cost (\$000)	Source of project	Benefits	Time frame
CS	A comparison of boat users' impact on key shires' marine infrastructure in NSW and the future of the State's marine industry	Conduct surveys to measure demand and supply issues of NSW boat users; measure impact on shires' marine infrastructure; measure impact on the marine industry in various shires. Measure the corresponding total income generated by boat users and marine industry firms in NSW, and particular shires or areas.	Dr Elias Sanidas (School of Economics, UOW)	60 (5 for SSC)	PHMP	Timely and adequate improvements of boat ramps and other marine facilities in NSW; assisting marine business in NSW to prosper. The comparison between SSC and other Shires will benefit SSC to become better in the future in this area. The socio-economic impact of boat users and marine firms will benefit all levels of government for planning purposes.	MT
CS	Dinghy study	Examine where dinghies are stored, identify opportunities and clean up foreshore (Pittwater case study)	NSW Maritime SSC (P&W)	5	PHMP	Improved foreshore management	MT
CS	Port Hacking Catchment Visitors study	Survey and field data for Boat ramps and recreation locations and facilities (excluding national park)	SSC (SPU)	30	SSMA and PHMP	Know who the clients are and information for tourism within the entire catchment (excluding national park)	MT
CS	Snorkel Trail	Snorkel trail for Salmon Haul Bay (interpretive signage and access)	George Cotis	10	PHMP	Provide a tourism and new access opportunity to the waterway	MT
CS	Economic value of marine activities	Research on economic benefits of the marine industry	UOW	NC	PHMP and SSMA		TBA
S	Heads of Bays including Yowie Bay Sediment Study	Core sampling to provide sediment time series and contaminant load	SSC Eng Professor Albani	35	PHMP	Better understanding of when sediments were added to the system and an indication of the contaminant levels	ST
S	Audley Weir sediment & weed removal	Remove aquatic weed and sedimentation from above weir	National Parks	75plus	Audley Masterplan	Social benefits, environmental improvement	LT
B/MS	Investigate dredging of the approach channel to Swallow Rock Boat Ramp	Identify preferred dredging area and indicative costing	SSC (P&W)	20	PHMP	Improved boating access to boat ramp	ST

Table 2.2 – Project list (Cont.)

Issue	Project/ Actions	Description	Contact	Cost (\$000)	Source of project	Benefits	Time frame
B/MS	Develop a dredging protocol	Identify conditions under which dredging should take place	SSC PHMP	No cost	PHMP	Better anticipation of dredging requirements	MT
B/MS	Plan of management for future dredging options	Investigate and plan for future options of the main navigation channels	NSW Maritime SSC Eng DECC	30	PHMP	Economic value, Vessel access	MT
FF	Riparian zone improvements	Rehabilitate McDonalds Flat	SSC (P&W)	20-80	SSC/NSW maritime	Improved environmental outcomes	ST
FF	Riparian zone improvements	Contractors work at 7 sites to supplement Bushcare and Clean Up Australia activities	SSC (P&W)	20	SSC/NSW maritime	Improved environmental and recreation outcomes for popular picnic locality	ST
FF	Fisheries update of sea grass mapping	Update mapping	Fisheries CMA	10 (5 + 5)	PHMP	Accurate and current data on sea grass locations including <i>C. taxifolia</i>	ST
FF	Water based feral animal control	Water based trial to boost existing culls of deer in conjunction with NPWS and Rural Land Protection Board	SSC (P&W) RNP	10	SSC	Removal of deer from more inaccessible foreshore locations	ST
FF	Ameliorate impediments to fish passage	Identify remove /connect channels for fish passage	DPI and SSC	100 200	NSW DPI	Maintain species diversity. Protect endangered ecological communities	ST/MT
FF	Rehabilitate Hacking River mangroves and saltmarsh areas	Investigate and rehabilitate mangrove areas Hacking River	Riverkeeper Fisheries	10-70	NSW DPI	Environmental/ Aquatic Habitat improvement	MT
FF	Cabbage Tree Basin	Assessment of priorities to ensure protection of the Basin	SSC (P&W)	NC	PHMP	Environmental/ aquatic habitat improvement	
FF	Jibbon Lagoon	Investigate habitat and dune protection	Riverkeeper RNP	NC	DECC(RNP) Maritime	Stabilise sand	MT
FF	Restoration projects in WCC area	Remediation of scoured streams in Helensburgh	WCC	NC	WCC/ PHMP		MT
FF	Audley Fishway and Audley Weir Fish Ladder Stage 2	Construct fishway on Audley Weir to allow native fish to migrate between estuarine and riverine habitats of the Hacking River catchment	DECC/RNP	NC	DPI Fisheries	Improved fish passage	MT

Table 2.2 – Project list (Cont.)

Issue	Project/ Actions	Description	Contact	Cost (\$000)	Source of project	Benefits	Time frame
H	Aboriginal sites	Protection of Aboriginal sites	DECC/SSC	NC	PHMP	Maintain and protect cultural heritage	LT
H	Sea wall repair	Repair and protection of heritage item required	RNP/SSC	NC	DECC(RNP)	Maintain and protect cultural heritage	LT
FT	Agreement/ MOU with Wollongong City Council	Reach formal understanding with WCC on catchment issues	PHMP	NC	PHMP	Environmental/ catchment benefits, health benefits	MT
SL	Identify and map risks from sea level rise	Identify & map residential and ecologically significant areas that are at risk of inundation from sea level rise, identify and implement planning controls to protect these areas, people and assets from future risk.	SSC	NC	SSC, DoP, CCG	Plan for and minimise future risks hazards and protect people, property and significant areas	LT
FT	Simpson's Bay Beach (Bonnie Vale sand spit)	Transfer management to National Park	SSC (P&W)	NC	SSC	Unified management of natural asset	LT
HM	Undertake an accessibility assessment	Develop an accessibility plan identifying the constraints and opportunities, identify transport available, how people access the waterways and location of infrastructure as this impacts on land uses in the catchment.	SSC (Science)	NC	SSC	Improved integration of waterways use with land use planning	LT

*The University of Wollongong has a proposed project for which an ARC linkage grant will be lodged in 2008. The business partners will include the SSC as well as other relevant shires, and government departments. The estimated start date is June 2008 with an estimated completion date of June 2011.

3. IMPLEMENTATION AND MONITORING

3.1 WHAT IS AN INDICATOR?

An indicator is something that helps you understand where you are, which way you are going and how far you are from where you want to be. Ideally, a good indicator flags a problem before it gets too bad and helps you recognise what needs to be done to fix it so that you can move towards ideal conditions. Indicators need to be measurable, credible and have meaning in terms of the plan's goals.

As monitoring and reporting are key components of this plan, a set of indicators has been developed. These indicators will enable the plan to be reported through the local government reporting processes. However, the variety of data collection methods, variability of timeframes and recording mechanisms means that establishing indicators is a problematic task.

3.2 IMPLEMENTATION MONITORING

To gain an appreciation of the progress of the plan implementation, a series of performance indicators can be assessed on a periodic basis. These are aimed at measuring the key aspects of the strategies identified, including the rate of implementation and the overall outcomes resulting from the execution of the plan.

The first set of performance measures should ascertain whether the strategies are being implemented and within an identifiable timeframe. As such, these primary performance measures are simply a measure of implementation, and will be reported through the PHMP on an annual basis.

The second set of performance indicators is aimed at measuring the outcomes of the plan, and includes reporting on the implementation of the strategies and other factors that have affected the potential sustainability of the catchment. One mechanism for gauging the outcomes of the strategies is long-term ecosystem health monitoring. This set of performance indicators is to be reported through the SSC Management Plan and integrated planning reporting requirements (SOE and SOS).

Therefore, the regular and systematic monitoring of various elements of the physical, biological and social environment of Port Hacking is an essential long-term component of assessing the overall success of the plan.

3.3 ECOSYSTEM MONITORING PILOT PROJECT

The NSW Natural Resources Commission (NRC) has recommended a standard, as well as 13 targets for natural resource management. One of these targets states that 'By 2015 there is an improvement in the condition of estuaries and coastal lake ecosystems'.

There are many biotic and abiotic parameters that can be assessed to provide an indication of environmental health and the factors/stressors impacting on this health. The monitoring of different parameters should be carried out on different timescales based on the relative rate of change of the parameter, and must be statistically valid to ensure that natural variation is taken into account, as well as identifying trends over time. Emphasis should be placed on condition indicators to ascertain environmental health.

A number of condition indicators will be monitored as part of a statewide pilot monitoring, evaluation and reporting project, including:

- Pelagic chlorophylla
- Macroalgae
- Turbidity/water clarity
- Distribution of seagrass, saltmarsh and mangroves
- Fish assemblages.

The statewide pilot project will make recommendations for the ongoing monitoring and reporting of condition indicators against the targets. The monitoring process of Port Hacking to assess its condition should include the recommended condition indicators listed above as well as relevant contextual information. Indicators of recreational water quality, such as faecal coliforms, should be collected as required and be consistent with recognised guidelines.

Table 3.1 – Primary Outcome Indicators

Indicator	Description	Source	Agency
Water quality	Measurement of water quality at various points	DECC Beachwatch SWaMP monitoring program	EPA (DECC), SSC, NPWS (DECC), Sydney Water, WCC
Water quality initiatives	Provision of structural water quality improvements (including devices) by sub catchment	SOS	SSC
Monitoring of foreshore development activities	CRMS Riverkeeper log	SSC Customer Response Management System Riverkeeper	SSC
Foreshore areas access by catchment	Listing of water access points in the Port Hacking catchment area by access types and improvements to these since the previous report	SOS 2003 SSC Parks & Waterways	SSC
Tourism indicator	Ferry Passengers Eco tourism participants	SSC tourism data RNP visitation	SSC NPWS (DECC)
Cultural/recreation indicator	Events conducted in Port Hacking catchment	Maritime NSW data – events permits	Maritime NSW
Maritime use, conflicts and safety	Incident reporting Infringements	Maritime NSW data	Maritime NSW
Vessel registrations	Number of recreation/ commercial vessels	Maritime NSW data	Maritime NSW
National Park indicator	Recording of annual achievements consistent with the RNP POM	State of the Parks Report and Annual Regional achievements reports	NPWS (DECC)
Volume of sediment	Volume of sediment and material collected from GPT's in Port Hacking catchment and type of material	Management Plan and SOE Report	SSC
Feral animal species	Culling of feral animal species by type and water catchment	Management Plan and SOE Report	SSC NPWS (DECC)
Extent of bushland	Extent of bushland mapped and habitats described by water catchment	Management Plan and SOE Report	SSC
Extent of aquatic macrophytes including sea grass, mangroves, saltmarsh and <i>C. taxifolia</i>	Seagrass mapping by type; Additional research on fish species present in sea grass beds; Catch return records	Seagrass mapping Fishcare Volunteer survey	DPI (Fisheries) Sydney CMA
Protection of heritage items	Review of heritage items	SSLEP 2010 Heritage Schedule Wollongong LEP NPWS (DECC) HHIMS Listing of Aboriginal sites; State Heritage Register	SSC NPWS (DECC) WCC
Preparation and implementation of sea level rise strategies	Mapping of areas susceptible to sea level rise	Sea Level rise risk assessment or LEP review (e.g. new flood maps)	SSC

Table 3.1 – Primary Outcome Indicators (Cont.)

Indicator	Description	Source	Agency
Economic indicator	<ul style="list-style-type: none"> • Visitor and Tourism Numbers and expenditure and usage figures (recreational and commercial) • Surveys of boat users/owners and maritime businesses including total income generated by users and firms. • Investment figures by private individuals and operators e.g. (environmental improvements) 	Tourist data Survey data 2007-2008 DA approvals register and qualitative surveys	Tourism NSW Maritime Association/Uni of Wollongong Marine Association/SSC
Governance	Reporting to PHMP on the implementation and outcomes of the plan.	Annual review of PHMP projects Port Hacking catchment report card	PHMP (SSC)
Involvement of stakeholders	<ul style="list-style-type: none"> • Bushcare groups • Tree planting days • Community groups • Greenweb • Cleanups • Heritage and historical societies 	SOE Management Plan RNP Volunteers reports	SSC WCC NPWS (DECC)

3.4 DATA SOURCES

The table above refers to a number of data sources. As there are extensive monitoring programs in place in NSW, the monitoring for the Port Hacking catchment will draw from the existing monitoring where possible, selecting data that specifically applies to the catchment. Below are the reports that will provide this data:

SSC Management Plan and Annual Report

The SSC Management Plan and annual report are produced annually as part of council's statutory requirements.

State of the Shire (SOS) and State of the Environment Report (SOE)

The SOS and SOE reports are being combined to deliver integrated planning. Previously, the SOS was produced approximately every three-four years by the Strategic Planning Unit at SSC.

Under NSW Government legislation, SSC is required to prepare a SOE report each financial year. The comprehensive SOE Report for 2006/07 describes the pressures on, and state of, the environment within the Sutherland Shire, while providing relevant background information to the various environmental response programs being undertaken by council and other agencies. This report is intended to be an information resource for residents, special interest groups and government.

DECC (EPA) Beachwatch

A major goal of the EPA is to reduce sewage and stormwater pollution of beaches and coastal waterways. Beachwatch contributes to this goal by:

- Monitoring coastal water quality throughout the Sydney metropolitan area
- Quality control of water monitoring by other agencies in the Hunter and Illawarra regions
- Reporting to the community on the risks of sewage and stormwater pollution at beaches and estuarine swimming areas in Sydney and the Illawarra

SWaMP Monitoring Program

SSC's Strategic Water Monitoring Program (SWaMP) has been conducted irregularly in summer and winter since 1994. The aim of this program is to identify areas in the Shire that require actions for improving water quality. Samples are taken from up to 20 sites from each of the Shire's sub-catchments and tested for metals, nutrients, sediments, oil and grease, oxygen demand and bacterial indicators.

Maritime NSW data

Maritime NSW collects data in a number of areas and this information is available on request.

NPWS (DECC) data

NPWS produces several reports, including the State of the Parks Report (Triennial Report), annual regional achievements reports, and the *Audley Masterplan – Action Priorities Plan. 2007.*

4. WHERE TO NEXT

The PHIEMP will be reviewed in five years. Until then monitoring of the plan will be undertaken by SSC and the PHMP to confirm that the activities taking place within the catchment contribute to a sustainable catchment and meet the responsibilities identified for the future of the Port Hacking catchment. As the impacts of climate change and other pressures become clearer, further action will be required to ensure that the catchment is preserved as a pristine and accessible environment.

If you would like to stay in contact with the activities that are happening in the Port Hacking catchment, please write to:

The General Manager

Sutherland Shire Council

Attn: Secretary, Port Hacking Catchment Management Panel

Sutherland Shire Council

Locked Bay 17

Sutherland NSW 1499

Or send an email to hacking@ssc.nsw.gov.au



5.1. OVERVIEW

This part of the report is called *'Channels and Markers - Background and Scientific Information to the Port Hacking Integrated Environmental Management Plan'*.

Why channels and markers? There are water channel and boating markers throughout the Port Hacking catchment to direct water users on the safest routes. Similarly, this report provides a summary of the evidence that has directed the development of the plan.

This evidence points to the route this report should take. In some areas there is good quality and extensive information, while in other areas more information needs to be gathered. In the case of climate change there are many uncertainties, though it is obvious action needs to be undertaken.

This section articulates the issues and challenges facing the management of the Port Hacking catchment in addition to providing:

- an overview of the regulatory tools
- a detailed glossary and comprehensive bibliography for those seeking further information on the catchment
- the evidence for management decisions
- a summary of information from previous scientific studies
- some new information written specifically for the development of the plan that accompanies this background report.

In addition to the background information, the plan has been developed utilising the principles that formed part of the original plan, indicated in brackets, and adopting new standards to reflect changing attitudes:

- The Port Hacking catchment is viewed as a whole system (POM, pp.18-19).
- Management decisions should be based on integrated multidisciplinary and interdisciplinary scientific information (POM, pp.18).

- There should be equitable use and access to the Port Hacking catchment (POM, pp.3,15). The plan supports the protection of the public interest in the public domain and the sharing of resources.
- Consideration should be given to the consequences of climate change, including predicted sea-level rise.
- Cumulative impacts of an activity are to be taken into consideration when making decisions and net potential detrimental effects avoided.
- A precautionary approach is to be adopted when insufficient evidence or knowledge about the environmental impacts of a proposal or activity is known.
- Ecological values are given the highest priority for protection (POM, pp.3,15).
- The Port Hacking catchment should be managed in a sustainable manner so that the ecological, social and economic values and experiences are maintained for future generations (POM, pp.3,15).
- The plan should encourage improved understanding and celebration of Aboriginal culture, and subsequent heritage.
- Consultation and stakeholder investments in the future of the Port Hacking catchment are recognised (POM, pp.5,18).

The development of the plan has followed the following estuary management process (Figure 5.1) described by the Department of Conservation and Climate Change (DECC).

Figure 5.1 Estuary Management Process



Phase 7 in the diagram above, Adoption and Implementation, will rely on regulatory, education and incentive mechanisms. The plan provides advice and information for a number of stakeholders within the catchment, complementing the existing work and location specific plans, such as the Yowie Bay, Gymea Bay and Gunnamatta Bay Estuary Management Plans, in addition to information that will be available in the future, for example on the Bundeena Creek Process Study and Plan of Management for Audley in the Royal National Park.

Monitoring of the plan will be essential to ensure the plan’s implementation. The Port Hacking Catchment Panel will develop a three-year program to be reported annually in the appropriate theme areas in the Sutherland Shire Council (SSC) Annual Report and for inclusion in the Management Plan.

5.2. DESCRIPTION OF THE CATCHMENT, ISSUES AND CHALLENGES

The northern foreshore of Port Hacking has changed from natural and low-density residential land to a high-density urban landscape moving towards the ridge. With few permanent residents in the RNP outside Bundeena and Maianbar, the waterfront suburbs along the northern shore account for the majority of residents.

Based on the 2006 Census, the Port Hacking catchment below Audley Weir is home to between 60,000-70,000 people. This includes settlements at Bundeena and Maianbar as well as the suburbs along the northern shores, including Grays Point, Gymea Bay, Lilli Pilli, Dolans Bay, Port Hacking, Woolooware, Burraneer and Yowie Bay, and 50 per cent of the populations of the ridge top/train line suburbs of Caringbah, Cronulla, Gymea, Heathcote, Waterfall, Kirrawee and Miranda. The majority of impacts in the freshwater areas of the catchment are from the urban settlements at Helensburgh and Otford, which have a combined population of almost 5,500 people.

SSC needs to address some critical challenges in planning for the future of the Port Hacking catchment. Some of these problems are challenges that already have been identified. Others will require council to adapt to a changing landscape. It is the beauty of the Port and its catchment that leads to problems as many people seek to access this splendour. Evidence for these challenges can be found in the Port Hacking Management Panel workshop (2006), which identified a number of issues to be addressed with some urgency, as seen in Table 5.1. Although these issues are ranked, all of the items are important issues and priority may shift based on location, scale and the focus of any proposed activities.

Table 5.1 – Ranked Issues from 2006 Port Hacking Catchment Management Panel workshop

Rank	Issue	Planning Challenges
1	Bacterial contamination	Water quality
2	Stormwater run-off	Sedimentation
3	Sedimentation of bays and basins	Sedimentation
3	Catchment run-off	Water quality
3	Further spread of <i>C. taxifolia</i>	Flora and fauna protection
6	Illegal disposal of material in the catchment and waterway	Water quality
7	Contaminated sediments	Sedimentation
8	Continuing foreshore development	Visual amenity/flora and fauna
9	Lack of reticulated sewage systems	Water quality
10	Resolution of conflict between users	Competition for space
11	Decline in saltmarsh	Flora and fauna protection
12	Decline in seagrass	Flora and fauna protection
13	Destruction of Aboriginal heritage sites	Heritage protection
14	Protection of existing littoral rainforest	Flora and fauna protection
15	Protection from modification of rocky shore aquatic habitats	Visual amenity/flora and fauna
16	Negative impact of boating	Competition for space
17	Sedimentation processes	Sedimentation
18	Public perception that water quality is poor	Water quality
19	Availability of boating facilities especially for the southern side	Competition for space
20	Navigation channel	Boating safety

Once the issues captured by the Port Hacking Management Panel are grouped thematically, it is evident that there are nine major planning challenges facing the Port Hacking catchment, as follows:

Aesthetic and heritage issues

- Concern over development on the waterfront, including impacts on visual amenity and ecological values in relation to continuing foreshore development and the need to protect rocky shore aquatic habitats from modification.
- The need for heritage protection and conservation, as well as the prevention of the destruction of Aboriginal heritage sites.

Social issues

- Competition for limited space from tourism pressures and user groups is a key consideration. In some locations there is conflict between users, such as between motorised and non-motorised watercraft, impact from PWC and a shortage of boating facilities for the southern side of Port Hacking.
- The need to manage the catchment in a holistic way.

Economic issues

- Challenges relating to boating safety, maintenance of the navigation channel and management of shoaling within the Port.
- The need to prepare for future threats and develop a risk assessment for factors such as climate change and sea-level rise.

Ecological issues

- The perception concerning diminishing water quality from bacterial contamination, stormwater run-off, catchment run-off, illegal disposal of material in the catchment and waterway and lack of reticulated sewage systems are at the head of the ecological queue, as well as the impact of expanding urban development in the Helensburgh area.
- Concern over impacts of sedimentation from stormwater run-off, sedimentation of bays and basins, contaminated sediments and sedimentation processes apparent in the area above the Audley weir on the Hacking River.
- Ongoing flora and fauna protection, including stopping the further spread of *C. taxifolia*, decline in saltmarsh and seagrass.

Each of these planning challenges will now be examined in more detail.

5.2.1 Aesthetic and heritage issues

Development

Concerns have been raised at the change in the scale and nature of development in some bays with the consequent move from a lower scale, or more natural character, to a more intense built-up character.

Existing land-use zones in the catchment include residential, industrial, open space commercial and special-use zones. The estimated proportions of different land uses within the catchment are detailed in Table 5.2.

Table 5.2 – Estimated Land use within the Hacking Catchment

Type of Land Use	Approximate Area (ha)	Approximate % of Total Catchment
Residential	4350	21%
Industrial	680	4%
Open space	15,260	73%
Commercial	70	0.5%
Special use	440	1.5%
TOTAL	20,800	100%

* Source: AWT, 1999

The foreshore areas fall into three categories for visual assessment. These categories are ridgeline/horizon, intermediate and waterfront. Further, each area may be examined for the extent to which the area is predominantly a natural, built-up or transitional setting or character.

Approximately 60 per cent of the Hacking River catchment is natural bushland (Knowles, 2000). This natural bushland is made up of the Royal National Park (RNP) (15,000 hectares) and Garawarra State Recreation Area (900 hectares) (HRCMC, 1997a). The basin on the southern shore of the Port is a special place that needs specific mention. This area of sand, water and mangroves has a distinctive formation that fulfils an important ecological and social role in the fabric of the southern shore.

There is concern over the continuing loss of natural foreshore and this plan seeks to protect the foreshore and seabed from further modification as recorded in the visual surveys undertaken by SSC. Similarly, unauthorised structures are an issue on the foreshore and an examination of the mechanisms for more effectively managing unauthorised foreshore structures is required.

Heritage

European and Aboriginal heritage is vulnerable to the impacts of development and neglect, particularly in relation to heritage items located

around the foreshores. Heritage items may include boat sheds, trees, natural formations or middens and Aboriginal artefacts. Several heritage items and cultural areas have been identified within the Port Hacking catchment as listed in the Sutherland Shire LEP 2006 (SSLEP) in Schedule 6, including:

Items of non-Aboriginal archaeological significance

- Items that comprise a precinct known as an archaeological site
- Building or landscape items
- Significant landforms
- Items other than any of the above such as monuments, relics and fences
- Items of regional or state heritage significance
- A significant tree or trees.

Aboriginal heritage

The Dharwal people occupied the area for 8,000 years up to the 1840s, even as late as the 1870s, with a population density approximately 5-10 people per 2.5 km² before European settlement (McCarthy, 2000). There are hundreds of Aboriginal artefacts, middens, rock carvings and cave paintings in the Port Hacking catchment (West et al., 2000).

In the mid 19th century shell grit was in high demand as a source of lime for building in the Sydney district. Consequently, mud and oyster rocks were collected in large numbers from Port Hacking catchment destroying a number of aboriginal midden sites in the region (West et al., 2000).

European heritage

During the late 1800s, Cronulla was established as a holiday and weekend destination and, at that time, was called the Village of Gunnamatta. In 1911, following the opening of the Sutherland–Cronulla tramline, large areas of land were subdivided around Cronulla and Woolooware, including Gynea Bay and Grays Point.

The Sutherland–Cronulla railway line was completed in 1939. However, urban development did not commence until the 1940s progressing into the 1950s (Nelson, 1997). The early Cumberland Planning Scheme proposed to reserve land along the waterfront in order to establish ‘green belts’ for open space, however this was abandoned following criticism that it interfered with private property rights (Nelson, 1997).

Reticulated water was made available to Sutherland in 1931 with the completion of the Woronora Dam (Nelson, 1997). Sutherland’s first sanitary depot was built in Dolans Road, north of the head of Burraneer Bay, although this site was soon closed down by the Department of Health and the depot re-established in Menai in 1939. Work on a reticulated sewerage system began in 1952, however Maianbar and Bundeena were still not connected to the system by 1997 (Nelson, 1997). Note that reference should be made to the SSLEP2006 and amendments for updated and detailed heritage information as required.

5.2.2 Social issues

Competition for space

The Port Hacking Protection Society (PHPS) has raised concerns about increasing use of the catchment. These concerns include an increase in conflict between low- and high-impact users, pollutants from a variety of activities, fishing and foreshore harvesting, sewage from cruisers, and safety problems (PHPS, 2004).

The Port Hacking catchment is used for a number of activities, including foreshore walking/cycling, swimming, fishing, picnicking, canoeing/kayaking and surfing (HRCMC, 1997b). The pattern of use of the estuary varies. In the southern areas, activities are characterised by a high degree of personal interaction with nature, for example swimming, sailing, walking and canoeing and kayaking. Other activities enjoyed in the catchment include power boating (Waterways Authority, 2003). A Catchment Management Committee study indicated

that the foreshore residents and visitors mostly enjoy activities that require good environmental conditions, for example swimming, kayaking and bushwalking (PHPS, 2004).

The waterway is public domain and therefore all citizens have a right to its use. But there needs to be a balance of the many demands on the resources, or there is a risk of degrading the waterway and the public's ability to experience it. Access may be visual or physical, in or on the water. Walking paths, boat ramps, marinas or jetties allow fishing and safe places to swim, but the provision and use of these facilities may generate conflict.

Boating facilities

Boating facilities available in Port Hacking catchment include emergency and courtesy moorings provided by the NSW Maritime Authority, as well as marinas, boatsheds, fuelling points, launching ramps, wharves and jetties and pump-out facilities (Waterways Authority, 2003). Boat ramps are often located within residential areas and the scope to expand the infrastructure is limited.

Property acquisition is expensive and there will always be a negative consequence for the immediate residential neighbourhood. In the end, while ramps may be upgraded to facilitate launching and retrieval, increased demand will need to be met by other means. Where possible, demand may be met by dry boat storage, for example dinghy storage for access to moored craft or storing and launching trailer craft. However, the developed nature of the Port's foreshores limits opportunities for such infrastructure.

As at July 2007, marinas provided approximately 200 commercial wet berths. There are limited options for creating new boating and on-water recreation access points to the Port Hacking catchment since most of the foreshore is privately owned.

Marinas are supported as a space-efficient means of in-water boat storage. However, marinas have been continually expanding in size to meet demand in boating numbers and the size of boats. The in-water area now occupied by marinas in Port Hacking has increased over time and continued expansion is likely to impact on users and adjoining owners.

The plan proposes that marinas retain the existing land and water footprint and increase the berthing capacity through better space utilisation. Any increases in marina capacity should be offset by a reduction in mooring holdings with these moorings being reallocated by public issue through Maritime NSW. A survey carried out by the Waterways Authority (now NSW Maritime Authority) in October 1999, indicated that 400-500 vessels were in use on the Port Hacking catchment with the estimated proportion and volume of vessel traffic in key areas was (Waterways Authority, 2003):

- Jibbon Beach – 20 per cent, 100 vessels
- Simpson Beach/East Deeban Spit – 10 per cent, 50 vessels
- South West Arm – 10 per cent, 50 vessels
- Gymea Bay – 5 per cent, 25 vessels
- The Hacking River (from Point Danger to Audley) – 15 per cent, 75 vessels.

(Note: These figures may not be representative of the whole boating season).

The heavily populated northern bays, particularly Gunnamatta, Burraneer and Yowie Bays, contain the majority of private moorings in the Port Hacking catchment (Table 5.3). There are limited boat-launching facilities available on the southern side of the Port Hacking catchment (HLAEnviroScience, 2001):

- **Bundeena:** Boats are usually launched across the beaches of the Bundeena and Bonnie Vale foreshores. The beach and ferry wharf is used as a landing and pick-up point for passengers and goods, however it does not enable any launching for small boats.
- **Maianbar:** There is no official launching site at Maianbar. Some smaller boats are launched with difficulty due to the presence of the steep, rocky foreshore and extensive shallows separate the settlement from deep water. In this area there is a lack of car and trailer parking.
- **Hacking River:** In the past small boats were launched from Audley at a landing wharf, but this is not longer in use.
- **Bonnie Vale:** There is currently a ramp over the sand, but this is only suitable for four-wheel drive access.

Table 5.3 – Moorings status in Port Hacking Catchment at July 1 2007

As At 01/07/07	Private Moorings	Commercial Moorings	TOTAL	PML Waiting List
Bundeena	12	5	17	1
Burraneer Bay	184	54	238	5
Dolans Bay	69	25	94	23
Fishermans Bay	28	1	29	0
Grays Point	41	3	44	5
Gunnamatta Bay	276	73	349	52
GyMEA Bay	85	1	86	32
Lilli Pilli	32	0	32	8
Little Turriel Bay	25	0	25	2
North West Arm	46	2	48	22
Gannons Bay	26	2	28	5
Great Turriel Bay	38	0	38	15
Yowie Bay	220	36	256	32
TOTAL	1082	202	1284	202

Source: NSW Maritime (2007)

Every opportunity should be provided for boat owners to moor their vessels. However, in order to manage the pressures on the Port as well as the increasing demand for in-water boat storage, the plan supports the continuation of:

- Existing geographic mooring limits with any increases in the moorings to be achieved by more space-efficient mooring techniques
- The audit of non-use of vessels to eliminate mooring 'hoarding'
- The exclusion of trailerable vessels (less than 5.2 metres in length) from mooring sites, while allowing for special exceptions such as 'clinker boats'
- The restriction on the full-time in-water storage of vessels at pontoons, jetties and poles, which can overshadow seagrasses
- The maintenance of public wharves as discreet facilities, that is independent of other developments.

Boating

Boating is enjoyed throughout the Port Hacking catchment area by locals and visitors. Less than a third of foreshore residents own or use a large vessel on the waterway. Large vessels used by residents include cabin cruisers, motorboats and sailboats, of which cabin cruisers are the most popular. Cabin cruisers are mainly used in Dolans, Burraneer and GyMEA Bays, while large sailboats and motorboats with accommodation are used mainly by people in Lilli Pilli, Mansion, Dolans and Yowie Bays.

People also charter party pontoons, fully equipped with barbecues and toilets, to enjoy cruising and relaxing on the Port (Waterways Authority, 2003). Powerboats are used heavily in the Port Hacking catchment, however PHPS (2004) noted that many of the power boating users tended to enjoy their recreation well away from other users. Audley in the RNP is popular for row boat, canoes, kayak, and aqua-bike hire.

From a census conducted by the Waterways Authority, approximately 35 per cent of households in Maianbar and 13 per cent of households in Bundeena have registered vessels. This equates to 88 vessels and 116 vessels, respectively (HLAEnvirosciences, 2001).

National Parks and Wildlife Service (NPWS) officers have observed that there has been an increase in the use of the national park's foreshore for boat-based recreation, and this is causing management problems with the destruction of vegetation, starting of fires, human waste and litter (HLAEnvirosciences, 2001).

Small beaches in the area, once used by bushwalkers, are now being used as a daytime base for water skiing parties, effectively excluding other uses (HLAEnvirosciences, 2001). The proportion of personal watercraft (PWC) has grown over the past five years to 6.4 per cent of the total registered vessels in January 2003. The proportion of yachts in the Shire fell from 5 per cent in 1998 to 4.3 per cent in 2003, which is comparable to the statewide decline (6.2 per cent to 5.5 per cent) (Waterways Authority, 2003).

In April 2007, a pilot boating waterway survey was undertaken of the Georges River, Botany Bay and Port Hacking catchment (SSMA, 2007). Two thirds of respondents were surveyed on entry to the water and one third on exit. Surveys were conducted at five main sites – Como, Tom Ugly's, Sylvania, Grays Point and Yowie Bay. The main results are summarised below:

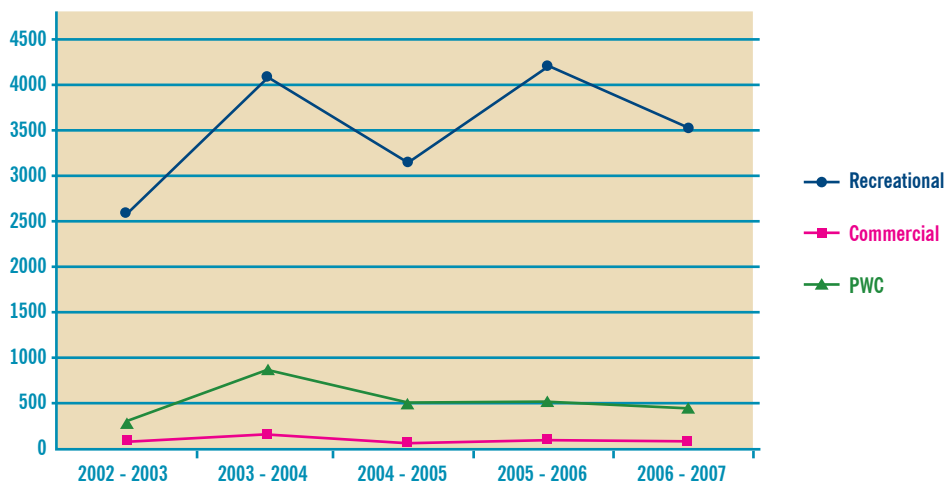
- The majority of respondents were male, with the largest individual group being males aged 36 to 55 (44 per cent). Less than 2 per cent of respondents were female.
- The frequency of waterway use was fairly evenly spread –
 - 21 per cent of respondents used the waterway more than once a week
 - 22 per cent used it once a week
 - 27 per cent used it once a fortnight
 - 23 per cent once a month
 - 8 per cent once or twice every 6 months.

- The number of visits to the waterway varied –
 - 47 per cent of respondents visited 0 -10 times in the last six months
 - 41 per cent reported between 11- 43 visits
 - 12 per cent reported more than 50 visits.
- Most respondents used the waterway for fishing (62 per cent), followed by for a boat trip/relaxation (21 per cent).
- Almost 61 per cent of respondents selected 'open runabout' as their boat type followed by a cabin cruiser (27 per cent), and a motor cruiser (5 per cent).
- The majority of boats were stored in a garage at home (50 per cent), with 28 per cent stored inside respondent's property in the open.
- 65 per cent of respondents indicated that they were not likely to use a stack facility and 11 per cent indicated that they absolutely would (SSMA, 2007).

In-water management is undertaken by NSW Maritime. As part of this process the department monitors vessels and vessel operations. The number of vessel inspections, for example an officer checking licence details, has been retrieved for combined Port Hacking, Botany Bay and Georges River between 2002 and 2007 (Figure 5.2). During this period there was an average of 3,521 recreational vessels, 81 commercial and 521 PWC inspections each year. An increase in the number of inspections for 2003–2004 coincides with an increase in incidents recorded for the same period (Figure 5.3).

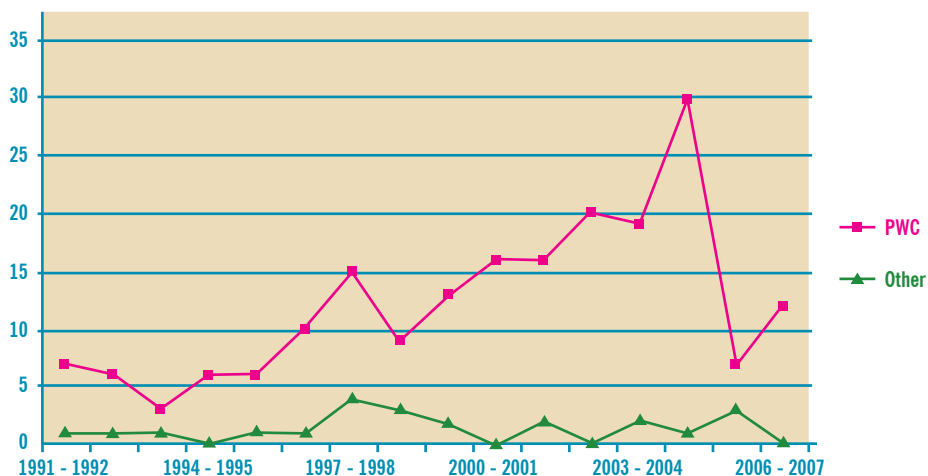
Between 1993 and 2002, there were 83 boating incidents reported on the Port Hacking catchment, most of which were due to human error, including lack of judgement and not maintaining proper lookout (Waterways Authority, 2003). In examination, an increase in the number of inspections for 2003-2004 coincides with an increase in incidents for the same time. It is thought these incidents may be related to the high incidence of storm damage to vessels.

Figure 5.2 – Vessel inspections in Port Hacking and Botany Bay



Source: NSW Maritime

Figure 5.3 – Incidents in Port Hacking (PWC and other vessels)



Source: NSW Maritime

Water-based events, tourism and recreation

Sutherland Shire has long been a popular tourist and recreational destination, primarily due to the beaches, the RNP, the historical significance of Captain Cook’s landing site, and other natural areas. Today, these attractions remain popular due to the close proximity to Sydney’s CBD and the international airport. There is a growing list of emerging attractions and experiences, such as the Bundeena Maianbar Art Trail, the Cronulla

and National Park ferry service, the alfresco dining in Cronulla and the romance of a small bed and breakfast accommodation in a relaxed settings.

The Sutherland Shire Tourism Strategy was adopted in 2005 and the range of tourism activities and commercial tourism operations available is diverse and reflects the array of experiences available, as shown in Table 5.4.

Table 5.4 – Range of tourism experiences in the Sutherland Shire

Botany Bay National Park	Swimming
Whale watching	Sydney Tramway Museum
Scuba diving/snorkelling	Sailing
Fishing, including charters	Walking – bush, esplanade, trails
Historic ‘meeting place’	Picnicking
Outdoor dining	Surf boutique shopping
River cruises	Boat hire
Canoeing/kayaking – hire and tours	Bundeena/Maianbar Art Trail
Indigenous heritage sites	Royal National Park
Symbio Wildlife Park	Mountain biking trails
Surfing/boarding, including surf schools	Historic Cronulla & National Park ferry service
Woronora Dam	ANSTO guided tours
Sporting facilities, for example golf courses	Como Pleasure Grounds
Conference facilities	Westfield Miranda
Hazelhurst Regional Gallery	Cronulla Plaza
EG Waterhouse Camellia Gardens	Joseph Banks Native Plant Reserve

Source: Sutherland Shire Tourism Strategy (2005)



The Port Hacking catchment is used for organised events, with the Waterways Authority issuing 21 aquatic licences for 376 aquatic events in the Port in 2002 (Waterways Authority, 2003). The events included sailing, dragon boat races, swimming and other aquatic festivals, for example:

- The Port Hacking Sailing Club using the Western Channel, South West Arm, Gymea, Yowie and Bate Bays.
- The Royal Motor Yacht Club conducting events in Gunnamatta and Bate Bays.
- Regular local fishing competitions, such as the offshore 'Port Hacking Catchment 100' that starts at Gunnamatta Bay.
- The Lilli Pilli Kayak Club conducting races regularly from March to September, primarily on the Hacking River west of Swallow Rock Reserve.

Detailed below are other activities carried out in various parts of the catchment (Waterways Authority, 2003):

- Jibbon Beach is popular for swimming and relaxation. During some summer weekends there are up to 25 cruisers visiting Jibbon Beach per day, generally with a half-day turn around period and an average of six persons per vessel. During peak periods, Jibbon Beach is estimated to attract up to 350 person visits per day.
- Deeban Spit and South West Arm are used by a number of vessels, usually cabin cruisers that stay in the area for a day or the weekend.
- The sheltered waters of South West Arm are used for rafting.
- Water skiing and related activities, including aquaplaning and wakeboarding, are popular in the wider reaches where speed restrictions do not apply, especially Burraneer, Gymea and Yowie Bays and parts of the South West Arm.
- Gunnamatta Bay and Cabbage Tree Point are used for surfing due to the configuration of Bate Bay and the Port, since suitable waves are generated under certain tide and swell conditions.

- Shiprock Aquatic Reserve is popular for snorkelling and scuba diving.
- The shallow waters of the Hacking River, Cabbage Tree Basin and South West Arm are used for kayaks, canoes, yachting and dinghy sailing.
- The RNP and other open spaces are used for picnicking, camping, swimming and bushwalking.
- Jibbon and Hordens Beaches, Bonnie Vale and Darook Park, and the southern end of Gunnamatta Bay are popular family swimming beaches.
- There are three swimming enclosures located at Gunnamatta Bay, Gymea and Lilli Pilli Point.
- Shallow draught, jet-propelled PWC were previously used throughout the Port, however in 1997 a PWC-free zone was established off Darook Park to ensure the safety of swimmers.
- Gunnamatta Bay provides a number of activities, including sunbaking, swimming, water skiing, kayaking, surf boat rowing, competitive sailing, picnics and other social events (Nelson, 2001).
- Yowie Bay is used mainly for walking, picnicking, swimming, boating, water skiing and recreational fishing. There are foreshore reserves located around the bay including Kareena Park and Camellia Gardens (Patterson Britton, 1996).
- Bonnie Vale is used for intensive recreation, including camping, picnicking, swimming, boating, walking and fishing. This is the main picnic site in Port Hacking catchment, as it has quiet, sheltered beaches and foreshore picnic areas (HLAEnviroSciences, 2001).
- Bonnie Vale is used to access the RNP for bushwalking and boat trips to other parts of the park (HLAEnvirosciences, 2001). Educational excursions and field trips are common in the Bonnie Vale area, which provides a valuable base to visit surrounding littoral, wetland and woodland environments and to demonstrate urban/bushland fringe effects (HLAEnvirosciences, 2001).

- Gymea Bay does not have any formal marinas or boat ramps. However, there are many waterfront properties with private wharfs or jetties. Most of the original foreshore has been replaced by retaining walls and landscaped gardens (WBM, 2002a), and Gymea Baths Reserve provides access to the baths (WBM, 2002a).
- Popular for swimming and passive recreation areas include Horderns Beach, Gunya Beach and Jibbon Beach. Gunya Beach has seen an increase in the number of boat moorings but no increase in the allowable numbers. Four-knot speed and swimming zones are now provided in these areas.

Tourism in Sutherland Shire has an exciting future, with the industry presenting many opportunities for growth and development.

Manage the catchment in a holistic way

The challenge of integrating agency and legislative activities is not small. Water catchments cross jurisdictional boundaries, as a catchment is an area of land, bound by hills or mountains from which all run-off water flows to the same low point. The low point could be a lake, dam, a river or the mouth of a river where it enters the ocean.

Rainwater will make its way to this lowest point, via creeks, rivers and stormwater systems. As well as rivers, creeks, lakes and dams, a catchment also includes groundwater, stormwater, wastewater and water-related infrastructure. Catchments are connected from top to bottom, so what happens upstream in a catchment has a large influence on what happens further down the catchment. This is why it is important to manage a catchment as a whole, rather than in parts (Sydney Catchment Authority). Management of the catchment in a holistic way requires the cooperation of land and water agencies utilising legislation, policy, education and incentives.

Land and water management agencies

SSC and Wollongong City Council (WCC), as well as state agencies including the DECC, the

NSW Department of Planning (DOP) and NSW Maritime, have a key role in the implementation of legislation within the catchment. The legislative environment is complex and changing as a number of pieces of legislation apply within the Port Hacking catchment. There are many plans that apply throughout the catchment and these are administered by various agencies. These plans include, for example, the National Parks Plan of Management, Boating Plan of Management and the Gymea, Yowie and Gunnamatta Bay Estuary Management Plans. The Natural Resources Commission (NRC) has developed standards and targets.

Legislation and Policy

Legislation for the Port Hacking catchment is developed by the state and federal government with a number of areas delegated to local government to administer. In May 2006 a Port Hacking Catchment Legislative Review (see Appendix 7) was undertaken by WBM and subsequently updated during the preparation of the updated PHIEMP 2007. Changes have been included where practicable, but it must be noted that the legislative environment constantly alters and thus requires regular monitoring to examine and document the impacts of these changes on the Port Hacking catchment. Current information can be found at the NSW Legislation website http://www.austlii.edu.au/au/legis/nsw/consol_act/

The plan and its supporting documentation go some way to drawing together the views of diverse stakeholder interests to ensure that the Port Hacking catchment is improved for the future.

Commercial and recreational fishing

The Port Hacking catchment was possibly the first estuary to receive some status as a marine reserve (West et al., 2000). Due to the declaration of the RNP, the waterway was closed to commercial fishing in the late 19th century and represents what is essentially the first marine or estuarine area reserved in Australia (West et al., 2000).

Commercial fishing is permitted in the area located east of a line between Hungry Point and Cabbage Tree Point (Waterways, 2003). For a history of commercial fishing in the Port, see Nelson, 1997.

Fishing activity in the wider Port Hacking catchment is now mainly limited to recreational angling with the area deemed an important recreational fishing location (Patterson Britton, 2002). Recreational fishing locations include Gunnamatta, Burraneer, Dolans and Gynea Bays, South West Arm, off Lilli Pilli Point and at the 'Ballast Heap' (Nelson Consulting, 2004). In 1987, a recreational survey by the Fisheries Research Institute indicated that the mouth of the Port Hacking catchment was the most popular fishing location and accounts for the greatest fish catch (Nelson Consulting, 2004). A recent survey indicated that Gynea Bay had the highest catch per unit effort in the estuary; however, fishing is mainly from the foreshore (WBM, 2002a).

The target species by recreational fishers are snapper (*Pagrus auratus*), tailor (*Pomotomus saltatrix*), yellowtail (*Trachurus novaezelandie*), bream (*Acanthopagrus australis*), luderick (*Girella tricuspidata*), whiting (*Sillago ciliata*) and leatherjacket (WBM, 2002a). The main method of fishing is hook and line using rod and reel or handlines. Spear fishing is not allowed west of a line between Jibbon Head and Glaisher Point, including Gynea Bay (WBM, 2002a).

5.2.3 Economic issues

Boating safety (navigation channel)

According to early correspondence, in 1796 the entrance to the Port Hacking catchment was about one mile wide, which then contracted to half its width becoming shallower upstream (Nelson, 1997). Dredging was carried out to improve navigation in the catchment as early as 1830 and has continued to this day (Nelson, 1997; Patterson Britton, 2002). Between 1979 and 1999, a total of 30,000 m³ of sand was removed from the catchment.

The majority of the dredging has been carried out within the entrance of Gunnamatta Bay and in the channel adjacent to Burraneer Point. A large amount of dredging also has occurred between Gogerlys Point and Lilli Pilli Point (Patterson Britton 2001). SSC reports that there is limited information describing the disposal of material dredged from the catchment (McCarthy, 2000). Sediment is likely to have been disposed of in a number of locations, in Port Hacking and elsewhere.

In late 2007 dredging was conducted on the channel across the mouth of Gunnamatta Bay, the Port entrance off Burraneer Point and other nominated areas heading west towards Lilli Pilli. The dispersal/distribution of *Caulerpa taxifolia* should not be increased by this dredging activity as vacuum suction methods are used, and no disposal of the dredged material occurs in the estuary. South West Arm has high quality seagrasses, such as *Posidonia australis*, and as such the NSW Department of Primary Industries (DPI, formerly NSW Fisheries) will not provide a licence to dredge in this area. However, dredging occurs close to South West Arm.

In order to manage maintenance dredging in the Port Hacking catchment, the navigation channel has been subdivided into eight areas by Patterson Britton (2001), as follows:

- Area 1: Gunnamatta Bay Channel
- Area 2: Channel across mouth of Gunnamatta Bay
- Area 3: Burraneer Point Channel
- Area 4: Channel across mouth of Burraneer Bay
- Area 5: Little Turriell Point Channel
- Area 6: Little Turriell Bay Channel
- Area 7: Lilli Pilli Channel
- Area 8: Bundeena Channel.

Future pressures

There are long-term issues requiring action, including sustainable use of the Port, climate change impacts (including rising sea levels), greater use demands and more intensive housing and

transportation development. The final decision for the use of the F6 corridor will have an impact in the catchment. These are some of the planning challenges facing the Port Hacking catchment and require attention now to prepare for the future.

Sustainability is about making sure that ecological, social and economic rights for future generations are put in place now without compromising those interests of the current generation. Water, land and social initiatives that form part of the PHIEMP will contribute to the sustainability of the Port Hacking catchment.

Climate change and rising sea levels

Australia, like most countries across the planet, is experiencing rapid climate change. Since the mid 20th century, Australia's minimum temperatures have risen on average 0.19°C per decade, with an increase in the frequency of heatwaves and a decrease in the numbers of frosts and cold days. Rainfall patterns also have changed with the northwest having an increase in rainfall over the past 50 years, while much of eastern and far southwest of Australia experiencing a decline. There is a significant body of evidence to suggest the increase of greenhouse, or heat-absorbing, gases in the atmosphere has resulted in a warming of the global climate during the previous century. Predictive work indicates that this warming will accelerate in the future due to continued anthropogenic greenhouse gas emissions.

In the 20th century the global average sea level has risen by 10-20 centimetres, primarily due to global warming. This sea-level rise will continue, and possibly accelerate, over the next century and beyond, through a combination of mechanisms, including:

- Thermal expansion of the oceans
- Melting of glaciers and ice caps
- Melting of the Greenland and Antarctic ice sheets
- Changes in terrestrial storage (Jones, date unknown).

Through studying past climate variability and projected changes in average climate, CSIRO (2004) indicates that mean relative sea-level rise in Sydney has been 1.2 millimetres per year over the last 82 years. Overall, Sydney will be warmer and drier. There is likely to be an increase in heat-related deaths from 176 to around 900 per year. Heat increases will see an increase of up to 30 per cent increased domestic energy usage due to air conditioning and the need to reduce water usage by 54 per cent by 2030 to maintain sustainable yields. For the Shire it is likely to mean an increase in coastal erosion and severe bushfire days. Escalating storm intensity will see a one in a 100-year event become a one in 40-year event by 2050 with a noticeable rise in flooding. The predicted sea-level rise of 0.22 to 0.6 by 2100 will see the inundation of coastal land, a loss of wetland systems and increased flooding (SSC Staff briefing, 2007).

On the NSW coast, where a narrow continental shelf limits the size of storm surges, large wind-driven waves can have significant impacts. A recent study has quantified the impacts of sea-level rise and storm surges in the Cairns region of North Queensland. Here, storm surges are a serious issue even in today's climate. Models were developed to estimate the average time between storm surges under present sea-level and tropical cyclone conditions and possible mid-century conditions.

The results show that the 100-year storm surge event in current climate conditions for a cyclone of extreme intensity would become a 60-year event under enhanced climate conditions. When the mid-range estimates for sea-level rise are included (20 centimetres by the year 2050) this further reduces the return period to a 40-year event (CSIRO, 2004). As data is available, residential areas should be identified as prone to inundation and planning controls in these areas should protect people and assets from future risk. All tiers of government will need to examine the policies to be pursued in the Port Hacking catchment and resolve a number of questions including: What public resources are at risk and what measures are necessary to protect or preserve these resources? Will this be at public or private expense?



F6 corridor development

The F6 corridor is a potentially substantial development within the catchment because of its location and scale, whether the land is used as a transport corridor, 'greenspace' or a combination of the two, it will have considerable impact on the catchment.

5.2.4 Ecological issues

Water quality

There is a perception that urbanisation and population growth in the catchment continues to have a major impact on stormwater run-off and the corresponding bacterial contamination and pollution load. In order to either confirm or challenge this perception, water quality monitoring in the catchment is undertaken by SSC and DECC.

Recreational water quality monitoring in Port Hacking was undertaken by SSC during the period of December 2005 to March 2006. Samples were collected at popular swimming spots at Darook Park and Swallow Rock (Table 5.5). The monitoring was done to measure concentrations of enterococci and faecal coliforms found in two popular recreational bays to determine the suitability of the two sites for recreational activities. Samples were collected weekly with the results indicating that compliance occurred over 80 per cent of the time for faecal coliforms and over 40 per cent of the time for enterococci for both locations. These two sites are now a target for water quality improvement and further monitoring.

Table 5.5 – Recreational monitoring program results for 2005/6
Darook Park and Swallow Rock - % compliance

2005/06	Darook Park		Swallow Rock	
	Faecal coliforms	Enterococci	Faecal coliforms	Enterococci
Comply	83%	43%	82%	46%
Fair	17%	57%	18%	54%

Source: SSC State of the Environment Report 2005/6

Since 1994 water quality monitoring of stormwater has been conducted through the Strategic Water Monitoring Program (SWaMP), sampling for metals, nutrients, sediments, oil and grease, oxygen demand and bacterial indicators. The program was suspended for a period of time but was recommenced for 2006/07 focusing on key areas, vulnerable areas and 'hot spots'. The data will continue to be used to identify areas where stormwater treatment devices should be installed.

One area of intense sampling has been the head of Gunnamatta Bay. The head of Gunnamatta Bay Water Quality Monitoring Program was initiated

as a result of recommendations made in the Gunnamatta Bay Estuary Management Plan. This program was specifically aimed at determining the source of stormwater pollution in the bay. Sampling was undertaken once a month during 2005/06 following a rainfall event at seven sites around the perimeter of Gunnamatta Bay.

The results from samples analysed from each location indicate that all analytes, with the exception of ammonia and enterococci, were consistently below the Recreational Guidelines (ANZECC 2000) following each rain period sampled. This has identified Gunnamatta Bay's



main source of pollution as organic in nature and may be related to incorrectly connected sewerage, overflows of sewerage or animal faeces entering the stormwater system. Locations exhibiting poor stormwater quality were identified and plans are being made to reduce the impact of stormwater run-off to recreational areas, with further investigation and follow-up actions required (SSC, 2005/06). This information will need to be updated as additional data becomes available.

SSC has made a commitment to improve water quality and it is important that council continues to invest in stormwater quality enhancement measures to protect the environment and quality of life in the Sutherland Shire. Some steps have already been taken to improve the Shire's waterways, for example in 2006/07 SSC took the opportunity presented by the NSW State Government to introduce a stormwater levy. The levy allowed council to commence its largest ever stormwater management program. This major drainage construction and water quality program totals \$2.515 million, of which \$1.81 million will be funded from the levy. Projects within the Port Hacking catchment include the installation of Gross Pollutant Traps (GPT) and upgrade of stormwater drains at several sites, as well as the rehabilitation of Kareena Creek in Caringbah.

There is a data gap in the upper catchment as WCC does not undertake water quality monitoring in the Helensburgh area and the 1996 pollution point source inventory information requires updating. However, the streams in the upper reaches of the Hacking River are thought to be of good water quality, although testing will be required to confirm this understanding. The emphasis then is to protect good water quality in the face of large housing development pressures, piggery developments and other agricultural activities, and inappropriate recreation use, particularly scouring of streams and the entry of sediment into the system.

Downstream sewage has been partly dealt with through works at Bundeena and Maianbar, but sewage pump-out facilities also will be required for boating activities. Sydney Water is conducting a \$45 million program to construct a sewerage system to service Coalcliff, Stanwell Park, Stanwell

Tops and Otford. By the end of June 2006 75 per cent of properties across these four villages had been connected to the new sewerage scheme. Collected sewage is transferred to Helensburgh and then to Cronulla STP for tertiary treatment.

Within the Wollongong LGA, approximately 1,200 properties utilise on-site sewage management systems (OSSMS) to treat and dispose of wastewater. Wastewater may be 'blackwater' (toilet waste), or 'greywater' (water from showers, sinks and washing machines), or a combination of both. The four most common types of OSSMS are absorption trenches, pump-out systems, aerated wastewater treatment systems and composting toilets. OSSMS are required in areas where a reticulated or centralised sewage service is not available, and in the Port Hacking catchment, include Stanwell Tops, Otford, and parts of Helensburgh. The geology and morphology of these suburbs is not ideally suitable for on-site effluent disposal, which when combined with poor maintenance practices and increased densities of OSSMS through the subdivision of land, has resulted in these systems negatively impacting on the natural environment (WCC SOE 2006/07).

Premises in Sutherland LGA that are licensed by DECC to discharge wastewater in waterways include DECC¹ and in Helensburgh include the Helensburgh Waste Disposal Depot and Metropolitan Collieries Pty (WCC SOE 2006/07).

Sedimentation, tidal delta sediments, heads of bays and acid sulphate soils

The natural processes of erosion and sedimentation are largely responsible for the character of the Port Hacking catchment landscape, including the formation of the Shire's beaches and other scenic features. However, urbanisation of the catchment has resulted in sediment and pollutant loads many times higher than during pre-European times being delivered to the Port and resulting in impacts on water quality, sedimentation levels and sediment quality.

After heavy rain, the Hacking River turns a milky-brown colour as sediment from the upper catchment moves down through the system. The importance of reducing this ongoing and serious issue must be emphasised. Human activity in the catchment area has exacerbated the rate of erosion and accelerated sedimentation in some places. The impact of sedimentation from the development process is especially evident in the northern bays.

Sediment has been deposited into these bays since the earliest market gardens were established in the Shire and has continued as development has intensified. Prior to European settlement, sedimentation would have occurred through processes such as bushfires followed by rainfall. Sediment problems within the developed areas of the catchment are largely historic. Waterfront owners often request dredging to return the depth of the estuary to a previous level indicated by remnant infrastructure such as boat rails and boatsheds. Increased sedimentation in the upper Hacking River and its tributaries is also a concern and can degrade aquatic habitats by smothering vegetation and creating conditions unsuitable for aquatic fauna. Sources of increased sediment are fire trails, walking tracks and urban development.

Tidal delta sediments

The large deposit of sediments present in the outer third of Port Hacking is the tidal delta formed by the redistribution of the marine sands during the last sea-level rise and has been documented since the Port was first explored in the late 1700s (Nelson, 1997). At present there is no significant input of sand into Port Hacking from the ocean (Patterson Britton, 2001).

The large shoal located off the Deeban Spit consists mainly of sand from dredging works (approximately 200,000 m³) associated with the creation of the fish hatchery in Cabbage Tree Basin in 1901 and 1902 (Patterson Britton, 2001). Additional sand has been deposited during the early dredging for navigation and, at present, these sediments are re-mobilised by waves and tidal flows.

Sediment sampling carried out by Albani (1999) indicated that sediments forming the tidal delta could be classified into four major clusters – Marine Province, Estuarine Province (low energy), Estuarine Province (medium energy) and Estuarine Province (high energy).

These sediments are very similar with a narrow range of grain sizes, indicating that the natural processes that have formed the tidal delta are constant and relatively uniform. The shallow samples from immediately seaward of the middle ground shoal had a smaller median grain size than the sands at the dropover locations (The Ecology Lab, 2002b) suggesting a lower energy condition at that location.

Sediment is mobilised from the seaward side of the middle ground shoal by waves and currents and transported landward onto the marine delta where it is redistributed on the channels of the main delta up to the dropovers at Lilli Pilli, Burraneer Bay and Gunnamatta Bay (Patterson Britton, 2001).

This process is evident from aerial photography, which reflects the changing nature of the middle ground shoal and the delta dropovers in the bays. Over the last 100 years, the middle ground shoal has eroded at an average rate of 4,500 m³/year (Public Works, 1986; Patterson Britton, 2002). Locations where the sediments are deposited within Port Hacking and the rate of sedimentation are detailed below. Sediments tend to remain in these locations unless mobilised by storm waves (Patterson Britton, 2002):

- **Gunnamatta Bay:** The sand dunes along the eastern shore are accreting at a rate of 100 m³/year.
- **Gunnamatta Bay:** The north-western corner of the Gunnamatta Bay dropover is prograding at a rate of 200 m³/year.
- **Gunnamatta Bay:** The dropover adjacent to the Gunnamatta Bay Channel is prograding at a slow rate.
- **Burraneer Bay:** The dropover at Burraneer Bay is prograding at a rate of 2.3 m/year or 500 m³/year.

- **Burraneer Bay:** The shoal at Burraneer Bay is increasing in volume at a rate of 300 m³/year and the southern portion of the shoal is prograding at a maximum rate of 1.5 m/year or 700 m³/year. The area of deep water to the north of this portion of the shoal appears to have been present over the last 20 years.
- **'Speed Hump':** Located west of Lilli Pilli Point, this site is increasing at a rate of 100m³/year due to the longshore transport of sediment.
- **South West Arm:** Sediment has accumulated on a shoal located between West Costen Point and Gogerlys Point at a rate of 200 m³/year.
- **Lilli Pilli:** The dropover is prograding at a rate of 2,500 m³/year.
- **Lilli Pilli:** The shoal has increased by approximately 250 per cent since 1965 with the shoal increasing in volume by 600 m³/year, however there has not been a significant increase in the height of the shoal. Near Burraneer Point, sediment movement is evident where tidal velocities are highest and there is a high sand flux of approximately 50,000 m³/year (Patterson Britton, 2002). In this area the water depths in the channels can change rapidly within a relatively short space of time, especially during storms. Further upstream, the sediment transport rate reduces to the Lilli Pilli dropover where there is a total net rate of sand deposition of about 2,500 m³/year (Patterson Britton, 2002).
- **Grays Point:** The main fluvial delta shows movement from Audley weir.

There are data gaps in areas such as Yowie Bay, North West Arm, Gymea Bay, Mansion Bay, Grays Point, Cabbage Tree Basin and Deeban Spit that will require attention in the future to assist with planning.

Geochemical analysis was carried out as part of a study investigating the sediment redistribution processes in Port Hacking (Albani, 1999). This involved analysing the sediment from 13 sediment samples taken from across the marine delta for a number of elements, including lead, arsenic, tin, copper, nickel, iron and chromium.

The results showed that for tin (Sn), cadmium (Cd), molybdenum (Mo) and uranium (U) the concentration for all 13 sediment samples were below the detection limit. Overall the results showed no obvious patterns in regard to sources of pollutions within the tidal delta. Similar studies have been conducted in Gunnamatta Bay (Mares, 2003) and in Fisherman's Bay.

Heads of bays sediments (Fluvial Deltas)

Urbanisation of the catchment has resulted in sediment and pollutant loads many times higher than during pre-European times being delivered to the Port. This has impacted on the water quality, sedimentation and sediment quality. Sediment sampling indicated that the large fluvial deltas in the northern bays contained polluted sediments, which may generate offensive odours and pose a public health risk, although levels of pollutants are considered to be relatively low (WBM, 2002a).

The sediments in the northern bay were contaminated with some heavy metals and Poly Aromatic Hydrocarbons (Nelson Consulting, 2004). Sediment sampling results for Yowie Bay indicated that the maximum measured contaminant values were still within the typical background range, according to 1992 ANZECC guidelines. However, the levels of lead and total phenolics were high, which is related to urban development (Patterson Britton, 1996).

Sediment sampling from Gymea Bay (WBM, 2002a) showed elevated levels of arsenic, lead, nitrogen, total organic carbon and silver, but none of the levels appeared to be elevated above background parameters, when compared to ANZECC (2000) guidelines. Geochemical analysis of sediment samples indicates that there is significant contamination of the sediments at the head of Gunnamatta Bay. Gunnamatta Bay sediment samples collected adjacent to the Cronulla Marina and Tonkin Park were found to contain the highest level of contaminants (Mares 2003; WBM, 2002b).

Acid sulphate soils

Acid sulphate soils (ASS) is the common name given to soils and sediments containing iron sulfides, the most common being pyrite. When exposed to air due to drainage or disturbance, the oxidation of these soils produces sulfuric acid, often releasing toxic quantities of iron, aluminium and heavy metals. This may have disastrous impacts, such as fish kills and damage to infrastructure.

Although some ASS were formed millions of years ago and occur in ancient marine rocks, those of most concern were formed after the last major sea-level rise, within the past 10,000 years (the Holocene epoch). These commonly occur on coastal wetlands as layers of Holocene marine muds and sands deposited in protected low-energy environments, such as barrier estuaries and coastal lakes. In similar environments, ASS are still being formed.

Maps of ASS risk within the Port Hacking catchment are produced by the DECC. The maps indicated that the majority of Port Hacking is classified as having high risk sediments. Other areas adjoining the waterway vary as to the risk of ASS. The SSLEP 2006 includes clauses on ASS environmental risk. The objectives of these clauses are to minimise impacts on water systems from the disturbance of ASS thereby protecting water quality in the Port Hacking catchment.

Management of shoaling

The naturally shoaled nature of the Port has resulted in human interventions from the late 19th and most of the 20th century. The creation and subsequent destruction of the fish hatchery in the middle ground shoal and subsequent dredging depositions is an important part of the history of the shoals. Dredging of the navigation channel for navigation purposes is supported as is the use of extractable sand from the estuary as a resource, within the above context. Sand from navigation dredging is a resource and can serve to assist principally for maintaining ocean beaches as a public resource.

The system is dynamic and primarily natural. As a naturally shoaled estuary, the Port requires constant

dredging to maintain the navigation channel otherwise the infill of natural channels produces unsafe boating conditions. The environmental and economic cost of dredging for social and recreation gains need to be balanced against the ecological impacts. The influence of the seabed on wave behaviour can become significant in water depths of 60 metres or less. As wave speed is reduced a shortening in wave length results in an increase in wave height. Boat users need to be aware of sand bars and shoaling within the Port.

Deeban Spit is the area of shoals that run from the sandy front westwards beyond Fishermans Bay to Costens. There are some shoals that historically have been viewed as a nuisance and available for extraction. The Deeban Spit was one, as was the shoal between Lilli Pilli Point and the church camps on the southern shore. Increased boat-based recreation pressures at Jibbon Beach has transferred the pressure to other shoals, in particular the Deeban Spit and the Lilli Pilli shoals. These shoals now have important social value and should be protected within the context of maintaining the intrinsic character of the Port.

Flora and fauna protection

Much of the catchment's flora and fauna is threatened by the issues that have already been discussed in this chapter. Saltmarsh is at risk from encroaching mangroves and deer activity, and mangroves are suffering from sedimentation in some of the heads of the bays. Seagrass beds suffer as a result of poor water quality and increased sedimentation, as well as direct disturbance through boating activities, such as anchoring. Marine fauna needs the protection of seagrass beds and the outbreaks of the invasive marine algae *Caulerpa taxifolia* will require continued monitoring and management.

Terrestrial flora and fauna also is threatened from human impacts. Clearing of habitat for housing and development, increased recreation pursuits and the ongoing degradation of fragmented remnant bushland and isolated trees is a continuing problem.



Terrestrial and intertidal vegetation

Vegetation within the catchment is a result of the interaction of many environmental factors including the underlying geology, soil, rainfall, temperature, aspect and fire regime. The geology of the catchment area is dominated by Hawkesbury Sandstone, more than 200 metres thick in parts, with a thin weathered layer of Wianamatta Shale above and older layers of Narrabeen Shale below. The catchment's soils are primarily derived from sandstone and are characteristically shallow in depth, low in nutrients and have poor water holding capacity.

Despite the impoverished nature of the soils there is support of a broad range of vegetation types. It is estimated that around 1,000 indigenous plant species contribute to the catchment's biodiversity providing habitat for native fauna and an irreplaceable natural resource to the community.

Vegetation in the southern parts of the catchment is largely protected by the RNP where natural processes such as fire and regeneration are able to continue. In the developed sections of the catchment, vegetation has been altered and continues to become degraded through clearing, fragmentation, invasion by weeds, altered hydrology and changed fire conditions. Nine vegetation

communities in the catchment, and many more individual plant species, are considered in danger of extinction if the existing threats are not mitigated.

Vegetation types and classification are dynamic and over time can change depending environmental conditions. The vegetation communities represented within the catchment are:

- Sydney Sandstone Gully Forest
- Sydney Sandstone Ridgetop Woodland
- Sydney Sandstone Plateau Heath
- Coastal Dune Heath
- Kurnell Dune Forest
- Riparian Scrub
- Subtropical and Warm Temperate Rainforests
- Littoral Rainforest
- Sydney Turpentine Ironbark Forest
- Shale Sandstone Transition Forest
- Sydney Freshwater Wetlands
- River Flat Eucalypt Forest
- Swamp Oak Floodplain Forest
- Swamp Sclerophyll Forest
- Coastal Saltmarsh
- Estuarine Mangrove Forest.

Sydney Sandstone Gully Forest

This is the most common vegetation community in the area occupying the broad sandstone gullies and slopes throughout urban areas and the national park. Suburbs such as Yowie Bay, Gymea, Miranda and Grays Point contain remnant gully forest bushland.

The community is dominated by a 15-30 metre canopy consisting of characteristic trees, including smooth-barked apple (*Angophora costata*), Sydney peppermint (*Eucalyptus piperita*), grey gum (*Eucalyptus punctata*), bloodwood (*Eucalyptus gummifera*) and scribbly gum (*Eucalyptus haemastoma*).

The mid-storey is diverse and is comprised of well-known shrub species such as old man Banksia (*Banksia serrata*), blueberry ash (*Elaeocarpus reticulatus*), needlebush (*Hakea sericea*), waratah (*Telopea speciosissima*) and the geebung (*Persoonia pinifolia*, *Persoonia levis* and *Persoonia linearis*).

Vines and climbers, including sarsaparilla (*Smilax glycyphylla*), traveller's joy (*Clematis aristata*) and wombat berry (*Eustrephus latifolius*) are common. Ferns, grasses and orchids also are well represented in Sydney Sandstone Gully Forest.

Sydney Sandstone Ridgetop Woodland

On sandstone ridgetops where environmental conditions are harsher than the lower slopes, the trees are shorter and spaced further apart creating the Sydney Ridgetop Woodland community. While the community has largely been removed in urban areas through development, it is extensive along ridgetops in the RNP.

Species composition is similar to the Sandstone Gully Forest with scribbly gum (*Eucalyptus haemastoma*) and bloodwood (*Eucalyptus gummifera*) the most common trees forming a canopy up to 10 metres high. Understorey plants include sclerophyllous shrubs particularly those in the families of Proteaceae and Fabaceae.

Bush peas (*Dillwynia retorta*, *Phyllota phyllicoides*, *Bossiaea heterophylla*, and *Pultenaea stipularis*) are common, as are many species of wattle including sunshine wattle (*Acacia terminalis*), sweet-scented wattle (*Acacia suaveolens*) and prickly Moses (*Acacia ulicifolia*). Heath plants, particularly in the family Epacridaceae, are well represented in this community with species such as native fuschia (*Epacris longiflora*), coral heath (*Epacris pulchella*) and bearded heath (*Leucopogon ericoides*) common.

The heart-leaved stringybark (*Eucalyptus camfieldii*) is a rare, small eucalypt found in a few scattered locations in the RNP on ridgetop woodland. The tree is listed as vulnerable on both the NSW Threatened Species Conservation (TSC) Act 1995 and the federal Environment Protection and Biodiversity Conservation (EPBC) Act 1999.

Sydney Sandstone Plateau Heath

In areas where sandstone bedrock is close to the surface and overlying soils are very shallow and poorly drained the trees are unable to establish and give way to a low dense Sandstone Plateau Heath. Areas of heath within the catchment are mostly in the RNP in places like The Meadows, Bass Heights and Uloola Heights. These communities contain an extremely high diversity of plants often with several hundred species within a few square metres. A high frequency fire regime ensures plants are well adapted to fire. Shrubs mostly have leaves that are prickly or reduced to spikes and produce fruits in woody capsules, or are able to sprout from underground stems and roots.

Shrubs in the Proteaceae, Casuarinaceae and Epacridaceae families dominate while sedges and rushes assist to give the community its unique character. Heath Banksia (*Banksia ericifolia*), sheoak (*Allocasuarina dystylla*) and dagger hakea (*Hakea teretifolia*) are all distinctive species of this community. A familiar sight in plateau heath is after fire when grass trees (*Xanthorrhoea resinosa*) flower in a synchronised display.

Coastal Dune Heath

Within the Port Hacking catchment area Coastal Dune Heath is restricted to deposits of deep sand near Bundeena where exposure to salt-laden winds effectively keep the vegetation low. Where vegetation is more protected or occurs behind dunes the community often grades into Kurnell Dune Forest.

Coastal tea tree (*Leptospermum laevigatum*), tree broom heath (*Monotoca elliptica*), old man Banksia (*Banksia serrata*) and coastal rosemary (*Westringia fruticosa*) are the dominant shrubs, while bush pea (*Aotus ericoides*), parrot pea (*Dillwynia floribunda*) and flannel flower (*Actinotus helianthi*) are also common. Plants in the Rutaceae family include the native rose (*Boronia serrulata*) and Sydney boronia (*Boronia ledifolia*).

Kurnell Dune Forest

As the name suggests this community occurs predominantly on sand dunes around Kurnell, however small areas of dune forest also occur in Bundeena and Maianbar.

The community is characterised by a low, open forest with a distinctive understorey containing mesophilic plants and climbers. Canopy tree species include smooth-barked apple (*Angophora costata*), swamp mahogany (*Eucalyptus robusta*), bangalay (*Eucalyptus botryoides*) and tuckeroo (*Cupaniopsis anacardioides*). Shrubs include old man Banksia (*Banksia serrata*), hairy clerodendron (*Clerodendron tomentosum*), cheese tree (*Glochidion ferdinandi*) and coastal tea tree (*Leptospermum laevigatum*). Common vines include guinea flower (*Hibbertia scandens*), pearl vine (*Sarcopetalum harveyanaum*) and snake vine (*Stephania japonica*). Ground strata include rice flower (*Pimelia linifolia*) and spiny mat rush (*Lomandra longifolia*).

Due to previous clearing for development and the disjunct small areas remaining, Kurnell Dune Forest is listed as endangered on the TSC Act 1995.

Riparian Scrub

Along many banks of creeks that drain into the Hacking River a dense, narrow band of vegetation grows where high levels of moisture and accumulated sediment and organic matter are available. The dense understorey usually occurs beneath the canopy of the surrounding open forest of Sydney peppermint (*Eucalyptus piperita*), smooth-barked apple (*Angophora costata*) and blackbutt (*Eucalyptus pilularis*).

Shrubs are thick with lemon scented tea tree (*Leptospermum polygalifolium*), woolly tea tree (*Leptospermum grandifolium*), Christmas bush (*Ceratopetalum gummiferum*), sally wattle (*Acacia floribunda*), black wattle (*Callicoma serratifolia*) and swamp wattle (*Acacia elongata*). In deeper shaded gullies water gum (*Tristaniopsis laurina*), coachwood (*Ceratopetalum apetalum*) and river lomatia (*Lomatia myricoides*) occur.

Subtropical and Warm Temperate Rainforests

Where the upper Hacking River cuts deeply through the Hawkesbury Sandstone and into the underlying Narrabeen Shale strata, soils are richer in nutrients and the deep, protected shady gullies create conditions suitable to support relics of Subtropical and Warm Temperate Rainforests.

Here Sydney blue gums (*Eucalyptus saligna*), blackbutt (*Eucalyptus pilularis*), turpentine (*Syncarpia glomulifera*) and the rarer red cedar (*Toona australis*), crabapple (*Schizomeria ovata*), coachwood (*Ceratopetalum apetalum*), lillypilly (*Acmena smithii*), brown beech (*Cryptocarya glaucescens*) and figs (*Ficus macrophylla* and *Ficus rubiginosa*) reach heights over 30 metres to create a dense, leafy canopy with shady understorey conditions.

Two palms occupy the rainforest – the cabbage palm (*Livistona australis*) and the less common bangalow palm (*Archontophoenix cunninghamiana*). Thick lianas and vines are conspicuous in the rainforest communities with wonga vine (*Pandorea pandorana*), water vine (*Cissus hypoglauca*), and native grape (*Cissus Antarctica*), white supplejack (*Ripogonum album*) and whip vine (*Flagellaria indica*) being the most commonly encountered.



Epiphytic orchids and ferns are a special feature of rainforest communities, including the huge elk horn (*Platycterium bifurcatum*), spider orchid (*Dendrobium tetragonum*), and the rarer orchids *Sarcochilius hillii*, *Sarcochilius australis* and *Papillilabium beckleri*.

Rainforests in the upper Hacking River are restricted in their distribution and are extremely vulnerable to fires. Many plants are not adapted to fire and repeated fires can lead to local extinctions and the conversion of rainforests to more common eucalyptus forests.

Littoral Rainforest

Littoral rainforest communities along the entire NSW coast are listed as endangered on the TSC Act 1995. In the Hacking River catchment littoral rainforest occurs as isolated communities on sheltered headlands and gullies in both the RNP and remnant urban bushland. Sites have soils that are enriched with high levels of organic

matter and are infrequently burnt. Important urban sites include Grays Point Reserve, Lilli Pilli Point Reserve, Darook Park and Marina Crescent Reserve GyMEA Bay and areas of Bundeena and Maianbar. Small pockets are found in the RNP at Jibbon Beach and on private property generally on steep south facing lots close to the foreshore where the topography is steep and vegetation has been spared from clearing.

Littoral rainforest is distinct from the surrounding vegetation and contains some of our rarest tree species. Characteristic trees include lillypilly (*Acmena smithii*), tuckeroo (*Cupaniopsis anacardioides*), guioa (*Guioa semiglauca*), blue lillypilly (*Syzygium oleosum*), corkwood (*Endiandra sieberi*), sandpaper fig (*Ficus coronata*), ribbonwood (*Euroschinus falcate*) and crabapple (*Schizomeria ovata*). One rare species is the native celtis (*Celtis paniculate*), which is found at Grays Point and is host to an endangered population of the beetle *Menippus fugitivus*. Grays Point is one of only three locations in Australia where the beetle has been recorded.

Understorey vegetation is moderately diverse and is typified by a variety of shrubs, climbers, ferns and grasses, many of which are quite rare. Cockspur torn (*Maclura cochinchinensis*), brush muttonwood (*Rapanea howittiana*) and bastard rosewood (*Synoum glandulosum*) are some of the unique species to this community. Littoral rainforests are an important refuge habitat for rainforest birds and grey-headed flying foxes that seek out fleshy fruits.

Sydney Turpentine Ironbark Forest

It is estimated that merely 0.5 per cent of the original areas of Sydney turpentine ironbark forest exist. For this reason the remaining extant communities are listed as endangered on both the TSC Act 1995 and the EPBC Act 1999.

The community is restricted in distribution to ridgetops where the upper Wianamatta Shale soils and shale lenses in sandstone still remain. Consequently, the sites are mostly located on the watershed boundary of the Hacking River catchment. Small remnants often exist as individual trees and occur along the ridgetop between Sutherland and Woolooware. Pollard Park in Kirrawee and scattered patches near Sutherland Hospital are two such sites.

In the southern part of the catchment East Heathcote is built on a Sydney turpentine ironbark forest. Turpentine (*Syncarpia glomulifera*) and grey ironbark (*Eucalyptus paniculata*) are the predominant canopy trees reaching heights of over 30 metres. At East Heathcote, Sydney bluegum (*Eucalyptus saligna*) is associated with the community. The understorey is characteristically open with a grassy ground layer and a variety of shrubs not usually associated with the surrounding sandstone vegetation, including Sydney green wattle (*Acacia decurrens*), silver-stemmed wattle (*Acacia parvipinnula*), blackthorn (*Bursaria spinosa*), bitter pea (*Daviesia ulicifolia*), small-leaf parrot pea (*Dillwynia parvifolia*) and the grasses *Themeda australis*, *Danthonia tenuior* and *Danthonia linkii*.

Shale Sandstone Transition Forest

This community occupies the ecotone between Sydney turpentine ironbark forest and more common sandstone gully forest. As a result the vegetation exhibits a very diverse range of species with representative plants from both communities. Found nearby and at a lower elevation than turpentine ironbark forest, the shale sandstone transition forest also is listed in state and federal legislation as endangered. Sometimes turpentine and grey ironbark trees are absent and the canopy may consist of white stringybark (*Eucalyptus globoidea*) or smooth-barked apple (*Angophora costata*).

Sydney Freshwater Wetlands

Freshwater wetlands are very rare and unique vegetation communities that occur at only a few locations in the Hacking River catchment area. While Sydney freshwater wetlands principally exist in dune swales on the Kurnell Peninsula, there are good examples behind Jibbon Beach and Yarmouth Swamp in Bundeena where the community grades into swamp sclerophyll forest and swamp oak floodplain forest.

The community is associated with periodic or semi-permanent inundation by freshwater and is dominated by herbaceous sedges and rushes. Species include water couch (*Paspalum distichum*), tussock sedge (*Carex appressa*), bullrush (*Typha orientalis*), jointed twig rush (*Baumea articulata*), soft twig rush (*Baumea rubiginosa*), common rush (*Juncus usitatus*), water ribbons (*Triglochin procera*) and frogmouth (*Philydrum lanugosum*).

Freshwater wetlands are an important fauna habitat particularly for threatened species including the green and golden bell frog (*Littoria qurea*), wallum froglet (*Crinia tinnula*) and the large-footed myotis bat (*Myotis adversus*). Because of the reduced distribution of the community and ongoing threats from infilling, draining, weed invasion, feral animals and pollution, Sydney freshwater wetlands are an endangered ecological community listed on the TSC Act 1995.

River Flat Eucalypt Forest

The river flat eucalypt forests occur on the floodplains and alluvial river terraces along the lower Hacking River, most notably around Audley where sandy, clay loam soils enriched with nutrients, moisture and organic matter support large trees such as blackbutt (*Eucalyptus pilularis*), grey ironbark (*Eucalyptus paniculata*), bangalay (*Eucalyptus botryoides*) and smooth-barked apple (*Angophora costata*).

Much of the understorey has been cleared for recreation but, where existing, is made up of small trees and shrubs, including prickly-leaved paperbark (*Melaleuca styphelioides*), sally wattle (*Acacia floribunda*), grey myrtle (*Backhousia myrtifolia*), swamp oak (*Casuarina glauca*) and occasionally cabbage tree palm (*Livistona australis*). Typical ground covers include soft bracken (*Calochlaena dubia*), harsh ground fern (*Hypolepis Muelleri*) and weeping meadow grass (*Microlaena stipoides*).

River flat eucalypt forests growing on floodplains along the NSW coast are considered in danger of extinction from a history of clearing for agriculture and recreation. Remaining communities are mostly degraded from weed invasion or modification. The community is listed as endangered on the TSC Act 1995.

Swamp Oak Floodplain Forest

On floodplains associated with estuary and tidal influence vegetation is more salt tolerant and eucalypts give way to swamp oaks (*Casuarina glauca*). Swamp oak floodplain forests exist along the Hacking River at Swallow Rock, Grays Point and Bundeena Creek.

The swamp oaks dominate the community though other trees such as prickly-leaved paperbark (*Melaleuca styphelioides*), cheese tree (*Glochidion ferdinandi*) and the endangered magenta lillipilli (*Syzygium paniculatum*) are found in here. The understorey is not diverse with only a simple association of salt-tolerant grasses, sedges or herbaceous plants. Species include salt couch (*Sporobolus virginicus*), sword grass (*Gahnia*

clarkei), sea rush (*Juncus krausii*), warrigal cabbage (*Tetragonia tetragonoides*) and common rush (*Phragmites australis*). Swamp oak floodplain forest is also listed as an endangered ecological community on the TSC Act 1995.

Swamp Sclerophyll Forest

As the vegetation on the floodplains merge, swamp sclerophyll forests grow in low-lying areas often adjoining freshwater wetlands or swamp oak floodplain forest. The community is usually subject to flooding and some influence from the spring high tides. In the Hacking River catchment the largest area is located at Yarmouth Swamp near Bundeena Oval where freshwater drains towards Bundeena Creek and occasionally estuarine waters enter at the mouth of the creek. Vegetation can experience periods of dry as well as temporary inundation.

Trees include swamp oak (*Casuarina glauca*), swamp mahogany (*Eucalyptus robusta*), bangalay (*Eucalyptus botryoides*), smooth-barked apple (*Angophora costata*) and cabbage palms (*Livistona australis*). The understorey is an interesting assemblage of shrubs, sedges, grasses and ferns with typical species swamp paperbark (*Melaleuca ericifolia*), sword sedges (*Gahnia sieberana*, *Gahnia clarkei* and *Baumea juncea*) and harsh ground fern (*Hypolepis muelleri*). As with other vegetation communities on floodplains, swamp sclerophyll forest is listed as an endangered ecological community on the TSC Act 1995.

Coastal Saltmarsh

Coastal saltmarsh is found in a niche between the mean high water mark and the astronomical high tide, where the elevation varies less than a metre. Growing on alluvial sediments coastal saltmarsh lacks trees, except for the occasional mangrove tree, and consists of only a few succulent or herbaceous species that can tolerate the extremely saline conditions. Saltmarshes are found in very small amounts around Port Hacking and the Hacking River at the heads of bays such as Cabbage Tree Basin, Constables Point Maianbar and Grays Point.

The characteristic plants are austral seablite (*Suaeda australis*), glasswort (*Sarcocornia quinqueflora*), salt couch (*Sporobolus virginicus*), twig rush (*Baumea juncea*), coast couch (*Zoysia macrantha*), Lobelia (*Lobelia alata*), creeping brookweed (*Samolus repens*) and sea rush (*Juncus kraussii*).

Locally, feral deer are a major threat to this community trampling and browsing on the fragile plants. Coastal saltmarsh is listed as an endangered ecological community along the entire NSW coast on the TSC Act 1995.

Estuarine Mangrove Forest

Mangroves colonise alluvial sediments in slow moving estuarine environments along the Hacking River and Port Hacking. A simple community consisting of one or two tree species that grow to an average height of 2-4 metres form a dense canopy. Extensive estuarine mangrove forests are found at Bonnie Vale, Cabbage Tree Basin, South West Arm, North West Arm and Grays Point. The predominant species is the grey mangrove (*Avicennia marina var. australasica*), while the smaller river mangrove (*Aegiceras corniculatum*) is less common.

Mangroves play an important role in stabilising sediment and maintaining water quality. These plants are crucial producers in the estuarine ecosystem, providing food in the form of organic detritus for fish and invertebrates. Mangrove forests also provide shade, protection and important habitat for a range of fish and other aquatic fauna. Boating activities and the associated wave action is causing shore bank erosion and loss of mangroves along some sections of the Hacking River.

Wetlands and waterways play a critical function in ecological processes as valuable breeding sites for a large range of species and a resource for sustaining the food chain for wildlife. Wetlands also help purify water thereby improving the quality of the larger bodies of water. Wetlands, wetland buffer areas, waterways and riparian zones in Sutherland Shire have all been mapped and are shown on a map entitled *Wetlands and Waterways*, which forms part of the Sutherland Shire 2006 DCP.

The objectives and controls in this section apply to all land identified on this map. Similarly, WCC has mapped the wetlands within its jurisdiction and vegetation communities on its Geographic Information System (GIS) system. These vegetation communities have been mapped as part of a regional bio assessment (National Parks and Wildlife Service, 2002).

Aquatic vegetation

Within the aquatic and intertidal environment, habitats characterised by seagrasses, mangroves and saltmarshes are major elements. Other aquatic habitats include mud flats, rocky outcrops and open water. Waterways act as valuable corridors for wildlife. The health and quality of the Shire's primary waterways are dependent upon the health of all wetlands and waterways in the catchment.

As such, it is essential that the connection between wetlands and waterways is recognised and equal attention is given to preserving and enhancing these locations. Run-off from surrounding landforms is critical to the performance of a wetland, therefore establishing buffer areas around wetlands are very important. Similarly, the riparian zone of a waterway is critical to the biodiversity of a waterway.

Seagrasses

Seagrass beds occupy shallow slow moving waters throughout the Port Hacking catchment and are an important component in the estuarine ecosystem. Seagrass beds are not grasses at all, rather submerged flowering plants that assist to create a unique habitat for a range of fish, molluscs, crustaceans, worms and other benthic fauna by providing organic matter, food and shelter. Seagrasses also host a diverse range of small algae, which grow on the leaf blades. Recognised as important habitat for juvenile fish and estuarine health, seagrasses are protected under the Fisheries Management Act 1994.

Over the last 40 to 50 years seagrass beds in the Port Hacking catchment have declined in area by 30-50 per cent (Meehan & West, 2002). Seagrasses are susceptible to anthropogenic damage and are slow to recover. Examples of impacts causing loss of seagrasses in the catchment include shell grit mining, dredging, foreshore development, scouring by vessels, swing moorings, increased nutrient loads and invasion by the noxious marine algae *Caulerpa taxifolia* (described below).

Seagrass beds lack the diversity of terrestrial plant communities with only four species existing in the Port Hacking catchment, two of which are uncommon and make up less than 1 per cent of the total biomass. Eelgrass (*Zostera capricorni*) is the most commonly encountered species as its narrow foliage is occasionally exposed at low tide while the wider leaved strap grass (*Posidonia australis*) is generally found in slightly deeper waters. The other two seagrasses found in the catchment are the paddleweeds (*Halophila decipiens* and *Halophila ovalis*). Paddleweed is inconspicuous with broad translucent foliage that generally grows among other seagrasses in small amounts. Seagrass beds can be almost pure stands of one species or a combination of species.

Algae

In the Port Hacking catchment algae is comprised of estuarine and oceanic phytoplankton and macro algae. The oceanic phytoplankton is dominant in the lower estuary and the estuarine species is dominant further upstream (Patterson Britton, 2002).

A toxic dinoflagellate species, *Gonyaulax ployedra*, has been recorded (Patterson Britton, 2002). Toxic dinoflagellates are known to cause red tides, which can be highly hazardous to both the environment and humans. Blooms of *Gonyaulax ployedra* can result from dredging through the release of nutrients. This is not known to have occurred in relation to previous dredging in Port Hacking (Patterson Britton, 2002).

Brown algae (*Sargassum sp*) is the dominant macro algae species through the Port Hacking catchment, except towards the entrance where it is generally replaced by kelp (*Ecklonia radiata*) and a variety of other brown and red algae (Patterson Britton, 2002). A number of macro-algae species were identified on the Bundeena-Maianbar footbridge, which was completed in 1958 (West et al., 2000).

The dominate algae species within the Basin are:

- Large brown algae, such as *Sargassum*, *Ecklonia* and *Cystophora*
- Short turf species, such as iridescent reds like *Laurencia*
- Encrusting species of coralline algae
- Free-floating species, such as *Ulva*, *Chaetomorpha*, *Enteromorpha*
- Epiphytic algae have attached to mangroves in the Basin, such as *Bostrychia*, *Caloglossa*, *Harmosira* and *Codium* (West et al., 2000).

Caulerpa taxifolia

Caulerpa taxifolia is an invasive species of macro algae or seaweed, which was discovered in the Port Hacking catchment by DPI in March 2000. Since then it has spread to a number of locations throughout the estuary, including Burraneer Bay, Fisherman Bay and Gunnamatta Bay (Patterson Britton, 2002). Mapping of *Caulerpa taxifolia* was carried out in 2000, February and August 2003 and March 2004.

The distribution of *Caulerpa taxifolia* in the Port Hacking catchment has increased in Gunnamatta Bay since 2000, however most recent mapping indicates there is no longer *Caulerpa taxifolia* at Bells Point, in the area further to the north as well as in Gynea Bay, in the bay to the north of Turiell Point, and Hungry Point. There is a high potential for *Caulerpa taxifolia* to become established in Gynea Bay due to its proximity to other infected areas in the Port Hacking catchment (WBM, 2002a).

The key characteristics of *Caulerpa taxifolia* are that it grows rapidly, may out compete and smother native flora, and produces toxic substances, which could have an adverse effect on fauna (NSW Fisheries, 2004). There is limited scientific understanding of these characteristics and further research is being carried out in NSW.

Caulerpa taxifolia can be spread in a number of ways, including fragments being caught in boat propellers as well as on anchor chains and other equipment (NSW Fisheries, 2004). Consequently, there is a need for users to wash down boats prior to leaving the area. Signs at boat ramps around the catchment inform boat owners of the problem with *Caulerpa taxifolia* and the importance of inspecting and cleaning equipment, including anchor wells and chains.

Recreational net fishing has been banned in the Port Hacking catchment in order to stop the spread of *Caulerpa taxifolia* (NSW Fisheries, 2004). In early 2004, *Caulerpa taxifolia* was classified as a Class 1 (prohibited) species under provision of the *Fisheries Management (General) Regulation 1995*. Therefore, it is an offence in NSW to sell *Caulerpa taxifolia*, and the algae is not allowed to be kept by anyone, even in an aquarium, without a specific licence. Educational activities and inspection of aquarium business will be carried out to ensure compliance (NSW Fisheries, 2004).

There are a number of methods that have been trialled in Australia and overseas to remove *Caulerpa taxifolia*. Methods include physical removal, smothering, osmotic shock, biological treatment and chemical treatment (NSW Fisheries, 2004). DPI indicated that the most useful method is salt treatment. However other species of seagrasses and benthic invertebrates also may be affected in the short-term, although recovery appears to be relatively rapid.

Further work is currently being carried out in order to determine whether *Caulerpa taxifolia* will re-shoot from submerged rhizomes, if multiple salt applications are required, and the long-term impacts on seagrasses and other biota (NSW Fisheries, 2004). Research by York et al (2006) suggests that *Caulerpa taxifolia* results in a

decrease of species richness possibly as a result of reduced habitat complexity or the differences in the availability of food between three different types of habitats.

Whatever the cause, the impact that *Caulerpa taxifolia* has had in the Mediterranean Sea indicates that close monitoring and research of its spread in Port Hacking should be continued.

Terrestrial fauna

There are some 80 species of threatened fauna recorded in the RNP, for example the broadhead snake and the red-crown toadlet, which are listed under the NSW threatened species legislation (AWT, 1999).

The diversity of vegetation communities in the RNP has provided a range of habitats for a rich assemblage of native animals. Although comprehensive surveys have not been carried out there have been recorded sightings in the RNP of 43 species of mammals, 241 species of birds (including offshore species and vagrants), 30 species of amphibians and 40 species of reptiles. The park is also an important area for invertebrates.

Pest species, particularly deer, have had significant impacts on saltmarsh and mangrove areas. The adoption of SSC's Feral Animal Policy and the appointment of a pest species officer will improve outcomes from pest species management. But there are challenges for all land managers due to the difficulty of accessing some areas for feral species management.

Aquatic fauna

Fish

The Port Hacking catchment is a nursery area for juvenile fish and contains four fish enclosures (AWT, 1999). The catchment supports between 200–500 fish species, including (AWT, 1999):

- Snapper (*Chrosphrys auratus*)
- Tailor (*Pomatomus saltatrix*)
- Yellowtail (*Trachurus novaezelandiae*)

- Bream (*Acanthopagrus australis*)
- Whiting (*Sillago ciliata*)
- Flathead (*Platycephalus fuscus*)
- Mulloway (*Argyrosoma holoepidotus*)
- Goby (*Favonigobius lateralis*)
- Port Jackson perchlet (*Velambassis jacksoniensis*)
- Richardson hardyhead (*Atherinason hepsetoides*)
- Sandy sprat (*Hyperlophus vittatus*)
- Three species of mullet and leatherjacket.

The diverse range of fish species includes approximately 20 per cent transient tropical species (Nelson Consulting, 2004). The Port is located in a subtropical and cooler temperate region with a variable, annual supply of tropical transient species from the East Australian Current (EAC) (Nelson Consulting, 2004). In addition, the Port is a drowned river valley that provides a relatively open mouth, with large areas of saline water and a diverse array of habitat types (Nelson Consulting, 2004).

The catchment provides an ideal habitat for juvenile fish due to the open nature of the entrance and water exchange in the lower estuary. A large number of post larvae and juveniles are present on the stable sand shoal tops, indicating that these areas are important as nurseries for these species (Patterson Britton, 2002).

Shiprock Aquatic Reserve was named after a prominent ship-like rock, which forms the headland between Burraneer and Dolans Bay at Port Hacking. The two-hectare site was declared an aquatic reserve in 1982 to protect marine plants and animals. A combination of submarine cliffs, strong currents and oceanic waters provides a diverse environment inhabited by plants, invertebrates and fish. More than 130 species of fish have been recorded within the reserve, including sweep, red morwong, hulafish, half-banded sea perch, eastern fortescue, gunthers wrasse, fan-bellied leatherjacket and estuarine catfish.

Each summer as the water warms, juvenile tropical fish appear. These include butterfly fish, damsel fish, wrasses and the butterfly cod. Within the reserve people can scuba dive and observe the marine

animals and plants. Fishing by any method is prohibited. Any activity that involves the collection, disturbance or destruction of marine animal or plants is not permitted, whether dead or alive.

On the southern shore is Cabbage Tree Point Intertidal Protected Area. Cabbage Tree Basin was previously a fish hatchery. The area was chosen mainly because it contained a variety of fish species and was seen as a breeding ground for fish (West et al., 2000). Over the years there has been a change in the fish species in Cabbage Tree Basin due to changes in habitats. The area was dominated previously by shallow seagrass beds but is now dominated by sandy shoals and a narrow creek favouring open water fish, such as whiting and flathead (West et al., 2000).

Oysters

Oysters were first identified in the Port Hacking catchment in 1821 and were observed to be abundant, but small, in Gunnamatta Bay. Between the 1870s and 1920s these undersized oysters were transferred to the Georges River (Nelson, 1997). There is no commercial harvesting of oysters carried out in the catchment.

Waterbirds

Most of the waterbirds that use the marine delta are migratory waders. SSC has international responsibilities under the JAMBA, CAMBA and ROKAMBA agreements to protect migratory bird habitat. All native birds are protected under NSW legislation (NP&W Act), including pied oystercatchers (threatened species), masked lapwing, double-banded plover, whimbrel, curlew sandpiper, sharp tailed sandpiper, eastern curlew and Caspian tern (Nelson, 1997).

Threatened species, including migratory shorebirds, are protected under the NSW Threatened Species Conservation Act 1995 and the national Environment Protection and Biodiversity Conservation Act 1999. Important habitats are located on the shoal along Maianbar and the shoreline fringe of Deeban Spit and Simpson Bay (Nelson, 1997).

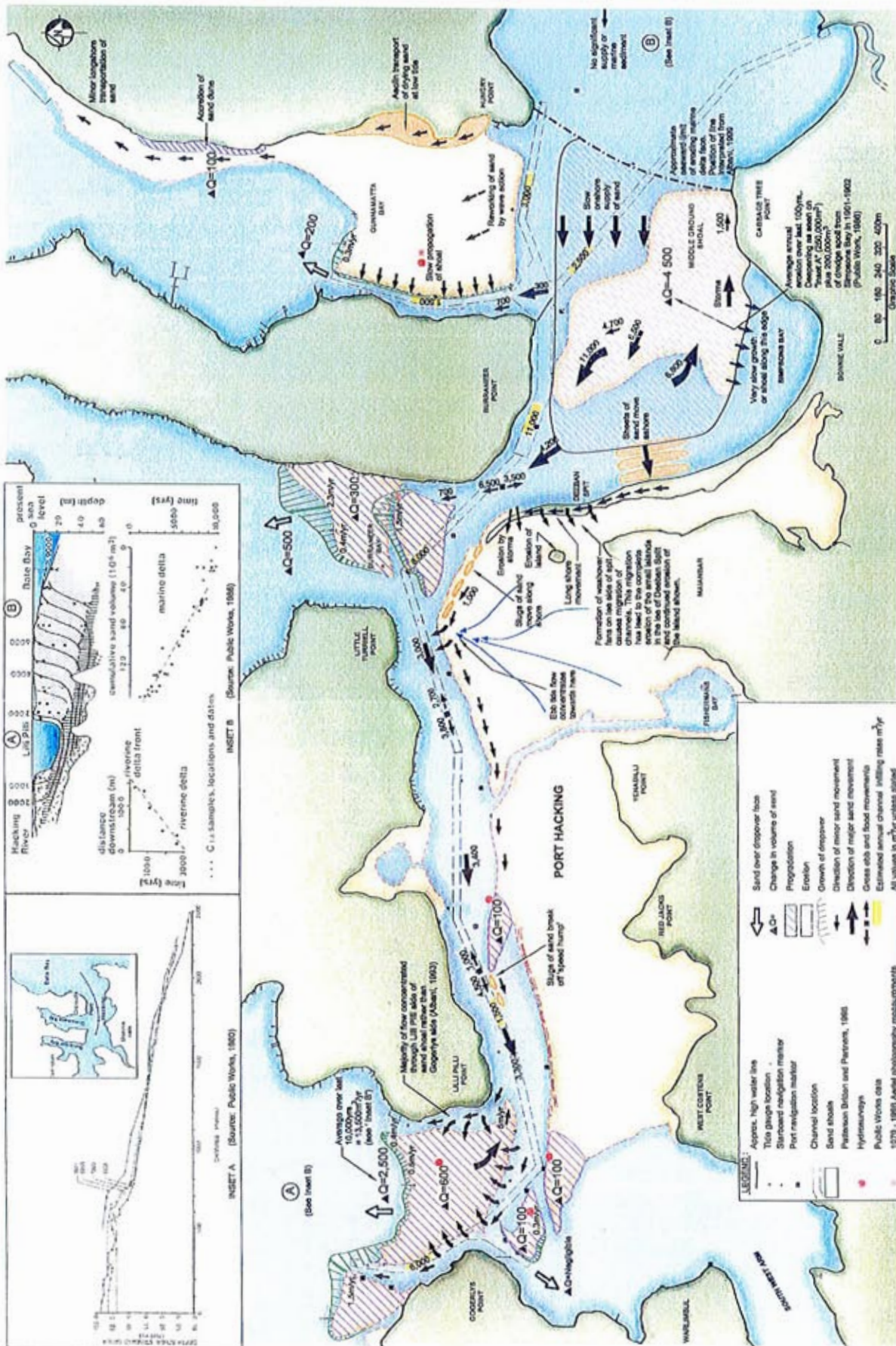
Table 5.6 – Summary of management and planning challenges for the Plan

	Theme	Challenge
	1. Visual and landscape values	
Aesthetic and heritage	Visual and landscape values	To maintain scenic qualities of the Port Hacking catchment foreshore and critical habitat in the intertidal zone.
	2. Heritage, culture and tourism	
Aesthetic and heritage	Heritage, culture and tourism	Conservation and protection of landscape and built heritage items. To retain the significance of these heritage items through the development process. Capture the cultural and tourism value of these heritage items and locations.
	3. Competition for space	
Social	Competition for space – the increasing pressure on existing aquatic and terrestrial facilities	To maintain the ecological and social values of popular places in the catchment.
Social	Waterway access	To improve access to the waterways to address community needs. To ensure that access to the waterways and riparian lands does not compromise ecological or social values within the catchment.
Social	Commercial and recreational fishing	Ensure fishing activities within the catchment and to promote long-term fish numbers and diversity.
	4. Holistic management of the catchment through catchment management	
Social	Holistic management	To ensure that the catchment is managed in a holistic way. To ensure that the protection of environmental and cultural values is combined with access and use of national parks land and water resources
	5. Boating safety	
Economic	Shoaling and water safety	Communicate an understanding to waterway users of the natural shoaling that takes place within the Port Hacking catchment estuarine areas as a result of sand movement around the Port.
Economic	Commercial uses of the waterways – marinas and ferries	To maintain the navigational channel in the Port Hacking catchment as sand moves constantly throughout the Port.
	6. Future threats	
Economy	Climate change and sea-level rise	Identify strategies to prepare for climate change and rising sea levels.

Table 5.6 – Summary of management and planning challenges for the Plan

	Theme	Challenge
	7. Water quality	
Ecology	Water quality	<p>To ensure consistent water quality throughout the catchment that is suitable for primary recreation, including swimming.</p> <p>To ensure water quality for the protection of aquatic ecosystems and geomorphologic values.</p>
Ecology	Sedimentation in the heads of the northern bays	Manage sedimentation to ensure equitable use of the heads of bays and protect waterways from existing sediment contamination.
	8. Flora and fauna protection	
	<i>Caulerpa taxifolia</i>	Limit the impact and spread of <i>Caulerpa taxifolia</i> .
Ecology	Flora and fauna	<p>To protect saltmarsh and seagrass.</p> <p>To reduce the impacts of feral and unrestrained domestic animals on the ecology of the catchment.</p>
Ecology	Conservation of wetlands and riparian corridors	<p>There is a need to protect wetlands and manage the encroachment of mangroves into saltmarsh areas. The impact of wave and tides on the banks of saltmarsh areas needs to be reduced, particularly downstream of the Audley weir.</p> <p>Protection of freshwater hanging swamps throughout the Port Hacking catchment particularly in the Helensburgh area.</p> <p>Protection of the Basin and South West Arm and other high value locations.</p> <p>Protection of riparian vegetation.</p>

APPENDIX 1



APPENDIX 2

COMMUNITY VALUES AND ASPIRATIONS SOURCE DATA

In 2007 a Beach Visitor Survey was conducted of the Cronulla Beaches (SSC, 2007). This survey asked questions about some sites in the Port Hacking catchment, including Bass and Flinders Point, Darook Park, Gunnamatta Beach and Park and Salmon Haul Bay. Respondents were asked to nominate their favourite place and why they chose this location. These responses describe natural values, views and low-key recreation activities. Table 6.1 below lists these comments. These issues are also mapped and the maps are available on the CD-Rom.

Table 6.1 – Favourite location and reason given

Location	Comment
Bass and Flinders Point	Great outlook and quite peaceful.
	Nice surrounding and looking at the Pacific Ocean, which is the pride of the Pacific and it makes it so special a place to look at.
	Not as crowded, more leisurely swim.
	Snorkelling.
	The views.
Darook Park	A good area to picnic, lots of trees, lots of shade. The water is not as rough as the ocean beaches, which is great for the kids.
	Clean park, beach and water and nice family atmosphere.
	Clean, peaceful, pretty.
	Family friendly, mainly quiet, nice scenery, beautiful beach, close to home.
	Great for kids, usually fairly quiet.
	Hidden beach and not commercial.
	Hot women.
	It is hidden away and not too many people know about it. Fantastic scenery.
	It is just simply beautiful, quiet and usually clean.
	It is quiet.
	It is quiet and there are no waves to knock over the little ones.
	It is very suitable for young children. It is not developed and feels 'safe'.
	It's a great family place and safe for the kids. A beautiful place for a picnic.
	It's quiet and secluded and unspoilt by hooligans and tourists.
	It's quieter than the other beaches. It has a great area for BBQs. It faces west so you get afternoon sun... and I can take my dog there in summer.
	Never over crowded, always good to watch the sunset.
	Not as many tourists about in this area, so it isn't as busy as everywhere else.
	Perfect for swimming with kids.
Private beach.	

Table 6.1 – Favourite location and reason given (Cont.)

Location	Comment
Darook Park (Cont.)	Quiet and mostly frequented by locals.
	Quieter and no waves.
	Quiet, peaceful and away from noisy shopping centre.
	Safe swimming.
	Safe water for the children, combination of shade and beach. Families
	Scenery.
	Secluded, thus not too crowded. Shallow waters make it accessible for my one-year-old.
	Shade for kids, less tension than in other parks where you are competing for space with large groups of people that monopolise facilities and have no consideration for others.
	Small, local, not crowded, water suitable for my younger child, relaxed atmosphere, able to have quiet enjoyment, hard to get to except by car and walk in.
	That it is a beautiful, quiet and peaceful location that has the most spectacular scenery. I love that it is a special place that is not widely known to the general public. It is a safe place to take children and everyone who visits is friendly and appreciates its beauty. I also love watching the boats and canoes go past.
	That you can walk out as far as u want and there is no seaweed.
	The bay is beautiful and the park is nice and shady.
	The natural setting with little infrastructure. The trees are fantastic! It is quiet and secluded from the main beaches on the ocean. The sand bar is also fantastic! I don't have children but it is a fantastic place for children and families, lots of shade and it is protected from extreme weather conditions.
	The setting and park although my child likes the new equipment at Gunnamatta Park.
	The view at Darook is second to none.
	This park is usually used by locals, is a great place to share a picnic with family and friends because of the peaceful surrounds, the shade, the outlook.
	Usually is a place frequented by local families, is unspoilt by others.
Usually quiet, usually clean, safe for families with children.	
Water safe for families with kids and most of the time away from louts.	

Table 6.1 – Favourite location and reason given (Cont.)

Location	Comment
Gunnamatta	It is quiet and usually uncrowded.
	Being a senior, it is easy to walk around - plenty of seating, cafe nearby, lots of trees and cool spots, easy on the eye too! I also enjoy South Cronulla Park and the CBD & Plaza for the same reasons, plus plenty of parking space for my car. (I only use the disabled parking space if I'm having an 'off' day. I have Rheumatoid Arthritis.
	Calmer water for little children.
	Child friendly x2.
	Close to home, can do some laps not too many people most of the time.
	Excellent for the kids.
	Good for kids.
	It has a great playground and the beach is perfect for the kids.
	It is more of a lake side setting, not too many young idiots.
	It's just nice.
	My favourite changes. Right now I like being able to swim at a beach protected from the wind with easy access. I also like Darook but the walk to the water can be a long one.
	No waves.
	Not too busy.
	Salmon Haul (near fisheries)
No shops, nice and quiet, protected from prevailing NE breeze.	
Quiet.	
Sheltered, calm waters.	
It is one of the last relatively untouched areas which are in danger of going forever.	

The 2007 Boat Survey (SSC/SSMA) asked about the quality of the waterway, facilities and moorings. Suggestions made follow in Table 2:

Style	Comment
Negative	Focus on boating access including ramps, parking and water depth for boating.
	Comments such as better parking for moored boats, better access to wharfs at low tide, better toilets, dredging of sand at end of bay and organise better boating pattern.
	Illegal parking is a big problem, with people taking trailer spots.
	Mow the lawn. It would make it look more presentable.
	Need more seating, more parking, more BBQ and concrete.
	Need to fix the boat ramp, caused a cut to foot.
	Needs a fish cleaning bay.
	Hacking River has good boat ramps but is hard to access.
Positive	Very slippery ramp, dangerous.
	The Port is excellent, best in Sydney.
	Most prestigious. Excellent.
	Flushed out every tide. Really clean.
	Except for pelicans, it's a good thing
	Good for bream.
	Good.
	Gorgeous.
Water related	Great maritime provide good service.
	Water considered good and clear.
	Water is clean, but needs dredging. There is money allocated so do something about it.
	Water is clean.
	Water is fine for boat.
	Water needs to be deeper.
Water quite good. Nothing wrong.	

APPENDIX 3

PLANS, POLICIES AND LEGAL INSTRUMENTS

In May 2006 a Port Hacking Legislative Review was undertaken by WBM and subsequently updated during the preparation of the PHIEMP. Changes have been included where practicable, but it must be noted that as the legislative environment is constantly changing it requires monitoring on a regular basis to examine the changes and impacts on the Port Hacking catchment.

Below is a list of the legislation that affects development proposals in the Port Hacking catchment. Current information can be found at the NSW Legislation website http://www.austlii.edu.au/au/legis/nsw/consol_act/

POLICIES

Statements of policy can have a legal or quasi-legal status. Government agencies have a responsibility to implement policy. These policies include:

1. State Environmental Planning Policy No.1 Development Standards
2. State Environmental Planning Policy No.14 Coastal Wetlands
3. State Environmental Planning Policy No.19 Bushland In Urban Areas
4. State Environmental Planning Policy No.26 Littoral Rainforests
5. State Environmental Planning Policy No.33 Hazardous and Offensive Development
6. State Environmental Planning Policy (Infrastructure) 2007
7. State Planning Policy No.60 Exempt and Complying Development
8. State Environmental Planning Policy No.62 Sustainable Aquaculture
9. State Environment Planning Policy No.65 Design Quality of Residential Flats

10. State Environmental Planning Policy No.71 Coastal Protection
11. NSW Estuary Management Policy
12. The NSW Wetlands Management Policy
13. State Environmental Planning Policy No.32 Urban Consolidation (Redevelopment of Urban Land)
14. State Environmental Planning Policy No.37 Continued mines and extractive industries
15. Australia's Ocean Policy
16. Australia's Ocean Policy - Specific Sectoral Measures
17. The Commonwealth Coastal Policy
18. Aquatic Habitat Management and Fish Conservation Policy and Guidelines
19. NSW Coastal Policy
20. The NSW State Groundwater Policy Framework Document.

PLANS

Plans have differing levels of legal authority. For example, the plan of management for the RNP is a statutory plan, but the Fish Habitat Protection Plan is more of an administrative guideline. Some plans have a lesser legal status as internal management decisions by the agency concerned (for example, the Interim Boating Management Plan), and are subordinate to other policy. It seems that for many agencies making a plan is an alternative to the implementation of less preferred, but legally more significant, laws or policies (for example, the overarching requirements under the EPBC Act to implement the precautionary principle).

Sometimes the words 'plan' and 'policy' are used interchangeably, with a plan being a specific decision to act, while a policy is a guide for making a decision to act. The plans that were identified earlier are listed below, but again some of these will be revised, redundant or replaced:

1. Navigation in Port Hacking (draft plan)
2. Southern Catchment Blueprint
3. Fish Habitat Protection Plan No. 1: General
4. Fish Habitat Protection Plan No 2: Seagrasses
5. Corporate Plan 2002-2207: NSW Fisheries (DPI)
6. Sutherland Shire Local Environmental Plan (SSLEP2006)
7. The National Greenhouse Strategy
8. National Strategy for the Conservation of Australia's Biological Diversity
9. National Strategy for Ecologically Sustainable Development
10. NSW Biodiversity Strategy
11. NSW Bitou Bush Strategy
12. Port Hacking Interim Boating Management Plan.

Of particular interest is the following legislation, planning instruments and policy:

- The Environmental Planning and Assessment Act 1979 - Sutherland Shire Local Environmental Plan 2006 (SSLEP 2006) and Sutherland Shire Development Control Plan 2006 (SSDCP2006)
- Southern Catchment Blueprint
- The Rivers and Foreshores Improvement Act 1948 (Water Management Act 2000)
- The Crown Lands Act
- The NSW Estuary Management Policy
- Port Hacking Interim Boating Management Plan (Waterways Authority, 2003).

The Environmental Planning and Assessment Act 1979

Operating at state, regional and local levels, administration of the planning system is primarily shared between the DECC and local councils.

Other agencies also have responsibilities in defined circumstances.

One of the key pieces of NSW legislation is the Environmental Planning and Assessment Act 1979 (EP&A Act). The EP&A Act establishes the framework for the planning system in NSW, including:

- plan making
- development assessment
- environmental assessment.

Section 79C of the *Environmental Planning and Assessment Act* sets mandatory heads of consideration that form the basis of development assessment, including:

- The likely impacts of the development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality
- The suitability of the site for the development
- The public interest.

Sutherland Shire Local Environmental Plan 2006 (SSLEP 2006)

The Minister for Planning gazetted the Sutherland Shire Local Environmental Plan on 15 November 2006. The plan applies to land in the Sutherland Shire except where the *Sydney Regional Environmental Plan No 17—Kurnell Peninsula (1989)* applies and where land is identified as a deferred matter or is specifically excluded.

The SSLEP2006 is the broad planning framework for Sutherland Shire. It seeks to protect and conserve the biodiversity of the Shire, while protecting and improving the environment. The SSLEP2006 controls development in order to achieve an appropriate balance and promote the orderly development of land, protect items of environmental and cultural heritage and ensure new development is of a high quality that minimises impacts on its immediate locality.

Within Sutherland Shire, impacts on Port Hacking extend from beyond the waterfront areas to the ridge where urban zones and employment lands exist. A number of land-use zones apply within the catchment, including, but not limited to:

- Zone 1—Environmental Housing (Environmentally Sensitive Land)
- Zone 2—Environmental Housing (Scenic Quality)
- Zone 3—Environmental Housing (Bushland)
- Zone 16—Environmental Protection (Waterways)
- Zone 17—Environmental Protection (Low Impact Rural)
- Zone 19—Aquatic Reserves
- Zone 20—National Parks, Nature Reserves and State Conservation Areas.

The objectives of the various zones are to specify the type of development that may be carried out with or without consent as well as the development that is prohibited in that zone.

The objectives of the environmental housing zones relate to the scale and nature of development to protect and conserve natural features, reduce the impacts of development, minimise risk and ensure the sharing of waterfront views between occupiers and users of new and existing buildings.

The objectives of the public open space or bushland zone are designed to enable development that facilitates recreation and preserves natural bushland areas located on publicly owned land. However, these objectives must not adversely affect natural bushland or wildlife corridors and needs to protect public open space of environmental significance.

The objectives of the environmental protection or waterways zone recognise the importance of the waterways within the Shire as an environmental and recreational asset. The objectives of the aquatic reserves zone include conservation of marine areas of natural, ecological, scenic, educational, scientific, cultural or historical importance, and to identify land in the Shire that is an aquatic reserve under the *Fisheries Management Act 1994*.

The national parks, nature reserves and state conservation zone objectives within the SSLEP

2006 are to conserve areas of natural, ecological, scenic, educational, scientific, cultural or historical importance to the state and to identify land in the Shire that is or is to be reserved under the *National Parks and Wildlife Act 1974*.

The SSLEP 2006 includes reference to buildings or works on land traversed by the foreshore building line. The objectives of this clause are to avoid adverse ecological effects on waterways, protect and enhance significant natural features and vegetation on riparian land, retain endemic vegetation along foreshore areas, restore and revegetate foreshore areas to improve estuarine flora and fauna habitat, and minimise any adverse impact from development on water quality.

The objectives also should, so far as is practicable:

- improve the quality of urban run-off entering waterways
- minimise any adverse visual impact of development when viewed from adjacent land and waterways by using a design and materials that complement the natural landscape of the land to which this clause applies
- minimise any adverse impact of development on the natural landform of foreshore areas and waterways by integrating structures into the site with minimal change to the natural topography of the land to which this clause applies
- to achieve an appropriate balance between private development and the public use of waterways; to maintain and improve public access to the intertidal area of waterfronts where there will be minimal environmental impact
- to conserve and enhance structures on waterfronts that are of heritage significance; and to minimise the obstruction of water views from public land.

The objectives of the environmental risk acid sulphate soils clause is to reduce disturbance of ASS and otherwise manage any disturbance to ASS so as to minimise impacts on natural water bodies, wetlands, native vegetation, agriculture, fishing, aquaculture and urban and infrastructure activities.

In 2006 the Department of Planning prepared a standard instrument LEP template and Sutherland Shire Council will be required to prepare and adopt an LEP using this framework by 2011. Until this

time the Sutherland Shire Local Environmental Plan 2006 (SSLEP 2006) is in force.

Sutherland Shire Development Control Plan 2006 (SSDCP 2006)

This development control plan is known as *Sutherland Shire Development Control Plan 2006* (SSDCP2006). The SSDCP2006 applies to all land to which *Sutherland Shire Local Environmental Plan 2006* (SSLEP2006) applies.

The SSDCP2006 has been prepared to provide more detailed provisions with respect to carrying out development permissible under the SSLEP2006. The provisions of the SSDCP2006 help to achieve the objectives of the SLEP2006.

The SSDCP2006 provides the fine grain detail to the planning framework. Section 79C of the *Environmental Planning and Assessment Act* sets mandatory heads of consideration that form the basis of development assessment, including:

- The likely impacts of the development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality
- The suitability of the site for the development
- The public interest.

This DCP contains detailed objectives and controls that will be used by council when determining applications. Essentially the DCP sets benchmarks of what is acceptable in land use, development and environmental management decisions. Each application will be considered on the individual circumstances and merits of the case in terms of achieving the objective. However, any variation to the controls must be supported by a statement documenting how these objectives are fully satisfied.

Any submission in support of a variation to a control must be in writing and demonstrate how the objectives have been achieved. The DCP also contains administrative provisions that detail how development applications will be publicly notified and the duration of consents.

Coastal Protection Act 1979 Section 55C

A coastal zone management plan must make provision for:

- Protecting and preserving beach environments and beach amenity.
- Emergency actions of the kind that may be carried out under the *State Emergency and Rescue Management Act 1989* or otherwise, during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event.
- Ensuring continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion.

The Fisheries Management Act 1994

The general objective of the *Fisheries Management Act 1994* is to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. As well as providing authorisation and permits for aquaculture, recreational and commercial fishing activities, the Act also lists threatened marine species, populations and ecological communities. The *Fisheries Management Act 1994* specifies that a public authority authorising or carrying out dredging or reclamation work or interrupting fish passage must give notice of the proposed work to the Minister of Fisheries and consider any matters raised.

The main provisions of this legislation that relate to Estuary Management works are:

- Habitat Protection Plans - allow for the gazettal of management plans for the protection of specific aquatic habitats.
- Dredging and Reclamation Plans - allow for the control and regulation of dredging and reclamation works, which may be harmful to

fish and fish habitat. It establishes requirements to obtain a permit from or to consult with Department of Primary Industries (Fisheries).

- Protection of mangroves and certain other marine vegetation, which requires permits to be obtained for the regulation of damage to or removal of certain marine vegetation including seagrass.

Of particular relevance to the Port Hacking Plan of Management are provisions within the Act relating to the preparation of Habitat Protection Plans. Fish Habitat Protection Plans describe potential threats to fish habitat and recommend actions to mitigate the effects of potentially damaging activities. There are three habitat protection plans gazetted to date and these are outlined briefly below.

Habitat Protection Plan No 1 General

An advisory document summarising the various protective measures in relation to dredging and reclamation activities, fish passage requirements, and the protection of mangroves, other marine vegetation and snags.

Habitat Protection Plan No. 2 Seagrasses

Deals specifically with the protection of seagrasses across NSW, and discusses activities which impact on seagrasses, including the construction of jetties, wharves, and bridges, dredging and reclamation, and the collection of seagrasses.

Habitat Protection Plan No 3 Hawkesbury Nepean River System

This Habitat Protection Plan does not apply to the study area.

The Fisheries Management Act 1994 protects fish species listed as endangered or vulnerable. Also of relevance to the Port Hacking Plan of Management (POM) Review is the Subdivision 2 - Development and activities within aquatic reserves, which outlines the requirements for applications within aquatic reserves, such as the Shiprock Aquatic Reserve.

Caulerpa taxifolia has been declared a Class 1 noxious species in all NSW waters under the *Fisheries Management Act 1994*. It is illegal to possess or sell the seaweed. There are fines of up to \$11,000. The noxious listing also provides the DPI with the power to seize and destroy *Caulerpa taxifolia*, or require its destruction.

At the time of the preparation of the Port Hacking Plan of Management 1992, the *Fisheries Management Act 1994* was not implemented and instead, fisheries resources and management were administered under the provisions of the *Fisheries and Oyster Farmers Act 1935*. The POM did, however, recognise the importance of marine vegetation, such as seagrasses, saltmarsh and mangroves. It also recognised the significance of the Shiprock Marine Reserve area, Cabbage Tree Basin, the South West Arm and, indeed, the whole estuary. Considering the history of conservation in Port Hacking, the management of the area pre-empted some legislation in NSW in affording protection to these important fish habitats.

A cursory perusal of the objectives of the POM Review indicates that the vision for the Port was consistent with the principles of the *Fisheries Management Act 1994*. For example, the plan aimed to 'retain all wetland areas including saltmarsh, mangrove and seagrass'. If the scientific review indicates the continued decline of key indicators, then future planning efforts should focus on the reasons that the objectives were not achieved, as opposed to dedicating resources into re-writing objectives. This would likely apply to more recent changes to the classification of saltmarsh as an ecologically endangered community under the *Threatened Species Conservation Act 1974*.

The Crown Lands Act 1989

The *Crown Lands Act 1989* provides for the administration and management of crown land, which includes most beaches, coastal reserves, near-shore waters and estuaries. The Act specifies the following principles for crown land management:

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

Crown reserves

The Act provides for the dedication or reservation of crown lands for public purposes. It establishes a management system in which corporate bodies known as reserve trusts are created to manage crown reserves. The Minister may appoint a council, trust board, corporation or an administrator to manage the affairs of a reserve trust.

Plans of management may be prepared for crown reserves and adopted by the Minister. The plan preparation process is not prescriptive, but plan provisions need to be consistent with the purpose for which the land is reserved or dedicated, such as 'public recreation' or 'environmental protection'. Plan provisions also need to be consistent with relevant local environmental plans and government policies.

Activities carried out within a crown reserve must also be consistent with the purposes for which the land is dedicated or reserved, and with any adopted plan of management that is in force. Certain activities may not be carried out unless authorised by a lease, licence or temporary licence, but these cannot confer exclusive possession of any part of a reserve that is reserved or dedicated for public recreation.

Of particular relevance for Port Hacking is the issuing of licences to individuals, businesses and

community organisations for a number of purposes, including (Department of Lands, 2005):

- Waterfront structures, for example, jetties, boat ramps and slipways.
- Lands below the high water mark of foreshore properties are crown lands and occupation of such lands must be authorised.
- Grazing of stock excluding areas with high environmental sensitivity.
- Extraction industry operations, for example, quarries and dredging of sand and gravel from waterways.

A permissive occupancy is a form of tenure held over crown land authorising an occupation or use, similar to a licence. Permissive occupancies were granted under previous legislation and are no longer issued, having been replaced by licences. A permissive occupancy cannot be transferred, but can be replaced by a new licence upon termination (Department of Lands, 2005).

Land assessment

The Act requires a land assessment to be undertaken prior to the reservation, dedication, exchange, vesting or sale of crown land, or the granting of easements, leases or licences in respect of such land. The process for land assessment is specified by the Act and the *Crown Lands Regulation 2000*. It requires the physical characteristics of the land to be identified, the land's capabilities to be assessed and suitable uses identified.

A draft land assessment is publicly exhibited for 28 days for comment. The exhibited draft may indicate a preferred use or uses. The final decision is reflected in the manner in which the land is dealt with, for example by the granting of a lease.

Land assessments relevant to Port Hacking have not been reviewed in preparing this document, however DIPNR has advised that the existing land assessment for the Port Hacking Foreshore is now more than ten years old and needs to be updated (Department of Lands Darren O'Connell pers. Comm. 2005).

Watercraft facilities, including jetties, ramps and pontoons are a permissible form of development below M.H.W.M under the SSC LEP. Since the development of the Port Hacking POM permissive occupancies have been replaced by licences for these structures.

A further recent development in the application of the *Crown Lands Act 1939* to Port Hacking was a recent judgement passed down concerning a jetty on crown land in the Georges River. The judgement was passed in the NSW Supreme Court in regard to the *Crown Lands Act 1939* (Georgesk v Owners Corporation SP49833[2004] NSWSC 1096). The claim sought was that the defendants were not permitted to use the plaintiff's jetty (under crown licence) for any purpose, including boating, fishing or swimming, other than to traverse the jetty in order to access the foreshore of the Georges River. These claims were dismissed and, as such, the ruling redefines the individual privileges of waterfront landholders. Based on the ruling, jetties and other foreshore structures are not, therefore, 'owned' by those that pay the licence fees. It is understood that the case will be subject to appeal.

The NSW Estuary Management Policy

The NSW Estuary Management Policy was released in 1992 under the umbrella of the State Rivers and Estuaries Policy of 1992. This policy forms part of a suite of catchment management policies and provides for the assessment of all estuarine uses, the resolution of conflicts and the production of a unified and sustainable management plan for each estuary, including remedial works and conservation activities, where appropriate. The policy is implemented through the preparation and implementation of Estuary Management Plans, as outlined in the NSW Government Estuary Management Manual 1992.

As the Port Hacking Plan of Management was developed prior to the implementation of the NSW Government Estuary Management Policy and accompanying Estuary Management Manual, the POM was not developed under this framework.

The principles of the policy should be embraced in the development of future planning documents for the estuary.

Three bays within Port Hacking have had Estuary Management Plans (EMPs) prepared under the framework of the Estuary Management Manual. These are Yowie Bay, Gunnamatta Bay and Gynea Bay. The EMPs are not in conflict, however some strategies overlap and will benefit from integration across the estuary and the opportunity exists to extract the best elements from each to develop an integrated EMP for Port Hacking. The three EMPs are considered in the following text.

Yowie Bay Estuary Management Plan

Five key objectives were developed by the community to guide the development of the Yowie Bay Estuary Management Plan:

- Reducing pollution in the bay
- Reducing siltation from catchment run-off
- Maintaining environmental significance
- Improving boating
- Education of the community.

To address these objectives, a range of management options were identified. The final list of Management Plan Tasks includes 34 individual strategies. Of the 34, the majority of 26, or more than 75 per cent, are strategies designed to prevent further pollution and degradation of the waterway. The strategies include a range of stormwater management, community education and habitat rehabilitation strategies.

The remaining eight tasks are related to infrastructure provision and could be described as 'hard' management strategies, including for example upgrading boat ramp facilities, creating a navigation channel, carrying out localised dredging and providing a landing jetty to allow boating access to the E. G. Waterhouse Camellia Gardens.

The Estuary Management Plan does show one conflict with the latest information presented in the scientific review prepared for the current project.

The recommended action is 'to provide adequate protection to existing stands of mangroves to avoid damage or removal'. While this remains consistent with the *Fisheries Management Act, 1994*, it does not acknowledge the more recently available scientific literature regarding statewide loss of saltmarsh to mangrove encroachment. As explained in the scientific data review (WBM 2005), the area of mangroves in Port Hacking has increased from around 15 hectares in 1930 to 35 hectares in 1999 (Patterson Britton, 2001; Williams and Meehan, 2000). The main growth has occurred at Cabbage Tree Basin and in the Hacking River (Williams and Meehan, 2000). Mangrove expansion at the expense of saltmarsh has been evident throughout NSW in the last 50 years (Saintilan and Williams, 1999) and there are a number of hypotheses to explain this trend, such as increased rainfall, land clearing, altered tidal regimes and increases in nutrients and sedimentation (Saintilan and Williams, 1999; Laegdsgaard, 2001). The implications of the Yowie Bay EMP are further considered in Section 2.5.4. A sediment removal feasibility study was included as an appendix to the report.

Gunnamatta Bay Estuary Management Plan

Four goals were developed for the Gunnamatta Bay Estuary Management Plan:

- enhance the quality of the bay's waters, foreshores and aquatic habitats
- enhance the biodiversity of Gunnamatta Bay
- enhance the scenic amenity and natural values of Gunnamatta Bay and its foreshores and conserve cultural heritage features
- provide a safe and pleasant environment and access for a range of recreational pursuits, which reflect the maritime character, and natural values of the bay.

The management plan includes seven recommended actions, summarised as:

- design, implement and co-ordinate a water quality monitoring program
- address identified sources of pollution (eg. Sewer network leaks)

- manage activities to reduce the risk of spreading *Caulerpa taxifolia* and research control methods
- encourage bushland management on private land
- implement planting programs on public lands
- carry out investigations and prepare a landscape master plan for the eastern foreshore of Gunnamatta Bay
- undertake navigation channel dredging as required at the entrance of the bay (employing effective control measures for *Caulerpa taxifolia*).

There is more detailed information within the plan that expands on each of these points, for example a water quality monitoring program presented in table format. The table includes monitoring objectives, suggested monitoring sites, parameters to be monitored and responsibilities. The preparation of the Gunnamatta Bay Estuary Management Plan also included an extensive community and stakeholder consultation program.

GyMEA Bay Estuary Management Plan

The GyMEA Bay Estuary Management Plan aims to meet four primary goals:

- enhance the quality of the Bay's waters and tributary creeks
- enhance the biodiversity of GyMEA Bay
- enhance the scenic amenity and natural values of GyMEA Bay and its foreshores and conserve cultural heritage features
- provide a safe and pleasant environment and access for water-based recreational pursuits, which relate to the natural values of the Bay.

The EMP includes six recommended actions, summarised as:

- design, implement and coordinate a targeted water quality monitoring program
- address identified sources of sewage pollution and undertake remediation as required
- address erosion within the catchment through slope stabilisation, planting with indigenous species and controlling stormwater run-off

- investigate removal of sediment within Gymea Baths
- undertake weed control and planting programs
- encourage bushland management on private properties.

As can be seen, these strategies are very similar to those developed for Gunnamatta Bay and are likely to be applicable to other areas in Port Hacking that have not been formally considered under the Estuary Management Policy. The major difference between this EMP and Yowie and Gunnamatta Bay is the exclusion of a management option recommending channel/navigation dredging. The development of this EMP also included an extensive community consultation program that utilised community questionnaires and stakeholder meetings.

Port Hacking Interim Boating Management Plan (Waterways Authority, 2003)

During 1999 the Waterways Authority (now NSW Maritime Authority) collected information on the community valued aspects and issues associated with Port Hacking. Further consultation was undertaken to elicit ideas for future management strategies to preserve these values and to address the identified issues.

The plan contains 46 actions that relate to the key areas of safety, environmental protection, equity of use and enhanced facilities. Each action has a timeframe and defined milestones to enable the monitoring and reporting of progress by NSW Maritime Authority. The plan has been designed to be responsive to changing priorities and conditions and integrated with other relevant plans.

In particular, this plan may change in response to the Integrated Management and Investment Plan being developed by the Port Hacking Management Panel. Accordingly, the plan has been labelled as an 'interim' document. The speed and general restrictions that apply to boating activities are presented on the Boating Safety Map available from

the NSW Maritime Authority, and include:

- four knot and eight knot speed limits
- no wash zones
- a no boating zone in Simpsons Bay
- a no water skiing zone in the Hacking River upstream of Shallow Rock Reserve
- a no PWC zone in Darook Park, Gunnamatta Bay.

The outcomes sought by the interim Boating Management Plan that relate directly to the planning documents reviewed for this report are:

- maintain current boating uses throughout the Port in a safe, responsible and sustainable manner
- a sustainable dredging regime
- appropriate protection of sensitive environments, including seagrasses and mangroves, and maintenance of natural setting where that exists
- the popular areas, such as Jibbon Bay, South West Arm and Cabbage Tree Basin, are used in a manner that maintains the natural setting of the waterway
- all boaters are made aware of the existence and boundaries of the Shiprock Aquatic Reserve
- protection of river banks along the Hacking River from erosion, especially in the busy Shallow Rock area
- minimisation of user conflicts.

The actions that have been designed to meet the desired outcomes of the Interim Boating Management Plan are generally consistent with the actions and objectives of the other key planning documents reviewed for this project. However, the plan does seek to 'maintain current boating uses', which could potentially conflict with ecological and recreational objectives. For example, the Gunnamatta Bay EMP includes the action 'Ensure boating activity does not impact on sensitive seagrass areas (revise boating maps, mooring locations and consider use of seagrass friendly moorings)' (see Appendix 6). The call for a sustainable dredging regime is consistent with the other plans and outcomes of the scientific review, provided that the term *sustainable dredging regime* includes the potential for reduced navigational access in the naturally shoaled and shallowing port.

Sydney Metropolitan Catchment Management Authority (SMCMA) Catchment Action Plan

The SMCMA has completed its draft of the Catchment Action Plan. The draft CAP will guide the activities of the SMCMA while forming the basis for partnerships with the community, business, industry and government. The draft 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 community. There are five themes: biodiversity, land, water, community and coastal. Under each of these, there are the Catchment Targets and Management Targets.

Regulation of Water in NSW

The regulation of water in New South Wales is currently governed by both the *Water Act 1912* and the *Water Management Act 2000*.

The *Water Management Act* operates in areas where Water Sharing Plans exist.

In the Port Hacking area, the *Water Act* continues to apply as no Water Sharing Plans are currently in place.

The *Rivers and Foreshores Improvement Act 1948* was repealed on 4 February 2008. Activities under the former act are now managed under “Controlled Activity” provisions of the *Water Management Act 2000*.

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GLOSSARY AND ACRONYMS

AASA	Standards Australia is a non-government standards development body.
Accretion	Gradual deposition of sediment that increases land area.
ANZECC guidelines	The Australian and New Zealand Environment and Conservation Council supply guidelines for fresh and marine water quality.
ASS	Acid sulphate soil – soils in areas along the coast containing iron sulphides which formed after the last sea-level rise. When exposed to air these sulphides oxidise to produce sulphuric acid. There is an estimated two million hectares of ASS in Australia. Drainage of wetlands for development releases enough acid to affect aquatic food chains, fish health and populations. (www.agric.nsw.gov.au/reader/10742 accessed 19/08/07)
BASIX	State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004 is an online program through which home builders enter information about their home, which is measured against energy and water targets. If the design meets the targets a certificate is issued that must be attached to a Development Application. BASIX has been introduced in stages since 2004 and on 1 October 2006 it became a requirement for all new building approvals and existing housing renovations in NSW. Administered through DOP.
Bathymetric	Data on the depth and topography of a body of water obtained through the measurement and charting of the river bed or sea floor.
Beachwatch	An EPA initiative that monitors coastal water quality throughout the Sydney metropolitan area; does quality control of monitoring done in the Hunter and Illawarra; and reports to the community on the risks of sewage and stormwater pollution at beaches and estuarine swimming areas.
<i>Caulerpa taxifolia</i>	A fast growing aquatic alga that has become established in ten NSW estuaries, including Port Hacking, and will potentially alter habitats and affect biodiversity. The weed easily regenerates and is difficult to eradicate. (www.fisheries.nsw.gov.au/threatened_species/general/content/fn_caulerpa1.htm accessed 07/08/07)
CCG	Coastal Councils' Group. Consists of 15 Sydney councils (Botany Bay, Hornsby, Leichhardt, Manly, Mosman, North Sydney, Pittwater, Randwick, Rockdale, Sutherland, City of Sydney, Warringah, Waverley, Willoughby and Woollahra). Established in 1989, the aim of CCG is to promote council coordination of natural resource management. (www.sydneycostalcouncils.com.au/ accessed 08/08/07)
CDS unit	Continuous Deflective Separation unit is a type of GPT.
CMA	Catchment Management Authority has 13 operations in NSW. These are statutory bodies that coordinate NRM in each catchment area and report to the Minister for Natural Resources.
CRMS	Customer Response Management System.
Crown Lands Act (1989)	An Act to provide for the administration and management of crown land in the Eastern and Central Division of the state.
DCP (Or SSDCP)	Sutherland Shire Development Control Plan.
DECC	The Department of Environment and Climate Change is a new agency formed on 27 April 2007. DECC consists of the former Department of Environment and Conservation (DEC) and sections of the Department of Natural Resources (DNR).
Dinoflagellates	Single-celled microalgae that produce harmful toxins. These toxins are accumulated by oysters and mussels, which, when eaten by humans, may cause Paralytic Shellfish Poisoning (PSP). Intense blooms and accumulation of toxins through the food chain can lead to poisoning and mortality of a wide range of shellfish, finfish and marine mammals. (http://www.marine.csiro.au/crimp/Reports/Infosht11_Tdfs0201S3.pdf accessed 08/08/07)
DO	Dissolved oxygen.

DOP	The NSW Department of Planning was formerly the Department of Planning, Infrastructure and Natural Resources (DIPNR).
DPI	NSW Department of Primary Industries acts in partnership with industry and other public sector organisations to foster profitable and sustainable development of primary industries in New South Wales. Fisheries is part of DPI.
Dredge/dredging	Scooping up material (sediment, mud, etc.) from the bottom of rivers to deepen the channel.
EAC	East Australian Current is the largest ocean current close to the Australian coast. The current brings tropical water down along the eastern coastline. This is important for fish stocks, shipping, recreational boating and swimming, and water quality renewal. (http://www.marine.csiro.au/LeafletsFolder/37eac/index.html , accessed 20/08/07)
EC	The electrical conductivity of water is used as a unit for measuring salt concentration.
EEC	Endangered Ecological Community is listed under the Threatened Species Conservation Act, 1995.
EMP	Estuary Management Plan.
ENSO	El-Niño/Southern Oscillation phenomenon is the sustained warming of the Pacific Ocean which affects weather patterns in Australia and is a natural part of the climate cycle that occurs every four to seven years.
Enterococci	Bacteria found in the gastrointestinal tract of warm blooded organisms that can enter water through faecal contamination. These bacteria can cause meningitis, diverticulitis and urinary tract infections and are often resistant to antibiotics. The amount of <i>Enterococci</i> in bodies of water is used as a measure of contamination.
EPA	NSW Environment Protection Authority has been incorporated into the new DECC.
EP&A Act	Environmental Planning and Assessment Act, 1979 institutes a system of environmental planning and assessment for NSW. (See http://www.legislation.nsw.gov.au/viewtop/inforce/act+203+1979+first+0+N)
Faecal coliforms	Faecal (or thermotolerant) coliforms are bacteria found in the gastrointestinal tract of warm-blooded organisms that can enter water through faecal contamination. The amount of faecal coliforms in water is used as a measure of contamination, although has now mainly been replaced by <i>Enterococci</i> as an indicator.
Feral	A plant or animal that has escaped from domestication and multiplied in the wild. Examples in the Port Hacking area include deer and privet.
Fishcare Volunteer Program	Fishcare volunteers are organised by the Department of Primary Industries (formerly NSW Fisheries). 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. Funded by the recreational fishing licence, the NSW Fishcare Volunteer Program continues to expand boasting volunteers in many inland and coastal areas around the State.
Fisheries	NSW Fisheries is a sub-department of the NSW Department of Primary Industries, responsible for managing the fisheries resources of NSW.
Fisheries Management Act (1994)	An Act relating to the management of fishery resources. (See http://www.legislation.nsw.gov.au/viewtop/inforce/act+38+1994+FIRST+0+N)
FIT	Free and independent traveller is a term used to describe tourists who do not participate in package or group tours.
Geochemical	Relating to the chemistry of soil.

Geomorphology	The study of the origin, characteristics and development of landforms.
GIS	Geographic Information System is a software based system that allows for the modelling and analysis of geographical data.
GPT	Gross Pollutant Trap is a stormwater trap that captures coarse pollutants, such as rubbish, large sediment, before being washed into waterways.
Gunya	A Dharuk and Eora word meaning 'house'.
HRCMC	Hacking River Catchment Management Committee was incorporated in 2000 by the Southern Catchment Management Board (SCMB). In 2003 the Catchment Management Boards were replaced by Catchment Management Authorities. The Hacking River Catchment was included in the Sydney Metropolitan Catchment Management Authority area.
Hydrodynamic	The movement, speed and direction of water flow.
Hydrology	The study of the properties, distribution and circulation of water.
Indicator	An indicator helps with understanding of location, direction and timeframes. Ideally, a good indicator highlights a problem before it gets too bad and helps identify what needs to be done to fix the problem. Indicators need to be measurable, credible and have meaning in terms of the plans vision and goals.
Landscape elements	
- <i>Fluvial delta</i>	Sedimentary deposit where a river flows into the ocean or estuary.
- <i>Hanging swamp</i>	Form on cliff sides in depressions with poor drainage. Water is trapped by the layers of shale underlying the sandstone, creating damp conditions ideal for mosses and heath plants.
- <i>Heathland</i>	Vegetation dominated by small shrubs occurring in sandy areas.
- <i>Holocene marine mud</i>	Marine mud that formed during the Holocene period, which is the geological time period from 10,000 years ago to present.
- <i>Littoral rainforest</i>	Classed as an EEC, this coastal rainforest is adapted to strong, salty sea winds, and is found all along the NSW coast. The littoral rainforest comprises less than 1 per cent of the total area of rainforest in the state. Examples of this community are mapped under SEPP 26. On headlands the littoral rainforest may take on the form of dense thickets shaped by wind, whereas in sheltered positions the stands are taller. (www.nationalparks.nsw.gov.au/npws.nsf/Content/Littoral_Rainforest_endangered accessed 07/08/07)
- <i>Narrabeen shale</i>	Beds of chocolate-coloured shales and greenish tuffs varying from a foot or so to about 1800 feet in thickness.
- <i>Pleistocene estuarine mud</i>	Estuarine mud that formed during the Pleistocene period, which is the geological time period around 1.6 million to 10,000 years before present, commonly known as the ice age.
- <i>Riparian zone</i>	Land adjoining a waterway that is influenced by the waterway and provides a link between aquatic and terrestrial ecosystems. The width of the riparian zone is dependant on the scale of the water body.
- <i>Riverine channel</i>	Natural or manmade deeper course through a river on which vessels can travel.
- <i>Saltmarsh</i>	Saltwater wetland tolerant of waterlogging and salinity and is vegetated by grasses, herbs and low shrubs.
- <i>Seagrass</i>	Seagrasses grow in shallow waters of estuaries where there is sufficient light penetration, and are an important habitat, feeding and nursery ground for aquatic animals.
- <i>Sedgeland or wet meadow</i>	Wetland communities found where the soil is normally saturated. Sedges or grasses are the dominant species.
- <i>Shoal</i>	Shallow areas in an estuary created by the deposition and build up of sediments.
- <i>Wianamatta shale</i>	Blue, red, and grey shales, with occasional beds of sandstone. These shales are used for the manufacture of bricks and tiles. (http://www.abs.gov.au/AUSSTATS/abs@.nsf/featurearticlesbyCatalogue/2B69A0F02F44C730CA2569DE001F1083?OpenDocument accessed 23/08/07)

LEP (Or SSLEP)	Sutherland Shire Local Environment Plan. The SSLEP 2006 is currently in force for the Sutherland LGA. This LEP was issued by the Minister for Planning on 15 September 2006, but did not come into effect until 29 November. Work on the new LEP is planned to finish in 2010, but the new LEP is not required until 2011.
LGA	Local Government Area.
Macrophytes	In aquatic environments, macrophytes are aquatic plants growing in or near the water large enough to see, eg. grasses.
Macro benthic	Organisms living at the bottom of a body of water that are visible to the naked eye.
Management Plan	The SSC Management Plan and Annual Report are produced annually as part of council's statutory requirements.
Maritime NSW	Maritime NSW is a self funding statutory state government body. Under the provisions of the Environmental Planning and Assessment Act, 1979 (EP&A Act) and other relevant legislation, NSW Maritime has four separate development approval roles with respect to its own land and adjacent foreshore land, i.e. as land owner, as consent authority in the development approval process, as a determining authority, and as a construction approval authority.
Metropolitan Greenspace Program	A DOP initiative to work with local councils in planning and improving greenspace such as parks, trails and reserves. (www.planning.nsw.gov.au/programservices/met.asp accessed 08/08/07)
Microphytobenthos	Benthic microalgae, or MPB, are microscopic algae and cyanobacteria that grow in the sediment of intertidal areas, such as estuaries and saltmarshes.
Midden	Sites where Aboriginal people discarded shells and bones, mostly found along the coast.
MoU	Memorandum of Understanding.
Multi-beam echo-sounder	A device used to map the seabed.
Nettech device	A type of GPT.
Nitrification	The conversion of ammoniacal nitrogen to oxidised nitrogen. It requires the consumption of oxygen.
NLWRA	National Land and Water Resources Audit reports on the condition of Australia's land, water and biological resources by collating data, social and economic information. (http://www.nlwra.gov.au/index.aspx accessed 21/08/07)
Non-point source pollution	When contaminants enter the waterway from distributed locations rather than specifically defined locations.
NPWS	National Parks and Wildlife Service (part of DECC).
NRC	Natural Resources Commission provides independent, scientific advice to the NSW Government on a range on natural resource management issues. The NRC recommends standards and targets for NRM, reviews CMAs catchment management plans and audits action from these plans. (http://www.nrc.nsw.gov.au/ accessed 21/08/07)
NRM	Natural Resource Management. The sustainable management of terrestrial, aquatic and biological systems.
NSW Estuary Management Policy	This policy forms part of a suite of catchment management policies and provides for the assessment of all estuarine uses, the resolution of conflicts and the production of a unified and sustainable management plan for each estuary, including remedial works and the redirection of activities, where appropriate. (http://test.dnr.nsw.gov.au/care/water/estuaries/about/estuary-policy.html accessed 22/08/07)

OSSMS	On-site sewage management systems are forms of treating and disposing of wastewater required in areas where a sewage service is unavailable.
PHC	Port Hacking Catchment.
PHIEMP	Port Hacking Integrated Environmental Management Plan.
PHMP	Port Hacking Management Panel.
PHPS	Port Hacking Protection Society.
PHWG	Port Hacking Management Plan Working Group.
Phytoplankton	Microscopic free-floating plants found in bodies of water.
Poly Aromatic Hydrocarbons	Also called Polycyclic Aromatic Hydrocarbons, molecules derived from petroleum commonly used in manufacturing dyes, insecticides and solvents.
POM	Port Hacking Plan of Management, 1992
Postglacial marine transgression	PMT is the landward migration of the ocean coastline with rising sea levels after the last ice age. It is estimated that sea levels rose 100m in the period between the last ice age and 6,500 years ago.
Prograding	The opposite of erosion where sand dunes that are increasing in size.
PWC	PWC, eg. jet skis.
River keeper	The position of river keeper combines the roles of a boating officer (promoting boating safety) and a ranger (environmental protection).
RNP	The Royal National Park is managed by DECC under the NPWS.
Sedimentation	The process of suspended solids settling to the bottom of water.
SEPP 26	State Environmental Planning Policy 26 - Littoral Rainforests aims to prevent development that is likely to damage or destroy littoral rainforest areas and to preserve those areas in their natural state.
SMCMA	Sydney Metropolitan Catchment Management Authority.
SOE	State of the Environment Report. Under NSW Government legislation, SSC is required to prepare a SOE each financial year. The report describes the pressures on, and state of, the environment within the Sutherland Shire while also providing relevant background information to the various environmental response programs being undertaken by council and other agencies. The report is intended to be an information source for residents, special interest groups and government. The state-pressure-response model is used.
SOS	State of the Shire Report. Produced by SPU every three to four years
SSC	Sutherland Shire Council. Internal abbreviations include: <ul style="list-style-type: none"> • Eng. – Engineering Division • P&W– Parks and Waterways Division • SPU– Strategic Planning Unit.
SSROC	Southern Sydney Regional Organisation of Councils is an association through which local councils share resources, cooperatively develop policy and lobby state and federal government. SSROC includes the councils of Botany Bay, Canterbury, Hurstville, Kogarah, Marrickville, Randwick, Rockdale, South Sydney, Sutherland, Waverley and Woollahra representing one million residents. (http://www.ssroc.nsw.gov.au/ accessed 17/08/07)
Stack facility	A type of dry storage facility that can accommodate large numbers of vessels by stacking on a framework.
Stakeholder	An individual or group with professional or personal interests in an issue or outcome.

Stormwater Levy	The stormwater levy results from council decision in 2006/7 to accept the NSW State Government's invitation to levy a stormwater management charge, allowing council to commence its largest ever stormwater management program. This major drainage construction and water quality program totals \$2.515m, of which \$1.81m will be funded from the stormwater management charge.
Stratification	In geology it is the structure formed by the deposition of sediments into layers. In hydrology it is the formation of distinct temperature layers in a body of water.
SWaMP	Strategic Water Monitoring Program.
Threatened Species Conservation Act (1995)	The Act identifies and protects threatened species, populations, ecological communities and their habitats. The Act encourages conservation through co-operative management. (www.threatenedspecies.environment.nsw.gov.au/legislation.aspx accessed 07/08/07)
TKN	Total Kjeldahl Nitrogen. The combination of organically bound nitrogen and ammonia in wastewater.
Turbidity	A measure of the ability of water to absorb light, which is affected by the presence of suspended matter.
UOW	University of Wollongong.
Water Management Act (2000)	An Act to provide for the protection, conservation and ecologically sustainable development of the water sources of the state, and for other purposes. (See http://www.legislation.nsw.gov.au/viewtop/inforce/act+92+2000+first+0+N)
WBM	WBM Oceanics Australia.
WCC	Wollongong City Council.
Wet berth	A location in a port where a vessel can be moored alongside a shoreline.
Woronora Ramp	A geological formation underlying the Woronora River comprised of Hawkesbury sandstone, which gently dips from the inland plateau to Port Hacking.
WSUD	Water Sensitive Urban Design is a form of urban development that prioritises water sustainability in its design.