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DRAFT
Environmental Management Plan for Cockburn Sound and its Catchment

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Prepared by the
Cockburn Sound
Management Council
for the
Environmental Protection Authority

December 2001

Draft Environmental Management Plan for Cockburn Sound and its Catchment

PREPARED BY THE

COCKBURN SOUND MANAGEMENT COUNCIL

FOR THE

ENVIRONMENTAL PROTECTION AUTHORITY

December 2001

What do you think?

Making Comments

The Cockburn Sound Management Council would like to know what you think of the proposals in this Draft Plan. Have you thought about writing a submission?

This is an opportunity to provide information, express an opinion, suggest alternatives or propose other management options. Your comments will be taken into account when writing the final Environmental Management Plan for Cockburn Sound and its Catchment.

To ensure your comments are as effective as possible:

- make them clear and concise;
- list your points in the same order as in the document;
- suggest alternatives or what you would like done; and
- be specific when your comments relate to a particular point.

Comments should be sent

by

31st March 2002

to

Chairman

Environmental Protection Authority

PO Box K822
PERTH WA 6842

Reference details

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Executive Summary

Setting the scene

Cockburn Sound, which is located some 20 km south of the Perth-Fremantle area (Figure 1a), is the most intensively used marine embayment in Western Australia.

In response to increasing pressures on the Sound, the Environmental Protection Authority is drafting an Environmental Protection Policy, which outlines the environmental values, objectives and criteria for managing Cockburn Sound.The Policy requires that an Environmental Management Plan for Cockburn Sound and its catchment be prepared by the Cockburn Sound Management Council.

This document – the *Draft Environmental Management Plan for Cockburn Sound and its Catchment* – details a five point plan of action towards implementing the Environmental Protection Policy:

1. **Protecting the environmental values of Cockburn Sound.**
2. **Facilitating multiple use of Cockburn Sound and its foreshore.**
3. **Integrating management of the land and marine environments.**
4. **Coordinating research and investigations.**
5. **Monitoring and reporting on performance.**

1. Protecting the environmental values of Cockburn Sound

The Environmental Protection Authority is broadly adopting the national approach to water quality management to protect Cockburn Sound from pollution, waste discharges (e.g. industrial effluent) and deposits (e.g. dredge spoil). The environmental values and objectives for the Sound have been determined and will form the basis of the Environmental Protection Policy for Cockburn Sound.

The environmental quality criteria (environmental benchmarks) are currently being finalised in consultation with the main stakeholders.

In the absence of the final criteria for Cockburn Sound, the management responses detailed in this Plan are based on the most up-to-date information on the state of Cockburn Sound, on current community concerns and, where appropriate, the Australian guidelines for marine water quality.

Proposed management recommendations aimed at protecting the ecological and social values of Cockburn Sound include:

- Supporting the implementation of international, national, State and local regulations and guidelines to control the use and management of tributyltin.
- Developing and implementing a Nutrient Management Strategy.
- Continuing the current approach of cooperative best management towards reducing nutrient loads to Cockburn Sound from industrial, urban and rural sources.
- Promoting recolonisation and re-establishment of seagrass in areas of Cockburn Sound where it once occurred by investigating the major constraints to seagrass regrowth and, where practicable, implementing remedial action.
- Ensuring proponents of future development proposals are guided by the prinicple of no net loss of ecological or social function in Cockburn Sound.
- Supporting the proposal to recycle waste water and remove industrial discharges (other than cooling water) from Cockburn Sound.

2. Facilitating multiple use of Cockburn Sound and its foreshore

The need to balance competing uses of the marine and foreshore environment of Cockburn Sound in an ecologically sustainable manner presents major challenges. A key role of the Cockburn Sound Management Council is to integrate the uses of the Sound to reach an acceptable balance of outcomes across the full range of uses and users.

In approaching this task the Management Council established a working group for each of the four main uses of Cockburn Sound: recreational and commercial (for example, fishing); industry; natural and cultural heritage; and defence. Each working group described and mapped the individual uses and determined compatibility within and between uses.

None of the current uses was found to cause a level of environmental impact or community conflict that would require total exclusion of the use from Cockburn Sound and its foreshore.

The main area of concern is that community use of the eastern foreshore of Cockburn Sound is becoming increasingly limited due to the construction of foreshore developments and the erosion of beaches at Wells Park, Challenger Beach and Woodman Point.

Whilst recognising that industry is the primary land use in the Jervoise Bay and Kwinana areas, the Management Council will be taking a cooperative approach to investigate ways of improving community access to, and use of, the eastern foreshore. Key issues to be addressed include enhancing beaches and facilities at existing public access points such as Challenger Beach, and identifying the constraints to public access within the Kwinana and Jervoise Bay areas and developing practical solutions with stakeholders.

Other key considerations for the future management of multiple uses in Cockburn Sound include the following:

- Recreational fishing pressure is predicted to increase by about 30% in the next 10 years and by more than 50% in the next 20 years.
- Water sports (such as jet skiing, water skiing, boating and sailing) are concentrated in Mangles Bay. Integrated boating facilities are required to minimise the current environmental impacts on seagrass meadows and to cater for future demand.
- Mussel production is expected to reach 1000 tonnes in 2001/2002 and has the potential to reach 4000 tonnes, worth over $10 million.
- Kwinana and Jervoise Bay are the State's prime heavy industry and marine construction sites, respectively. The Kwinana Industrial Area alone is estimated to produce goods worth at least $6 billion/year.
- Potential future developments include the James Point Private Port (which could include the live sheep trade) and the proposed Fremantle Port Authority harbour.
- Protecting the remaining healthy meadows of seagrass in the Sound is a high priority.
- The level of shipping and boat traffic in Cockburn Sound will increase dramatically in future years, with recreational boating predicted to increase 43% by 2011, commercial shipping 5% per year, and Navy vessels 25% by 2004.

The Cockburn Sound Management Council will be coordinating a comprehensive survey to establish future types of use, areas of use and intensity of use for the long-term environmental management of Cockburn Sound and its foreshore.

3. Integrating management of the land and marine environments

Land uses within the catchment of Cockburn Sound include urban, industrial and rural. Expansions of urban areas and industrial land use are either planned or expected, in many cases encroaching into rural areas. The main way that land uses affect the marine environment is by contamination of groundwater and surface water that flows into the Sound.

At present, nutrient inputs to the Sound are largely from groundwater contaminated by industry, but these are decreasing and the relative role of rural areas is starting to become significant. There is less information on other sources, such as urban stormwater and drainage.

Proposed catchment management strategies aimed at minimising the overall impact of ground and surface water contamination on the environmental values of Cockburn Sound include:

- Assessing the effectiveness of existing planning controls to limit nutrient inputs from urban, rural and industrial sources.

- Working with local government and planning agencies to establish planning mechanisms to protect the waters of Cockburn Sound.
- Initiating a Catchment Partnership with rural, urban and industrial land users to implement Environmental Best Management Practices.
- Mapping the stormwater catchments around the urbanised areas of Rockingham, Cockburn and Kwinana and identifying discharge points into the Sound.

4. Coordinating research and investigations

Cockburn Sound is one of the most intensively studied marine systems in Western Australia. Much of this work is reported in the *Cockburn Sound Environmental Study (1976-1979)*, the *Southern Metropolitan Coastal Waters Study (1991-1994)* and most recently, the *State of Cockburn Sound (2001)* report. These studies provide us with a broad understanding of the physical and ecological processes that define the Cockburn Sound environment and the main pressures that threaten the values of this system.

The Cockburn Sound Management Council is responsible for coordinating and, where appropriate, undertaking research and investigations to improve the information and knowledge base required for management. Key recommendations aimed at filling the gaps in our knowledge base of Cockburn Sound include:

- Developing an agreed method for evaluating the cumulative impacts of current and future activities and developments.
- Collecting additional data to improve our understanding of water movement and coastal processes.
- Developing an agreed understanding of the effects of nutrient inputs to Cockburn Sound.
- Determining the influence of the Garden Island Causeway on the environmental quality of the Sound and the potential environmental benefits of modifying its design.
- Updating the inventory of contaminated sites, giving priority to sites within five kilometres of Cockburn Sound.
- Developing a better understanding of the social and cultural aspects of Cockburn Sound that the community values.

5. Monitoring and reporting on performance

A key role of the Cockburn Sound Management Council is to monitor the management actions of government agencies, industry, Defence, local councils and user groups, and to report to the community on their collective progress towards a healthier Cockburn Sound.

The Environmental Management Plan outlines a Community Awareness and Involvement Program which entails:

- Reporting annually to the government and the community on the 'state' of Cockburn Sound.
- Producing monthly updates on progress through a newsletter, *Sound News*.
- Seeking feedback through regular community forums.
- Providing a 'shop front' office in Rockingham where the latest information on Cockburn Sound is easily accessible.

Implementing the plan

Implementing the recommendations of the Environmental Management Plan will take place over the next seven years. In many instances, actions are already under way.

It is proposed to take a cooperative approach to implementing the Plan with at least 14 government agencies at a local, State and Commonwealth level and many community and interest groups responsible for working together to ensure that various recommendations are completed. The State government agencies will primarily be responsible for pursuing funding for implementing the Plan, although many actions within the Plan rely heavily upon community, industry and local and Commonwealth government involvement.

Following the release of the draft Environmental Management Plan and the public consultation period, an Implementation Table will be developed as part of the final Plan.

Acronyms

AMSA	Australian Maritime Safety Authority
AQIS	Australian Quarantine and Inspection Service
CoC	City of Cockburn
CoR	City of Rockingham
CSMC	Cockburn Sound Management Council
CPBA	Cockburn Power Boat Association
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CALM	Conservation and Land Management
DoA	Department of Agriculture
DoD	Department of Defence
DEP	Department of Environmental Protection
DoF	Department of Fisheries
DHWA	Department of Health Western Australia
DIA	Department of Indigenous Affairs
DoIT	Department of Industry and Technology
DMPR	Department of Minerals and Petroleum Resources
DPI	Department of Planning and Infrastructure
EPA	Environmental Protection Authority
FPA	Fremantle Port Authority
IMO	International Maritime Organisation
KIC	Kwinana Industries Council
LGAs	Local Government Authorities
MPRA	Marine Parks and Reserves Authority
Recfishwest	Recfishwest
RAN	Royal Australian Navy
SoE	State of the Environment
SWG	South West Group
ToK	Town of Kwinana
WRC	Water and Rivers Commission
WC	Water Corporation
WAFIC	Western Australian Fishing Industry Council
LandCorp	Western Australian Land Authority
WAM	Western Australian Museum
WATC	Western Australian Tourism Commission
WAVGA	Western Australian Vegetable Growers Association

Contents

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Tables

Figures

Setting the Scene

Why have an Environmental Management Plan for Cockburn Sound?

Cockburn Sound, which is located some 20 km south of the Perth-Fremantle area, is the most intensively used marine embayment in Western Australia (Figure 1a).

With its sheltered waters, diversity of marine life and close proximity to Perth's southern suburbs, Cockburn Sound is highly valued by the community for recreational and commercial purposes such as swimming, sailing, fishing, aquaculture and tourism.

The embayment also provides a safe shipping anchorage and a protected setting for significant maritime facilities for the State's major industrial and ship building complexes and Australia's naval forces.

The hinterland of Cockburn Sound supports a full range of land uses including urban, rural, industrial, defence and nature conservation.

These many, and sometimes competing, uses are placing increasing pressure on the Sound and they will intensify as the population in the catchment is expected to increase by over 30% within the next 10 years. The need to manage these complex, multiple uses and the associated environmental impacts has never been greater.

In response, the Cockburn Sound Management Council (CSMC/the Management Council) was established in August 2000 to coordinate environmental planning and management of Cockburn Sound and its catchment (Figure 1b). The Management Council comprises 26 members who represent the community; recreation and conservation groups; industry; and Commonwealth, State and local governments.

At the same time as the Management Council was formed, the Environmental Protection Authority commenced drafting an Environmental Protection Policy for Cockburn Sound. The Policy outlines the environmental values, objectives and criteria for managing Cockburn Sound, and requires the preparation of an Environmental Management Plan by the Cockburn Sound Management Council.

This document – the *Draft Environmental Management Plan for Cockburn Sound and its Catchment* – details the following five point plan of action towards implementing the Environmental Protection Policy:

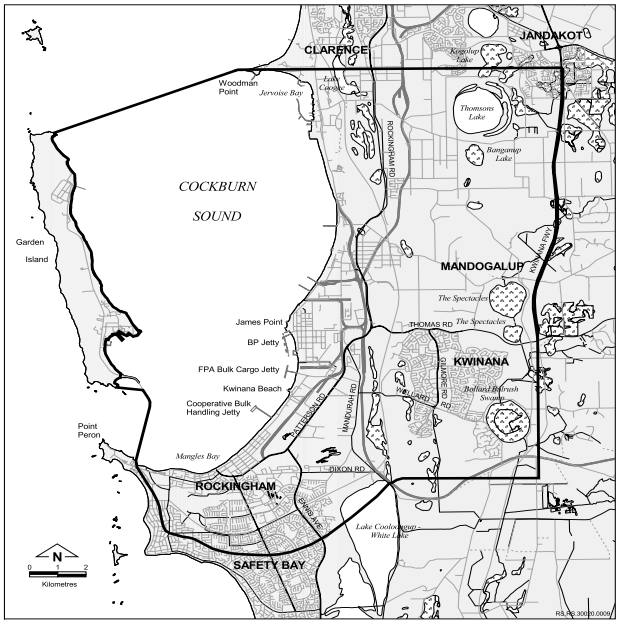

Figure 1b. Management area of the Cockburn Sound Management Council

1. ***Protecting the environmental values of Cockburn Sound.***
2. ***Facilitating multiple use of Cockburn Sound and its foreshore.***
3. ***Integrating management of the land and marine environments.***
4. ***Coordinating research and investigations.***
5. ***Monitoring and reporting on performance.***

This Plan builds on the previous studies including the *Cockburn Sound Environmental Study* (Department of Conservation and Environment, 1979), the *Southern Metropolitan Coastal Waters Study* (Department of Environmental Protection, 1996) and, a compilation of the most recent work, the *State of Cockburn Sound* report (DAL, 2001). Much of the background information in this Plan is drawn directly from the *State of Cockburn Sound* report.

In relation to the management area, the primary focus of the Environmental Management Plan is the marine environment of Cockburn Sound. The extent to which the Plan deals with the terrestrial environment is limited to those issues that directly or indirectly impact on the water quality of the Sound, for example groundwater and surface water contamination.

Other important catchment issues, such as the conservation of wetlands and management of air quality, are addressed in a range of management documents, which link to and complement the *Environmental Management Plan for Cockburn Sound and its Catchment*.

Format of this Plan

The Plan consists of the following sections:

Management Context – This section outlines the principles and policies that guide the management of Cockburn Sound and describes the relationship between the Environmental Protection Policy and the Plan. The roles and responsibilities of the bodies involved in implementing the Plan are also listed.

Management Response – This section details a five point action plan for Cockburn Sound and its catchment. The format of each of the five sub-sections broadly follows the approach taken by the Department of Conservation in management planning for marine areas in the conservation estate of Western Australia.

Adopting this approach ensures that there will be consistency in future planning and management of Cockburn Sound and adjacent marine areas, such as the Shoalwater Islands Marine Park.

This approach involves: recognising the key ecological and social **values**; identifying the main **issues** regarding these values; and developing management **objectives** and **recommendations** to address these issues. Listed next to each recommendation in the Plan are the **agencies/groups responsible for implementation**, together with the **time frame** for commencing and completing the task.

Many of the management issues and recommendations overlap within sections of the Plan. For example, the protection of seagrass meadows is addressed in Section 1.3 Maintaining a Healthy Ecosystem, and in Section 2.4.1 Marine Habitats. Rather than eliminate this duplication, each section is written to stand alone, enabling the reader to find most of the relevant information in one place in the Plan.

Implementing the Plan – This section proposes a cooperative approach to implementing the Environmental Management Plan and provides an example of an Implementation Table to be incorporated into the final Plan to assist in tracking progress.

Management Context

Principles

At a national level, the planning and management of marine waters is guided by a range of strategies, including the *National Strategy for Ecologically Sustainable Development* (Commonwealth of Australia, 1992), the *National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia, 1996), *Australia's Oceans Policy* (Commonwealth of Australia, 1998), and the *National Water Quality Management Strategy, Paper No.4* (ANZECC/ARMCANZ, 2001).

Australia's Oceans Policy, in particular, provides specific guidance on applying the concept of ecologically sustainable development to the marine environment. The following Principles for Ecologically Sustainable Ocean Use are relevant to the planning and management of Cockburn Sound:

Ecosystem integrity

The maintenance of healthy and productive marine ecosystems is fundamental to the management of the marine and land environments. If the potential impact of an action is of concern, priority should be given to maintaining ecosystem health and integrity.

Multiple use

Environmental, social, cultural and economic aspirations are to be accommodated through integrated planning and management of multiple uses of marine resources.

Community participation

The benefits from the use of common marine resources, and the responsibility for their continued health and productivity, should be shared by the whole community.

Ecologically sustainable marine-based industries

Ecologically sustainable marine industries provide opportunities for wealth generation, employment and regional development, in a manner that does not compromise the social and ecological values.

Decision-making

The processes for assessing, planning, allocating and managing marine resources should:

- be easily understood;
- be certain;
- have clear lines of accountability;
- provide for equity within and between generations;
- be designed to deliver outcomes that are clearly transparent and balance long and short-term environmental, social, cultural and economic considerations;
- encourage cooperation and ensure coordination between government agencies and across user groups; and
- take into account wider interests and ensure effective community involvement.

Knowledge

Management of the human activities that affect our marine environment will require progressive improvement in our understanding of living and non-living marine resources and processes. Marine planning and management decisions should be based on the best available scientific and other information, recognising that information regarding marine resources will often be limited.

Precautionary measures

Incomplete information should not be used as a reason for postponing precautionary measures intended to prevent serious or irreversible environmental degradation of the marine environment.

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Policy

At a local level the Environmental Protection Authority is incorporating the national strategies and principles into an Environmental Protection Policy for Cockburn Sound. Through this Policy the Authority will establish the management framework to declare and protect the environmental values of Cockburn Sound, under the *Environmental Protection Act 1986*.

The Cockburn Sound Environmental Protection Policy (EPP) is structured into three main parts, a number of Schedules and an accompanying Reference Document.

Part 1 Preliminary

This section states the purpose of the Policy, identifies the Policy area and protected area to which the Policy applies, and defines the terms used. The EPP broadly aims to:

- establish environmental values, environmental quality objectives and environmental quality criteria for the waters of Cockburn Sound;
- identify a program to protect the environmental values;
- integrate environmental planning and management of the land and marine environment;
- establish an Environmental Management Plan (EMP) to coordinate management;
- provide a mechanism for the Management Council to coordinate environmental management efforts; and
- provide for regular reporting on progress against objectives.

Part 2 Environmental values, environmental quality objectives, environmental quality criteria for the protected area

This describes the actual values that are to be protected; the environmental quality objectives necessary to achieve or maintain those values; and the criteria used to measure whether or not the objectives are being met, including the area to which they apply. This approach is broadly consistent with the National Water Quality Management Strategy.

Part 3 Program to protect environmental values and achieve environmental quality criteria

This section establishes a framework to protect the environmental values of Cockburn Sound, and a management program to implement the framework. The EMP for Cockburn Sound is a key component of both the framework and management program. It is through this part of the Environmental Protection Policy that the EPA intends delegating authority to the Cockburn Sound Management Council for the preparation and implementation of an Environmental Management Plan for Cockburn Sound. The process for amending the Plan will also be described in this part of the Policy.

Schedules

The Schedules carry the same status and enforceability as the other parts of the Environmental Protection Policy. The maps showing the location of the EPP area and the environmental quality areas will be placed in the Schedules of the EPP.

Reference Document

The tables detailing the environmental quality criteria, together with the standard procedures for collecting and analysing samples and data, will be located outside the EPP in an accompanying Reference Document. The process for amending the Reference Document will be contained in the EPP.

Planning and Implementation

The Cockburn Sound Environmental Protection Policy provides the legal basis for the Environmental Management Plan.

Under this arrangement the Management Council is charged with developing the Plan for the waters of Cockburn Sound and its catchment which will:

- Recognise and facilitate multiple use management of Cockburn Sound.
- Incorporate the environmental quality objectives and criteria of the EPP.
- Foster the integration of environmental planning and management for the land and marine environment.

Traditionally, environmental management plans have been produced after the environmental protection policy for an area has been completed. In the case of Cockburn Sound, the decision was made to develop the EPP and EMP concurrently. This ensured that the community and interested stakeholders, such as industry and local user groups, were involved in shaping the 'on-ground' management response.

The final version of the Plan will be released after the Minister for the Environment has approved the Cockburn Sound EPP. Upon the release of the Plan, the Management Council will be responsible for:

- Administering and coordinating the implementation of the Plan, and publicly reporting on its performance in achieving its stated objectives.
- Investigating, monitoring, reviewing and reporting on environmental objectives, criteria and targets.
- Coordinating and/or undertaking research and investigations as a basis for development and implementation of management objectives.
- Reporting annually to the Ministerial Council and the Board of the Water and Rivers Commission on progress.

In implementing the Plan, the Management Council will draw upon the skills, experience and legislative powers of its broad membership, which includes representatives of the general community, recreation and conservation groups, industry, Defence and local, State and Commonwealth government agencies. Table 1 provides a summary of the roles and responsibilities of the agencies represented on the Management Council.

The Management Council also has community, recreation, conservation, and local industry representatives. Council membership of these groups, together with representatives of the broader community, is one of several important mechanisms used to directly obtain community views on issues referred to the Council for consideration and comment. Details of the representatives of community groups and local industry are provided in Table 2.

Table 1. Roles and Responsibilities of the Agencies Represented on the Cockburn Sound Management Council

Agency	Role and Responsibilities
Department of Environmental Protection (DEP)	Assists the Environmental Protection Authority in the process of assessing proposals that may significantly affect the environment and in developing policies.Administers pollution control legislation through planning approvals and licensing mechanisms under the *Environmental Protection Act 1986*.
Water and Rivers Commission (WRC)	Investigates, assists, plans and promotes the protection and efficient use of water resources. Manages the taking of groundwater and surface water under the *Rights in Water and Irrigation Act 1914*.Is the lead agency and provides support for the Cockburn Sound Management Council.
Department of Conservation and Land Management(CALM)	Provides the lead role in the conservation of native plants and animals through integrated management of terrestrial and marine reserves. Roles include: implementation of management plans; wildlife research; and management of nature-based tourism.
Department for Planning and Infrastructure(DPI)	Coordinates land use and transport infrastructure planning, and service delivery in Western Australia. Principal focus and outcomes include: • Strategic planning for land use and infrastructure. • Provision of infrastructure, transport, land development, and property administration services. In Cockburn Sound, DPI is responsible for maritime facilities, coastal management advice, marine safety and navigation, and co-ordination of pollution response.
Fremantle Port Authority (FPA)	Ensures that port services and facilities within Fremantle Harbour are provided in a reliable, competitive and efficient way. The outer boundary of Fremantle Harbour extends south to include Cockburn Sound.
Department of Fisheries(DoF)	Manages and conserves fish and fish habitat resources, licenses commercial and recreational fishers, undertakes research and compliance activities to ensure the sustainable use of the resources. Provides research, development and licensing services for aquaculture production.
Water Corporation(WC)	Provides water, waste water and drainage services throughout the Cockburn Sound catchment.
Department of Minerals and Petroleum Resources (DMPR)	Manages State Agreements under which most of the major industries at Kwinana operate. Assists development and establishment of major new resource processing projects. Advises government on strategic policy and planning for industrial land use and infrastructure.
Department of Industry and Technology (DIT)	Oversees the State's economic development to maximise benefits deriving from new and emerging industries and technologies, while supporting competitiveness of existing industries.
City of Cockburn (CoC),Town of Kwinana (ToK) City of Rockingham(CoR)	Three local government authorities are partly situated within the Cockburn Sound catchment. They have responsibility for local planning and development control. The *Town Planning and Development Act 1928 – 1986* also confers several important powers through the preparation of town planning schemes, approval of development proposals and advice to the Western Australian Planning Commission.
Royal Australian Navy (RAN)	Protects Australia's security interests as part of the Australian Defence Force. The Royal Australian Navy operates the HMAS Stirling Naval base on Garden Island.
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Performs research and development in areas of economic and social value, including: agriculture, minerals and energy, manufacturing, communications, construction, health and the environment.

Table 2. Roles and Responsibilities of Community and Interest Groups Represented on the Cockburn Sound Management Council

Representative Group or Interest	Roles and Responsibility
General CommunityMembers	Represent the general community interests and facilitate opportunities for broad community involvement in managing Cockburn Sound.
Cockburn Powerboat Association	Offers a range of services for small recreational boat owners in areas of safety support, fishing and diving activities, and social facilities. Located at the Woodman Point Marina.
Community Networking Inc.	Actively presents the community position on issues affecting the future of the South West Metropolitan Area. Facilitates communication between communities and raises awareness of issues through information displays, public meetings and media channels.
Conservation Council	Western Australia's peak organisation for the conservation movement. Campaigns, lobbies and informs the public and Governments regarding conservation and sustainability issues.
Kwinana Industries Council (KIC)	Represents industries within the State's major industrial complex. Coordinates the response of Kwinana industries to a range of issues, including environmental matters. Aims to provide effective and positive liaison with the community.
Recfishwest	Represents recreational fishers and aims to raise community awareness of the importance of protecting the aquatic environment. Ensures that responsible authorities are aware of potential impacts that proposed developments can have on fish stocks and habitats.
South West Group	A regional organisation of Councils comprising the Cities of Fremantle, Melville, Cockburn, and Rockingham, and the Towns of East Fremantle and Kwinana.Acts as a regional advocate for the future development and wellbeing of South West Metropolitan Perth. It seeks to position local government as a facilitator and senior partner in the region's future.
Western Australian Fishing Industry Council	Provides the formal link between the commercial fishing industry and government, Department of Fisheries, and other groups such as conservation and environmental groups, recreational fishers and tourism operators.Represents the interests of the seafood, pearling and aquaculture industries.
Western Australian Vegetable Growers Association	Represents the interests of horticulturists in the catchment of Cockburn Sound on sustainable rural land use issues.

Management Response

1. Protecting the Environmental Values of Cockburn Sound

This section details the approach proposed to protect the full range of ecological and social values and uses of Cockburn Sound from pollution, waste discharges (for example, industrial effluent) and deposits (for example, dredge spoil).

1.1 Past Management of Cockburn Sound

The eastern foreshore of the Sound is home to the State's heavy industrial area and since 1955 liquid waste products have been discharged into its waters.

The first comprehensive environmental study of the Sound between 1976 and 1979 identified a large variety of contaminants in industrial discharges entering the Sound. The study recorded the deterioration of water quality and widespread death and loss of seagrass beds (Department of Conservation and Environment, 1979). Industry responded by reducing contaminant and nutrient discharges, particularly nitrogen, and by the early 1980s the Sound's water quality was much improved.

By the late 1980s the water quality in the Sound had declined again, triggering a second comprehensive investigation – the *Southern Metropolitan Coastal Waters Study* (1991-1994). This study found that seagrass dieback had slowed considerably, but nutrient-related water quality was only slightly better than in the late 1970s. Contaminated groundwater had replaced direct industrial pipeline discharge as the main nitrogen input to the Sound, and came mainly from the southern part of the Kwinana Industrial Area and industries within the Jervoise Bay hinterland.

Industrial discharge of metals and organic contaminants (e.g. pesticides and petroleum products) had decreased substantially, as had contamination of sediments and biota. There was, however, widespread contamination of sediments and mussels with tributyltin (TBT, a highly toxic ingredient in antifoulant paints commonly applied to boats), with particularly high levels near harbours, marinas, and commercial and naval wharves. The introduction of foreign marine organisms via shipping activities (ballast discharge, hull fouling) was also raised as a concern.

A review of the most recent studies (DAL, 2001) has confirmed that a mix of co-operative and regulatory management has resulted in no further deterioration of the overall health of surviving seagrass meadows, and no significant losses related to water quality. Overall nutrient-related water quality has improved slightly since the early 1990s, apart from in the Jervoise Bay Northern Harbour. Nutrient inputs from human activities have declined from an estimated 2000 tonnes/year in 1978 to about 300 tonnes/year in 2000, about 70% of which is from groundwater. However, tributyltin levels in sediments still remain high in Jervoise Bay and Careening Bay.

1.2 The New Approach

To continue the positive trend towards a healthier marine environment within Cockburn Sound, the EPA is broadly adopting the national approach to water quality management (ANZECC/ARMCANZ, 2001). This approach involves:

Step 1 Identifying the **environmental values** of Cockburn Sound, which cover ecological components and social uses. Environmental values are defined as 'particular values or uses of the environment that are important for a healthy ecosystem or for public benefit, welfare, safety or health and which require protection from the effects of pollution, waste discharges and deposits' (ANZECC/ARMCANZ, 2001).

Step 2 Developing **environmental quality objectives** for each of the environmental values identified and determining the area to which they should apply. An environmental quality objective is defined as a specific management goal that can be either ecosystem-based by describing the desired level of health for the ecosystem or socially based by describing the specific uses to be protected (for example, swimming).

Step 3 Establishing the **environmental quality criteria**, which are numerical values or descriptive statements that serve as benchmarks against which to measure whether the environmental quality objectives have been achieved. Each criterion consists of:

- a **Guideline** – used as an initial assessment of environmental quality, which if exceeded will trigger a more detailed assessment.
- a **Standard** – used to assess whether an environmental quality objective has been achieved, which if exceeded will trigger a management response.

Step 4 Comparing the monitoring data for Cockburn Sound against the quality criteria to determine if key biological, chemical and physical indicators are within limits.

Step 5 Initiating appropriate management responses if the environmental quality criteria are exceeded.

1.2.1 Environmental Values and Objectives

Using this approach, the environmental values and objectives for Cockburn Sound have been determined (Table 3) and they form the basis of the Sound's Environmental Protection Policy.

For the objective of maintaining ecosystem integrity, three levels of protection – high, moderate and low - have been defined in terms of structure (e.g. biodiversity, biomass, and abundance of biota) and function (e.g. food chains and nutrient cycles). Schedule 2 of the EPP shows the proposed boundaries of these areas in Cockburn Sound.

These levels of protection reflect the community's expectation that Cockburn Sound should be a healthy, abundant, and diverse natural environment, yet at the same time accommodate other valid societal uses such as industrial development, shipping, and harbours, even though they can lower environmental quality or preclude certain social uses in localised areas (Environmental Protection Authority, 2000).

1.2.2 Environmental Quality Criteria

The Environmental Protection Authority is currently developing the environmental quality criteria (environmental benchmarks) for the environmental objectives of the Sound, in consultation with the main stakeholders. The types of measurements for which criteria are being developed include: nutrient-related effects; contaminant levels in water and sediments; biological indicators of excessive levels of contaminants or nutrients; safety of seafood for human consumption; recreational safety (e.g. faecal bacteria in water, harmful algal blooms); and aesthetics (e.g. water clarity and colour, dust films, faunal deaths, rubbish, maintenance of aesthetic features and natural character of the area).

1.2.3 A Benchmarking Exercise

Once the environmental quality criteria for Cockburn Sound are finsalised, the Environmental Protection Authority will be able to compare the criteria against the current data available for the Sound. In some cases additional data will need to be collected before this comparison can be made.

This comparison, or 'bench-marking' exercise, will be simplified and summarised in the form of 'report cards', rather like a school report, to allow managers and the community to clearly see the areas where a management response is required.

Table 3. Environmental Values and Objectives for Cockburn Sound

Environmental Values	Environmental Quality Objectives
Ecosystem Health	Maintenance of ecosystem integrity in terms of structure (e.g. biodiversity, biomass, and abundance of biota) and function (e.g. food chains and nutrient cycles).
Seafood safe for eating	Maintenance of aquatic life for human consumption, such that seafood is safe for human consumption when collected or grown.
Aquaculture	Maintenance of aquaculture, such that water is of a suitable quality for aquaculture purposes.
Recreation and Aesthetics	Maintenance of primary contact recreation values, such that primary contact recreation (e.g. swimming) is safe.Maintenance of secondary contact recreation values, such that secondary contact recreation (e.g. boating) is safe.Maintenance of aesthetic values, such that the aesthetic values are protected.
Industrial Water Supply	Maintenance of industrial water supply values, such that water is of suitable quality for industrial water supply purposes.

It should be noted that the 'report card' assessment is very general by nature, relating to the whole of Cockburn Sound. It provides a broad assessment of the scale of the problems and the overall management response. Localised events that are often transient in nature (for example, algal blooms) are not covered. It is also not practical to report on all of the individual criteria as the list of indicators is very extensive. For example, the criteria for toxicants in sediments and water, which will be broadly based on the Australian guidelines (ANZECC/ARMCANZ, 2001), is likely to cover more than 50 different chemical indicators.

Using this extensive list as a starting point, the Cockburn Sound Management Council will coordinate a process to identify the toxicants that pose the greatest potential risk to the health of Cockburn Sound. These priority contaminants will then form the basis of the monitoring program and will be the key indicators listed on the 'report cards'.

Over time, as more information on the condition of Cockburn Sound becomes available, the Management Council intends to improve the reporting system by providing more detailed 'report cards' for particular locations within the Sound (for example, Jervoise Bay). This will enable local communities to have a better understanding of the condition of their particular section of coastline.

1.2.4 Management Response

Where the existing data or monitoring programs indicate environmental quality criteria have been exceeded, the Cockburn Sound Management Council will be responsible for coordinating a response and reporting to the Environmental Protection Authority. The level of the response is determined by whether a guideline or standard has been exceeded.

In instances where the guideline is exceeded, the Management Council will co-ordinate investigations into the cause and, where necessary, take precautionary action in conjunction with the relevant public authorities. Monitoring against the guidelines provides an early warning of potential environmental problems.

At the next level of concern, if the standard is exceeded, the Management Council will coordinate the investigations and where a specific cause or causes are identified a management response will be initiated such that:

- where the discharge is found to be from a licensed premises then the licensee and the relevant public authority will implement a management response;
- where the discharge is found to be from diffuse and other sources then the Cockburn Sound Management Council will coordinate a cooperative management response.

Pollution events and breaches of industry licence conditions will continue to be dealt with by the Department of Environmental Protection under the existing regulatory and enforcement powers of the *Environmental Protection Act 1986*.

1.2.5 Interim Response

In this interim period while the specific environmental quality criteria for the Sound are being finalised, the management response will be based on the most up-to-date information on the state of Cockburn Sound, on current community concerns and, where appropriate, the Australian guidelines for marine water quality (ANZECC/ ARMCANZ, 2001).

Interim management responses will be modified and adapted as new information becomes available and the criteria specific to the Sound are drafted, trialed and refined. This will be an iterative process until there is general agreement within the community that the ecological and social values are being adequately protected.

The interim management response to protecting the environmental values is described in the remainder of Section 1 and involves:

1.3 Maintaining a healthy marine ecosystem;
1.4 Ensuring safe seafood for eating;
1.5 Protecting the health of aquaculture species;
1.6 Maintaining clean waters for swimming, boating and aesthetics; and
1.7 Ensuring suitable water quality for industry.

1.3 Maintaining a Healthy Marine Ecosystem

Perth's coastal waters are within a region of biogeographical 'overlap', that extends from Cape Leeuwin to North West Cape. This overlap is between the main temperate biogeographic region (Cape Leeuwin to South Australia) and tropical biogeographic region (north-east of North West Cape). Perth's waters are at the southern end of the overlap region, so temperate species predominate.

Although the region is relatively poor in marine species in general, it has the highest number of species of seagrass in Australia. There are only about 50 species of seagrass worldwide, 13 of which are found in Perth's coastal waters. There are six main 'meadow-forming' species: *Amphibolis griffithii*, *A. antarctica*, *Posidonia australis*, *P. sinuosa*, *P. angustifolia* and *P. coriacea*.

The most dense stands of seagrass occur in shallow sheltered areas and consist of meadows of *P. sinuosa* or *P. australis*. Cockburn Sound had extensive areas of these species before the massive seagrass die-off that occurred in the late 1960s and early 1970s.

The distribution of seagrass, sand, reef and silt habitats in Cockburn Sound is shown in Figure 2.

The fauna of Cockburn Sound have been studied less regularly and extensively than the flora. Dybdahl (1979) estimated that there were about 130 species of fish and 14 large crustacean and mollusc species in Cockburn Sound. The Department of Fisheries believes that the whole of the Sound is significant as a fish nursery and habitat (Department of Fisheries, pers. com., 2001).

A population of Bottlenose Dolphins (*Tursiops truncatus*) resides in Cockburn Sound, and has become a popular tourist attraction. About 180 animals have been identified and approximately a quarter of these are adult females with calves, which is unusually high for dolphin populations (Donaldson, unpublished data).

Since at least 1986, a small colony of approximately 50 adult Little Penguins (*Eudyptula minor*) has inhabited the limestone walling at Careening Bay, Garden Island. Migratory birds also regularly utilise Garden Island with14 species recognised under the Japan Australia Migratory Bird Agreement and/or China Australia Migratory Bird Agreement.

A healthy Cockburn Sound marine ecosystem is a significant community asset, providing a range of ecological (e.g. fish habitat, seagrass meadows) and social values (e.g. swimming, fishing, aquaculture).

The integrity of an ecosystem, such as Cockburn Sound, is maintained when the level of change resulting from human activities remains within the limits that avoid an unacceptable risk of irreversible change or decline.

Based on the best available information and expert advice, a preliminary assessment of the health of the marine ecosystem is reported in Tables 4a and 4b for areas afforded a high level of protection (the broader area of Cockburn Sound) and a moderate level of protection (the eastern foreshore), respectively.

The Interim Report Cards for Ecosystem Integrity (Tables 4a and b) show that the main areas of concern are:

- tributyltin (TBT) levels in the sediments in Jervoise Bay and Careening Bay;
- seagrass health at sample locations in Mangles Bay and Kwinana; and
- phytoplankton blooms (measured by chlorophyll 'a' levels) along the eastern foreshore and within Mangles Bay.

The final Plan will include maps showing the specific locations of these areas of concern or 'hot spots'.

Further investigations and precautionary action are required on seagrass health, light attenuation and chlorophyll 'a' levels in the broader Cockburn Sound waters, and on chlorophyll 'a' and algal growth potential along the eastern foreshores.

Table 4a. Interim Report Card:
Maintaining a Healthy Marine Ecosystem in Areas of High Level of Protection

Section 1. relates directly to the Draft EPP

Interim Report Card 2001

Subject: Ecosystem Health in Areas of a High Level of Protection (broader area of Cockburn Sound)

Environmental Quality Indicators		*Management Response	Comments
Physical & Chemical Measures	• Chlorophyll 'a' • Light Attenuation		Continue investigations and precautionary actions (see Recommendations 8–12).
	• Dissolved Oxygen • Temperature		Criteria for dissolved oxygen and temperature currently under review.
Indirect Biological Measures	*Algal Growth Potential* • Periphyton		Continue monitoring.
Direct Biological Measures	*Phytoplankton Blooms* • Chlorophyll 'a'		Overall Chlorophyll 'a' levels in Cockburn Sound meet guideline, **except in the Mangles Bay area.**
	Seagrass • Shoot density • Depth limits		Seagrass generally meet standard, **except at sample locations in Mangles Bay and Kwinana (see Recommendations 13–16).**
Toxicants in Water	*Metals and Metalloids* *Non-metallic Inorganics* *Organics* *Pesticides* *Herbicides and Fungicides* *Surfactants* *Hydrocarbons* *Miscellaneous / Others*		For the range of water toxicants monitored to date, levels are either below ANZECC guidelines or below normal laboratory detection limits.
Toxicants in Sediments	*Metals and Metalloids*		For the range of sediment toxicants monitored to date, levels are either below ANZECC guidelines or below normal laboratory detection limits. Additional sampling for TBT required.
	Organometallics (e.g. TBT)		
	Organics		

LEGEND

*** Management Response:**

Monitor – Below guideline; continue monitoring. – Below normal laboratory detection limits.

Investigate – Above guideline; investigate and, where necessary, take precautionary action.

Action Required – Above standard; initiate management response.

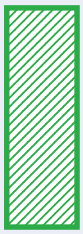
Research – Additional information required to establish state of the Sound and/or criteria.

The 'report cards' provide a broad assessment of Cockburn Sound and indicate the overall management response required.

Table 4b. Interim Report Card:
Maintaining a Healthy Marine Ecosystem in areas of Moderate Level of Protection

Interim Report Card 2001

Subject: Ecosystem Health in Areas of a Moderate Level of Protection (eastern foreshore)

Environmental Quality Indicators		*Management Response	Comments
Physical & Chemical Measures	• Chlorophyll 'a' • Light Attenuation • Dissolved Oxygen • Temperature		Continue investigations and precautionary actions to address elevated chlorophyll 'a' levels (see Recommendations 8–12). Criteria for dissolved oxygen and temperature currently under review.
Indirect Biological Measures	*Algal Growth Potential* • Periphyton		Continue investigations and precautionary actions to reduce algal growth potential (see Recommendations 8–12).
Direct Biological Measures	*Phytoplankton Blooms* • Chlorophyll 'a' *Seagrass* • Median shoot density • Minimum shoot density		Continue management actions to reduce nutrients, with priority on groundwater sources (see Recommendations 8–12). Seagrass monitoring required along the eastern foreshore.
Toxicants in Water	*Metals and Metalloids* *Non-metallic Inorganics* *Organics* *Pesticides* *Herbicides and Fungicides* *Surfactants* *Hydrocarbons* *Miscellaneous / Others*		For the range of water toxicants monitored to date, levels are either below ANZECC guidelines or below normal laboratory detection limits.
Toxicants in Sediments	*Metals and Metalloids* *Organometallics (e.g. TBT)* *Organics*		For the range of sediment toxicants monitored to date, levels are generally below ANZECC guidelines or below normal laboratory detection limits, **apart from TBT levels in Jervoise and Careening Bays (see Rec. 5 and 6). Recent sampling indicates that mercury is present at a few isolated sites near jetties. Further testing, consistent with ANZECC/ARMACANZ 2000 guidelines and the proposed decision-trees in the EPP Reference Document, indicates that the guideline has not been breeched.**

LEGEND

*** Management Response:**

Monitor – Below guideline; continue monitoring. – Below normal laboratory detection limits.

Investigate – Above guideline; investigate and, where necessary, take precautionary action.

Action Required – Above standard; initiate management response.

Research – Additional information required to establish state of the Sound and/or criteria.

The 'report cards' provide a broad assessment of Cockburn Sound and indicate the overall management response required.

Issues

Sediment Contamination

- A 1999 sediment survey found that contaminant levels were well below environmental guidelines, apart from TBT in some areas. TBT levels in sediments were generally lower than in 1994, but still high in the Jervoise Bay Northern Harbour area and adjacent to naval facilities in Careening Bay. Considerable action is being taken to reduce the environmental impact of TBT through complementary international guidelines, State regulatory controls and port restrictions on activities considered to present the greatest threat (see Text Box on TBT).

Water Quality

- Overall nutrient-related water quality has improved only slightly since the early 1990s despite the large decline in nitrogen inputs from human activities from an estimated 1080 tonnes in 1990 to about 300 tonnes in 2000. A better understanding of the relationship between nutrient inputs and water quality indicators (e.g. chlorophyll 'a' and light attenuation) is required. In the interim, all practicable efforts will continue to be made to reduce nitrogen inputs from human activities.

- The Water Corporation and local Kwinana industries have jointly developed a proposal to construct a water treatment plant to produce high quality, industrial grade water from secondary treated effluent drawn from the Cape Peron pipeline. Treated waste water from local industries would re-enter the pipeline for disposal off-shore (4.2 km) into the Sepia Depression. The end result would be the removal of discharges of industrial waste water into Cockburn Sound, other than the return of seawater used for cooling purposes.

Seagrass

- The total area of seagrass within the management area of the Management Council has declined from 2,821 ha in 1965/67 to 632.3 ha in 1999, a reduction of 78% (DAL, 2001). Recent surveys show there has been no further deterioration in the health of the remaining seagrass, except for one site off the Kwinana foreshore. Seagrass in the Mangles Bay area remains highly stressed (Lavery and Westera, 2000).

Development Proposals

- Physical alterations to the shoreline and seabed, such as dredging and rock breakwater construction, may result in the direct loss of habitat and the suspension of fine sediment and soil particles causing water turbidity problems and the deposition of materials on benthic communities. In future all such works will be required to meet the environmental quality criteria for maintaining ecosystem integrity detailed in the EPP for Cockburn Sound.

- The cumulative impacts of developments along the coastline are difficult to measure and predict. A guiding principle for future developments should be that there is no net loss of ecological or social function in Cockburn Sound.

- Events and activities which have the potential to impact on the ecological and social values of Cockburn Sound, yet are transient and often localised in nature (such as algal blooms, beach erosion from storms, and fauna deaths), can be difficult to routinely detect and manage. An early alert system involving a network of government, community and individual stakeholders is required.

Overall Objective

- To maintain the integrity of the Cockburn Sound marine ecosystem.

Management Objectives

- To improve the overall quality of water and sediments to levels that meet the environmental quality standards for Cockburn Sound and, in the long term, the environmental quality guidelines.

- To maintain the ecological function, abundance, species diversity and range of habitat types.

- To ensure that development proposals do not have a significant adverse impact on the environmental and social values of Cockburn Sound.

MANAGEMENT OF TRIBUTYLTIN (TBT)

Tributyltin (TBT), the principal toxic ingredient of antifouling paints used on ships' hulls since the mid-1960s has been found to produce deformities in various shellfish such as oysters and sea snails. TBT antifouling paints work by releasing, in a controlled manner, small quantities of TBT, which is toxic to fouling organisms. Although TBT dissolved in the water column breaks down into much less harmful products within days, its accumulation in bottom sediments, particularly in heavily used areas such as ports, marinas and ship maintenance areas, requires longer periods for breakdown to occur.

The potential adverse environmental impacts of TBT-based antifouling systems are understood at a local, national and international level. Considerable action has been undertaken to reduce the impact through complementary international guidelines, regulatory controls at a State level and Fremantle Port restrictions on activities considered to present the greatest threats, for example, use on small craft, hull cleaning and dry dock maintenance facilities. A comprehensive 1999 sediment contamination survey conducted in waters surrounding Fremantle Port has confirmed that TBT levels have declined dramatically since the previous 1996 study and that only three of the 31 sites sampled had elevated TBT levels at which further investigation for potential environmental impacts should be undertaken.

The International Maritime Organisation intends to introduce a global ban on the application of TBT in antifouling systems to ships from 1 January 2003 and a complete prohibition on the presence of TBT antifouling systems on ships from 1 January 2008. This, combined with local controls, is expected to result in significant reductions in TBT in the marine environment to levels that will not adversely impact on any aspect of the marine environment.

Source: Fremantle Port Authority Environmental Fact Sheet No.1 The Management of Tributyltin (TBT) Anti-foulants in Western Australia, July 2001.

RECOMMENDATIONS

Environmental Quality Criteria

1. Continue to develop the environmental quality criteria and refine the boundaries for the levels of protection for marine ecosystem integrity (EPA: 2002).

2. Develop and implement an Environmental Quality Monitoring Program, in partnership with stakeholders. The Program will be based on the environmental indicators for ecosystem integrity, with priority on monitoring TBT levels, seagrass health, and the water quality indicators of chlorophyll 'a' and light attenuation (CSMC, DEP, WRC, KIC, DoD, FPA, commercial users: 2002 - Ongoing).

3. Where the data for the environmental indicators exceed the criteria, implement management action according to the following hierarchy:

   · **Guideline** CSMC to coordinate investigations and, where necessary, precautionary action (CSMC: 2002 - Ongoing).

   · **Standard** CSMC to coordinate investigations and management responses to address the problem (CSMC: 2002 - Ongoing).

   The CSMC will report all exceedences and their investigation to the EPA as soon as practicable.

4. In consultation with major stakeholders, review and evaluate the effectiveness of the environmental quality criteria for ecosystem integrity and the 'report card' approach (EPA: Annually).

Sediment Quality

5. Support the implementation of international, national, State and local regulations and guidelines to control the use and management of TBT (IMO, AMSA, FPA, DoD, DEP, CSMC: 2002 - Ongoing).

6. Coordinate investigations into the cause of both diffuse and point sources of the elevated TBT levels in Jervoise Bay and Careening Bay and, in conjunction with relevant authorities, take appropriate action. Report to the Environmental Protection Authority on the outcomes of the management response (CSMC, DoD, FPA, industry: 2002 - Ongoing).

7. Continue to monitor metals and metalloids in sediments adjacent to jetties to ensure the environmental and social values of Cockburn Sound are protected (CSMC, industry, FPA, DoD: 2002 - Ongoing).

Water Quality

8. Continue the current approach of cooperative best management towards reducing nutrient loads to Cockburn Sound from industrial, urban and rural sources (CSMC, KIC, LGAs, rural industries, DoA, community: Ongoing).

9. Coordinate investigations so as to better understanding why reductions in nutrient inputs into the Sound from human activities since the 1990s have resulted in only a slight improvement in nutrient-related water quality indicators (e.g. chlorophyll 'a' levels and light attenuation readings). Report to the Environmental Protection Authority on the outcomes of the investigations and implications for environmental quality criteria (CSMC, DEP, WRC, KIC: 2002 -2003).

10. Develop and implement a Nutrient Management Strategy, in consultation with major stakeholders and consist with the outcome of Recommendation No. 9 above. The Strategy will cover: the sources of nutrients; nutrient hot-spots; nutrient recovery from groundwater, stormwater disposal, drain management, industrial discharges, catchment management, community awareness, research, and funding arrangements (CSMC: 2002 - Ongoing).

11. Support the proposal by the Water Corporation and local Kwinana industries to recycle waste water and remove industrial discharges (other than cooling water) that flow into Cockburn Sound (WC, KIC, CSMC: 2002 – Ongoing).

12. Continue to work with managers of the Swan-Canning and Peel-Harvey systems and the Perth coastal waters to minimise nutrient and other inputs (e.g. oil spillage) from adjacent waters to Cockburn Sound (CSMC, WRC, CALM, DPI: Ongoing).

Seagrass Meadows

13. Conduct site specific studies in the Mangles Bay and Kwinana area to determine sources of stress to seagrass meadows (CSMC, DEP, WRC, CoR, KIC: 2003 - 2005).

14. Specify mooring and anchorage types and locations which minimise seagrass damage (DPI: 2002 - Ongoing).

15. Promote the recolonisation and re-establishment of seagrass in areas of Cockburn Sound where it once occurred. Investigate the major constraints to seagrass regrowth and, if practicable, implement remedial action (CSMC, DEP, WRC, industry: 2004-07).

16. Monitor seagrass health every year and seagrass distribution every three years (CSMC, WRC, DEP: Ongoing). Priority areas are

    - the western margin of Cockburn Sound, as protecting the remaining healthy meadows is a high priority; and
    - the eastern margin, to investigate anecdotal reports of the existence of patches of healthy seagrass adjacent to the industrial area.

Development Proposals

17. Ensure that the impacts associated with works along the shoreline and on the seabed, such as dredging and rock breakwater construction, meet the environmental quality criteria for ecosystem integrity detailed in the EPP for Cockburn Sound (EPA: Ongoing).

18. Ensure proponents of future development proposals are guided by the principle of no net loss of ecological or social function in Cockburn Sound (CSMC, EPA: Ongoing).

19. Actively involve the community and other stakeholders in developing and implementing response procedures for addressing transient, localised events (e.g. algal blooms, beach erosion) that may result in significant ecological and social impacts (CSMC: 2003 – Ongoing).

1.4 Ensuring Safe Seafood for Eating

Cockburn Sound with its easily accessible sheltered waters and close proximity to the population of Perth is an ideal location for recreational and commercial fishing and aquaculture.

There is a clear community expectation that seafood caught in Cockburn Sound should be safe to eat (Jacoby *et al*., 1999).

The Sound is a particularly popular area for recreational fishers and crabbers. Within the coastal waters from Augusta to Kalbarri it is second in importance only to the Hillarys area, with over 12 000 boating trips recorded annually (Sumner and Williamson, 1999). The main species caught are crabs, whiting (especially King George whiting), Australian herring, squid, garfish, trevally, dhufish, tailor and pink snapper (Sumner and Williamson, 1999). These are many of the species targeted by commercial fishers.

The commercial fishery plays an important role in providing fresh fish, crabs and bait to the local market. The commercial catch comprises mainly baitfish, crabs, garfish, Australian herring, tailor, skipjack trevally, King George whiting, yellowtail scad and pink snapper (Fisheries Western Australia, 1999a).

Mussel aquaculture in Cockburn Sound is also gaining in prominence. With mussels destined for supermarkets, local restaurants and, increasingly, export markets, the quality of the product is strictly controlled under the Western Australian Shellfish Quality Assurance Program (Health Department of Western Australia and Fisheries Western Australia, 2001). Regular monitoring in Cockburn Sound under this Program for chemical toxicants, bacterial levels and toxic algal blooms ensures all products meet seafood health standards.

Mussels also act as indicators (or sentinels) of the quality of recreational and commercial fish and crab species, as they can be used to detect very low levels of contaminants in seawater (Leighton, pers. com., 2001).

The 'Interim Report Card for Safe Seafood' shows that current levels of chemical toxicants, bacteria and toxic algal blooms are not a concern for human consumption (Table 5). Continued monitoring is required as algal blooms and bacteria contamination are often site specific and transient in nature.

Issues

- Surveys of contaminant levels in mussels in 1991 and 1994 found that, with one exception (TBT), levels of organic contaminants and heavy metals were either below detection limits or very low (Department of Environmental Protection, 1996). More recent monitoring under the Western Australian Shellfish Quality Assurance Program indicates that TBT levels in mussels do not pose a public health and safety concern (Health Department of Western Australia and Fisheries Western Australia, 2001).
- Monitoring of the near-shore waters of Cockburn Sound occasionally shows elevated levels of bacteria (faecal streptococci and thermotolerant coliforms) adjacent to stormwater drains. Potential sources of bacterial contamination include: animal faeces (for example, from seagulls and pigeons) and seepage from septic tanks (Bowman, Bishaw and Gorham, 2001).

Objective

- To maintain aquatic life for human consumption.

Recommendations

Environmental Quality Criteria

1. Continue to develop the environmental quality criteria and environmental indicators for the maintenance of clean, safe aquatic life for human consumption (EPA: 2002).

2. Continue to monitor water quality and shellfish health under the WASQAP (DHWA; DoF; Aquaculture industry: Ongoing).

3. Where the data for the environmental indicators exceed the criteria, implement management action according to the following hierarchy:

   · **Guideline** CSMC to coordinate investigations and, where necessary, precautionary actions (CSMC: 2002 – Ongoing).

   · **Standard** CSMC to coordinate investigations and management responses to address the problem (CSMC: 2002 – Ongoing).

   The CSMC will report all exceedences and their investigation to the EPA as soon as practicable.

4. Investigate extending the current shellfish monitoring program to include recreational and commercial fish and crab species (CSMC, DHWA, DoF and WAFIC: 2004 – Ongoing).

5. In consultation with major stakeholders, review and evaluate the effectiveness of the environmental quality criteria for clean, safe, aquatic life for human consumption (EPA: Annually).

Bacterial Quality of Near-shore Waters

6. Support efforts to control pigeons at the Co-operative Bulk Handling Terminal to reduce faecal contamination of stormwater entering Cockburn Sound (CBH, DHWA, CoR: Ongoing).

7. Implement the Palm Beach Catchment Strategic Drainage Management Plan, with priority on identifying sources of faecal pollution (CoR, WRC: 2002 – Ongoing).

8. Investigate extending the approach taken to stormwater management at Palm Beach to other beaches with elevated bacteria levels (CSMC: 2003).

9. Assess the bacterial water quality in areas commonly used for recreational shellfish harvesting. (DHWA: 2004)

Table 5. Interim Report Card: Safe Seafood for Eating

Interim Report Card 2001

Subject: Safe Seafood for Eating

Environmental Quality Indicators		*Management Response	Comments
Biological Contaminants	• Thermotolerant faecal coliforms in water • Thermotolerant faecal coliforms in seafood flesh • Algal biotoxins		Bacteria levels in Cockburn Sound are generally below guideline levels for shellfish harvesting, although elevated readings can occur in localised waters (e.g. Grain Terminal). Species of potentially toxic algae may occur in Cockburn Sound, but generally at densities below guideline levels and in localised areas (eg. Jervoise Bay). Subsequent testing of algae has yet to find high levels of toxin production.
Chemical Contaminants in Seafood Flesh	• Metals • Organic Chemicals		Mussels are routinely sampled under the WA Shellfish Quality Assurance Program.

LEGEND

*** Management Response:**

Monitor – Below guideline; continue monitoring. – Below normal laboratory detection limits.

Investigate – Above guideline; investigate and, where necessary, take precautionary action.

Action Required – Above standard; initiate management response.

Research – Additional information required to establish state of the Sound and/or criteria.

The 'report cards' provide a broad assessment of Cockburn Sound and indicate the overall management response required.

1.5 Protecting the Health of Aquaculture Species

With fisheries stocks under increasing pressure from recreational and commercial users, aquaculture is becoming an increasingly important source of seafood and other products. It currently accounts for approximately 25% of total aquatic food production in Australia (ANZECC/ARMCANZ, 2001).

Mussel farming is currently the only aquaculture activity in Cockburn Sound. Production commenced in 1988 to overcome the declining catches of the wild mussel fishery and to provide a more consistent quality and source of product.

Currently 690 tonnes of mussels are produced annually from three lease areas: Southern Flats, Kwinana Grain Jetty and north Garden Island. Production is predicted to increase to 1000 tonnes in 2001/2002 and has the potential to reach 4000 tonnes, worth over $10 million (Fisheries Western Australia, 2001).

The increasing importance of aquaculture is recognised in the National Water Quality Management Strategy (ANZECC/ARMCANZ, 2001) as it provides specific criteria for protecting aquaculture species. These criteria have been incorporated into the Environmental Protection Policy for Cockburn Sound as a basis for determining an appropriate level of water quality for existing and future aquaculture activities in the Sound.

The 'Interim Report Card for Protecting the Health of Aquaculture Species' shows that there are no indications to date that the growth or quality of mussels in Cockburn Sound have been reduced (Table 6).

It needs to be noted that the criteria for protecting the health of aquaculture species do not apply to recreational and commercial fisheries, as the health of wild stocks is best covered under the criteria for maintaining ecosystem integrity (see Section 1.3). Also the criteria do not cover waste discharges from aquaculture activities as this issue is addressed through licence conditions (see Section 2.2.4).

Issue

- Regular monitoring is required to ensure that there is no loss in growth or quality of aquaculture species caused by changes in water quality.

Objective

- To protect the health of aquaculture species by maintaining an appropriate level of water quality.

Recommendations

1. Continue to develop the environmental quality criteria and environmental indicators for the maintenance of aquaculture (EPA: 2002).

2. Continue to monitor water quality and shellfish health under the WASQAP (DHWA; DoF; aquaculture industry: Ongoing).

3. Where the data for the environmental indicators exceed the criteria, implement management action according to the following hierarchy:

   · **Guideline** CSMC to coordinate investigations and, where necessary, precautionary actions (CSMC: 2002 – Ongoing).

   · **Standard** CSMC to coordinate investigations and management responses to address the problem (CSMC: 2002 – Ongoing).

   The CSMC will report all exceedences and their investigation to the EPA as soon as practicable.

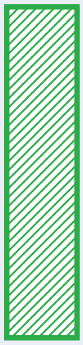
4. In consultation with major stakeholders, review and evaluate the effectiveness of the environmental quality criteria for aquaculture (EPA: Annually).

Section 1. relates directly to the Draft EPP

Table 6. Interim Report Card: Protecting the Health of Aquaculture Species

Interim Report Card 2001

Subject: Protecting the Health of Aquaculture Species

Environmental Quality Indicators		*Management Response	Comments
Physical-Chemcial Stressors	• Dissolved Oxygen • pH • Salinity • Suspended Solids		No indication that current levels of physico-chemical stressors have reduced growth or quality of mussels.
Toxicants in Water	• Non-metalic inorganic chemicals. • Metals and metalloids • Organic chemicals • Pesticides		For the range of water toxicants monitored to date, levels are generally below ANZECC guidelines or below normal laboratory detection limits.

LEGEND

*** Management Response:**

Monitor – Below guideline; continue monitoring. – Below normal laboratory detection limits.

Investigate – Above guideline; investigate and, where necessary, take precautionary action.

Action Required – Above standard; initiate management response.

Research – Additional information required to establish state of the Sound and/or criteria.

The 'report cards' provide a broad assessment of Cockburn Sound and indicate the overall management response required.

1.6 Maintaining Clean Waters for Swimming, Boating and Aesthetics

The waters of Cockburn Sound are an important focus of recreation and enjoyment by people who live in, or visit the region. High water quality is required for primary contact (direct contact with the water) sports such as swimming, for secondary contact (less frequent contact) activities like boating, and passive recreation uses (no contact), for example admiring the view across the Sound.

Woodman Point, Kwinana, Wells Park, Rockingham and Palm Beaches are the most popular beaches for swimming (Dielesen, 1994). Water skiing and 'free style' driving of personal water craft (i.e. jet ski) are restricted to areas in Mangles Bay/Palm Beach. The area immediately offshore from Churchill Park, Rockingham, is a regionally important SCUBA diving and training site as it contains a number of small wrecks. About two-thirds of Garden Island is open to the public in daylight hours, and is ideally suited for picnics, swimming, diving (snorkel and SCUBA) and fishing.

Cockburn Sound also provides a sheltered expanse of water for small motor boats, yachts and sailboards, particularly during the summer months when strong sea-breezes can make off-shore conditions hazardous.

The café strip and public walkways at Palm Beach are very popular with locals and tourists, especially in January/ February. Enjoyment of passive recreation in these areas (e.g. sitting in a café and admiring the view) depends greatly on the scenic value of the coastal features, the clarity of the water and ambience of the area.

This interplay between existing natural and cultural characteristics, and the experience and enjoyment people derive from them, creates the aesthetic values of the Sound. These values are becoming increasingly important in today's society for maintaining a sense of wellbeing and quality of life (Cleary, 2001).

Clean ocean water is an essential attribute of the recreation and aesthetic values of Cockburn Sound. The Interim Report Cards show that the waters of Cockburn Sound are clean for swimming, boating, and maintaining aesthetic values (Tables 7 and 8), with the exception of surface debris. The aesthetic criteria need further development and trialing. Continued monitoring of algal blooms and bacteria levels is required as these indicators are often site specific and transient in nature.

Issues

- The Cockburn Sound Management Council has received a number of complaints regarding the loss of amenity in Cockburn Sound due to surface slicks of grain dust on the water and shoreline of Cockburn Sound. The dust originates from the ship loading facilities at the Kwinana Grain Terminal.
- Activities such as dredging and rock breakwater construction may result in the suspension of fine sediment and soil particles causing plumes that limit water clarity. This issue has caused problems for marine nature-based tour operators, where swimming with and viewing the dolphins underwater is the main attraction.
- Monitoring of the near-shore waters of Cockburn Sound occasionally shows elevated levels of bacteria (faecal streptococci and thermotolerant coliforms) adjacent to stormwater drains. Potential sources of bacterial contamination include: animal faeces (for example, from seagulls and pigeons) and seepage from septic tanks (Bowman, Bishaw and Gorham, 2001).
- A workshop held in March 2001 to assist in developing aesthetic criteria for Cockburn Sound identified the following threats: surface films, dust from grain loading; nuisance organisms; dredging; algal blooms; rubbish (floating and submerged); boat traffic; and causes of fauna deaths and seagrass loss (Cleary, 2001)

Objectives

- To maintain primary contact (for example, swimming) recreational values.
- To maintain secondary contact (for example, boating) recreational values.
- To maintain aesthetic values.

Table 7. Interim Report Card:
Clean Waters for Swimming and Boating

Interim Report Card 2001

Subject: Clean Waters for Swimming and Boating

Environmental Quality Indicators		*Management Response	Comments
Biological Measures	• Faecal pathogens (swimming) • Faecal pathogens (boating). • Toxic algae		Bacteria levels in marine water are generally below ANZECC guidelines, although elevated readings do occur in localised areas (e.g. Palm Beach). Species of potentially toxic algae may occur in Cockburn Sound, but generally at densities below guideline levels and in localised areas (eg. Jervoise Bay). Subsequent testing of algae has yet to find high levels of toxin production.
Physical Measures	• pH • Water clarity		Physical measures meet ANZECC guidelines.
Radiological Measures	• Gross alpha and beta activity.		Monitoring has found no elevated levels of alpha or beta radioactivity in water, sediments or mussels.
Toxicants in Water	• Inorganic chemicals • Organic chemicals • Pesticides		For the range of water toxicants monitored to date, levels are below ANZECC guidelines.

LEGEND

*** Management Response:**

Monitor – Below guideline; continue monitoring. – Below normal laboratory detection limits.

Investigate – Above guideline; investigate and, where necessary, take precautionary action.

Action Required – Above standard; initiate management response.

Research – Additional information required to establish state of the Sound and/or criteria.

The 'report cards' provide a broad assessment of Cockburn Sound and indicate the overall management response required.

Table 8. Interim Report Card: Clean Waters for Aesthetics

Interim Report Card 2001

Subject: Clean Waters for Aesthetics

Environmental Quality Indicators		*Management Response	Comments
Visual Indicators	• Nuisance organisms		Monitoring of visual indicators is required.
	• Faunal deaths		
	• Water clarity		
	• Colour		Additional information required to establish existing conditions in Cockburn Sound.
	• Reflectance		
	• Surface films		
	• Surface debris		Investigate and, where necessary, implement practices to minimise the loss of grain dust from ship loading facilities (see Recommendation 6).
Odour			Additional research required to establish existing odour levels in Cockburn Sound.
Fish Tainting Substances			Data for toxicants measured to date are generally below guidelines.

LEGEND

*** Management Response:**

Monitor – Below guideline; continue monitoring. – Below normal laboratory detection limits.

Investigate – Above guideline; investigate and, where necessary, take precautionary action.

Action Required – Above standard; initiate management response.

Research – Additional information required to establish state of the Sound and/or criteria.

The 'report cards' provide a broad assessment of Cockburn Sound and indicate the overall management response required.

Recommendations

Environmental Quality Criteria

1. Continue to develop the environmental quality criteria and environmental indicators for the maintenance of primary and secondary recreational values, and aesthetic values (EPA: 2002).

2. Develop and implement, in partnership with stakeholders, an Environmental Quality Monitoring Program based on the environmental indicators for primary and secondary recreational values, and aesthetic values (CSMC, DHWA, KIC, DoD, FPA: 2002 - Ongoing).

3. Where the data for the environmental indicators exceed the criteria, implement management action according to the following hierarchy:

   · **Guideline** CSMC to coordinate investigations and, where necessary, precautionary actions (CSMC: 2002 – Ongoing).

   · **Standard** CSMC to coordinate investigations and management responses to address the problem (CSMC: 2002 – Ongoing).

   The CSMC will report all exceedences and their investigation to the EPA as soon as practicable.

4. In consultation with major stakeholders, review and evaluate the effectiveness of the environmental quality criteria for primary and secondary recreational values, and aesthetic values (EPA: Annually).

Aesthetics

5. Undertake a community perception survey to determine the relationship between the quality criteria (for example, water colour and clarity) and aesthetic values (for example, scenic beauty) (CSMC: 2004).

6. In partnership with the Fremantle Port Authority and Co-operative Bulk Handling, investigate and, where necessary, implement practices to minimise the loss of grain dust from ship loading facilities (CSMC, FPA, CBH: 2004).

7. Ensure that aesthetic criteria for water quality are given adequate weighting in environmental assessment of future works and developments (EPA, CSMC: Ongoing).

1.7 Ensuring Suitable Water Quality for Industry

Under the National Water Quality Management Strategy, industrial water use is recognised as an important environmental value as it provides significant economic benefit to the community (ANZECC/ARMCANZ, 2001).

The Strategy, however, provides no specific guidance for protecting the quality of industrial water, because industrial water requirements vary greatly both within and between industries. Sources of water for industry generally have other coincidental environmental values (for example, ecosystem health) that tend to drive management of the resource.

Within the Kwinana Industrial Area marine waters are currently used for cooling purposes: electricity generation (Western Power) and oil refining (BP Refinery) being the two main uses.

A recently approved 'waste to energy and water plant' in Kwinana proposes to use seawater for cooling purposes and as a source for a desalination plant to produce potable water.

Issues

- The requirements of industrial water supply are specific to industrial processes. In general, marine waters need to be free of marine pests (that may grow prolifically, blocking intake pipes) and plant debris, and contain relatively low levels of contaminants.

- Marine fauna, such as juvenile fish, may be drawn into marine water intake pipes.

Objective

- To maintain industrial water supply values in Cockburn Sound.

Recommendations

1. Identify the key attributes of marine waters for industrial users. Incorporate these requirements into the broader planning and management of Cockburn Sound (CSMC, industry, DMPR: 2002).

2. Ensure practices and procedures are in place to avoid marine fauna being drawn into seawater intake pipes or allow for their trapping and removal (Industry: Onging).

2. Facilitating Multiple Use of Cockburn Sound and its Foreshore

2.1 The Approach – Multiple Use Planning

The need to balance competing uses of the marine and foreshore environment of Cockburn Sound in an ecologically sustainable manner presents major challenges. The Sound's deep, sheltered waters are extremely popular for commercial and recreational activities yet, at the same time, they support a busy port, a heavy industrial area and a strategic naval base. All these uses are expected to intensify in the near future.

Planning and management for multiple uses must ensure that decisions about resource access or use and the allocation of benefits are equitable, objective and transparent. They should include explicit assessments of impacts, in particular on other recognised uses and on ecosystem integrity. Integrated management of multiple uses should provide a capacity to manage conflicts between uses and sensitive environmental concerns adaptively. It should ensure that the mix of uses optimises the flow of benefits to the community in terms of environmental, social, cultural and economic outcomes in the longer term (Commonwealth of Australia, 1998).

A key role of the Cockburn Sound Management Council is to integrate the uses of the Sound to reach an acceptable balance of outcomes across the full range of uses and users. This is based on the principles of maintenance of ecosystem integrity, wealth generation and resource use, equity, and a participatory framework for decision-making.

In approaching this task the Management Council established a working group for each of the four main uses of Cockburn Sound and its foreshore.

Natural and Cultural Heritage Uses

- Foreshore habitats/use
- Marine habitats/uses
- Indigenous heritage
- European heritage

Recreational and Commercial Uses

- Fishing
- Water sports
- Coastal uses
- Nature-based tourism
- Aquaculture

Industrial Uses

- Heavy industry
- Marine construction
- Ports and harbours

Defence Uses

- Shipping and shore facilities

Each working group described and mapped the individual uses (see Figures 2 to 5), developed management objectives and strategies, and determined compatibility within and between uses. None of the current uses were found to cause a level of environmental impact or community conflict that would require total exclusion of the use from Cockburn Sound and its foreshore.

Using the results of the mapping exercise, the Management Council then determined the priority uses in specific 'management areas' for Cockburn Sound (Table 9) and identified areas where there is potential for conflict between uses (Figure 6).

It is acknowledged that the assessment of priority uses and compatibility between uses is subjective and as such provides only a broad guide for managing multiple use. More detailed mapping of future uses, together with a better understanding of the local community's long-term vision for Cockburn Sound and its foreshore, are required before this approach can be used to assess the suitability of proposed uses and developments.

Key considerations for the future management of multiple uses in Cockburn Sound include the following:

- Recreational fishing pressure is predicted to increase by about 30% in the next 10 years, and by more than 50% in the next 20 years.
- Water sports (such as jet skiing, water skiing, boating and sailing) are concentrated in Mangles Bay. Integrated boating facilities are required to minimise the current environmental impacts on seagrass meadows and to cater for future demand.
- Mussel production is expected to reach 1000 tonnes in 2001/2002 and has the potential to reach 4000 tonnes, worth over $10 million.
- Kwinana and Jervoise Bay are the State's prime heavy industry and marine construction sites, respectively. The Kwinana Industrial Area alone is estimated to produce goods worth at least $6 billion/year.
- Potential future developments include the James Point Private Port (which could include the live sheep trade) and the proposed Fremantle Port Authority harbour.

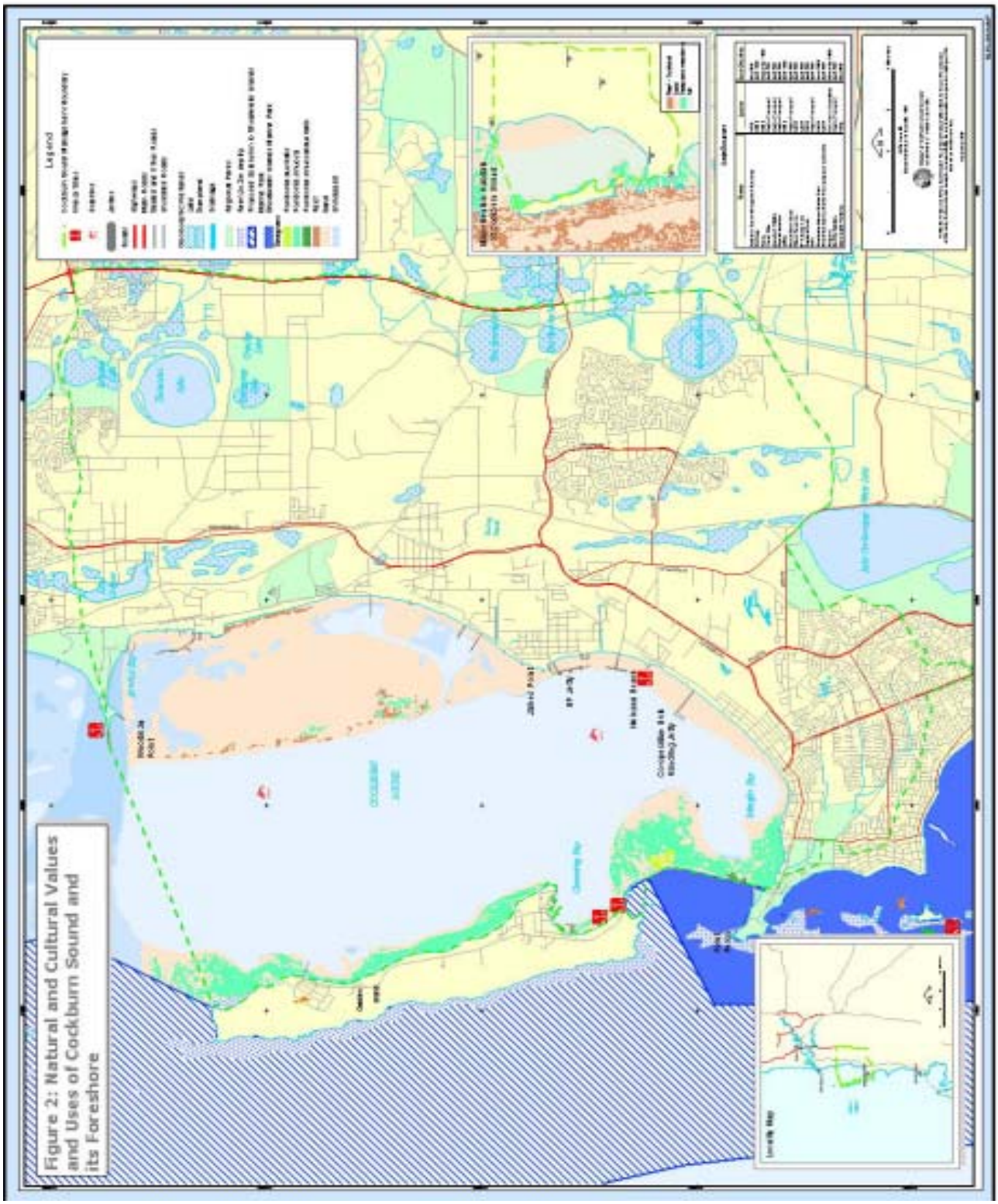


Figure 2. Natural and Cultural Values and Uses of Cockburn Sound and its Foreshore

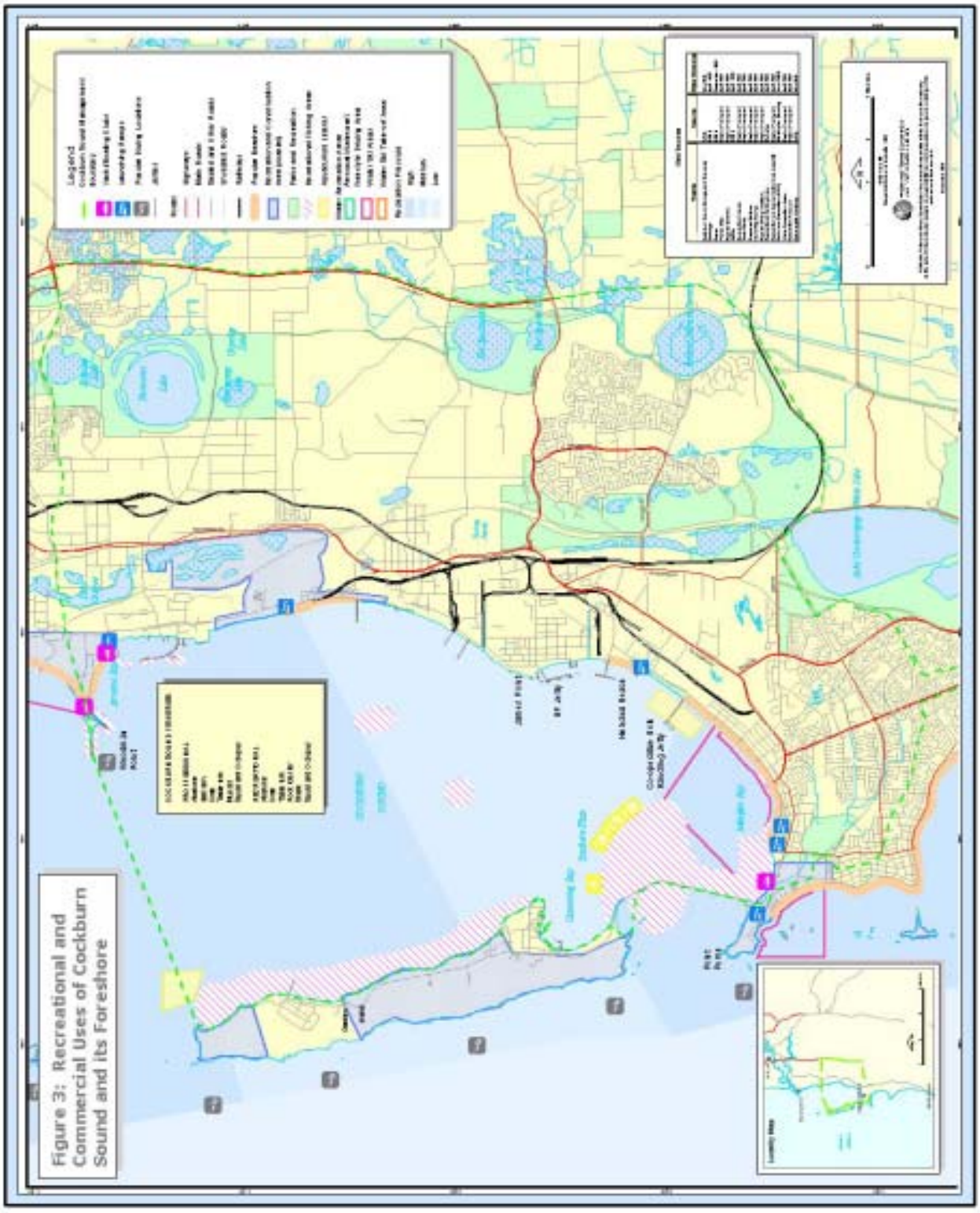


Figure 3. Recreational and Commercial Uses of Cockburn Sound and its Foreshore

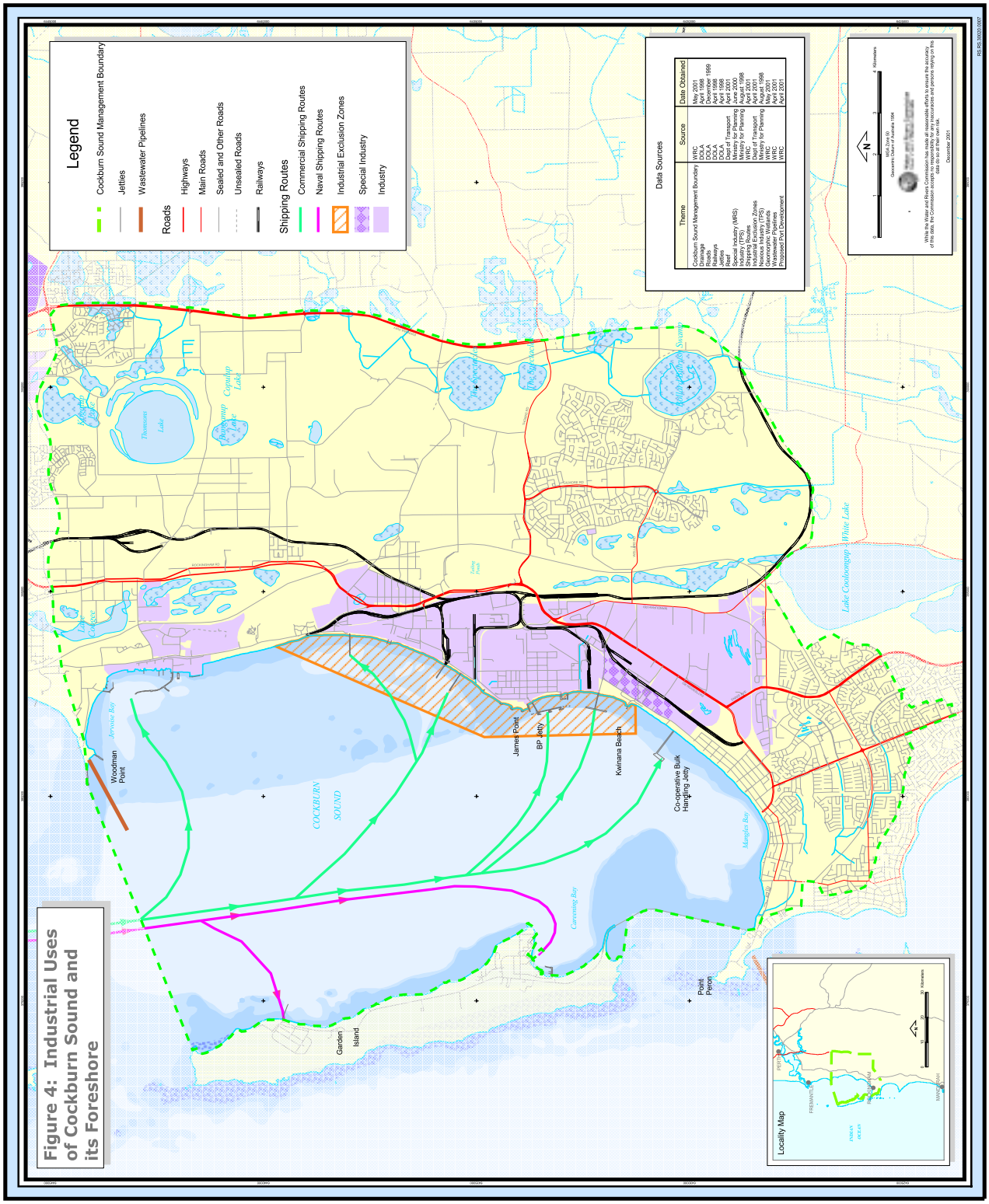


Figure 4. Industrial Uses of Cockburn Sound and its Foreshore

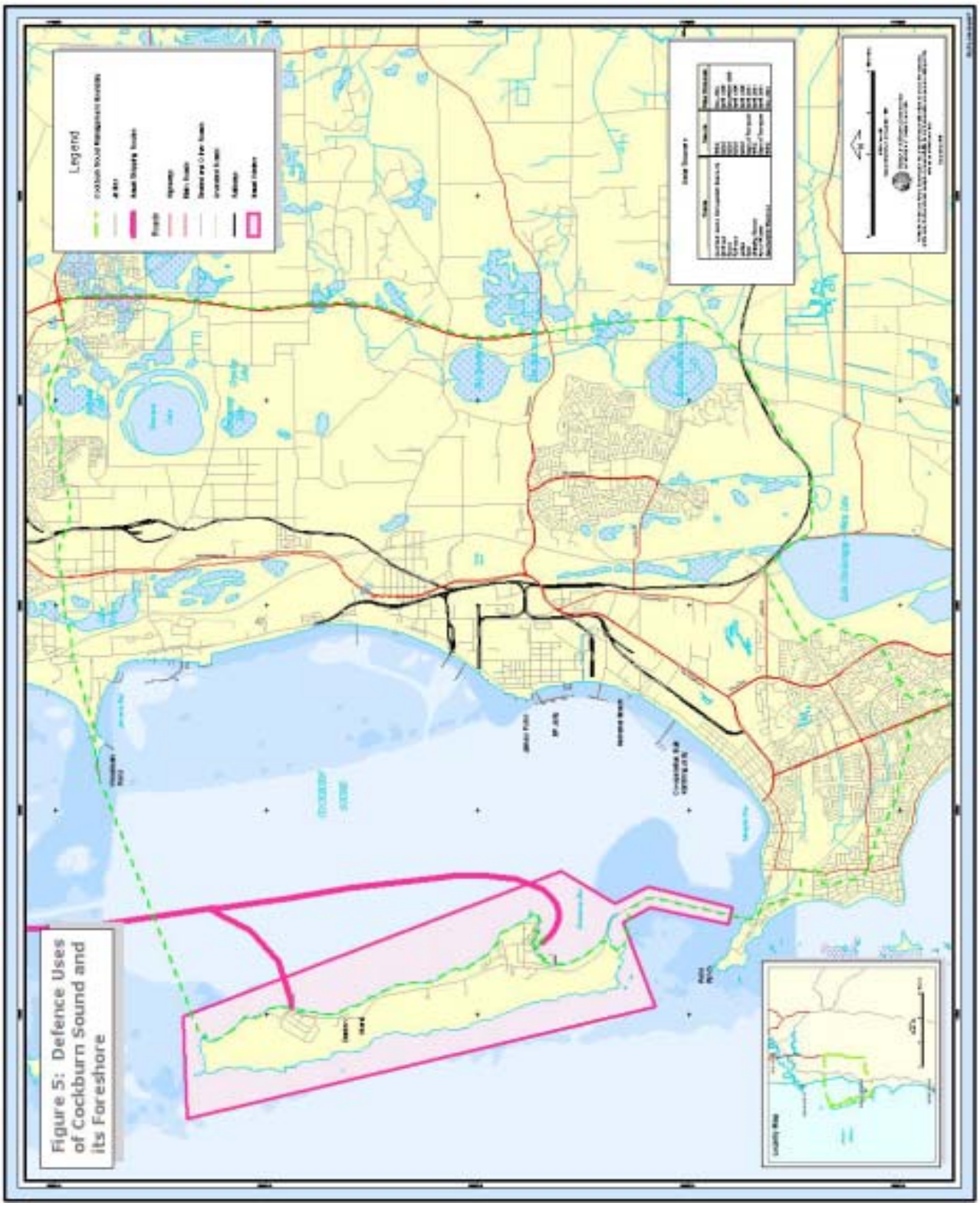


Figure 5. Defence Uses of Cockburn Sound and its Foreshore

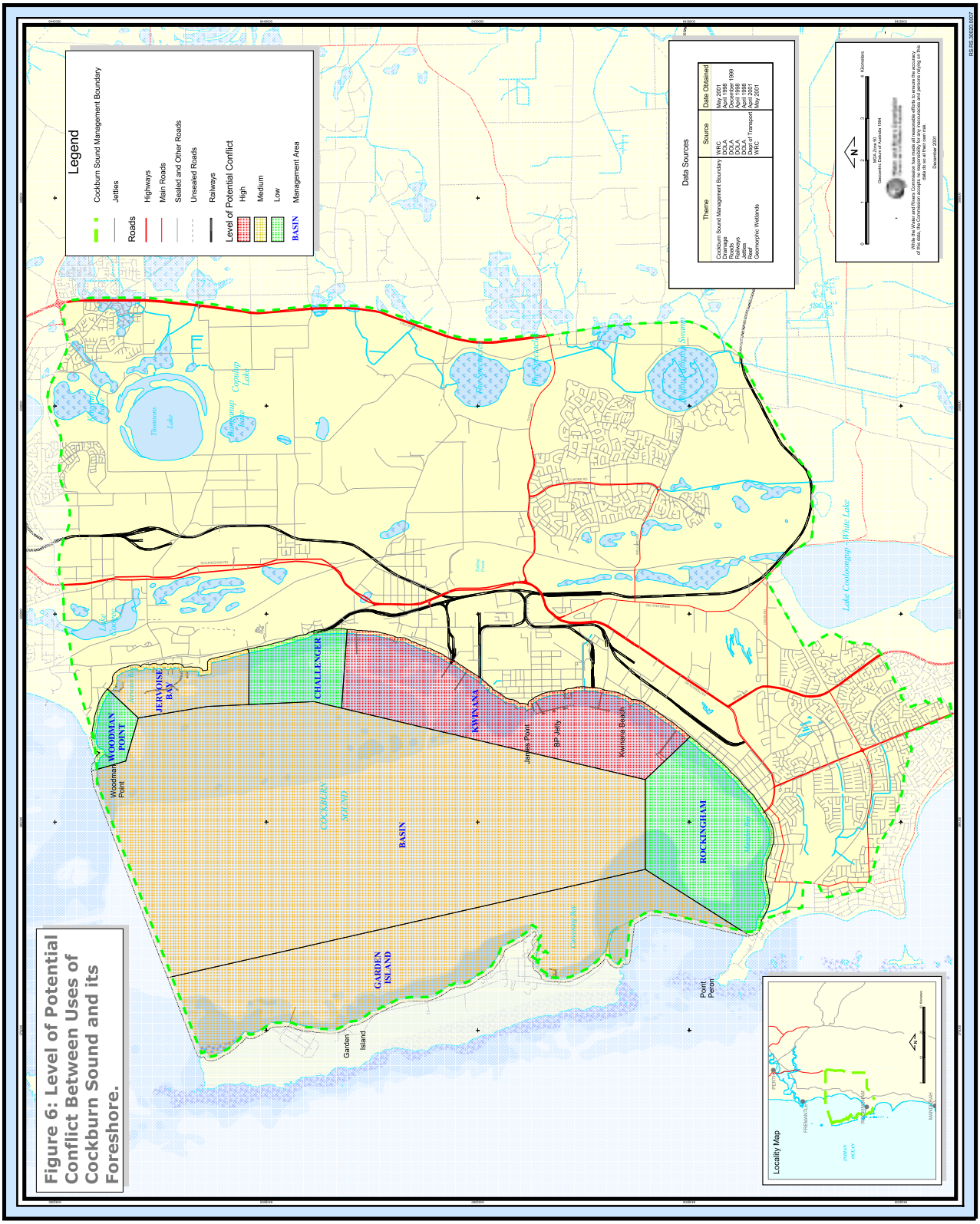


Figure 6. Level of Potential Conflict between Users of Cockburn Sound and its Foreshore

Table 9. Multiple Use Planning for Cockburn Sound and its Foreshores

	Management Areas						
	Garden Island	Rockingham	Kwinana	Challenger Beach /Cliffs	Jervoise Bay	Woodman Point	Central Basin
Multiple Use							
Natural/Cultural	✔	✔	✔	✔✔ (Cliffs)	✔	✔✔	✔
Recreational/Commercial	✔ R	✔✔	✔ R	✔✔ (Beach)	✔	✔	✔
Industrial	✖	✖	✔✔	G	✔✔	✔	✔
Defence	✔✔	N/A	N/A	N/A	✔	N/A	✔

✔✔	**Primary Use**	*Priority use of a management area.*
✔	**Secondary Use**	*Use compatible with primary use and management area.*
✔ R	**Restricted Use**	*Use restricted within a management area by legal constraints.*
G	**Gap in Knowledge**	*Additional information required to assess compatibility with other uses and/or management area.*
✖	**Incompatible**	*Use incompatible with other uses and/or management area.*
N/A	**Not Applicable**	*Assessment of use is not relevant.*

- Protecting the remaining healthy meadows of seagrass in the Sound is a high priority.
- The level of shipping and boat traffic in Cockburn Sound will increase dramatically in future years, with recreational boating predicted to increase 43% by 2011, commercial shipping 5% per year, and Navy vessels 25% by 2004.

Overall Objective

- To recognise and facilitate multiple use management of Cockburn Sound and its foreshore.

Recommendations

1. Coordinate a comprehensive survey to establish future types, areas and intensities of use as the basis for the long-term multiple use management of Cockburn Sound and its foreshore (CSMC: 2003 – 05)

2.2 Recreational and Commercial Uses

2.2.1 Water Sports

Based on surveys conducted in 1978 (Feilman & Associates, 1978) and 1994 (Dielesen, 1994) swimming is the most popular water sport in Cockburn Sound. Kwinana, Wells Park, Rockingham and Palm beaches and Woodman Point are the most popular for swimming. Sailing (yachting and windsurfing) is popular in Mangles Bay. SCUBA diving is undertaken extensively within Cockburn Sound, and the area immediately offshore from Churchill Park, Rockingham, is a regionally important diving and training site as it contains a number of small wrecks.

About two-thirds of Garden Island is open to the public in daylight hours, and is also popular for picnics, swimming, diving (snorkel and SCUBA), fishing, and sailing (yachting and windsurfing). There is an Industrial Exclusion Area between Kwinana and Challenger Beaches (see Figure 4), within which the Fremantle Port Authority may restrict the access of water craft that present a safety hazard to shipping and port operations.

Water skiing and 'free style' driving of personal water craft (jet ski) are restricted to areas in Mangles Bay/Palm Beach and there is a Department of Defence ban on personal water craft all year round within naval waters around Garden Island. Outside these areas, personal water craft are permitted but for the purposes of boating regulations are considered as power boats, and must be driven accordingly.

There are no recent surveys of water activities in Cockburn Sound, but a snapshot survey of Owen Anchorage in 1998 by Annandale (1999) that included Woodman Point, found a similar pattern of use to the 1978 and 1994 surveys mentioned.

The issue of potential conflict between users was also investigated, and in most cases the potential was greatest in the summer months when there were more people using the water. Swimmers were affected by the greatest range of other users, with people using boats and/or jet skis cited most by other users as affecting, or interfering with, their recreational use of the area. Fishers were the next most likely to affect other users of the area. Users in conflict with other users were often engaged in the same activity, for example, pleasure boats versus other pleasure boats, and fishers versus other fishers.

Issues

- The main requirements of water sports are high water quality, easy access to water, separation of incompatible uses and adequate shore-based facilities. A comprehensive survey is urgently required to establish types of use, areas of use and intensity of use for environmental management and planning.
- Water sports (such as jet skiing, water skiing, boating and sailing) are concentrated in Mangles Bay. These craft can cause damage to marine flora and fauna from moorings, anchors and landings; scouring of the seabed; discharge of sullage; spillage of fuel and oil; emission of engine exhaust pollutants, and litter. The seagrass in Mangles Bay is under stress and elevated bacteria levels have been recorded in waters at Palm Beach. Integrated boating facilities are required within Cockburn Sound to minimise the current environmental impacts and to cater for future demand.

Objectives

- To ensure that water sports are managed in a manner that is consistent with protecting Cockburn Sound's ecological and social values.
- To recognise and facilitate water sports as one of the multiple uses of Cockburn Sound.
- To work cooperatively with Department of Planning and Infrastructure, local government and user groups to integrate environmental planning and management for the water sports in Cockburn Sound.

Recommendations

1. Determine the nature, spatial and temporal patterns, compatibility and potential environmental impacts of water sports in Cockburn Sound (CSMC: 2004-06).
2. Incorporate the requirements of water sports (high water quality, separation of incompatible uses, easy access, adequate shore-based facilities) and growth trends into the future planning for Cockburn Sound (CSMC: Ongoing).
3. Use a combination of regulations, community education, codes of conduct and enforcement to maintain marine safety standards and manage conflicts within and between water sports (DPI, recreational user groups: Ongoing).

4. Promote the use of low impact moorings in areas where seagrass is being damaged, particularly in Mangles Bay and the northern shallows of Garden Island (DPI, DoD: Ongoing).

5. Investigate the advantages and disadvantages of integrating boating requirements (for example, launching, mooring, repairing, fuelling, sullage and bilge disposal) into common facilities in the Mangles Bay area (DPI, CoR, Land Corp: 2005-06).

2.2.2 Coastal Uses

Coastal uses include activities, such as boat launching, picnics, visits associated with swimming, walking, relaxation and exercising dogs and horses.

Cockburn Sound is particularly popular for small boat use due to its sheltered nature. The estimated 44,270 boats launched at public ramps each year along the Cockburn Sound foreshore is the highest in the southern metropolitan coastal area. The busiest times are September to April, especially January and February. Use is predicted to increase significantly to 63 280 boat launches (43%) by 2011 and 77 451 (75%) by 2021 (Department of Transport, 1999).

Local governments play a key role in the management of coastal areas by separating incompatible uses, ensuring suitable facilities (rubbish bins, toilets, boat ramps) are available and providing suitable paths and/or barriers to control erosion.

There are a number of coastal, foreshore and/or recreation management plans in place: City of Cockburn has a Coastal Management Strategy, the Town of Kwinana has a Coastal Management Plan (currently being updated), and the City of Rockingham has a Strategic Coastal Management Plan (currently under review).

Community use of the eastern foreshore of Cockburn Sound is becoming increasingly limited due to the construction of foreshore developments and the erosion of beaches at Wells Park, Challenger Beach and Woodman Point.

Community concerns have been expressed that more and more people are wanting beach access, while less and less beach is available. The lack of recreational opportunities along the eastern foreshore is leading to increased congestion and conflict between users (Community Forums, 2001).

Issues

- The main requirements of coastal users are clean beaches, a stable coastline, easy and safe access, and good facilities. A comprehensive survey of users is urgently required to establishes types of use, areas of use and intensity of use for environmental management and planning.

- Whilst recognising that industry is the primary land use in the Jervoise Bay and Kwinana areas (see Table 9), a cooperative approach is required to identify the opportunities and constraints for improved community use of the eastern foreshore of Cockburn Sound. The retention and enhancement of Wells Park, Challenger Beach and Woodman Point beaches are critical issues for the local community (Community Forums, 2001).

- Coastal erosion is occurring at Mangles Bay, Kwinana Beach, Challenger Beach and Woodman Point. This is of considerable concern to local beach users (Community Forums, 2001). There is no standard approach presently available for detailed assessment of coastal erosion measures and adapting them for local conditions in Cockburn Sound.

Objectives

- To ensure that coastal uses are managed in a manner that is consistent with maintaining Cockburn Sound's ecological and social values.

- To recognise and facilitate coastal uses as one of the multiple uses of Cockburn Sound.

- To work cooperatively with the Department of Planning and Infrastructure, local government, industry and the local communities to integrate coastal planning and management in Cockburn Sound.

Recommendations

1. Determine the nature, spatial and temporal patterns, compatibility and potential environmental impacts of the use of the coastal environment of Cockburn Sound (CSMC: 2004-2006).

2. Seek to better undestand the implications of predicted changes in sea level (for example, due to global warming) and incorporate this understanding into future planning (CSMC: 2005).

3. Ensure the requirements of coastal use (clean beaches, coastal stability, easy and safe access and good facilities) are considered in the future planning for, and management of, Cockburn Sound and its foreshore (CSMC: Ongoing).

4. In cooperation with industry, local government and local communities, investigate ways to improve community access to, and use of, the eastern foreshore including:

   - enhancing beaches and facilities at Wells Park, Challenger Beach and Woodman Point; and
   - identifying the constraints to public access in coastal areas within Kwinana and Jervoise Bay areas and developing practical solutions with stakeholders (CSMC, LGAs, industry, Land Corp, CALM, local communities: 2002-04).

5. In partnership with community groups, and local and State government agencies, investigate the causes of coastal erosion and develop a set of beach protection and restoration guidelines for the Cockburn Sound foreshore. Priority areas for management are Mangles Bay, Challenger Beach and Woodman Point (CSMC, DPI, LGAs, CALM, community groups: 2002 – Ongoing).

2.2.3 Fishing

Over 130 species of fish and 14 large crustacean and mollusc species have been found in various habitats in Cockburn Sound (Dybdahl, 1979). The major commercial and recreational species include:

- *Open and deep water* – Snapper, pilchards, bonito, whiting, squid, cuttlefish, butterfish, sampson fish, skipjack and crabs (Penn, 1977).
- *Shallow water with sandy seabed* – Whiting, juvenile king prawns, anchovies, blue sprat, whitebait.
- *Seagrass meadows* – Leatherjackets, wrasse, crabs, herring, garfish.
- *Jetties and groynes* – Herring, yellowtail, scad, trevally, samson fish, mussels.

Considerable overlap of species occurs between the various habitats.

The Sound is an important fish nursery (particularly the sheltered seagrass areas) and feeding habitat for many of the important commercial and recreational species listed above. It is an ecosystem that needs to be protected and carefully managed.

Commercial fishing

The level of fish harvesting from Cockburn Sound has been recorded annually from 1977 onwards using Department of Fisheries statutory commercial catch data from block 9600. This block includes all waters within Owen Anchorage and Cockburn Sound, although the great majority of commercial fishing occurs within the Sound.

Annual commercial catches of finfish and molluscs (excluding mussels from aquaculture) are shown in Figure 7. Wild harvest mussel data are only available from 1982 to 1992, however catches before 1982 and after 1992 were extremely low. Mussel aquaculture has now virtually replaced wild mussel harvesting.

The greater part of the commercial catch until about the last three years has been plankton-feeding baitfish. Recent low catches of baitfish are most likely due to environmental factors, market pressure, changes in gear type and fishing effort, and poor recruitment levels. King George and western sand whiting, squid and octopus have also declined and the same factors may be responsible.

There are four commercial fisheries that operate within Cockburn Sound (fisheries block 9600) and a further two commercial fisheries that operate partly within the Sound. The six fisheries are summarised in Table 10 (Fisheries WA, 2000a).

A restricted entry regime was introduced for Cockburn Sound in 1985. Management of major fishing activities is now by way of formal management plans declared in 1995 under the *Fish Resources Management Act 1994*. Minor fishing activities are managed through a combination of regulations (Fish Resources Management Regulations 1995); orders under the Act; and conditions attached to fishing boat and commercial fishing licences.

Management is achieved via controls on access (number of fishers, seasons, closed areas), catch size, and type of fishing gear. For example, there is a temporary closure for line fishing for snapper between 15th September and 31st October during the spawning season.

Due to increasing levels of competition between commercial and recreational crabbers, a voluntary resource sharing agreement was recently reached by the fishing industry, Recfishwest, and Department of Fisheries (Fisheries WA, 2000b). The agreement will reduce the number of crab traps used by professional fishers from 1,600 to 800 over three years, or will achieve a share of the catch of five-eighths commercial and three-eighths recreational.

The long-term management of commercial fisheries in Cockburn Sound is being addressed as part of a broader strategic approach to managing Western Australia's estuarine and marine embayment fisheries (Fisheries Management Paper No. 131, Fisheries Western Australia, 1999b).

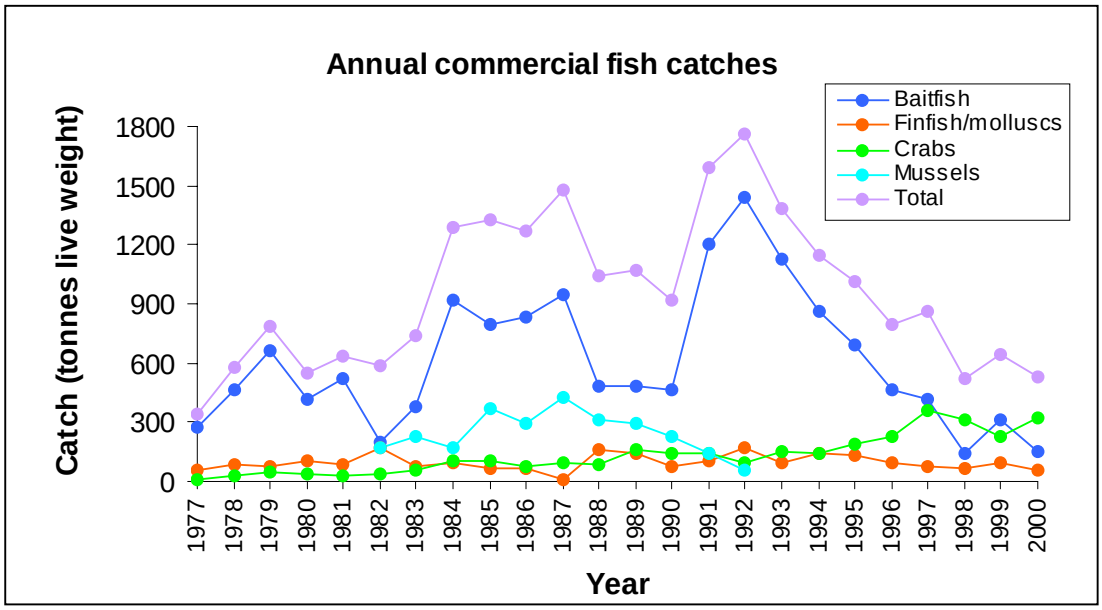


Figure 7. Annual Commercial Fish Catches in Cockburn Sound Fisheries Block 9600 (excluding mussels from aquaculture)

Table 10. Details of Commercial Fisheries Operating in Cockburn Sound

Fishery and Boundaries	Target Species	No. of LIcences
Cockburn Sound (Crab) Managed Fishery (Block 9600)	Blue manna crab	16
Cockburn Sound (Fish Net) Managed Fishery (Block 9600)	Garfish and Australian herring (lesser amounts of shark, whiting and mullet)	4
Cockburn Sound (Line and Pot) Managed Fishery (Block 9600)	Whiting, pink snapper, Australian herring, shark, garfish, squid, octopus	32 (not all currently utilised)
Cockburn Sound (Mussel) Managed Fishery (Block 9600)	Mussels	3
The West Coast Beach Bait (Fish Net) Managed Fishery (*Moore River to south of Mandurah)*	Whitebait and bluebait	13
West Coast (Purse Seine) Managed Fisheries (*Lancelin to Cape Bouvard)*	Pilchards, some scaly mackerel. Majority of fishing occurs outside the Sound.	14

Recreational fishing

Cockburn Sound is very popular for recreational boat fishing. A 1996/97 survey of coastal waters from Augusta to Kalbarri found that the Sound is second in importance only to the Hillarys area, with over 12 000 boating trips recorded annually (Sumner and Williamson, 1999).

The main fish species caught in Cockburn Sound by boat-based recreational fishers are: Australian herring (13 tonnes), squid (58,000 animals, weight not known), King George whiting (9 tonnes), whiting other than King George (7 tonnes), skipjack trevally(5 tonnes), tailor (3 tonnes) and garfish (2 tonnes) (Sumner pers. com., 2001).

By comparison the commercial finfish catch (excluding baitfish) reported for 1998 (commercial fisheries block 9600) comprised mainly garfish (22 tonnes), Australian herring (21 tonnes), tailor, skipjack trevally, King George whiting, yellowtail scad and pink snapper (Fisheries WA, 1998). The total commercial catch of finfish (excluding baitfish) was 60 tonnes, compared to the recreational catch of 39 tonnes for the fish listed above (excluding squid). As these data do not include shoreline recreational fishing, it is estimated that the recreational finfish catch is of a similar magnitude to the commercial catch (Sumner and Williamson, 1999).

Cockburn Sound is also particularly popular with recreational crabbers, who caught an estimated 19 tonnes in 1996/97. The boat-based recreational catch was approximately 5% of the commercial catch for the same period (347 tonnes; Fisheries WA, 1998).

Recreational boat-based fishing effort is fairly widespread throughout the Sound, although fishing for pink snapper tends to occur near the channel markers south of Parmelia Bank, including Woodman Channel, Three Fathom Bank and the main FPA entrance channel. Recreational crabbers tend to fish in shallower waters than their commercial counterparts (Figure 3).

Although the level of recreational fishing has certainly increased, fishers are now more environmentally aware and the catch is managed by means of licences, bag limits, minimum sizes and gear controls set by the Department of Fisheries (Sumner and Williamson 1999).

A recent review of recreational fisheries management arrangements for the broader west coast region (Fisheries Management Paper No. 139) recommends minimum sizes for various fish species according to their size at sexual maturity, and sets bag limits for most species according to how 'prized' or vulnerable they are (Fisheries WA, 2000c).

Implementation of these fishing strategies will help protect vulnerable fish species and manage the recreational catch in Cockburn Sound. The Department of Fisheries also produces a variety of educational brochures aimed at promoting environmentally responsible fishing.

Community groups such as the Cockburn Power Boat Association (CPBA) and Recfishwest play an active role in encouraging environmentally responsible fishing in Cockburn Sound. For instance, the CPBA promotes single species fishing competitions, where only one fish can be weighed in for each species.

Issues

- The main requirements of fishers are continued beach and boat access; healthy fish stocks; and clean, relatively unpolluted and productive waters.
- Both commercial and recreational fishing are generally compatible with other uses, with current controls and the level of management that are in place. Shore access is becoming increasingly limited as industry, ports and harbours expand along the eastern foreshore of Cockburn Sound.
- As the level of recreational fishing pressure increases, the main management issues are likely to be the sustainability of the combined catches of commercial and recreational fishing, creating the need for greater resource sharing.
- Better estimates of recreational catches will be needed for integrated catch management (commercial and recreational) fisheries. A Department of Fisheries survey of recreational fishing in Cockburn Sound—boat-based and shore-based—will commence in late 2001 (Sumner, pers. com., 2001).
- To ensure sustainable fishing, more information is needed on the biology and life history of commercially and recreationally important fish species. Management measures will be different depending on whether species are resident in the Sound, or have important links with adjacent waters such as the Swan River and the open ocean.

Objectives

- To ensure that fishing activities are managed in a manner that is consistent with maintaining Cockburn Sound's ecological and social values.
- To recognise and facilitate fishing as one of the multiple uses of Cockburn Sound.

- To work cooperatively with the Department of Fisheries, the Western Australian Fishing Industry Council, and Recfishwest to integrate the requirements of fishers into the environmental planning and management for Cockburn Sound.

Recommendations

1. Consolidate existing information on recreational and commercial fishing in Cockburn Sound to better understand current levels of use and future trends (DoF, Recfishwest, WAFIC, CSMC: 2004-06).

2. Incorporate the requirements of recreational and commercial fishing (healthy fish stocks, productive waters and continued access) into the future planning for Cockburn Sound (CSMC: Ongoing).

3. Work with the Department of Fisheries to sustainably manage Cockburn Sound's fisheries through implementing *Management Directions for Western Australia's Estuarine and Marine Embayment Fisheries* (Fisheries Management Paper No. 131) and *A Quality Future for Recreational Fishing on the West Coast* (Fisheries Management Paper No. 139) (DoF, CSMC: On-going).

4. Provide community information and maps showing points of public access along the eastern foreshore of Cockburn Sound and details of the industry and port exclusion areas (DoF, DPI, Recfishwest: Ongoing).

5. Minimise the risk of introducing marine pests into Cockburn Sound's fisheries by supporting the implementation of the mandatory ballast water requirements and hull fouling management measures (AQIS, FPA, DoD, CSMC: Ongoing).

2.2.4 Aquaculture

Aquaculture is the farming of aquatic organisms including fish, molluscs, crustaceans, and aquatic plants, with some sort of intervention to enhance production, such as regular stocking, feeding or protection from predators. It provides the potential for an environmentally sustainable industry (Commonwealth of Australia, 2001).

Mussel farming is currently the only aquaculture activity in Cockburn Sound. Mussel production in the Sound commenced in 1988 to overcome the declining catches of the wild capture fishery and to provide a more consistent quality and source of product.

Currently 690 tonnes of mussels are produced annually from three lease areas: Southern Flats, Kwinana Grain Jetty and north Garden Island (Figure 3). Production is predicted to increase to 1000 tonnes in 2001/2002 and has the potential to reach 4000 tonnes, worth over $10 million (Fisheries Western Australia, 2001).

All health aspects of aquaculture are carefully controlled under the Western Australian Shellfish Quality Assurance Program. Freedom from contamination and meticulous hygiene are essential for successful marketing of the product (Health Department and Fisheries Western Australia, 2001).

The potential for adverse effects on sensitive benthic habitats due to the shading effects of mussel lines and waste products from the mussels is considered low as the lease areas are generally not located over seagrass meadows.

As a positive impact, mussels filter (clean) the water and the mussel lines provide fish habitat. On the negative side, the buoys of the long mussel lines are viewed by some as an eyesore that lessens the aesthetic value of the Sound.

Mussel aquaculture leases are regulated in accordance with an agreement between the Minister for Fisheries and the Fremantle Port Authority. Navigation is a major factor constraining further aquaculture development in Cockburn Sound, although small recreational boats are able to move among the aquaculture lines to fish.

Issues

- Aquaculture is generally compatible with other uses with controls and management in place. However, in locating leases there is a need to consider navigation issues; aesthetics of the buoyed lines; and the potential impact on benthic habitat.

- The mussel industry requires relatively deep water (>10 m), good circulation, excellent water quality (low levels of faecal bacteria, contaminants, and toxic species of phytoplankton), and sufficient phytoplankton for the mussels to feed on.

Objectives

- To ensure that aquaculture is managed in a manner that is consistent with maintaining Cockburn Sound's ecological and social values.

- To recognise and facilitate aquaculture as one of the multiple uses of Cockburn Sound.

- To work cooperatively with Department of Fisheries, the aquaculture industry and the broader community to integrate environmental planning and management for aquaculture within Cockburn Sound.

Recommendations

1. Consolidate existing information on aquaculture in Cockburn Sound to better understand current levels of use and future trends. Develop an Aquaculture Management Strategy (DoF, WAFIC, CSMC: 2004-06).

2. Incorporate the requirements of aquaculture (relatively deep water; good circulation; low levels of faecal bacteria, contaminants, and toxic phytoplankton species; and sufficient phytoplankton for good mussel growth) into the future planning for Cockburn Sound (CSMC: Ongoing).

3. Ensure that aquaculture licences include conditions covering: assessment and monitoring of potential impacts on benthic habitat; aesthetic impact; night lighting and navigational markings; and access by other users (for example, recreational boat fishers) (DoF, DPI, FPA, WAFIC, Recfishwest, CSMC: Ongoing).

4. Encourage the use of purpose-built buoys for mussel lines that blend with the surroundings, particularly in highly visual areas such as Kwinana Beach (DoF: Ongoing).

5. Integrate phytoplankton monitoring and tissue testing conducted for aquaculture with the broader water quality monitoring program for Cockburn Sound (CSMC, DoF, DHWA: 2002 - Ongoing).

2.2.5 Nature-Based Tourism

Cockburn Sound with its easily accessible, sheltered waters, diversity of marine and coastal habitats and close proximity to Perth provides a range of opportunities for people to enjoy the marine environment. The adjacent Regional Parks of Woodman Point, Beeliar and Rockingham Lakes complement this setting by providing a diversity of coastal environs for nature study and appreciation activities, such as bird watching. Each year the area is increasingly attracting local, interstate and international visitors.

Currently the dolphin tours are the only nature-based tourism operation within Cockburn Sound. The dolphin tour operator is licensed by the Department of Conservation and Land Management, which applies strict conditions regarding the interaction with the dolphins. The dolphins in Cockburn Sound have built up a relationship based on trust with the tour operator over the past 12 years, and interact out of curiosity and not as a result of food rewards. The current tour operator in Cockburn Sound has recently been awarded the 2001 Western Australian Tourism Award in the Environmental Tourism Category.

The operator runs one trip of dolphin watching and swimming with the dolphins per day for nine and half months (spring to autumn), but has the potential to run all year. The tours cover the entire area of the Sound, depending on the location of the dolphins. There are approximately eight pods of dolphins consisting of 180 individuals within Cockburn Sound.

The Department of Fisheries has recently initiated a major Charter Fishing and Ecotourism initiative which may result in additional tour operations in Cockburn Sound.

Issues

- Nature-based tourism depends on retaining clean beaches, high water quality, healthy marine plants and animals, high aesthetic quality and access to natural values. Nature-based tourism is experiencing rapid growth worldwide.

- Nature-based tourism is generally compatible with most other uses in Cockburn Sound, however there may be times when shipping, naval and industrial activities limit access to some areas of the Sound.

- Some dolphins have taken to begging for food alongside recreational and commercial fishing boats and jetties within Cockburn Sound. This can result in their entanglement in fishing lines and hooks as well as being fed an unsuitable diet that may lead to sickness. The dolphin tour operator is working with the Department of Conservation and Land Management and local government authorities to implement a Keep the Dolphins Wild program. The program aims to protect the wild nature of the dolphins through providing a direct response to animals in distress, education and prevention, and research and monitoring.

Objectives

- To ensure that nature-based tourism is sustainable and managed in a manner that is consistent with maintaining the ecological and social values of Cockburn Sound.

- To recognise and facilitate nature-based tourism as one of the multiple use values of Cockburn Sound.

- To work cooperatively with local tour operators, Department of Conservation and Land Management, the WA Tourism Commission and local government to integrate environmental planning for, and management of, nature-based tourism in Cockburn Sound.

Recommendations

1. Incorporate the requirements of nature based-tourism into the broader planning and management of Cockburn Sound (CSMC: Ongoing).

2. Work with the Western Australian Tourism Commission, Department of Conservation and Land Management, Department of Fisheries and local tour operators to develop an overall strategy for nature-based tourism in Cockburn Sound. The strategy needs to include a Code of Practice for operators (WATC, CALM, DoF, local tour operators, CSMC: 2005-06).

3. Develop in consultation with the Department of Planning and Infrastructure and Fremantle Port Authority strategies to manage conflict between tour operators and shipping and port operations within the Sound (DPI, FPA, tour operators: 2002-03).

4. Support tour operators' efforts to raise community awareness through programs such as the Keep the Dolphins Wild (CSMC, LGAs, CALM: 2002-Ongoing).

5. Provide opportunities to integrate dolphin research into the overall monitoring program for Cockburn Sound (CSMC, tour operators: 2002 –Ongoing).

2.2.6 Aesthetics

Cockburn Sound provides a rich combination of natural and cultural characteristics that attracts people and provides positive experiences and enjoyment. Together these create the important aesthetic values of the area.

Cockburn Sound is a very attractive setting for human use and enjoyment. The relatively sheltered waters provide a safe anchorage and an ideal location for swimming, fishing, boating and sailing. Enhancing this attractiveness is a range of natural and cultural features including rugged limestone cliffs, sweeping beaches, prominent landforms, diverse vegetation and the expansive waters. The Sound has also been an important place for indigenous people and was the landing place for the first European settlers in the Perth area.

There are extensive opportunities for passive enjoyment of the area, with many people coming to experience the open space, solitude, and expansive views.

There is a need to better understand, identify and manage these aesthetic values. It is expected that there will be increased development pressure on areas surrounding the Sound and that recreation use will also increase as this development occurs. These changes may threaten aesthetic values by restricting access, affecting water quality, creating conflicts between uses and users, degrading natural and cultural features, reducing the extent of natural areas, and spoiling views.

There are opportunities to manage aesthetic values of the Sound by managing human activity to provide for appropriate activities while protecting the natural and cultural features, and increasing awareness and understanding of the environmental values of the Sound.

Issues

- To date, there has been no comprehensive assessment of recreation use, aesthetic values or community perceptions of aesthetic value. A working document has recently been prepared to provide a basis for future management of aesthetic values, particularly in relation to water pollution. A key challenge is to build an adequate knowledge base for planning and management.

Objectives

- Provide positive experiences and enjoyment for people through good land and water use planning, environmental care and community activity planning.

- Maintain, and where possible enhance, existing aesthetic values, or ensure that potential impacts are minimised.

- Provide a framework for identifying, planning for and managing aesthetic values.

Recommendations

1. Identify aesthetic values, in particular:

    - assess the natural and cultural characteristics that contribute to aesthetic values;
    - assess community use (particularly recreation);
    - survey community perceptions related to aesthetic values;
    - research the correlation between natural and cultural characteristics and community perceptions (CSMC: 2006-2008).

2. Develop general treatments or guidelines that meet objectives for managing aesthetic values (CSMC; 2006).

3. Ensure that aesthetic values are adequately considered in the preparation and evaluation of development proposals (CSMC, LGAs, DoD, CALM: Ongoing).

4. Monitor changes to aesthetic values, particularly natural and cultural characteristics and community perceptions (CSMC: Ongoing).

2.3 Industrial Uses

2.3.1 Industrial Land Uses

Heavy industry is centred on the suburbs of East Rockingham, Kwinana Beach and Naval Base, and includes an oil refinery, chemical production, an alumina refinery, power generation, a titanium dioxide plant, cement production and a nickel refinery.

Heavy industry is of considerable importance to the State economy, with the Kwinana Industrial Area alone estimated to produce goods worth at least $6 billion/year (Baker, pers. com., 2001).

An international ship building precinct (construction, repair and maintenance of steel and aluminum-hulled vessels) is also based at Henderson, at the Jervoise Bay Northern Harbour. The ship building industry is now recognised as a world leader in construction of high speed lightweight vessels and other marine craft (Department of Commerce and Trade, 2000).

A waste water treatment plant, which services a large portion of Perth's southern metropolitan area, is located in the Woodman Point area.

The attraction of the Cockburn Sound foreshore for industry lies in the shipping facilities, road and rail transport, energy, cooling water, and proximity of synergistic industries.

Current plans involve optimising the use of the Kwinana area (Ove Arup, 1999); developing the East Rockingham Industrial Park (Taylor Burrell, 1998); establishing Southern Harbour and the Marine Technology Park at Jervoise Bay (Department of Commerce and Trade, 2000); and, in the long term, expanding into the Hope Valley-Wattleup area (Western Australian Planning Commission, 2000b; Government of Western Australia, 2001).

Proposals for future development include the Global Olivine Waste to Water and Energy Plant, the HIsmelt pig iron plant, the Western Power electricity generation facilities upgrade, the James Point Private Port (which could include the live sheep trade) and the proposed Fremantle Port Authority harbour.

The multiple use planning exercise conducted by the Cockburn Sound Management Council recognises that industry is the primary use of Kwinana and Jervoise Bay (see Table 9). Secondary uses include: natural and cultural heritage in both areas, as well defence in the Jervoise Bay area. Recreational and commercial uses are restricted in the Kwinana area (Table 9).

A review of the most recent environmental studies has found no further broadscale deterioration in the health of surviving seagrass meadows, and no significant losses related to water quality (DAL, 2001). Overall nutrient-related water quality has improved slightly since the early 1990s, apart from in the Jervoise Bay Northern Harbour.

Estimated discharges of metals and oil by industry have continued to decrease due to improved waste treatment practices. Depending on the contaminant, they are presently about one sixth to one thousandth of discharge levels recorded in 1978.

A 1999 sediment survey found that contaminant levels, apart from TBT in some areas, were well below environmental guidelines (see Section 1.3 Maintaining a Healthy Marine Ecosystem and 2.3.2 Ports, Harbours and Shipping).

Nitrogen input from human activities has declined from an estimated 2000 tonnes/year in 1978 to about 300 tonnes/year in 2000 (see Figure 8). Industrial sources - pipeline discharges plus inputs from groundwater contamination - currently contribute approximately 75% of the total nitrogen load that enters the Sound (DAL, 2001).

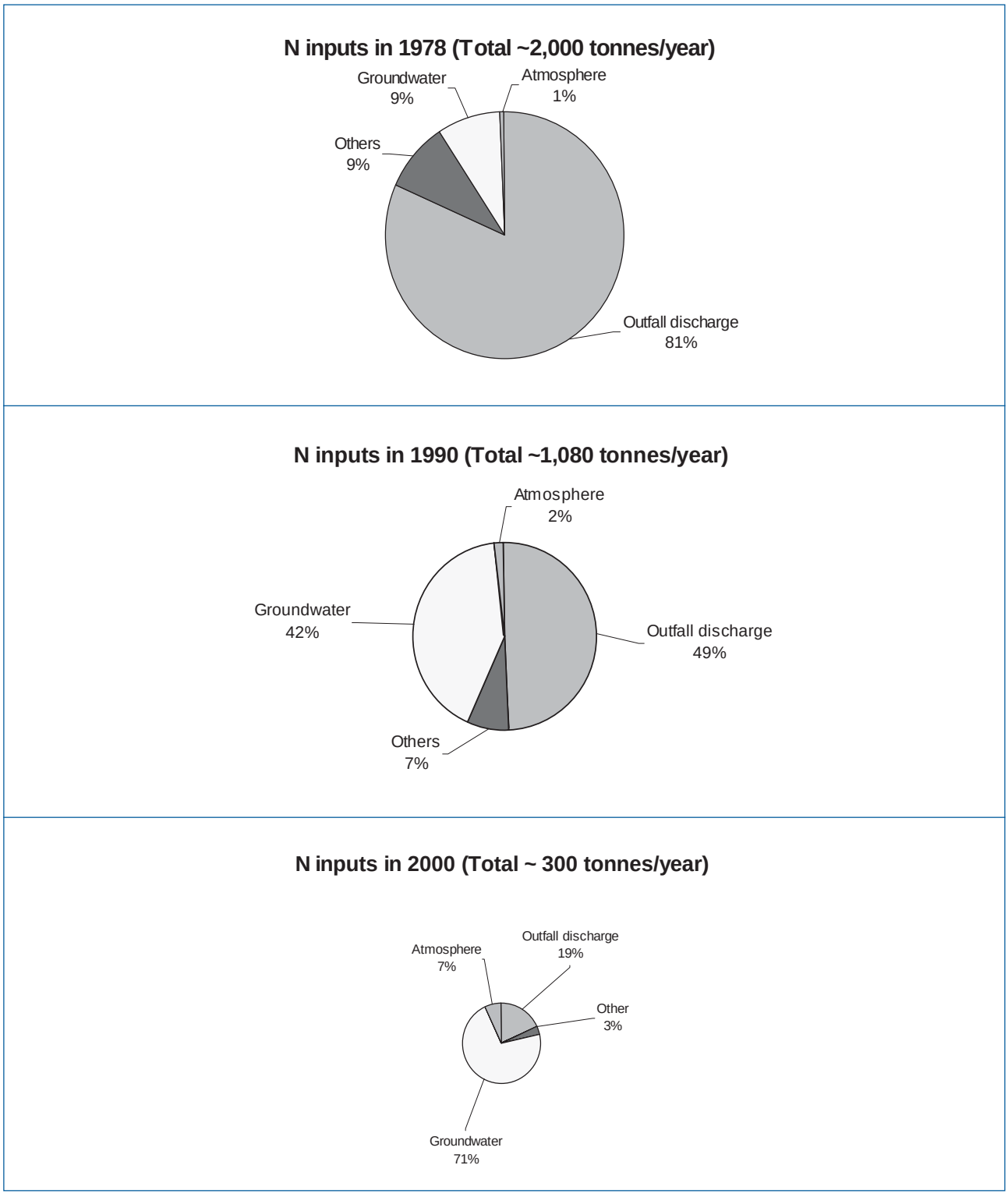
There are five industrial outfalls presently discharging into Cockburn Sound: Western Power, BP Refinery, Tiwest Joint Venture, Wesfarmers CSBP, and Millenium Chemicals. The amount of nitrogen entering the Sound from the industrial outfalls has declined from more than 1600 tonnes per year in 1978 to the current estimated load of 55 tonnes per year.

In addition, the Water Corporation is upgrading the Woodman Point Waste Water Treatment Plant to advanced secondary treatment, reducing total discharge of nitrogen and faecal micro-organisms) to the Sepia Depression, south of Cockburn Sound.

The upgrade of the treatment plant also provides the opportunity for industrial reuse of some of the highly treated waste water via the Water Corporation's Kwinana Water Reuse project. This will provide the opportunity for removing all industrial effluent discharges (except for cooling water) from Cockburn Sound, subject to the resolution of technical and financial issues.

The Department of Environmental Protection has recognised the management of the Woodman Point WWTP and the monitoring of the effects of marine disposal of waste water by awarding the Corporation a Best Practice Environmental Licence.

There have also been concerted efforts by industry to reduce nitrogen inputs from groundwater sources to Cockburn Sound (Figure 8). Much of the nutrient enrichment of groundwater is a legacy of past practices and a number of industries are now in the process of treating or removing the nutrients. For example, as a result of Groundwater Remediation Programs, the groundwater nitrogen contributions to Cockburn Sound from beneath the Kwinana Nickel Refinery site have been reduced from about 500 tonnes per year in 1990 to eight tonnes per year. Nitrogen inputs to the Jervoise Bay Northern Harbour from groundwater are expected to decrease from 66 tonnes per year to 26 tonnes per year within a year (DAL, 2001).



Note: The areas of the pie graphs are proportional to their relative inputs.
Excludes inputs from sediment nutrient release.

Figure 8. Estimated Nitrogen Inputs to Cockburn Sound from Outfall Discharges; Ground and Surface Water; Atmospheric Deposition; and Spills from Ship Unloading in 1978, 1990 and 2000

Woodman Point Waste Water Treatment Plant

The upgrade of the Woodman Point Waste Water Treatment Plant (WWTP) from primary to advanced secondary treatment is necessary to accommodate increased waste water flows from the growing population south of the Swan River while at the same time maintaining the protection of public health and the marine environment. The upgrade includes the construction of:

- A new high capacity sewage pump station and the eventual decommissioning of the existing Munster pump station;
- New inlet works and upgraded primary treatment with odour controls;
- Methane capture and use for heating, generation of electricity and reduction of greenhouse gas emissions;
- A new sequencing batch reactor (SBR) to treat the primary effluent to advanced secondary standard;
- Additional sludge handling facilities to treat and dewater the increased sludge volumes from the secondary treatment process; and
- Storage of treated secondary effluent in an open 85 megalitre storage dam, which will allow the balancing of flows.

The introduction of advanced secondary treatment at the Woodman Point WWTP will:

- Enable the total nitrogen load discharged to the Sepia Depression to be held to below the 1994 loading (estimated as 1,778 tonnes of nitrogen per year);
- Allow for additional treatment capacity at the completion of the upgrade to achieve a further nitrogen reduction to 75% of 1994 loadings;
- Substantially reduce the discharge of faecal micro-organisms to the Sepia Depression; and
- Substantially reduce the metal loads discharged to the Sepia Depression.

There is, however, still considerable groundwater contamination under industrial sites due to metals and organic compounds. For example, as a result of past practices, a plume of groundwater pollution containing high concentrations of phenols and herbicides 2.4.D and 2.4.5.T exists within the Kwinana Industrial Area (DAL, 2001).

Recreational and commercial uses are categorised as 'restricted use' within the Kwinana area (Table 9), as the level of noise, odour, waste water discharge and public safety risk associated with industrial land use limits the community's use of these areas. In many cases the foreshore is owned by private companies or vested in government development agencies, such as Land Corp.

Nevertheless, the local community has expressed a strong desire to enjoy the remaining natural values (for example, foredunes) of the eastern foreshore of Cockburn Sound and to have access, albeit restricted, for recreational activities (Community Forums, 2001).

A key role of the Cockburn Sound Management Council will be to facilitate an acceptable balance of outcomes between different uses along the eastern foreshore of Cockburn Sound.

Consideration of 'Risk'

The establishment of the industrial complex in the Kwinana area has brought with it many benefits to the State and community. However, as with any industrial operation, there are also attendant risks. The responsibility for managing these risks is shared by those owning the plant, those working on the plant and the regulatory authorities.

Guidelines have been set by the regulatory authorities for the level of acceptable risk for different land uses. Unrestricted access by the public to the eastern foreshore in the Kwinana Industrial Area could result in an unacceptable risk exposure to the public. In such circumstances industry would be required to reduce the level of risk, which could result in severe operational limitations and/or significant costs. Also the types of heavy industry that could be located in the Kwinana Industrial Area in the future would be severely restricted.

Unrestricted beach access by the public at large to the eastern foreshore in the Kwinana Industrial Area has public liability implications for industry that would be difficult to manage, and appropriate insurance cover, if available, would be very expensive.

Issues

- Industry generally requires: access to a deep water port or sheltered harbour as well as main roads and rail routes; close proximity to supporting services, a workforce and metropolitan markets; adequate buffers; and opportunities for vertical and horizontal integration of industries. The Kwinana and Jervoise Bay industrial areas have all of these attributes.
- Despite the large declines in nitrogen inputs to Cockburn Sound, particularly by industry, overall nutrient-related water quality has improved only slightly since the early 1990s. Therefore, better understanding of the relationship between nutrient inputs and water quality is required. In the interim, the current cooperative approach of reducing all sources of nitrogen inputs from human activities needs to continue.
- The Water Corporation and local Kwinana industries have jointly developed a proposal to construct a water treatment plant to produce high quality, industrial grade water from secondary treated effluent drawn from the Cape Peron pipeline. Treated waste water discharges from local industries would re-enter the pipeline for disposal off-shore (4.2 km) into the Sepia Depression, south-west of Cockburn Sound. The end result would be the removal of discharges of industrial waste water into Cockburn Sound, other than the return of seawater used for cooling purposes, and less use of the groundwater. The groundwater resource can then be re-allocated to other uses.
- An inventory of contaminated sites likely to impact on Cockburn Sound was compiled in 1993 (Martinick and Associates and Mackie Martin and Associates, 1993), updated five years later (Hine, 1998) and reviewed as part of the State of Cockburn report (DAL, 2001). A systematic approach needs to be developed whereby the inventory is linked to the monitoring undertaken by industry under licence conditions set by the Department of Environmental Protection and Water and Rivers Commission. Under this arrangement a large component of the inventory would be updated annually.
- Whilst recognising that industry is the primary land use in the Jervoise Bay and Kwinana areas (see Table 9), a cooperative approach is required to identify the opportunities and constraints for improved community use of the eastern foreshore of Cockburn Sound. The retention of beaches and enhancement of facilities at Wells Park, Challenger Beach and Woodman Point are critical issues for the local community (Community Forums, 2001).
- The beaches and foredunes of the eastern foreshore are an integral component of the ecosystems of Cockburn Sound. Future industrial uses should be planned to minimise the impact on the coastal environment.
- Coastal erosion and accretion are natural processes; however, the construction of structures both on beaches (e.g. breakwaters) and on the foredunes (e.g. land reclamation) has altered these coastal processes. There are now ongoing problems in predicting and managing sand transport along the Sound's beaches, in particular, at Mangles Bay, Kwinana Beach, Challenger Beach and Woodman Point (Community Forums, 2001).

Objectives

- To ensure that industrial activities are managed in a manner that is consistent with maintaining Cockburn Sound's ecological and social values.
- To recognise and facilitate industrial use as one of the multiple uses of Cockburn Sound and its foreshore.
- To work cooperatively with industry and the local community to integrate the requirements of industrial land use into the environmental planning and management of Cockburn Sound and its foreshore.

Recommendations

1. Incorporate the requirements of industry into the broader planning for Cockburn Sound and its foreshore (CSMC: Ongoing).
2. Work with government departments, industry groups and local communities to implement environmental components of existing industrial management strategies for Kwinana, East Rockingham and Jervoise Bay. Key issues to be addressed include: land contamination, noise, visual impact, Aboriginal heritage, public safety risks, and marine impacts (CSMC, DMPR, DoIT, industry, LGAs, local communities: Ongoing).
3. Continue the current approach of cooperative best management towards reducing nutrient loads to Cockburn Sound from industrial, urban and rural sources (KIC, LGAs, WAVGA and other rural industry groups, DoA: Ongoing).
4. Develop and implement a Nutrient Management Strategy. The Strategy will be developed in consultation with major stakeholders and will cover: the sources of nutrients; nutrient hot-spots; nutrient recovery from

groundwater, stormwater disposal, drain management, industry discharges, catchment management, community awareness, research, and funding arrangements (CSMC: 2002 – Ongoing).

5. Implement investigations to better understand the current relationship between nutrient inputs into the Sound from human activities and water quality, particularly chlorophyll 'a' levels and seagrass regeneration (CSMC, WRC, DEP, KIC: 2002)

6. Support the proposal by the Water Corporation and local Kwinana industries to recycle waste water and remove industrial discharges (other than cooling water) that flow into Cockburn Sound (WC, KIC, CSMC: 2002 – Ongoing).

7. Update the inventory of contaminated sites within the catchment using data collected by industry under DEP and WRC licence requirements, giving priority to sites within five kilometres of the foreshore (DEP, WRC: 2004).

8. In assessing the environmental and social impacts of future development proposals ensure that all practicable measures are taken to protect the foreshore environment (e.g. beaches and foredunes) and maintain coastal processes (e.g. sand movement).

9. In cooperation with industry, local government and local communities, investigate ways to improve community access to and use of the eastern foreshore, including:

   - restoring beaches and enhancing facilities at Wells Park, Challenger Beach and Woodman Point; and
   - identifying the constraints to public access in coastal areas within industrial areas and developing practical solutions with stakeholders. (CSMC, LGAs, industry, Land Corp, CALM, local communities: 2002-04).

10. Initiate a Coast Care program between industry, local and State government and local community user groups to protect and rehabilitate the beaches and foredunes along the eastern foreshore of Cockburn Sound (CSMC: 2004 - Ongoing).

2.3.2 Ports, Harbours and Shipping

Cockburn Sound comprises the main part of the Outer Harbour of the Port of Fremantle, and the navigation channel dredged through Parmelia and Success Banks is the only means of access to Cockburn Sound for larger cargo and naval vessels. There were approximately 967 ship arrivals recorded by the Fremantle Port Authority for Cockburn Sound in 2000, of which 232 were naval vessels.

There are six main commercial shipping jetties within Cockburn Sound: the Alumina Refinery Jetty, the Steelworks Jetty No 1 and 2, the BP Oil Refinery Jetty, the Bulk Cargo Jetty, and the Kwinana Grain Jetty.

A breakdown of the commodities handled in the Inner Harbour (Fremantle) and Outer Harbour (Cockburn Sound) is shown in Figure 9. In the 1999/2000 year, the Fremantle Port Authority handled a total of 23.4 million tonnes of commodities.

Based on available data, the Fremantle Port Authority believes it will be approximately 20 years before the capacity of the Inner Harbour is reached and additional facilities are required in Cockburn Sound. A variety of

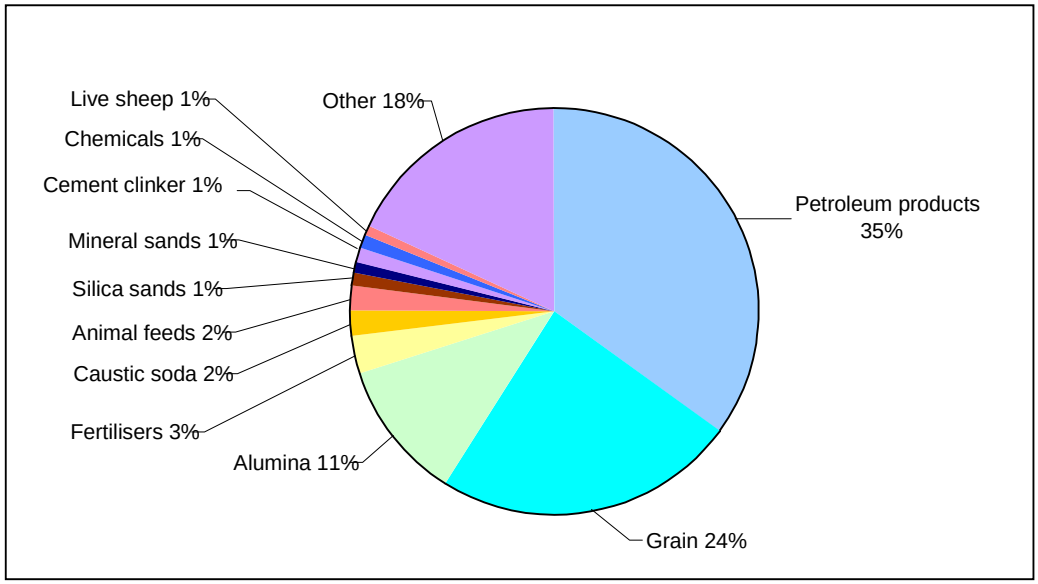


Figure 9. Types of Commodities Handled by the Fremantle Port Authority (1999/2000)

designs (for example, an offshore port) will be considered by the Authority to minimise the potential environmental impacts (Fremantle Port Authority, *pers. com*., 2001).

In addition to the main commercial jetties in Cockburn Sound, the Northern Harbour in Jervoise Bay supports six major shipbuilding enterprises which use the Sound to sea trial vessels.

Shipping activities are controlled by a number of International Maritime Organisation (IMO) and Commonwealth regulations. These cover the various sources of ship generated marine pollution including oil, noxious liquid substances in bulk, harmful substances in packaged form, sewage and garbage. For example, the International Maritime Organisation (IMO) has also recently announced that it will ban the application of TBT to ship's hulls from January 2003 to reduce contamination from this source.

At the Commonwealth Government level, the Australian Quarantine and Inspection Service (AQIS) has recently implemented new mandatory ballast water requirements for international vessels visiting Australian waters, and for vessel movements between Australian ports.

Other relevant Commonwealth guidelines include:

- *Best Practice Guidelines for the Provision of Waste Reception Facilities at Ports, Marinas and Boat Harbours in Australia and New Zealand* (ANZECC, 1996).
- Code of practice for the use of antifoulants (Hyder Consulting, 2000).
- *International Maritime Dangerous Goods Code* implemented by the Australian Maritime Safety Authority. The Code ensures that any cargoes intended for carriage by sea, including fuel, stores or other commodities whether packaged or in bulk, that have dangerous properties are handled in accordance with Australian Standard AS 3846-1998.

Issues

- A 1999 sediment survey found high levels of TBT in the Jervoise Bay Northern Harbour area and adjacent to naval facilities in Careening Bay. Considerable action is being taken to reduce the environmental impact of TBT through complementary international guidelines, State regulatory controls and port restrictions on activities considered to present the greatest threat, for example hull cleaning and dry dock maintenance facilities (see also Section 1.3 Maintaining a Healthy Marine Ecosystem).
- The replacement of TBTs with more environmentally friendly ship hull anti-foulants, may increase the risk of introducing marine pests if these new products prove less effective.
- A 1999 survey of introduced marine species in Perth's coastal waters found at least 18 exotic species. Of concern, two known marine pests – the European fan worm and the Asian date mussel – were recorded in Cockburn Sound. These two pests are prolific growers and can out-compete native species, affecting biodiversity. However, this does not seem to be occurring in the Sound at present (see Text Box on Ballast Water Management).
- The construction of breakwaters for harbour developments can modify coastal processes and may cause direct loss of seagrass meadows and shallow sand habitats (see also Section 1.3 Maintaining a Healthy Marine Ecosystem).
- There is potential for reduced water quality on the eastern margin of the Sound due to altered circulation patterns and flushing characteristics associated with several large-scale developments that are either under construction (the Jervoise Bay Southern Harbour) or proposed (FPA Harbour and the James Point Private Port) (see Section 1.3 Maintaining a Healthy Marine Ecosystem).
- The dredging of harbours and shipping channels can result in: increased turbidity, release of contaminants previously trapped in the sediments, and changes to the flushing rates of harbours and ports (Environmental Protection Authority, 1999). Disposal of dredge spoil can also result in water turbidity problems and can smother benthic communities.
- Ship loading spillage contributes approximately 5.6 tonnes per year of nitrogen to the Sound and dust from grain loading impacts on the visual amenity of the water and foreshore. The FPA has adopted a 'no spillage' policy at the Bulk Cargo Jetty in the past few years, involving new drainage and bunding systems, deflector plates and unloading equipment.
- The level of shipping and boat traffic in Cockburn Sound will increase dramatically in future years. The estimated 44 270 recreational boats launched at public ramps each year are predicted to increase by 43% to 63 280 boat launches by 2011 (Department of Transport, 1999). Commercial shipping is increasing at a rate of approximately 5% per year, although this could increase significantly if the proposed James Point Port proceeds. Navy vessels at Garden Island are also

expected to increase by 25% by 2004.

- Within Northern Harbour Jervoise Bay there is potential for conflict between large commercial vessels (up to 100 m in length) which have been constructed, repaired or serviced within the harbour and small recreational boats launched from the boat ramp located in the north-west of the harbour .

- Low-frequency high-impact accidents such as ship collisions may cause substantial ecological damage, put workers' and the community's health at risk and incur massive clean-up costs. The risk of such accidents in Cockburn Sound is currently minimised by strictly adhering to international and Commonwealth guidelines. Both the Fremantle Port Authority and the Royal Australian Navy have comprehensive environmental management systems in place.

Objectives

- To ensure that port facilities and shipping activities are managed in a manner that is consistent with maintaining Cockburn Sound's ecological and social values.

- To recognise and facilitate shipping activities and port facilities as one of the multiple uses of Cockburn Sound.

- To work cooperatively with Department of Planning and Infrastructure, Fremantle Port Authority, jetty and harbour operators and the local community to integrate environmental planning and management of port facilities and shipping activities within Cockburn Sound.

Recommendations

1. Incorporate the requirements of port facilities and shipping activities (sheltered waters, managed exclusion areas, dredged channels, low sand movement) into the broader planning for Cockburn Sound (CSMC: Ongoing).

2. Ensure all aspects of port, harbour and shipping operations comply with relevant international, national and State legislation, policy and guidelines. A priority for management are low-frequency high-impact accidents, TBT and marine pests (AQIS, AMSA, FPA, RAN, DPI: Ongoing).

3. Encourage all port and harbour operators to develop an Environmental Management System consistent with the Australian Standards AS/NZS ISO 1400 series. A priority for management is reduction in accidental spillage (FPA, RAN, DPI: Ongoing).

4. Ensure that all dredging operations are managed according to a Dredging and Dredge Spoil Management Plan. The plans need to address a range of issues including: dredging method; assessment of potential impacts; contamination assessment; disposal of sediments and slurry; monitoring plans and water quality criteria; management practices and contingency measures for accidents. Proponents need to physically demonstrate prior to commencement that their operations comply with the Management Plan (EPA: Ongoing).

5. Work with port and harbour operators and the local boating community to minimise potential safety issues arising between large ships and small recreational boats (FPA, RAN, DPI, commercial fishers, boat user groups: Ongoing).

Ballast Water Management

The use of sea water as ballast in ships presents an opportunity for marine organisms to transfer from one marine environment to another. Because many organisms are extremely small, it is possible for them to be taken aboard a ship with its incoming ballast water. If the organism survives the various physical and chemical changes and stresses that occur during the voyage and the transfer operations it may become established in the waters of the destination port. As the factors that contribute to the successful translocation are very complex, most species transported in ships' ballast do not survive. However, it is likely there have been several thousand successful translocations worldwide, some with very significant effects, the majority with little or no impact.

Australia is leading the way in attempting to have international controls for ballast water management introduced by the International Maritime Organisation. Recognising this is a slow process, the Australian Quarantine and Inspection Service (AQIS) has developed a leading edge risk-based system to support ballast water management. These controls have gained mandatory status as of 1 July 2001 under the Quarantine Act and require ships' masters to obtain written permission from AQIS to discharge any ballast water within Australian waters.

A thorough baseline survey of local waters, including Cockburn Sound, has been conducted to support the AQIS controls. This baseline survey has confirmed the existence of two known marine pests and that they are not presenting any significant environmental impacts. The Fremantle Port Authority is encouraging and supporting the research efforts to develop practical monitoring programs and to further reduce the risk of any introductions.

Source: Fremantle Port Authority Environmental Fact Sheet No.2 Ballast Water Management in Western Australia, July 2001.

2.4 Natural and Cultural Heritage Uses

2.4.1 Marine Habitats

Cockburn Sound is unique along Perth's metropolitan coast due to the degree it is sheltered from ocean swells, and its depth. These physical features are responsible in turn for its regional significance in ecological terms, namely, extensive areas of species of seagrass that prefer sheltered conditions, and organic-rich silts on the bottom of the deep basin.

Marine Flora

The marine flora that provide the basis of the food webs in Cockburn Sound include seagrasses, seagrass epiphytes, phytoplankton, microphytobenthos (microscopic algae similar to phytoplankton, which live on and in the seabed throughout the Sound), and macroalgae (seaweed) found on small patches of reef in the Sound.

Seagrasses

In 1967 seagrass was widespread in waters less than 10 m deep, and covered an area of 2821 ha within the CMSC boundary. Much of the seagrass on the eastern flats of the Sound was lost between 1967 and 1972. Between 1972 and 1982 further losses occurred on Southern Flats, and on the eastern shore of Garden Island in Careening Bay and around the Armaments Jetty. There has been little loss since 1982 except for small areas on the eastern shore of Garden Island. A survey in 1999 estimated that only 632.3 ha of seagrass remained, approximately 22% of the original area (DAL, 2000).

There have also been several reports of healthy clumps of seagrass on the eastern flats of the Sound, in areas where the historical dieback took place, although these are not apparent in the aerial photographs due to their small size (Paling, pers. com., 2001: Astill, pers. com., 2001).

Reef communities

There are patches of limestone reef along the eastern shore of the Sound between Challenger Beach and the Jervoise Bay Northern Harbour, and isolated hummocks on the eastern flats. The shoreline reefs are mainly covered with brown algae (kelps and *Sargassum*), while on the reefs further offshore red algae are more common. Green algae (*Ulva*, *Cladophora*) are also common, and some of the reefs have patches of coral, including the reef-building species *Flavites* (Halpern Glick Maunsell, 1997).

Phytoplankton and microphytobenthos

There are over 300 species of phytoplankton present in the Sound, the four main groups being diatoms (Bacillariophyta), dinoflagellates (Dinophyta), silicoflagellates (Chrysophyta) and blue-green algae (Cyanophyta). Diatoms typically predominate in south-west waters of Western Australia, including the Sound (Chaney, 1978; Helleren and John, 1995).

Occasionally, the blue-green algae *Oscillatoria erythraea* (*Trichodesmium*), which can cause skin irritations to swimmers, appears as surface slicks in the Sound. This species often blooms in offshore waters up and down the south-west coast of WA in late summer/early autumn (when conditions are calm), and sometimes drifts into nearshore areas.

Marine Fauna

The fauna of Cockburn Sound have been studied less regularly and extensively than the flora. This is partly because faunal studies are time consuming and expensive, and results are often very difficult to interpret due to the considerable natural variations (e.g. seasonal) that occur in fauna populations.

Zooplankton

Zooplankton in Cockburn and Warnbro Sounds were studied from 1992 to 1994 as part of the Southern Metropolitan Coastal Waters Study (SMCWS). The type and abundance were found to be typical of temperate coastal regions, apart from large blooms of radiolarians during late winter and early spring (Department of Environmental Protection, 1996). Zooplankton in Cockburn Sound were about twice as abundant as in Warnbro Sound, presumably in response to the greater phytoplankton food supply.

Invertebrate fauna

The benthic invertebrate fauna of the deep basin have been studied in 1978 (Department of Conservation and Environment, 1979) and 1993 (Department of Environmental Protection, 1996). The deep basins of Cockburn Sound, Warnbro Sound and Owen Anchorage contain fine organic-rich silts due to accumulation of detritus from surrounding areas, and have species of flora and fauna that, to date, have been found nowhere else on the central west coast of Western Australia (Wilson *et al.*, 1978).

It is difficult to interpret the spatial patterns of invertebrates in the Sound. The southern end of the Sound has sediments

with a higher proportion of fine particles, more nutrients and more frequent periods of low oxygen than the northern half. These are all factors that influence benthic invertebrate populations, and is the explanation favoured by Chalmers (1993) for the differences in their distribution and abundance.

Fish

Cockburn Sound provides a very important fish nursery and feeding habitat. Over 130 species of fish and 14 large crustacean and mollusc species have been recorded in the Sound (Dybdahl, 1979). The important commercial and recreational species known to frequent various habitats in the Sound are listed in Section 2.2.3 Fishing.

Marine mammals, reptiles and seabirds

A resident population of Bottlenose Dolphins (*Tursiops truncatus*) lives in Cockburn Sound, and has become a popular tourist attraction. Eight pods of about 180 animals have been identified as using Cockburn Sound, and approximately a quarter of these are adult females with calves, which is unusually high for dolphin populations (Donaldson, unpublished data).

A colony of Australian Sea-lions (*Neophoca cinerea*) inhabit the adjacent Shoalwater Islands, occasionally visiting Cockburn Sound. Whales have also been sighted in the Sound.

Loggerhead, Leatherback and Green turtles sometimes stray as far south as Cockburn Sound, but this is rare.

At least 12 species of seabird are found in the Cockburn Sound/Warnbro Sound area, but as the eastern shores of Cockburn Sound are heavily developed, they are less important as a nesting, feeding and roosting area than the Shoalwater Islands Marine Park and Garden Island. A small colony (maximum 50 adults) of Little Penguins (*Eudyptula minor*) inhabit the limestone walling at Careening Bay, Garden Island.

Issues

- The main requirements of the marine flora and fauna of Cockburn Sound are good quality water, maintenance of coastal processes, and protection of habitat.
- Recent surveys show there has been no further deterioration in the health of the remaining seagrass, except for one site off the Kwinana foreshore. Seagrass in the Mangles Bay area remains highly stressed (Lavery and Westera, 2000). Most of the remaining healthy seagrass meadows are located along the western margins of Cockburn Sound (Garden Island). Extending the Shoalwater Islands Marine Park to encompass these areas would offer greater habitat protection.
- Two acknowledged marine pests have also been found in the benthic fauna of Cockburn Sound: the European fan worm *Sabella* cf. *Spallanzanii*, and the Asian date mussel *Musculista senhousia* (see Section 2.3.2 Ports, Harbours and Shipping).
- Physical alterations to the shoreline, such as the construction of breakwaters, may restrict community access, can cause direct or indirect loss of seagrass meadows and shallow sands and may modify coastal processes. The cumulative impacts of these developments along the coastline are difficult to measure and predict. A guiding principle for future developments should be that there is no net loss of ecological or social function in Cockburn Sound (see Section 1.3 Maintaining a Healthy Marine Ecosystem).
- Bottlenose Dolphins are the icon species in Cockburn Sound and there is a history of human-dolphin interaction. Little is known about the specific requirements of dolphins, although ecological research by Murdoch University on the Cockburn Sound population is ongoing. As the top predators in Cockburn Sound, dolphins are useful for detecting changes in the food chain and are sensitive indicators of the overall health of the ecosystem (Finn, pers. com., 2001).
- Key gaps in the information base required for management are in the areas of: modelling of water movement in Cockburn Sound, coastal processes, nutrient cycling in Cockburn Sound and the assessment of cumulative environmental impacts (see Section 4 Coordinating Research and Investigations).

Objectives

- To protect and conserve marine flora, fauna and associated habitats.
- To recognise and facilitate natural heritage values and uses as one of the multiple uses of Cockburn Sound.
- To work cooperatively with local and State government agencies and the community to integrate planning and management for the marine and coastal environment of Cockburn Sound.

Recommendations

1. Incorporate the requirements of the marine flora and fauna of Cockburn Sound (good water quality, maintenance of coastal processes, and protection of habitat) into the broader planning for Cockburn Sound (CSMC: Ongoing).

2. Work with the Marine Parks and Reserves Authority and the Department of Defence to investigate the benefits and constraints of extending the Shoalwater Islands Marine Park to include the seagrass meadows of the western waters of the Sound (CSMC, MPRA, DoD: 2003-05).

3. Provide information on the marine flora, fauna and habitats as part of community awareness and involvement programs (CSMC: Ongoing).

4. Minimise the impact of recreational and commercial uses on major habitats, particularly on seagrass meadows, through information, education and enforcement (CSMC, CALM, DoF: Ongoing).

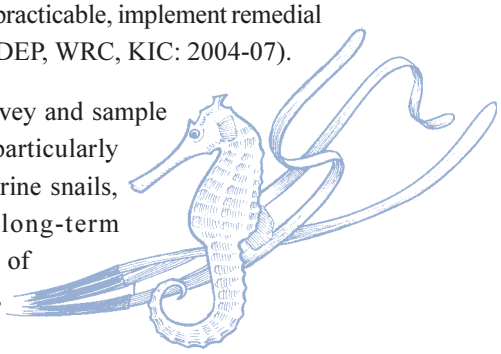
5. Survey and map the marine habitat types of Cockburn Sound and monitor trends and distributions of flora and fauna (CSMC, WRC, DEP: Ongoing).

6. In partnership with tertiary institutions, support student research projects on the marine flora, fauna and associated habitats of Cockburn Sound, with priority on seagrass and dolphins (CSMC: Ongoing).

7. Monitor seagrass health every year and seagrass distribution every three years (CSMC, WRC, DEP: Ongoing). Priority areas are the western margin of Cockburn Sound, as protecting the remaining healthy meadows is a high priority, and the eastern margin, to investigate anecdotal reports of the existence of patches of healthy seagrass adjacent to the industrial area.

8. Promote the recolonisation and re-establishment of seagrass in areas of Cockburn Sound where it once occurred. Investigate the major constraints to seagrass regrowth and, if practicable, implement remedial action (CSMC, DEP, WRC, KIC: 2004-07).

9. Periodically survey and sample marine fauna, particularly mussels and marine snails, to determine long-term trends in levels of contaminants (DoF, DHWA: Ongoing).



2.4.2 Foreshore Habitats

The coastline of Cockburn Sound consists of wind blown deposits, which through time have developed the Spearwood Dune System and the younger Quindalup Dune System. In the Challenger Beach area the soils of the Spearwood Dunes have been leached and the carbonate precipitated to form the coastal limestone (Seddon ,1972).

The different soils and topography of both Dune Systems create a distinctive flora and fauna.

Coastal Flora and Fauna

Eastern shore of Cockburn Sound

There are two main vegetation complexes along the eastern coastal fringe of Cockburn Sound:

- The Quindalup Vegetation Complex, which comprises herblands, sedgeland and *Acacia* shrubland. The two main areas are within the Woodman Point Regional Park, and Mangles Bay/Cape Peron area (part of the Rockingham Lakes Regional Park). There are also isolated patches from James Point to Cape Peron.
- The Cottesloe Complex-Central-South which is associated with the coastal limestone of the Spearwood Dunes and consists of low, closed heath dominated by *Acacia saligna* or *Melaleuca huegelii*; and dense low closed heath/thicket dominated by *Dryandra sessilis*. This Complex occurs within the Beeliar Regional Park on the coastal strip from Challenger Beach to the Jervoise Bay Southern Harbour. The vegetated limestone cliffs in this area are unique in the Perth metropolitan region. Its very high conservation value is reflected by its interim listing on the Register of the National Estate (Environmental Protection Authority, 1998b).

There are three threatened flora species recorded for the coastal strip of the Sound -*Grevillea olivacea, Dodonaea hackettiana* and *Verticordia plumosa* and three terrestrial fauna species of special conservation significance likely to occur in the area - Southern Brown Bandicoot (*Isoodon obesulus fusciventer*), Peregrine Falcon (*Falco peregrinus*), a Schedule 4 species, and the Carpet Python (*Morethia spilota imbricata*), a Schedule 4 species.

Garden Island

Garden Island is listed on the Register of the National Estate for a variety of natural and cultural heritage values.

The Quindalup Vegetation Complex on Garden Island includes sedgeland, heathland, shrubland, and extensive tracts of 'low, closed coastal forest' of *Callitris preissii* (Rottnest Island Cypress) and *Melaleuca lanceolata* (Rottnest Island Tea Tree) with some species classified as restricted and threatened.

Fauna surveys have identified 94 species of birds, 14 species of reptile and one native mammal (the Tammar Wallaby – a Schedule 4 species) (Brooker *et al*., 1995; Robinson *et al*., 1987). Garden Island is a regionally important nesting site for many bird species and is visited by 14 migratory species recognised under the Japan Australia Migratory Bird Agreement and/or China Australia Migratory Bird Agreement.

Coastal Processes

Two forces principally shape the foreshore of Cockburn Sound: southerly wind systems that set up longshore sediment transport through local wind, waves and longshore currents during the spring and summer months; and north-west storm systems consisting of swell waves, local wind waves and wind-driven currents.

While the shores of Cockburn Sound are sheltered from extreme wave action, they are subject to erosion on the rare occasions when elevated sea levels are accompanied by strong winds which create erosive waves (Andrews, pers. comm., 2001).

Coastal processes and shoreline stability have been investigated at some specific areas around Cockburn Sound, generally due to proposed developments (James Point and Mangles Bay) or as a result of existing developments (Jervoise Bay and Woodman Point). Artificial structures such as groynes, causeways, and breakwaters have altered the natural patterns of longshore sediment movement. There are now ongoing problems in predicting and managing sand transport along the Sound's beaches.

James Point

Severe erosion of the small sand cliffs at James Point has occurred since 1953 and has been attributed to the passage of north-west storms (Hsu, 1992). To prevent further erosion of the beach at James Point, offshore breakwaters were constructed to increase the beach width and therefore reduce the effect of the storm surge.

Mangles Bay

Erosion has been occurring in Mangles Bay since the causeway to Garden Island was constructed. The causeway prevents the natural pattern of sediment movement from Cape Peron into Cockburn Sound (Department of Marine and Harbours, 1992), and so there is accumulation of sand on the western side of the causeway and erosion on the eastern side to as far as the Bell Street Boat ramp. This

erosion is still continuing, and is mitigated by transport (by truck) of sand from the western side of the causeway to the eastern side (Middle, pers. com., 2001).

Woodman Point and Jervoise Bay

The greatest changes to the foreshore of Cockburn Sound have occurred between Woodman Point and the limestone cliffs of Challenger Beach. Between 1913 and 1918 Woodman Point was built out approximately 400 m and extended south-westward a similar distance by means of a rubble structure, as part of a plan to develop the peninsula into a naval facility (Powell and Emberson, 1981).

Jervoise Bay has also undergone development, particularly in the past 30 years. Modifications to the coastline in this region include dredging, infilling, and the establishment of breakwaters to encompass the Northern Harbour and Southern Harbour. The shoreline has been extensively modified and severe erosion on the western side of the Northern Harbour breakwater has caused the loss of beach amenity and risks to public safety.

Foreshore Management

The City of Cockburn, the Town of Kwinana and the City of Rockingham each have management policies, plans or strategies to manage coastal areas by separating incompatible uses, providing and maintaining suitable and safe recreational facilities and paths, and undertaking erosion control measures.

Cockburn, Kwinana and Rockingham are represented on the Western Australian Municipal Association's Coastal Management Advisory Group, that covers the whole State. Its aim is to better coordinate coastal planning and to provide a good communication network for environmental issues.

The Department of Defence has an Environmental Management Plan for Garden Island and HMAS Stirling, and this is currently being revised to reflect and complement initiatives at the regional level.

Community groups such as Com-Net, Cockburn Power Boat Association, Recfishwest, Kwinana Watchdog Group and the Conservation Council play a vital role as 'environmental watchdogs' and in raising community awareness about environmental issues.

The management of foreshore issues is further complicated in that CALM manages the coastal environment, but not the beaches, in areas of foreshore adjacent to Regional Parks. Also some industrial sites (both private and government owned) within the Kwinana and Jervoise Bay areas extend across beaches into the water. The Department of Planning and Infrastructure also has a role advising on the technical aspects of coastal erosion.

Issues

- Coastal erosion and accretion are natural processes; however, the construction of structures both on beaches (e.g. harbour breakwaters) and on the foredunes (e.g. carparks and paths) has altered these coastal processes. There are now ongoing problems in predicting and managing sand transport along the Sound's beaches, in particular at Mangles Bay, Kwinana Beach, Challenger Beach and Woodman Point.
- Coastal erosion is technically difficult to manage, with many options resulting in damage to flora and fauna habitats, a reduction in water quality and loss of recreational use.
- Management of coastal issues is complex, involving Commonwealth, State, and local government as well as industry. The local community is often confused by these arrangements and frustrated by the lack of consultation in developing management options (Community Forums, 2001).
- Future planning for the Kwinana and Jervoise Bay industrial areas needs to make provision for maintaining coastal processes and beach stability.
- Garden Island and the Regional Parks (Woodman, Beeliar and Rockingham) contain important representative samples of coastal landforms and flora and fauna communities. They also provide important ecological links to inland communities and wetlands. The secure long-term conservation of these coastal landforms and communities is integral to maintaining the biodiversity of the region.
- Areas of foreshore vegetation outside the Regional Park system also play an important role in that they provide ecological links along the coastline and, to some degree, provide a visual and physical buffer to Cockburn Sound from inland uses.
- Management of recreational and commercial activities should aim to encourage non-disruptive, passive uses, that protect and enhance the special environmental qualities of the beaches and foreshores of Cockburn Sound.

Objectives

- To maintain the integrity, function and environmental values of foreshore areas.
- To ensure existing and proposed developments do not have a significant impact on coastal processes and beach stability.
- To protect representative landform systems.
- To maintain the abundance, diversity, geographic distribution and productivity of vegetation community types.
- To recognise and facilitate natural heritage values and uses as one of the multiple uses of Cockburn Sound.
- To work cooperatively with the Department of Conservation and Land Management, local government and the community to integrate planning and management for the foreshore environment of Cockburn Sound.

Recommendations

1. Incorporate the requirements of the coastal flora, fauna and habitats of Cockburn Sound (maintenance of coastal processes, conservation of representative communities, protection of habitat) into the broader planning for Cockburn Sound (CSMC: Ongoing).
2. Provide information on the coastal flora, fauna and habitats as part of community awareness and involvement programs (CSMC, CALM: Ongoing).
3. Minimise the impact of recreational and commercial uses on major habitats, particularly on coastal limestone communities, through information, education and enforcement (CSMC, CALM: Ongoing).
4. Survey and map the coastal habitat types of Cockburn Sound and monitor trends and distributions of flora and fauna (CSMC, CALM: Ongoing).
5. Initiate a Coast Care program involving industry, Commonwealth, State and local government and local community user groups, to protect and rehabilitate the beaches and foredunes along the eastern foreshore of Cockburn Sound. Priority areas are Mangles Bay, Kwinana Beach, Challenger Beach and Woodman Point (CSMC: 2004 - Ongoing).
6. In partnership with the Department of Planning and Infrastructure, and local government authorities, develop an understanding of the key coastal processes of Cockburn Sound and assess the effectiveness of existing erosion control measures. Develop and implement Best Management Practices to protect the Sound's foreshore (CSMC, DPI, LGAs: 2002).
7. Assist CALM in the production of Management Plans for Woodman Point, Beeliar, and Rockingham Lakes Regional Parks (CSMC: Ongoing).
8. Support local government authorities in implementing coastal management plans for the Cockburn Sound foreshore in a coordinated manner (CSMC: Ongoing).
9. In assessing the environmental and social impacts of future development proposals on the Sound's coastal environment, apply the following guiding principles:
    - maintain coastal processes and beach stability;
    - conserve coastal landforms and flora and fauna communities contained in the Regional Parks; and
    - ensure proponents demonstrate that there will be no net loss of ecological and social function of the coastal environment (CSMC: Ongoing).

2.4.3 Aboriginal Heritage

This section is based on a report commissioned by Cockburn Sound Management Council on the Aboriginal heritage in Cockburn Sound and its hinterland (O' Connor, 2001). Additional background information and detailed references can be found in this report.

Evidence from an archaeological site at Upper Swan shows that humans have occupied the Swan Coastal Plain for at least 38,000 years. Occupation patterns over this time span would have been affected by fluctuations in sea levels, with the present level being reached approximately six thousand years ago when Garden, Carnac and Rottnest Islands were separated from the mainland by rising waters.

At the time of European settlement in the south-west of Western Australia, the area forming a rough triangle from the Dongara region to Esperance, was populated by Aboriginal people who shared a common language, albeit divided into separate dialects, and a common culture, again with regional variations on a fundamental theme.

Early records suggest that the Cockburn Sound and its hinterland were within the lands of the Whadjug dialect group. 'Beeliar' was recorded by Lyon (1833) as the name of the district between the Canning River and the northern extremity of the Murray River Aborigines' land. Armstrong (1836) and Symmons (1840) referred to the Aborigines of Beeliar as the 'Mangles Bay tribe'. The Beeliar Aborigines were thus a local sub-group of the Whadjug dialect group.

The Beeliar Aborigines shared the same social organisation as their immediate neighbours - the group was divided into two matrilineal moieties (divisions of society), known as *manitjmat* (white cockatoo) and *wardungmat* (crow), with at least four exogamous (marrying outside) matrilineal divisions grouped under each moiety. This system, coupled with a preference for marriage with persons from outside the individual's home country, meant that complex family relationships were built up across the dialect group and beyond it with members of other dialect groups.

Such relationships inevitably led to interlinking rights of access to country and to its resources across a wide area, with the result that, when a plenitude of any given resource occurred in one area, neighbours would share in its use and would, in turn, bestow reciprocal rights on their hosts when appropriate.

Beeliar was part of an Aboriginal track or pad from the Swan River to the Murray River, which passed from Fremantle, through North and Bibra Lakes and the chain of freshwater lakes leading to Mandurah. A pad led also from this north-south track west to the present Rockingham area. Access to this route was guaranteed by the patterns of resource sharing noted above.

Cockburn Sound and its hinterland incorporate two distinct Aboriginal resource complexes - one associated with the marine environment and the other with Thomsons Lake, Folly Pool and The Spectacles. Molluscs, crustaceans, fish and other marine resources were utilised from Cockburn Sound, while ducks, swans, gilgies and tortoises were food sources from the wetlands.

The entire traditional social, geographical and economic universe was underwritten and supported by an overarching mythic world view, fragments of which remain to the present day amongst the survivors of the Beeliar Aborigines and their neighbours.

Although social organisation broke down among the Aboriginal people of the south-west as a result of European settlement, some Aboriginal families tended to retain contact with their traditional countries.

In the area east of the Cockburn Sound hinterland Aboriginal people continued to work on farms and to cut timbers for bean and tomato supports for market gardeners until at least the nineteen-sixties. 'Fringe camps' associated with these economic activities are still remembered by today's elders. Families also continued to utilise the marine resources on occasions, along with the wider community. This latter usage continues to the present day.

This historical situation has resulted in the lodgement of three Applications for Determination of Native Title over lands which include all or part of the Cockburn Sound Management Area, namely the Gnaala Karla Booja application (WC98/58), the Combined Metropolitan Working Group application (WC99/6) and the Ballaruk application (WC95/86). The two first claims have satisfied the requirements of Section 190A of the *Native Title Act*, as amended, and have been listed on the Register of Native Title Claims; the third has not.

Issue

- Thirty-three listed Aboriginal heritage surveys have been carried out in or adjacent to the Cockburn Sound Management Area, resulting in the recording of thirty-five Aboriginal heritage sites. All site identification and recording has been a result of development-specific heritage surveys. Many more sites may exist in the area, particularly in the vicinity of sand dunes, less disturbed coastal areas and lakes. Future development in the vicinity of these areas needs to be managed appropriately to avoid conflict.

Objectives

- To involve Aboriginal people in environmental protection.
- To manage the known Aboriginal heritage environment.
- To ensure that future development is carried out in such a way that potential conflict over Aboriginal heritage is avoided.

Recommendations

1. Communicate with relevant native title groups and invite input into developing and implementing the Environmental Management Plan (CSMC, DIA, Noongar Land Council: Ongoing).
2. Invite Aboriginal participation in the decision-making of the Management Council (CSMC: Ongoing).
3. Ensure that future development in Cockburn Sound and its catchment is preceded by appropriate Aboriginal consultation and heritage surveys (DIA: Ongoing).
4. Ensure that Aboriginal heritage sites within the Cockburn Sound Management Area are protected (DIA: Ongoing).
5. Involve the relevant Aboriginal people in designing appropriate protection measures for heritage sites (DIA: Ongoing).

2.4.4 European Heritage

Cockburn Sound, with its naturally deep waters and shelter from Garden Island, has a long history as one of the states major shipping harbours. In 1827 Captain James Stirling in his ship *Success* first landed in Cockburn Sound before making his passage to explore the Swan River. Two years later Captain Stirling returned to establish the Swan River colony, with the first settlement being established on Garden Island, near Cliff Head. During the early stages of the colony Cockburn Sound provided a natural harbour for ships loaded with settlers from Europe.

In 1872 the first jetty was constructed on Rockingham Beach to service the rapidly growing town and timber trade. Cockburn Sound became a major shipping port for the timber trade with a direct rail link to the forestry operations in the Darling Scarp. Careening Bay on Garden Island was named after its use during this time and became a ship maintenance facility for the numerous visiting vessels.

With the construction of the Fremantle port in the early 1900s, the role of Cockburn Sound as a port was greatly reduced. It was not until the dredging of the Parmelia and Success Banks, which previously restricted the entry of larger vessels, that Cockburn Sound again gained prominence as a port.

During the Second World War, Garden Island was the location of one of the gun batteries that formed part of defence network of Fremantle harbour. The Island was also the training base for reconnaissance operations, such as the mini-submarine force or Z force.

From the late 1950s to early 1960s onwards large industrial shipping facilities were constructed along the north-eastern foreshore of Cockburn Sound to cater for the rapidly expanding industry and export trade. The settlements supporting the busy port of Cockburn Sound and associated industrial area grew steadily over time. The three townsites of Rockingham, Kwinana and Cockburn each have an individual and unique history reflecting the gradual growth and establishment.

Throughout this time, Cockburn Sound has been known for its abundance of marine life and has been recognised as an important commercial and recreational fisheries resource. With its protected waters, sandy beaches and abundance of fish, the Sound has been enjoyed for generations as a beach-side holiday destination.

Issues

- Under the *Maritime Archaeology Act 1973*, all wrecks or objects dated prior to 1900 are deemed to be 'historic shipwrecks or relics' and subject to the provisions of the Act. The Western Australian Maritime Museum is to be notified of any discovery of maritime objects or a wreck site and all activity is to be halted until the importance of the site has been assessed.
- Four wrecks in Cockburn Sound are recognised as historic wreck sites - the *Day Dawn* (1890) and *Dato* (1893) located in Careening Bay and the *Contest* (1874) and *Amur* (1887). The *Day Dawn* and *Dato* are listed on the Register of the National Estate.
- At least 37 other known wreck sites exist in Cockburn Sound. Many of these sites are popular recreational dive sites.

Objectives

- To recognise and protect the European heritage of Cockburn Sound.
- To recognise, and facilitate the protection of, European heritage as one of the multiple use values of Cockburn Sound.
- To work cooperatively with local governments, historical societies, WA Museum and WA Tourism Commission to integrate cultural heritage into the environmental planning and management of Cockburn Sound.

Recommendations

1. Consolidate the existing historical information on Cockburn Sound, in particular focusing on identifying wreck sites within Cockburn Sound (CSMC, WAM, LGAs: 2006-08).
2. Work with local dive schools, tour operators and dive clubs to ensure the protection of historically important wreck sites (WAM, commercial dive operators, recreational dive clubs, CSMC: Ongoing).
3. Support the WA Museum in identifying and researching the significance of wreck sites within Cockburn Sound (CSMC: Ongoing).

2.5 Defence

Garden Island (1200 ha) is owned by the Commonwealth Government and HMAS Stirling is homeport to approximately half the major vessels of the Royal Australian Navy (RAN). It is surrounded by a further 2500 ha of declared Naval Waters (see Figure 5). Approximately 30% of the Island is designated for naval development, while the remainder is managed for conservation and is open to the public under specific conditions; for example, public access is only allowed by boat and restricted to daylight hours (URS, 2001). The Navy also controls 3.6 ha of land where the causeway joins the mainland at Cape Peron. The boundary of the Cockburn Sound Management Area abuts, but does not include, Garden Island.

Most the Navy's facilities are concentrated in the south-east corner of Garden Island and within Careening Bay, with main wharves and workshops, small boats harbour, administration and stores, and accommodation being based in these areas. Precincts external to the south-east area contain the Helicopter Support Facility, armaments and explosive area, an explosives demolition and burning ground, sewage treatment plant and the School of Survivability and Ship Safety. Other minor developments around the Island include various aerial sites, a quarry and the Kalkara launch site. The defence facilities are also shared by the Army and Air Force (Dames & Moore, 2000).

The main pressures on Cockburn Sound due to Navy facilities and shipping are:

- Construction of the causeway and future defence developments on the Island;
- Dredging and dredge spoil disposal (see Section 2.3.2);
- TBT contamination (see Sections 1.3 and 2.3.2);
- Potential for introduction of foreign marine species from ballast water and ships' hulls (see Section 2.3.2);
- Oil spillage during loading and unloading and bunkering (see Section 2.3.2); and
- Handling of explosives and other dangerous goods.

The Department of Defence is committed to environmental management, and has a comprehensive environmental policy manual which sets out its environmental obligations and commitments in all areas of environmental management and impact assessment.

An Environmental Management Plan is in place for HMAS Stirling and Garden Island (URS, 2001) and the Garden Island Environmental Advisory Committee advises on environmental matters. It is an inter-governmental body, with community representation, which helps integrate the management objectives of both the Commonwealth and State Governments to maintain the natural values of the Island while meeting Defence objectives and allowing for compatible public recreational access.

Defence, as a Commonwealth Authority, is bound by the obligations of international treaties and Commonwealth legislation, except where expressly exempt from complying. The Royal Australian Navy seeks to comply with all relevant provisions except where emergency conditions or operational imperatives dictate otherwise.

The Commonwealth *Explosives Act 1961* and Explosives Regulations 1991 specify the requirements Defence must meet in the transport, storage and handling of explosives by land, sea or air. There are a number of Defence policies and procedures that are specifically aimed at ensuring the RAN's compliance with this legislation.

HMAS Stirling also serves as a designated port for visits by nuclear-powered ships.

Issues

- The Navy generally requires: access to a deep water port, sheltered waters south of the cyclone belt, access to ship maintenance yards and fuel supplies, and restricted public access. Garden Island has all of these attributes.
- The Navy's presence on Garden Island is expected to expand by 25% over the next three years, as part of the 'Two Oceans' defence policy. The increase in naval vessels, together with the predicted rise in commercial shipping (5% per year) and recreational boating (43% by 2011) means there will be increasing need to manage the traffic in the open waters and navigational channels of Cockburn Sound.
- High levels of TBT in the sediments, along with 100% imposex in marine snails, were recently found in surveys of Careening Bay, Garden Island. The Royal Australian Navy has banned TBT use on ships less than 40 m in length, and is replacing TBT on larger naval vessels with a copper-based paint (see Section 1.3 Maintaining a Healthy Marine Ecosystem).

- Two acknowledged marine pests – European fan worm and the Asian date mussel – are present in Cockburn Sound. These two pests are prolific growers and can out-compete native species, affecting biodiversity, but this does not seem to be occurring at present (see Section 2.3.2 Ports, Harbours and Shipping).
- The causeway linking Garden Island to the mainland has reduced water flow through the Sound's southern entrance by approximately 40% (Maritime Works Branch, 1997a and b). Additional research work is required to assess the influence of the causeway on the environmental quality of the southern portion of Cockburn Sound, and the potential environmental benefits of modifying its design (Environment Protection Authority, 1998a).
- Low-frequency high-impact accidents such as ship collisions may cause substantial ecological damage, put workers' and the community's health at risk and incur substantial clean-up costs. The HMAS Stirling Emergency Response Plan is the basis for addressing all emergency situations and details the response to major issues such as fire, oil spills and nuclear accidents.
- Investigations are proceeding to determine whether there are any localised impacts on seagrass due to groundwater nutrients inputs from the waste water treatment plant which services HMAS Stirling (Wykes, pers. com., 2001).

Objectives

- To ensure that defence facilities and activities are managed in a manner that is consistent with maintaining Cockburn Sound's ecological and social values.
- To recognise and facilitate defence facilities and activities as one of the multiple uses of Cockburn Sound.
- To work cooperatively with Department of Defence to integrate environmental planning and management of defence facilities and activities within Cockburn Sound.

Recommendations

1. Incorporate the requirements of defence facilities and activities (access to a deep water port, sheltered waters south of cyclone belt, access to ship maintenance yards and fuel supplies, and restricted public access) into the broader planning for Cockburn Sound (CSMC: Ongoing).
2. Support the Department of Defence, port and harbour operators and the local boating community in efforts to minimise potential safety issues arising between large ships and small recreational boats (DoD, FPA, DPI, commercial fishers, boat user groups: Ongoing).
3. Support the Department of Defence in implementing the international ban on applying TBT to ship hulls from January 2003 (DoD, CSMC: 2003 – Ongoing).
4. Support the Department of Defence in implementing the Commonwealth Government's new (July 2001) mandatory ballast water requirements for international vessels visiting Australian waters, and for vessel movements between Australian ports (DoD, CSMC: Ongoing).
5. Assess the influence of the Garden Island causeway on the environmental quality of Cockburn Sound, and the potential environmental benefits of modifying its design (CSMC, CoR, DEP, DoD, DPI: 2002-03).
6. Ensure all aspects of defence operations comply with relevant policies, plans and guidelines. A priority for management are low-frequency high-impact accidents (DoD: Ongoing).
7. Support investigations to determine whether there are any localised impacts on seagrass due to groundwater nutrient inputs from the waste water treatment plant which services HMAS Stirling. Implement remedial action, if required (DoD: Ongoing).

3. Integrating Management of the Land and Marine Environments

The extent to which this Environmental Management Plan deals with the terrestrial environment is limited to those issues that directly or indirectly impact on the water quality of Cockburn Sound.

Much of the historical deterioration in water quality and loss of marine habitat in the Sound can be attributed to waste inputs from land-based sources.

In the past most of the waste inputs were via pipeline discharges directly into the Sound. With the tightening of licence conditions and a concerted effort by industry to employ environmental best practices in waste management, direct discharges now account for a much smaller proportion of the total input. For example, the direct pipeline discharge of nitrogen to Cockburn Sound has fallen dramatically from more than 80% of the total nitrogen inputs in 1978 to less than 20% in 2000.

Under a proposal by the Water Corporation and Kwinana industries, in which treated waste water discharged from local industries would enter the Point Peron pipeline for disposal off-shore (4.2 km) into the Sepia Depression, there would be 'zero' pipeline discharge to Cockburn Sound, other than the return of seawater used for cooling purposes.

Groundwater contamination, mainly as a result of past practices, is now the major source of waste inputs into Cockburn Sound. Groundwater flow contributes more than 70% of the nitrogen load to the Sound. Surface water drains and emissions from motor vehicles and industry (via atmospheric fallout) also contribute to contaminant inputs to the Sound, but to a much lesser extent (DAL, 2001).

Clearly any initiative to manage the marine waters of Cockburn Sound must be fully integrated with the planning and management of land-based activities in the catchment.

Land uses within the Cockburn Sound catchment that currently impact on the quality of surface and groundwaters include urban areas, industry and rural holdings (Figure 10).

Urban Areas

The three local government authorities located within the Cockburn Sound catchment area are the City of Cockburn, the Town of Kwinana and the City of Rockingham. The two main urban areas are centred around Rockingham, Shoalwater, Safety Bay and Cooloongup; and Medina, Orelia, Calista, Kwinana and Parmelia. These are also the areas where urban expansion is planned, for example some areas of Beeliar around Thomsons Lake. A population increase of 30% in the next 10 years is anticipated (Western Australian Planning Commission, 2000a).

In urban areas, gardening practices can contribute nutrients, metals and pesticides to groundwater, while a range of contaminants are present in urban stormwater runoff.

Surface runoff from a large proportion of the Rockingham, Shoalwater, Safety Bay area is collected by the Lake Richmond drain, which discharges into Mangles Bay. The South Jandakot Main Drain also discharges to the Sound through the Woodman Point Pipeline.

New residential subdivisions in the catchment are planned using the principles of water sensitive urban design, where the emphasis is on water retention, treatment, use and quality, rather than drainage and disposal. These practices have the potential to greatly reduce the contamination of surface and groundwater from urban sources.

Urban areas also require sewage collection (or septic tanks) and rubbish collection, which in turn means that increased capacity at rubbish tips and waste water treatment plants is needed to process these wastes. Inappropriate storage and/or disposal of waste has the potential to contaminate land, groundwater and surface water. For example, the old sludge drying beds of the Woodman Point waste water treatment plant were one of the two main contributors to nutrient-rich groundwater entering the Jervoise Bay Northern Harbour.

Rural Land Uses

The main rural activities are: market gardens (346 hectares); cut flower production (60 hectares); turf farms (38 hectares); and orchards (11 hectares). Rural residential blocks, usually 2 to 4 ha in size, are also located in the catchment. These land uses are centred on Mandogalup, Hope Valley, Wattleup and Munster.

There is a general pattern of encroachment on these areas by urban and industrial uses.

Agricultural practices can contaminate groundwater with nutrients and metals (mainly cadmium) from fertilisers and wash-down areas, pesticides and herbicides, and fuel from fuel storage areas. Losses of nutrients can be considerable

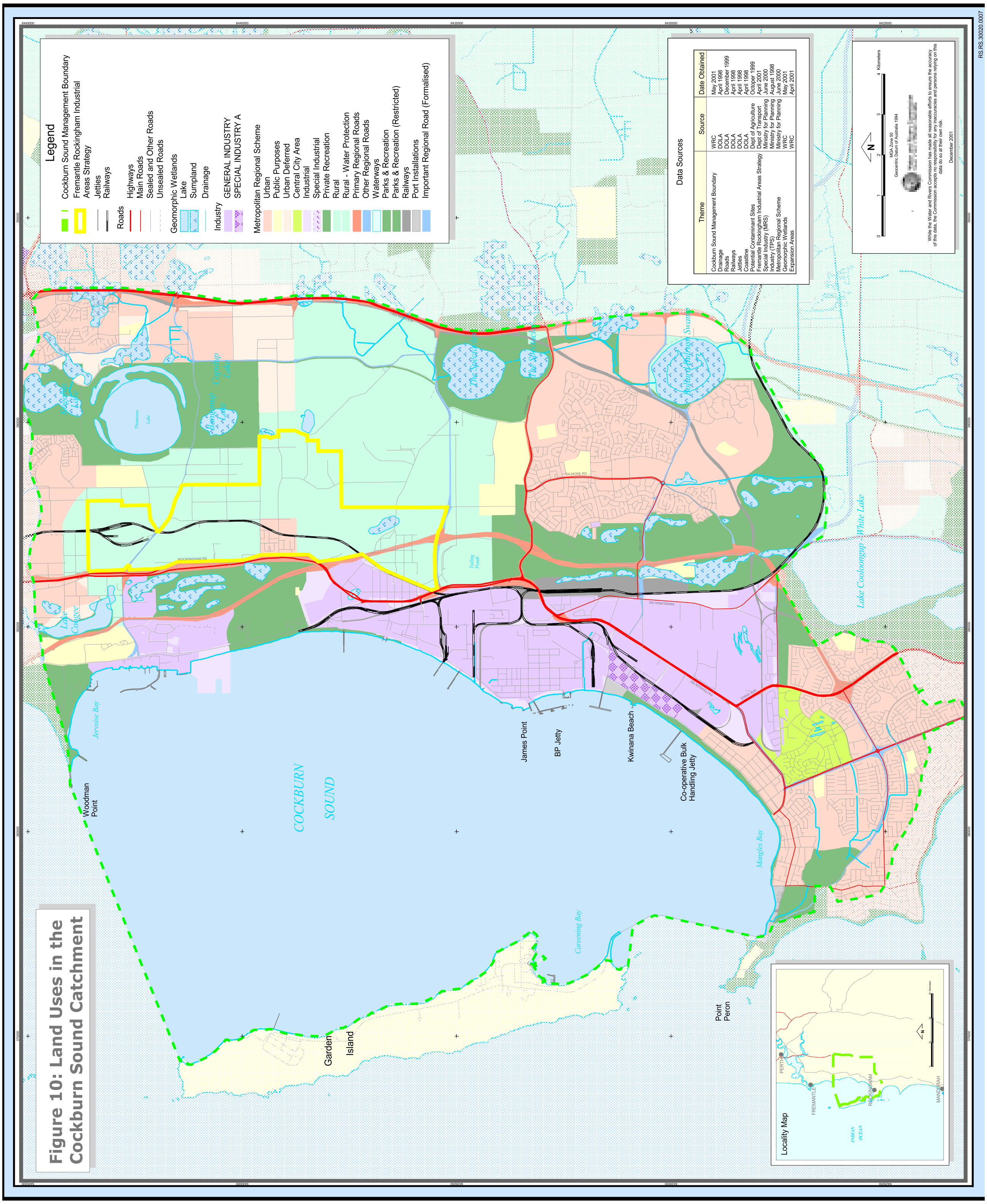


Figure 10. Land Uses in the Cockburn Sound Catchment

due to the porous nature of the local soils, and the amounts of nutrients and water needed to grow commercially viable crops.

Rural industry groups, together with the Department of Agriculture, Water and Rivers Commission and the Department of Environmental Protection, recognise these problems and are now in the process of developing and implementing environmental best management practices or 'codes of practice' for specific rural uses. Those most relevant to the rural activites in the Cockburn Sound catchment are: vegetable and potato growing, turf establishment and maintenance, horse activities, poultry and nurseries.

Industrial Land Uses

The existing industrial areas within the Cockburn Sound catchment were described previously in Section 2.3.1. Heavy industry is centred on the suburbs of East Rockingham, Kwinana Beach and Naval Base. An international ship building precinct (construction, repair and maintenance of steel and aluminum-hulled vessels) is based at Jervoise Bay, with support facilities and services at Henderson.

The most severe groundwater contamination problems in the Cockburn Sound catchment have resulted from spills and leakages on industrial sites and from seepages from waste disposal ponds. Large groundwater plumes exist within the Kwinana and Jervoise Bay industrial areas as a result of past waste disposal practices. The contaminants within the groundwater include ammonium sulphate, sodium hydroxide, hydocarbons, nitrogen and herbicides.

Contaminant loads to Cockburn Sound that occur via groundwater from the eastern shore were estimated as part of the recent State of Cockburn Sound study (DAL, 2001). The available data were quite variable in quality, and data for all contaminants were not available for all sites. Nitrogen data were available for all the facilities included in the survey and thus provide the most reliable information (DAL, 2001).

Nitrogen contributions to the Sound from groundwater are declining (see Figure 8). For example, groundwater remediation at the Kwinana Nickel Refinery site has reduced nitrogen discharges from approximately 500 tonnes/year to the current estimate of eight tonnes. There has also been a 14% improvement in ammonium discharges from the Wesfarmers CSBP site in the four years to 2000 (DAL, 2001).

Water quality inside Northern Harbour is expected to improve by the end of 2001 as a result of the Jervoise Bay groundwater recovery operations to remove some 40 tonnes per year of nitrogen from the inland aquifers.

As a result of these reductions by industry and the overall decline in nitrogen loads, the relative role of catchment land uses is starting to become significant.

There is significant groundwater contamination under industrial sites due to metals and organic compounds. For example, as a result of past practices, a plume of groundwater pollution containing high concentrations of phenols and herbicides 2.4.D and 2.4.5.T exists within the Kwinana Industrial Area (DAL, 2001).

There has been a major proposal for new industrial land made in the Fremantle-Rockingham Industrial Area Regional Strategy (Western Australian Planning Commission, 2000b). Under this Strategy it is proposed to extend heavy industry into the Hope Valley area and to develop the existing townsite of Wattleup and surrounding rural areas as general industrial land. The exact mix of industrial, urban and rural land is currently being determined through the development of a master plan for the area (Government. of WA, 2001).

Although the impacts on groundwater quality from existing rural and urban land uses will be reduced, there may be additional cumulative impacts from industry on groundwater quality unless comprehensive groundwater controls are put in place (Environmental Protection Authority, 1999).

Issues

- Long-term improvement in groundwater quality throughout the catchment will involve working with the rural, urban and industrial users to identify those activities that presently have the greatest impacts on groundwater quality, and to develop cooperative approaches (e.g. best management practices) to minimise future impacts.
- The relative contribution of catchment land uses will become increasingly significant, as industrial discharges to the Sound reduce and the overall nitrogen loads declines. A coordinated approach to planning across the catchment is required to determine acceptable land uses and to develop environmental conditions to reduce nutrient export to Cockburn Sound.

- An inventory of contaminated sites likely to impact on Cockburn Sound was compiled in 1993 (Martinick and Associates and Mackie Martin and Associates, 1993), updated five years later (Hine, 1998) and reviewed as part of the State of Cockburn report (DAL, 2001). A systematic approach needs to be developed whereby the inventory is linked to the monitoring undertaken by industry under licence conditions set by the Department of Environmental Protection and Water and Rivers Commission. Under this arrangement a large component of the inventory would be updated annually.
- As a first step to improving stormwater management, information on the urban drainage system of Cockburn, Rockingham and Kwinana needs to be consolidated.
- Very little information is available on the contributions of runoff from road reserves and urban areas, or from atmospheric deposition into Cockburn Sound.
- The groundwater resources of the Cockburn Sound catchment are almost fully allocated to rural, urban and industrial land uses. The Water and Rivers Commission is currently developing an Interim Allocation Strategy to ensure the resource is sustainably managed. A key environmental consideration in this planning will be to ensure adequate flow through to Cockburn Sound, maintaining any benthic communities or ecosystem processes that may be dependent on freshwater flow.

Objectives

- To integrate planning and management of catchment land uses to minimise the overall impact of ground and surface water contamination on the environmental values of Cockburn Sound.

Recommendations

1. Assess the effectiveness of existing planning controls to limit nutrient inputs from urban, rural and industrial sources (CSMC, LGAs, MPI, DEP, WRC: Ongoing).
2. Develop a better understanding of the implications that the environmental quality criteria (e.g. seagrass health) for protecting the environmental values of Cockburn Sound will have on planning and management of land uses in the catchment (CSMC, DEP: 2003).
3. Work with local government and planning agencies to establish planning mechanisms to protect the waters of Cockburn Sound. This may involve developing a Memorandum of Understanding and appropriate statutory arrangements, if required (CSMC, LGAs, DPI, DEP, WRC: 2002).
4. Initiate a Catchment Partnership between industry, urban and rural land uses; local and State government; schools and the local community, to identify those activities that presently have the greatest impact on groundwater quality, and to develop and implement best management practices to minimise future impacts (CSMC: 2003-Ongoing).
5. Ensure comprehensive groundwater management plans are incorporated into new industrial projects proposed under the Fremantle-Rockingham Industrial Area Regional Strategy (Land Corp: Ongoing).
6. Update the inventory of contaminated sites within the catchment using data collected by industry under DEP and WRC licence requirements, giving priority to sites within five kilometres of the foreshore (DEP, WRC: 2004).
7. Map the storm water catchments around the urbanised areas of Rockingham and Kwinana and the identification of discharges to the Sound. This should include the estimation of contributions to groundwater by the urban areas, location of major infiltration basins and the identification of stormwater pipes that discharge directly to the Sound (CSMC, LGAs, WRC: 2002-04).
8. Initiate a community monitoring program to better estimate the nutrient contributions of runoff from road reserves and urban areas, and from atmospheric deposition into Cockburn Sound (CSMC: 2005).
9. Ensure that planning for the allocation of the groundwater resource aims to maintain an adequate flow of fresh water through to the Cockburn Sound ecosystem (WRC: 2002).

4. Coordinating Research and Investigations

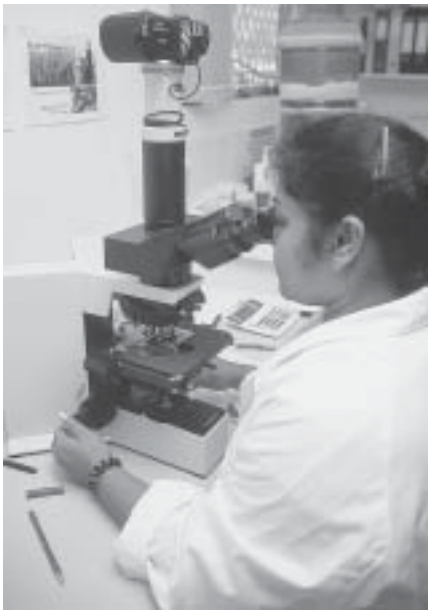
Cockburn Sound is one of the most intensively studied marine systems in Western Australia. Much of this work is reported in the *Cockburn Sound Environmental Study 1976-1979* (Department of Conservation and Environment, 1979), the *Southern Metropolitan Coastal Waters Study 1991-1994* (Department of Environmental Protection, 1996) and in Bulletin 907 *The Marine Environment of Cockburn Sound – Strategic Environmental Advice* (Environment Protection Authority, 1998a).

These studies and reports provide a broad understanding of the physical, biological and chemical processes that define the Cockburn Sound environment and the main pressures that threaten the values of this system.

A review of the most recent information suggests that more focused studies are now required for managers to better understand specific marine, terrestrial and social issues, and to further develop management actions (DAL, 2001). The key issues identified in Sections 1, 2 and 3 of this Plan that require research and investigation are listed below.

Issues

- In order to better assess the potential impacts of port and harbour developments on Cockburn Sound and its foreshore more specific, spatial and temporal information is required on: the circulation and mixing of waters along the eastern foreshore; the sources and movement of toxicants; nutrient recycling and algal blooms; and the biological assemblages of the eastern foreshore.



- Overall nutrient-related water quality has improved only slightly since the early 1990s despite the large decline in nitrogen inputs from human activities from an estimated 1080 tonnes in 1990 to about 300 tonnes in 2000. A better understanding of the relationship between nutrient inputs and water quality indicators (e.g. chlorophyll 'a' and light attenuation) is required.

- The causeway linking Garden Island to the mainland has reduced water flow through the Sound's southern entrance by approximately 40% (Maritime Works Branch, 1997a and b). Additional research work is required to assess the influence of the causeway on the environmental quality of the southern portion of Cockburn Sound, and the potential environmental benefits of modifying its design.

- An inventory of contaminated sites likely to impact on Cockburn Sound was compiled in 1993 (Martinick and Associates and Mackie Martin and Associates, 1993), updated five years later (Hine, 1998) and reviewed as part of the State of Cockburn report (DAL, 2001). A systematic approach needs to be developed whereby the inventory is linked to the monitoring undertaken by industry under licence conditions set by the Department of Environmental Protection and Water and Rivers Commission. Under this arrangement a large component of the inventory would be updated annually.

- The Cockburn Sound Management Council's current approach to multiple use management is relatively subjective and as such provides only a broad guide for managing multiple use. More detailed mapping of future uses, together with a better understanding of the local community's long-term vision for Cockburn Sound and its foreshore, are required before this approach can be used to assess the suitability of proposed uses and developments.

Objective

- To coordinate research and investigations to improve the information and knowledge base required for management of Cockburn Sound and its catchment.

Recommendations

1. In partnership with major stakeholders, develop and implement a five year research and investigations program for Cockburn Sound based on the priorities listed below (CSMC, KIC, DEP, WRC, CSIRO, DoF, DoIT, FPA, WAFIC, community groups: 2003-08).

Marine Environment

- Develop an agreed conceptual model of the effects of nutrient inputs to Cockburn Sound.
- Develop an agreed method for evaluating the cumulative impacts of current and future activities and developments.
- Gather additional data to improve modelling of water movement and coastal processes along the eastern foreshore of Cockburn Sound.
- Determine the influence of the Garden Island Causeway on the environmental quality of the Sound and the potential environmental benefits of modifying its design.
- Maintain the monitoring of seagrass health and distribution.
- Initiate studies on the local populations of fish and shellfish and the connections between these populations, the commercial and recreational fisheries and adjacent areas such as the Swan River.

Terrestrial Environment

- Produce a full inventory of contaminated sties within five kilometres of Cockburn Sound.
- Map stormwater catchments around the urbanised areas of Rockingham, Cockburn and Kwinana.
- Develop a systematic approach to quantifying the quality of groundwater discharging to the Sound.

Social and Cultural Uses

- Develop a better understanding of the social and cultural aspects of Cockburn Sound that the community values.
- Conduct a comprehensive user survey that establishes the future types, areas and intensity of multiple use of Cockburn Sound and its foreshore.·
- Obtain better estimates of recreational fish catches, both boat and shore-based, for integrated catch management of fisheries.

2. Facilitate opportunities for local community groups, agencies, educational institutions, volunteers and individuals to be involved in research and investigation projects within Cockburn Sound and its catchment (CSMC: 2003 – Ongoing).
3. Establish a data-base of the main past, current and proposed research and investigation programs (CSMC: 2002 – Ongoing).

5. Monitoring and Reporting on Performance

A key role of the Cockburn Sound Management Council is to monitor the management actions of government agencies, industry, Defence, local government authorities and user groups, and to report to the community on their collective progress towards a healthier Cockburn Sound.

As part of this process the Management Council has commissioned the first State of Cockburn Sound report (DAL, 2001). This report follows the Pressure-State-Response model of the Organisation for Economic Co-operation and Development, that has been adopted by the Commonwealth and State governments in Australia for State of the Environment (SoE) reporting (Figure 11).

The 'report cards' (Tables 4 to 8) illustrated in Section 1 of this Plan will form the basis of future reporting to the community on the 'state of Cockburn Sound'.

In addition to reporting annually to government and the community, the Management Council provides comprehensive communication channels to the community by producing monthly up-dates on progress through its newsletter, *Sound News*, seeking feedback through regular community forums, and providing a 'shop front' office in Rockingham where the latest information on Cockburn Sound is easily accessible.

These communications will form the basis of an ongoing Community Awareness and Involvement Program that will be an important part of implementing the Environmental Management Plan.

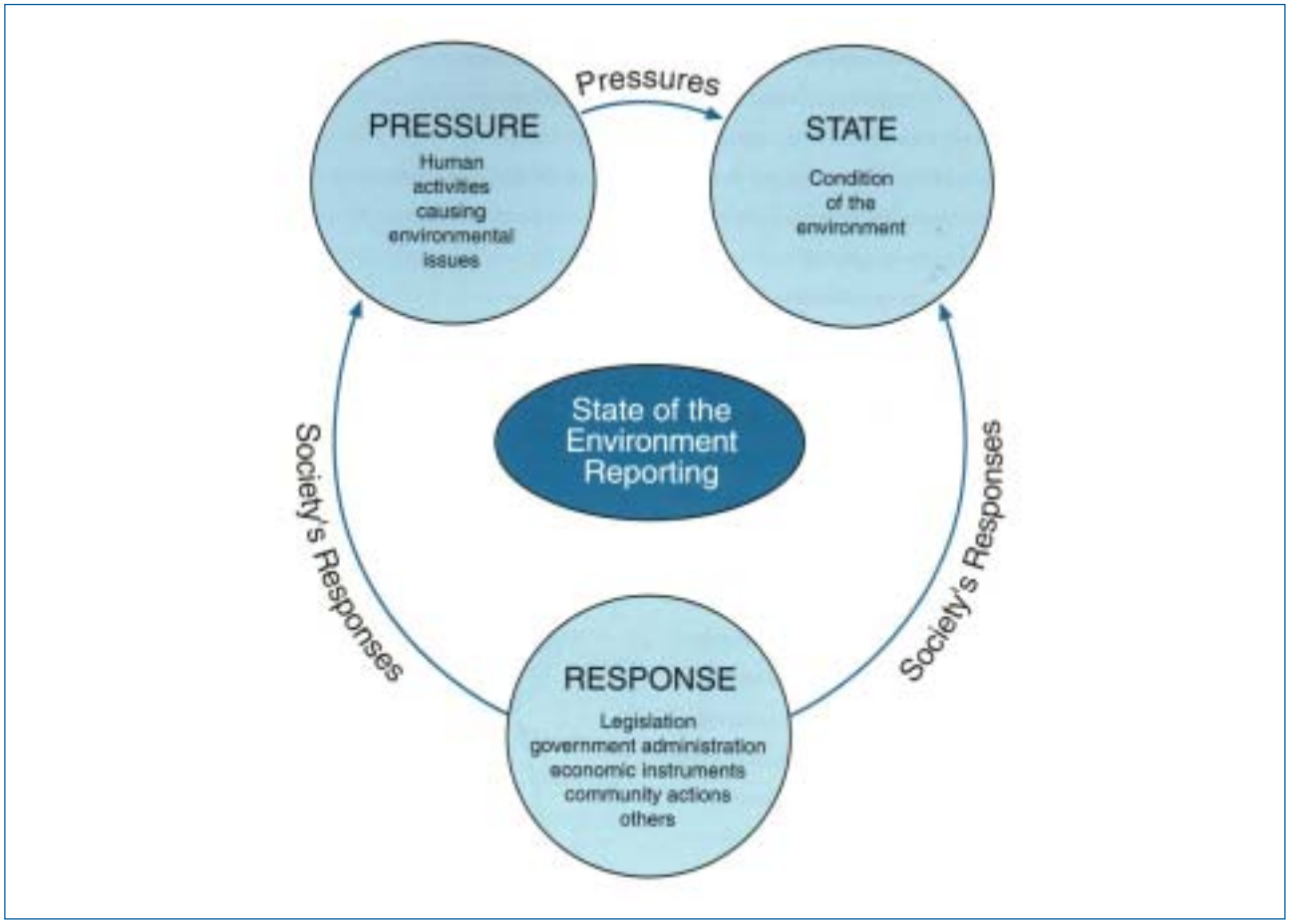


Figure 11. Pressure-State-Response Model

OBJECTIVES

- To encourage and facilitate community involvement in the implementation of the Environmental Management Plan.
- To publicly report on performance in implementing this Management Plan.

RECOMMENDATIONS

1. In consultation with major stakeholders, develop and implement a Community Awareness and Involvement Program. The Program will be guided by the following principles:
    - link and add value to current programs;
    - raise awareness of marine and catchment issues across the whole of the community to back up other specific issues or local area projects;
    - empower local action by responding to community needs for information, providing opportunities for involvement, and developing local initiatives;
    - develop partnerships so that stakeholders, including local government, community groups, industry, and government agencies, work co-operatively to address problems;
    - ensure accountability to the community;
    - provide opportunities for community feedback; and
    - be responsive to changing environmental and community issues.

    (CSMC: 2003 - Ongoing)
2. Report annually to the local community on the 'state of Cockburn Sound' using the 'report cards' as a basis for reporting (CSMC: Annually).
3. Report annually to the Ministerial Council for the Cockburn Sound Management Council and to the Board of the Water and Rivers Commission on progress in implementing the Environmental Management Plan (CSMC: Annually).

Implementing the Plan

Implementing the recommendations of the Environmental Management Plan will take place over the next seven years. In many instances, actions are already under way.

It is proposed to take a cooperative approach to implementing the Plan with at least 14 government agencies at a local, State and Commonwealth level and many community and interest groups responsible for working together to ensure that various recommendations are completed. The State government agencies will primarily be responsible for pursuing funding for implementing the Plan, although many actions within the Plan rely heavily upon community, industry and local and Commonwealth government involvement.

Following the release of the draft Environmental Management Plan and the public consultation period, an Implementation Table will be developed as part of the final Plan.

The Implementation Table, which will be based on the approach used in the Perth Air Quality Management Plan Consultation Draft (Department of Environmental Protection, 2000), will summarise all the recommendations contained in the Plan, and indicate:

- The expected outputs and outcomes;
- The potential impact on water quality from the implementation of the recommendation;
- The timing for implementing the recommendation;
- The agency responsible for the recommendation; and
- The expected status of each recommendation after five years of implementation.

Performance indicators against which the success of the plan is to be measured will also be developed, as well as defining the frequency and form for reporting implementation progress.

Table 11 is an example of the proposed format of the Implementation Table.

Interpreting the Implementation Table

Code

This is the recommendation's reference number, as used in the Management Response sections of the Plan. For example, Code 1.3.1 refers to Section 1.3 Maintaining a Healthy Marine Ecosystem, Recommendation 1.

Description

This is the recommendation statement, as used in the Management Response sections in the Plan.

Output

This identifies the type of product delivered from the recommendation. The following categories of outputs are proposed:

• **Water quality model**, a computer model where various combinations of physical, chemical and biological variations can be simulated to assess changes in ambient water quality.

• **Community awareness**, includes structured awareness-raising or educational activities targeted generally at the community, as well as specific groups. It also includes items such as information packages and community forums.

• **Best management practice**, represents non-statutory documentation that provides guidance, such as environmental codes of practice and industry guidelines and non-statutory statements of government policy.

• **Inventory**, refers to the publicly available collation of water quality data.

• **Monitoring program**, refers to the water quality monitoring, and includes industry, government and other monitoring.

• **Strategy**, refers to a group of integrated actions that will be implemented as a set, and includes site specific or issue specific plans (e.g. nutrient management strategy).

• **Report**, includes a one-off report or reports required on an annual, biennial, triennial or five yearly basis.

• **Investigation**, indicates a field activity undertaken to prove, clarify or define a management issue to determine if a management response is required.

• **Research,** refers to the collection, analysis and interpretation of data to improve the knowledge base for decision-making.

• **Guidelines and Standards,** refers to the develop of environmental quality criteria for the environmental objectives for Cockburn Sound.

• **Management response**, represents a tangible 'on-the-ground' or 'in-the-water' response to investigations of a management issue.

Expected Outcomes

This is currently a description of the perceived result from the recommendation. The following categories proposed are:

• **Basis for future decision-making**, refers to actions that will deliver information crucial to making a scientifically informed decision, either at a policy or action level.

• **Behaviour change**, refers to recommendations that:
- Will influence a change in general community action or specific stakeholder activity, through the provision of general or targeted information, including specific programs and training courses.
- Aim to improve awareness within the community in general or specifically.

•**Defining water quality problem**, refers to recommendations that are of an investigative or research nature that will lead to clarification of a water quality problem.

• **Improvement to the system**, refers to actions that:
- Bring about effectiveness in data or information gathering;
- Lead to additional information being accessed;
- Identify knowledge gaps or duplications in functions;
- Provide information not currently available; or
- Bring about consistency across jurisdictions.

• **Improvement in meeting the environmental quality criteria**, refers to quantifiable actions towards:
- Maintaining a healthy marine ecosystem;
- Ensuring safe seafood for eating;
- Protecting the health of aquaculture species;
- Maintaining clean waters for swimming, boating and aesthetics; or
- Ensuring suitable water quality for industry.

Work will continue during the public consultation period to refine the *expected outcomes*.

Expected Impact on Water Quality

The expected impact is currently defined by a subjective statement. The two categories used are:

- *Direct impact on water quality*, an action that will directly influence the waters of Cockburn Sound; and
- *Indirect impact on water quality*, an action that will influence water quality, but not directly (e.g. changes in community behaviour). It also includes supportive actions such as undertaking essential data gathering to manage an improvement in quality, or an action that will add to the understanding about the magnitude of a water quality issue.

Work will continue during the public consultation period to quantitatively define the expected impact on water quality.

Agency Responsible

This identifies the State government agency or authority responsible for ensuring that the recommendation is undertaken. Details are taken directly from the Management Response section of the plan. In some circumstances two or more agencies may be identified (e.g. Department of Planning and Infrastructure and Fremantle Port Authority). This indicates that both agencies are responsible for the recommendation and that cooperation between the named agencies will be agreed and arranged. Abbreviations for all of the government agencies and other authorities are defined at the front of the Environmental Management Plan.

Timing - Start

This indicates the year in which the action is expected to commence.

Status after Five Years

This indicates the expected progress of each recommendation in the first five years of implementation. Some actions will be completed within this period.

Timing – End

This indicates the year in which implementation of the recommendation is expected to be completed.

Reviewing the Environmental Management Plan

It is intended that the Environmental Management Plan will be reviewed:

- After five years, for progress made on implementation of the recommendations, applicability of the recommendations and prioritisation of subsequent or future actions (including emerging issues); and
- Annually, with a report of progress being submitted to the Minister for the Environment, Heritage and Water Resources.

Objective

- To implement the Environmental Management Plan on a priority basis.

Recommendation

1. Following the release of the draft Environmental Management Plan and the public consultation period, develop an Implementation Table based on Table 11. (CSMC: 2002-Ongoing).

Table 11. Implementation Table – *Example Only*

Code	Description	Output	Expected outcome	Expected impact on water quality	Agency responsible	Timing – start	Status after 5 years	Timing – end
1.3.1	Continue to develop the environmental quality criteria and refine the boundaries for the levels of protection for marine ecosystem	• Guidelines and Standards.	• Basis for future decision-making. • Defining water quality problem.	Indirect impact on water quality.	EPA	2002	Criteria developed	Ongoing
1.3.2	Develop and implement an Environmental Quality Monitoring Program, in partnership with stakeholders. The Program will be based on the environmental indicators for ecosystem integrity, with priority on monitoring TBT levels, seagrass health, and the water quality indicators of chlorophyll 'a' and light attenuation.	• Monitoring program	• Basis for future decision-making. • Defining water quality problem. • Improvement to system.	Indirect impact on water quality.	CSMC, DEP, WRC, KIC, DoD, FPA, commercial users.	2002	Monitoring program implemented.	Ongoing
1.3.3	Where the data for the environmental indicators exceed the criteria, implement management action according to the ollowing hierarchy:· • Guideline: CSMC to coordinate investigations and, where necessary, precautionary actions. • Standard: CSMC to coordinate investigations and management responses to address the problem. The CSMC will report all exceedences and their investigation to the EPA as soon as practicable.	• Investigations. • Management response. • Report.	• Defining water quality problem. • Improvement in meeting environmental quality criteria.	Direct impact on water quality.	CSMC	2002	Report on exceedences. Improvement in meeting environmental quality criteria.	Ongoing

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