SUTHERLAND SHIRE COUNCIL

YOWIE BAY ESTUARY MANAGEMENT STUDY & PLAN

Issue No. 3
FEBRUARY 1999

Patterson Britton
& Partners Pty Ltd
consulting engineers

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YOWIE BAY ESTUARY MANAGEMENT PL

EXECUTIVE SUMMARY

A long term Management Plan has been prepared for the Port Hacking sub-estuary of Yowie Bay. The Plan has been based on studies which investigated the estuarine processes, and management constraints and opportunities of the bay.

Through a community consultation process, 16 primary objectives of a long term Management Plan for Yowie Bay were determined. These objectives are listed below.

Water Quality and Pollution

1. To reduce the amount of floatable stormwater pollution entering Yowie Bay
2. To reduce the amount of organic debris entering Yowie Bay
3. To reduce other pollution sources entering Yowie Bay
4. To reduce discharges from sewer overflows entering Yowie Bay

Siltation

5. To minimise any further siltation of the heads of Yowie Bay
6. To reduce siltation from all stormwater drains
7. To re-establish navigable access to waterfront properties

Ecology

8. To maintain or even increase biodiversity of sand flats in delta areas
9. To minimise detrimental effects on existing seagrass beds, particularly deepwater beds
10. To re-establish indigenous foreshore vegetation
11. To re-establish seagrass beds in the bay

Boating

12. To minimise environmental impacts of recreational vessels using Yowie Bay
13. Minimise conflicts between recreational users of Yowie Bay
14. To enhance foreshore access and facilities around Yowie Bay associated with boating
15. To restrict the amount of vessels permanently moored on the waterway

Environmental Education

16. To gain a better appreciation for the biodiversity and ecology of Yowie Bay

A series of options were considered by the community and the Estuary Management Committee to address these long term management objectives. A range of "achievable" tasks were identified and compiled into a single planning document – the Yowie Bay Estuary Management Plan. These tasks involve either specifically focussed activities, or involve more general application. **Figure ES1** presents those tasks applicable to the wider catchment, while **Figures ES2** and **ES3** outlines tasks specific to the Camellia Gardens delta and Ewey Creek delta, at the heads of Yowie Bay, respectively.

Management tasks are detailed below.

Specific Tasks

A. Reduce litter, organics and sediment by construction of more, or upgrading of existing, stormwater litter collection devices such as Pollutech CDS units, Humeceptor units or trash racks and GPTs

B. Reduce organics from Garden Refuse by regular collection service

C. Encourage and promote commercial and retail businesses to initiate measures to reduce litter

D. Reduce organic detritus through establishment of native species and removal of weeds in private gardens

E. Encourage reduction of oils and hydrocarbons due to use of bilge blankets in moored and berthed vessels

F. Reduce nutrients and bacteria due to sewer overflows by lobbying for sewer upgrading

G. Reduce sediment supply by installing erosion control measures within creek reserves

H. Remove weeds and replace with indigenous species

I. Protect seagrass pockets through community awareness program and examine scope for restricting boating activity including mooring and anchoring in vicinity of established seagrass beds

J. Upgrading boatramp facilities to provide improvements such as upgraded ramp, additional parking, boat washdown area, fish cleaning facilities, additional rubbish bins, public toilets, picnic amenities and small craft landing facilities

K. Examine feasibility and pros and cons of replacing some of the existing moorings with a new marina complex, as well as marina facilities, such as sewer pump-out

L. Restrict number and extent of future additional moorings. Examine feasibility of introducing less space consuming mooring measures

M. Encourage and support community groups to enhance habitat and improve appearance of foreshore by regular removal of litter

N. Create a navigation channel to provide small craft access to waterfront properties and to provide tidal flushing of the plunge pool

O. Carry out localised dredging around peripheries of delta in vicinity of private pontoon and jetties

P. Enhance marine habitat by possible planting of saltmarshes in conjunction with litter clean-up (Task M)

Q. Provide interpretive signage along existing bush tracks in Kareena Park and provide eco-educational walking trails around the foreshore generally

R. Provide mangrove boardwalks with interpretive signage

S. Provide timber landing jetty to allow boating access to Camellia Gardens and walking trails

T. Provide adequate planning controls to protect existing stands of mature mangroves against damage or removal

to retain habitat diversity. Implement relevant community awareness program

U. Provide adequate planning controls to protect juvenile mangroves and seedlings against damage or removal. Implement relevant community awareness program

V. Provide adequate planning controls to protect existing areas of saltmarshes on higher sections of the delta sand flats. Implement relevant community awareness program

W. Restore timber jetty to provide water access and a viewing platform for Camellia Gardens bay and provide safe access to jetty from Matson Crescent

Non-Specific Tasks

Z1. Pollution Hotline to inform Council of pollution within tributary creeks

Z2. Investigate need for sewage pump-out and long term impacts of boat discharges

Z3. Investigate water quality and identify sources of water quality pollution

Z4. Investigate sediment quality in deeper sections of the bay

Z5. Assess collected litter and other pollution to determine sources and means of reduction

Z6. Ensure strict compliance of development consents for building sites

Z7. Monitor the extent and health of seagrasses

Z8. Impose stricter speed restrictions within different sections of the bay

Z9. Place interpretive signage within the Yowie Bay catchment to educate the community

Z10. Develop School project kits and organise guided walking tours of Yowie Bay foreshores and Kareena Park

Z11. Promote Kareena Park as a "native" garden which contrasts to the adjacent Camellia Gardens

FIGURE ES1

A REDUCE LITTER, ORGANICS AND SEDIMENT BY CONSTRUCTION OF MORE, OR UPGRADING OF EXISTING, STORMWATER LITTER COLLECTION DEVICES SUCH AS PROPRIETARY POLLUTION CONTROL UNITS, TRASH RACKS AND GPTS

B REDUCE ORGANICS FROM GARDEN REFUSE BY REGULAR COLLECTION SERVICE

C ENCOURAGE AND PROMOTE COMMERCIAL AND RETAIL BUSINESSES TO INITIATE MEASURES TO REDUCE LITTER

D REDUCE ORGANIC DETRITUS THROUGH ESTABLISHMENT OF NATIVE SPECIES AND REMOVAL OF WEEDS IN PRIVATE GARDENS

E ENCOURAGE REDUCTION OF OILS AND HYDROCARBONS BY THE USE OF BILGE BLANKETS IN MOORED AND BERTHED VESSELS

F REDUCE NUTRIENTS AND BACTERIA DUE TO SEWER OVERFLOWS BY LOBBYING FOR SEWER UPGRADING

G REDUCE SEDIMENT SUPPLY BY INSTALLING EROSION CONTROL MEASURES WITHIN CREEK RESERVES

H REMOVE WEEDS AND REPLACE WITH INDIGENOUS SPECIES

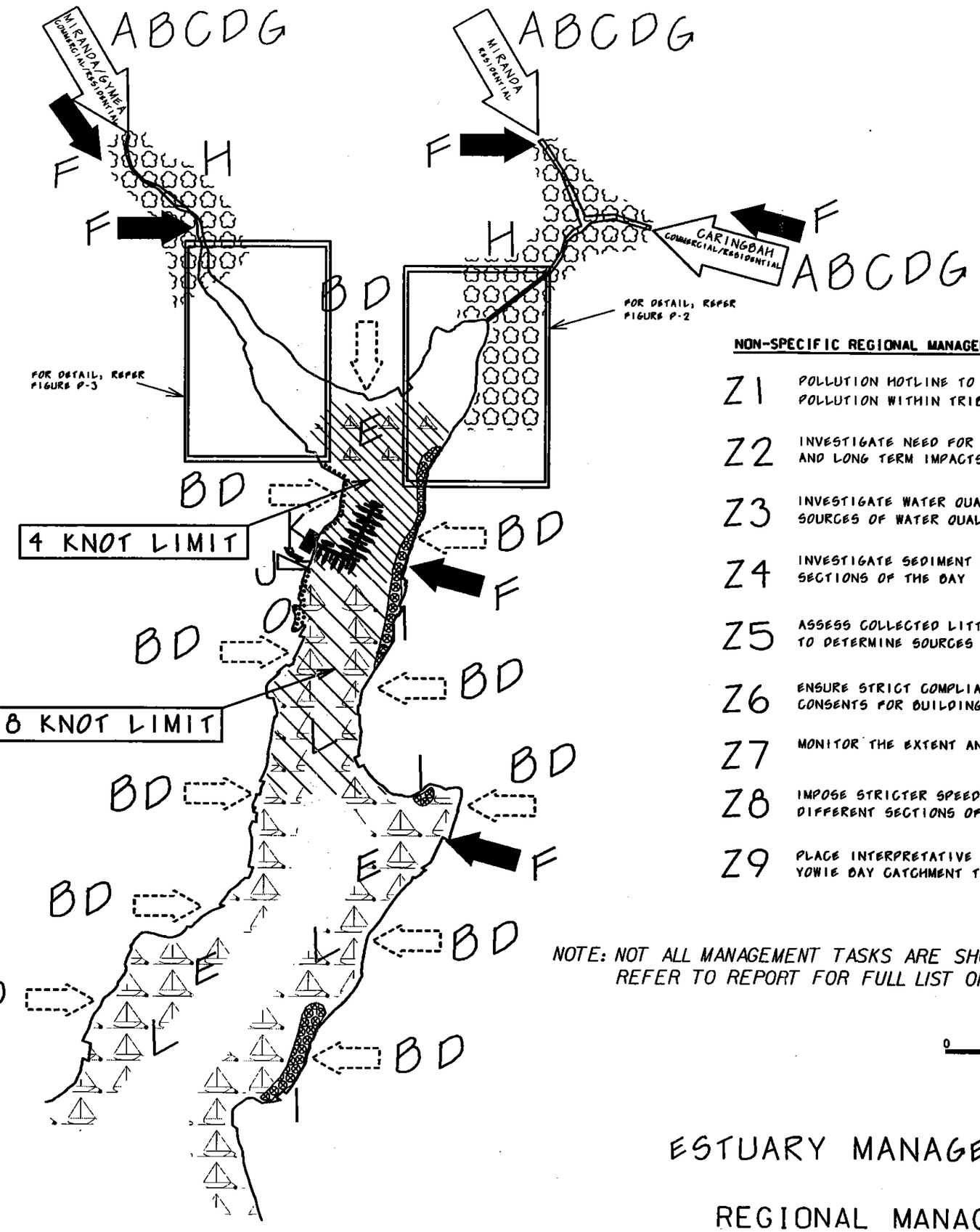
I PROTECT SEAGRASS POCKETS THROUGH COMMUNITY AWARENESS PROGRAM AND CONSIDER SCOPE FOR RESTRICTING BOATING ACTIVITY INCLUDING MOORING AND ANCHORING IN VICINITY OF ESTABLISHED SEAGRASS BEDS

J UPGRADING BOATRAMP FACILITIES TO PROVIDE IMPROVEMENTS SUCH AS UPGRADED RAMP, ADDITIONAL PARKING, BOAT WASHDOWN AREA, FISH CLEANING FACILITIES, ADDITIONAL RUBBISH BINS, PUBLIC TOILETS, PICNIC AMENITIES AND SMALL CRAFT LANDING FACILITIES

K EXAMINE FEASIBILITY AND PROS AND CONS OF REPLACING SOME OF EXISTING MOORINGS WITH A NEW MARINA COMPLEX, AS WELL AS MARINA FACILITIES SUCH AS SEWAGE PUMP-OUT

L RESTRICT NUMBER AND EXTENT OF FUTURE ADDITIONAL MOORINGS. CONSIDER FEASIBILITY OF INTRODUCING LESS SPACE CONSUMING MOORING MEASURES

O EXAMINE DETAILED FEASIBILITY OF CARRYING OUT LOCALISED DREDGING AROUND PERIPHERIES OF DELTA IN VICINITY OF PRIVATE PONTOONS AND JETTIES



NON-SPECIFIC REGIONAL MANAGEMENT TASKS

Z1 POLLUTION HOTLINE TO INFORM COUNCIL OF POLLUTION WITHIN TRIBUTARY CREEKS

Z2 INVESTIGATE NEED FOR SEWAGE PUMP-OUT AND LONG TERM IMPACTS OF BOAT DISCHARGES

Z3 INVESTIGATE WATER QUALITY AND IDENTIFY SOURCES OF WATER QUALITY POLLUTION

Z4 INVESTIGATE SEDIMENT QUALITY IN DEEPER SECTIONS OF THE BAY

Z5 ASSESS COLLECTED LITTER AND OTHER POLLUTION TO DETERMINE SOURCES AND MEANS OF REDUCTION

Z6 ENSURE STRICT COMPLIANCE OF DEVELOPMENT CONSENTS FOR BUILDING SITES

Z7 MONITOR THE EXTENT AND HEALTH OF SEAGRASSES

Z8 IMPOSE STRICTER SPEED RESTRICTIONS WITHIN DIFFERENT SECTIONS OF THE BAY

Z9 PLACE INTERPRETATIVE SIGNAGE WITHIN THE YOWIE BAY CATCHMENT TO EDUCATE THE COMMUNITY

NOTE: NOT ALL MANAGEMENT TASKS ARE SHOWN ON THIS DRAWING REFER TO REPORT FOR FULL LIST OF MANAGEMENT TASKS

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YOWIE BAY ESTUARY MANAGEMENT PLAN

REGIONAL MANAGEMENT TASKS

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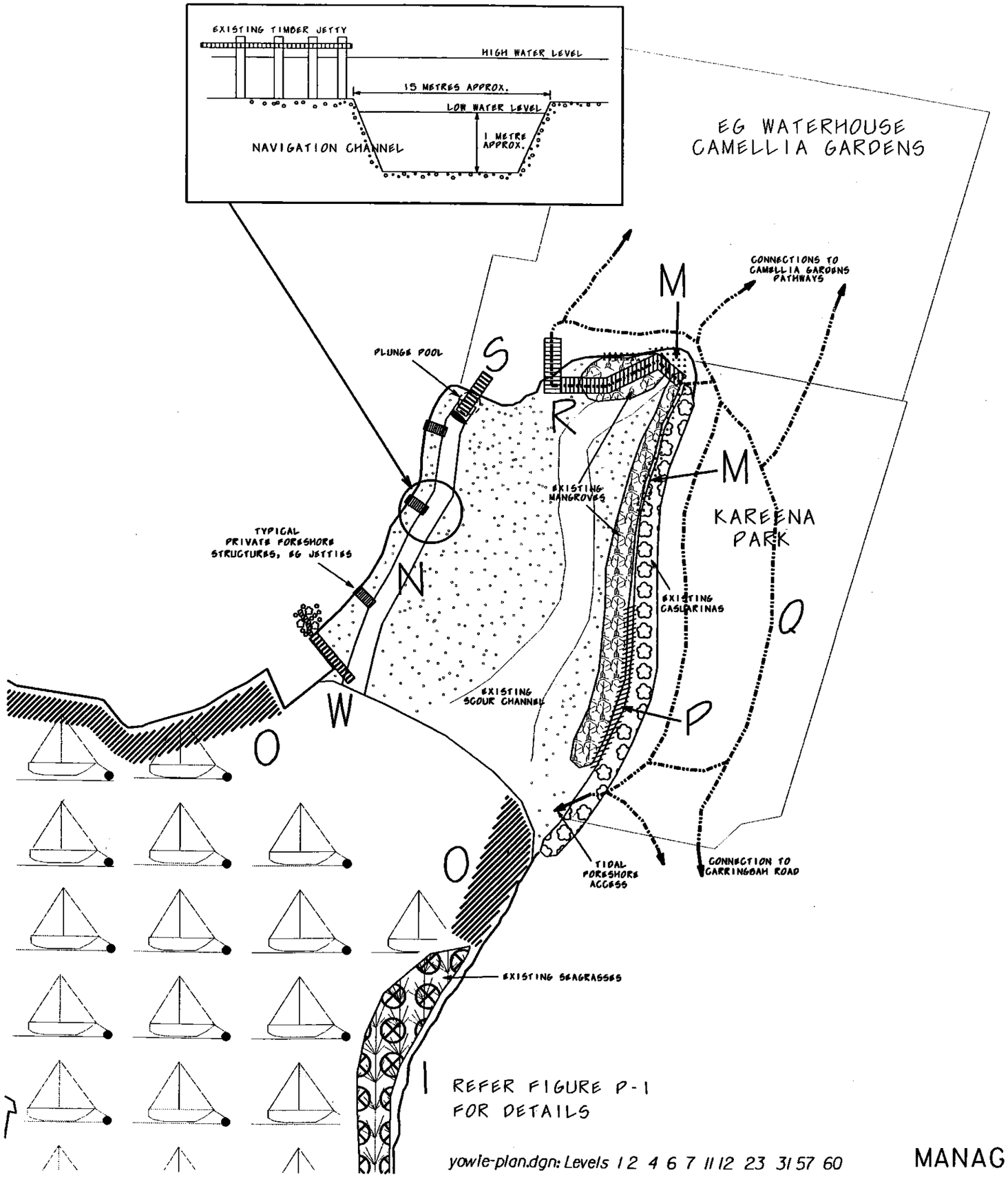

FIGURE ES2

M ENCOURAGE AND SUPPORT COMMUNITY GROUPS TO ENHANCE HABITAT AND IMPROVE APPEARANCE OF FORESHORE BY REGULAR REMOVAL OF LITTER

N CREATE A NAVIGATION CHANNEL TO PROVIDE SMALL CRAFT ACCESS TO WATERFRONT PROPERTIES AND TO PROVIDE TIDAL FLUSHING OF PLUNGE POOL. DEPENDING ON THE FREQUENCY OF USE, THE PLANTING OF SEAGRASSES IN THE NAVIGATION CHANNEL MAY BE CONSIDERED

O CARRY OUT LOCALISED DREDGING AROUND PERIPHERIES OF DELTA IN VICINITY OF PRIVATE RAMPS PONTOONS AND JETTIES

P ENHANCE MARINE HABITAT BY POSSIBLE PLANTING OF SALTMARSHES IN CONJUNCTION WITH LITTER CLEAN-UP - TASK M

DEVELOP ECO-EDUCATIONAL TRAILS AROUND THE FORESHORE INCLUDING:

Q — PROVIDE WALKING TRAILS WITH INTERPRETIVE SIGNAGE - INDICATIVE ONLY

R — PROVIDE MANGROVE BOARDWALKS WITH INTERPRETIVE SIGNAGE - INDICATIVE ONLY

S — PROVIDE TIMBER LANDING JETTY TO PROVIDE BOATING ACCESS TO CAMELLIA GARDENS AND WALKING TRAILS - INDICATIVE ONLY

W — RESTORE TIMBER JETTY TO PROVIDE WATER ACCESS AND A VIEWING PLATFORM FOR CAMELLIA GARDENS BAY AND PROVIDE SAFE ACCESS TO JETTY FROM MATSON CRESCENT

NON-SPECIFIC CAMELLIA GARDENS BAY MANAGEMENT TASKS

Z10 DEVELOP SCHOOL PROJECT KITS AND ORGANISE GUIDED WALKING TOURS OF YOWIE BAY FORESHORES AND KAREENA PARK

Z11 PROMOTE KAREENA PARK AS A "NATIVE" GARDEN WHICH CONTRASTS TO THE ADJACENT CAMELLIA GARDENS

NOTE: NOT ALL MANAGEMENT TASKS ARE SHOWN ON THIS DRAWING REFER TO REPORT FOR FULL LIST OF MANAGEMENT TASKS

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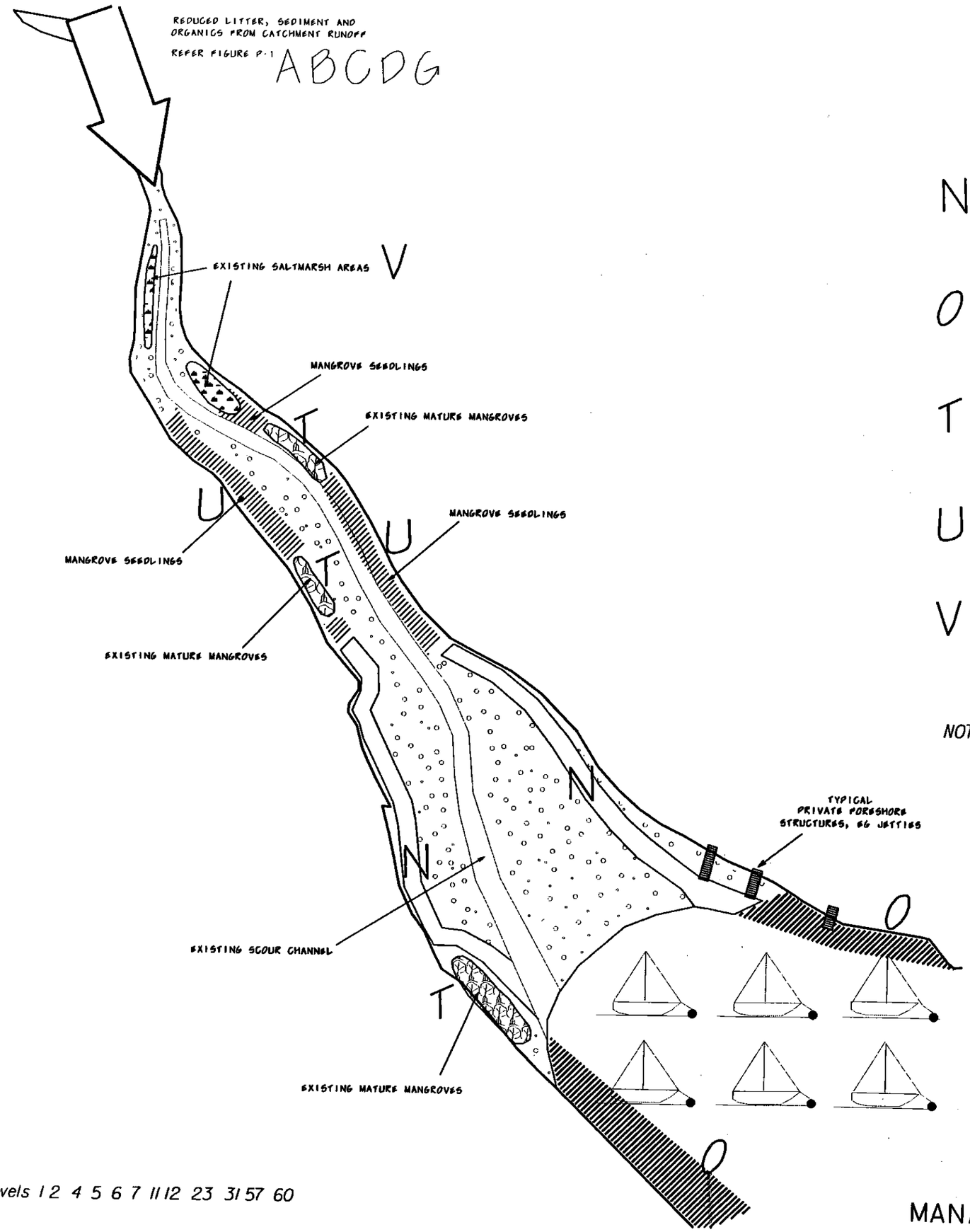
YOWIE BAY ESTUARY MANAGEMENT PLAN

MANAGEMENT OPTIONS - CAMELLIA GARDENS BAY

FIGURE ES3



N CREATE A NAVIGATION CHANNEL TO PROVIDE SMALL CRAFT ACCESS TO WATERFRONT PROPERTIES

DEPENDING ON THE FREQUENCY OF USE, THE PLANTING OF SEAGRASSES IN THE NAVIGATION CHANNELS MAY BE CONSIDERED

O CARRY OUT LOCALISED DREDGING AROUND PERIPHERIES OF DELTA IN VICINITY OF PRIVATE RAMPS PONTOONS AND JETTIES ALSO, REFER FIGURE P-2

T PROVIDE ADEQUATE PLANNING CONTROLS TO PROTECT EXISTING STANDS OF MATURE MANGROVES AGAINST DAMAGE OR REMOVAL TO RETAIN HABITAT DIVERSITY. IMPLEMENT COMMUNITY AWARENESS PROGRAM

U PROVIDE ADEQUATE PLANNING CONTROLS TO PROTECT JUVENILE MANGROVES AND SEEDLINGS AGAINST DAMAGE OR REMOVAL. IMPLEMENT COMMUNITY AWARENESS PROGRAM

V PROVIDE ADEQUATE PLANNING CONTROLS TO PROTECT EXISTING AREAS OF SALTMARSHES ON HIGHER SECTIONS OF THE DELTA SAND FLATS. IMPLEMENT COMMUNITY AWARENESS PROGRAM

NOTE: NOT ALL MANAGEMENT TASKS ARE SHOWN ON THIS DRAWING REFER TO REPORT FOR FULL LIST OF MANAGEMENT TASKS

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YOWIE BAY
ESTUARY MANAGEMENT PLAN
MANAGEMENT OPTIONS - EWEY CREEK BAY

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TABLE OF CONTENTS

TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS

Page No.

1. INTRODUCTION

1.1 BACKGROUND

Yowie Bay, an arm of the Port Hacking estuary, is located on the southern outskirts of Sydney, within the Sutherland Shire. The bay is fringed by low level residential development, foreshore reserves and formal gardens. Located within the Yowie Bay catchment is Miranda Fair Shopping Centre, and South Caringbah Shopping Centre, as well as isolated pockets of commercial, and special use zonings, including Sutherland Hospital.

The local community is concerned that the bay has deteriorated significantly over the past 100 years, most notably due to shoaling of the deltas at the heads of the bay, and the amount of litter emanating from the catchment. In recognition of growing pressures on the estuarine ecosystem of Yowie Bay, an Estuary Management Committee was formed for the purpose of developing an Estuary Management Plan for the long term protection and ecological sustainability of the Bay.

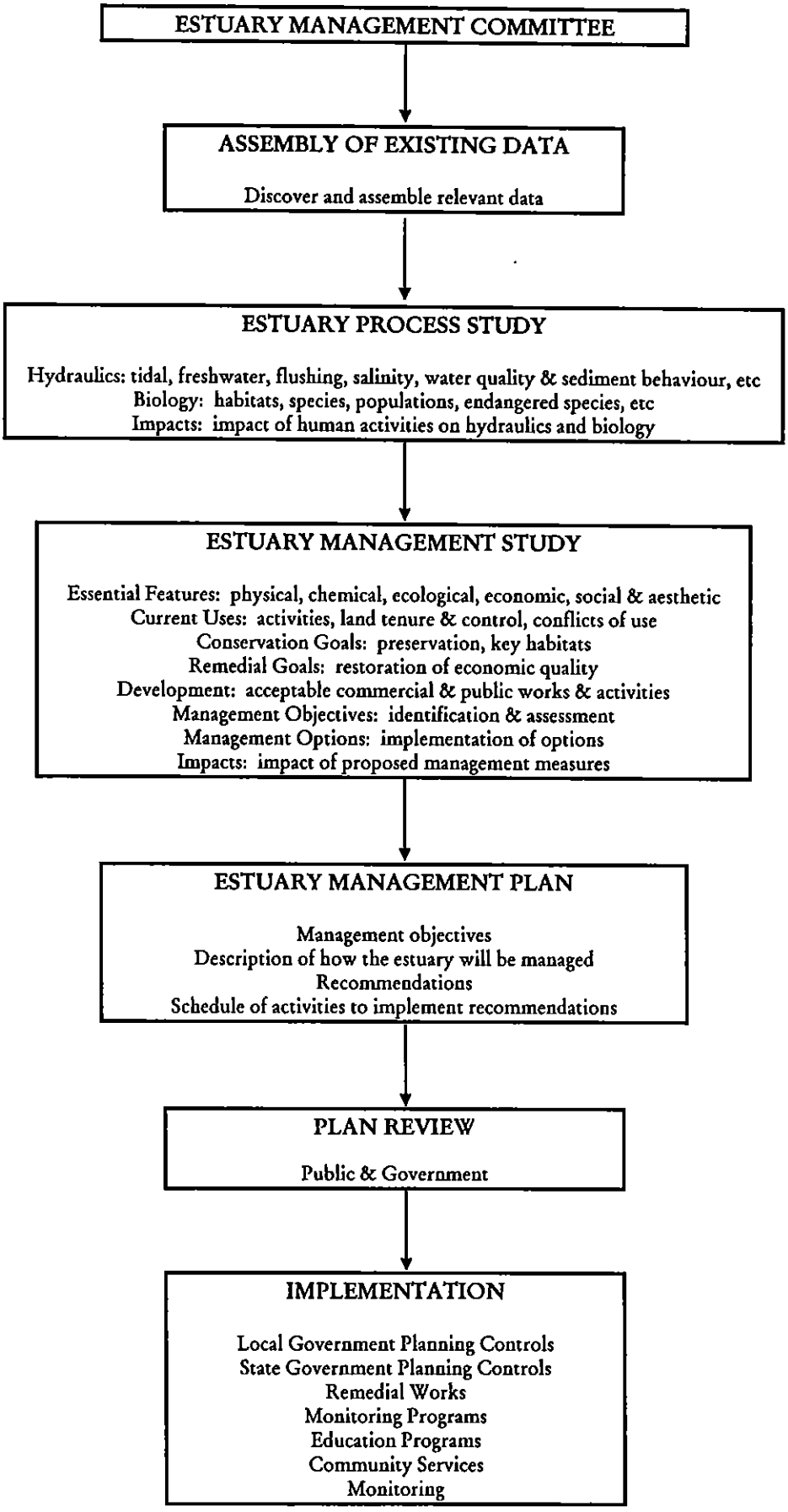
1.2 THE ESTUARY MANAGEMENT PROCESS

In 1987, the NSW State Government introduced an *Estuary Management Policy*, aimed at managing the growing pressures on estuarine ecosystems. The process of managing an estuary, in accordance with this Policy, is initiated by the establishment of an Estuary Management Committee. This Committee is then responsible for the development of an Estuary Processes Study, which outlines all the hydraulic, sedimentation, water quality and biological processes within the estuary, and the impacts of human activities on these processes.

The Processes Study provides the necessary understanding of physical and biological processes for an Estuary Management Study. The Management Study identifies the essential features and the current uses of the estuary, and determines the overall objectives required for management of the estuary. The Management Study also identifies options for meeting these objectives, and determines hydraulic and ecological impacts of the proposed options.

From the findings of the Management Study, an Estuary Management Plan is prepared. The Plan describes how the estuary will be managed, gives recommended solutions to management problems, and details a schedule of activities for the implementation of the recommendations. Once the Plan has been accepted by both the Community and the relevant Government Departments, the Plan can be implemented through planning controls, works programs, monitoring programs, and education services.

This report sets out the findings of an Estuary Management Study of Yowie Bay. It identifies the management objectives, and the constraints and opportunities, for the Bay. Working within the limitations identified by the constraints and opportunities, the management objectives are addressed by appropriate management options. The impacts of these options on the hydraulic and ecological processes are also discussed.


ESTUARY MANAGEMENT COMMITTEE
ASSEMBLY OF EXISTING DATA
Discover and assemble relevant data
ESTUARY PROCESS STUDY
Hydraulics: tidal, freshwater, flushing, salinity, water quality & sediment behaviour, etc
Biology: habitats, species, populations, endangered species, etc
Impacts: impact of human activities on hydraulics and biology
ESTUARY MANAGEMENT STUDY
Essential Features: physical, chemical, ecological, economic, social & aesthetic
Current Uses: activities, land tenure & control, conflicts of use
Conservation Goals: preservation, key habitats
Remedial Goals: restoration of economic quality
Development: acceptable commercial & public works & activities
Management Objectives: identification & assessment
Management Options: implementation of options
Impacts: impact of proposed management measures
ESTUARY MANAGEMENT PLAN
Management objectives
Description of how the estuary will be managed
Recommendations
Schedule of activities to implement recommendations
PLAN REVIEW
Public & Government
IMPLEMENTATION
Local Government Planning Controls
State Government Planning Controls
Remedial Works
Monitoring Programs
Education Programs
Community Services
Monitoring

1.3 YOWIE BAY COMMON MISPERCEPTIONS

Following a review of documents prepared by various community representatives, and a detailed assessment of the relevant processes associated with the hydraulics, sedimentation, water quality and biology of Yowie Bay[1], it appears that there are a number of common misperceptions regarding Yowie Bay processes. These misperceptions are discussed below.

"The sediments in the bay are polluted"
Sediment sampling carried out as part of the Estuary Processes Study indicated that the sediments on the sand shoals at the heads of Yowie Bay are not polluted in excess of what would be expected from a typical residential catchment. Heavy metals, hydrocarbons and nutrients were all within acceptable limits, and do not pose any serious risk to the aquatic environment.

"The shoals have only formed since the catchment has become developed"
Sedimentological testing carried out during the Processes Study indicated that contemporary sedimentation, that is, the sedimentation that has occurred since European settlement, accounts for only the top 0.5 to 1.0 metres of the shoals at the heads of the bay. Below this level is a rich organic silty, and shelly mud, which is devoid of any contemporary European influence. It represents the old shallow subaqueous estuarine shore, established when the sea level stabilised some 6000 years ago. The largely sandy soils associated with the Yowie Bay catchment result in a clear differentiation between estuarine-sourced sediment, and catchment runoff-source sediments.

"The shoals have resulted in poor marine biodiversity"
An ecological assessment of the shoals was carried out during the Processes Study. This assessment concluded that the shoals provide valuable intertidal habitats for a great variety of plants and animals. For example, mangroves have been able to establish along some delta fringes, which provides a feeding and nurturing ground for juvenile fish, while the sand flats are heavily burrowed by crustacea *(eg, crabs and yabbies)* and polychaetes *(worms)*. Because of the abundant burrowing fauna, the sand flats are also foraging areas for aquatic birds.

"Ewey Creek shoal is in poorer condition than the Camellia Gardens shoal"
The same ecological assessment determined that the Camellia Gardens shoal had a significantly lower biomass than the Ewey Creek shoal *(approximately 50% lower)*. This difference was determined by the reduced number of invertebrate burrows in the shoal and the reduced vigour of oysters along the foreshore. The reason for reduced biomass in the Camellia Gardens shoal could be associated with the poorer water quality emanating from the Camellia Gardens Creek, which was shown to be high in nitrate concentrations and bacterial contamination.

"The main arm of Yowie Bay has shoaled up"
Although the shoals at the heads of the bay have encroached into the main arm approximately 20 metres each over the past 50 years, it is unlikely that the main arm has shoaled by any significant level within a contemporary timeframe. As the soils within the catchments are

[1] Patterson Britton and Partners (1996) *Yowie Bay Estuary Processes Study* Prepared for Sutherland Shire Council

mostly sandy, it is likely that most of the deposition occurred on the shallow intertidal deltas. Nonetheless, some finer material associated with catchment runoff would have settled out within the deeper sections of the estuary. Around the fringes of the bay, other localised areas of shoaling would be associated with local stormwater outlets, and would only affect the area in the immediate vicinity of the outlet.

"All shoaling at the heads of the bay is due to Miranda Fair, President Ave, ..."
Soil analyses have shown that the contemporary shoaling of the deltas at the heads of the Bay accounts for approximately 0.5 to 1.0 metres. Of this, the lower 0.1 to 0.3 metres of sedimentation would have been due to initial catchment clearing and rural development *(as indicated by finer material with a lack of foreign matter)*, while the upper 0.5 to 0.8 metres would have been the result of urbanisation of the catchment, as indicated by the presence of foreign matter in the soil profile, such as igneous rock *(blue-metal)*, glass and traces of brass. The presence of such material indicates the shoaling of the deltas was due to catchment-wide development, and not just to a few specific developments, such as Miranda Fair, the cutting of President Avenue and the railway line, and the old quarry adjacent to Ewey Creek.

Shoaling due to catchment-wide activities, rather than specific developments, is further supported by the fact that both heads of Yowie Bay have experience similar shoaling patterns, however, Miranda Fair and the old quarry are within the Ewey Creek catchment only.

1.4 GLOSSARY OF TERMS

Anoxic	*Significantly reduced levels of oxygen in the water, ie is an unhealthy condition which fish and marine life would avoid.*
Anthropogenic	*Pertaining to humans.*
Benthic	*Pertaining to the bed of the waterway.*
Bilge Blanket	*Oil absorbent blanket that is placed in the bilge of a vessel to capture any oils or fuel which leaks from the motor.*
Biodiversity	*The diversity of biological organisms within an environment.*
Biomass	*The amount (mass) of biological organisms within an environment.*
Boat Pump-out	*Facility to pump sewage from vessel holding tanks and discharge into the municipal sewer system.*
Catchment Runoff	*Water which runs off the catchment after rainfall events.*
Contemporary	*Relating to the time since European settlement and subsequent urbanisation of the catchment.*
Crustaceans	*Animals of the marine environment with hard shells and skeletal system, such as crabs, yabbies and shellfish.*
Depauperate	*Unhealthy or significantly limited growth.*
Estuarine	*Pertaining to an estuary, ie a tidal waterway.*

Eutrophic state	*Waterway condition with high nutrients, and a potential to generate algae blooms.*
Fauna	*Pertaining to animals.*
Flora	*Pertaining to plants.*
Flotsam	*Floatable litter and other debris.*
Indigenous	*Native to an area or country.*
Invertebrate	*Animals without a skeletal system.*
Marine	*Pertaining to the water.*
Plunge Pool	*Deeper pool at the base of a stormwater outlet, formed naturally by the stormwater discharge plunging onto the bed of the waterway.*
Polychaetes	*Worm species.*
Pneumatophores	*Peg roots of mangroves.*
Riparian	*Pertaining to the banks of rivers and waterways.*
Single Armour	*A layer of small cobbles placed on a bank to stabilise the material and protect it against wave attack.*
Shoaling	*Build-up of sediment over time.*
Subaqueous	*Underwater.*
Terrestrial	*Pertaining to the (dry) land.*
Urbanisation	*The development of a catchment into an urban environment.*
Wave Scarping	*Erosion of a bank due to wind and boat waves.*

2. MANAGEMENT OBJECTIVES

The objectives outlined below represent a balanced cross-section of community concerns regarding management issues which need to be addressed by an Estuary Management Plan. The objectives have been compiled in close consultation with the Yowie Bay Estuary Management Committee, and a number of local residents, including Yvette Graf *(spokesperson for the Friends of Ewey Creek Environmental Group)*, Bernie Clark *(volunteer worker for Sutherland Shire Environment Centre and knowledgeable of the marine environment within the Shire)*, Kevin Fell *(Chairperson of the South Caringbah Precinct Committee)* and Max Webb *(long-time owner of the Yowie Bay Marina)*.

2.1 OVERALL GOAL

The overall goal of the management plan is to ***"rehabilitate and restore Yowie Bay to its former 'pristine' condition"***. Although past, present and future anthropogenic influences prevent the Bay from being fully restored to its pre-settlement, 'pristine' condition, all future impacts should be minimised and works undertaken to reestablish, as much as possible, the natural conditions which prevailed 150 years ago, where possible. In respect of reestablishing past conditions, the community has identified the following key objectives:

- Deep water access to waterfront properties;
- Reestablish seagrasses;
- Weed eradication;
- Reducing sedimentation and litter; and
- Maintaining high water quality.

These key objectives, plus ancillary objectives, are discussed below. The management objectives have been itemised under a number of headings representing the primary issues of concern, including Water Quality / Pollution, Siltation, Ecology, Boating and Environmental Education.

2.2 DISCUSSION OF OBJECTIVES

WATER QUALITY AND POLLUTION

OBJECTIVE 1. TO REDUCE THE AMOUNT OF FLOATABLE STORMWATER POLLUTION ENTERING YOWIE BAY

During most rainfall events, significant quantities of floatable litter enters Yowie Bay through tributaries and stormwater outlets. Due to predominant southerly winds, the litter tends to accumulated in the heads of the bay, and

becomes entangled in foreshore vegetation, such as mangrove pneumatophores *(peg roots)*. The litter is unsightly, smothers intertidal habitats, and poses a hazard to the ecology of the estuary, such as foraging birds and fish. The floatable litter typically contains styrofoam packaging, fast food containers and drink cans and bottles. Minimising the amount of floatable litter entering Yowie Bay should be addressed by the Management Plan.

OBJECTIVE 2. TO REDUCE THE AMOUNT OF ORGANIC DEBRIS ENTERING YOWIE BAY

During storm events, significant amounts of organic debris finds its way into stormwater drains and tributaries, which eventually ends up in Yowie Bay. The organic debris material consists primarily of leaves, tree branches, lawn clippings etc. Larger material would tend to accumulate on shallow sections of the bay, such as the sandy deltas at the heads of the bay. Smaller material would tend to get caught up with existing foreshore vegetation. Decomposition of the organic debris takes time, and can cause localised effects such as depletion of oxygen in the bed sediments. The interception of organic debris, before it enters Yowie Bay, should be addressed by the Management Plan.

OBJECTIVE 3. TO REDUCE OTHER POLLUTION SOURCES ENTERING YOWIE BAY

Discharges which contain pollutants have entered Yowie Bay in the past via the stormwater drainage system or the tributaries of the bay. These discharges represent different sources, or mechanisms, by which the bay can become polluted. Such mechanisms include the pump-out of building sites after rainfall, petro-chemical spills, nutrients and herbicides from gardening and horticultural practices, and bacteriological contamination from the congregation of water birds (ie the ducks in the Camellia Gardens).

Pollution can also be directly discharged into Yowie Bay, via accidental spills from boats. These pollution sources degrade the water and sediment quality of the estuary, and impact on the marine and riparian ecology, and as such, should be reduced to a degree that has negligible impact on the biodiversity of Yowie Bay.

OBJECTIVE 4. TO REDUCE DISCHARGES FROM SEWER OVERFLOWS ENTERING YOWIE BAY

Raw sewage can enter Yowie Bay through a number of different sewerage overflow structures, most notable at the end of Clifford Road, Winifred Avenue, and the end of Burraneer Bay Road. Effluent associated with these overflows would impact on the water quality and hence aquatic flora and fauna of Yowie Bay, especially at the heads of the bay where the major overflows are located. Sydney Water is looking at options to address sewer overflows as part of an upgrade of the Cronulla Sewage System. Measures should be taken to reduce the impact of sewer overflows on the ecology of Yowie Bay.

SILTATION

OBJECTIVE 5. TO MINIMISE ANY FURTHER SILTATION OF THE HEADS OF YOWIE BAY

The heads of Yowie Bay have shoaled by between 0.2 and 1.0 metres since European settlement and the drop-off faces of the deltas have prograded by approximately 20 metres in the last 50 years. Although the majority of shoaling occurred during the urban development of the catchment, some siltation has continued into present times. The shoals, however, have created an intertidal habitat which now supports a diverse marine environment, including fringing mangroves. Although these mangroves could not establish before shoaling, it is considered that any further siltation of the delta areas would depauperate the existing intertidal communities. Hence, the Plan should address the reduction of sediment runoff to the heads of the Bay.

OBJECTIVE 6. TO REDUCE SILTATION FROM ALL STORMWATER DRAINS

As well as at the heads of the Bay, siltation occurs in the vicinity of stormwater outlets. The sediment associated with urban runoff is deposited on the bed of the estuary fanning out from the stormwater drain. The sediment may cause navigation problems and may smother benthic flora

and fauna, and seagrasses, for example, may not establish if shoaling causes low tide drying of the bed.

The sediment may also contain pollutants which could lead to anoxic conditions and a sharp reduction in the benthic biomass in the area of concentrated sediment build-up. The Management Plan should identify measures to minimise the discharge of sediments into Yowie Bay from urban drains.

OBJECTIVE 7. TO REESTABLISH NAVIGABLE ACCESS TO WATERFRONT PROPERTIES

Over the past 30 years or so, shoaling of the heads of Yowie Bay has occurred by up to a metre, and the delta fronts have encroached further into the estuary. As a result, water depths at foreshore properties have significantly reduced to the extent that water access can no longer be maintained throughout the tidal cycle. Navigable access could be restored to existing boatsheds, pontoons and jetties, and for general small boat access to the head of the Bay. A navigation channel could be established only to the extent of the generally shallow depths which existed at the turn of the century, and only to the extent that present day ecology would not be adversely impacted.

ECOLOGY

OBJECTIVE 8. TO MAINTAIN OR EVEN INCREASE BIODIVERSITY OF SAND FLATS IN DELTA AREAS

As a result of significant shoaling over the past 150 years, the deltas at the heads of Yowie Bay have been transformed from a sub-aqueous environment to inter-tidal sand flats. These sand flats are especially significant as inter-tidal habitats are naturally scarce in Yowie Bay. The marine environment of Yowie Bay has been enhanced, with the expansion of fringing mangroves at the head of the Bay, while significant numbers of burrowing crustaceans and polychaetes provide food for foraging and wading birds. Any measures taken to address other management issues should recognise the ecological value

of the marine life that has become established on the Yowie Bay sand flats and the evolving intertidal vegetation.

OBJECTIVE 9. TO MINIMISE DETRIMENTAL EFFECTS ON EXISTING SEAGRASS BEDS, PARTICULARLY DEEPWATER BEDS

Seagrass beds are extremely valuable in marine ecosystems, as they provide necessary shelter and feeding grounds for both juvenile and adult fish and other marine species. They are among the highest producers of biomass per unit area of any habitat. Seagrasses beds are present in Yowie Bay, but their extent is limited, and they are mostly in deepwater *(Posidonia sp.)*. For these two reasons, the beds are particularly valuable to the marine ecosystem of Yowie Bay, and their preservation should be recognised in the Management Plan.

OBJECTIVE 10. TO REESTABLISH INDIGENOUS FORESHORE VEGETATION

Sections of the Yowie Bay foreshore, particularly at the heads of the Bay, contain many weed species such as Privet, Lantana and Asparagus Fern. To restore the natural setting of the waterway, these weeds should be removed, and replaced with indigenous plants, such as Casuarinas, Melaleucas and Banksias. In addition, there may be opportunities to establish more mangroves around the waterway peripheries. Mangroves provide a valuable feeding and nurturing habitat for juvenile fish.

OBJECTIVE 11. TO REESTABLISH SEAGRASS BEDS IN THE BAY

Like mangroves, seagrasses provide habitat for a variety of marine fauna. Unfortunately some seagrasses *(eg. Posidonia sp.)*, which prefer deeper water, are difficult to establish, however, other species *(eg. Zostera sp.)*, which prefer shallower waters, are easier to establish. Opportunities for creating new seagrass beds within Yowie Bay should be pursued by the Management Plan.

BOATING

OBJECTIVE 12. TO MINIMISE ENVIRONMENTAL IMPACTS OF RECREATIONAL VESSELS USING YOWIE BAY

Yowie Bay is regarded as one of the more popular destinations for boaters on Port Hacking due to its deep and wide entrance, and the existing boating facilities *(ie, boat ramp and marina)*. Unfortunately, all boating has the potential to impact on the natural environment, including effects such as wave scarping at the waters edge along sandy foreshores, damage to seagrass beds caused by anchors etc, and effluent and petro-chemical discharges. The Yowie Bay Estuary Management Plan should recognise that these impacts need to be minimised.

OBJECTIVE 13. MINIMISE CONFLICTS BETWEEN RECREATIONAL USERS OF YOWIE BAY

Yowie Bay attracts a wide variety of recreational use, which includes sailing, rowing, kayaking, power boating / cruising, jet skiing, swimming and fishing. The combination of passive and active waterway uses may sometimes result in conflicts between users. A re-evaluation of the allowable uses of particular waterway areas within the Bay with a view to minimising future waterway conflicts should be examined by the Yowie Bay Estuary Management Plan.

OBJECTIVE 14. TO ENHANCE FORESHORE ACCESS AND FACILITIES AROUND YOWIE BAY ASSOCIATED WITH BOATING

Foreshore access and facilities associated with recreational boating and other recreational use of the bay are somewhat limited. In response to increasing recreational demands, additional foreshore access and waterfront facilities should be addressed by the Yowie Bay Estuary Management Plan.

OBJECTIVE 15. TO RESTRICT THE AMOUNT OF VESSELS PERMANENTLY MOORED ON THE WATERWAY

At present, Yowie Bay contains over 250 swing moorings, which covers a significant waterway area *(approximately 70% of Yowie Bay)*. The Management Plan should recognise the need for restrictions on new moorings in the bay to maintain sufficient waterway area for recreational activities.

ENVIRONMENTAL EDUCATION

OBJECTIVE 16. TO GAIN A BETTER APPRECIATION FOR THE BIODIVERSITY AND ECOLOGY OF YOWIE BAY

The marine and terrestrial ecology of Yowie Bay, and its foreshores, is varied, with some areas of remnant woodland and open forest still present at the heads of the Bay. It represents a good example of the biodiversity offered by estuaries which fringe coastal regions. Visitors to the area, as well as local residents, should be educated about the natural ecology of Yowie Bay, and why it is important in the context of the whole Sutherland Shire.

Appreciation of the ecological value of the Bay will promote greater interest in and caring for the Bay.

Possible matters which could be addressed include:

- appropriate disposal of grass clippings (not in bushland or creeks);
- minimal use of fertilisers;
- appropriate litter disposal;
- reserve encroachments;
- eco-educational facilities;
- student study kits; and
- encouragement of 'native' gardens.

2.3 SUMMARY OF OBJECTIVES

1. *To reduce the amount of floatable stormwater pollution entering Yowie Bay*
2. *To reduce the amount of organic debris entering Yowie Bay*
3. *To reduce other pollution sources entering Yowie Bay*
4. *To reduce discharges from sewer overflows entering Yowie Bay*
5. *To minimise any further siltation of the heads of Yowie Bay*
6. *To reduce siltation from all stormwater drains*
7. *To re-establish navigable access to waterfront properties*
8. *To maintain or even increase biodiversity of sand flats in delta areas*
9. *To minimise detrimental effects on existing seagrass beds, particularly deepwater beds*
10. *To re-establish indigenous foreshore vegetation*
11. *To re-establish seagrass beds in the bay*
12. *To minimise environmental impacts of recreational vessels using Yowie Bay*
13. *Minimise conflicts between recreational users of Yowie Bay*
14. *To enhance foreshore access and facilities around Yowie Bay associated with boating*
15. *To restrict the amount of vessels permanently moored on the waterway*
16. *To gain a better appreciation for the biodiversity and ecology of Yowie Bay*

3. BACKGROUND INFORMATION

3.1 SIGNIFICANCE OF YOWIE BAY IN RELATION TO THE PORT HACKING ESTUARY

Yowie Bay is one of the more important bays with regard to waterway recreational use. It has a substantial number of moorings *(265)* plus private jetties and pontoons and is home to the Port Hacking Open Sailing Club. Recreational boating facilities include the two lane boat ramp and public jetty at Wonga Road and adjacent slipway and refuelling facilities at the Yowie Bay Boatshed.

In terms of recreational use and facilities Yowie Bay would rank third after *(in order)* Gunnamatta Bay and Burraneer Bay / Dolans Bay which accommodate more craft, marina facilities and, in the case of Gunnamatta Bay, public baths and a public wharf. In contrast to Yowie Bay, Gunnamatta Bay is used by several recreational clubs and has high visitation levels by both Sutherland Shire residents and visitors.

Foreshore use of Yowie Bay is concentrated at the head of the Bay. Camellia Gardens is a popular and important passive recreational resource, as well as being important from a cultural and botanical perspective *(it is listed as being of regional heritage significance in SSC's Local Environmental Plan)*. Kareena Park contains remnant bushland and small pockets of remnant vegetation occur along Ewey Creek, although these have been degraded, primarily by weed invasion. Larger areas of foreshore bushland are located around Burraneer Bay, Gymea Bay and North West Arm. It is likely that the latter is the most significant in terms of remnant vegetation because it is less accessible and hence subject to less disturbance. **Figure 1** outlines the foreshore and waterway uses of Yowie Bay.

The estuarine and intertidal vegetation communities in Yowie Bay are relatively intact. There is little information to assess the significance of Yowie Bay in relation to Port Hacking as a whole, in terms of aquatic ecology. The most significant area in Port Hacking is Shiprock Aquatic Reserve, which is located near the entrance to Burraneer Bay. **Figures 2** and **3** outline the ecological, and water quality, significance and essential features of Yowie Bay, respectively.

3.2 PLANNING FRAMEWORK

Legislation, policies, plans, guidelines and strategies which may be relevant to the management of Yowie Bay are listed below. Further information on the policies, plans, guidelines and strategies is included in **Appendix A.**

Legislation:

- Catchment Management Act 1989
- Crown Lands Act 1989

FIGURE 1

PRIVATE JETTIES AND BOATSHEDS ARE LOCATED AROUND THE FORESHORE EXCEPT IN AREA (57)

AREAS (51) (53) (54) (56) (59) (61) (62) AND (64) HAVE BEEN IDENTIFIED BY CROWN LANDS AS SUITABLE FOR ADDITIONAL FORESHORE STRUCTURES

EG WATERHOUSE NATIONAL CAMELLIA GARDEN AND TEA HOUSE

THE PARK IS POPULAR FOR PICNICS, ORGANISED BUS OUTINGS AND WEDDINGS. IT IS ESTIMATED THAT THE GARDENS ATTRACT ABOUT 2000-2500 VISITORS PER WEEK DURING THE WARMER MONTHS.

TIDAL FORESHORE ACCESS VIA CAMELLIA GARDENS CARPARK

LIMITED WATER ACCESS VIA OLD PARTIALLY DILAPIDATED TIMBER JETTY

KAREENA PARK

POPULAR PICNIC AREA WITH PLAY EQUIPMENT, SEATING AND BARBEQUES. ALSO POPULAR FOR WALKING, JOGGING AND BIKE RIDING.

TIDAL FORESHORE ACCESS VIA KAREENA PARK

222 PRIVATE SWING MOORINGS AND 43 COMMERCIAL MOORINGS

YOWIE BAY MARINA AND BOATSHED

WONGA ROAD BOATRAMP AND PUBLIC JETTY

SANDSTONE SEAWALL LISTED AS A HERITAGE ITEM ON SCC'S LEP

FORESHORE ACCESS VIA BURRANEER BAY ROAD

TIDAL FORESHORE ACCESS VIA UNSEALED END OF TAREN ROAD

PUBLIC RESERVE *RESTRICTED ACCESS*

SWING MOORINGS
BOATRAMP
MARINA
PUBLIC JETTY
NATIONAL CAMELLIA GARDENS
PARKS / OPEN RESERVES
PORT HACKING SAILING CLUB
(51) CROWN LAND AREAS
FORESHORE ACCESS

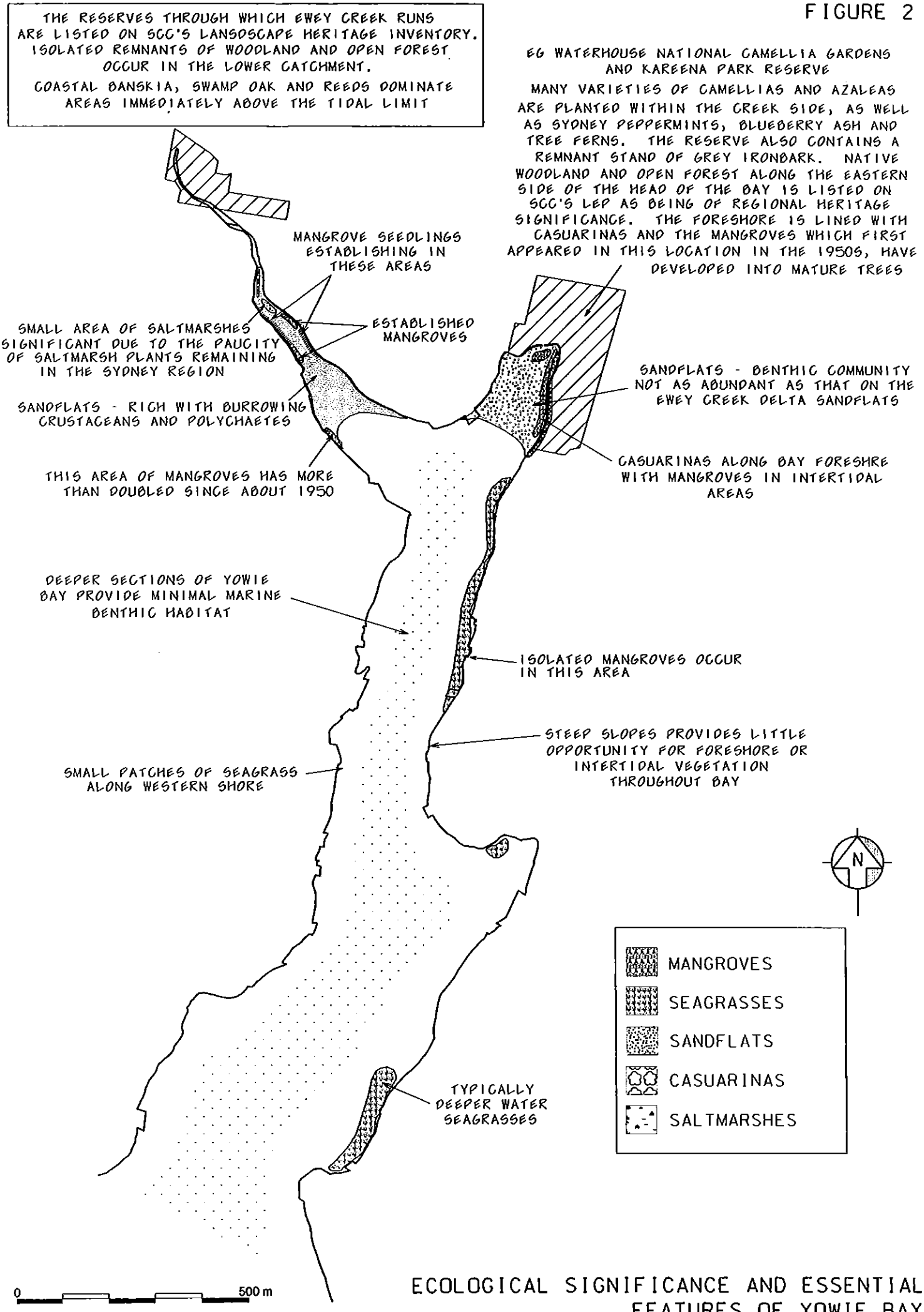
0 500 m

Ref: yowle2.dgn; levels 21 22 23 24 25 26 27 28 31 57 58 63

YOWIE BAY ESTUARY MANAGEMENT STUDY

FORESHORE AND WATERWAY USES AND ACCESS

FIGURE 2



ECOLOGICAL SIGNIFICANCE AND ESSENTIAL FEATURES OF YOWIE BAY

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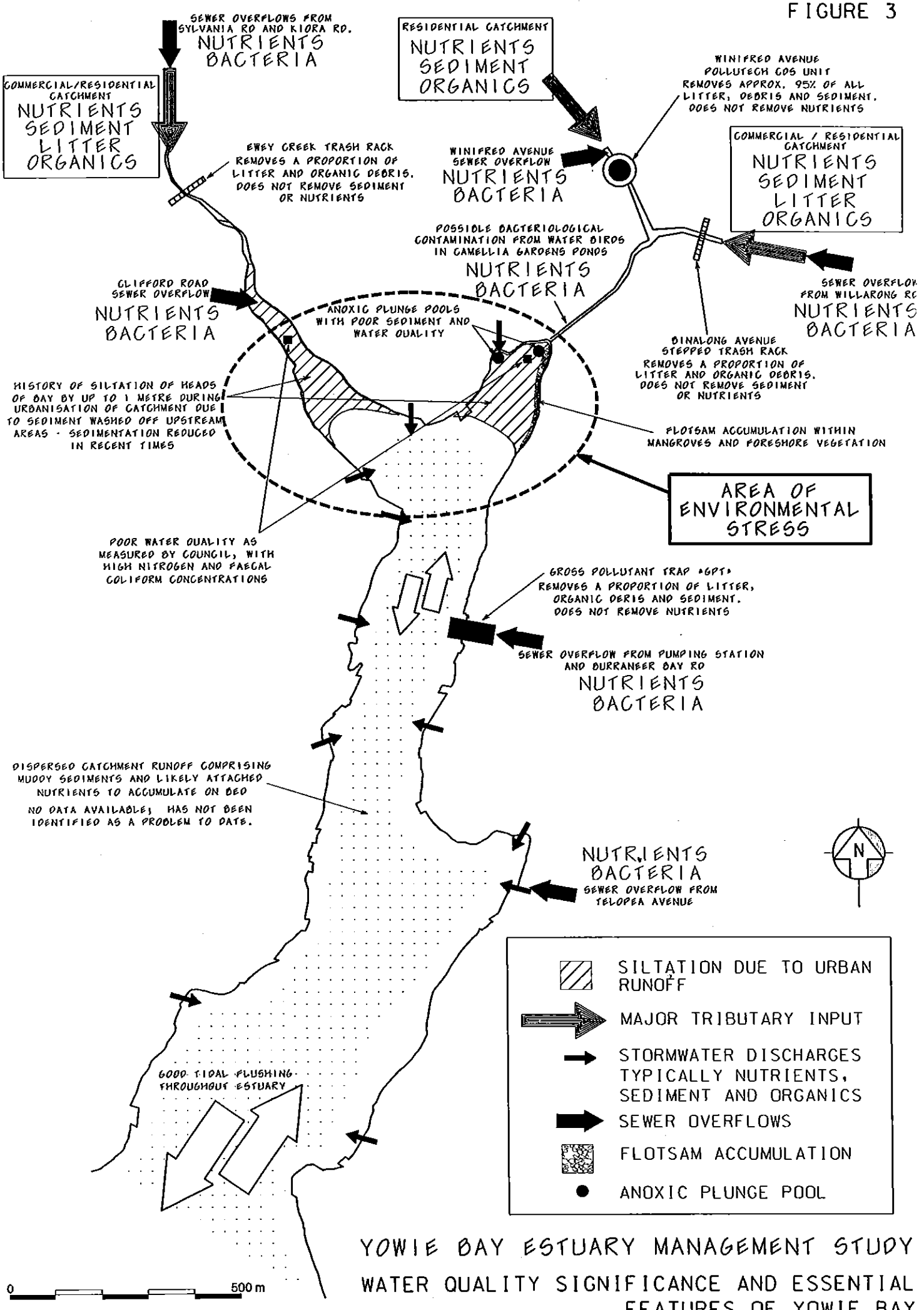
FIGURE 3



YOWIE BAY ESTUARY MANAGEMENT STUDY

WATER QUALITY SIGNIFICANCE AND ESSENTIAL FEATURES OF YOWIE BAY

Ref: yowie2.dgn; levels 29 31 32 33 34 35 37 38 39 49 57 58 63

- Local Government Act 1993
- Rivers and Foreshore Improvements Act 1948
- Environmental Offences and Penalties Act 1989
- Clean Waters Act 1970
- Pollution Control Act 1970
- Environmental Planning and Assessment Act 1979 *(part of this Act relates to control of land use, see following section for a discussion on Sutherland Shire land use controls)*
- Heritage Act 1977
- Fisheries Management Act 1994
- Marine *(boating safety - alcohol and Drugs)* Act 1991
- Maritime Services Act 1935
- Navigation Act 1901
- Threatened Species Conservation Act 1995
- National Parks and Wildlife Act 1974

The Acts listed above either:

1. provide for/require the preparation of plans of management for open space, fisheries or catchments;
2. protect significant natural, cultural or built features; or
3. control activities or developments in and around estuaries.

The Yowie Bay Estuary Management Plan should be consistent with the provisions of these Acts and depending upon final outcomes of the Plan, there may be a need for various consents, licences and permits to be acquired under some of these acts. Items/areas of heritage *(eg the Camellia Gardens and the sandstone seawall near the boatramp)* and natural values *(eg mangroves and seagrasses)* are shown in **Figures 1** to **3**.

Statutory Planning Policies:

- State Environmental Planning Policy *(SEPP)* No. 19 - Bushland in Urban Areas
- State Environmental Planning Policy *(SEPP)* No. 35 - Maintenance Dredging of Tidal Waterways
- State Environmental Planning Policy *(SEPP)* No. 46 – Protection and Management of Native Vegetation
- NSW Habitat Plan No.1
- Fish Habitat Protection Plan No. 2

SEPP No. 35 sets out the planning procedure for maintenance dredging *(this would apply to dredging the delta areas of Yowie Bay)*, while SEPP No. 19 aims to protect remnant plant communities and other values associated with urban bushland. This SEPP would relate to Kareena Park and some areas around Ewey Creek. The habitat plan aims to protect marine

vegetation and endangered fish species and any proposed works which could impact on protected flora and fauna would require consent from the Minister for Fisheries.

General Policies and Guidelines:

- NSW Government Estuary Management Manual, October 1992
- NSW Fisheries Estuarine Habitat Management Guidelines, 1993 *(edited by JJ Buchmore, DA Pollard, MJ Middleton and RJ Williams)*
- NSW Public Works Marina Guidelines, November 1987; and
- NSW Public Works Draft Fishing Port Planning and Design Guidelines, June 1994 *(which supersedes the Design Guidelines for Wharves and Jetties, 1990)*

The aims of the Estuary Management Policy and Manual are discussed in the Introduction. The other guidelines contain issues and principles to be taken into account in the design of structures or works in waterways. The habitat management guidelines also contain general conservation principles.

Port Hacking Plans and Strategies:

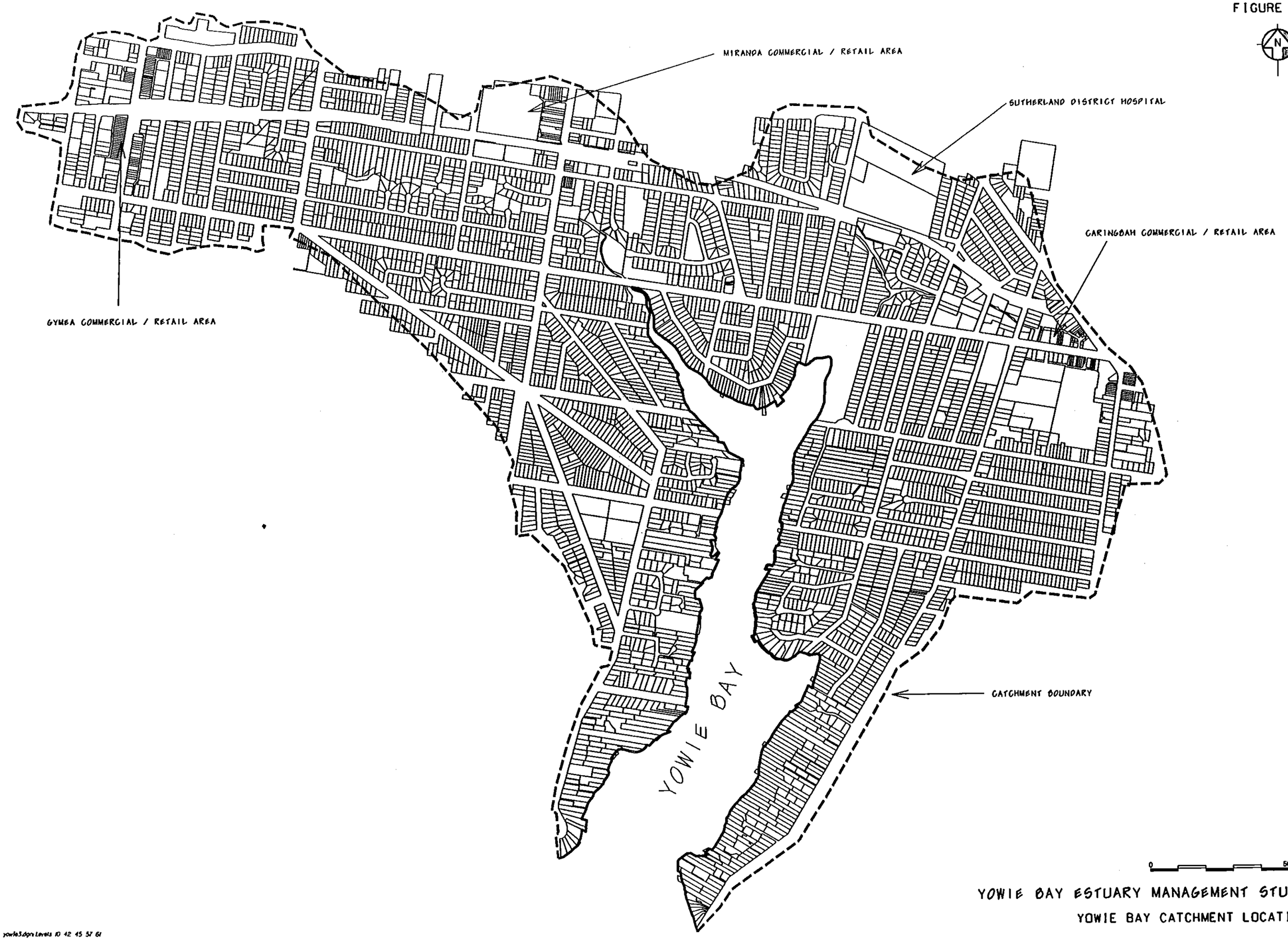
- Hacking River Catchment Management Strategy
- Port Hacking Plan of Management
- Assessment of Crown Land at Port Hacking

The first two documents set out overall goals and objectives for the management of Port Hacking and its catchment. The latter contains recommendations on the development of foreshore structures. The Yowie Bay Estuary Management Plan should be consistent with these plans and strategies.

3.3 LAND USE CONTROLS

Land use within the Yowie Bay catchment is controlled by the Sutherland Shire Local Environmental Plan *(LEP)* 1993 and a number of development control plans *(DCPs)*. The Yowie Bay catchment area is shown in **Figure 4**, while **Figure 5** shows land use zones within the catchment. A breakdown of the area covered by various land use zones within the catchment is shown in **Table 1**.

FIGURE 4



YOWIE BAY ESTUARY MANAGEMENT STUDY

YOWIE BAY CATCHMENT LOCATION

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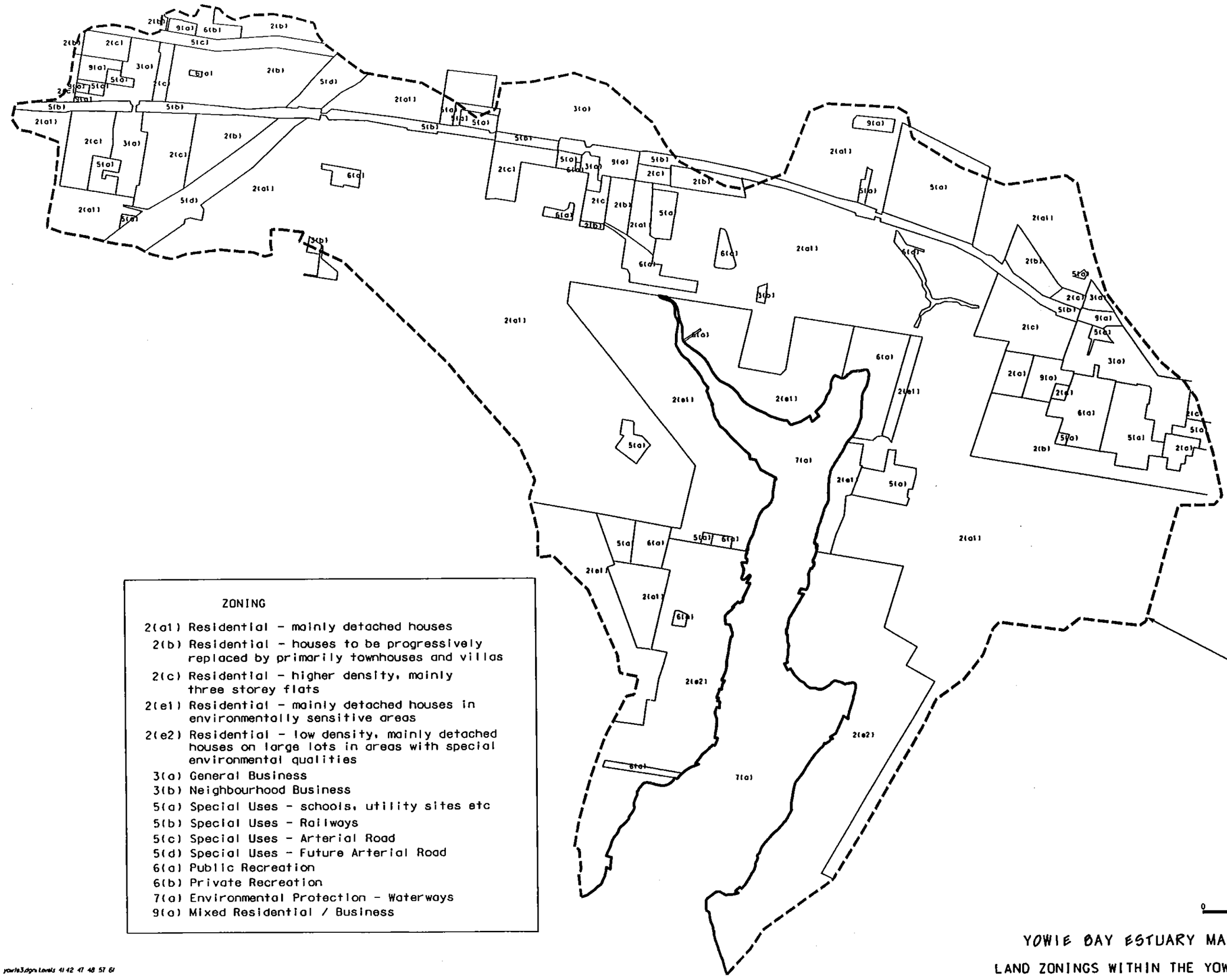
FIGURE 5



ZONING

- 2(a1) Residential - mainly detached houses
- 2(b) Residential - houses to be progressively replaced by primarily townhouses and villas
- 2(c) Residential - higher density, mainly three storey flats
- 2(e1) Residential - mainly detached houses in environmentally sensitive areas
- 2(e2) Residential - low density, mainly detached houses on large lots in areas with special environmental qualities
- 3(a) General Business
- 3(b) Neighbourhood Business
- 5(a) Special Uses - schools, utility sites etc
- 5(b) Special Uses - Railways
- 5(c) Special Uses - Arterial Road
- 5(d) Special Uses - Future Arterial Road
- 6(a) Public Recreation
- 6(b) Private Recreation
- 7(a) Environmental Protection - Waterways
- 9(a) Mixed Residential / Business

YOWIE BAY ESTUARY MANAGEMENT STUDY

LAND ZONINGS WITHIN THE YOWIE BAY CATCHMENT

yowie3.dgn Levels 41 42 47 48 57 61

Table 1 Yowie Bay Catchment Land Use Zones

	Land Use Zone	Area (ha)	%
2(a1)	Residential - mainly detached houses	254.8	49.6
2(b)	Residential - houses to be progressively replaced by primarily townhouses and villas	30.7	6.0
2(c)	Residential - higher density - mainly three storey flats	23.9	4.7
2(e1)	Residential - mainly detached houses in environmentally sensitive areas	49.0	9.4
2(e2)	Residential - low density - mainly detached houses on large lots in areas with special environmental qualities	63.9	12.4
3(a)	General Business	22.1	4.3
3(b)	Neighbourhood Business	0.3	0.1
5(a)	Special Uses - schools, utility sites etc	23.3	4.5
5(b)	Special Uses (Railways)	10.2	2.0
5(c)	Special Uses (Arterial Road)	2.9	0.6
5(d)	Special Uses (Future Arterial Road)	7.8	1.5
6(a)	Public Recreation	16.7	3.3
6(b)	Private Recreation	1.3	0.3
9(a)	Mixed Residential/Business	6.5	1.3
	Total	**513.1**	**100%**

Medium density *(townhouses and villas)* and dual occupancies are permitted in all residential zones in accordance with the LEP and development control plans. Different minimum lot sizes, maximum floor space ratios and minimum landscaped areas apply in different zones.

Yowie Bay is zoned 7(a) Environmental Protection *(Waterways)*. The LEP states that *development of waterways should not adversely affect the ecology, scenic value or navigability of the waterways.* Structures and works which require consent are listed below:

- beach and foreshore protection works
- commercial water-related recreational activities
- jetties
- marinas
- mooring piles
- swimming enclosures
- watercraft launching and landing facilities
- wharfs

The foreshore area around Yowie Bay, as defined by the Foreshore Building Lines (see **Figure 6**), varies in width between 10 m and 30 m from mean high water mark. The objectives of the foreshore building lines are:

- *preservation and enhancement of the natural features and vegetation of the area where the land meets the water;*
- *restoration of the land below the foreshore building line, so far as practicable, to a natural state, with a minimum intrusion of man-made structures;*
- *no development below the foreshore building line other than development excepted* (see below);
- *a significant reduction in the number of structures below the foreshore building line, particularly on redevelopment;*
- *conservation and enhancement of waterfront development of heritage value; and*
- *avoidance of pollution of, or adverse ecological effects on, the waterways.*

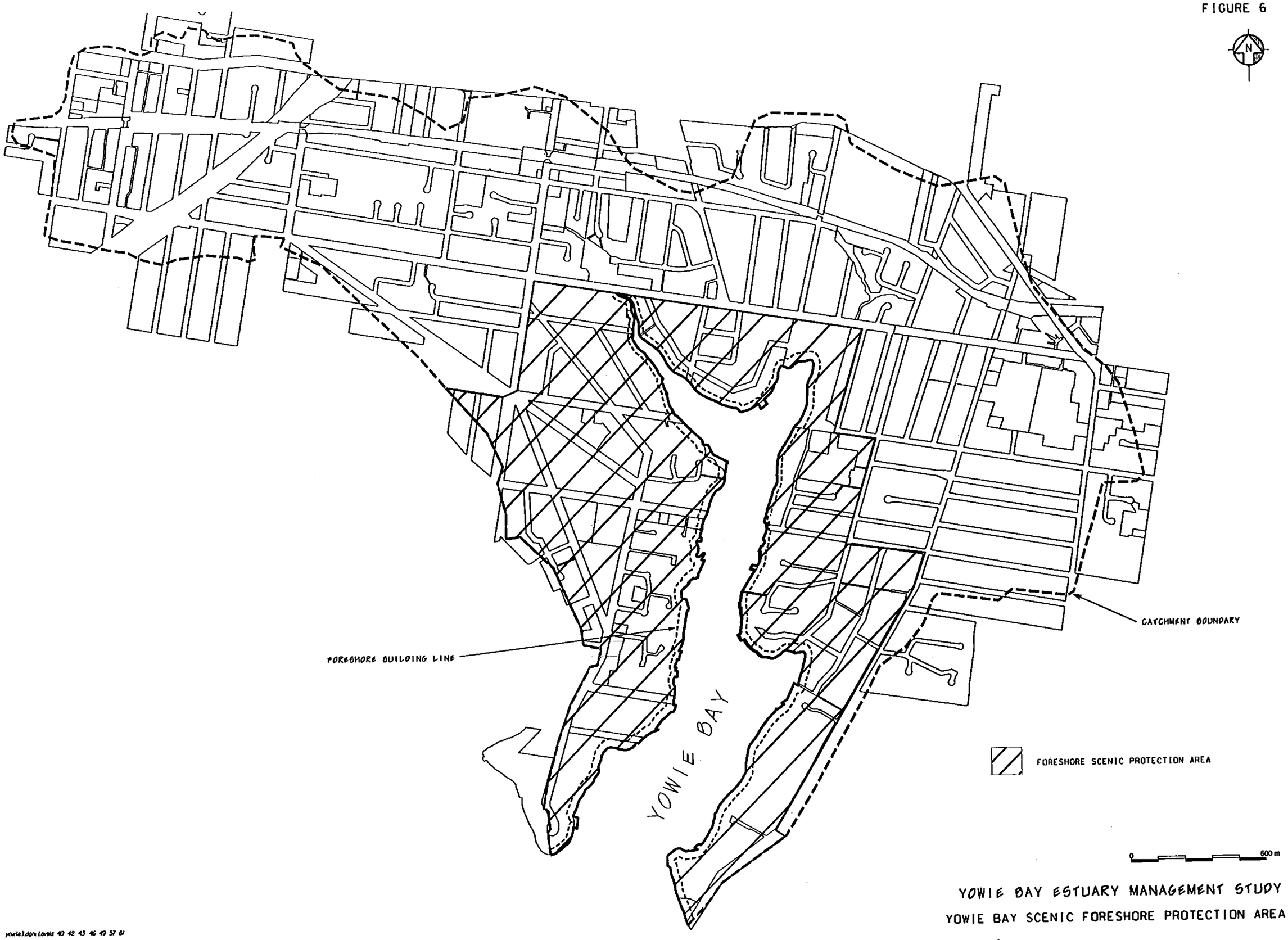
Structures permitted within the foreshore area are single storey boat sheds, boat launching and slipping facilities, below ground swimming pools, works such as inclinators to enable pedestrian access, landscaping and barbecues, jetties and swimming enclosures. Development within the waterway will not generally be permitted by NSW Fisheries if the development will impact on seagrass, mangroves or commercial fishing grounds.

Land zoned 2(e1), 2(e2), and some 2(a1) land within the catchment of Yowie Bay is included in the Foreshore Scenic Protection Area. The aim of the Foreshore Scenic Protection Area is to limit the scale of development in foreshore areas. The Foreshore Scenic Protection Area surrounding Yowie Bay is shown in **Figure 6**. In addition, land zoned 2(e1) and 2(e2) is subject to the *Code for Foreshore Development*. The aims of the code include, to:

- *ensure that development creates a minimum of disturbance to the natural landscape;*
- *integrate development into the site and natural surroundings;*
- *encourage the siting of buildings with regard to retaining as much existing flora as possible;*
- *encourage landscaping to soften the appearance of the development when viewed from adjoining properties and the waterways; and*
- *minimise the obstruction of water views and have regard to the amenity of adjoining properties.*

Developments/activities not favoured under the code are swimming enclosures, seawalls, dredging, reclamation and breakwaters.

FIGURE 6



YOWIE BAY ESTUARY MANAGEMENT STUDY

YOWIE BAY SCENIC FORESHORE PROTECTION AREA

yowie3.dgn Levels 40 42 43 46 49 57 61

3.4 FUTURE USES AND DEMANDS

The Sutherland Shire Housing Strategy[2] notes that population growth in the Sutherland Shire has been steady over the past 25 years. However, occupancy ratios have declined in the established suburbs, such as Miranda and Caringbah. This decline is expected to continue, so more dwellings will be needed to house the same population.

During the period 1996 - 2011, Sutherland Shire's housing strategy will provide for a maximum of 5000 dwellings throughout the Shire, in addition to the 7000 dwellings which can be accommodated under the existing LEP. This will provide for a predicted population, as indicated in the housing strategy, of up to 205,000 by the year 2011.

Opportunities for additional dwellings have been identified:

- in the medium and higher density 2(b), 2(c), 3(a) and 9(a) zones, which are located around the major centres *(eg Miranda Fair, and Miranda and Caringbah railway stations)*;
- as concentrating attached housing developments around neighbourhood centres *(few within the Yowie Bay catchment)*; and
- as the redevelopment of surplus government land *(eg Energy Australia's site on Karimbla Road, Miranda, which could accommodate about 100 dwellings if it was zoned 2(c))*.

Although residential densities within the catchment are likely to increase over time through redevelopment, this is unlikely to be significant given the more stringent development controls in the Residential 2(e1) and 2(e2) zones and Foreshore Scenic Protection Areas generally, which surround Yowie Bay and cover approximately 40% of the catchment. In foreshore scenic areas specific limitations on the scale of development apply, together with a requirement for more landscaped area per lot. The LEP describes these areas as containing only scattered dual occupancy and cluster housing developments. In addition, foreshore building lines apply to properties surrounding Yowie Bay which limit foreshore development.

The Yowie Bay catchment is essentially developed and as noted in the housing strategy, the major opportunities for an increase in housing are through the redevelopment of surplus government land and land around major centres. Major centres are located on the periphery of the catchment and the redevelopment of land around these centres, and in other areas, would not be expected to adversely impact on Yowie Bay *(ie impervious surfaces already exist in these areas, so there would be little, if any, change to runoff)*, provided effective site water and sediment control plans were implemented during the construction phase.

AGB:McNair *(1987)*[3] found the most popular recreational activities *(in order)* at Port Hacking to be swimming, picnics / barbecues, boating *(non-sailing)*, walking / bushwalking, fishing (from a boat), water-skiing, sailing and fishing *(non-boating)*. Recreational use of Port Hacking is primarily by Sutherland Shire residents *(at least 70%)*, then other residents of

[2] Sutherland Shire Council (1997) *Sutherland Shire Housing Strategy 1996 - 2011*
[3] AGB:McNair (1987) *Report on resident survey of Sutherland Shire* Prepared for the Dept. of Public Works

southern Sydney, with overseas and interstate visitation concentrated around Cronulla[4]. At Yowie Bay, the Camellia Gardens are a major attraction and are visited by bus tour groups and used for wedding ceremonies.

A recreational needs survey[5] provided an indication of the demand for different types of settings and facilities by asking respondents to allocate hypothetical funds. The highest priorities for works or settings *(in order)* were provision of tracks / boardwalks, bush regeneration, family recreational settings, bike paths, foreshore reserves and coastal foreshore protection. With regard to waterways, SKP[6] estimated the demand for berths in 30 years time *(from the report date)* to be 370 from the local population and 450 from residents of areas more remote from Port Hacking.

Although there is a demand for more foreshore open space, there is no scope for the development of additional foreshore reserves in Yowie Bay without property resumption. The demand for swing moorings also limits future increases in the amount of open waterway for recreational uses, unless the existing marina is expanded to accommodate some of the existing moorings.

As few opportunities exist to expand recreational facilities in and around Yowie Bay, the scope for increases in recreational use, or new recreational activities, is limited and confined to the boatramp area and existing parks.

The predicted increase in population within the Sutherland Shire is likely to increase pressures on the existing recreational facilities in and around Yowie Bay. The Bay has a regional significance with regard to recreation, and the increasing demands of future development should be addressed by the Management Plan. The Plan should recognise the need to increase, and provide a greater variety, of recreational opportunities around Yowie Bay to accommodate for the increasing recreational demands in a manner that does not affect the environment, and preserves the overall objectives of the Plan.

[4] Environmental Partnership and Tourism Marketing and Investment (TMI) (1990) *Sutherland Tourism Development Plan* Prepared for SCC and the NSW Tourism Commission

[5] Gutteridge Haskins and Davey (1995) *Sutherland Shire Open Space and Recreation Needs Survey*

[6] Sinclair Knight and Partners (1987) *Port Hacking Marina Berth Demand Study* Prepared for the Public Works Department

4. MANAGEMENT OPTIONS

A variety of options have been developed which address the management objectives set out in this report. These options encompass a range of structural and non-structural measures.

For each management objective, applicable constraints and considerations have been identified. Some management options are applicable to more than one objective, in which case, they are discussed under each separate objective. A brief assessment of the impacts of the management options on the estuarine hydraulics and biology, where applicable, is also discussed.

4.1 DISCUSSION OF OPTIONS

The management options are outlined below, and summarised in schematic plans on **Figures 7, 8** and **9.**

Objective 1: To reduce the amount of floatable stormwater pollution entering Yowie Bay

The amount of floatable stormwater pollution entering Yowie Bay can be reduced by:

a) interception, collection and disposal of floatables before they get into Yowie Bay,

b) reduction of floatables at the source of the pollution, or

c) a combination of a) and b) above.

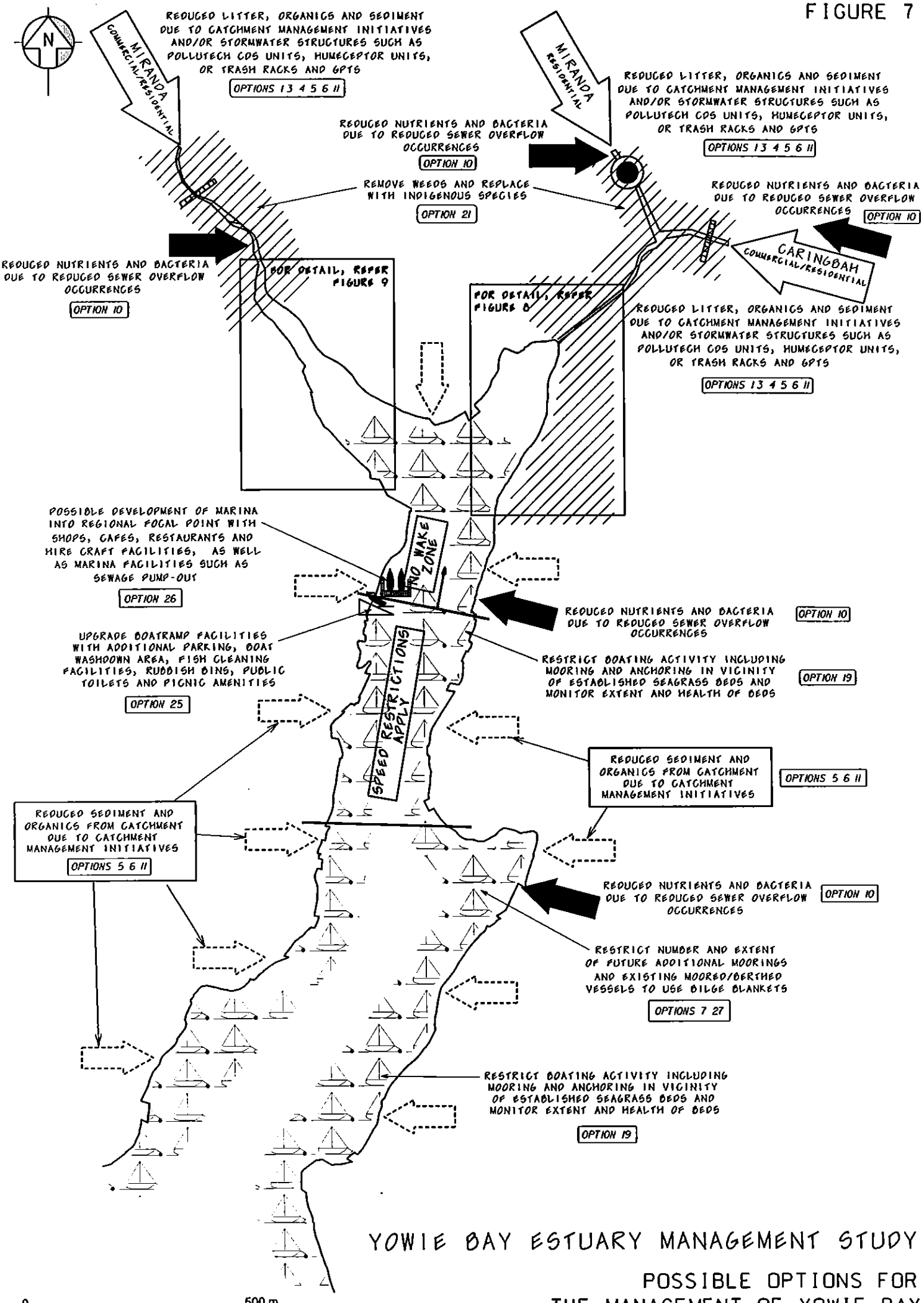
These different approaches to the reduction of floatable litter have different constraints and opportunities, and as such, different management options have been determined.

OPTION 1: INCREASE THE NUMBER OF LITTER COLLECTION DEVICES WITHIN THE DRAINAGE SYSTEM

Physical structures within the watercourses can be effective at capturing floatable litter associated with stormwater flow. Structures such as trash racks and Gross Pollutant Traps *(GPT)* have already been installed within the Yowie Bay catchment, with varying degrees of efficiency. Additional structures could be installed on other stormwater drains which do not contain litter collection devices.

Such devices could include conventional trash racks, such as the structure upstream of President Avenue on Ewey Creek, Pollutech *(CDS)* units, such as the device at the end of

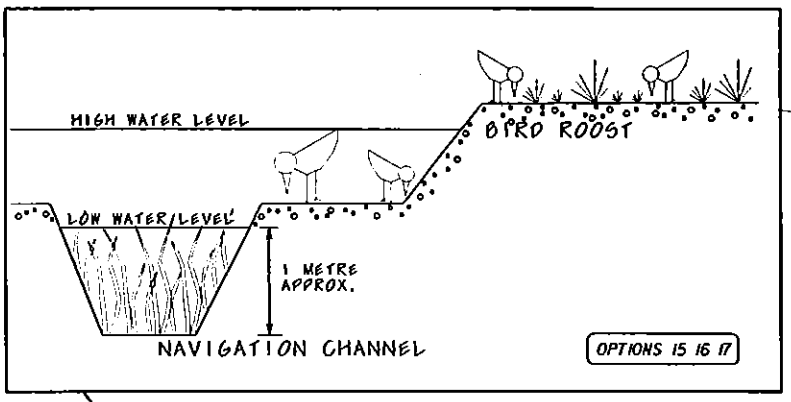
FIGURE 7



YOWIE BAY ESTUARY MANAGEMENT STUDY

POSSIBLE OPTIONS FOR THE MANAGEMENT OF YOWIE BAY

FIGURE 8



EG WATERHOUSE CAMELLIA GARDENS

ENHANCE HABITAT AND IMPROVE APPEARANCE BY REMOVAL OF FLOTSAM
OPTION 2

PUBLIC JETTY AND LANDING FOR POSSIBLE FUTURE FERRY SERVICE
OPTION 28

CONNECTIONS TO CAMELLIA GARDENS PATHWAYS

TIMBER VIEWING PLATFORM WITH INTERPRETIVE SIGNAGE
OPTIONS 28 30

TIDAL FLUSHING OF PLUNGE POOL

MANGROVE BOARDWALK

TYPICAL PRIVATE FORESHORE STRUCTURES, EG JETTIES

BIRD ROOST ISLAND WITH PLANTED SALTMARSHES
OPTION 16

EXISTING MANGROVES

SHINGLE ARMOUR TO PROTECT AGAINST WIND WAVES

RETAIN MAJORITY OF SANDFLATS FOR BIRD WADING AND CONSERVATION OF INTERTIDAL BENTHIC BIOMASS

PERIMETER NAVIGATION CHANNEL ESTABLISHED WITH SEAGRASSES TO PROVIDE ACCESS TO FORESHORE STRUCTURES AND ISOLATION OF BIRD ROOST
OPTIONS 15 17

KAREENA PARK

SEAGRASSES ESTABLISHED ON SHALLOW BENCH AT DELTA DROP-OFF
OPTION 22

BROADSCALE DREDGING OF ALL CONTEMPORARY SEDIMENT FROM DELTA AREA
OPTION 15A

RESTORE MATSON CRES. JETTY AND FORESHORE ACCESS
OPTION 33

DEVELOP ECO-EDUCATIONAL SIGNAGE ALONG EXISTING WALKING TRAILS IN CAMELLIA GARDENS
OPTIONS 28 29

POSSIBLE SALTMARSH PLANTING

EXISTING SCOUR CHANNEL

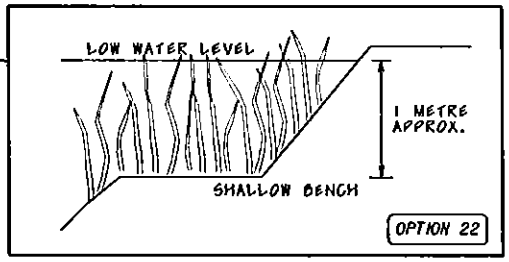
POSSIBLE FERRY SERVICE

POSSIBLE FERRY SERVICE

TIDAL FORESHORE ACCESS

EXISTING CASUARINAS

CONNECTION TO CARRINGDAH ROAD



PERIPHERAL DREDGING AROUND EXISTING FORESHORE STRUCTURES
OPTION 15B

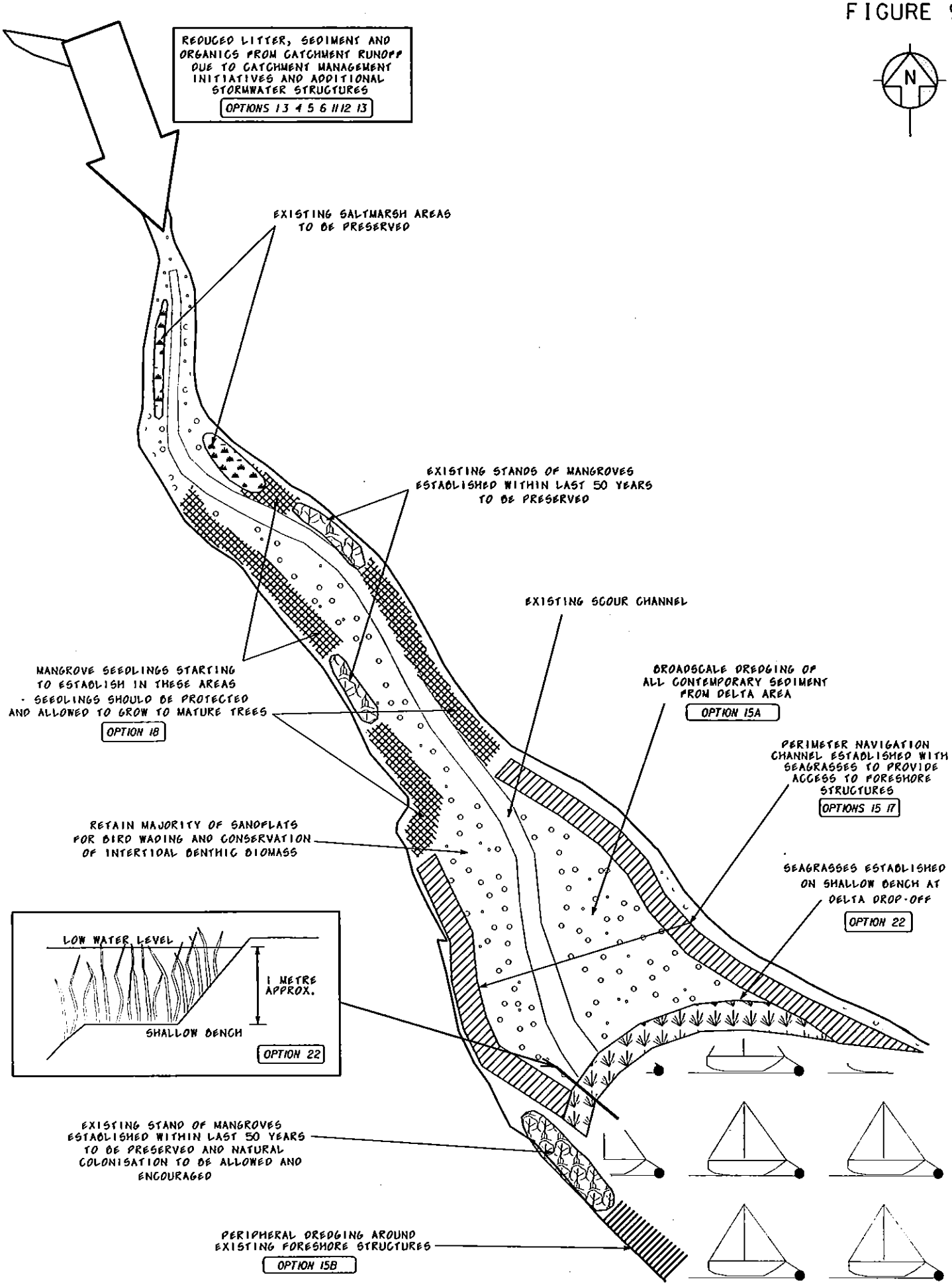
EXISTING SEAGRASSES

0 100 m

YOWIE BAY ESTUARY MANAGEMENT STUDY

POSSIBLE MANAGEMENT OPTIONS CAMELLIA GARDENS BAY AND FORESHORES

FIGURE 9



YOWIE BAY ESTUARY MANAGEMENT STUDY

POSSIBLE MANAGEMENT OPTIONS EWEY CREEK BAY AND FORESHORES

Winnifred Avenue, Caringbah, or more custom designed structures, such as wire baskets at the outlet of piped urban stormwater systems. The efficiency of all floatable systems depends on the regularity of cleaning, however, structures such as track racks and wire baskets would need cleaning after every significant rainfall event. These structures are also susceptible to overtopping, at which time, a large amount of the trapped litter could be lost downstream.

The Pollutech *(CDS)* units, however, are designed to intercept up to approximately 95% of all flows, and once captured, the litter cannot be lost downstream *(providing the unit is cleaned regularly and has the capacity to accept the litter)*. As the majority of litter occurs within the 'first flush' associated with a storm event, the CDS units will capture at least 95% of all floatable stormwater litter.

Associated with the increased installation of litter collection devices, Council would need to devote considerable resources to cleaning and maintenance of the trash interception systems.

Constraints and Considerations

- costs associated with construction of pollution control devices
- lack of open space to install pollution control devices
- lack of access for maintenance
- annual budget provisions for regular cleaning of pollution control devices
- difficulties in retrofitting devices

OPTION 2: ENCOURAGE COMMUNITY GROUPS TO CLEAN-UP FLOATABLE LITTER AND DEBRIS FROM THE SAND FLATS AND FORESHORES OF YOWIE BAY

In the past, Yowie Bay has been cleaned-up once a year, on "Clean-up Australia Day". Community groups from the local area could be encouraged *(and supported with services)* to be actively involved in regular 'clean-ups' of Yowie Bay with respect to visual litter and debris on the sand flats and along the foreshores.

Avenues could also be explored to seek government assistance in the clean-up process. In this regard, people required to carry out community service duties could participate in clean-up programs specifically targetted for this type of assistance.

Constraints and Considerations

- 'Clean-up Australia Day' is only once a year
- existing bushcare groups working within the Yowie Bay area
- implementation of Catchment Management Strategy recommendations

OPTION 3: DISCUSS LITTER REDUCTION MEASURES WITH LOCAL BUSINESSES

Constructive dialogue, possibly through an interactive workshop *(with follow-up and regular news column in the local newspaper)*, could be conducted with all local businesses to discuss measures by which litter disposal could be improved. The workshop would need to identify what help the businesses need in order to reduce the amount of litter produced, or methods in which the litter is intercepted and collected. A regular newspaper column would also provide advertising rewards for those businesses participating and would encourage others to become involved.

Possible outcomes from this dialogue could include increased or additional Council services such as the introduction of street sweeping, particularly in the commercial centres of Miranda and Caringbah, and/or an increased garbage collection service to necessary businesses.

Constraints and Considerations

- lack of corporate will to reduce packaging, especially when it also serves as advertising
- costs associated with increased street sweeping and garbage collection

OPTION 4: INCREASE COMMUNITY AWARENESS WITH RESPECT TO THE IMPLICATIONS OF LITTERING IN THE YOWIE BAY CATCHMENT

This option is discussed in more detail under Objective 16, however, it would involve simple, yet informative, signage throughout the catchment, especially at the retail centres of Miranda Fair and Caringbah CBD.

Constraints and Considerations

- costs of signs and proliferation of signs
- effectiveness of signs
- resources to police littering

- distribution of Sydney Coastal Council's existing stormwater educational pamphlets

Objective 2: To reduce the amount of organic debris entering Yowie Bay

Although an undeveloped catchment would produce significantly more organic debris, an urbanised catchment enables the organic debris to enter high velocity drainage systems, comprising paved surfaces and drains. Under natural conditions, organic debris would fall to the ground and decompose, thereby rejuvenating the soil with valuable nutrients. The natural debris would also work to reduce surface runoff.

For an urbanised catchment, organic debris, such as lawn clippings, fallen leaves, tree trimmings etc, is largely transported through the waterway systems with the floatable litter. As such, waterway structures designed to intercept floatable litter would also intercept organic debris, although not with the same efficiency. In this regard, Option 1 (Objective 1) would also be applicable to this Objective.

OPTION 5: COMMUNITY EDUCATION AND ENCOURAGEMENT OF NATIVE GARDENS

Unlike floatable litter, where the major source of input would be from commercial and retail centres, organic debris within the waterways would largely be the result of residential households. Therefore community education on the correct disposal methods of garden refuse would be the most effective means of reducing the organic debris in Yowie Bay.

Council could also encourage residents to plant evergreens, particularly native trees and shrubs in preference to deciduous species requiring collection and disposal of leaves. A brochure similar to Council's "Landscape and Planting Guidelines for Fire Prone Areas" could be developed. It could also include information on composting garden and household refuse.

Constraints and Considerations

- Council has no control over what people plant in their gardens apart from noxious weeds
- Council currently encourages the planting of appropriate native species, particularly Eucalypt canopy
- changes in individual attitudes take time with regard to dumping garden refuse in bushland and it is difficult to police this activity

OPTION 6: COUNCIL TO PROVIDE A GARDEN REFUSE COLLECTION SERVICE

Like some other Councils within the Sydney area, Sutherland Shire Council could introduce a regular service for the collection of garden refuse from the households within the Yowie Bay catchment. Residents could be encouraged to use this method for disposal of organic material, such as lawn clippings and fallen leaves, rather than dumping in the drains, gutters and watercourses.

Constraints and Considerations

- costs associated with collecting garden refuse
- larger clippings and branches can be chipped and combined with grass clippings for mulch, which could then be sold. This has been successfully trialed by Kimbriki Recycling Centre at Terry Hills.

Objective 3: To reduce other pollution sources entering Yowie Bay

Other pollution which finds its way into Yowie Bay would generally be of a dissolved nature. Therefore, this pollution cannot readily be separated from the flows into the bay. As such, the main methods of reducing other pollution sources would be through community education. A more detailed option for addressing community eduction is outlined under Objective 16.

OPTION 7: ENCOURAGEMENT OF BILGE BLANKETS FOR MOORED AND BERTHED VESSELS

The large number of recreational vessels permanently moored or berthed on Yowie Bay is a source of pollution. To minimise the impact of hydrocarbon spills from these boats, owners could be encouraged to install bilge blankets in the vessel's motor compartment. Bilge blankets are textile mats which can absorb up to 25 times their volume of oil and other hydrocarbons. They are very effective at preventing oil and fuel leaks from vessel motors from entering the waterway when placed in the motor compartment, or boat bilge.

Constraints and Considerations

- there is no legal requirement for boats to use bilge blankets
- discussions could be held with Waterways Authority regarding making the use of bilge blankets a licence condition
- removal and disposal of bilge blankets with minimal spillage

OPTION 8: INVESTIGATE THE NEED FOR SEWAGE DISCHARGE RESTRICTIONS AND A BOAT PUMP-OUT AT YOWIE BAY

In accordance with the Clean Waters Act 1970, Port Hacking and Yowie Bay are "no discharge zones". However, unlike Sydney Harbour, there is no formal requirement for commercial vessels, or vessels with toilets, to have sewage holding tanks. Pump-out facilities are available in Gunnamatta and Burraneer Bays, but not at Yowie Bay. The need for tighter restrictions on sewage discharge and the need for pump-out facilities in Yowie Bay should be investigated.

Constraints and Considerations

- existing pump-out facilities may adequately cope with sewage from boats in Port Hacking
- not all boats are fitted with holding tanks
- there is no legal requirement for boats to pump-out sewage
- if marina facilities are expanded in Yowie Bay, a condition of consent could include the provision of pump-out facilities
- the use of sewage holding tanks for commercial vessels and vessels with toilets could be legislated in Port Hacking, like in Sydney Harbour

OPTION 9: INVESTIGATE WATER QUALITY AND SEDIMENTS TO DETERMINE LONG TERM IMPLICATIONS AND THE POTENTIAL HAZARD TO THE COMMUNITY

Water Quality at the heads of the Bay

Noted sources of pollution into Yowie Bay are the Camellia Gardens Creek and Ewey Creek, which both contain high levels of nitrate and bacteria. As a first step, the water quality in these creeks should be investigated further, and any potential hazards to the community determined, particularly as the community has ready access to the water within the Camellia Gardens. The sources of the pollution should also confirmed, and also, the impacts of the poor water quality on the marine habitats of Yowie Bay.

A possible link between the depauperate invertebrate community on the Camellia Gardens sandflat (as compared to the Ewey Creek sandflat), and poor water quality in the Camellia Gardens Creek, should be investigated.

The degree to which oysters on all peripheries of the Bay could be a health risk, needs to be tested. Council has an obligation to warn the public of potential health risks.

If the bacterial contamination of this water is considered hazardous, options for treatment and management should be investigated.

Sediment Quality within Yowie Bay

The greater majority of the Bay is deep and acts as a large sediment trap for the accumulation of fine sediment delivered by catchment runoff. Pollutants associated with the sediment are generally attached to the surface of fine sediment particles, and therefore can accumulate into a significant quantity over time. Such pollutants can pass into the overlying water if the conditions at the bed become anoxic.

There are many examples where nutrients released from bed sediments have lead to water quality problems, such as algae blooms. The propensity for Yowie Bay to develop such a situation is unknown. The Plan should recognise this lack of knowledge and identify the need for preliminary tests to establish the nutrient and toxicity regimes of the bed sediments of the Bay, with a view to establishing a benchmark for future testing of the eutrophic state of the Bay.

Constraints and Considerations

- if ducks and other water birds are the main contributors to pollution in the Camellia Gardens Creek, this will be difficult to address as the birds, and open ponds which attract them, are one of the attractions of the gardens

Objective 4: To reduce discharges from sewer overflows entering Yowie Bay

The discharge of sewage into Yowie Bay via sewer overflows is primarily the responsibility of Sydney Water. Sydney Water is presently investigating options for the upgrading of the Cronulla Sewage System Overflows, which address management practices, management responses, and steps required to reduce the impacts of overflows. For the latter, these steps could include pre-treatment or overflow containment.

OPTION 10: CONTINUE TO LOBBY FOR THE UPGRADING OF THE CRONULLA SEWERAGE SYSTEM INCLUDING COLLECTION OF WATER QUALITY DATA

Sutherland Shire Council, either individually, or through Council's membership of Sydney Coastal Councils, should continue to lobby with Sydney Water to upgrade sewer overflows in the area.

Water quality data in the vicinity of the sewer overflows could be routinely collected to identify the impacts of the overflows on the water quality of Yowie Bay, and its marine habitats.

Constraints and Considerations

- Council has no control over the Cronulla sewerage system
- Council has monitored water quality in Yowie Bay in the past
- A specifically developed water quality monitoring program should be implemented

Objective 5: To minimise any further siltation of the heads of Yowie Bay

Options for reducing further siltation from the heads of Yowie Bay are somewhat limited. Structural options would involve the construction of silt traps which generally require large areas (as the sediment in the water has to fall out of suspension), while non-structural options would involve actually addressing the source of the sediment pollution.

Now that the catchment is essentially fully urbanised, significant siltation is unlikely. However, redevelopment of land, and general surface runoff, still has a somewhat limited potential to charge the watercourses with sediment.

OPTION 11: INSTALLATION OF SEDIMENT CONTROL STRUCTURES WITHIN THE DRAINAGE SYSTEM

At present, there are a limited number of devices for trapping sediment in the drainage system before discharge into Yowie Bay. The most effective sediment control device within the catchment is the Pollutech *(CDS)* unit on Winifred Avenue, which on average, removes about 5 cubic metres of pollutant solids every 3 months, of which sediment makes up approximately 5 - 10%. This quantity of sediment (approximately 1 tonne) corresponds to about 20% of the total sediment potentially generated from the subcatchment which this unit services. Alternative, smaller structures, such as Humes' **Hume***ceptor*™ units, could be more easily installed at

locations further upstream within the catchment drainage network.

The installation of other CDS, or alternative, units, strategically located within the Yowie Bay heads subcatchments, would significantly reduce further deposition on the deltas at the heads of the bay. Such units would also reduce the floatable litter and organic debris from the stormwater flows, as discussed under Option 1, Objective 1.

Constraints and Considerations

- lack of open space to install pollution control devices
- lack of access for maintenance
- costs associated with cleaning sediment control devices
- difficulties in retrofitting devices
- costs associated with construction of sediment control devices

OPTION 12: EROSION CONTROL WITHIN THE CREEK RESERVES

A potential source of sediment is the creek banks and mobile beds in the tributaries upstream of Yowie Bay. Urbanisation of the catchment would have increased the amount of flow discharging down the creeks, which would, inevitably, increase the potential for erosion of the creek bed and banks.

The potential for erosion of the creek banks could be minimised by reducing bank slopes, where possible, and appropriate planting of ground cover. Vegetation significantly inhibits erosion by stabilising creek banks.

Constraints and Considerations

- lack of open space to regrade and stabilise creek banks
- carry out detailed assessment of stream bank states and develop low cost measures for eliminating areas of significant sediment scour
- recommendations from the Ewey Creek Management Plan, including:
    - * rehabilitate bushland;
    - * integrate with existing larger open parkland;
    - * pollution control traps;
    - * artificial wetlands;
    - * planting, waste and water runoff management;
    - * community education; and
    - * development controls.

OPTION 13: ENSURE STRICT COMPLIANCE WITH SITE SEDIMENT CONTROL PLANS OR CONDITIONS OF CONSENT / APPROVAL

For larger developments, Council Development Consent conditions require the implementation of water and sediment control plans. To help minimise sedimentation at the source of the pollution, Council could ensure that these plans are being strictly complied with during the course of the development.

Constraints and Considerations

- Council resources required to police Development Consent conditions

Objective 6: To reduce siltation from all stormwater drains

Options for reducing siltation from all other stormwater drains within the Yowie Bay catchment are essentially the same as those outline under Options 11 to 13 (Objective 5).

OPTION 14: DREDGE SEDIMENT FANS IN THE VICINITY OF STORMWATER OUTLETS

Once in the bay, the sediment could be removed by means of dredging. This would only be considered if the sediment fan resulting from the stormwater drain is impeding safe navigation, or access to jetties and pontoons. The dredged material, which would only be relatively small quantities, could then be deposited in the deeper sections of the bay.

Constraints and Considerations

- costs associated with dredging
- funding for dredging where benefits are restricted to one or two stakeholders
- Permit for dredging is required from NSW Fisheries
- Damage to mangroves or seagrasses will not generally be permitted by NSW Fisheries

Objective 7: To reestablish navigable access to waterfront properties

Re-establishing navigable access to waterfront properties at the heads of the Bay through dredging and maintenance of channels to foreshore structures such as boatsheds, pontoons and jetties, or broadscale dredging of the whole of the delta areas.

OPTION 15: DREDGE SMALL NAVIGATION CHANNELS ALONG THE FORESHORES OF EWEY CREEK BAY AND THE WESTERN FORESHORE OF CAMELLIA GARDENS BAY

A number of maritime structures exist along the western foreshore of the Camellia Gardens bay, and the foreshores of the Ewey Creek bay. Channels could be dredged close to the foreshores which allow navigable access from these structures into the deeper sections of Yowie Bay. Channels would be adjusted locally to avoid environmentally sensitive areas on the deltas, such as mangroves, seagrasses and saltmarshes.

The channels would be designed so that they would be multi-functional. That is, they would satisfy other specific objectives, as outlined in other sections of this chapter. Specifically, they would be designed to increase the habitat diversity of the area by providing deeper water to facilitate seagrass growth, which then has the potential to increase the biodiversity of the delta. As an alternative to conventional disposal of the channel dredgings off site, which would be expensive and require numerous environmental considerations, the dredgings could be used to create a raised section on the sandflat to possibly provide an area for bird roosts. The formation of a bird roost island in the middle of the delta was not supported by the local community nor the Yowie Bay Estuary Management Committee. As another alternative, dredgings could be disposed within the deeper sections of Yowie Bay subject to approval by relevant authorities (ie, NSW Fisheries, EPA etc).

The channel within Camellia Gardens bay could also provide water access to the Camellia Gardens and could tie into a suggested eco-educational walk around the bay foreshores *(refer Option28, Objective 16)*. In addition, this channel would provide a flushing mechanism for the plunge pool located adjacent to the Camellia Gardens foreshore, at the end of a stormwater drain. This plunge pool would benefit from increased tidal flushing, as it presently exhibits poor water quality and its bed sediments are anoxic, and devoid of marine life.

The material that would be dredged from the channel has been determined to be of reasonable quality. Laboratory tests have shown that the sediments in either Camellia Gardens bay or Ewey Creek bay are generally within guideline values, and as such, would not pose a hazard to the benthic environment of

Yowie Bay once disposed within the deeper sections of the bay. If a bird roost island is to be considered, it may need a small shingle armour layer to protect it against wind wave attack, and to stop it from slumping back into the dredged channels. Treatment for acid sulphate leachate from the sediment may also be required if disposed subaerially (ie above water), depending on results of further sediment analyses.

To ensure that the dredged channels do not silt-up within an unreasonable timeframe, measures should also be implemented to reduce the amount of sediment discharged into the bay, refer Options 11 to 13 *(Objective 5)*.

The dredged channels would not alter the tidal hydraulics of the delta areas, and would have little impact on the ongoing sedimentation of the sandflat.

Constraints and Considerations

- the Crown lands assessment notes that the western side of Camellia Gardens bay is unsuitable for additional foreshore structures
- Council's *Code for Waterfront Development* states that dredging is not favoured
- funding for dredging works
- costs associated with channel maintenance
- cost efficient and environmentally balanced disposal of dredgings
- applicability of SEPP35 maintenance dredging policy
- permit is required from NSW Fisheries to carry out any dredging, and for damage or removal of mangroves and seagrasses
- licences required from EPA for discharge of dredging supernatant (liquids) and for the general operation aspect of the dredging activity

OPTION 15A: BROADSCALE DREDGING OF CONTEMPORARY SEDIMENT FROM THE HEADS OF YOWIE BAY

As an alternative to dredging small navigation channels along the foreshore, the whole sand flat areas of the bays could be dredged, thus reinstating the former, pre-European, delta condition. There was support from the local community and foreshore property owners for this option. As such, a detailed assessment was carried out to determine the feasibility of removing all contemporary sediment from the delta areas at the heads of Yowie Bay. This assessment is presented in **Appendix B**.

The dredging feasibility assessment considered options for removal of the sediment and for disposal locations. Based on additional sediment analyses, it also outlined the likely treatment the sediment would require before disposal, and a list of social and environmental issues which would require consideration should the dredging proceed. An assessment of indicative costs was also carried out for the different alternatives that were identified.

In summary, the assessment showed that the removal of contemporary sediment from the heads of Yowie Bay *is technically feasible*. The sediment can be removed in a number of different ways, however, the most cost effective method would involve excavation via a small cutter suction dredger.

Excavation using land based equipment working from constructed bunds within the bays was considered and determined to be feasible for Camellia Gardens bay. However, vehicular access to the Ewey Creek bay would be difficult to obtain. Therefore, land-based options were considered not to be feasible for the Ewey Creek bay. Removal of the material from an excavator positioned on a barge which then pumps (or barges) the sediment onshore was also considered and determined to be technically feasible, however, costs of floating plant and equipment would be high, and would inhibit the practicality of this option.

A preliminary sediment quality analysis which was carried out as part of the dredging feasibility assessment showed that the majority of sediments are not contaminated, and can be classified as "Inert Waste" (according to the EPA's Environmental Guideline document "Assessment, Classification and Management of Non-Liquid Waste"). As a result, the sediment is suitable for disposal as cover material at Menai Tip (possibly free of tip fees, subject to specific negotiations between Council, Waste Services and EPA), or can be used as general fill at other designated local sites. Other sites considered as part of the assessment were the old rock quarry adjacent to Ewey Creek (owned by Council), and the abandoned brick pit in Kirrawee (owned by Sydney Water). An EIS would be required to determine environmental impacts if the sediment was disposed at a local site (ie, anywhere except a designated landfill).

Nine government authorities were contacted regarding the possible removal of sediments from the heads of Yowie Bay. In general, authorities were receptive to the proposal providing that

the works were carried out in a manner which does not destroy or damage marine and terrestrial habitats, and the proposal includes adequate controls to minimise environmental and social disturbances. An EIS would be required to fully describe the nature of identify the existing environment and quantify the impacts that the proposal would have on the environment.

Costs associated with the proposal vary between approximately $1.4 million and $3.5 million, depending on the method of removal, the end use of the material, and the extent and quality of the sediment removed (ie the study found that there are some pockets of slightly contaminated / polluted sediment which would need to be avoided or removed and handled separately). The project would likely take between 4 and 12 months to complete, again depending on the method adopted for removing the material, and the extent and quality of the material being removed.

Constraints and Considerations

- the Crown lands assessment notes that the western side of Camellia Gardens bay is unsuitable for additional foreshore structures
- Council's *Code for Waterfront Development* states that dredging is not favoured
- funding for dredging works
- preparation of an EIS or similar to determine impacts on marine and terrestrial environments of the bay, and the disposal location
- cost efficient and environmentally balanced approach to removal of sediment and the disposal of the dredgings
- applicability of SEPP35 maintenance dredging policy
- permit is required from NSW Fisheries to carry out any dredging, and for damage or removal of mangroves and seagrasses
- licences required from EPA for discharge of dredging supernatant (liquids) and for the general operation aspect of the dredging activity
- detailed assessment of quality of sediment being removed, given that some sediment is not "inert"

Objective 8: To maintain or even increase biodiversity of sand flats in delta areas

Some options outlined in this management study involve works within the sand flats of the delta areas at the heads of the bay. The sand flats are valuable marine habitats and should be preserved as such.

Many of the options discussed previously would increase the variety of habitats, and hence the biodiversity of the sand flats. For example, a reduction in the amount of floatable litter and organic debris entering the bay (Options 1 to 6 (Objectives 1 and 2)) would result in less smothering of the mangrove pneumatophores and benthic micro-environments. A reduction in the build-up of litter along the foreshores may also minimise breeding and inhabitation of rodents and snakes.

Likewise, a reduction in the amount of siltation would prevent the smothering of the existing benthic environments, and seagrasses (refer Option 17, below).

OPTION 16: FORMATION OF A BIRD ROOST ISLAND IN CAMELLIA GARDENS BAY

A stable island, rising to no more than about 0.5 metres above high tide and surrounded at low tide by a perimeter channel full of water, could be created in Camellia Gardens bay to provide a safe haven for foraging and wading birds against predator attack. The island could be constructed from material dredged from the perimeter channel, as detailed in Option 15 *(Objective 7)*, and may require small shingle armour on the southern facing side to protect against wind waves.

The island could be planted with saltmarsh species, presently rare in the Yowie Bay area, and reeds, which are favoured by birds as they provide protection and cover from predators.

The island could be easily designed such that the side slopes would be stable, and the island would not slump back into the navigation channel. The island would not have any significant impact on the tidal hydraulics of delta area.

Constraints and Considerations

- there is limited habitat of this type in Yowie Bay
- could be an integral component of the eco-educational elements *(refer Option 28, Objective 16)*
- Council's *Code for Waterfront Development* states that dredging is not favoured
- costs associated with channel construction and maintenance
- an island may not be favoured by the community, ie sedimentation is not being removed

OPTION 17: ESTABLISHMENT OF SEAGRASSES WITHIN THE DREDGED NAVIGATION CHANNELS

One means of increasing the biodiversity of the delta areas would be to provide conditions favourable for the establishment of seagrass beds within the dredged navigation channels. Seagrasses would provide another habitat type in the delta areas. To facilitate the seagrass establishment, the channels would need to be dredged to approximately 0.5 to 1.0 metres below low water. This depth would be consistent with that required for small craft access, and would also be consistent with the pre-urbanised catchment delta levels.

To allow a viable seagrass community to establish within the deltas, the dredged channels would need to be about 5 to 10 metres wide, and have shallow side slopes.

Constraints and Considerations

- Seagrasses may not establish in the channel quickly, through natural colonisation, and may need to be planted
- Opportunities for trial planting of seagrasses, with possible research input from the Fisheries Institute at Cronulla
- Need appropriate sediment and water quality conditions for seagrass to colonise
- Need a suitable source of seagrass

OPTION 18: PROTECTION OF EXISTING MANGROVE SEEDLINGS ALONG EWEY CREEK FORESHORE

As seen in both heads of the bay, establishing mangroves are adding to the biodiversity of the delta areas. Shoaling of the heads of Yowie Bay during contemporary times means that the delta areas are presently ideal for the establishment of mangroves. As such, mangrove seedlings have naturally established along significant stretches of the Ewey Creek bay foreshore. The protection of these seedlings, and the nurturing of the trees into mature mangroves would ensure that the viable habitats of the Ewey Creek bay are maintained and enriched.

Constraints and Considerations

- mangroves in front of properties could be regarded as a nuisance by landowners
- additional mangroves provide more opportunity for litter and flotsam to become entangled
- mangroves are protected by NSW Fisheries legislation and a permit is required to remove or damage them

Objective 9: To minimise detrimental effects on existing seagrass beds, particularly deep water beds

Seagrass beds are not common in Yowie Bay. As such, the existing seagrass beds are an extremely valuable ecological resource, and need to be maintained and protected against future damage.

Some Management Options already discussed in this chapter would work to reduce impacts on the beds, such as minimising the amount of sediment associated with stormwater discharges. Other options are discussed below.

Community education on the ecological value and significance of seagrasses would also minimise detrimental affects on the existing beds. Options for community education are discussed under Objective 16.

OPTION 19: MINIMISE BOATING ACTIVITY IN THE VICINITY OF EXISTING SEAGRASS BEDS

To preserve the existing seagrass beds, mooring or anchoring in the beds should be restricted. For example, signs could be erected prohibiting, or at least, discouraging anchoring in the vicinity of the beds and existing moorings in the vicinity of seagrass beds moved, is possible. Also, speed restrictions could be imposed to minimise the amount of damage to the beds associated with propeller currents, and localised increased turbidity, which temporarily restricts the amount of light reaching the seagrasses.

Constraints and Considerations

- lack of available waterway area to move moorings
- current management of Yowie Bay moorings by Waterways Authority to determine if any more moorings could be accommodated by the bay

OPTION 20: MONITOR THE EXTENT AND HEALTH OF EXISTING SEAGRASS BEDS

Routine monitoring of the extent and general health of the seagrasses could be carried out to assess changes to seagrass beds which may be due to anthropogenic impacts. If a link between the reduction in seagrass bed area or health, and, for example, stormwater drains, is apparent, further steps could be taken to reduce the impacts.

Constraints and Considerations

- in some cases it may be difficult to distinguish whether changes to seagrass beds are due to anthropogenic or natural variations
- the NSW Fisheries Institute is located at Cronulla and may be able to assist with seagrass monitoring

Objective 10: To reestablish indigenous foreshore vegetation

Foreshore and creek reserves contain remnant woodland and open forest, presenting opportunities for regeneration of indigenous species. Bushcare groups are currently working in Kareena Park and Ewey Creek, and should continue to be supported.

OPTION 21: CONTINUE TO REMOVE WEEDS, AND PLANT NATIVE VEGETATION AROUND THE FORESHORES OF YOWIE BAY

Within the public reserves around the foreshores of Yowie Bay, weeds such as Privet, Lantana and Asparagus Fern, are a problem. Such weeds could continue to be removed and replaced, where appropriate, with Australian native plants which are more fitting to the character of the estuary, and would encourage native birdlife to the area.

Constraints and Considerations

- most of the Yowie Bay foreshores are in private ownership, therefore access for weed removal is limited
- residents are can only be required to remove noxious weeds
- Council's bushcare groups have obtained grants from the CMC for bush regeneration works in Council reserves and further grants should be pursued
- there may be opportunities to involve more residents and nearby schools in bushcare activities

Objective 11: To reestablish seagrass beds in the Bay

There is limited potential for establishment of new seagrasses within Yowie Bay, as the sides of the estuary are steep. Opportunities for seagrass establishment are largely restricted to the sand flat areas at the heads of the bay.

Option 17 (Objective 8) already details means whereby seagrasses could be encouraged to establish within navigation channels traversing the sand flat.

OPTION 22: CREATE A BENCH ALONG THE DELTA DROP-OFFS TO PROMOTE SEAGRASS ESTABLISHMENT

In addition to the establishment of seagrasses along any new navigation channels, a shallow bench could be provided, to a depth of approximately 1 metre below low water, at the edge of the delta drop-off, to promote the establishment of seagrasses in that area. The existing material could be scraped into the deeper sections of the bay with minimal effort and negligible impact on the environment.

As the previous Processes study found that the delta drop-offs are now stable, or moving very slowly, the shallow bench would be a viable area for the establishment of seagrasses.

Constraints and Considerations

- the community may not favour more modification of the drop-off as this is not removing sedimentation
- provides a relatively low cost method of reducing the visual impact of sedimentation and creates an alternative and vigorous marine habitat
- some cost involved, but relatively minor

Objective 12: To minimise environmental impacts of recreational vessels using Yowie Bay

The environmental impacts of recreational vessels using Yowie Bay have not been clearly identified. To a large extent, Options previously proposed have addressed the majority of issues associated with environmental impacts of recreational boating. These include Option 19 (Objective 9) - Restriction of boat moorings and anchoring in the vicinity of seagrass beds, Option 7 (Objective 3) - Use of bilge blankets on moored and berthed vessels, and Option 8 (Objective 3) - Investigate the need for a pump-out facility in Yowie Bay.

No other specific Management Options are proposed for this Objective.

Objective 13: Minimise conflicts between recreational users of Yowie Bay

Conflicts between active and passive users is a feature of most waterways around Sydney. The most effective means of minimising conflicts is to try and separate the users as much as possible.

Of particular concern in Yowie Bay is the power boats which travel at high speed between the Wonga Road boatramp and Port Hacking.

OPTION 23: DISCOURAGE POWER BOATING IN DESIGNATED AREAS BY MEANS OF IMPOSING ADDITIONAL SPEED LIMITS

Areas within Yowie Bay, most ideally in the northern section of the bay (ie, to the north of the Wonga Road boatramp), could be designated primarily for passive waterway use. A possible outcome of the Plan would be that the integrated eco-educational trail *(refer Option 28, Objective 16)* and perimeter dredging *(refer Option 15, Objective 7)* will be conducive to family orientated cruising, row boating and small sailing craft. This could be achieved by restricting power boats to a 4 knot, or a "NO WAKE" speed limit, which would still allow access to power boats moored in the area. Passive waterway users would be encouraged to use those areas designated for passive use, while power boats would be encouraged to only use to area they need, that is, a designated route between the boatramp and Port Hacking. Passive use of the bay could be incorporated into an eco-educational experience, which is discussed further under Objective 16.

Conflicts south of the boatramp could be minimised by imposing speed restrictions, 8 knots say, in the area of Yowie Bay which is narrow and contains many cross-channel moorings.

Constraints and Considerations

- it may be difficult to police segregation of waterway uses
- presently, a speed limit of 8 knots only applies to the north of the Wonga Road boatramp
- people may not favour changes to their traditional use of the waterways, but these needs to be balanced against the opportunity to provide expanded opportunities for non-powered boating which would be compatible with the possible habitat enhancement and eco-educational options for the heads of the Bay.

OPTION 24: MINIMISE NOISE POLLUTION FROM POWER BOATS BY LIMITING SPEEDS WITHIN YOWIE BAY

The peacefulness of Yowie Bay could be affected by the noise of power boats travelling between the boatramp and Port Hacking. Noise from power boats could be minimised by limiting speeds within Yowie Bay.

In addition to imposing speed restrictions, the limits would need to be enforced by Waterways Authority personnel to ensure compliance.

Constraints and Considerations

- Waterways Authority can also police noisy craft
- resources required to adequately police speed restrictions

Objective 14: To enhance facilities around Yowie Bay associated with boating

Foreshore facilities are somewhat limited around Yowie Bay. Additional public facilities would greatly increase the enjoyment of Yowie Bay.

OPTION 25: IMPROVE EXISTING BOATRAMP FACILITIES

There is only one boatramp in Yowie Bay, and its facilities are very limited. The Yowie Bay boatramp could be improved to provide facilities such as boat washdown areas, fish cleaning facilities, public toilets, picnic facilities, rubbish bins and more formalised car and trailer parking.

Constraints and Considerations

- most of the foreshore is in private ownership
- the topography of Yowie Bay makes public access difficult
- there are few reserves around Yowie Bay
- existing reserves are discontinuous
- lack of room to expand existing boat ramp facilities
- no opportunities for additional boatramp facilities
- possible sealing of existing grassed parking area with alternative porous pre-cast units.

OPTION 26: REPLACE EXISTING MOORINGS WITH A LARGER BERTH MARINA

A larger berth marina could be constructed in Yowie Bay, providing moorings are reduced by at least a similar number, thereby providing more waterway area for recreational use. Expanded marina facilities could include designated visitor berths and necessary visitor facilities, such as sewage pump-out.

A larger marina could also serve as a regional retail outlet, serving the recreational users of the bay. Passive watercraft, such as canoes and row-boats, could be hired from the marina, and possibilities could be explored for providing a ferry service

to the Camellia Gardens to tie into an eco-educational foreshore boardwalk (refer Objective 16).

Constraints and Considerations

- there would need to be commercial interest in developing a marina
- a marina complex could provide more recreational opportunities
- a marina may not be favoured by the community as they are seen as only servicing one section of the community
- a condition of development consent could be the provision of pump-out facilities
- would need to consider environmental and planning controls / restrictions

Objective 15: To restrict the amount of vessels permanently moored on the waterway

At present, moorings in Yowie Bay are controlled by the Waterways Authority. Waterways are presently carrying out a management plan for all the Port Hacking bays to determine how many more moorings could be accommodated within each bay. Additional moorings in Yowie Bay would be provided in accordance with Council's recommendations.

There are presently 222 private moorings and 43 commercial moorings within Yowie Bay. Nine private moorings are presently vacant, indicating that, at present, there is not a large demand for mooring facilities in Yowie Bay.

OPTION 27: CONSULT WITH WATERWAYS AUTHORITY TO RESTRICT FURTHER MOORINGS WITHIN YOWIE BAY

Waterways Authority controls moorings within Yowie Bay. At present, moorings are restricted to a total of 265 *(222 private and 43 commercial moorings).* This Authority could be consulted with the view to maintain restrictions on moorings in Yowie Bay, and ensure that the overall objectives of the Yowie Bay Management Plan are acknowledged by the Authority, and the implications of further increases in the number of moorings in the bay.

These implications would include further limitations with respect to useability of the bay for both passive and powered recreational vessels, and further adding to the overall impacts of boating on Yowie Bay.

Constraints and Considerations

- existing rights of mooring leases
- demand for moorings in Yowie Bay at present and in future
- Management plan of moorings currently being conducted by Waterways Authority

Objective 16: To gain a better appreciation of the biodiversity and ecology of Yowie Bay

By gaining a better appreciation of Yowie Bay, the community will value and care for it more, to the extent that they will take pride in the estuary and will make every effort to keep it in good health.

OPTION 28: FORMALISE FORESHORE WALKS INTO AN EDUCATIONAL ECO-TRAIL AROUND YOWIE BAY

Foreshore walking tracks around the northern end of Yowie Bay could be linked together and combined with educational interpretative signage on flora, fauna and the history of the area to produce an educational eco-trail. The trail could include boardwalks through the mangroves, an over the water viewing platform at the northern end of Camellia Gardens bay, and could tie into a public jetty possibly servicing Camellia Gardens from the Yowie Bay Marina. Over the water facilities would probably become popular fishing sites too. The eco-trail would also tie into existing "bush tracks" through Kareena Park, with smaller interpretive signage posted within the Park only at appropriate locations.

Constraints and Considerations

- commercial viability of ferry services to Camellia Gardens. Even so, a jetty would provide a new and interesting venue for boating generally within Port Hacking.
- costs of producing additional site specific educational / interpretive material
- effectiveness of signs
- vandalism of signs
- aesthetics of introducing more signs
- bush regeneration work is already being undertaken at Kareena Park and the profile of the park could be lifted by providing interpretive material about indigenous vegetation
- the linking of walks through Camellia Gardens and Kareena Park and heads of Bay foreshore
- opportunities for field education kits for school children *(refer Option 32, Objective 16)*

OPTION 29: PROMOTION OF KAREENA PARK AS A 'NATIVE' NATURE RESERVE

Kareena Park, located immediately adjacent to the Camellia Gardens, could be promoted as a nature reserve with a strong emphasis on indigenous species of plants, which would hopefully attract indigenous fauna. Many overseas visitors are attracted to the Camellia Gardens. A walk through Kareena Park would provide a contrast to the Camellia Gardens, and would allow the visitors to experience an indigenous Australian environment, ie what it would have been like before European settlement.

Constraints and Considerations

- costs of producing additional site specific educational / interpretive material
- effectiveness of signs
- vandalism of signs
- the linking of walks through Camellia Gardens and Kareena Park

OPTION 30: SIGNAGE REGARDING HUMAN IMPACTS ON YOWIE BAY THROUGHOUT THE CATCHMENT

Educational signage, outlining the human impacts on the Bay, and measures whereby the community can minimise these impacts, could be placed at strategic locations around the Bay, and also throughout the Yowie Bay catchment. The signage could be fitting within the eco-educational experience of the foreshore walking trails, but could also be placed at major pedestrian congregation centres, such as Miranda Fair and within the Caringbah CBD.

Signage could be extended into major displays within retail centres, or could even take the form of letter drops at households within the catchment. Alternatively, a series of articles could be placed in the local newspaper to try and increase community awareness of their impacts on Yowie Bay.

Signage could also be placed on street gutters in the vicinity of inlet pits detailing where the pit drains to. For example

"This drain leads directly to Yowie Bay.
Please keep our waterways free from rubbish"

Or, the internationally adopted "yellow fish" campaign, which is being adopted by some Councils within Australia, including Pittwater Council.

Constraints and Considerations

- drain stencilling has been undertaken in other areas and appears to increase the communities awareness of the impacts of littering etc
- press coverage of drain stencilling also raises awareness
- utilisation of material already produced *(eg Sydney Coastal Councils brochure and Council brochures)*
- involvement in planned material/campaigns by the CMC *(eg the CMC Strategy on public communication notes information/education campaigns in conjunction with other groups on TCM, stormwater pollution, impacts of wastes and chemical, impacts of domestic animal and weeds on native flora and fauna)*

OPTION 31: COMMUNITY PARTICIPATION IN REHABILITATING YOWIE BAY TO A PRISTINE CONDITION

Community participation should be encouraged when carrying out significant measures within the Management Plan framework, such as building walking tracks and boardwalks, planting mangroves and seagrasses, and removing litter from the foreshore reserves and sand flat areas. Actual participation in the works would instil a greater sense of pride in the estuary and as a result, would be cared for in a more thoughtful manner.

Constraints and Considerations

- a 'Friends of Yowie Bay' group could be formed if there is community support, or the activities of the bushcare groups could be expanded, perhaps with input from surrounding schools

OPTION 32: DEVELOPMENT OF SCHOOL PROJECT KITS AND GUIDED TOURS OF THE AREA

Once an educational and interpretive walking trail has been established around the foreshores of the bay, Council could develop school project kits on the ecology of the area. This could be further complemented by the provision of guided tours by local authorities, who could point out significant features of Yowie Bay and the aquatic and terrestrial flora and fauna which

inhabit it. These tours could be organised through Council, or the Sutherland Shire Environment Centre, or both.

Constraints and Considerations

- hold discussion with local geography teachers, the Australian Association of Environmental Education and universities regarding opportunities for student involvement in projects on Yowie Bay.

4.2 SUMMARY OF OPTIONS

Objective 1

1. *Increase the number of litter collection devices within the drainage system*
2. *Encourage community groups to clean-up floatable litter and debris from the sand flats and foreshores of Yowie Bay*
3. *Discuss litter reduction measures with local businesses*
4. *Increase community awareness with respect to the implications of littering in the Yowie Bay catchment*

Objective 2

5. *Community education and encouragement of native gardens*
6. *Council to provide a garden refuse collection service*

Objective 3

7. *Encouragement of bilge blankets for moored and berthed vessels*
8. *Investigate the need for sewerage discharge restrictions and boat pump-out at Yowie Bay*
9. *Investigate water quality and sediments to determine long term implications and the potential hazard to the community*

Objective 4

10. *Continue to lobby for the upgrading of the Cronulla Sewerage System, including collection of water quality data*

Objective 5

11. *Installation of sediment control structures within the drainage system*
12. *Erosion control within the creek reserves*
13. *Ensure strict compliance with site sediment control plans or conditions of consent / approval*

Objective 6

14. *Dredge sediment fans in the vicinity of the stormwater outlets*

Objective 7

15. *Dredge small navigation channels along the foreshores of Ewey Creek bay and the western foreshore of Camellia Gardens Bay*

15A. *Broadscale dredging of contemporary sediment from the heads of Yowie Bay*

Objective 8

16. *Formation of a bird roost island in Camellia Gardens Bay*
17. *Establishment of seagrasses within the dredged navigation channels*
18. *Protection of existing mangrove seedlings along Ewey Creek foreshore*

Objective 9	**19.** *Minimise boating activity in the vicinity of the existing seagrass beds*
	20. *Monitor the extent and health of existing seagrass beds*
Objective 10	**21.** *Continue to remove weeds, and plant native vegetation around the foreshores of Yowie Bay*
Objective 11	**22.** *Create a bench along the delta drop-offs to promote seagrass establishment*
Objective 12	*Refer Options 7, 8 and 19*
Objective 13	**23.** *Discourage power boating in designated areas by means of imposing additional speed limits*
	24. *Minimise noise pollution from power boats by limiting speeds within Yowie Bay*
Objective 14	**25.** *Improve existing boatramp facilities*
	26. *Replace existing moorings with a larger berth marina*
Objective 15	**27.** *Consult with Waterways Authority to restrict further moorings within Yowie Bay*
Objective 16	**28.** *Formalise foreshore walks into an educational eco-trail around Yowie Bay*
	29. *Promotion of Kareena Park as a 'native' nature reserve*
	30. *Signage regarding human impacts on Yowie Bay throughout the catchment*
	31. *Community participation in rehabilitating Yowie Bay to a pristine condition*
	32. *Development of school project kits and guided tours of the area*

5.0 COMMITTEE AND COMMUNITY REVIEW

5.1 COMMITTEE REVIEW

The draft Estuary Management Study report, comprising all preceding chapters of this report, was reviewed by the members of the Yowie Bay Estuary Management Committee. The Committee members were generally satisfied with the objectives and options that were set out in the draft report, however, community representatives on the Committee expressed some concern regarding the estuarine processes, in particular the rates of siltation, and that the proposed options did not address the issues sufficiently. This view was similar to that expressed by some of the participants at the community drop-in centre, as detailed in **Section 5.2.**

The Committee recognised that the options had been developed with a balanced approach wherever possible, that is, more than one objective was addressed by a particular option. For example, the dredging of a small perimeter channel was proposed primarily to reinstate small craft access, however, the channel also provided an opportunity to enhance the local marine habitat through planting seagrasses within the channel, and using the dredging spoil from the channel to create an artificial bird roost island. The Committee also recognised that the options represented an achievable Plan, given the environmental, legislative and economic constraints that would be imposed.

The draft Estuary Management Study report was also reviewed by the Hacking River Catchment Management Committee *(CMC)*. The CMC was generally supportive of the balanced and broad perspective of the study, however it raised some concerns regarding the future potential for sediment runoff from the catchment and the likely benefits and limitations of an artificial bird roost island within the Camellia Gardens bay. The CMC was also of the opinion that resolution of complex Yowie Bay issues would not be possible until a broad policy framework was formulated in respect of all the sand shoals of Port Hacking. It is understood that the CMC is in discussion with relevant organisations with a view to formulating appropriate policies for Yowie Bay and the other sub-estuaries of Port Hacking.

Of particular interest to the CMC is the development of a "Sediment Management Framework" for Port Hacking. The CMC felt that such a framework should address fundamental questions such as "when is dredging justifiable?", "how can dredging be funded?", "when should privately funded dredging be permitted?" and "how are recreational demands to be managed?".

Yowie Bay is the first sub-estuary within Port Hacking to be specifically addressed by an Estuary Management Study. Given that management issues would be similar for most other sub-estuaries of Port Hacking, it is likely that the Yowie Bay Estuary Management Plan will become a benchmark for all future management studies in Port Hacking. In view of the overarching Sediment Management Framework being developed by the CMC, it is considered that the Yowie Bay Estuary Management Committee should work closely with the CMC in

addressing the relevant management issues and developing a shire-wide sediment management policy framework.

5.2 COMMUNITY REVIEW

A community drop-in centre was conducted on the evening of 15th October 1997. The drop-in centre provided an opportunity for the public to provide feedback on the objectives and options proposed in the draft Estuary Management Study report. The main aim was to obtain a sense of community views to assist the Committee to identify those management objectives which the community perceived to be important, and to identify the management options which would be mostly supported by the local community. Support by the community is fundamental to the success of an Estuary Management Plan.

A number of display panels were prepared and exhibited in the hall of the Yowie Bay Public School which outlined the key findings of the draft Estuary Management Study report. In addition, community participants were given a brief document at the drop-in centre which summarised the proposed management objectives and options and contained a questionnaire which gave the opportunity for the participants to provide written feedback. Some participants completed the questionnaire on the night, while others posted their responses to PBP after further consideration of the various management proposals.

Over 100 members of the local community attended the drop-in centre, with 17 completed questionnaires or written comments being received. A detailed analysis of the responses was outside the scope of this study, however, Committee members and staff from PBP who attended the drop-in centre were able to gauge the general community view through casual discussions that took place on the night, and a review of the questionnaire responses and other written comments. Community comments / reactions to the range of management options contained in the draft report are outlined below:

- Approximately 30% of participants were mainly interested in broadscale dredging of the heads of the bays, and made little comment about the other management issues. A relatively high proportion of waterfront property owners from Matson Crescent, George Street and Baliga Avenue attended the community drop-in centre, many of whom expressed interest in broadscale dredging. Primary management objectives for this portion of the community were removal of existing siltation at the heads of the bay to re-establish navigable access, and strict control of future siltation. These participants were generally dissatisfied that the draft study did not include broadscale dredging of the heads of the bay as an option *(this option has now been included in the final Management Study document – refer Option 15A, Objective 7, of the preceding chapter)*;

- Approximately 30% of participants were in favour of all the proposed management options. These participants expressed an interest in all the management objectives and were particularly concerned with pollution, siltation and environmental issues; and

- Approximately 30% of participants placed a low priority on works around the foreshore and within the estuary, and preferred to see effort concentrated on catchment-wide strategies and pollution reduction campaigns. These participants were mostly concerned with those management objectives which relate to catchment runoff issues, including floatable stormwater pollution, siltation, and building site runoff. This group considered that enough works had already been carried out around the estuary, and that efforts should be concentrated on prevention within the catchment, rather than collection at the receiving waters.

In addition to the above, there were a number of participants who were interested in the information on display and discussed the proposed management options, but did not indicate either support or dissatisfaction with them.

6. THE YOWIE BAY ESTUARY MANAGEMENT PLAN

The Yowie Bay Estuary Management Plan is a concise, stand alone document addressing the perceived needs of the Yowie Bay estuary. It is to be used as a planning guide by Council to address the long term management issues associated with Yowie Bay. The Estuary Management Plan outlines the tasks which have been identified through the Estuary Management Study to address the range of issues affecting the long term sustainability of the waterway. These tasks address the key management objectives of:

1. Reducing pollution in the bay
2. Reducing siltation from catchment runoff
3. Maintaining environmental significance
4. Improving boating, and
5. Education of the community

A range of structural and non-structural tasks have been identified to address these management objectives. Structural tasks incorporate the construction or formation of physical structures to achieve the desired results. Non-structural tasks generally incorporate a broader community-wide participation program and investigation of issues which require further data. The tasks presented in the Management Plan have been drawn from the long list of management options outlined in the Estuary Management Study report, as well as other options which were subsequently developed by the Committee taking into account public comments and suggestions made during the community consultation phase of the project. The tasks represent the most practical means of addressing the management issues within the context of Council's budgetary constraints and policies.

Tasks are presented below in categories defined by the key management objectives.

FIGURE P-1

A REDUCE LITTER, ORGANICS AND SEDIMENT BY CONSTRUCTION OF MORE, OR UPGRADING OF EXISTING, STORMWATER LITTER COLLECTION DEVICES SUCH AS PROPRIETARY POLLUTION CONTROL UNITS, TRASH RACKS AND GPTS

B REDUCE ORGANICS FROM GARDEN REFUSE BY REGULAR COLLECTION SERVICE

C ENCOURAGE AND PROMOTE COMMERCIAL AND RETAIL BUSINESSES TO INITIATE MEASURES TO REDUCE LITTER

D REDUCE ORGANIC DETRITUS THROUGH ESTABLISHMENT OF NATIVE SPECIES AND REMOVAL OF WEEDS IN PRIVATE GARDENS

E ENCOURAGE REDUCTION OF OILS AND HYDROCARBONS BY THE USE OF BILGE BLANKETS IN MOORED AND BERTHED VESSELS

F REDUCE NUTRIENTS AND BACTERIA DUE TO SEWER OVERFLOWS BY LOBBYING FOR SEWER UPGRADING

G REDUCE SEDIMENT SUPPLY BY INSTALLING EROSION CONTROL MEASURES WITHIN CREEK RESERVES

H REMOVE WEEDS AND REPLACE WITH INDIGENOUS SPECIES

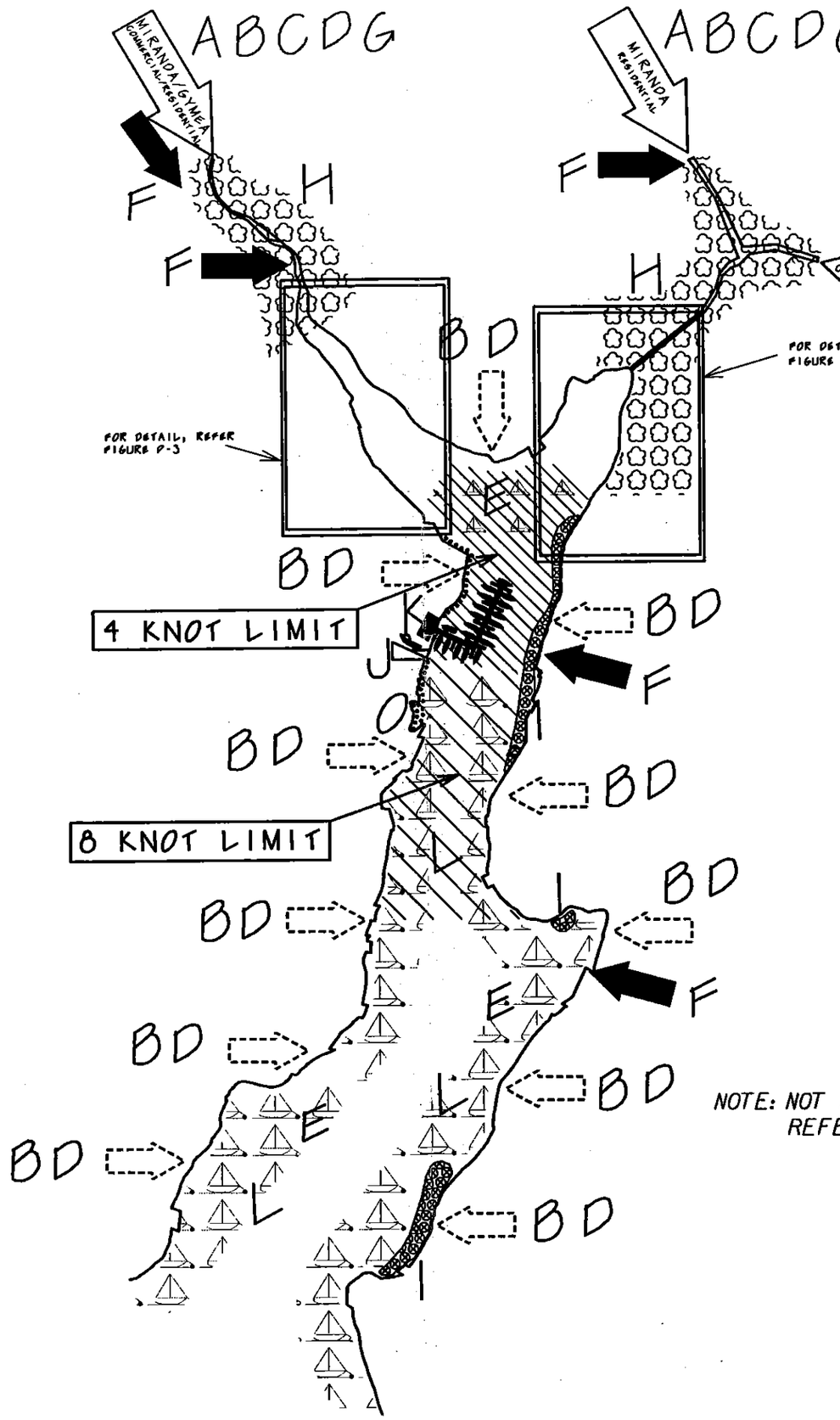
I PROTECT SEAGRASS POCKETS THROUGH COMMUNITY AWARENESS PROGRAM AND CONSIDER SCOPE FOR RESTRICTING BOATING ACTIVITY INCLUDING MOORING AND ANCHORING IN VICINITY OF ESTABLISHED SEAGRASS BEDS

J UPGRADING BOATRAMP FACILITIES TO PROVIDE IMPROVEMENTS SUCH AS UPGRADED RAMP, ADDITIONAL PARKING, BOAT WASHDOWN AREA, FISH CLEANING FACILITIES, ADDITIONAL RUBBISH BINS, PUBLIC TOILETS, PICNIC AMENITIES AND SMALL CRAFT LANDING FACILITIES

K EXAMINE FEASIBILITY AND PROS AND CONS OF REPLACING SOME OF EXISTING MOORINGS WITH A NEW MARINA COMPLEX, AS WELL AS MARINA FACILITIES SUCH AS SEWAGE PUMP-OUT

L RESTRICT NUMBER AND EXTENT OF FUTURE ADDITIONAL MOORINGS. CONSIDER FEASIBILITY OF INTRODUCING LESS SPACE CONSUMING MOORING MEASURES

O EXAMINE DETAILED FEASIBILITY OF CARRYING OUT LOCALISED DREDGING AROUND PERIPHERIES OF DELTA IN VICINITY OF PRIVATE PONTOONS AND JETTIES



NON-SPECIFIC REGIONAL MANAGEMENT TASKS

Z1 POLLUTION HOTLINE TO INFORM COUNCIL OF POLLUTION WITHIN TRIBUTARY CREEKS

Z2 INVESTIGATE NEED FOR SEWAGE PUMP-OUT AND LONG TERM IMPACTS OF BOAT DISCHARGES

Z3 INVESTIGATE WATER QUALITY AND IDENTIFY SOURCES OF WATER QUALITY POLLUTION

Z4 INVESTIGATE SEDIMENT QUALITY IN DEEPER SECTIONS OF THE BAY

Z5 ASSESS COLLECTED LITTER AND OTHER POLLUTION TO DETERMINE SOURCES AND MEANS OF REDUCTION

Z6 ENSURE STRICT COMPLIANCE OF DEVELOPMENT CONSENTS FOR BUILDING SITES

Z7 MONITOR THE EXTENT AND HEALTH OF SEAGRASSES

Z8 IMPOSE STRICTER SPEED RESTRICTIONS WITHIN DIFFERENT SECTIONS OF THE BAY

Z9 PLACE INTERPRETATIVE SIGNAGE WITHIN THE YOWIE BAY CATCHMENT TO EDUCATE THE COMMUNITY

NOTE: NOT ALL MANAGEMENT TASKS ARE SHOWN ON THIS DRAWING REFER TO REPORT FOR FULL LIST OF MANAGEMENT TASKS

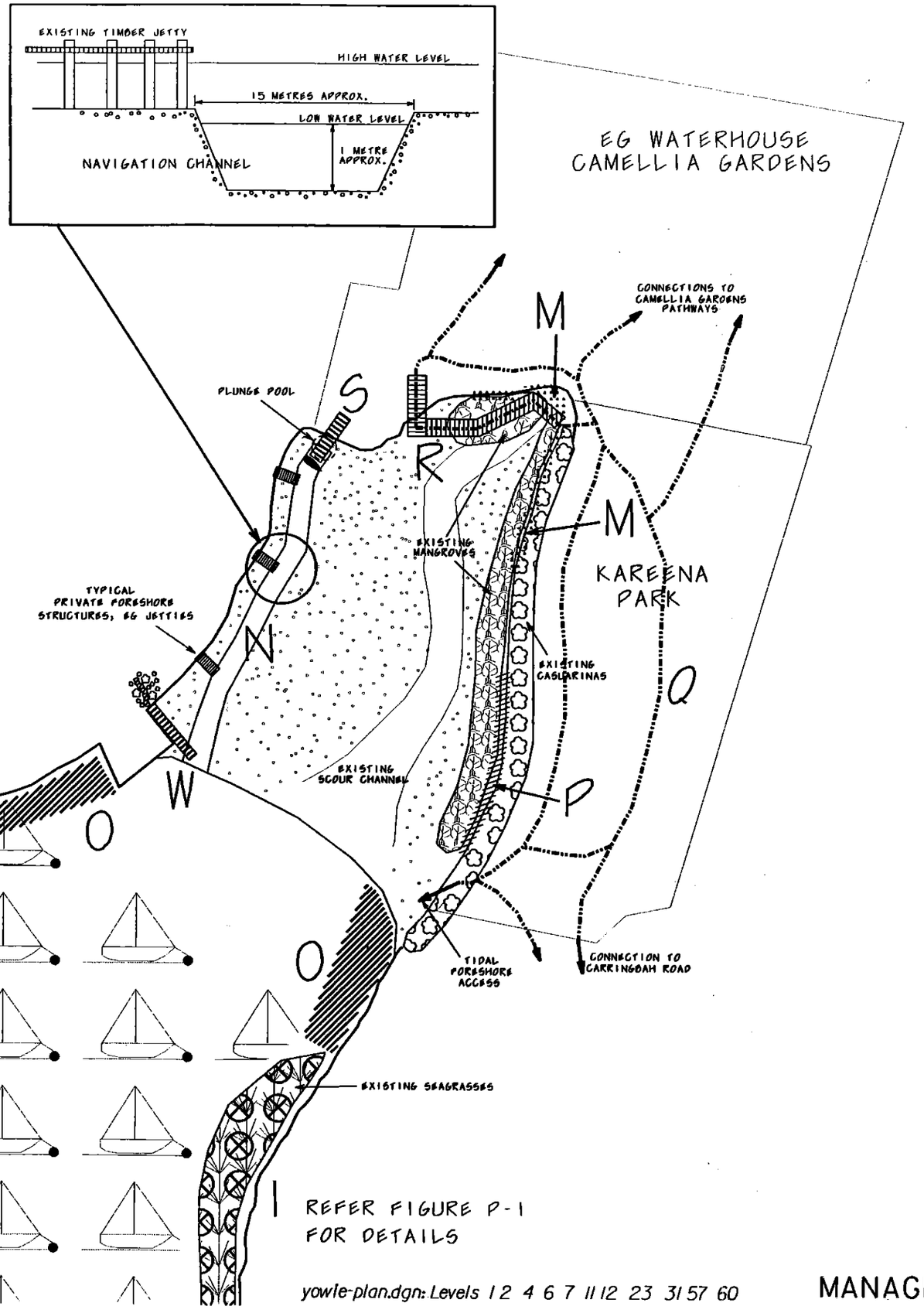
0 500 m

YOWIE BAY ESTUARY MANAGEMENT PLAN

REGIONAL MANAGEMENT TASKS

yowie-plan-reg.dgn: Levels 9 21 22 29 31 49 50 57 63

FIGURE P-2



M — ENCOURAGE AND SUPPORT COMMUNITY GROUPS TO ENHANCE HABITAT AND IMPROVE APPEARANCE OF FORESHORE BY REGULAR REMOVAL OF LITTER

N — CREATE A NAVIGATION CHANNEL TO PROVIDE SMALL CRAFT ACCESS TO WATERFRONT PROPERTIES AND TO PROVIDE TIDAL FLUSHING OF PLUNGE POOL. DEPENDING ON THE FREQUENCY OF USE, THE PLANTING OF SEAGRASSES IN THE NAVIGATION CHANNEL MAY BE CONSIDERED

O — CARRY OUT LOCALISED DREDGING AROUND PERIPHERIES OF DELTA IN VICINITY OF PRIVATE RAMPS PONTOONS AND JETTIES

P — ENHANCE MARINE HABITAT BY POSSIBLE PLANTING OF SALTMARSHES IN CONJUNCTION WITH LITTER CLEAN-UP - TASK M

DEVELOP ECO-EDUCATIONAL TRAILS AROUND THE FORESHORE INCLUDING:

Q — PROVIDE WALKING TRAILS WITH INTERPRETIVE SIGNAGE - INDICATIVE ONLY

R — PROVIDE MANGROVE BOARDWALKS WITH INTERPRETIVE SIGNAGE - INDICATIVE ONLY

S — PROVIDE TIMBER LANDING JETTY TO PROVIDE BOATING ACCESS TO CAMELLIA GARDENS AND WALKING TRAILS - INDICATIVE ONLY

W — RESTORE TIMBER JETTY TO PROVIDE WATER ACCESS AND A VIEWING PLATFORM FOR CAMELLIA GARDENS BAY AND PROVIDE SAFE ACCESS TO JETTY FROM MATSON CRESCENT

NON-SPECIFIC CAMELLIA GARDENS BAY MANAGEMENT TASKS

Z10 — DEVELOP SCHOOL PROJECT KITS AND ORGANISE GUIDED WALKING TOURS OF YOWIE BAY FORESHORES AND KAREENA PARK

Z11 — PROMOTE KAREENA PARK AS A "NATIVE" GARDEN WHICH CONTRASTS TO THE ADJACENT CAMELLIA GARDENS

NOTE: NOT ALL MANAGEMENT TASKS ARE SHOWN ON THIS DRAWING REFER TO REPORT FOR FULL LIST OF MANAGEMENT TASKS

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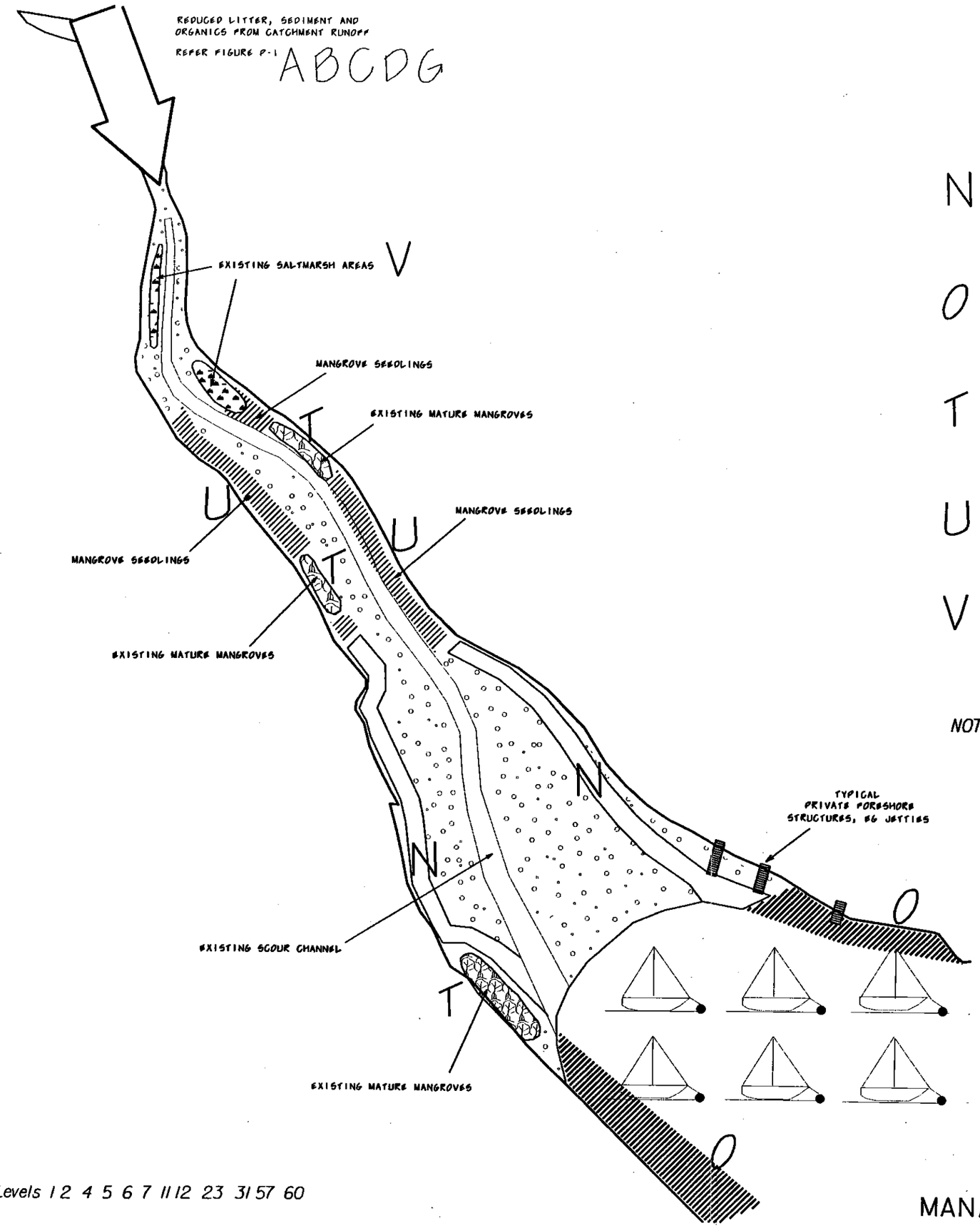
YOWIE BAY ESTUARY MANAGEMENT PLAN

MANAGEMENT OPTIONS - CAMELLIA GARDENS BAY

yowie-plan.dgn: Levels 1 2 4 6 7 11 12 23 31 57 60

FIGURE P-3



N — CREATE A NAVIGATION CHANNEL TO PROVIDE SMALL CRAFT ACCESS TO WATERFRONT PROPERTIES

DEPENDING ON THE FREQUENCY OF USE, THE PLANTING OF SEAGRASSES IN THE NAVIGATION CHANNELS MAY BE CONSIDERED

O — CARRY OUT LOCALISED DREDGING AROUND PERIPHERIES OF DELTA IN VICINITY OF PRIVATE RAMPS PONTOONS AND JETTIES ALSO, REFER FIGURE P-2

T — PROVIDE ADEQUATE PLANNING CONTROLS TO PROTECT EXISTING STANDS OF MATURE MANGROVES AGAINST DAMAGE OR REMOVAL TO RETAIN HABITAT DIVERSITY. IMPLEMENT COMMUNITY AWARENESS PROGRAM

U — PROVIDE ADEQUATE PLANNING CONTROLS TO PROTECT JUVENILE MANGROVES AND SEEDLINGS AGAINST DAMAGE OR REMOVAL. IMPLEMENT COMMUNITY AWARENESS PROGRAM

V — PROVIDE ADEQUATE PLANNING CONTROLS TO PROTECT EXISTING AREAS OF SALTMARSHES ON HIGHER SECTIONS OF THE DELTA SAND FLATS. IMPLEMENT COMMUNITY AWARENESS PROGRAM

NOTE: NOT ALL MANAGEMENT TASKS ARE SHOWN ON THIS DRAWING REFER TO REPORT FOR FULL LIST OF MANAGEMENT TASKS

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YOWIE BAY
ESTUARY MANAGEMENT PLAN
MANAGEMENT OPTIONS - EWEY CREEK BAY

yowie-plan.dgn: Levels 1 2 4 5 6 7 11 12 23 31 57 60

6.1 REDUCE POLLUTION IN THE BAY

The pollution in Yowie Bay is mostly derived from the urban catchment. Typical urban pollution comprises floatable litter *(which is mostly derived from the commercial / retail centres within the catchment)*, lawn clippings, natural leaf and twig detritus, and runoff from building sites. Spills associated with boating on the bay also contribute to pollution. During storm events, sewer overflows also discharge raw sewage into the bay, further polluting the estuary.

SPECIFIC WORKS

Install more litter collection devices (option 1)

Litter collection devices operating in the catchment presently include trash racks, gross pollutant traps and CDS units, with a varying degree of efficiency *(which is a function of the type of device, and the maintenance / cleaning schedule)*. The Plan calls for a high priority to be given to the reduction of urban stormwater pollution. Therefore Council should give consideration to installing more litter collection devices within the catchment. Highest priority would be the reduction of pollution in Ewey Creek, downstream of Miranda Fair and Gymea Shopping Centres.

A: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Regular garden refuse collection service (option 6)

The Plan recognises the need for reducing organic detritus within the stormwater system. Therefore, Council should examine the feasibility and cost implications of implementing a garden refuse collection service across the whole Shire, including Yowie Bay, as part of the weekly garbage and recycling services. This collection would discourage the community from discarding the waste into drains, vacant lots or creek reserves. The feasibility assessments should include the possibility of mulching and selling the refuse to help offset costs of collection.

The Plan identifies a need for Council to initiate and maintain a community awareness program to encourage the community to reduce household and garden waste. A formal monitoring program would be required to determine the on-going effectiveness of the campaign.

B: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

COMMUNITY-WIDE INITIATIVES

Clean-up campaigns (option 2)

The Plan recognises the need for physical removal of the litter and flotsam which accumulates around the foreshores of Yowie Bay, particularly at the heads of the bay. Hence, Council should encourage and support community-based clean-up campaigns on a regular basis. Council support could be provided by way of services and resources, and also supplementary volunteers through the Bushcare group. Clean-up campaigns should be conducted at least on a quarterly basis, and should focus on areas of high visitation, such as around the Camellia Gardens and Kareena Park reserve.

M: ***Refer Yowie Bay Estuary Management Plan: Figure P-2***

Litter reduction measures for local businesses (option 3)

The Plan identifies that there could be considerable merit derived from Council initiating discussions with local businesses to determine ways in which commercial and retail litter can be reduced. Support from the community and positive media promotion would encourage businesses to become involved in such campaigns.

C: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Weed removal & native gardens (option 5)

The Plan recognises that non-indigenous plant species generally result in significantly more production of organic detritus than native species *(particularly during autumn)*. Through a series of community awareness programs which should be initiated by Council, the community could be encouraged to use native plants, where possible, to minimise the organic material load to the waterways. Removal of weeds from private yards would also stem the proliferation of weeds along creek reserves and foreshore areas, which also contribute to the organic material in the creeks.

D: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Bilge blankets for moored and berthed vessels (option 7)

The Plan recognises the desirability of reducing discharges from vessels within Yowie Bay. Therefore, Council should encourage the use of bilge blankets in moored and berthed vessels. Bilge blankets are capable of absorbing large amounts of oils and hydrocarbons, thus preventing spills from entering the waterway. Discussions could also be held with Waterways Authority to make the use of bilge blankets a licence requirement.

E: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Pollution Hotline (new option)

The Plan recognises the potential benefits from a response system which is geared for quick notification of pollution within the waterways. Thus, Council should establish a procedure whereby community members could ring appropriate Council personnel when pollution within the urban creeks is observed. Residents living along the creek would be informed about the service, and encouraged to contact Council when necessary. Swift action by residents and Council would result in pollution sources being identified, and appropriate action *(and prosecution, if appropriate)* being taken.

z1: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

FURTHER INVESTIGATIONS AND CONSULTATIONS

Boat discharge restrictions and pump-out (option 8)

The Plan identifies a need to minimise future boat discharges. Therefore, Council should investigate the need for boat sewage pump-out services in Yowie Bay, and determine the long term impact of allowing sewage discharge from vessels to continue to be discharged into the waterway.

z2: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Water quality and sources of pollution

The Plan recognises that water quality at the heads of the bay, and in the major tributaries is showing signs of pollution. To address this, Council should carry out a detailed assessment of the water quality processes at the heads of the bay. The assessment should quantify the

(option 9)

sources of pollution, the impacts of deteriorating water quality on the marine habitats, and the potential hazards to the community. A further assessment of the toxicity of oysters and other shell life should be carried out to provide additional insight into the water quality status of the bay.

z3: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Sediment quality in deeper section of bay

(option 9)

The deeper sections of Yowie Bay would have received a significant amount of finer material associated with catchment runoff over the last 150 years. The Plan recognises that these sediments may affect the water quality and marine habitats of Yowie Bay. As such, Council should test these bed sediments to determine if they contain significant levels of pollutants, and if these pollutants are likely to impact on the water column. The Plan also recognises the need to determine the existing sediment quality as a benchmark which should then be monitored over time.

z4: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Upgrade sewer overflow system

(option 10)

The Plan recognises that Yowie Bay receives sewage effluent from a number of sewer overflows within the catchment. To address this issue, Council should continue to lobby Sydney Water to upgrade the existing sewer system and minimise the amount of sewer overflows entering the waterway. Where feasible, Council should collect water quality data on the sewer overflows so as to provide hard evidence and strengthen Council's case for upgrading of the system. Such data should be collected by Council whenever overflows are known to occur *(ie, after significant rainfall events)*.

F: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Assessment of collected litter & other pollution

(new option)

The Plan recognises that a study of material collected from interception devices and during clean-up campaigns would provide further insight into the sources of the pollution, and also possible means of preventing or improving interception of the pollution before it reaches the Yowie Bay receiving waters. Therefore, Council should initiate a comprehensive inventory of the performance of its interception devices *(ie, quantity and*

physical and chemical composition of intercepted material).

z5: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

6.2 REDUCE SILTATION FROM CATCHMENT RUNOFF

Siltation associated with catchment runoff has been a significant problem for Yowie Bay in the past. Although the amount of sediment runoff presently coming from the catchment would be considerably less than that which occurred during the original urbanisation of the catchment some 30 to 40 years ago *(typically 10 times less*[7]*)*, existing catchment practices still provide some sediment load into the bay. The community has been particularly critical of the recent policy of site redevelopment, where the control of site runoff may not always be in accordance with approved sediment control plans. Other sources of sediment may be the bed and banks of creeks, as well as general urban runoff associated with established properties.

SPECIFIC WORKS

Install more sediment control devices (option 11)

Sediment control structures currently operating in the catchment include gross pollutant traps and CDS units, with a varying degree of efficiency *(which is a function of the type of device, and the maintenance / cleaning schedule)*. The Plan calls for a high priority to be given to the reduction of sediment entering the bay from catchment runoff. Therefore, Council should install more sediment control devices within the catchment. Highest priority would be given to the reduction of sediment in Ewey Creek, which presently has no sediment control measures.

The sediment load from the Ewey Creek catchment has been predicted to be in the order of 200 tonnes *(or 110 m^3)* per year[7]. At present, this would result in additional shoaling of the sand delta at the head of the bay by an average of almost 5 cm approximately every decade.

A: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

[7] Patterson Britton and Partners (1996) *Yowie Bay Estuary Processes Study* Prepared for Sutherland Shire Council

Erosion control within creek reserves (option 12)

A possible source of sediment entering Yowie Bay is from the creek reserves, and specifically from the bed and banks of the creeks. Because of urbanisation of the catchment, the flows conveyed along the creeks would be significantly greater than pre-european conditions. As such, the higher discharges and velocities would readjust the creek alignment through erosion of the creek bed and banks.

The Plan recognises the need to minimise erosion of the tributary creek channels. As such, Council should consider options for minimising such erosion through the construction of flow control structures to reduced velocities, and / or regrading and revegetation of the creek banks. Council should carry out a comprehensive assessment of the creeks to identify erosion sites and possible amelioration measures.

G: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Ensure strict compliance with development consents (option 13)

One source of pollution within the catchment is runoff and discharges from building redevelopment sites. The community has raised concerns that the runoff from such building sites causes significant discolouration in the creeks after rainfall events. The Plan recognises that appropriate action should occur to prevent or minimise the impacts of site runoff. Therefore, Council should inspect building sites on a regular basis, and ensure that site runoff measures are implemented in accordance with development consent conditions.

The Plan also recognises that the community can be encouraged to help by notifying appropriate Council personnel when pollution in the creeks is observed. Swift action by residents and Council can result in preventative action, and possibly prosecution, taking place. A pollution hotline should be established by Council for this purpose *(refer previous water quality tasks)*.

Z6: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

Small navigation channels and peripheral dredging

The Plan recognises the need to reinstate small craft access to waterfront properties. Dredging can be costly and there is a need to adopt a practical scale of works which recognises the habitat value of the present day shoals. As a small scale solution, the Plan indicates that

(option 15) Council should consider dredging of small navigation channels along the northern and southern foreshores of Ewey Creek bay for a distance of some 200 - 250 metres from the delta edge, and along the western edge of the Camellia Gardens bay for a distance of approximately 150 metres from the delta edge. These channels would tie into existing private pontoons and jetties. The channel in Camellia Gardens bay would continue to the existing plunge pool to promote regular tidal flushing, and hence improved water and sediment quality.

Approximately 8,500 cubic metres of material would need to be removed to form these channels. Council would need to consider alternatives for disposal of the material removed from these channels.

N: ***Refer Yowie Bay Estuary Management Plan: Figures P-2 and P-3***

The Plan also identifies a need for localised dredging along the peripheries of the deltas, in the vicinity of pontoons and jetties where foreshore structures on the edge of the deltas have lost considerable water depth due to the encroachment of the sand deltas. Hence, Council's dredging feasibility assessment should include these localised areas of dredging.

Dredging around these pontoons may require the removal of up to an additional 2,000 cubic metres of sediment. Again, Council should consider alternatives for the disposal of the material removed by the dredging. Dredging should not occur in areas of existing seagrass beds, such as adjacent to the northern end of Baliga Avenue.

O: ***Refer Yowie Bay Estuary Management Plan: Figure P-2***

These channels, particularly the Ewey Creek channel, would be subject to sediment movement across the surface of the sand delta. As such, they may be infilled by redistribution of fine sand from the delta within a planning time-frame. Council should consider the needs and costs of on-going maintenance dredging of these channels, as well as long term implications for disposal of the dredged material.

6.3 MAINTAIN ENVIRONMENTAL SIGNIFICANCE

The marine habitat of Yowie Bay has been altered as a result of urbanisation of the catchment, and the subsequent shoaling of the deltas at the heads of the bay. It is impossible to judge whether this change has had a positive or negative effect on the environment, as the present marine habitat offers many benefits which were previously not offered, and which are somewhat rare in the Port Hacking area. Hence a balanced environmental approach to the Plan is required which recognises the present worth of the existing marine habitat and places a priority on preventing or at least minimising future habitat degradation through continued urban occupation of the catchment.

SPECIFIC WORKS

Plant native vegetation along bay foreshores (option 21)

The Plan recognises that weeds such as Lantana and Privet currently infest some of the bay foreshores and creek reserves. Council should implement a program of broadscale eradication of these weeds and introduce a community awareness program to prevent their re-establishment within the Yowie Bay proximity.

As part of the eradication program, Council should consider planting appropriate native vegetation along the bay foreshore and creek reserves, where possible. A greater array of native vegetation will attract more birdlife to the area. Council should also continue to encourage the planting of native species on private land.

H: ***Refer Yowie Bay Estuary Management Plan: Figure P-1***

The Plan also identifies the opportunity for Council to enrich the marine habitat at the heads of the bay by planting saltmarsh species along the waters edge, such as immediately behind mangroves in the Camellia Gardens bay.

P: ***Refer Yowie Bay Estuary Management Plan: Figure P-2***

COMMUNITY-WIDE INITIATIVES

Protection of mangroves and mangrove seedlings

(option 18)

Stands of mangroves have established within contemporary times along the foreshores of the heads of the bay as a direct consequence of the shoaling of the deltas. Although mangroves were not a part of the original native environment of the heads of Yowie Bay, they have added to the overall marine diversity of the area by providing additional grounds for juvenile fish nurturing and feeding.

The Plan recognises the importance of mangroves to marine ecology and requires Council to ensure that current planning controls are adequate to protect the existing mangroves, and mangrove seedlings. Council should initiate a community awareness program outlining the benefits of mangroves to the marine habitat.

The peg roots of mangroves can result in accumulation of floatable litter and accelerated siltation. Litter and sediment, however, will be reduced through other Management Plan tasks. Therefore, once the Plan is implemented, the mangroves should have only positive benefits to the Yowie Bay environment.

T & U: ***Refer Yowie Bay Estuary Management Plan: Figure P-3***

The Plan also recognises the importance of saltmarshes to the marine ecology. Council should ensure that current planning controls are adequate to protect the existing areas of saltmarshes on the Ewey Creek delta.

V: ***Refer Yowie Bay Estuary Management Plan: Figure P-3***

Minimise boating in the vicinity of seagrasses beds

(option 19)

The Plan recognises that boating can severely damage seagrass beds through propeller wash, anchoring, and discharges / leaks. Consequently, Council should initiate awareness programs for the boating public to inform the public about the environmental importance of seagrasses in Yowie Bay *(especially as there are not many)*, and the potential impacts of boating on seagrass beds.

Council should also hold discussions with the Waterways Authority to establish areas, in the vicinity of existing seagrass beds, where it may be possible to prohibit the

use of power boats and anchoring.

Refer Yowie Bay Estuary Management Plan: Figure P-1

FURTHER INVESTIGATIONS AND CONSULTATIONS

Monitor the extent and health of seagrasses (option 20)

As seagrasses are *not* prolific in Yowie Bay, the existing beds are extremely valuable to the present marine habitats. Council should consider initiating programs to monitor the extent and health of the existing beds in Yowie Bay. Council may consider initiating discussions with NSW Fisheries at Cronulla to assist in establishing monitoring procedures and carrying out monitoring tasks.

Through seagrass monitoring, Council would address the long term management needs of seagrasses in Yowie Bay, including minimising future adverse effects of catchment urbanisation.

Refer Yowie Bay Estuary Management Plan: Figure P-1

6.4 IMPROVE BOATING IN THE BAY

The Yowie Bay waterway is used for a number of different purposes. Most notably is the accommodation of some 260 vessels on swing moorings, and launching of vessels via the Wonga Road boatramp. General facilities for the boating public around the Yowie Bay foreshores are somewhat limited. Conflicts of interest are also presently experienced by the powered and non-powered boating community.

SPECIFIC WORKS

Improve existing boatramp facilities (option 25)

The Plan recognises that there are only 4 boatramps within Port Hacking and consequently the Yowie Bay boatramp services a high demand. There are a limited number of formal and informal parking spaces for cars and trailers near the boatramp. Even though there is limited space, Council should carry out a feasibility assessment into improving facilities at the Yowie Bay boatramp to include services such as a boat wash-down area, improved parking, picnic and fish cleaning facilities

and small craft landing facilities.

J: *Refer Yowie Bay Estuary Management Plan: Figure P-1*

Replace existing moorings with a marina complex (option 26)

The present swing moorings occupy a large amount of space within Yowie Bay. Council could consider possible benefits of allowing developments for the partial replacement of swing moorings with an equivalent berth marina. Such a development would free up valuable waterway area, particularly at the northern end of Yowie Bay, and may also provide additional facilities which would attract visitors to the area. A boat pump-out facility would be a mandatory component of such a development.

K: *Refer Yowie Bay Estuary Management Plan: Figure P-1*

COMMUNITY-WIDE INITIATIVES

Impose stricter speed restrictions within the bay (options 23 & 24)

The most practical way to avoid conflicts between different users of the bay is to try and keep them segregated. Consequently, the Plan requires Council to examine, with the Waterways Authority, ways and means of encouraging non-powered vessels to use one section of the bay, say the northern end, and discouraging power boats in that area. This could be achieved through stricter speed restrictions and enforcement in chosen areas.

At present, a speed restriction of 8 knots only applies to the northern section of the bay *(ie, the area to the north of the Yowie Bay Marina).* Council should initiate discussions with the Waterways Authority with a view to possibly reducing the speed limit to 4 knots, and restricting the remainder of Yowie Bay, as far south as Turtle Road Bay, to 8 knots.

Restricting speeds within the middle, narrow section of the bay would significantly reduce the noise impacts of power boats on the adjacent property owners.

z8: *Refer Yowie Bay Estuary Management Plan: Figure P-1*

Restrict additional moorings in the bay (option 27)

At present, there is a total of 265 moorings within Yowie Bay. Although Waterways Authority is not under any pressure at present to significantly increase this number, Council should initiate discussions with Waterways Authority to impose restrictions on the addition of further moorings within the bay.

It is considered that swing mooring limit the recreational potential of the bay by occupying a considerable area per vessel. Alternative, higher density moorings would free a considerable area of the waterway. Council should examine the feasibility of introducing such measures such as a marina, fore and aft moorings and the like.

The long term consequences of mooring pressures in Yowie Bay is unknown, It is considered that a boating demand study should be carried out to better understand the long term needs and the options for accommodating future demand in a planned, environmentally sustainable manner.

Refer Yowie Bay Estuary Management Plan: Figure P-1

6.5 EDUCATION OF THE COMMUNITY

The general community does not always appreciate that many of its actions have a direct impact on the environmental sustainability of Yowie Bay. Community education is required to inform the community regarding specific issues of Yowie Bay, and the contribution each member of the community can make towards improved long-term management of Yowie Bay. Specific education campaigns should address:

- Litter reduction in commercial / retail areas
- Appropriate disposal of garden and household refuse
- Planting native vegetation
- Eradicating weeds
- Reporting of pollution in the creeks via a *Pollution Hotline*
- Eco-education

SPECIFIC WORKS

Eco-educational walks around the foreshores (option 28)

The Plan recognises the recreational and educational opportunities offered by the creation of walking trails, mangrove boardwalks and viewing platforms around the foreshores of Yowie Bay, each with interpretative signage, to enable the community to experience, view and learn about the various habitats of Yowie Bay and its foreshores. Consequently, specific works in this regard are included in the Plan.

A significant amount of work has been carried out in Kareena Park by local Bushcare groups, in terms of weed eradication and planting of native vegetation. Through interpretive signage, this park could be fully appreciated for the significant benefits it has to the local Yowie Bay environment.

Q R

S & W:

Refer Yowie Bay Estuary Management Plan: Figure P-2

Signage within catchment on Yowie Bay (option 30)

As part of the community awareness programs, Council should consider the installation of suitable educational signs within the catchment at appropriate vantage sites. These sites would be at community congregation areas, such as shopping centres and halls. The signs would provide interesting information on the impact of urbanisation on receiving waters in Yowie Bay. They would need to be periodically updated/changed to maintain interest and therefore awareness.

Council could also give consideration to having regular displays at shopping centres, such as displaying the contents of a trash rack, or school projects on Yowie Bay. Council could also investigate possibilities for starting a periodic column in the local newspaper about the environment, and regularly outline ways in which the community can serve the environment better, as well as drain stencilling throughout the catchment.

Z9:

Refer Yowie Bay Estuary Management Plan: Figure P-1

School project kits and guided tours (option 32)

Once an educational platform has been initiated around the Yowie Bay foreshores, and Kareena Park in particular, Council should consider developing a series of school project kits to help make children *(and their parents)* aware of the value of the Yowie Bay habitats, as well as the impact of humans on these habitats.

As a further step, Council could consider the feasibility of organising guided tours of the area, conducted by local authorities.

z10: ***Refer Yowie Bay Estuary Management Plan: Figure P-2***

COMMUNITY-WIDE INITIATIVES

Promote Kareena Park as a "native" garden (option 29)

Kareena Park is very important, as it is one of only a few areas of remnant bushland within the area. Because of its value to the environment, Kareena Park is protected from development under NSW SEPP No. 19 – *Bushland in Urban Areas.*

Kareena Park is located immediately adjacent to the EG Waterhouse National Camellia Gardens, which is visited by up to 2000 – 3000 people per week, many of which are international visitors. The Plan recognises that there is an opportunity to attract some of these visitors to Kareena Park to experience an "Australia native garden" in contrast to the formal Camellia Gardens. Through interpretative signage, visitors to Kareena Park could have a comprehensive environmental and educational experience of Yowie Bay.

z11: ***Refer Yowie Bay Estuary Management Plan: Figure P-2***

6.6 SUMMARY OF MANAGEMENT PLAN TASKS

Specific Tasks

A. *Reduce litter, organics and sediment by construction of more, or upgrading of existing, stormwater litter collection devices such as Pollutech CDS units, Humeceptor units or trash racks and GPTs*

B. *Reduce organics from Garden Refuse by regular collection service*

C. *Encourage and promote commercial and retail businesses to initiate measures to reduce litter*

D. *Reduce organic detritus through establishment of native species and removal of weeds in private gardens*

E. *Encourage reduction of oils and hydrocarbons due to use of bilge blankets in moored and berthed vessels*

F. *Reduce nutrients and bacteria due to sewer overflows by lobbying for sewer upgrading*

G. *Reduce sediment supply by installing erosion control measures within creek reserves*

H. *Remove weeds and replace with indigenous species*

I. *Protect seagrass pockets through community awareness program and examine scope for restricting boating activity including mooring and anchoring in vicinity of established seagrass beds*

J. *Upgrading boatramp facilities to provide improvements such as upgraded ramp, additional parking, boat washdown area, fish cleaning facilities, additional rubbish bins, public toilets, picnic amenities and small craft landing facilities*

K. *Examine feasibility and pros and cons of replacing some of the existing moorings with a new marina complex, as well as marina facilities, such as sewer pump-out*

L. *Restrict number and extent of future additional moorings. Examine feasibility of introducing less space consuming mooring measures*

M. *Encourage and support community groups to enhance habitat and improve appearance of foreshore by regular removal of litter*

N. *Create a navigation channel to provide small craft access to waterfront properties and to provide tidal flushing a plunge pool*

O. *Carry out localised dredging around peripheries of delta in vicinity of private pontoon and jetties*

P. *Enhance marine habitat by possible planting of saltmarshes in conjunction with litter clean-up (Task M)*

Q. *Provide interpretive signage along existing bush tracks in Kareena Park and provide eco-educational walking trails around the foreshore generally*

R. *Provide mangrove boardwalks with interpretive signage*

S. *Provide timber landing jetty to allow boating access to Camellia Gardens and walking trails*

T. *Provide adequate planning controls to protect existing stands of mature mangroves against damage or removal to retain habitat diversity. Implement relevant community awareness program*

U. *Provide adequate planning controls to protect juvenile mangroves and seedlings against damage or removal. Implement relevant community awareness program*

V. *Provide adequate planning controls to protect existing areas of saltmarshes on higher sections of the delta sand flats. Implement relevant community awareness program*

W. *Restore timber jetty to provide water access and a viewing platform for Camellia Gardens bay and provide safe access to jetty from Matson Crescent*

Non-specific Tasks

Z1. *Pollution Hotline to inform Council of pollution within tributary creeks*

Z2. *Investigate need for sewage pump-out and long term impacts of boat discharges*

Z3. *Investigate water quality and identify sources of water quality pollution*

Z4. *Investigate sediment quality in deeper sections of the bay*

Z5. *Assess collected litter and other pollution to determine sources and means of reduction*

Z6. *Ensure strict compliance of development consents for building sites*

Z7. *Monitor the extent and health of seagrasses*

Z8. *Impose stricter speed restrictions within different sections of the bay*

Z9. *Place interpretive signage within the Yowie Bay catchment to educate the community*

Z10. *Develop School project kits and organise guided walking tours of Yowie Bay foreshores and Kareena Park*

Z11. *Promote Kareena Park as a "native" garden which contrasts to the adjacent Camellia Gardens*

APPENDIX A
ADDITIONAL PLANNING INFORMATION

STATUTORY PLANNING POLICIES

State Environmental Planning Policy No. 35 - Maintenance Dredging of Tidal Waterways

SEPP No. 35 relates to dredging works required to maintain or restore tidal flows, or safe navigation routes for shipping in tidal waterways. The policy allows public authorities to carry out maintenance dredging in tidal waterways, provided that appropriate consultation and environmental impact assessments have been undertaken. The policy also requires the public authority to give notice in writing to authorities likely to be affected by, or having an interest in, the proposed dredging operation.

State Environmental Planning Policy No. 19 - Bushland in Urban Areas

SEPP No. 19 relates to *land on which there is vegetation which is either a remainder of the natural vegetation of the land or, if altered, is still representative of the structure and floristics of the natural vegetation.*

The aims of SEPP 19 are:

- *to protect the remnants of plant communities which were once characteristic of land now within an urban area;*
- *to retain bushland in parcels of a size and configuration which will enable the existing plant and animal communities to survive in the long term;*
- *to protect rare and endangered flora and fauna species;*
- *to protect habitats for native flora and fauna;*
- *to protect wildlife corridors and vegetation links with other nearby bushland;*
- *to protect bushland as a natural stabiliser of the soil surface;*
- *to protect bushland for its scenic values, and to retain the unique visual identity of the landscape;*
- *to protect significant geological features;*
- *to protect existing landforms, such as natural drainage lines, watercourses and foreshores;*
- *to protect archaeological relics;*
- *to protect the recreational potential of bushland;*
- *to protect the educational potential of bushland;*
- *to maintain bushland in locations which are readily accessible to the community; and*
- *to promote the management of bushland in a manner which protects and enhances the quality of the bushland and facilitates public enjoyment of the bushland compatible with its conservation.*

NSW Habitat Plan No.1

The plan protects existing mangroves, seagrasses and marine vegetation in NSW and aims to maintain existing populations of prawns and to protect endangered fish species. The plan requires the consent of the Minister for Fisheries for:

- *dredging or otherwise destroying seagrass, mangroves or other marine vegetation in NSW waters;*
- *erecting or altering a weir, barrage, dam or other obstruction in NSW waters; and*
- *opening an estuary to the sea.*

Consent would only be granted if the action will implement or achieve the objectives of the *Fisheries Management Act.*

GENERAL POLICIES AND GUIDELINES

NSW Government Estuary Management Policy and draft Manual 1992

The goal of the Estuary Management Policy is *to achieve an integrated, balanced, responsible and ecologically sustainable use of the State's estuaries.* The objectives of the policy are to:

- protect estuarine habitats and ecosystems; and
- prepare and implement balanced long-term management plans which address -
  conservation of aquatic and other wildlife habitats,
  conservation of the aesthetic values of estuaries and wetlands,
  estuary degradation,
  damage to the estuarine environment,
  sustainable use of estuarine resources.

The Estuary Management Manual provides a framework for planning and management in estuarine areas and includes information on physical, chemical and ecological processes to assist in decision making.

NSW Fisheries Estuarine Habitat Management Guidelines 1993

The Habitat Management Guidelines include information on important estuarine habitats and activities which may affect these habitats. The major objectives of estuarine habitat management, as set out in the guideline, include to:

- preserve and protect estuarine habitats and foreshores in their natural state through appropriate zonings and regulation;
- provide well marked foreshore reserves at least 30 m wide with full public access;
- ensure that development activities do not interfere with commercial and recreational fishing;
- ensure that pollution of estuaries is avoided, either by disposal of wastes to alternative sites or through high-level treatment;

- ensure that developments and activities do not restrict the tidal exchange of waters or block fish passage;
- protect and manage representative and unique aquatic habitats through gazettal as Aquatic Reserves;
- restore habitats where past damage has occurred and create new habitats where a development or activity may damage existing habitats.

NSW Public Works Marina Guidelines 1987

The marina guidelines identify the principle issues to be considered in development and assessment of marina proposals and provide technical advice on design concepts. The guidelines relate to recreational boats up to 20 m in length and contain information on:

- the marina approvals process;
- environmental issues;
- site selection and investigations;
- marina layout, materials and engineering design;
- safety;
- boat launching ramps;
- services; and
- maintenance.

Public Works Wharf and Jetty Guidelines 1990

The guidelines identify the principle issues that should be considered for wharf and jetty development, reconstruction or upgrading and provide technical guidance. Information provided generally covers the topics noted above for the Marina Guidelines.

SPECIFIC PLANS AND STRATEGIES

Hacking River Catchment Management Strategy 1996

Total Catchment Management (TCM) is defined as *the coordinated and sustainable use and management of land, water, vegetation and other natural resources on a catchment basis so as to balance resource utilisation and conservation.*

The Catchment Management Strategy prepared by the Hacking River Catchment Management Committee covers the catchments of both the Hacking River and Port Hacking. The goals of the Committee, as outlined in the strategy, are:

- *To facilitate a fundamental shift in attitudes and behaviour of the community to ensure that the natural resources and environmental values of the catchment are maintained and improved.*
- *To maintain and improve the water quality in the Hacking River catchment area.*
- *To maintain and enhance the ecosystems and natural recreational attributes of Port Hacking and the Hacking River.*

- *To balance urban development with other land uses in the catchment and to minimise its impacts on the surrounding environment through effective planning and management.*
- *To optimise the diversity and abundance of native flora, fauna and wildlife habitats in the Royal National Park and all land and water environments throughout the catchment.*

Port Hacking Plan of Management 1992

This report was prepared by the Port Hacking Planning and Advisory Committee and provides an overall framework for the management of Port Hacking, the Hacking River, and its catchment. The aims of the plan are to:

- *Preserve the ecological and aesthetic values of Port Hacking and its catchment.*
- *Provide the maximum opportunities for beneficial recreational and residential use of the Port and its surrounds, within the constraints of sustainable use.*
- *Provide a basis for the coordinated management of the entire Port and its catchment to achieve these ends.*

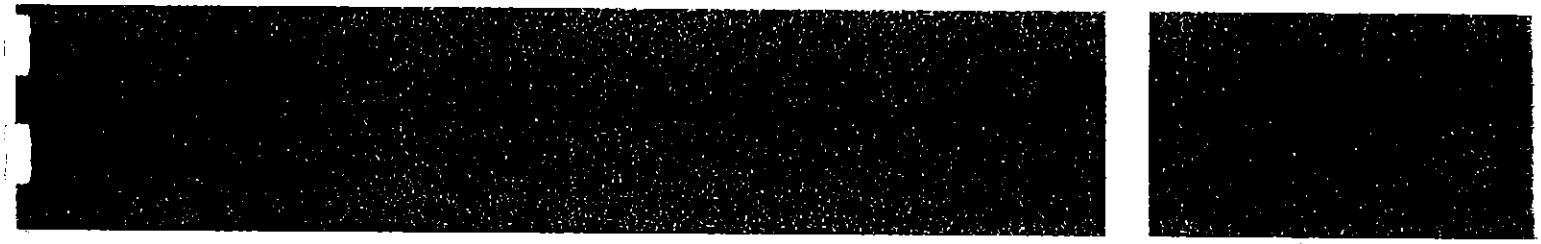
The plan contains background information on Port Hacking and a discussion on the various issues affecting the Port. It also contains aims, objectives, policies and actions to address issues, eg investigate heads of bay siltation areas and alternative measures for trash collection.

Assessment of Crown Land at Port Hacking 1991

The then Department of Conservation and Land Management undertook a Crown lands assessment under Part 3 of the Crown Lands Act 1989. The report contains brief descriptions of foreshore habitats and comments on the level of foreshore development, access and recreational capacity. It also contains recommendations on the suitability of various foreshore areas for new private foreshore structures.

APPENDIX B
SEDIMENT REMOVAL FEASIBILITY ASSESSMENT

SUTHERLAND SHIRE COUNCIL



YOWIE BAY
SEDIMENT REMOVAL FEASIBILITY ASSESSMENT

Issue No. 2
FEBRUARY 1999

Patterson Britton
& Partners Pty Ltd
consulting engineers

SUTHERLAND SHIRE COUNCIL

YOWIE BAY
SEDIMENT REMOVAL FEASIBILITY ASSESSMENT

Issue No. 2
FEBRUARY 1999

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TABLE OF CONTENTS

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This assessment has shown that the removal of contemporary sediment from the heads of Yowie Bay ***is technically feasible.***

The sediment can be removed in a number of different ways, however, the most technically feasible method would involve excavation via a small cutter suction dredger.

Excavation using land based equipment working from constructed bunds within the bays was considered and determined to be feasible for Camellia Gardens bay. However, vehicular access to the Ewey Creek bay would be difficult to obtain. Therefore, land-based options were considered not to be feasible for the Ewey Creek bay. Removal of the material from an excavator positioned on a barge which then pumps (or barges) the sediment onshore was also considered and determined to be technically feasible, however, costs of floating plant and equipment would be high, and would inhibit the practicality of this option.

A preliminary sediment quality analysis has shown that the majority of sediments are not contaminated, and can be classified as "Inert Waste" (according to the EPA's Environmental Guideline document "Assessment, Classification and Management of Non-Liquid Waste"). As a result, the material is suitable for disposal as cover material at Menai Tip (possibly free of tip fees, subject to specific negotiations between Council, Waste Services and EPA), or can be used as general fill at other designated local sites.

Government authorities were contacted regarding the possible removal of sediments from the heads of Yowie Bay. In general, authorities were receptive to the proposal providing that the works were carried out in a manner which does not destroy or damage marine and terrestrial habitats, and the proposal includes adequate controls to minimise environmental and social disturbances. An EIS would be required to fully describe the nature of identify the existing environment and quantify the impacts that the proposal would have on the environment. Items identified by each authority which would need to be considered by the EIS are included in **Section 9**.

Costs associated with the proposal vary between about $1.4 million and $3.5 million, depending on the method of removal, the end use of the material, and the extent and quality of the sediment removed (ie the study found that there are some pockets of slightly contaminated / polluted sediment which would need to be removed and handled separately). The project would likely take between 4 and 12 months to complete, again depending on the method adopted for removing the material, and the extent and quality of the material being removed.

1 BACKGROUND

Sediments have accumulated in the heads of Yowie Bay as a result of catchment development and urbanisation over the past 100 years. The sediment, which generally comprises slightly silty sands, has raised the surface of the natural alluvial deltas at the heads of the bay by 0.3 to 1.0 metres, causing extensive loss of navigation amenity and loss of low tide, shallow water habitat. The sediment build-up has prograded the delta 'drop-offs' by approximately 20 metres seaward. Preliminary calculations have estimated the quantity of contemporary sediment build-up as approximately 30,000m^3, or about 50,000 tonnes (PBP, 1995)[1]. **Figure 1** shows the extent of contemporary sedimentation in the heads of Yowie Bay.

As part of developing an overall Management Plan for the bay The Yowie Bay Estuary Management Committee of Sutherland Shire Council is investigating the feasibility of removing all contemporary sediments from the heads of the bay, in order to restore the deltas to their former, deeper water condition.

A number of factors influence the feasibility of removing the contemporary sediments from the heads of Yowie Bay. These factors include:

- The quality of the sediment (ie, the grain size and degree of pollutants contained within);
- Disposal location (s) for the removed sediment;
- Method of physical removal;
- Method of transportation to the disposal location (s);
- Pre-disposal treatment requirements; and
- Restrictions / conditions imposed by various Government Authorities.

As well as consideration for the above factors, indicative costs have been estimated, and likely environmental and social considerations have been identified.

[1] Patterson Britton and Partners (1995) Yowie Bay Estuary Processes Study Prepared for Sutherland Shire Council

2 SEDIMENT QUALITY ANALYSIS

Five (5) sediment samples taken from the heads of Yowie Bay were analysed for pollutants and other chemical residuals as part of the previous Yowie Bay Estuary Processes Study (PBP, 1995). The five sample locations included one location directly below a sewer overflow, two samples below stormwater outlets, and two samples from the sandy delta flats. The results of this geochemical analysis are shown in **Table 1**.

Constituent	Maximum Value Measured (mg/kg)	Minimum Value Measured (mg/kg)
Arsenic	6.5	3.4
Cadmium	<0.05	<0.05
Cobalt	5.9	0.75
Chromium	13.1	4.5
Copper	47.2	5.9
Lead	309	42.5
Manganese	278	15.5
Nickel	11.9	1.95
Zinc	112	33.5
Mercury	<0.05	<0.05
PAH's	0.1	<0.1
PCB's	<0.02	<0.02
Chemical Oxygen Demand	11,600	4,570
Total Phenolics	7.8	3.9
Total Nitrogen	323	108
Total Phosphorus	211	-

Table 1: Assessment of Sediment Quality (from PBP, 1995)

When compared to ANZECC guidelines (ANZECC, 1992)[2] all constituents in Table 1 were within the range of typical background concentrations, with the exception of Lead and Total Phenolics. Elevated concentrations of these constituents indicate that the sediment has been

[2] Australian & New Zealand Environment and Conservation Council (1992) Australian Water Quality Guidelines for Fresh and Marine Waters

affected by typical urban runoff, however, the EPA has indicated that the Lead and Total Phenolic concentrations were not excessively high, and hence were not of concern (PBP, 1995).

Since this previous assessment, the NSW EPA has developed a guideline / classification document for sediments(EPA, 1997)[3]. This documents allows for the classification of sediments into one of four categories, viz: Inert, Solid, Industrial and Hazardous. Materials handling and disposal requirements depend on the classification of the sediment.

According to the guidelines set out by EPA (1997, Table A2), the sediments at the heads of Yowie Bay would be classified as 'Industrial Waste', due to the measured concentrations of Lead. Apart from Chromium and Nickel, which are in the 'Solid Waste' category range of values, all other measured constituents are within the 'Inert Waste' range of values. With a classification of 'Industrial Waste', the sediments could only be disposed at designated landfills, such as Lucas Heights.

The EPA guidelines indicate that sediments with elevated total concentrations of pollutants can be reclassified based on the leachable concentrations of these pollutants. Therefore, as part of this assessment process, sediment samples were again collected from the same locations in the heads of Yowie Bay, as well as from cores taken at the edge of the deltas, and analysed for potential leachable concentration for Lead, Chromium and Nickel. The results are summarised in **Table 2.** The complete sediment quality analysis, along with results of a sedimentological analysis of the material extracted from the cores taken at the delta drop-offs, are provided in **Appendix A.**

Constituent	Maximum Value Measured (mg/l)	Minimum Value Measured (mg/l)
Chromium	< 0.05	< 0.05
Lead	< 0.05	1.6
Nickel	< 0.04	< 0.04

Table 2: Assessment of Potential Leachable Metals

For all sampled sites, leachable concentrations of Chromium and Nickel were < 0.05mg/L and < 0.04mg/L, respectively. These concentrations place them well within the 'Inert Waste' category. For Lead, all but one sample recorded a concentration of between 0.2 mg/L and 0.5 mg/L. The one exception, with as concentration of 1.6 mg/L, was sampled directly below the sewer overflow in Ewey Creek. If this one high value was disregarded, the maximum value for leachable concentration of Lead would be 0.5 mg/L, and hence, the greater majority of the sediments can be classified as 'Inert Waste'. If the one high value is included in the assessment, the sediment would be classified as 'Solid Waste'.

[3] NSW Environment Protection Authority (1997) Environmental Guidelines: Assessment, Classification and Management of Non-Liquid Waste

Significant disposal benefits would be attained if the material could be classified as inert waste rather than solid waste. Therefore, it may be considered appropriate not to remove any pockets of sediments from the heads of the bay which contain Lead leachate concentrations in excess of 0.5 mg/L, or alternatively isolate this material and dispose of it separately in accordance with the requirements for Solid Waste. Based on the location of the sample with higher lead leachate concentrations, a conservative estimate of the quantity of material which may be classified as 'solid waste' would be about 10,000 tonnes, or 20% of the total amount of sediment to be removed.

During the design phase of the dredging project, rigorous sediment sampling would need to be carried out to identify and map the areas of the bay where leached lead concentrations exceed 0.5mg/L. The sediment within these areas could then be left in-situ, or handled and disposed of separately from the bulk of the sediment.

In addition to the geochemical analysis, four sediment samples were tested for acid sulphate leachate potential. Sediment was sampled from the cores taken at the edge of the deltas, one each from the top 0.5 metres and from a depth of approximately 2 – 3 metres below the surface (ie still within the contemporary sediment build-up on the prograded delta front). The analysis was carried out using the POCAS method. The results are summarised in **Table 3**.

Sample #	6	7	8	9	Action Criteria Limit[4]
S_{POS} (% w/w)	0.57	1.2	0.46	0.93	0.02
Ca_A (% w/w)	0.12	0.97	0.32	1.3	-
TPA (kg H_2SO_4/tonne)	2.5	< 0.5	< 0.5	< 0.5	0.6

*Refer to **Figure A1** in **Appendix A** for locations of sediment samples*

Table 3: Results of Acid Sulphate Leachate Potential Analysis

The results show that there is significant potential for acid leachate in the material, as indicated by the high S_{POS} values in relation to the action criteria limit. However, the natural buffering / neutralising capacity of the soil, due to the naturally occurring shell content, was also high for 3 out of the 4 samples (as indicated by the Ca_A values), meaning that the net acid leachate potential (TPA), was higher than the action criteria for only one sample (Sample No 6, representing the top 450mm of sediment at the distal edge of the Ewey Creek delta). Based on the concentration of potential acid leached from the one sample, approximately 4 kilograms of lime would be required to neutralise the leachate for each tonne of material excavated from the heads of Yowie Bay.

[4] Department of Urban Affair and Planning and ASSMAC (1997) Acid Sulphate Soils Workshop Resource Manual

3 DISPOSAL OF SEDIMENTS

Four sites were identified by Council as possible disposal location for the sediment from Yowie Bay. These sites are Kurnell landfill, Lucas Heights I or II (Menai tip), the abandoned rock quarry adjacent to Ewey Creek, and the abandoned clay pit in Kirrawee – refer **Figure 2**. The feasibility of disposing sediments from the heads of Yowie Bay at these sites was investigated, as outlined below.

3.1 KURNELL LANDFILL

The Kurnell Land Fill Company was initially approached by Council with the concept of using the Yowie Bay sediments within their existing sand extraction and processing operation. After reviewing the Yowie Bay Estuary Processes Study (PBP, 1995), which outlined some indicative sediment quality results, Kurnell Land Fill Company advised Council that they would not be interested in accepting any material from the heads of Yowie Bay, as it would not be feasible, nor viable, and they would not be prepared to potentially contaminate the existing site groundwater with saline, or polluted leachate. A copy of the letter from Kurnell Landfill outlining this decision is provided in **Appendix B**.

3.2 LUCAS HEIGHTS I OR II (MENAI TIP)

Lucas Heights can accept inert, solid or hazardous waste material. The current fee for disposal of mixed waste is $56.50/tonne *(pers. comm. P Baxter, Waste Services)*. Although the Tip would accept the material regardless of its sediment quality, the material would need to be in an appropriate physical condition, ie it would need to be unsaturated and compactable. On-site trials would need to be carried out to verify the physical condition of the sediment before it would be accepted by Menai Tip.

As outlined in **Section 2**, the majority of the sediment does not pose any risk, and as a result, can be categorised as 'Inert Waste'. From discussions with Waste Services NSW, who operate the Lucas Heights Waste Centre, it was indicated that there may be some opportunity to use the Inert Yowie Bay sediments as cover material *(pers. comm. P Baxter, Waste Services)*. Normally, EPA would only permit clean excavated fill to be used as cover material, however, as there is a shortage at present, an exception may be made if no risks are posed.

If this is possible, disposal of the material may be free of charge (including a rebate on the Government levy on waste, presently $17/tonne, which would have to be claimed by the landfill operator) *(pers comm P Baxter, Waste Services and Neil Phillip, NSW EPA)*.

3.3 ROCK QUARRY NEXT TO EWEY CREEK

The land is owned by Council, and is maintained by a local Bushcare group. Council has indicated that limited space may be available for the disposal of sediments, however, a Local Environmental Plan (LEP) and an Environmental Impact Statement (EIS) would be required to determine potential impacts on existing vegetation, habitats and groundwater. A likely outcome of the EIS would be that the material would need to be free of precipitated salt, as saline runoff from the material could significantly affect the existing ecological and vegetative habitats of the quarry, and along the creek.

In principal, EPA would permit the disposal of the sediment at the rock quarry providing that it poses no risk (ie, it can be classified as 'Inert Waste'). For quantities in excess of 20,000 tonnes, a waste licence would be required under the Waste Minimisation and Management Act (1995) *(pers comm Neil Phillip, EPA)*.

Assuming an area of 100m by 100m is available within the old rock quarry for disposal of the sediments, the fill would be approximately 3 to 4 metres high assuming all the material was disposed at this site (subject to bulkage and compaction factors).

3.4 BRICK PIT IN KIRRAWEE

The land known as the old Brick Pit in Kirrawee is owned by Australian Water Technologies (AWT). In the past, they have rejected all requests for disposal of spoil material on the site because of fears of contamination and non-compactability. The site is 'ear-marked' for sale by the end of 1998, however, AWT would be prepared to consider a request for disposal, providing evidence is shown that the material is not contaminated and has sufficient compactability *(pers. comm. Paul Carroll, AWT Property Services)*.

As the material is slightly silty sands, it should have sufficient compactability providing it is well drained before disposal. With regard to contamination, the material to be removed can be classified as Inert Waste (assuming areas of higher Lead concentration are either left undisturbed, or are handled separately and excluded from this disposal location), therefore runoff or groundwater seepage through the material should not be problematic.

In principal, EPA would also permit the disposal of the sediment at the abandoned Brick Pit in Kirrawee providing that it poses no risk (ie, it can be classified as 'Inert Waste'). For quantities in excess of 20,000 tonnes, a waste licence would be required under the Waste Minimisation and Management Act (1995) *(pers comm Neil Phillip, EPA)*. Council has indicated that an LEP and an EIS would be required to identify all possible environmental impacts of the activity if the sediment from Yowie Bay was to be disposed at the Kirrawee Brick Pit, particularly in respect to aquatic fauna, which was noted in Council's response letter *(refer **Section 7 and Appendix C**)*.

Assuming an area within the Brick Pit of about 40,000m^2 is available for disposal, the material would fill the pit by a height of approximately 0.7 to 1.0 metres (subject to bulkage and compaction factors).

3.5 OTHER DISPOSAL ALTERNATIVES:

Although outside the scope of works for this dredging feasibility assessment, a couple of other disposal alternatives have been identified and discussed briefly.

Another option may be ***subaqueous disposal*** of the material within Port Hacking. Although bottom dumping of the material into the deeper holes of the estuary may not be acceptable to various authorities, options could be explored for use of the material to form shallow intertidal benches to regenerate mangrove colonies. If feasible, strict environmental controls, such as silt curtains, would be required to minimise the impacts of the subaqueous disposal on the estuary. It is envisaged that a works program, which combines the removal of sediment and the formation of intertidal benches, would need to be formulated with NSW Fisheries, as it is unlikely that such a large quantity of sediment (20,000 – 30,000m^3) could be utilised at the one time for mangrove recolonisation. This option is also subject to an appropriate site for the mangroves being located within a feasible proximity to the heads of Yowie Bay.

Another possibility may be to ***sell the material as top soil or general fill for domestic uses***. Although outside the scope of work for this feasibility assessment, preliminary investigations with the sand extraction industry have indicated that should the sand product prove to be saleable, it may be worth approximately $6/tonne (ie, total inert sediment value would be around $240,000) *(pers comm Peter Toole, Benedict Sand and Gravel)*.

Therefore, land-based removal is not feasible for Ewey Creek bay. Water-based methods would be required to remove contemporary sediments from the Ewey Creek bay (refer **Section 4.2**).

Costs associated with land-based removal (or the Camellia Gardens bay only) would reflect the difficulties associated with the removal process. The total volume of material which would need to be handled for construction of the working bunds would be approximately 4,000m^3, which is significant in comparison to the total volume of sediment to be removed (10,000 – 15,000m^3 from Camellia Gardens bay). The main advantage with this methodology, however, is the fact that the material would be relatively 'spadable' upon removal (ie easily drained), as compared to being in a slurry form, which would be the case if the material was to be dredged or hydraulically pumped (refer **Section 4.2**). Unlike water-based methods which are restricted in operation due to the tide (refer **Section 4.2**), land-based methods can operate throughout the tide, meaning that the removal of contemporary sediments for the Camellia Gardens bay would take about 2 - 4 months.

The land-based removal process would generally follow the basic steps outlined below:

1. A working bund would be constructed to the maximum length using dozers, tip trucks etc.
2. A long reach excavator would excavate the contemporary sediment from the delta and dump the material on the working bund or directly into a 4WD dump truck (a properly designed clamshell grab would minimise the collection of water during excavation);
3. A loader or 4WD truck would transport the material from the working platform to a temporary onshore dewatering stockpile (this stockpile would have a perimeter bund and a sedimentation trap to prevent fines from working back into the bay);
4. Dewatering would occur merely through gravitational drainage from the stockpile;
5. Once dewatered, the sediment would be screened to remove larger foreign objects, such as sticks, litter, oyster shells, etc;
6. Screened sediment would then be loaded into trucks and hauled to the designated disposal location (s) or stockpiled for loading and transportation at a later time;
7. Liquid tailings (supernatant) from the dewatering process would be filtered for fine material before being returned to the bay;
8. Fines and larger foreign objects would be disposed off-site.

4.2 WATER-BASED REMOVAL

Two main options exist for the material to be removed from water-based activities, viz:

- Equipment on barges; or
- Cutter suction dredger.

4.2.1 Equipment on Barges

The first option involves conventional land-based plant and equipment, such as an excavator, floated on a shallow draft barge. Material excavated from the delta could be placed in an adjacent barge and towed to a convenient unloading and processing location,

as shown in **Figure 4**, or could placed directly into a hopper barge and pumped to the onshore area via either a hydraulic or displacement pumping system.

If tow barges were adopted, an unloading facility at Camellia Gardens would be required (ie, another excavator with a toothless, or ditch cleaning bucket). Excavation activities and transportation to the onshore area would be restricted to higher states of the tide to avoid grounding of the barge. Excavation of the Camellia Gardens bay would need to be carried out before the Ewey Creek bay, or at least a deeper navigation channel within the Camellia Gardens bay would need to be excavated, and a docking facility, such as a wharf, would also need to be constructed at the Camellia Gardens site to facilitate unloading of the material.

For hydraulic pumping of the material, the excavator would dump sediment directly into a constant density tank located on a barge, which would also be fed by a continual inflow of salt water. From the sump of the constant density tank, the sand and water slurry would be pumped, via a hydraulic pump to the Camellia Gardens onshore facility. Treatment of the slurry onshore would be either in a containment pond or through another constant density tank and cyclone centrifuge, which is discussed in more detail in **Section 4.2.2**.

For displacement pumping, the sediment solids (ie no additional water) would be placed in a hopper and pumped via a displacement pump, such as a concrete pump. Removal of the material without excess water would be critical to ensuring efficient pumping rates and minimal pipe blockages (ie, a retrofitted clamshell grab would be necessary for excavation of the material).

The minimum draft for the excavator on the barge would be about 1 to 1.25 metres. This means that the operation could be carried out during higher states of the tide only. The barge would additionally be restricted to manoeuvre only within the area which had already been excavated (refer **Figure 4**). In order to minimise the draft of the barge, the excavator would be small, however, long-reach attachments would not be required, so the bucket capacity would be similar to that which was adopted for the land-based excavation method (ie 0.4 to 0.5m^3). With restricted operating hours due to the tides, this method of excavation is likely to take considerable time (in the order of 6 to 12 months for excavation of both bays).

As an alternative to manual removal of the sediment, a vacuum slurry pump could be attached to the end of the excavator arm. Sand and water would be combined at the pump intake to form a sand slurry, which would then be hydraulically piped directly to an onshore processing area. This methodology is expensive and inefficient for large areas, however, it avoids the need for additional barges and additional materials handling at the onshore processing site. This method is not common practice for larger removal volumes because of its ineffectiveness, and as such, would have significant cost penalties associated with its implementation.

4.2.2 Cutter Suction Dredger

The second water-based removal option involves dredging the material directly via a small cutter suction dredger, as shown in **Figure 5**. The sand and water slurry would be pumped directly to the Camellia Gardens onshore processing area from either bay. As for the excavator on a barge, the dredger would only be able to operate during the higher states of the tide and would be restricted to manoeuvre only within the area which had already been excavated. The dredger could essentially excavate its way into the bays, lowering the delta bed to a level which could accommodate its draft at high tide (in the order of 1 – 1.25 metres).

Once onshore, the sand and water slurry discharged by the dredger could be handled in one of two ways:

1. The first option, as shown in **Figure 6**, is to pump the slurry into a constant density tank (after an initial screening to remove larger foreign material). From the constant density tank, the slurry would be pumped into a cyclone centrifuge where the water component is extracted from the solids. The unsaturated sand would then be loaded into trucks for transport to the disposal sites, or would be stockpiled for transport at a later time. The tailings from the constant density tank, as well as the supernatant from the cyclone centrifuge would be directed into a sedimentation pond, where the fines would be removed before discharge back into the bay.

2. The other option is to pump the slurry directly into a containment pond, with high mounds of sediment forming under the discharge pipe (which would need to be moved at regular intervals). Over time, the natural gravitational drainage of the stockpiles would dewater the sandy sediment, which would then be excavated, screened for larger material and loaded into trucks for transport to disposal locations. The supernatant drained from the sediment piles would pass through a sedimentation pond to remove fines before discharge back into the bay. This approach is convenient if space is readily available, and sufficient time is available for the stockpiles to dewater naturally. Given the limited working area at the end of Kareena Road, it is envisaged that the former option would be more appropriate at Yowie Bay.

Considering the relatively difficult environment for dredging, it is estimated that the dredger would operate at a rate of approximately $100m^3/hr$ (solids) only. The efficiency of the dredging would be reduced further as it would operate during higher states of the tide only. As a result, dredging of both Camellia Gardens bay and Ewey Creek bay would take approximately 6 - 8 months to complete.

5 TRANSPORTATION METHODS

Of the four possible disposal locations identified by Council, only three have the potential to accept the material. The distance from these three locations from the heads of Yowie Bay varies considerably. The old rock quarry, adjacent to Ewey Creek just upstream of President Avenue, is the closest disposal location, being only a few hundred metres from the deltas.

Despite its close proximity, any material disposed at the old rock quarry would still need to be trucked to the site. Although technically feasible to pipe the material up Ewey Creek to the old quarry in the form of a sand and water slurry, the liquid component of the slurry would be saline and would drain back into Ewey Creek. This salt water would have significant detrimental affects on the ecological and floral habitats of the quarry and the creek.

The other two feasible disposal locations (viz: Kirrawee Brick Pit and Menai Tip) would also require trucking to the site, however, travel times to these sites would be considerably greater. Kirrawee Brick Pit is approximately 4.5 kilometres from Yowie Bay, while Menai Tip is approximately 18 kilometres from the disposal site.

Approximately 2,000 truck movements would be required to transport the 20,000 to 30,000 cubic metres of material from the heads of the bay (assuming 20 tonne capacity trucks).

Likely trucking routes are shown in **Figure 7**.

6 LIKELY TREATMENT REQUIREMENTS

Authorities have indicated that material would only be acceptable at the disposal locations if:

1. *It poses no risks (unless disposed at Menai Tip as mixed waste), and*
2. *It has adequate physical characteristics (ie, it is compactable).*

With respect to the first requirement, the initial sediment quality analysis indicated that the majority of the material does not pose a risk from heavy metal leachate, however, acid sulphate testing showed that there is a small risk of acid leachate if the material is oxidised. To overcome this risk, approximately 4 kilograms of lime would be required to be added to each tonne of sediment removed from the heads of Yowie Bay. In total, approximately 200 tonnes of lime would need to be added to the sediment. For convenience, liming of the material would take place during disposal, as it requires considerable area to spread the sediment, spread the lime, and then rotivate the mix, using conventional agricultural tillage plant and equipment or heavier duty earthworking rotary hoes. Temporary perimeter bunds would need to be constructed around the liming area to ensure lime-rich runoff does not escape into the natural waterways.

For the sediment which has a Lead leachate potential in excess of 0.5mg/L (ie, classified as 'Solid Waste' instead of 'Inert Waste' – refer **Section 2**), treatment is not available to reduce the risks associated with this leachate. Therefore, the only options for this sediment is either leave it in place in the heads of Yowie Bay, or dispose of it at Menai Tip as 'Mixed Waste', which attracts a tip fee of $56.50/tonne. The actual quantity of material in question is unknown, but it would be somewhat less than 5,000 - 10,000 tonnes.

With respect to the second disposal requirement, all material needs to be relatively compactable so that differential settlement of the fill does not occur with time. Dewatering of the sediment to a unsaturated state, and screening for larger foreign matter, as outlined in **Section 4**, would be sufficient to ensure satisfactory compaction of the material upon disposal because of its non-cohesive, predominantly sandy nature.

7 CONSULTATION WITH GOVERNMENT AUTHORITIES

Nine government authorities were asked to comment 'in principal' on the general feasibility of removing the sediments from the heads of Yowie Bay, and to provide an outline of any restrictions or considerations which would impact on this feasibility assessment. The government authorities asked to provide comments were:

- National Parks and Wildlife Service
- Waste Services NSW
- Department of Land and Water Conservation
- NSW Waterways Authority
- NSW Fisheries
- Sutherland Shire Council
- NSW Environment Protection Authority
- Roads and Traffic Authority
- Department of Urban Affairs and Planning

The responses from these government authorities are summarised below. A copy of the response documents from the authorities is presented in **Appendix C**, along with a copy of the letter which was sent to the authorities regarding the proposal.

In general, all authorities contacted had no major concerns regarding the proposal, providing that the works are carried out in a manner which does not destroy or damage marine and terrestrial habitats, and the proposal includes adequate controls to minimise the environmental and social disturbances.

7.1 NSW NATIONAL PARKS AND WILDLIFE SERVICE (NPWS)

The response from NPWS made reference to the "General Guidelines for Impact Assessment", (March 1998), a copy of which was attached. These general Guidelines state NPWS's areas of interest, ie:

- Areas of native vegetation,
- Areas of potential value as habitat for native fauna,
- Sites and places of Aboriginal heritage, including areas of archaeological potential, and
- Land dedicated under the National Parks and Wildlife Act (NP&W Act).

Also included in the guidelines are:

- A list of the numerous matters recommended to be addressed in the assessment;
- Mentioning of the replacement of the Endangered (Interim Protection) Fauna Act 1991 by The Threatened Species Conservation Act, 1995 (TSC Act);
- A recommendation to assess Aboriginal cultural values should the proposal involve disturbance to substantially unmodified ground surfaces and
- Discussion of the two GIS databases:
  - Atlas listing of fauna and flora records in NSW and
  - Aboriginal Sites Register.

7.2 WASTE SERVICE NSW

Waste Services NSW made reference to their letter of 28 January 1998 to Sutherland Shire Council, and emphasised the need for further testing of the sediment and discussion with EPA to clarify classification of the sediment for disposal purposes.

Acceptance of the sediment at either of the Lucas Heights facilities would depend on its physical condition, ie it would need to be suitable for compaction.

7.3 DEPARTMENT OF LAND AND WATER CONSERVATION (DLWC)

In addition to general requirements regarding sediment quality and the impacts of the activity on aquatic habitats, DLWC noted the following environmental constraints:

- Availability of a suitable land base for dewatering and treatment of return water to EPA standards;
- Effect changed local wave and current conditions will have on adjacent shorelines, especially erosion;
- Depending on the depth of the dredging, the possibility of stratification and effects on water quality;
- Effects on water quality and aquatic flora and fauna during the dredging operation, and
- Effects any odours generated may have on adjacent residents.

A number of matters regarding planning constraints would need to be considered, however, possibly at a later stage than a feasibility assessment. These are:

- Determination whether SEPP35 on maintenance dredging is applicable;
- Obtaining of a Crown Land licence;
- A Land Assessment might be required, depending on the range of issues covered by the feasibility assessment and any ensuing environmental assessment;
- The question whether Native Title is applicable would need to be addressed through consultation with the State Lands Service.

7.4 WATERWAYS AUTHORITY

No comments were made in regard to the dredging proposal. However, they did request a copy of the feasibility assessment when it was completed.

7.5 NSW FISHERIES

Based on Part 7 of the Fisheries Management Act 1994, a permit from NSW Fisheries would be required for the proposed dredging, and also for any damage to mangroves and seagrasses. Information required prior to considering the permit would include:

- The exact nature of the proposed dredging and its relationship to nearby mangroves and seagrasses;
- An up-to-date map with a resolution of no worse than 1 metre, showing the distribution and composition of mangroves and seagrasses throughout the area.

A dredging permit would include general conditions regarding:

- Extent of sediment removal;
- Condition/features of newly formed bed;
- Protection of *Posidonia* seagrass and saltmarsh;
- A BACI monitoring program focusing on seagrasses and benthos;
- An environmental bond;
- The use of silt curtains; and
- Treatment and discharge of water from dredge spoil.

Permission to remove mangroves or any *Zostera* or *Halophila* seagrasses would depend on their specific location, condition and whether a satisfactory transplanting protocol is in place.

7.6 SUTHERLAND SHIRE COUNCIL

According to advice from Council's Environmental Lawyer:

- The tidal nature of Yowie Bay may permit maintenance dredging to be carried out under SEPP35;
- A full Environmental Impact Statement should be carried out for any dredging of sediment at the Heads of Yowie Bay;
- Deposit of the sediment to any site beyond the two existing landfill sites, ie Menai Tip and Kurnell Landfill would require a Local Environmental Plan for the site and an Environmental Impact Statement. The use of the abandoned Sydney Water site at Kirrawee may be constrained by the existence of certain species of aquatic fauna;
- The dredging of sediment does not fall under the classification of Extractive Industry.

In the event of sediment removal taking place, additional conditions/controls would apply in regard to issues such as:

- Truck movements;
- Noise;
- Hours of operation;
- Protection of the waterway from contamination; and
- Location of site equipment.

7.7 NSW ENVIRONMENT PROTECTION AUTHORITY (EPA)

Advice provided regarding environmental constraints included:

- The presence or extent of any contamination of the sediment will need to be fully investigated, followed by a classification of the sediment in accordance with the EPA publication: Environmental Guidelines: Assessment and Classification of Non-Liquid Wastes. This classification may establish the appropriate end use in accordance with the waste management hierarchy specified in the Waste Minimisation and Management Act;
- Under the existing environmental legislation the proponent will need to seek an Approval from the EPA under Section 17K of the Pollution Control Act for the water quality controls associated with the dredging operation. The EPA also recommends that the proponent seek a licence from the EPA covering the operation aspects of the dredging activity;
- The EPA does not have a preference between grab and cutter suction dredging. However, the proponent will need to balance the environmental costs and benefits of both methods to establish which may result in the lesser environmental impact. The EPA will assess the proponent's preference at the Approval stage.

7.8 ROADS AND TRAFFIC AUTHORITY (RTA)

The response included a list of issues to be addressed in an Environmental Impact Statement, viz:

- A Traffic Management Plan for any proposed route;
- Access issues for trucks, pedestrians other vehicles and cyclists;
- Sedimentation and erosion issues affecting roads;
- All pollution control legislation;
- Incident management procedures for spills on roadway and/or road corridors;

Also mentioned were a number of issues not directly associated with RTA, however possibly relevant for carrying out the project. Issues other than those already mentioned by the above authorities were:

- Navigation within the bay;
- Storage and transport of waste would need to consider the Waste Minimisation and Management Act. Storage, disposal and transport procedures would need to reflect the classification regarding contamination;
- Removal of sediments from a core area is likely to precipitate a "caving in" effect of sediments over a large area. This could possibly stimulate the release of toxins bound to colloidal particles. Over a large area this could significantly impact adversely on the ecosystem of the bay;
- Potential impact on economic parameters, eg regarding aquaculture;
- Potential impact on health parameters, eg swimming, consumption of marine food from the bay;
- Potential impact of rapid alteration of hydrology regimes following the removal of the sediments.

7.9 DEPARTMENT OF URBAN AFFAIRS AND PLANNING (DUAP)

DUAP indicated their comments would be sent to Sutherland Shire Council directly.

8 INDICATIVE COST ESTIMATES

As outlined in this report, there are a number of options associated with each component of the proposed project. Costs associated with these options vary considerably. Hence, the final total cost estimate for the works would fall within a large range of costs.

Indicative costs for the different tasks associated with the sediment removal project are summarised in the following sections.

8.1 COST OF SEDIMENT REMOVAL

Options associated with the removal of the sediment are:

1. *Conventional land-based equipment operating from working bunds for removal of sediment from Camellia Gardens bay only, and dredging of sediment from Ewey Creek bay (it was assumed that these operations occurred simultaneously);*
2. *Conventional land-based equipment working from a barge and using a hopper and displacement pump to transport material to onshore processing site;*
3. *Small cutter-suction dredger piping material (in slurry form) to onshore processing site.*

Costs for these different options are outlined below in **Table 4.**

Item / *Approx Duration*	*Option 1* *4 – 6 mths*	*Option 2* *6 – 12 mths*	*Option 3* *6 – 8 mths*
Site Establishment	$70,000	$15,000	$50,000
Form working platform bunds	$75,000	-	-
Excavator	$60,000	$150,000	-
Barge for excavator	-	$400,000	-
Small cutter suction dredger	$200,000	-	$375,000
Pumping to onshore area	-	$250,000	-
Site materials handling, screening, dewater	$250,000	$150,000	$150,000
Site disestablishment and remediation	$75,000	$50,000	$50,000
Subtotals	***$730,000*** ***(~$30/m^3)***	***$1,015,000*** ***(~$40/m^3)***	***$625,000*** ***(~$25/m^3)***

Table 4 – Indicative Cost Estimate for Sediment Removal Process

8.2 COST OF TRANSPORTATION

Trucking of the material from Yowie Bay to the designated disposal location is the only feasible means of transportation. Costs of transportation will depend entirely on the location for disposal of the material, as indicated in **Table 5**.

Disposal location	*Lucas Heights I or II (Menai Tip)*	*Kirrawee Brick Pit*	*Old Rock Quarry next to Ewey Ck*
Approx. Distance	18 km	4.5 km	0.5 km
Approx. Cost	***$280,000***	***$70,000***	***$35,000***

Table 5 – Indicative Cost Estimate for Transportation of Material

8.3 COST OF DISPOSAL

The cost of disposal varies with the disposal location. Indicative costs are presented in **Table 6**.

	Menai Tip	*Brick Pit*	*Old Quarry*
Tip Fees	- *	-	-
Spreading, liming, rotivation and compaction of fill	$10,000 **	$100,000	$100,000
Preparation of Site Management Plan and EIS		$50,000	$50,000
Subtotals	***$10,000***	***$150,000***	***$150,000***

* Assumes 'inert waste' can be disposed free of charge for use as cover material.

** Assumes Menai Tip would cover the costs associated with spreading and compaction of the material

Table 6 – Indicative Cost Estimate for Disposal of Material

8.4 COST OF REMOVING 'SOLID WASTE' SEDIMENT

In addition to the above costs, which have been calculated for the estimated 'inert waste' proportion of sediments at the heads of Yowie Bay, the sediments which would be classified as 'solid waste', due to their higher potential Lead leachate concentrations, could also be removed. This sediment could only be disposed at Menai Tip. Costs associated with the removal of this sediment are briefly summarised in **Table 7**.

	Removal Option 1	*Removal Option 2*	*Removal Option 3*
Removal of sediment (assuming site is already set-up)	$120,000	$200,000	$100,000
Transportation	$55,000	$55,000	$55,000
Disposal Tip Fee ($56.50/tonne)	$565,000	$565,000	$565,000
Subtotals	***$740,000***	***$820,000***	***$720,000***

Table 7 – Indicative Cost Estimate for Removing 'Solid Waste' Sediment

8.5 COST COMPARISONS

Based on the various options available for the removal and disposal of the sediment, a number of different combinations can be economically assessed and compared. **Table 8** summarises the costs for different combinations of removal techniques and disposal locations.

Removal Option 1	Removal Option 2	Removal Option 3	Menai Tip	Brick Pit	Old Quarry	Inert W only	Inert + Solid W	Indicative Cost [1]
✓			✓			✓		$1,690,000
	✓		✓			✓		$2,160,000
		✓	✓			✓		$1,510,000
✓				✓		✓		$1,570,000
	✓			✓		✓		$2,040,000
		✓		✓		✓		$1,400,000
✓					✓	✓		$1,510,000
	✓				✓	✓		$1,850,000
		✓			✓	✓		$1,340,000
✓			✓				✓	$2,900,000
	✓		✓				✓	$3,510,000
		✓	✓				✓	$2,700,000
✓				✓			✓	$2,780,000
	✓			✓			✓	$3,390,000
		✓		✓			✓	$2,590,000
✓					✓		✓	$2,720,000
	✓				✓		✓	$3,200,000
		✓			✓		✓	$2,530,000

[1] 10% has been added to indicative costs to allow for survey, investigations (including environmental assessments), designs and contract supervision, and an additional 50% for general contingencies.

Table 8 – Total Indicative Costs for Sediment Removal Options

Total costs for the sediment removal project could range between about $1.4 million and $3.5 million depending on which material was removed, how it was removed, and where it was deposited. A 50% contingency has been factored into these cost estimates to account for:

1. the general difficulty of carrying out a major civil engineering project within an urban environment;
2. the retrofitting required to the methodology to remove such a shallow depth of material over a large area; and
3. working around the tidal nature (and shallow depth) of the removal area.

9 SOCIAL AND ENVIRONMENTAL ISSUES FOR CONSIDERATION IN AN EIS

From consultation with the various government authorities, a list of issues which would need to be assessed as part of an EIS has been compiled, and is presented below. In addition to that presented below, DLWC indicated they would provide a more comprehensive list of EIS requirements prior to the undertaking of such an assessment.

General

• Description of the proposal, ie exact nature of proposed dredging;	*NPWS, NSW Fisheries*
• Map(s) placing the proposal in a regional and local setting;	*NPWS*
• Appropriately scaled maps which identify the location and extent of the areas of natural and cultural heritage in relation to the area of proposed development.	*NPWS*
• Provisions of the Threatened Species Conservation Act (1995) should be considered when undertaking an EIS	*NPWS*
• An up-to-date map with a resolution of no worse than 1 metre, showing the distribution and composition of mangroves and seagrasses throughout the area.	*NSW Fisheries*
• Extent of sediment removal;	*NSW Fisheries*
• Condition/features of newly formed bed;	*NSW Fisheries*
• Navigation within the bay	*RTA*
• Impacts of rapid alteration of hydrology regimes following removal of sediments	*RTA*

Environmental

• Description of the way in which the environment will be modified by the proposal;	*NPWS*
• Detailed description and mapping of all vegetation communities in the study area;	*NPWS*
• Identification of any vegetation communities or plant species which are of local, regional or state conservation significance (including threatened communities, plant species or populations listed under the Threatened Species Conservation Act, 1995);	*NPWS*
• Description of known fauna assemblages within the study area;	*NPWS*

• Identification of fauna habitat likely to be of local, regional or state significance (including habitat or threatened fauna species or populations listed under the Threatened Species Conservation Act, 1995);	*NPWS*
• Identification of habitat corridors and linkages between areas of remnant native vegetation which may assist faunal movement through the area;	*NPWS*
• Prediction (and quantification where possible) of the likely impact of the proposal on the vegetation and faunal communities and habitats;	*NPWS*
• Assessment of measures available to minimise the impact of the proposal on the vegetation and faunal communities and habitats (including threatened terrestrial and aquatic species), and monitoring programs if appropriate;	*NPWS, RTA*
• Availability of land to dewater the material;	*DLWC*
• Treatment of the return water to EPA standards;	*DLWC, NSW Fisheries*
• Quality of the sediment and its suitability for the proposed disposal site;	*DLWC, EPA*
• Possible effect of stratification caused by dredging and effects on water quality;	*DLWC*
• Effects on water quality and aquatic flora and fauna during the dredging operation;	*DLWC*
• Effects any odours generated may have on adjacent residents;	*DLWC*
• Relationship of proposal on mangroves and seagrasses;	*NSW Fisheries*
• Protection of *Posidonia* seagrass and saltmarsh;	*NSW Fisheries*
• A BACI monitoring program focusing on seagrasses and benthos;	*NSW Fisheries*
• The use of silt curtains and other turbidity controls;	*NSW Fisheries, RTA*
• Control of truck movements;	*Council*
• Noise controls;	*Council*
• Hours of operations;	*Council, RTA*
• Protection of the waterway from contaminants;	*Council*
• An acceptable and approved site to receive the sediment;	*Council*
• Water quality controls associated with the removal operation	*EPA*
• Consideration of removal methodology with respect to environmental impacts	*EPA*
• Sedimentation and erosion issues affecting roads;	*RTA*
• Contaminated sediments releasing toxins both in the bay and on land for storage / disposal;	*RTA*
• Pollution controls for air, noise, water and waste	*RTA*

Social

• Identification of whether there are any sites or places of cultural significance to the Aboriginal community;	*NPWS*
• Mapping of the location of all Aboriginal sites (including archaeological sites and potential sites) within the study area and an assessment of the significance of these sites;	*NPWS*
• Determine if consideration of Native Title is applicable through consultation with the State Lands Service;	*DLWC*
• Traffic Management Plan to minimise impacts on community and environment;	*RTA*
• Consultation with affected communities	*RTA*
• Impact on economic parameters, eg aquaculture	*RTA*
• Impact on health parameters, eg swimming, eating the marine foods from the bay	*RTA*

Planning

• Applicability of LEPs, REPs and SEPPs (including SEPP44 and SEPP46) to the proposal;	*NPWS*
• Information on the current and past land uses of the site and surrounding areas;	*NPWS*
• Prediction of the likely impact of the proposal on land dedicated under the NP&W Act;	*NPWS*
• Determination of whether SEPP35 (maintenance dredging) is applicable;	*DLWC*
• A possible Land Assessment;	*DLWC*
• An LEP and EIS for the disposal of the sediment if not disposed at Menai Tip or Kurnell Landfill;	*Council*
• Location of Site Equipment	*Council*
• Access Issues for trucks / pedestrians / other vehicles / cycles;	*RTA*
• Incident management procedures for spills on roadways and / or road corridors.	*RTA*

10 CONCLUSIONS

This assessment has demonstrated that the removal of contemporary sediment from the heads of Yowie Bay is technically feasible. A range of conventional methods of sand extraction can be adopted to remove the material, however, given the tidal nature of site and the shallow water depths from which the material will be removed, significant time and cost penalties would result.

Given the range of possible end uses for the sediment (refer **Section 3**), it is unlikely that the material would need to be tipped at Menai Tip as mixed waste, which attracts a tipping fee of over $50/tonne (or $2.5M for all the sediment). More economic alternatives would be to extract the better sediment (approx 80% of the material) in isolation and dispose at one of a number of sites as clean engineering fill. The remaining 20% could be either left in place at the heads of the bay, or removed and disposed as mixed waste at Menai Tip (for an estimated tip fee of only about $500,000).

The next step in the process would be to decide on an appropriate end use for the material, and carry out an Environmental Impact Assessment for the proposal. In addition, detailed designs of the removal project could be carried out, which would include a detailed ground survey of the area and a comprehensive geotechnical survey to accurately map the sediments and quantify the volume of material to be removed.

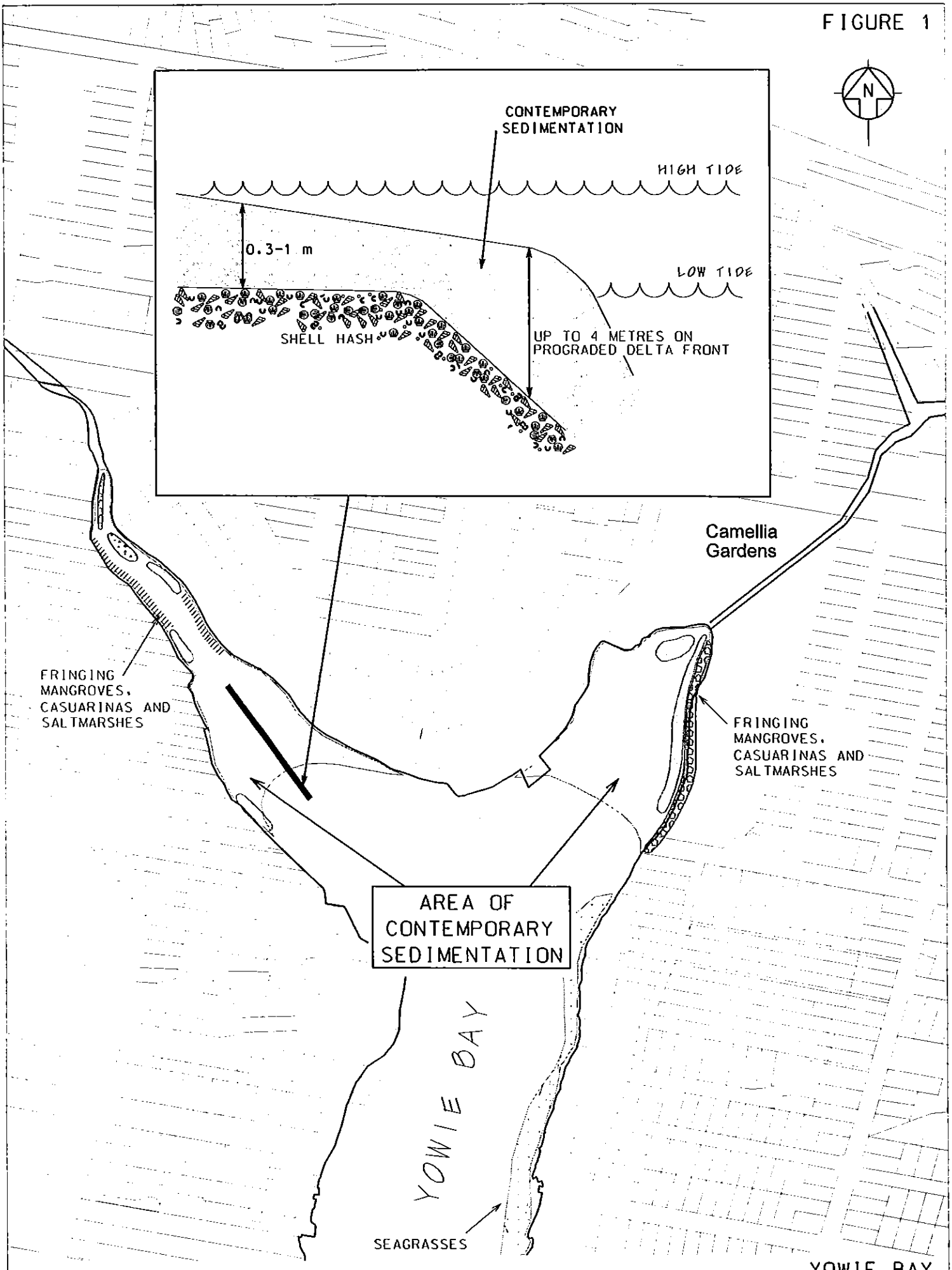
Costs for carrying out the proposal have been estimated to range between $1.4 million and $3.5 million, depending on the sediment removal method, the end use of the material, and the extent (and quality) of the material removed. However, as indicated in **Section 3.5**, there may be some opportunity to allay some of this cost through the sale of the sediment. Although beyond the scope of this assessment, preliminary inquiries indicated that the material may be worth up to $6/tonne, ie a total value for the sediment of approximately $240,000.

The most practical method of removal of the contemporary sediment is via a small cutter suction dredger. Although technically feasible, the removal of the sediment from an excavator on a barge would not be economical as floating plant and equipment is very expensive. Restricted access to Ewey Creek bay significantly limits the possibilities for sediment removal of this delta. As such, only water-based removal methods are practical, of which, only dredging would be economically viable. However, the final choice of a removal method for the project would need to consider wider factors, such as likely environmental and social impacts of the different options.

Likewise, it is technically feasible to dispose of the sediment at all nominated disposal locations, with the exception of Kurnell landfill, however, associated costs for the different locations vary. Therefore, the choice of a disposal location would also need to consider wider factors, such as likely environmental and social impacts of the disposal, and the transportation of the material to the disposal location.

FIGURES

FIGURE 1



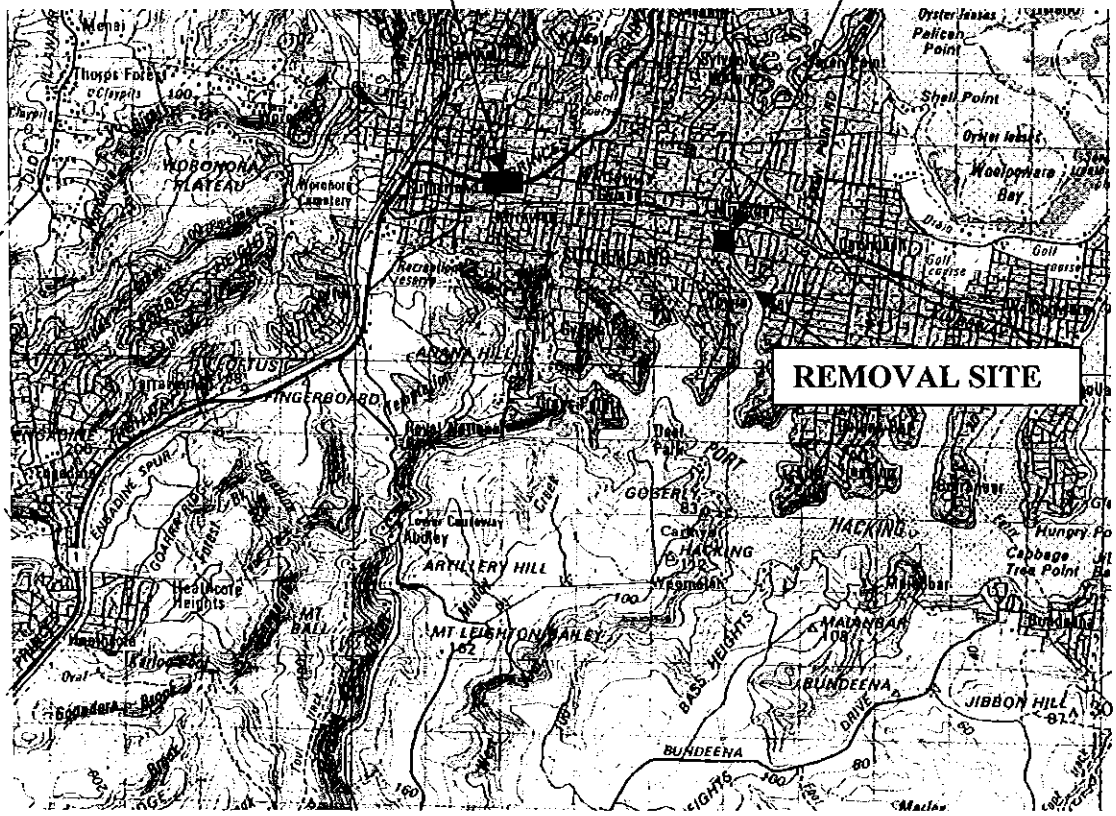
YOWIE BAY
SEDIMENT REMOVAL
FEASIBILITY ASSESSMENT
LOCATION AND EXTENT OF SEDIMENTATION

KIRRAWEE BRICK PIT

OLD QUARRY SITE

TO KURNELL LANDFILL

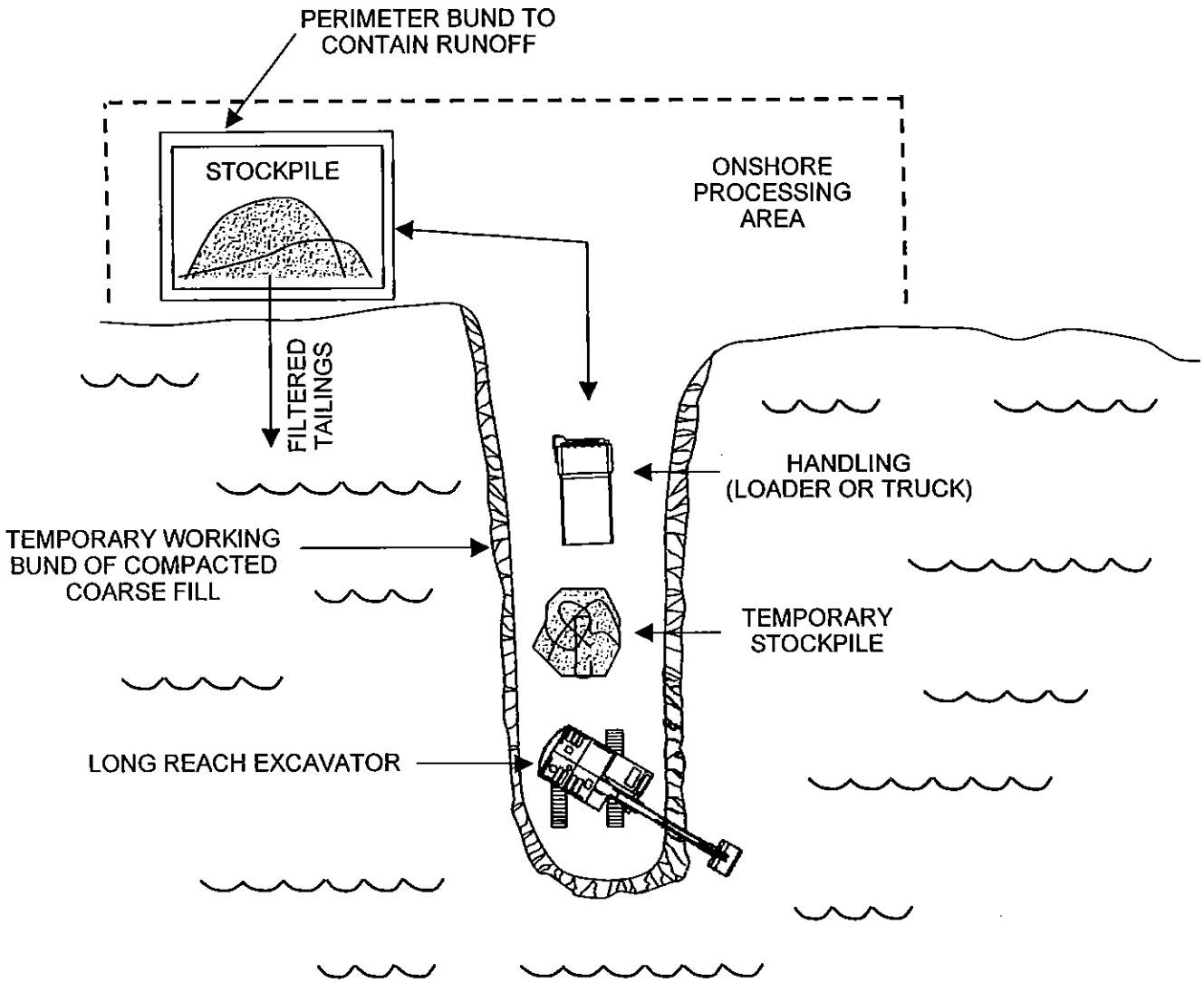
TO MENAI TIP



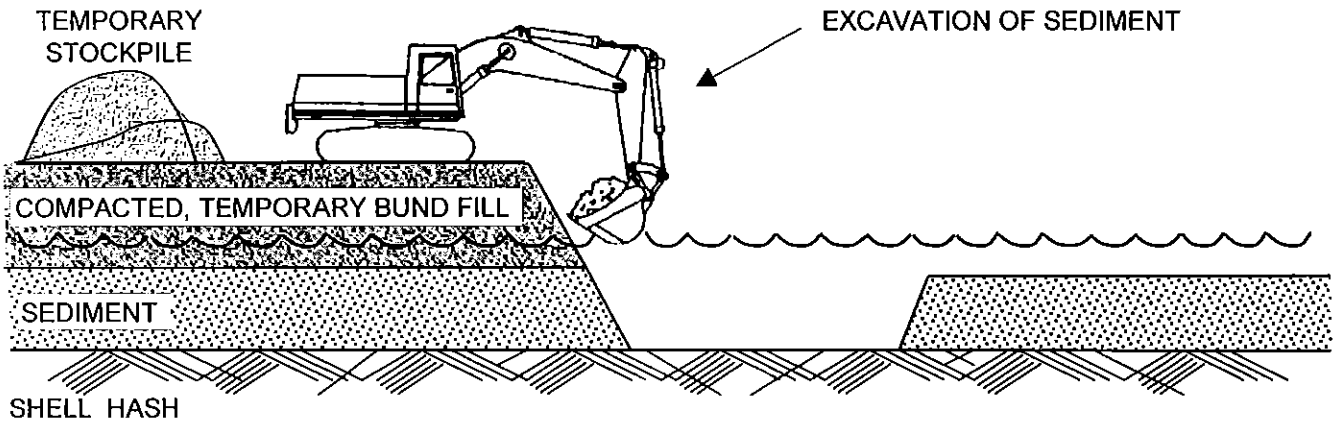
YOWIE BAY
SEDIMENT REMOVAL FEASIBILITY ASSESSMENT

POSSIBLE DISPOSAL LOCATIONS

FIGURE 3



PLAN



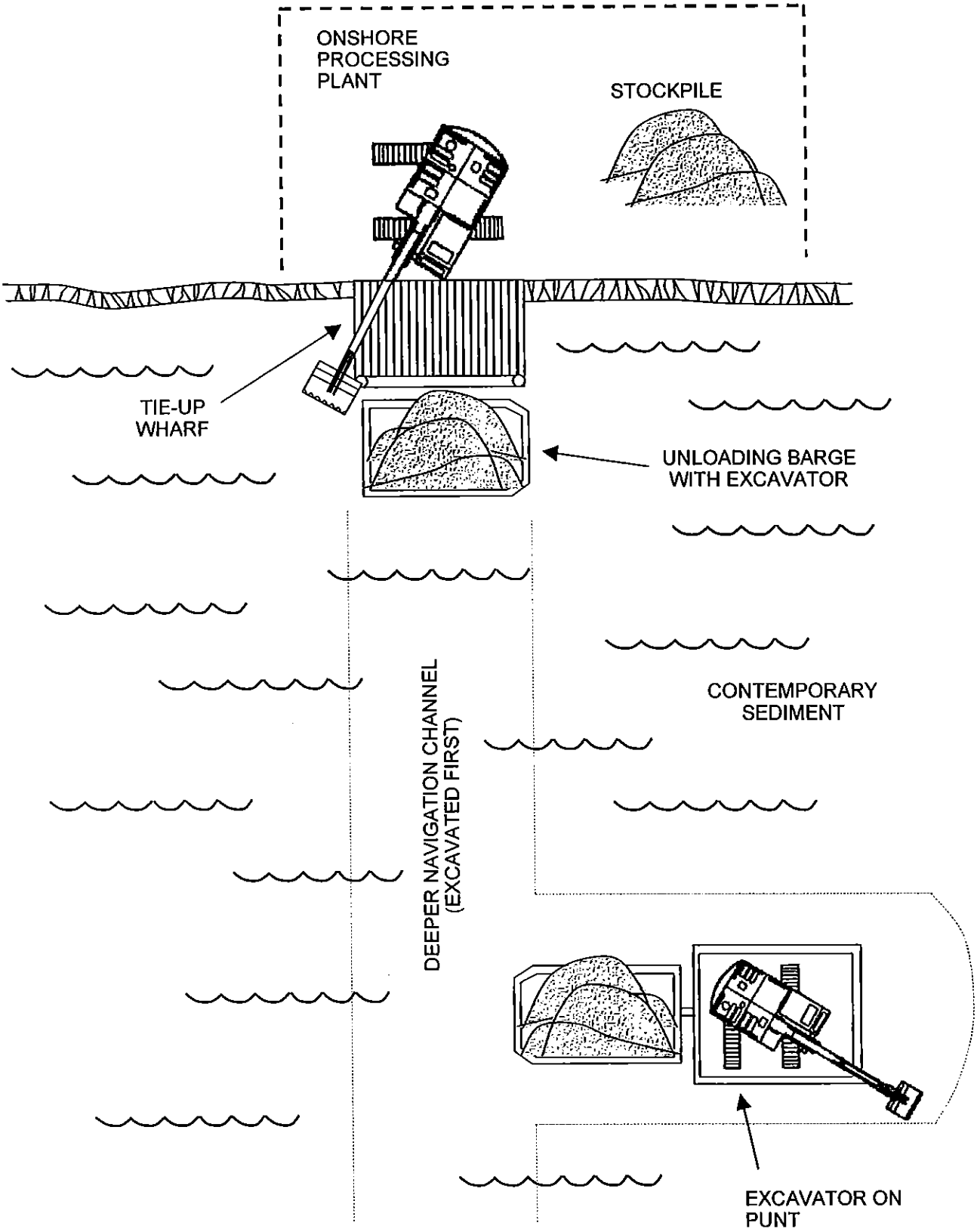
ELEVATION

YOWIE BAY SEDIMENT REMOVAL FEASIBILITY ASSESSMENT

DIAGRAMATIC ONLY -NOT TO SCALE

LAND BASED REMOVAL

FIGURE 4



YOWIE BAY SEDIMENT REMOVAL
FEASIBILITY ASSESSMENT

WATER-BASED REMOVAL
-EXCAVATOR ON PUNT & BARGES

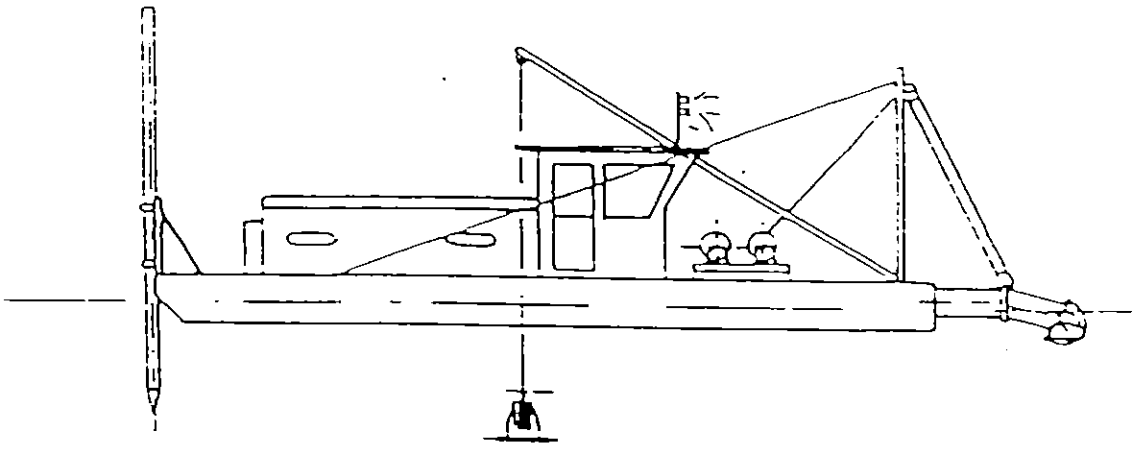
DIAGRAMMATIC ONLY
-NOT TO SCALE

DREDGE NO. 8

CUTTER SUCTION

REBUILT	1987
LENGTH	32 METRES
WIDTH	5.6 METRES
DRAUGHT	1.0 METRES
GROSS WEIGHT	70 TONNE
DREDGING DEPTH	13 METRES
ENGINE	ROLLS ROYCE - 350HP
AUXILIARY ENGINE	ROLLS ROYCE - 200HP
SAND PUMP	WARMAN 12/10
WINCHES	HYDRAULIC
MOVEMENT	FITTED WITH TILTING SPUD AND/OR XMAS TREE
CUTTER	150HP

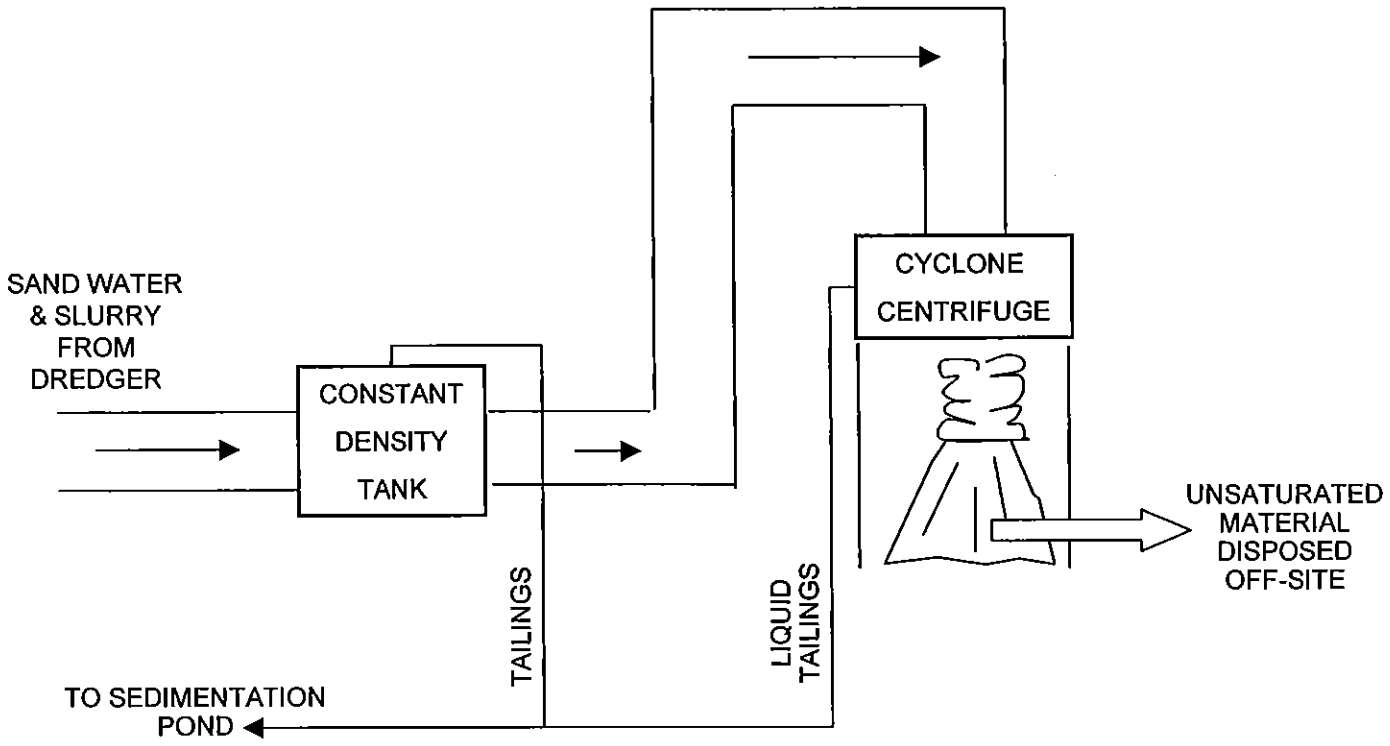
Note: Due to the modular designs of our dredges, this specification indicates the normal configuration of this dredge.



YOWIE BAY
SEDIMENT REMOVAL FEASIBILITY ASSESSMENT

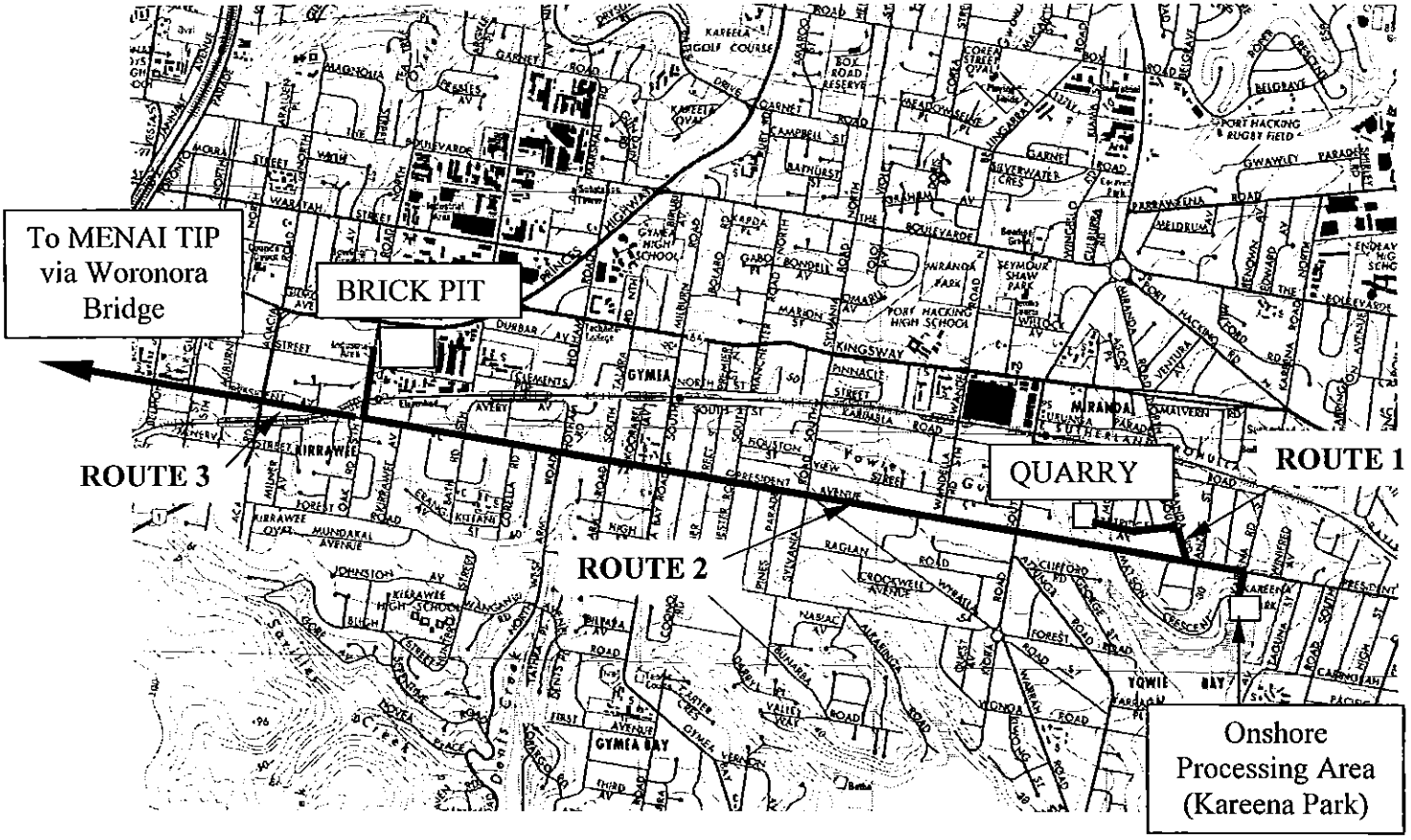
CUTTER SUCTION DREDGER

FIGURE 6



YOWIE BAY SEDIMENT REMOVAL FEASIBILITY ASSESSMENT

OFFSHORE PROCESSING OF SLURRY



Route 1: Kareena Park to Old Rock Quarry
Via Kareena Road, President Avenue, Miranda Road South and Partridge Avenue

Route 2: Kareena Park to Abandoned Brick Pit (Kirrawee)
Via Kareena Road, President Avenue and Oak Road South

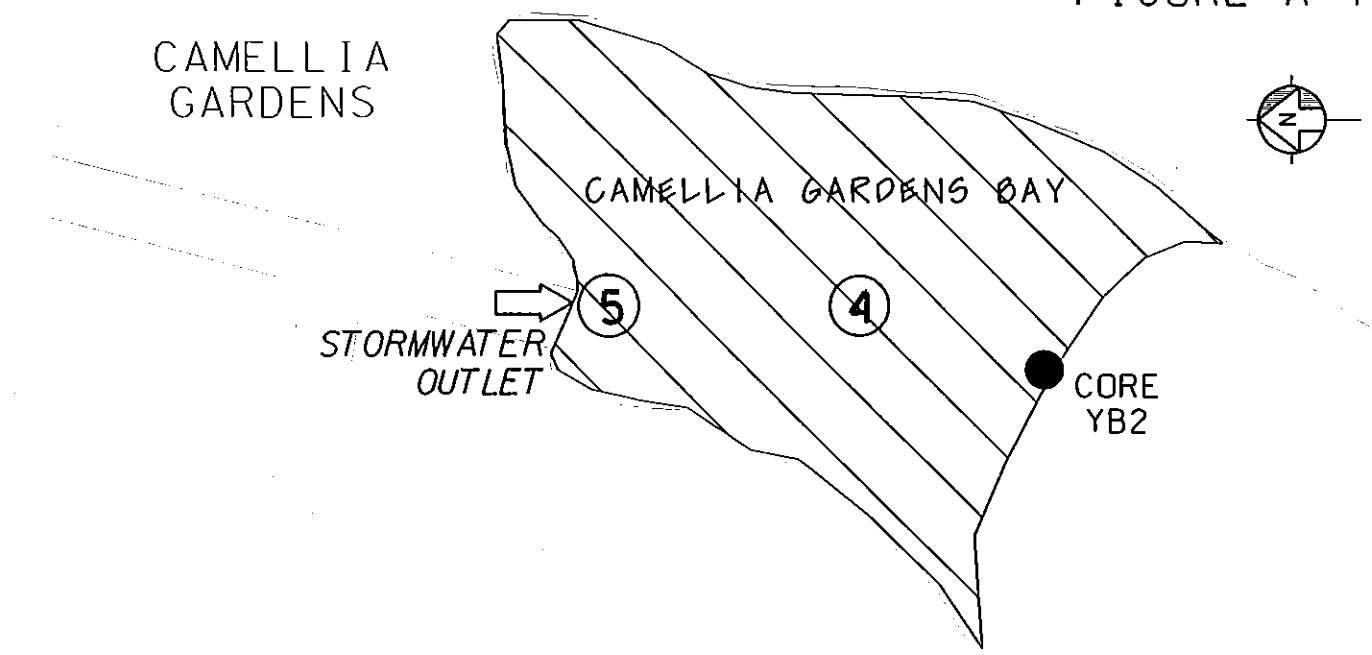
Route 3: Kareena Park to Menai Tip (Lucas Heights)
Via Kareena Road, President Avenue, Sutherland Rail Bridge, Lindon Street, River Road, Menai Road and the New Illawarra Prad.

YOWIE BAY
SEDIMENT REMOVAL FEASIBILITY ASSESSMENT

POSSIBLE TRUCKING ROUTES

APPENDIX A – SEDIMENT ANALYSIS RESULTS

FIGURE A-1

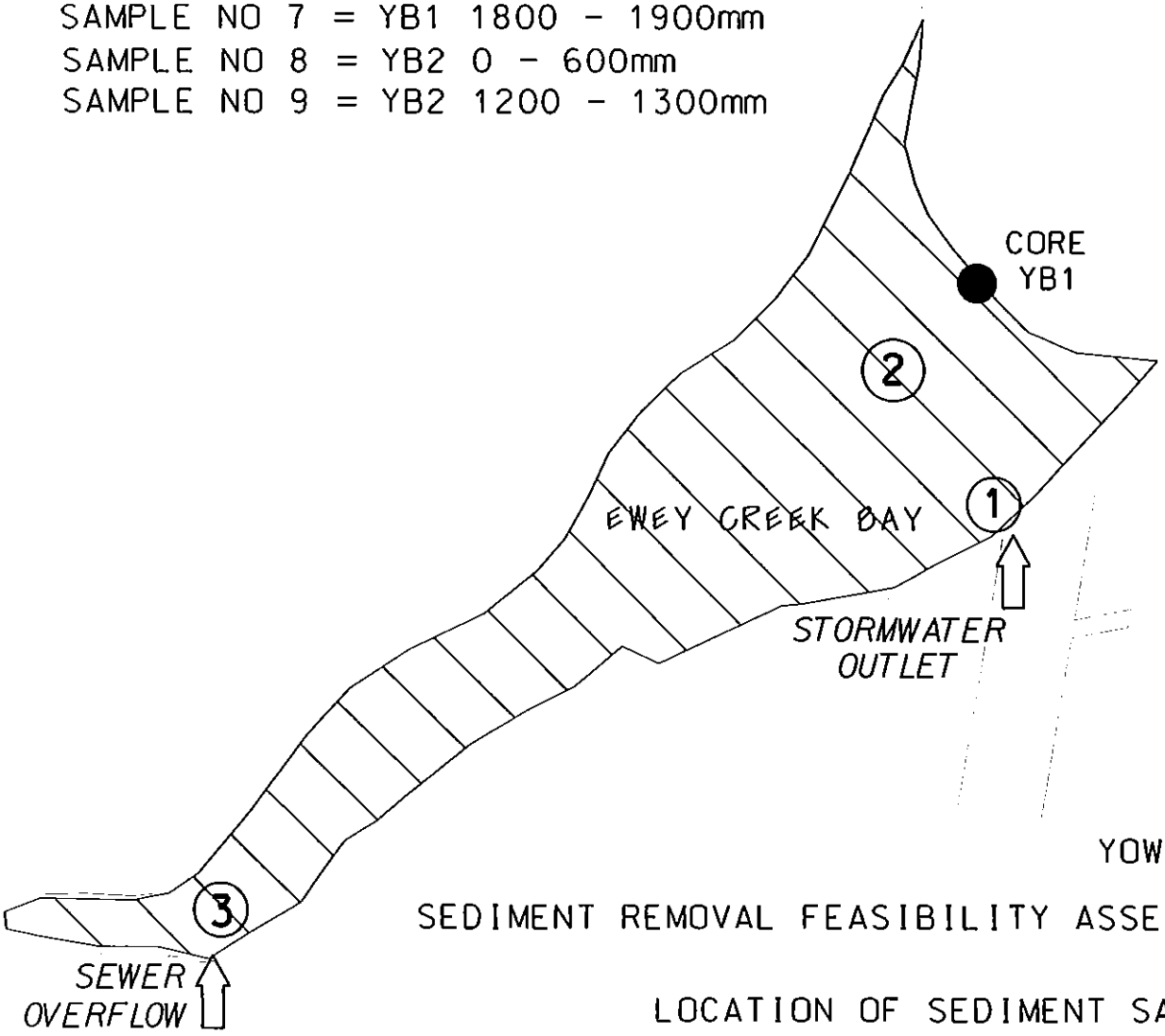


LEGEND

(2) LOCATION OF SAMPLE NO 2 (EG)

NOTE:

SAMPLE NO 6 = YB1 0 - 450mm
SAMPLE NO 7 = YB1 1800 - 1900mm
SAMPLE NO 8 = YB2 0 - 600mm
SAMPLE NO 9 = YB2 1200 - 1300mm



YOWIE BAY

SEDIMENT REMOVAL FEASIBILITY ASSESSMENT

LOCATION OF SEDIMENT SAMPLES

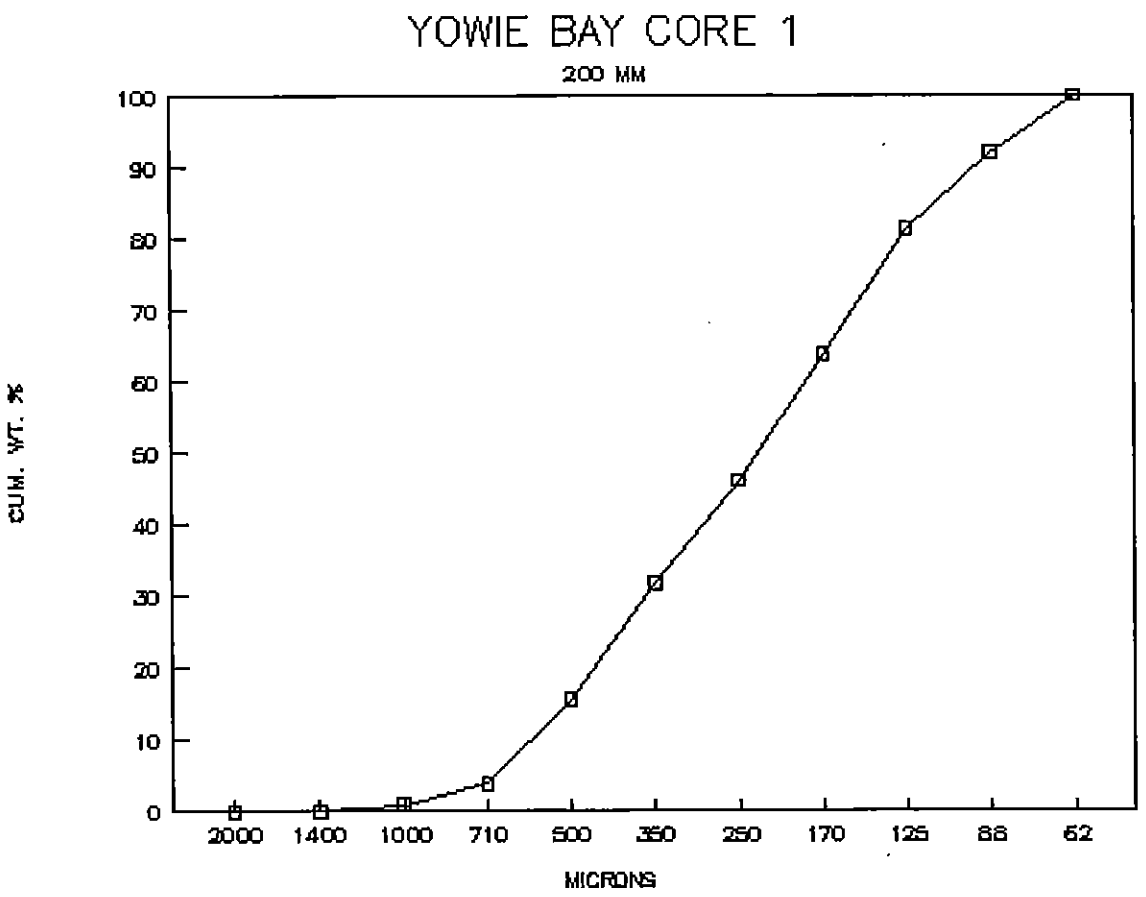
CORE PARAMETERS YOWIE BAY

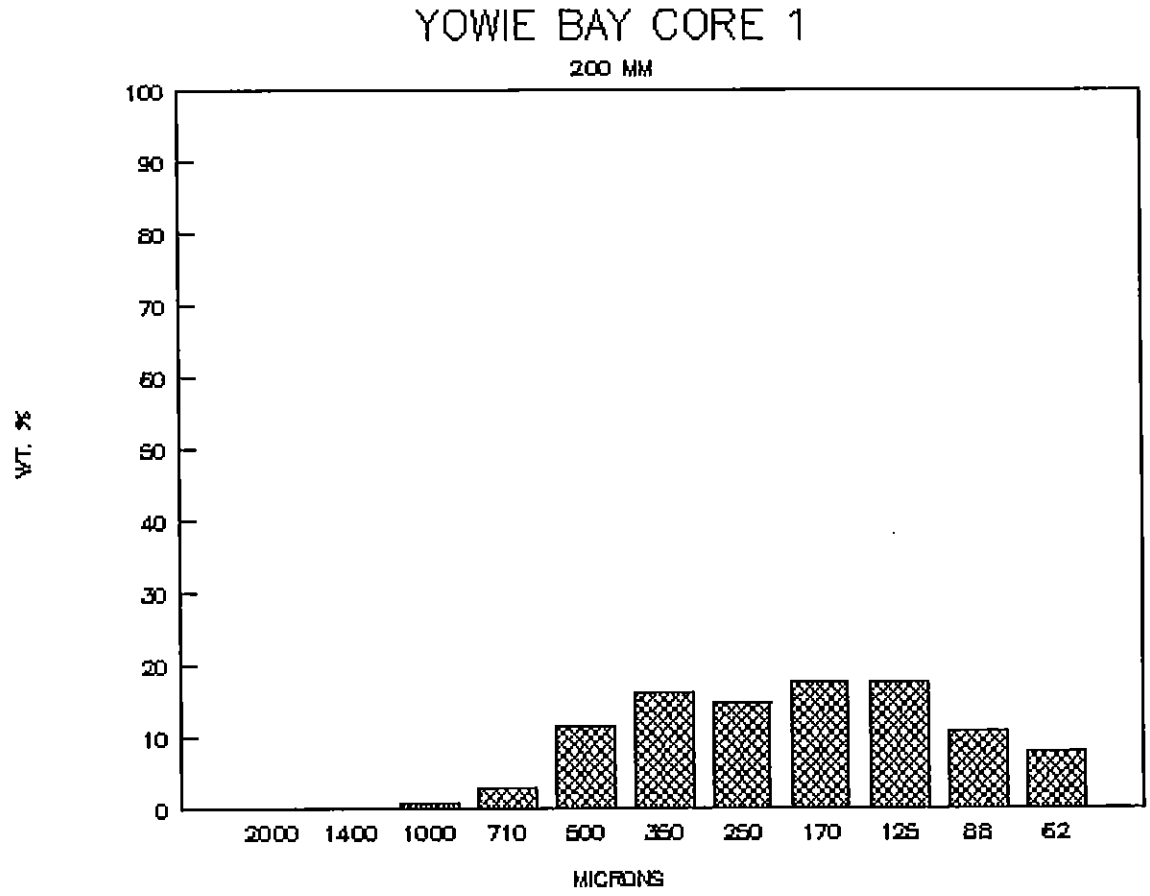
CORE	DATE	TIME	TIDE STATE	WATER mm	PENETRATION mm	RECOVERY mm	COMPACTION mm	COMPACTION %	TDR
YB 1	10/8/98	1130	1300mm F	1400	4590	3070	1520	33.1	1.495
YB 2	10/8/98	1230	900mm F	850	2800	1900	900	32.1	1.474

TDR = 'true depth ratio', eg if TDR = 1.5, then a sample from 1000mm actually comes from 1500mm

YOWIE BAY CORE SEDIMENTS - TEXTURE

CORE	GRAVEL %	SAND %	MUD %
YB1			
200	0	80.6	19.4
600	0.2	81.5	18.3
2000	5.7	80.8	13.5
3050	10.7	78.6	10.7
YB2			
100	2.2	93.3	4.6
500	0.0	76.6	23.4
1000	5.6	72.5	21.9
1850	98.6	1.1	0.3


YOWIE BAY CORE 1
200 MM
CUM. WT. %
100
90
80
70
60
50
40
30
20
10
0
2000
1400
1000
710
500
350
250
170
125
88
62
MICRONS


YOWIE BAY CORE 1
200 MM
WT. %
100
90
80
70
60
50
40
30
20
10
0
2000
1400
1000
710
500
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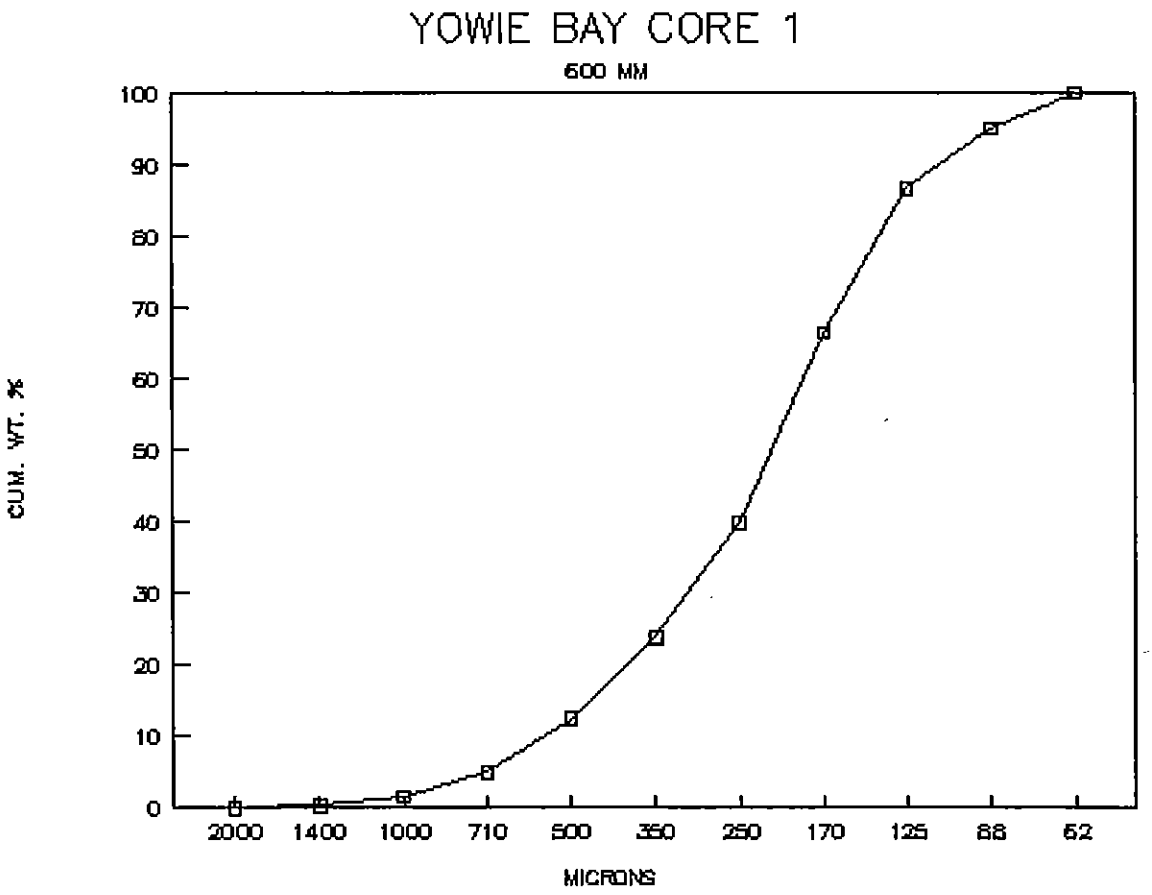
250
170
125
88
62
MICRONS


YOWIE BAY CORE 1
600 MM
CUM. WT. %
100
90
80
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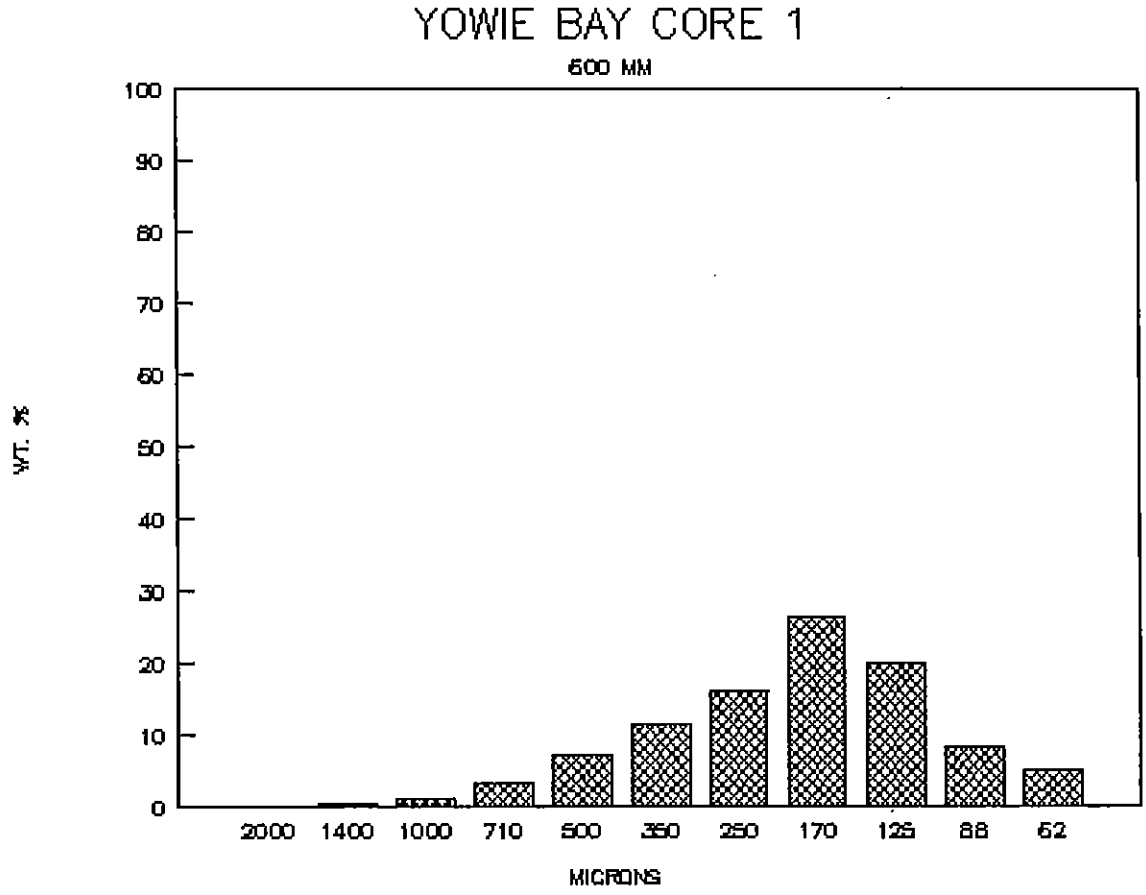
MICRONS


YOWIE BAY CORE 1
600 MM
WT. %
100
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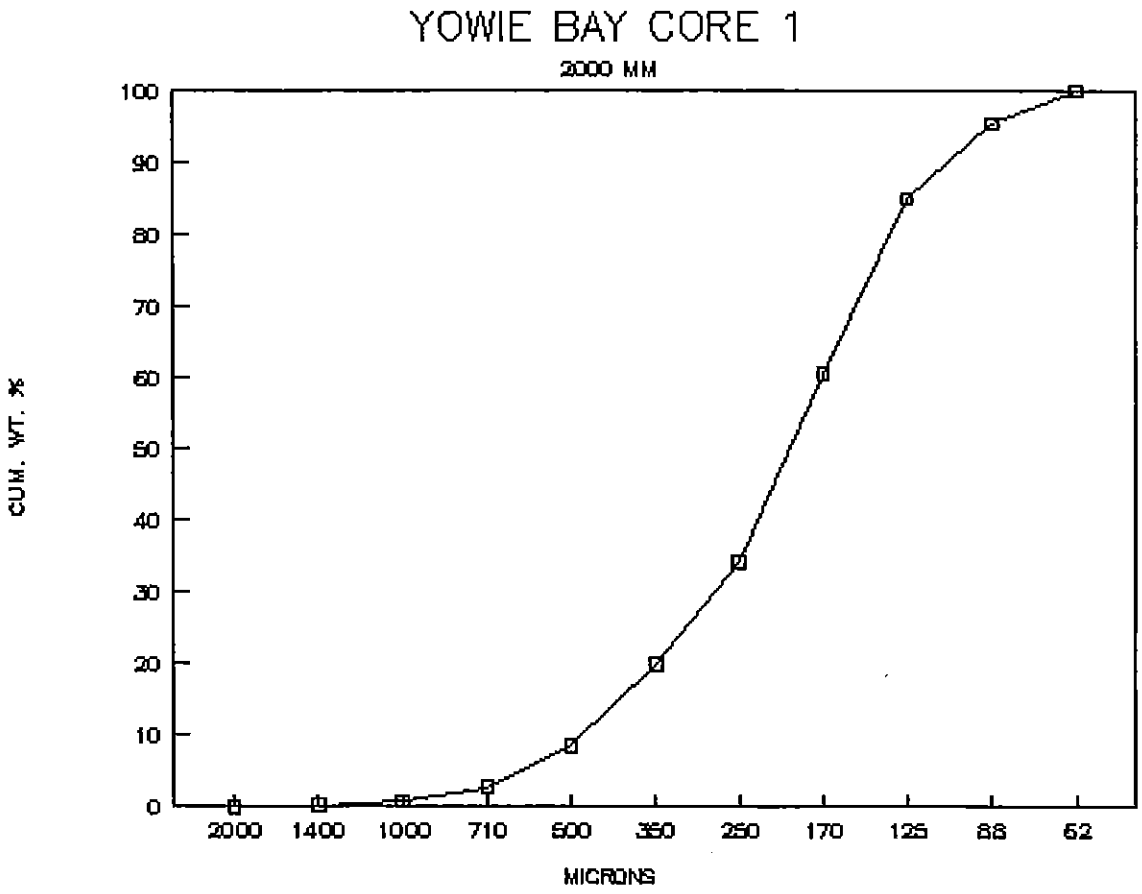
MICRONS


YOWIE BAY CORE 1
2000 MM
CUM. WT. %
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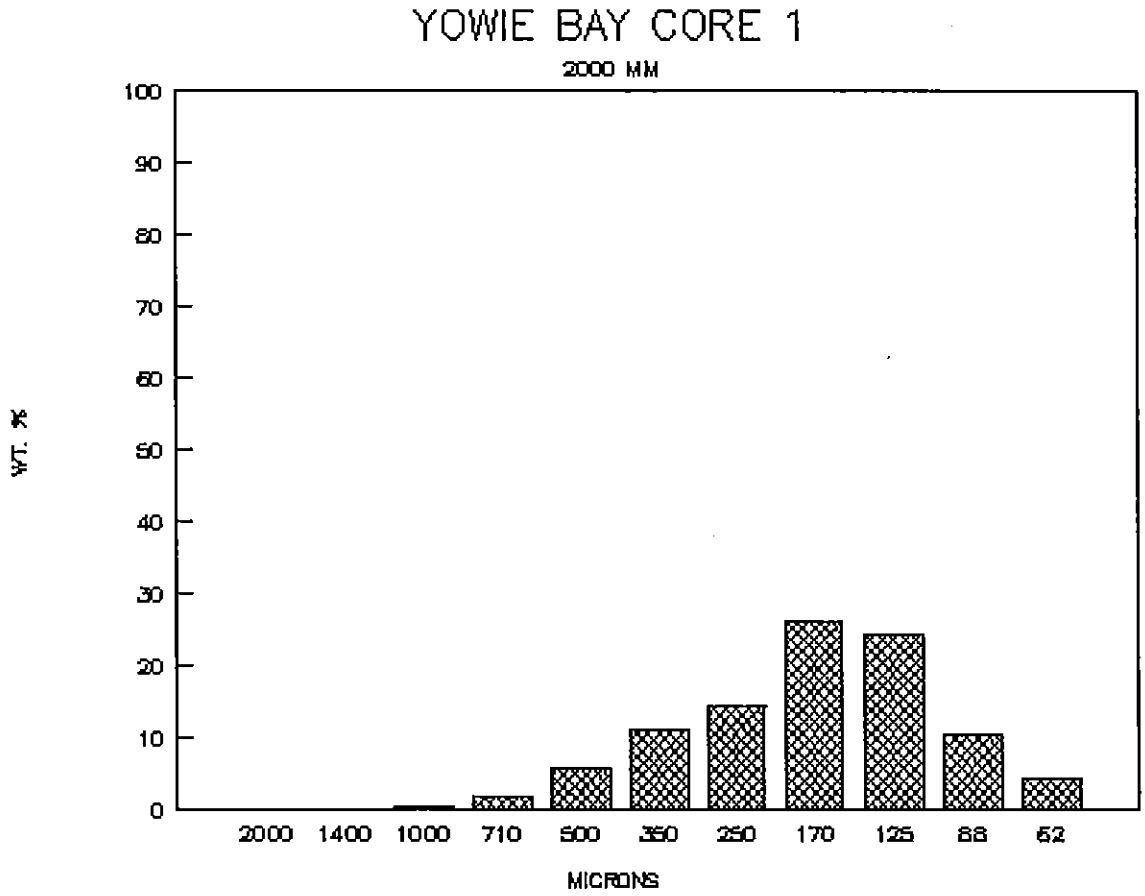
YOWIE BAY CORE 1
2000 MM
WT. %
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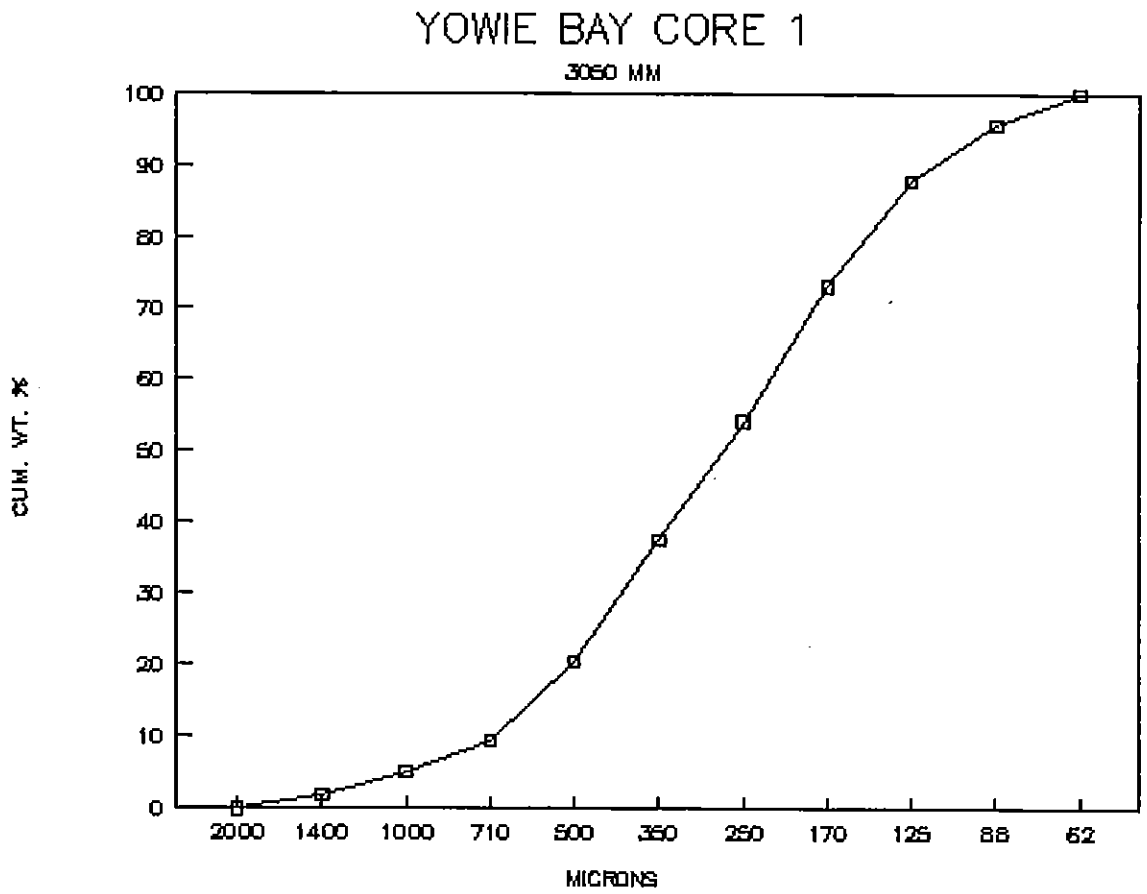
YOWIE BAY CORE 1
3060 MM
CUM. WT. %
100
90
80
70
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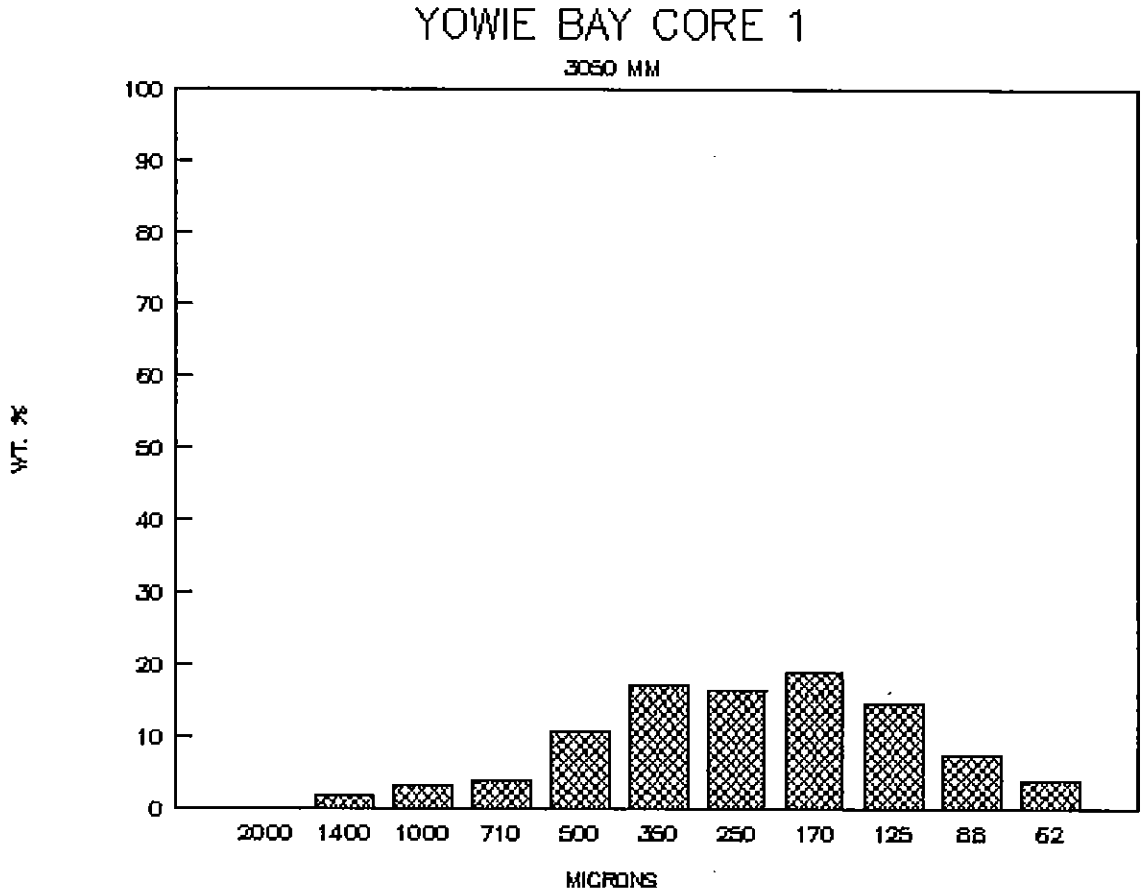
MICRONS


YOWIE BAY CORE 1
3060 MM
WT. %
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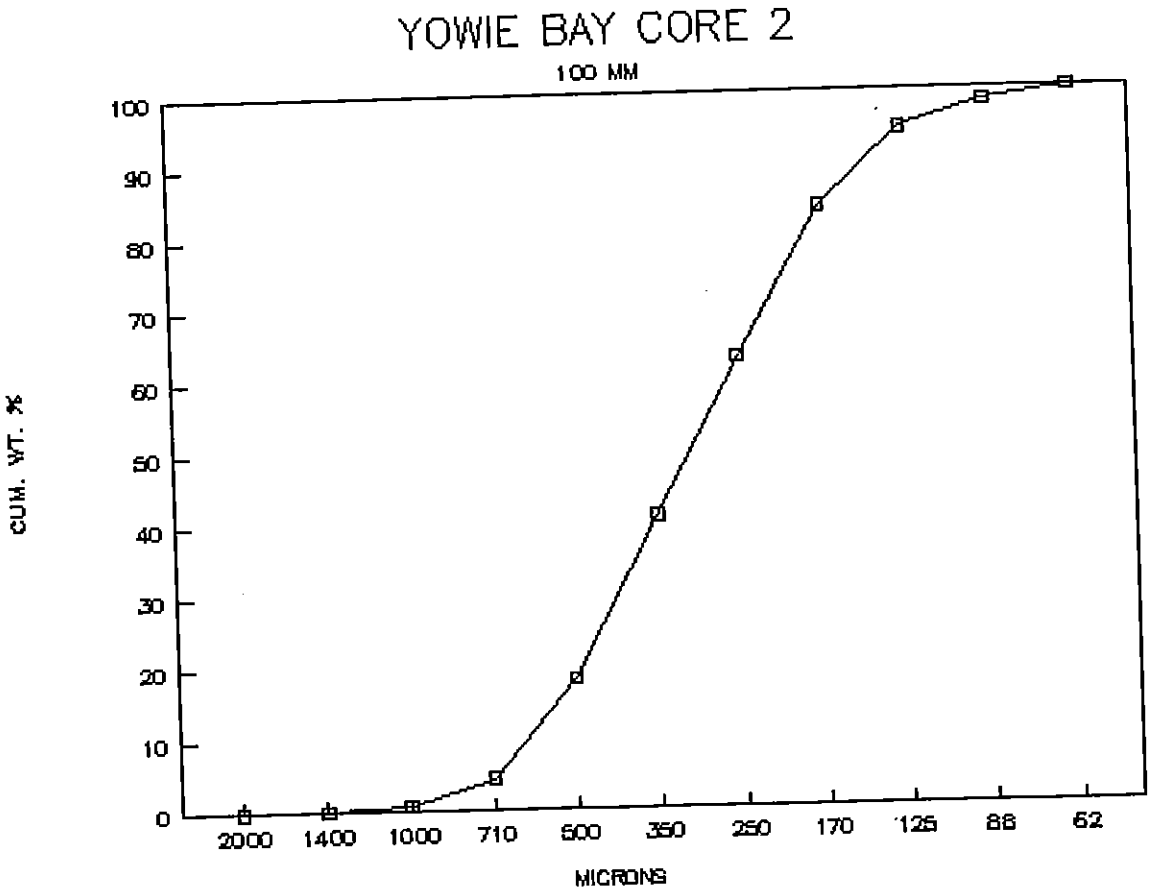
YOWIE BAY CORE 2
100 MM
CUM. WT. %
100
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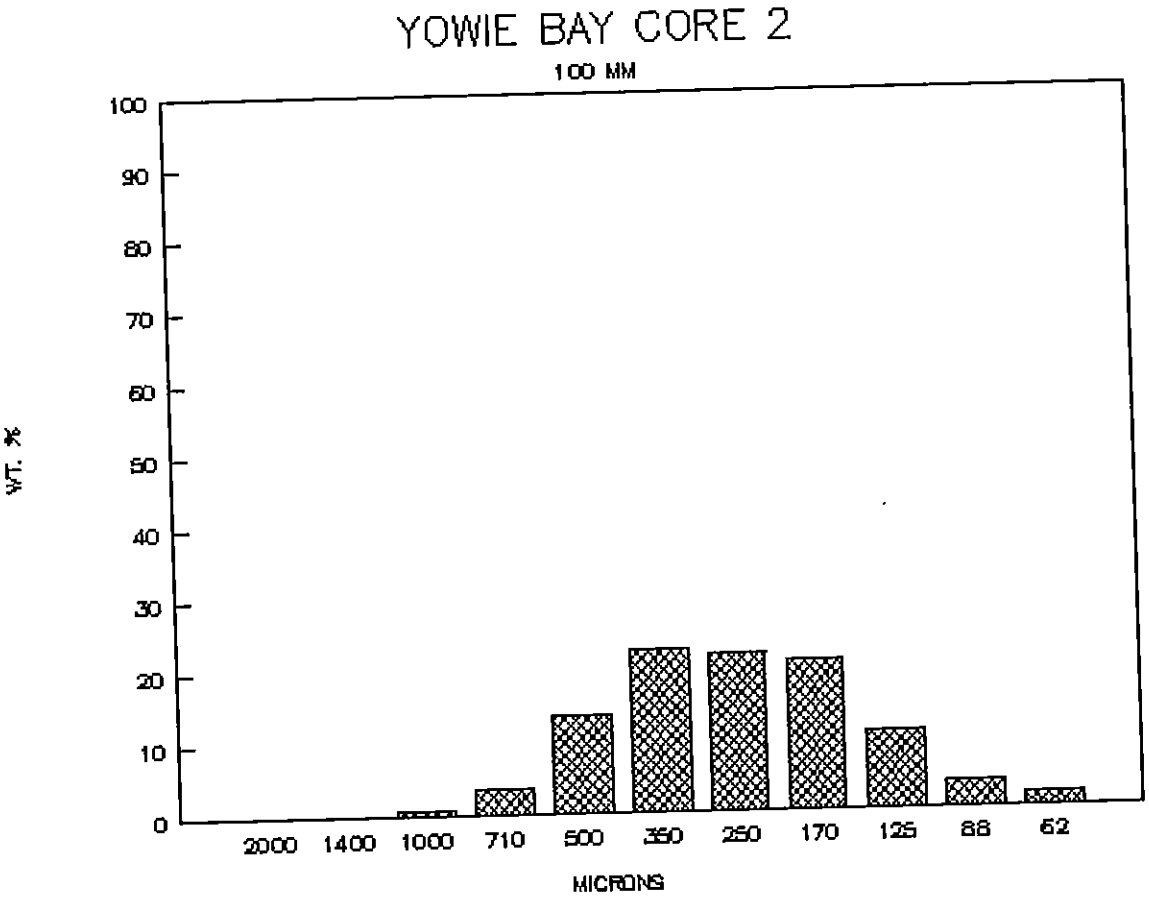
MICRONS


YOWIE BAY CORE 2
100 MM
WT. %
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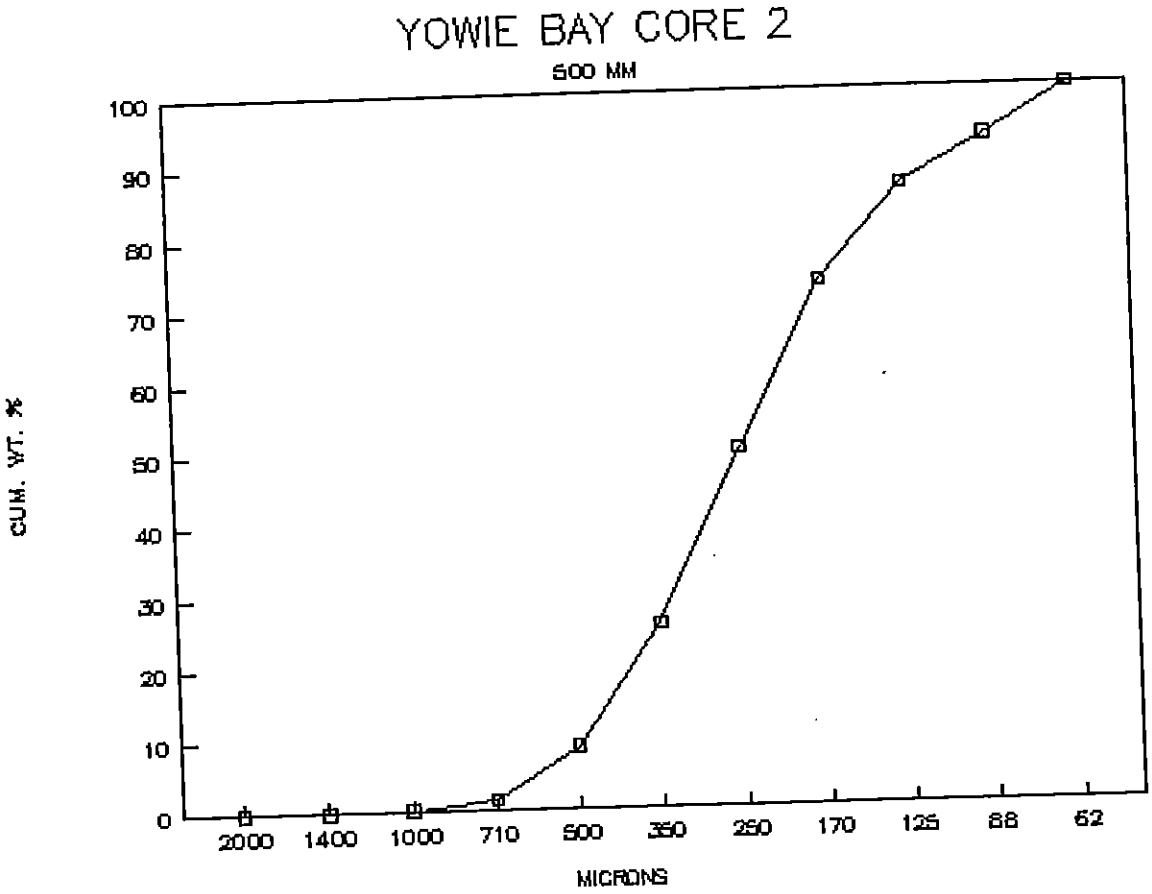
YOWIE BAY CORE 2
500 MM
CUM. WT. %
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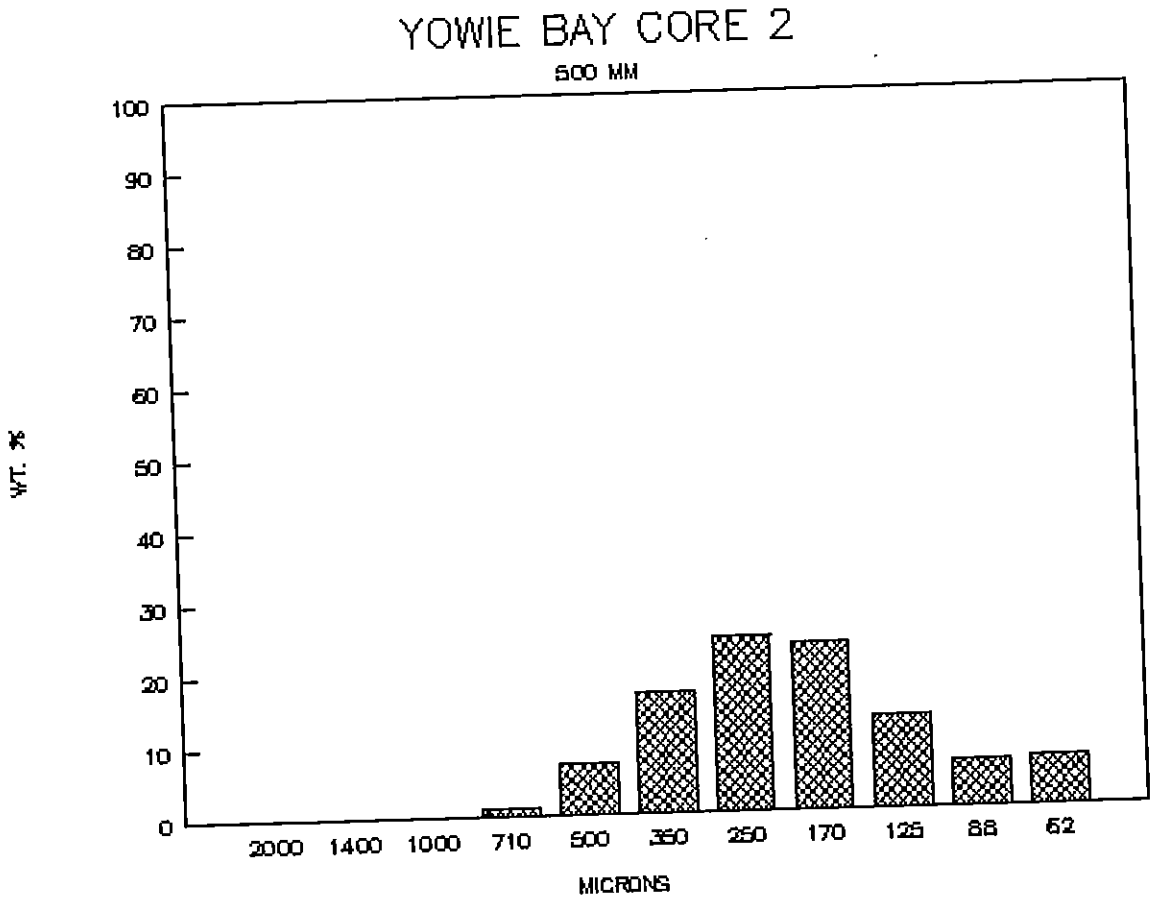
MICRONS


YOWIE BAY CORE 2
500 MM
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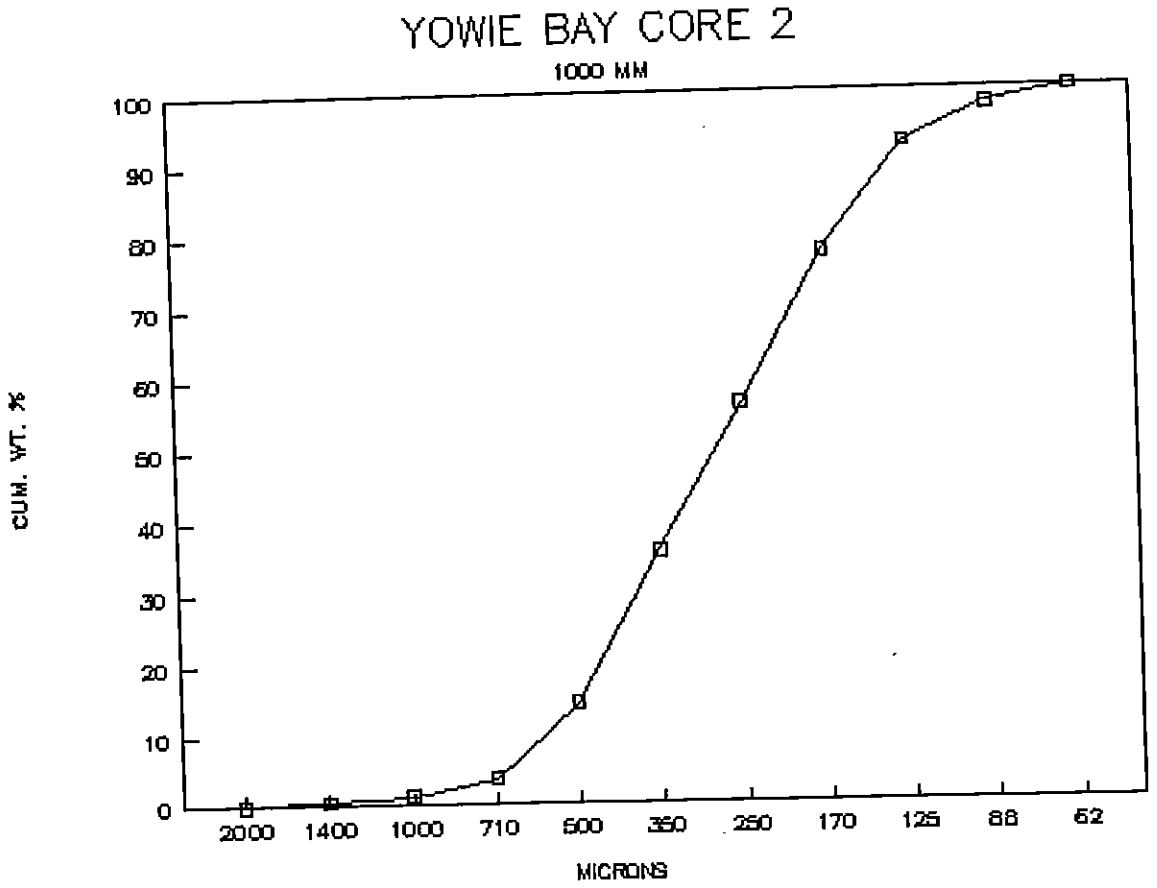
MICRONS


YOWIE BAY CORE 2
1000 MM
CUM. WT. %
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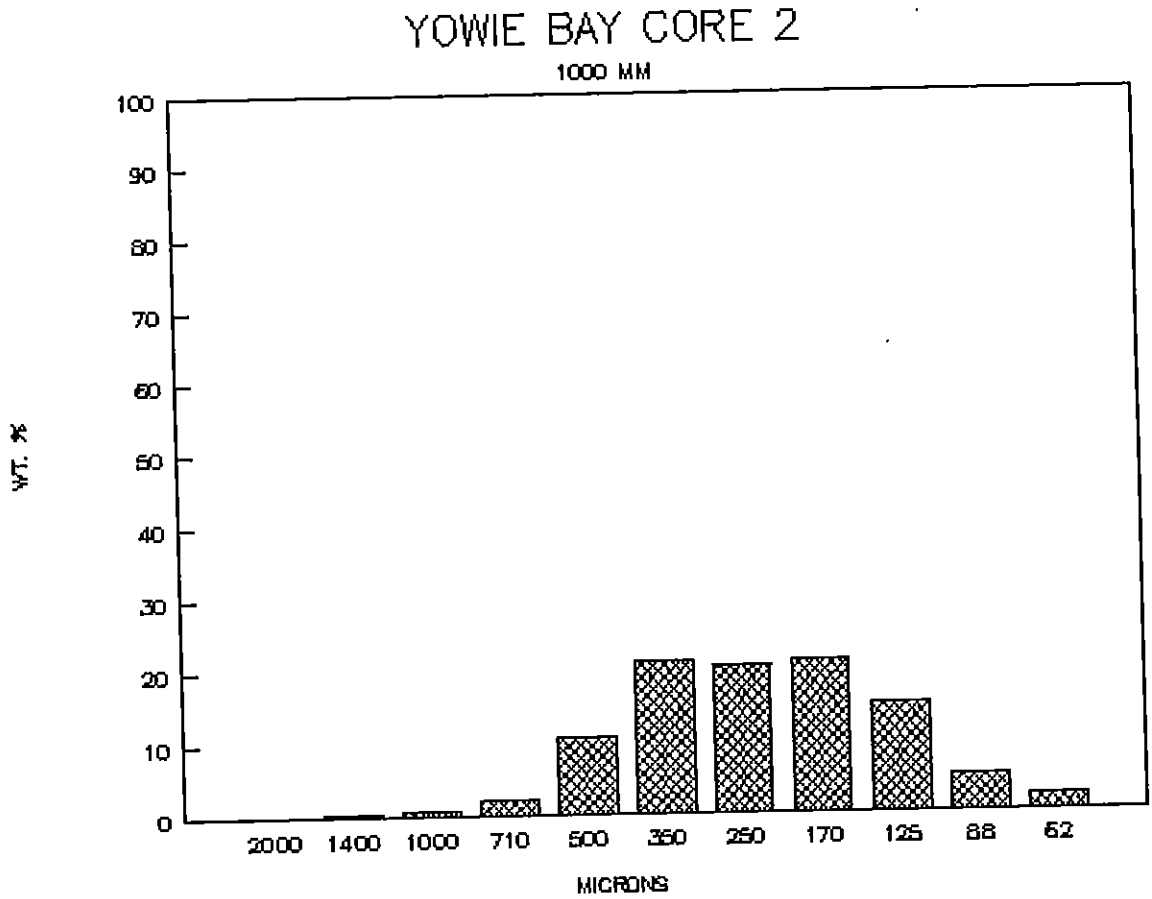
YOWIE BAY CORE 2
1000 MM
WT. %
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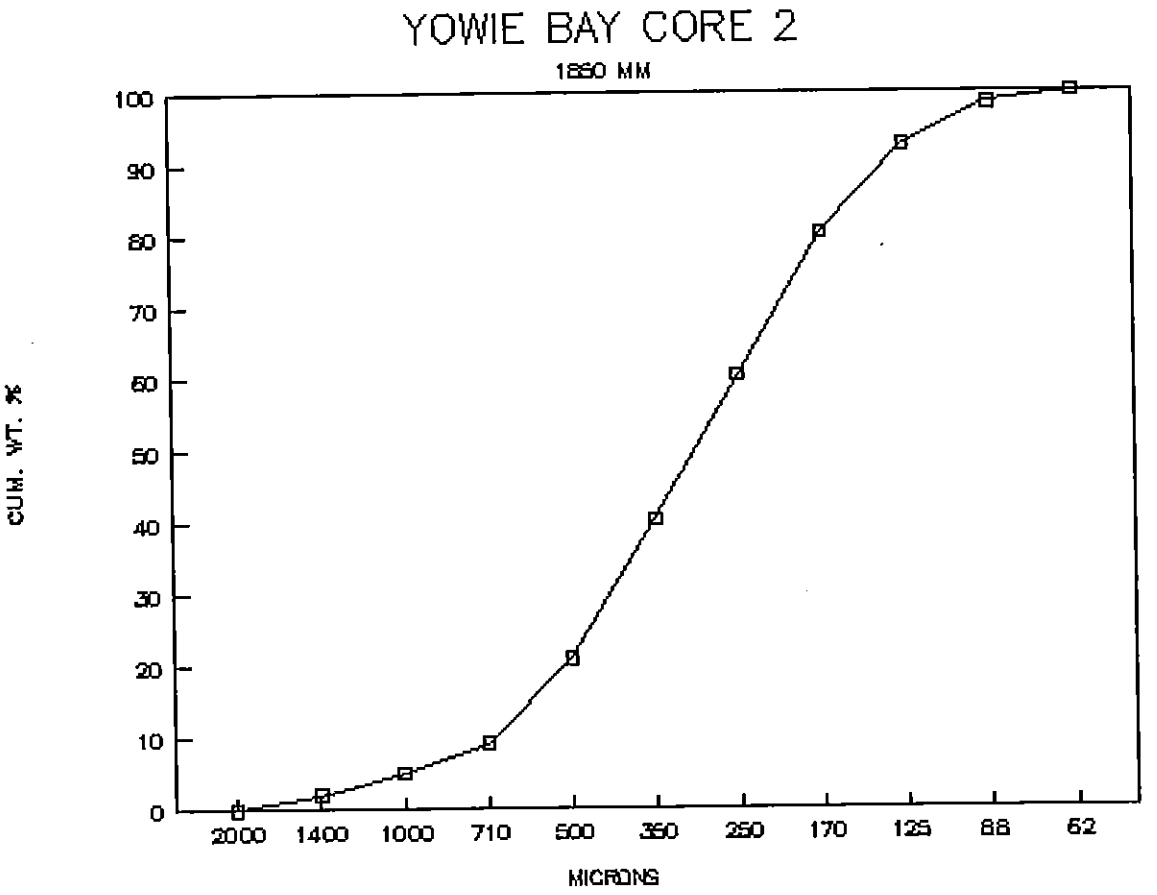
MICRONS


YOWIE BAY CORE 2
1860 MM
CUM. WT. %
100
90
80
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60
50
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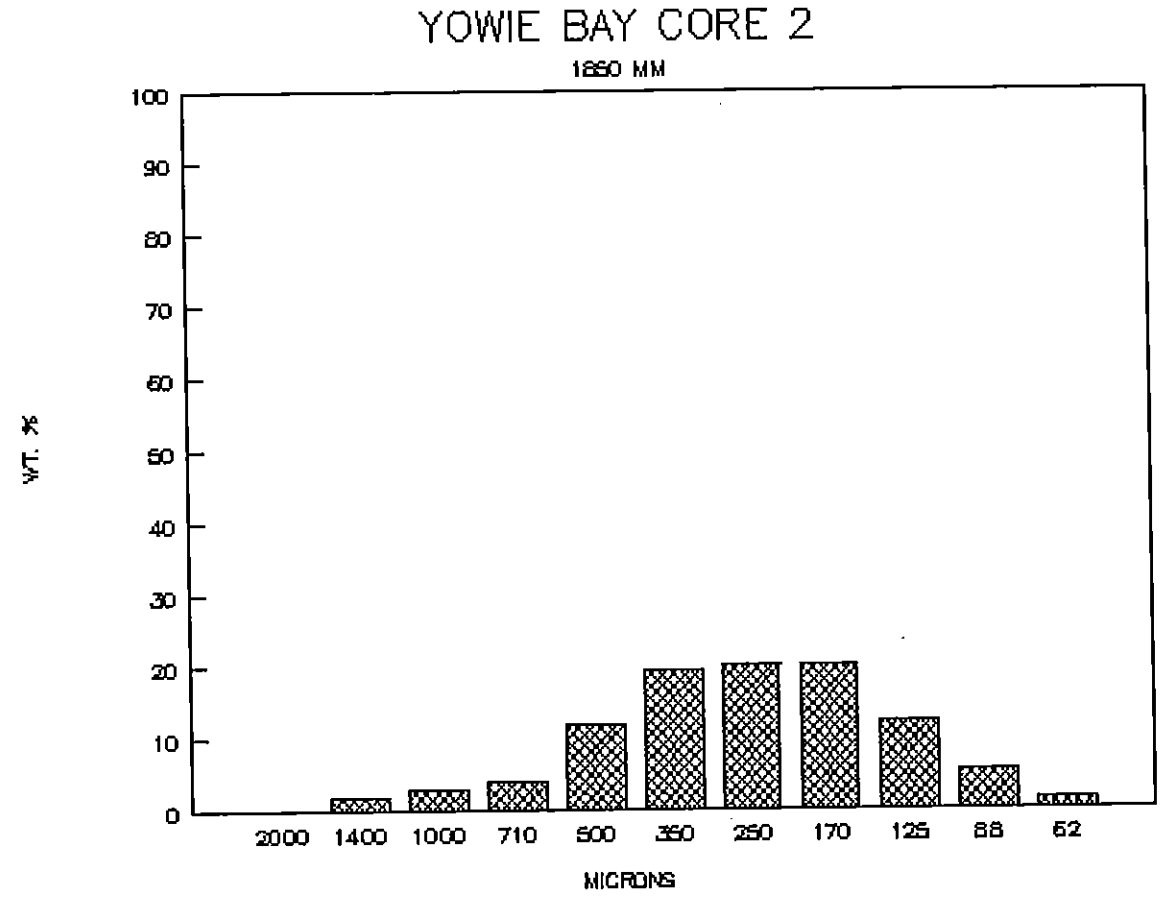
MICRONS


YOWIE BAY CORE 2
1860 MM
WT. %
100
90
80
70
60
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0
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500
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250
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125
88
62
MICRONS

YOWIE BAY – SEDIMENT DESCRIPTION

SAMPLE	GRAVEL	SAND						
		Rel. Size	Shape	Sorting	Shell %	Quartz %	Others#	d_{50} microns
CORE 1								
200	-	medium	a-sr	v poor	2	85	13 (RF, sl, BM)	230
600	mollusc	med-fine	a-sr	poor	3	95	2 (RF)	220
2000	mollusc	fine-med	a-sa	poor	5	95	-	210
3050	mollusc	medium	a	v poor	5	95	-	275
CORE 2								
100	mollusc, brick	medium	a	poor	-	97	3 (sl, RF)	300
500	-	med-fine	a-sa	poor	-	100	-	250
1000	mollusc	medium	a-sa	poor	3	97	-	275
1850	mollusc (to 6cm)	medium	a	v poor	3	97	-	300

LEGEND

In all instances shape factors and to a certain extent size factors apply to the terrigenous fraction of the sands. Shell is usually found in the coarser fractions and is generally angular mollusc.

RF – rock fragment
fp – faecal pellet
sl – furnace? ash
BM – 'blue metal'
anthro – anthropogenic material including glass, paint, metal, plastic, fibro etc
co - coal
a - angular
sa – sub-angular
sr – sub-rounded
r – rounded
mod – moderately
v – very
Fe – iron oxide stained
* - samples that have been analysed for grain-size distribution, $\mathbf{d_{50}}$ has been calculated for these sediments
- - indicate absence of component

Australian
Environmental
Laboratories

Quality Endorsed Company

31 August 1998

Patterson Britton & Partners Pty Ltd
Level 2
104 Mount Street
North Sydney
NSW 2060

Your Reference: Yowie Bay sediment samples
Report Number: 9135

Attention: Philip Haines

Dear Philip
The following samples were received from you on the date indicated.

Samples: Qty.	9 Soils
Date of Registration	18/08/98
Date of Receipt of Samples:	18/8/98
Date of Receipt of Instructions :	18/8/98

These samples were analysed in accordance with your written instructions.
A copy of the instructions is attached with the analytical report.

The results and associated quality control are contained in the following pages of this report.
Unless otherwise stated, solid samples are expressed on a dry weight basis, air and liquid samples as received.

A preliminary report was issued under the same report number

Should you have any queries regarding this report please contact the undersigned.

Yours faithfully
AUSTRALIAN ENVIRONMENTAL LABORATORIES

Anthony Connaughton
Manager Sydney

David Springer
Manager Operations

National Association of Testing Authorities, Australia
NATA ENDORSED DOCUMENT
This document may not be reproduced except in full.

(Analabs Pty. Ltd.) ACN 004 591 664
12 Exell Street, Banksmeadow New South Wales 2019 Australia
Telephone: (61 2) 9316 4255 Facsimile: (61 2) 9316 5541

PROJECT: Yowie Bay sediment samples **REPORT NO: 9135**

Metals on TCLP extract Our Reference: Your Reference Depth	UNITS ---------- ----------	9135-1 1 -	9135-2 2 -	9135-3 3 -	9135-4 4 -	9135-5 5 -	9135-6 7 YB1 0-450	9135-7 8 YB1 1800-1900	9135-8 9 YB2 0-600
Chromium, Cr	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead, Pb	mg/L	0.3	0 5	1.6	0 2	0.4	0 2	<0.05	0.5
Nickel, Ni	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04

PROJECT: Yowie Bay sediment samples **REPORT NO: 9135**

Metals on TCLP extract Our Reference: Your Reference Depth	UNITS ---------- ----------	9135-9 10 YB2 1200-1300
Chromium, Cr	mg/L	<0.05
Lead, Pb	mg/L	<0.05
Nickel, Ni	mg/L	<0.04

QUALITY CONTROL Metals on TCLP extract	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base Sample:Duplicate	Spike Sm#	Matrix Spike Duplicate + RPD
Chromium, Cr	mg/L	0.05	SEM-002	<0.05	9135-1	<0.05 || <0.05	9135-2	118 || 125 || RPD: 6
Lead, Pb	mg/L	0.05	SEM-001	<0.05	9135-1	0.3 || 0.3	9135-2	113 || 108 || RPD: 5
Nickel, Ni	mg/L	0.04	SEM-001	<0.04	9135-1	<0.04 || <0.04	9135-2	114 || 111 || RPD: 3

Result Codes

[INS] : Insufficient Sample for this test
[NR] : Not Requested
[NT] : Not tested
[HBG] : Results not Reported due to High Background Interference
* : Not part of NATA Registration

Results Comments

Cr Spike accepted as all other QC Ok.

Please refer to the attached pages in the appendix - POCAS analysed by AEL Cairns Report No: 39339.

APPENDIX

Australian
Environmental
Laboratories

CERTIFICATE OF ANALYSIS

26 August, 1998

Australian Environmental Laboratories
12 Exell Street
BANKS MEADOW NSW 2019

Your Order No: - 9135
Laboratory Report No: 39339

Date Received: 19 August 1998

Dear Sir

Four soil samples were received and analysed for the parameters as listed in the following table. Please find the results in the attached report.

Yours faithfully,

AUSTRALIAN ENVIRONMENTAL LABORATORIES

Jon Dicker
Operations Manager
CAIRNS

Margaret Nunkervis
Business Manager
CAIRNS

(Analabs Pty Ltd.) ACN 004 591 664
2/58 Comport Street Portsmith Nth. Queensland 4870 Australia
Telephone: (07) 4035 5111 Facsimile: (07) 4035 5122

Australian Environmental Laboratories

Laboratory Report No: 39334

RESULTS I

Sample	Moisture % H_2O	pH $_{KCl}$ 1:2	TAA (pH 5.5) kg H_2SO_4/tonne	TAA (pH 7.0) kg H_2SO_4/tonne	pH $_{ox}$ 1:2	TPA (pH 5.5) kg H_2SO_4/tonne	TPA (pH 7.0) kg H_2SO_4/tonne	TSA (pH 5.5) kg H_2SO_4/tonne	TSA (pH 7.0) kg H_2SO_4/tonne
Blank	-	6.7	-	-	6.5	-	-	-	-
9135-6	32	7.7	<0.5	<0.5	3.6	2.5	4.7	2.5	4.7
9135-7	42	7.9	<0.5	<0.5	6.4	<0.5	0.5	<0.5	<0.5
9135-8	29	8.3	<0.5	<0.5	5.4	<0.5	0.5	<0.5	<0.5
9135-9	43	8.2	<0.5	<0.5	7.4	<0.5	<0.5	<0.5	<0.5
Detn. Limit	1	0.1	0.5	0.5	0.1	0.5	0.5	0.5	0.5
DNR method	-	21A	21F	-	21B	21G	-	21H	-

7 YB1 0 - 450mm
8 YB1 1800 - 1900
9 YB2 0 - 600mm
10 YB2 1200 - 1300

Australian Environmental Laboratories

Laboratory Report No: 39339

RESULTS II

Sample	S POS % w/w	Ca KCl % w/w	Ca P % w/w	Ca A % w/w	Mg KCl % w/w	Mg P % w/w	Mg A % w/w	Na KCl % w/w	Na P % w/w	Na A % w/w
Blank	-	-	-	-	-	-	-	-	-	-
9135-6	0.57	0.19	0.31	0.12	0.10	0.16	0.054	0.63	0.57	<0.005
9135-7	1.2	0.45	1.4	0.97	0.17	0.24	0.065	0.93	0.90	<0.005
9135-8	0.46	0.15	0.46	0.32	0.16	0.097	<0.005	0.42	0.41	<0.005
9135-9	0.93	0.46	1.7	1.3	0.13	0.12	<0.005	0.79	0.77	<0.005
Detn. Limit	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
DNR Method	21Ee	21Vh	21Wh	21Xh	21Sm	21Tm	21Um	21Ms	21Ns	21Ps

7 4B1 0-450 mm
8 4B1 1800-1900
9 4B2 0-600 mm
10 4B2 1200-1300

level 2
104 Mount Street
North Sydney 2060

PO Box 515
North Sydney 2059
Australia

telephone (02) 9957 1619
facsimile (02) 9957 1291
email. patbrit@ozemail.com.au
A.C.N. 003 220 228

Patterson Britton
& Partners Pty Ltd

consulting engineers

MEMO

TO: David Springer, Australian Environmental Laboratory
Level 1
12 Excell Street
BANKSMEADOW

FROM: Philip Haines, Patterson Britton

SUBJECT: Yowie Bay sediment samples

DATE: 18 August, 1998 JOB No. 2677

REF: ..\2677mm02.doc

David

Enclosed are 10 sediment samples (numbered 1 to 10) requiring laboratory analysis.

Please carry out leachate testing for Chromium. Lead and Nickel on all 10 samples.

Also, please carry out POCAS acid sulphate testing on sample Nos 7, 8, 9 and 10.

Please let me know of test results at your earliest convenience.

only 9 Samples
(No Sample 6)

Many regards

P.J. Haines

Philip Haines
Associate

I/CC	PATTERSON
1	1
2	2
3	3
4	4
5	5
6	7 YB1 0-450mm
7 2677mm02	8 YB1 1800-1900
8	9 YB2 0-600mm
9	10 YB2 1200-1300

Australian Environmental Laboratories
Received 18/8/98
Time ... am/pm
By ...
Ice/cooler pack yes/no frozen.
Samples intact yes/n
Results Expected By: 26/8/98
Contact Name: DAVID
Comments:
9135

Form 5.4.6(v2)

APPENDIX B – RESPONSE FROM KURNELL LANDFILL

To: PHILLIP HAINES F:9957291

SUTHERLAND SHIRE COUNCIL 081205

Kurnell Land Fill Company

Site Office: Captain Cook Drive, KURNELL 2231
Postal Address: PO Box 379, KURNELL 2231
A.H. (0418) 27.4452 9634.1392
Fax: 9668.9978

SUTHERLAND SHIRE COUNCIL			
LETTER No.	026122		
FILE No.	813/4/18		
REC'D	12 DEC 1997		
DIV	OFFICER	DATE	DEALT WITH SIGNED
ENG	MR	16/12	MRR
LAST ACTION MUST BE FILED			

General Manager
Sutherland Shire Council
P.O. Box 17
SUTHERLAND NSW 2232

Attention: Mr M.D. Rogers.

28 November, 1997

Dear Sir,

I refer to your letter dated 18 November, 1997 regarding the disposal of 50,000 tonnes of sediment from Yowie Bay Estuary.

I have read the "Study" by Patterson Britton and Partners Pty. Ltd and conferred with Rocla regarding this matter and wish to advise the following.

In my opinion it is not feasible or viable to recycle this material therefore this Company would not be interested in purchasing any. In fact because there is some borderline contamination present in the sediment I am not prepared to risk polluting the groundwater on my site and as such I will not accept any material from this project for disposal.

Should you require any further clarification regarding this matter I can be contacted on the above mentioned phone numbers.

Yours faithfully,

Eric le Provost

Eric le Provost
Operations and Development Manager.

FILE

CLOSED

SEE PART 3.

GT 11/8/99

APPENDIX C – RESPONSES FROM AUTHORITIES

level 2
104 Mount Street
North Sydney 2060

PO Box 515
North Sydney 2059
Australia

telephone (02) 9957 1619
facsimile (02) 9957 1291
Email: patbrit@ozemail.com.au
ACN 003 220 228

Patterson Britton
& Partners Pty Ltd

consulting engineers

Waste Service NSW
PO Box 699
Chatswood NSW 2057

zx578:2677:PH:ph

24 July, 1998

Attention: Mr Phil Baxter

Dear Mr Baxter,

REMOVAL AND DISPOSAL OF SEDIMENT FROM THE HEADS OF YOWIE BAY

Patterson Britton and Partners (PBP) has been engaged by Sutherland Shire Council, on behalf of the Yowie Bay Estuary Management Committee, to investigate the feasibility of removing contemporary sediment which has accumulated at the heads of Yowie Bay, in the Port Hacking estuary, as shown in Figure 1. The sediment comprises slightly silty sand, to a maximum depth of approximately 1 metre over the top of the natural alluvial delta. At present, the surface of the contemporary sediment is located at a level of approximately RL 0.0 to RL 0.5m AHD. Contemporary sedimentation has also prograded the location of the delta 'drop-off' approximately 20 metres seaward. The depth of contemporary sedimentation in the drop over could be as much as 5 metres. The total volume of contemporary sediment at the heads of Yowie Bay is approximately 30,000 m^3, or about 50,000 tonnes.

The feasibility assessment will consider a range of different removal techniques, transportation options, and disposal sites, as follows:

Possible removal techniques

Investigation of removal techniques will include suction dredging, mechanical excavation from barge and mechanical excavation from earth platforms. The feasibility of the different removal techniques will also depend on the materials handling requirements once the sediment has been removed from its in-situ location. On-site treatment of the sediment may also be required, depending on the results of chemical analyses which are currently being carried out. Treatment might include drainage and possible addition of buffering chemicals. Treatment would be carried out in ponds with any supernatant confined and treated if necessary before being returned to the bay.

Transportation options

The sediment will be in either a solid form (ie, drained and spadable), a saturated form (ie, undrained), or a slurry form (ie, mixed with saltwater to a viscous slurry). The transportation of the sediment will depend largely on the form in which it will be processed. For a solid form, the sediment would be trucked to disposal sites. For a saturated form, the sediment would also be

trucked, however, trucks would be required to be sealed, so that spillage does not occur during transportation. For a slurry form, the sediment would be pumped to the disposal site. This option would only be feasible for transportation over relatively short distances (ie, less than 1000m or so).

Likely disposal sites
The disposal sites which will be investigated as part of this study are:

- Kurnell land fill;
- Lucas Heights I
- Lucas Heights II
- Abandoned rock quarry adjacent to Ewey Creek; and
- Abandoned clay pit in Kirrawee.

As well as a general cost and functionality assessment, this feasibility is to include any environmental or planning constraints which may be imposed by your department. As such, we would appreciate your time to consider the proposal and outline to us any restrictions or considerations which we should include in our feasibility assessment.

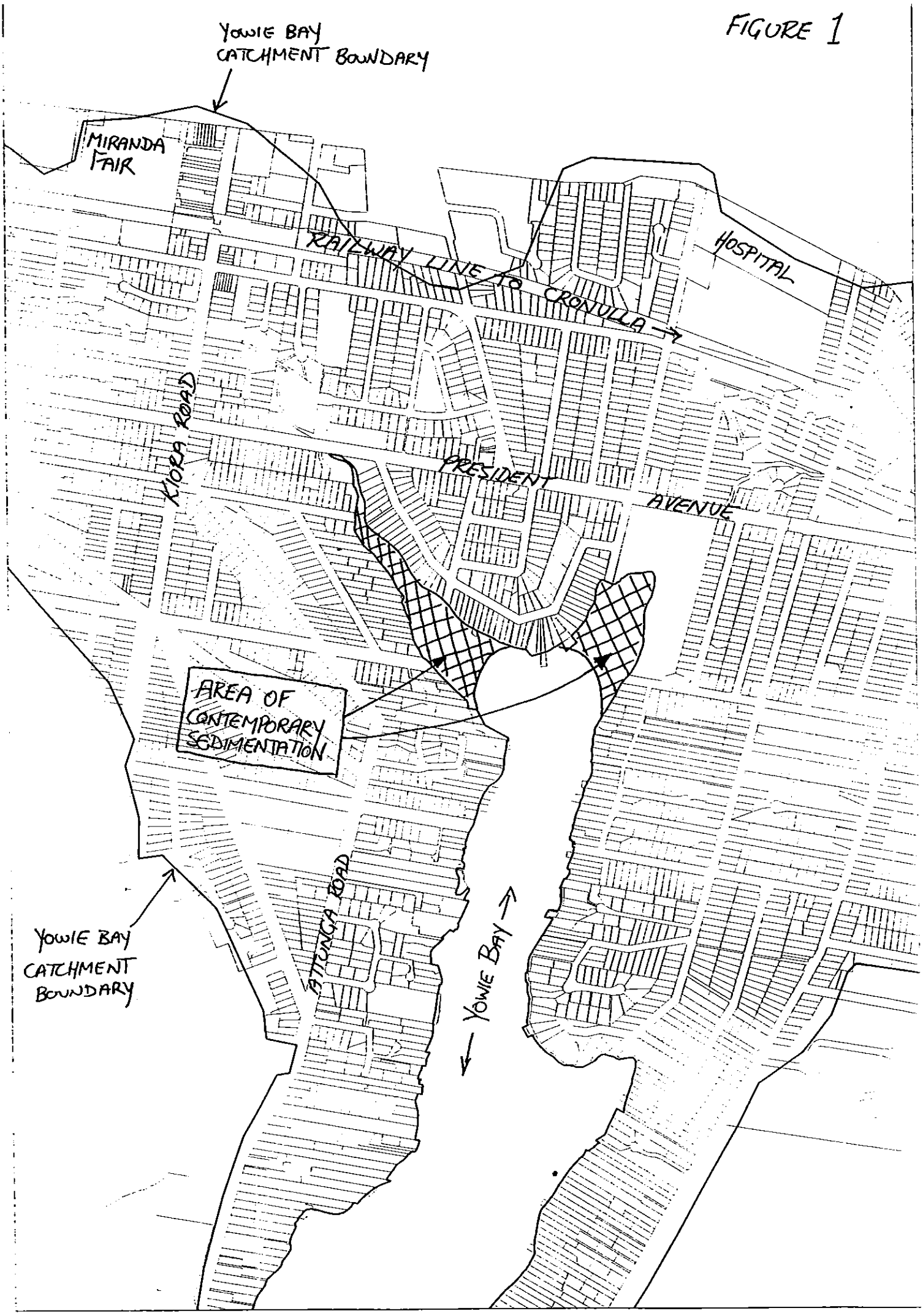
We would appreciate a written response by Friday 7 August 1998. We look forward to your response. If you have any queries regarding the proposal, please do not hesitate to contact Mr Philip Haines of this office, on 9957 1619.

Yours faithfully
PATTERSON BRITTON

Review / Verification by ------Date
24/7.98
Created 02/07/98 16:06

B M Druery
Principal

FIGURE 1


YOWIE BAY CATCHMENT BOUNDARY
MIRANDA FAIR
RAILWAY LINE TO CRONULLA →
HOSPITAL
KIORA ROAD
PRESIDENT AVENUE
AREA OF CONTEMPORARY SEDIMENTATION
ATTUNGA ROAD
YOWIE BAY →
YOWIE BAY CATCHMENT BOUNDARY

9957-1291

Rec'd 29/7/98

Sydney Zone

NSW NATIONAL PARKS AND WILDLIFE SERVICE

Regent Honeyeater *Xanthomyza phrygia*

Facsimile

To: B M Druery Patterson Britton

From: Derek Steller

Date: 29/7

No. of pages following:

Subject: Removal of Sediment from Yowie Bay

Ph: (02) 9585 6678 91

Fax: (02) 9585 6442

PO Box 1967
HURSTVILLE NSW 2220

Please find attached a copy of the NPWS' "General Guidelines for Impact Assessment" in response to your letter dated 29/7/98 regarding the above proposal.

Derek Steller
Env. Planning Officer

NSW NATIONAL PARKS AND WILDLIFE SERVICE

GENERAL GUIDELINES FOR IMPACT ASSESSMENT

The National Parks and Wildlife Service (NPWS) has an interest in the potential impacts of the proposal on the following:

- areas of native vegetation,
- areas of potential value as habitat for native fauna,
- sites and places of Aboriginal heritage, including areas of archaeological potential, and
- land dedicated under the National Parks and Wildlife Act (NP&W Act).

If these attributes are anticipated to be present in your study area and / or likely to be impacted, it is recommended that assessments by a suitably qualified person be undertaken to determine the extent of impact. Details of the qualifications and experience of the person undertaking the work should be provided. In addition, a detailed description of survey methodology including survey design, sampling methods, weather conditions, time and duration of surveys and location of survey sites and transect lines should also be provided as part of the consultant's report to council.

The matters recommended to be addressed in the assessment are as follows:

- description of the proposal and the way in which the environment will be modified;
- map(s) placing the proposal in a regional and local setting;
- applicability of Local Environmental Plans, Regional Environmental Plans and State Planning Policies (including SEPP 44 and SEPP 46) to the proposal should be discussed;
- information on the current and past land uses of the site and that of the surrounding area;

- detailed description and mapping of all vegetation communities in the study area;
- identification of any vegetation communities or plant species which are of local, regional or state conservation significance (including threatened communities, plant species or populations listed under the Threatened Species Conservation Act, 1995). The criteria for establishing significance should be documented;
- description of known or expected fauna assemblages within the study area;
- identification of fauna habitat likely to be of local, regional or state significance (including habitat of threatened fauna species or populations listed under the Threatened Species Conservation Act, 1995);
- identification of whether there are any sites or places of cultural significance to the Aboriginal community;
- mapping of the location of all Aboriginal sites (including archaeological sites and potential sites) within the study area and an assessment of the significance of these sites;
- identification of habitat corridors and linkages between areas of remnant native vegetation which may assist faunal movement through the area;
- prediction of the likely impact of the proposal on the above attributes (quantification of the extent of impact where practical);
- assessment of measures available to minimise the impact of the proposal on these attributes and monitoring program if appropriate, and
- prediction of the likely impact of the proposal on land dedicated under the NP&W Act.
- appropriately scaled maps which identify the location and extent of the areas of natural and cultural heritage value in relation to the area of proposed development.

Threatened Species legislation

You are also advised that the Threatened Species Conservation Act, 1995 (TSC Act) came into effect on the 1 January 1996. The TSC Act effectively replaces the legislative scheme introduced by the Endangered Fauna (Interim Protection) Act, 1991 and amends the way threatened species are considered under the Environmental Planning and Assessment Act, 1979 and the National Parks and Wildlife Act, 1974.

The provisions of the TSC Act should be considered when undertaking the assessment of a proposal. Information on the provisions of the TSC Act may be obtained from the Department of Urban Affairs and Planning Circular No. A13 (12 December 1995). The NPWS has also produced Information Circulars on the TSC Act which may be obtained by contacting the NPWS' Information Centre on (02) 9585 6528.

Aboriginal heritage and community consultation

It is recommended that an assessment be conducted of the Aboriginal cultural values of the study area if the proposal involves disturbance to substantially unmodified ground surfaces. If the study area is considered to have archaeological potential or cultural significance then it is recommended that a survey and assessment be undertaken in accordance with NPWS guidelines. These guidelines are contained in the NPWS' publication "Aboriginal Cultural Heritage: Standards and Guidelines", which may be purchased by contacting the NPWS' Cultural Heritage Conservation Division on (02) 9585 6571.

Should Aboriginal archaeological sites be present in the study area, you should consider the requirements of the NP&W Act with regard to Aboriginal relics. Under s90 of the NP&W Act it is an offence to knowingly damage or destroy relics without the prior permission of the Director-General of the NPWS.

In assessing Aboriginal heritage values, consideration should also be given to whether the study area is likely to contain places of cultural significance to the Aboriginal community. It should be noted that places of cultural significance to the Aboriginal community are not limited to archaeological sites. An assessment of cultural significance should involve consultation with community representatives and if necessary, documentary research to establish whether there are any places of traditional or historic significance to the Aboriginal community.

Databases

The NPWS has two GIS databases which may provide information of use to you if you proceed to undertake further assessment. These are:

- Atlas listing of fauna and flora records in NSW;
- Aboriginal Sites register.

The material from these databases is available upon written application and the receipt of the appropriate fee. If you are interested in obtaining access to the Atlas database, please contact the Data Licensing Officer, GIS Division, on (02) 9585-6684. Records from the Aboriginal Sites register may be obtained upon written application to the Registrar, Cultural Heritage Conservation Division, on (02) 9585-6471.

WASTE SERVICE NSW

4 August 1998

Reference: PB/dh

Patterson Britton and Partners P/L
PO Box 515
NORTH SYDNEY NSW 2059

Rec'd 6/8/98

Attention: Mr Philip Haines

RE: DISPOSAL OF SEDIMENT FROM YOWIE BAY

Dear Sir,

I refer to your letter to Waste Service dated 24 July 1998 re the removal and disposal of sediment from the heads of Yowie Bay.

Waste Service, in its letter dated 28 January 1998 responded to Sutherland Shire Council letter of 8 December 1997 (see attached copies), regarding this issue. It is felt that your query has been addressed in that letter. As outlined in Waste Service's letter, further testing of the sediment and discussion with the EPA would clarify its classification for disposal purposes. Its acceptance at either of the Lucas Heights facilities will also depend on its physical condition - in general, it would need to be in a condition suitable for compaction.

For any further queries on this matter please contact myself or Mr David Williams on 9934 7000.

Yours sincerely,

P Baxter
for Managing Director

G:\CO\BAXTER\LET1998\PBP0408.WPD

WASTE SERVICE NSW

28 January 1998

Reference F0532 PB:vw

General Manager
Sutherland Shire Council
PO Box 17
SUTHERLAND NSW 2232

Attention : Mr M D Rogers

Dear Sir,

RE : DISPOSAL OF YOWIE BAY SEDIMENT

I refer to your letter of 8th December 1997 and the Yowie Bay Estuary Processes Study of June 1996.

Council's letter seeks advice regarding disposal of 50,000 tonnes of dredged sediment to either the Lucas Heights II Landfill or the Lucas Heights I former landfill. Waste Service has reviewed both the Study and Council's letter and offers the following comments:

- Analytical data on the sediments is limited, although there is enough information to sensibly apply the EPA's "Environmental Guidelines: Assessment, Classification and Management of Non-Liquid Wastes". The maximum concentrations for analytes, other than lead, in the sediment, which are included in the guidelines, indicate that the sediment may be regarded as "Solid Waste" and suitable for disposal at Lucas Heights II. The concentrations of chromium and nickel mandate this classification rather than "Inert Waste".

- Contrary to advice from the EPA, mentioned in the report, that the lead levels are not of concern, the maximum concentration of lead (309 mg/kg) exceeds the guideline threshold (100 mg/kg) for classification as a "Solid Waste" and pushes the sediment into the "Industrial Waste" classification. It may be possible to negotiate with the EPA acceptance of the sediment, as a waste, at Lucas Heights II while issue of the EPA's guidelines for industrial waste landfills is pending, however, it is unlikely to be regarded as "Inert Waste" for cover material, or landfill, at Lucas Heights I.

- Although there is no information in the report, the results of a leaching test on chromium, lead and nickel may allow the sediments to be classified as "Inert Waste". In view of their history in this case, it is unlikely that these metals will be readily available and leach test results should be favourable. These results, coupled with the much higher total concentration thresholds, may allow reclassification to "Inert Waste" and facilitate disposal (or use) at either Lucas Heights I or II.

- The physical condition of the sediments also needs consideration. Even though they may be drained to a "spadeable" condition, they will still have a high water content and may be thixotropic. That is, they may appear to be quite acceptable at the point of loading but liquefy during transport to become highly mobile and unacceptable at the point of disposal. Trials should be conducted to verify the physical acceptability of the sediments.

In our opinion, the dredged sediment would not meet the EPA's definition of Virgin Excavated Natural Material (VENM) and should be regarded as a waste. A leach test would provide information to assist proper classification of the sediment and determination of its suitability for use at either site. Discussions with the EPA may also assist any assessment of the sediment and its management. If the sediment is deemed suitable for use as cover material, that is, for engineering purposes, the Section 72 levy, payable to the EPA, may be claimed for rebate. Trials to assess its physical condition at the point of disposal should be carried out.

In summary, based on the information provided by Council, Waste Service would regard the dredged sediment as a waste attracting the Section 72 levy and appropriate disposal charges. We would be pleased to consider any additional information and discuss these comments with Council.

Any further queries on this matter may be directed to Mr Phil Baxter on 9934 7042.

Yours sincerely,

P. Baxter

for Managing Director

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SUTHERLAND SHIRE COUNCIL

for further information please contact:
Mr MD Rogers 9710 0484
File Ref: 97/

ADMINISTRATION CENTRE
ETON STREET SUTHERLAND NSW
AUSTRALIA

8 December 1997

Mr P Baxter
Waste Service NSW
PO Box 699
CHATSWOOD NSW 2057

Dear Mr Baxter

Disposal of 50,000 tonnes of Yowie Bay Sediment

Further to my telephone enquiry of 4 December, 1997, I enclose a copy of the Yowie Bay Estuary Processes Study, June 1996.

As discussed, Council is investigating the feasibility of dredging the sediment out of the two heads of Yowie Bay in Port Hacking. Only the top 0.5 to 1.0 metres of post European settlement sediment would be removed. It comprises, as you can see from the study, mainly granular material. The underlying natural marine silt would be left in place. The sediment to be removed does however contain some organic material, road gravel, pieces of concrete, bricks, bottles, in fact anything which has washed into the bay from stormwater run-off. The large proportion is however granular material. Your attention is particularly drawn to the appendices in the study which show the composition of the material and test results.

Could you advise if the material could be used as fill at the old tip site at Lucas Heights where I understand fill will be required over perhaps a 10 year period. Alternatively, could it be utilised as "cover" material at the operating Lucas Heights tip at no charge to Council.

It is intended that, subject to approvals being obtained, Council could dredge the material to a bunded area perhaps near Yowie Bay or elsewhere to dry out to a "spade-able" consistency taking all necessary environmental protection measures. It would then be trucked to the disposal site.

I await your advice.

Yours faithfully

MD Rogers
for J W Rayner
General Manager

EX		FS			
AS		IT			
CO	PBV	LI		TS	
CS		MK			
ES		PL			
FILE No.	F0210		28118		

ENCL.

Please reply to: General Manager
PO BOX 17 SUTHERLAND NSW 2232 AUSTRALIA
PHONE (02) 9710 0333 DX4511 SUTHERLAND
ADMINISTRATION FAX: (02) 9710 0265

AR/AR PBP27

Contact: Mr A. Roper
(02) 4226 8559

LAND & WATER CONSERVATION

Patterson Britton & Partners
P.O. Box 515
NORTH SYDNEY NSW 2059

Attention: Mr P Haines

Dear Sir,

Removal and Disposal of Sediment from the Heads of Yowie Bay

I refer to your letter of 24 July 1998 requesting the Department's comments on any environmental or planning constraints relevant to this proposal.

Without providing a comprehensive list of requirements for an environmental assessment (REF or EIS) the following points should be considered for a feasibility assessment:

Environmental Constraints

- the availability of a suitable land base for dewatering and treatment of return water to EPA standards
- the quality of the sediment to be dredged and its suitability for the proposed disposal site
- the effect changed local wave and current conditions will have on adjacent shorelines, especially erosion
- depending on the depth of the dredging, the possibility of stratification and effects on water quality
- the effect of dredging on valuable aquatic habitats such as seagrass beds and any benthic fauna that may have established on the fluvial deltas and whether recolonisation is likely to occur from adjacent areas considering substratum, photic limits and other factors
- the effects on water quality and aquatic flora and fauna during the dredging operation
- the effects any odours generated may have on adjacent residents.

Planning Constraints

There would be a number of matters that would need to be considered, although possibly at a later stage than a feasibility assessment, as follows:

- the proponent should determine whether SEPP35 on Maintenance Dredging is applicable
- a Crown Land licence would be required
- a Land Assessment would normally be required, however, some flexibility may be possible depending on the range of issues covered by the feasibility assessment and any ensuing environmental assessment

- the question of whether Native Title is applicable would need to be addressed through consultation with the State Lands Service.

Please note that when an application for development approval is formally submitted to the consent authority, any referrals should be made to the Department's Environmental Review Coordinator located in this office.

I trust this information satisfies your inquiry but please liaise with the contact officer if you have any further queries.

Yours faithfully

6/5/98

for: B T Dooley
Manager
Resource Access Works & Services
Sydney/South Coast Region

Waterways
We're with you on the water

6 August 1998

AR : AR 11/8.
PH : PH
File 2677

Mr B M Druery
Principal
Patterson Britton & Partners Pty Ltd
P O Box 515
NORTH SYDNEY NSW 2059

11/8

Dear Sir

Re: Removal and Disposal of Sediment from the heads of Yowie Bay
Your ref: zx572:2677:PH:ph

I wish to acknowledge receipt of your letter dated 24 July 1998 regarding the above matter.

Your comments have been noted and we would appreciate if you could forward a copy of your feasability study in due course.

Yours faithfully

FOR:
Stephen Black
Operations Manager
Botany Bay/Port Hacking

WATERWAYS AUTHORITY UNIT 11 20-24 GIBBS STREET MIRANDA NSW 2228
TELEPHONE (02) 9524 7899 FACSIMILE (02) 9524 9361

Rec'd 11/8 A

NSW FISHERIES

BLD · 8/8
AR 11/8
PH File
File 12677

B. M. Druery
Principal
Patterson Britton & Partners Pty Ltd
PO Box 515
NORTH SYDNEY NSW 2059

re: removal and disposal of sediment from the heads of Yowie Bay

Dear Sir/Madam

Thank you for the opportunity to consider this proposal. NSW Fisheries appreciates the problems associated with sedimentation in the heads of Yowie Bay, and recognises that the sediment has accumulated since European settlement. However, these areas also contain seagrasses and mangroves, which are important fish habitats. Any sediment removal will need to done in such a way that does not destroy or damage these habitats. NSW Fisheries supports land use/disposal options for the sediment provided that creeks or wetlands are not adversely affected.

Under Part 7 of the *Fisheries Management Act 1994*, a permit from NSW Fisheries will be required for the proposed dredging, and also for any damage to mangroves or seagrasses. NSW Fisheries will require information on the exact nature of the proposed dredging, and its relationship to nearby mangroves and seagrasses, before any permits could be considered. An up-to-date map showing the distribution and species composition of mangroves and seagrasses throughout the area will also be necessary. This map should have a resolution of no worse than 1 metre.

If a dredging permit was issued by NSW Fisheries it would probably include the following general conditions:

(1) Only the contemporary sediment is to be removed;

(2) Sediment may not be taken from deeper than 2 metres below mean low tide level.

(3) The resulting bottom must be free of holes or hollows and battered to a slope of no greater than 1 in 6.

(4) No *Posidonia* seagrass or saltmarsh are to be damaged or destroyed;

(5) A BACI design monitoring program, focusing on seagrasses and benthos, and to the satisfaction of NSW Fisheries, is to be in place before works commence;

(6) An environmental bond is to be posted by the proponent, and may be forfeited in the event of unacceptable damage to seagrasses or mangroves;

(7) Silt curtain(s) are to be used; and

(8) Any discharge arising from removal or transportation of dredge spoil is to be fully treated, and not released within 50 metres of any seagrass bed.

Permission to remove mangroves or any *Zostera* or *Halophila* seagrasses will depend on their specific location and condition, and whether a satisfactory transplanting protocol is in place. NSW Fisheries is most likely to approve the removal of mangroves if they are small, isolated, and are to be replanted in a suitable location. NSW Fisheries *may* also approve a scheme by which *Zostera* or *Halophila* growing at around the low tide level is removed prior to dredging, before being replanted into the natural alluvial sediment.

Further information and permit application forms are available in the NSW Fisheries publication "Policy and Guidelines: Aquatic Habitat Management and Fish Conservation", a flier for which is enclosed.

Should you have any questions, or wish to discuss these matters further, please do not hesitate to contact me on 95667865.

Yours Sincerely,

JACK HANNAN
Conservation Manager
7 August 1998

Encl.

SUTHERLAND SHIRE COUNCIL

for further information please contact:
Mr. M. Fursland
File Ref: 97/1391

ADMINISTRATION CENTRE
ETON STREET SUTHERLAND NSW
AUSTRALIA

Recd 17/8

10 August 1998

Mr. Philip Haines
Patterson Britton and Partners P/L
Level 2, 104 Mount Street North Sydney 2060

→ fig 2677

Dear Philip

Comments to Removal of Sediments proposal for the Heads of Yowie Bay

Council's Environmental Planning Department has sought comment from our Environmental Lawyer regarding the existence of any legal constraints either under Sutherland Shire Local Environmental Plan 1993 or State Environmental Planning Policy 35 for the removal of sediment at the Heads of Yowie Bay and as outlined by Patterson Britton P/L.

Council's Environmental Lawyer has advised that the tidal nature of Yowie Bay may permit maintenance dredging to be carried out under SEPP35.

It was also advised that a full Environmental Impact Statement should be carried out for any dredging of sediment at the Heads of Yowie Bay. The nature and extent of contaminants in the sediments would in part justify a full EIS.

It should be noted that any scenario that involves the tipping of sediment to any site beyond the two existing land fill sites ie Menai Tip and Kurnell landfill would require a Local Environmental Plan for the site and an Environmental Impact Statement. The use of the abandoned Sydney Water site at Kirrawee may be constrained by the existence of certain species of aquatic fauna. (For further detail on this site please contact Council's Environmental Science Unit)

The view advanced by DUAP'S Rockdale Office that the dredging of sediment may fall under the classification of Extractive Industry is not supported by Council's Environmental Lawyer.

Should this project progress to physical removal of sediments there would be the conditioning of sediment removal to control such matters as :-

* Control of truck movements

* Noise controls

* Hours of operation

* Protection of the waterway from contamination

* The location of site equipment.

* The selection of an acceptable and approved site to receive sediment, etc etc.

If you should have any questions regarding this submission please contact Mr. Mike Fursland from Council's Environmental Planning Department on 97100181.

Yours faithfully

M. Fursland
for J W Rayner
General Manager

Please reply to: General Manager
PO BOX 17 SUTHERLAND NSW 2232 AUSTRALIA
PHONE (02) 9710 0333 DX4511 SUTHERLAND
ADMINISTRATION FAX: (02) 9710 0265

Rec'd 13/8/98

PH | AR | File 2697

ROADS AND TRAFFIC AUTHORITY

SYDNEY OPERATIONS

ENVIRONMENTAL SERVICES BRANCH

To: Phillip Haines
9957 1291

From: Mr Les McClusky
Environment Planning Adviser
Sydney Operations
Roads and Traffic Authority
83 Flushcombe Road
BLACKTOWN NSW 2148

Tel: (02) 9831 0087
Fax: (02) 9831 0184

Phillip

As you are aware the overview document for the removal and disposal of sediment from the heads of Yowie Bay was sent to the RTA for comment. As discussed I have compiled a list of issues that the RTA considerers would need to be addressed in any Environmental Impact assessment. The issues the RTA would like to flag include:

- A Traffic Management Plan for any proposed route that minimises impact on the community and environment.
- Access issues for trucks/pedestrians/other vehicles/cyclists.
- Sedimentation and Erosion issues effecting roads

  Contaminated sediments releasing toxins both in the bay and on land for storage/disposal
- All pollution control legislation (air, noise, water, waste) and Fisheries Management Act.
- Incident management procedures for spills on roadway and/or road corridors.
- Hours of work/operation eg night time noise impacts

As requested general issues not directly associated with RTA but part of a brainstorming exercise

- Consultation with key regulatory agencies and the affected community eg Councils, DL&WC, EPA, Fisheries, DUAP etc
- Navigation within the bay

FAXIB.DOT

* Turbidity control within the Bay

* Threatened species protection - both in the terrestrial environment and the aquatic environment.

* Heritage issues

* Storage and transport of waste would need to consider the Waste Minimisation and Management Act. The waste would also need to have a classification eg contaminated or clean waste???. Storage, disposal and transport procedures will need to reflect that classification

* Removal of sediments from a core area is likely to precipitate a "caving in" effect of sediments over a large area. This could potentially stimulate the release of toxins bound to colloidal particles. Over a large area this could significantly impact adversely on the ecosystem of the Bay.

* Will there be any impact upon economic parameters eg aquaculture

* Will there be any impact upon health parameters eg swimming, eating the marine food of the bay.

* Impacts of rapid alteration of hydrology regimes following the removal of the sediments

As discussed I tried to flag general issues not just those associated with roads. I hope this is of some help.

Cheers

Les McCluskey

DATE: 13/8/98

No of Pages: 2
(Including cover sheet)

EPA

Environment
Protection
Authority
New South Wales

Civic Tower
Cnr of Jacobs Street
and Rickard Road
Locked Bag 1502
Bankstown
NSW 2200

Telephone. 02. 9795 5000
Facsimile. 02. 9795 5002
www.epa.nsw.gov.au

Mr B M Druery
Patterson and Britton & Partners P/L
PO Box 515
NORTH SYDNEY NSW 2059

File : 2677

Our Reference: BA2606

Your Reference: zx574:2677:PH:ph

26/8/98

18 AUG 1998

Contact: Bob Marr

Dear Mr Druery

RE: REMOVAL AND DISPOSAL OF SEDIMENT FROM THE HEADS OF YOWIE BAY

I refer to your letter dated 24 July 1998 regarding the above matter.

The Environment protection Authority (EPA) has considered your request for advice about environmental constraints and on the basis of the limited information provided offers the following comments:

- The proponent will need to fully investigate the presence or extent of any contamination of the sediment to be dredged. The sediments will then need to be classified in accordance with the EPA publication: *Environmental Guidelines: Assessment and Classification and Management of Non-liquid Wastes.* This classification may establish the appropriate end use in accordance with the waste management hierarchy specified in Waste Minimisation and Management Act.

- Under the existing environmental legislation the proponent will need to seek an Approval from the EPA under Section 17 K of the Pollution Control Act for the water quality controls associated with the dredging operation. The EPA also recommends that the proponent seek a licence from the EPA covering the operational aspects of the dredging activity.

- The EPA does not have a preference between grab and cutter suction dredging. However, the proponent will need to balance the environmental costs and benefits of both methods to establish which may result in the lesser environmental impact. The EPA will assess the proponent's preference at the Approval stage.

If you wish to discuss this matter further please contact Bob Marr on 9325 5363.

Yours sincerely

WARREN HICKS
Manager Sydney Catchments
for **Director General**