Coastal Resource Atlas for Oil Spills in Brisbane Water

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COASTAL RESOURCE ATLAS FOR OIL SPILLS IN BRISBANE WATER / Scott Carter

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Coastal Resource Atlas for Oil Spills in Brisbane Water

Prepared at the request of the
coordinating authority for oil spill response,
the New South Wales State Committee of Advice to the
National Plan to Combat Pollution of the Sea by Oil,
for use as an advisory document.

AMSA
Australian Maritime
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Other titles in the series:

- Coastal Resource Atlas for Oil Spills in Trial Bay (1986)
- Coastal Resource Atlas for Oil Spills in Botany Bay (1989)
- Coastal Resource Atlas for Oil Spills in Jervis Bay (1989)
- Coastal Resource Atlas for Oil Spills in and Around the Port of Newcastle (1989)
- Coastal Resource Atlas for Oil Spills in and Around Port Kembla (1989)
- Coastal Resource Atlas for Oil Spills in and Around Twofold Bay (1990)
- Coastal Resource Atlas for Oil Spills from Cape Dromedary to Cape Howe (1991)
- Coastal Resource Atlas for Oil Spills in Broken Bay, Pittwater and the Hawkesbury River (1992)
- Coastal Resource Atlas for Oil Spills from Point Danger to Clarence River (1992)
- Coastal Resource Atlas for Oil Spills from Clarence River to Smoky Cape (1992)
- Coastal Resource Atlas for Oil Spills from Barrenjoey Head to Bellambi Point (in press)
- Coastal Resource Atlas for Oil Spills in Port Jackson (in press)

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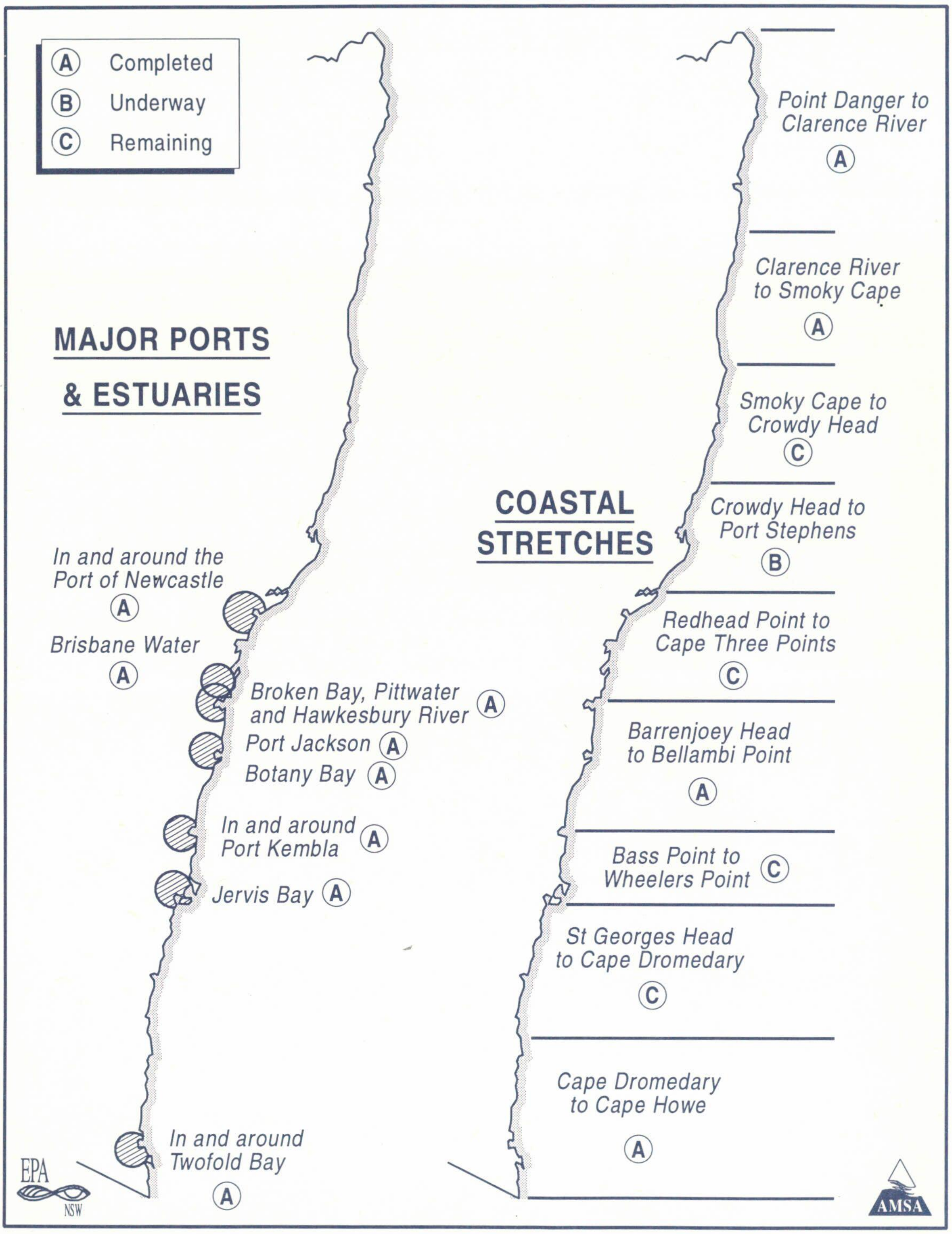

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Summary and recommendations

This atlas details environmentally sensitive areas of Brisbane Water (Figure 1). The atlas is designed to complement existing manuals/plans for dealing with oil spills in general and contains recommendations to minimise the impact of a spill in this region.

The resources in the region are divided into four categories of sensitivity: extreme, high, moderate and low. If there is an oil spill, the first priority is to protect the extreme and high sensitivity areas (Figure 1). The extreme sensitivity areas include mangroves, saltmarshes, intertidal seagrass beds, and the feeding and roosting sites of birds protected under international agreements or listed in Schedule 12 of the NSW National Parks and Wildlife Act 1974. Areas of high sensitivity include sites inhabited by birds that are not protected under treaties or listed in Schedule 12, oyster and mussel leases, and subtidal seagrass beds.

There are many potential sources of oil spills in the region, including an offshore release of oil that is swept into the estuary with the tide, oil spilt at a recreational vessel refuelling point, an accident involving a commercial vessel within the estuary, or a collision on a roadway or other land-based spill within the catchment. An oil spill may come into contact with sensitive resources within hours of occurring, so a rapid response is required to try to protect these resources.

When planning measures to counter oil spills, it is important to consider a region's environmentally sensitive areas, particularly when planning the deployment of booms or the use of dispersants. Less than optimal use of these measures may cause further damage.

The coastline in the region is generally composed of protected rocky shoreline interspersed with sandy beaches in the lower estuary, grading to protected rocky shores and mangroves in the upper reaches. The protection of resources is a high priority. Dispersant will only work on some types of oil, and even in those cases it may cause damage to subtidal resources if it is used in waters less than 5 metres deep or in waters where there is little tidal flushing (Figure 10). Consequently, the use of dispersants in Brisbane Water is not recommended. Spills within the waterway will need to be contained or deflected away from sensitive resources by defensive booming. Protecting the area from oil spills that originate outside Brisbane Water is a high priority, and is best achieved by closing the entrances (where possible) with booms. Stores of equipment for responding to oil spills, including booms and dispersant, are kept in Port Jackson and Botany Bay.

In the case of a spill affecting the estuary, the main beaches can be accessed, which enables oiled sand to be removed by earthmoving equipment. However many areas are best approached from the water.

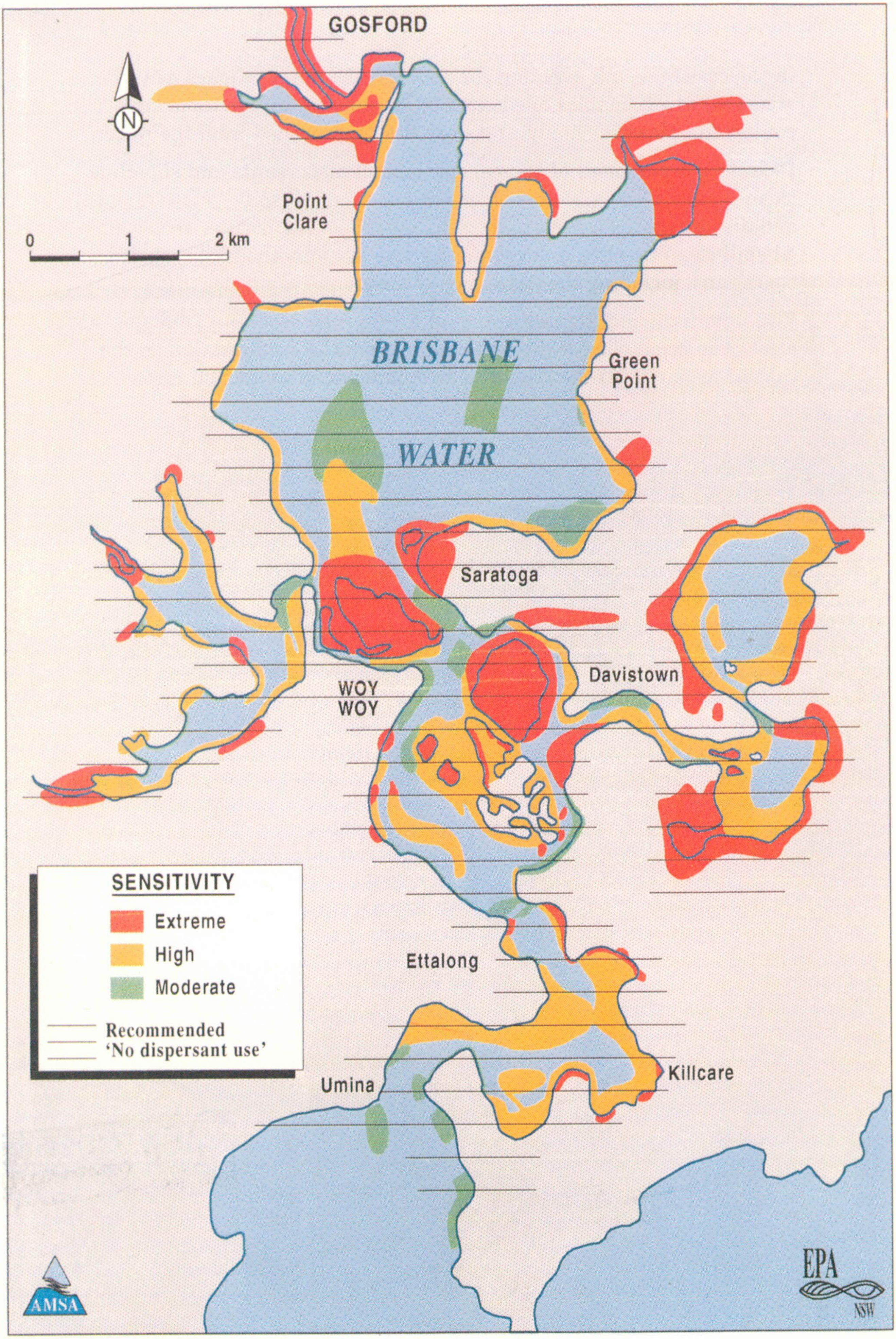
Defensive deployment of booms, spraying of dispersants and shoreline clean-up are all possible response options to an oil spill. Waste removal and disposal options need to be clearly defined. Authorities responsible for oil spill clean-up should develop expertise in all methods of response operations, including the protection of environmentally sensitive areas.

This summary and Figures 1 and 10 contain the essential points of the atlas. The remainder of the text contains detailed information on the coastal resources in the region and recommended protection measures.

Figure 1

Sensitivity of resources in Brisbane Water

Figure also shows 'no dispersant use' areas.



1. INTRODUCTION

This atlas is one of a series designed to assist in the control of oil spills and the protection of coastal resources in New South Wales. The atlases complement planning and actions to reduce the frequency and mitigate the effects of oil spills. If there is a spill, the environment will be better protected if proper contingency plans (based on these atlases) have been prepared. The atlases provide information on environmentally sensitive areas within a region, with values derived from environmental assessment and identification of potential conflicts of interest that may arise between scientific, commercial and recreational uses. The atlases also define areas where the use of dispersants is not recommended, and sites where booms could be effectively deployed.

The atlas is divided into three parts:

1. an analysis of the resources at risk and their sensitivity
2. an assessment of the threat
3. a review of oil spill countermeasure resources.

The region covered by this atlas is the estuary of Brisbane Water (Figure 2). This is a relatively small (27 square kilometres), broad, shallow estuary connected to Broken Bay through a narrow channel. The estuary is entirely within the City of Gosford on the Central Coast of New South Wales. The atlas is designed to be used in conjunction with the Coastal Resource Atlas for Oil Spills in Broken Bay, Pittwater and the Hawkesbury River.

2. ASSESSMENT OF RESOURCES AT RISK

The risk assessment of resources looks at three main groupings:

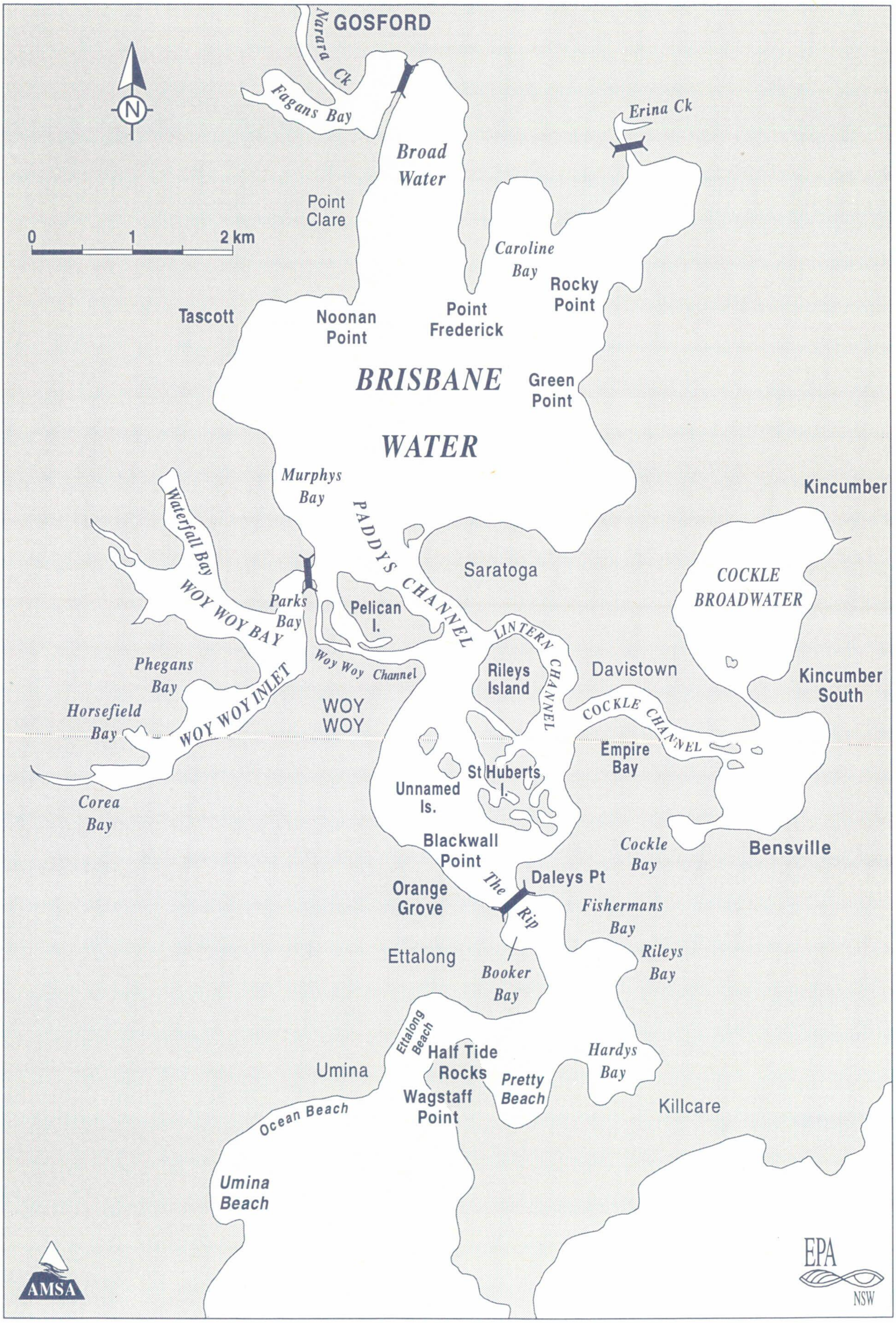
1. **Ecological resources**. These resources relate directly to the natural environment and there may also be some economic value attached to them. These resources include birds and their habitats, mangroves, saltmarshes, seagrass beds, rocky shores and fish nursery and spawning grounds.
2. **Socio-economic resources**. These are resources that can be assessed as having a monetary value to society, and include recreational beaches, boats and moorings, oyster leases, commercial and recreational fisheries and diving areas.
3. **Cultural resources**. These include archaeological sites and historic or heritage sites.

Each resource is assigned to one of four categories relating to the sensitivity of that resource to an oil spill. These categories are:

- Extreme sensitivity
- High sensitivity
- Moderate sensitivity
- Low sensitivity.

The geomorphology of a region and the clean-up options available must be taken into account when determining a resource's final category. The geomorphology

Figure 2
Locations referred to in the text



may relate to the area's potential to retain oil and its ability to recover from an oil spill, e.g. a rocky headland exposed to heavy seas would be less affected by an oil spill than a protected rocky headland, because the oil would be rapidly broken down and removed by natural means (waves, sun, wind and weathering). In some cases, clean-up activities may cause more damage to the environment than the oil spill, e.g. using mechanical plant and equipment in saltmarsh areas.

Earlier Coastal Resource Atlases have set a precedent of not assigning National Parks and Nature Reserves to a particular category, but the resources found within these areas are discussed in the relevant sections.

2.1 Extreme sensitivity

Resources that are categorised as extremely sensitive to oil spills generally have one or more of the following characteristics:

- they have a high potential to retain oil, and may suffer severe or irreparable damage from an oil spill
- they are of international significance or are considered rare, vulnerable or threatened with extinction
- they cannot be restored or replaced after an oil spill
- they cannot be cleaned up without compounding damage.

Extremely sensitive resources include mangroves, saltmarshes, intertidal seagrass beds, and birds that are protected under international treaties or listed in Schedule 12 of the National Parks and Wildlife Act 1974.

2.1.1 Birds protected under international treaties or listed under Schedule 12 of the National Parks and Wildlife Act 1974

Most of the birds protected under international agreements are waders (*Charadriiformes*) and sea birds (*Procellariiformes*, *Pelecaniformes* and *Sphenisciformes*). The birds and their habitats are both extremely sensitive to oil spills. Australia is a signatory to several international agreements that protect migratory birds and their habitats: the Japanese-Australia Agreement for the Protection of Migratory Birds, Birds in Danger of Extinction and their Environment (JAMBA) and the Agreement between Australia and the People's Republic of China for the Protection of Migratory Birds and their Environment (CAMBA), the Bonn Convention on the Conservation of Migratory Species of Wild Animals (1979) and the Ramsar Convention on the Protection of Significant Wetlands (1975). Schedule 12 of the National Parks and Wildlife Act 1974 lists birds that may be threatened or endangered and therefore require protection (Appendix 1).

Tidal movements influence the feeding patterns of many species of birds. Most waders move into the intertidal areas at low tide to feed and roost in special sites during high tide. An oil spill that reaches the intertidal flats or the high-tide mark may bring the waders into direct contact with the oil, as well as damaging the intertidal food sources the birds rely on.

Brisbane Water is considered to be of international significance because the area holds more than 1% of the total Australian population of one species of water bird, the eastern curlew (Morris 1983). The National Parks and Wildlife Service in the Species Management Plan for Waders (Smith 1992) rates Brisbane Water as Priority 4 for wader sites in NSW. Priority for the conservation of individual species was also recommended for the bush stone curlew (Priority 1), pied oystercatcher (Priority 2) and eastern curlew (Priority 3).

There are several extensive areas of mudflat in Brisbane Water that provide an important habitat for waders (Figure 3). Sharp-tailed sandpiper, bar-tailed godwit, terek sandpiper, Mongolian plover and pied oystercatcher are all reported to visit the area (DEP 1983). The beaches and shallows surrounding many of the islands and coastline support numerous waders. Grey and pacific golden plovers, large egret, red-necked stint, curlew sandpiper, terek sandpiper, sanderling, Mongolian plover, broad-billed sandpiper and common sandpiper have all been reported as feeding in the area (DEP 1983, Smith 1992), with many of these species also resting in the saltmarshes of the region. The most important sites for waders are around Rileys Island, Saratoga and Empire Bay.

The bush thick-knee (bush stone curlew) is scheduled as a threatened species by the National Parks and Wildlife Service, and is reported as breeding on Rileys Island and Pelican Island, and feeding at Empire Bay (DEP 1983, Smith 1992) and on the tidal mudflats of the estuary.

2.1.2 Mangroves

Mangroves are extremely sensitive to oil pollution. The destruction of seedlings and the oil-induced dieback of mature trees caused by repeated oiling is likely to destroy mangrove areas. Mangrove shorelines are very important in maintaining a high biological diversity of marine life in the estuaries they inhabit. They act as significant sediment traps and the consolidated sediments provide a habitat suitable for a wide variety of intertidal organisms. Mangroves also act as nursery areas for many fish and invertebrate species, and provide important nesting, feeding and roosting sites for a wide variety of birds and other animals. They are also important areas of primary production for the surrounding waters.

The two mangrove species found in Brisbane Water are *Avicennia marina* and *Aegiceras corniculatum*. Mangroves in the region cover a combined area of 163 hectares (West et al 1985), with the largest discrete areas on Pelican Island (43 ha) and in Erina Creek (33 ha) (DEP 1983, Figure 4). Many of the mangrove areas are included in State Environmental Planning Policy 14—Coastal Wetlands.

2.1.3 Saltmarshes

Like mangroves, saltmarshes form an important habitat for waders and other birds and are extremely sensitive to oil pollution. Saltmarshes act in similar ways to mangroves in primary production and sediment accumulation. Saltmarshes also regulate nutrients in estuarine waters (Adam 1984). The small area (58 km^2, West et al 1985) of saltmarsh habitat in N.S.W. suggests that the protection of this habitat is vital. Saltmarsh often recovers from a single spill if left to recover naturally.

The saltmarsh in Brisbane Water (Figure 4) covers approximately 95 hectares (West et al 1985, DEP 1983). The largest area of saltmarsh is found in Cockle

Figure 3

Feeding, resting and roosting sites for birds protected by international treaty or Schedule 12, and for other birds

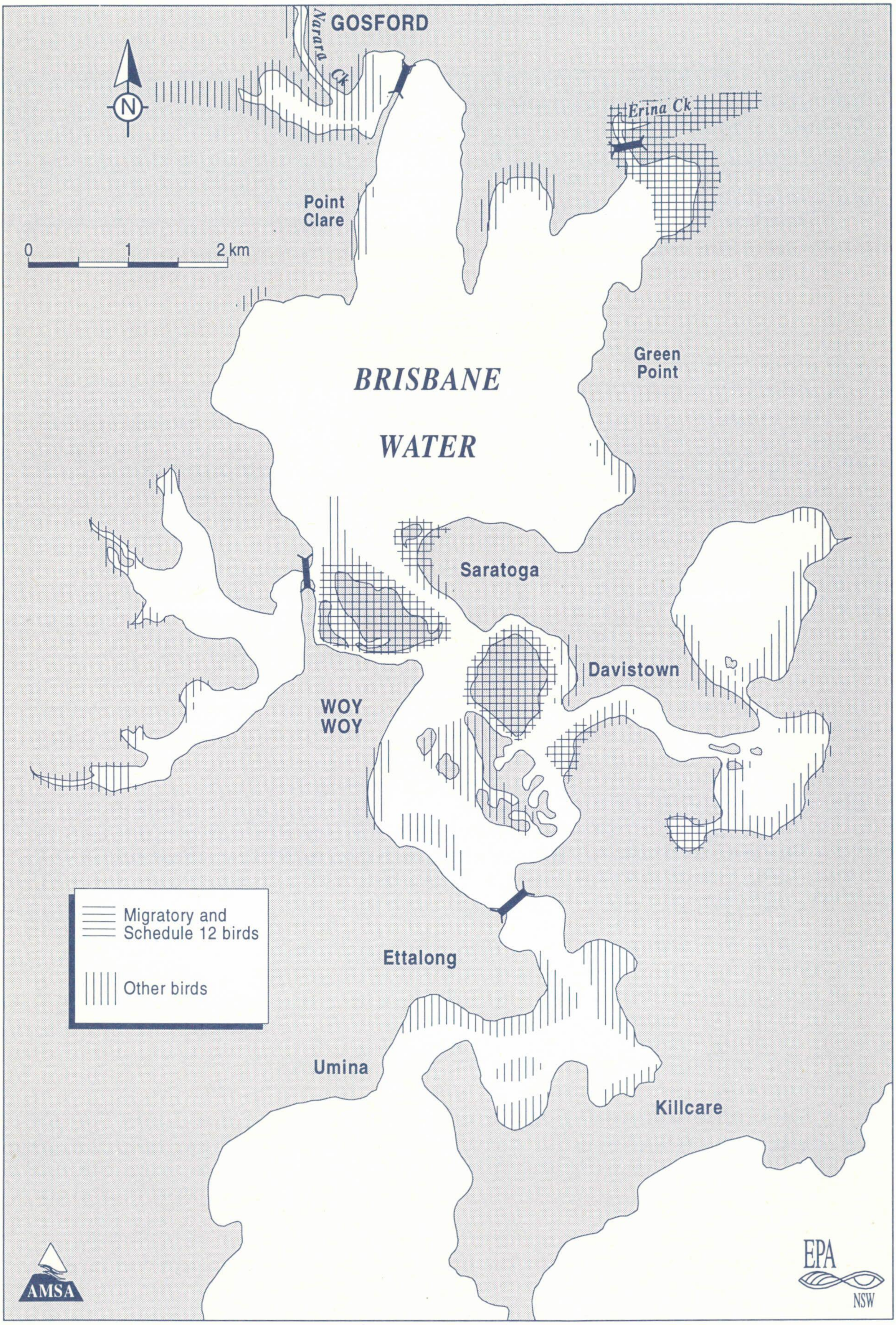
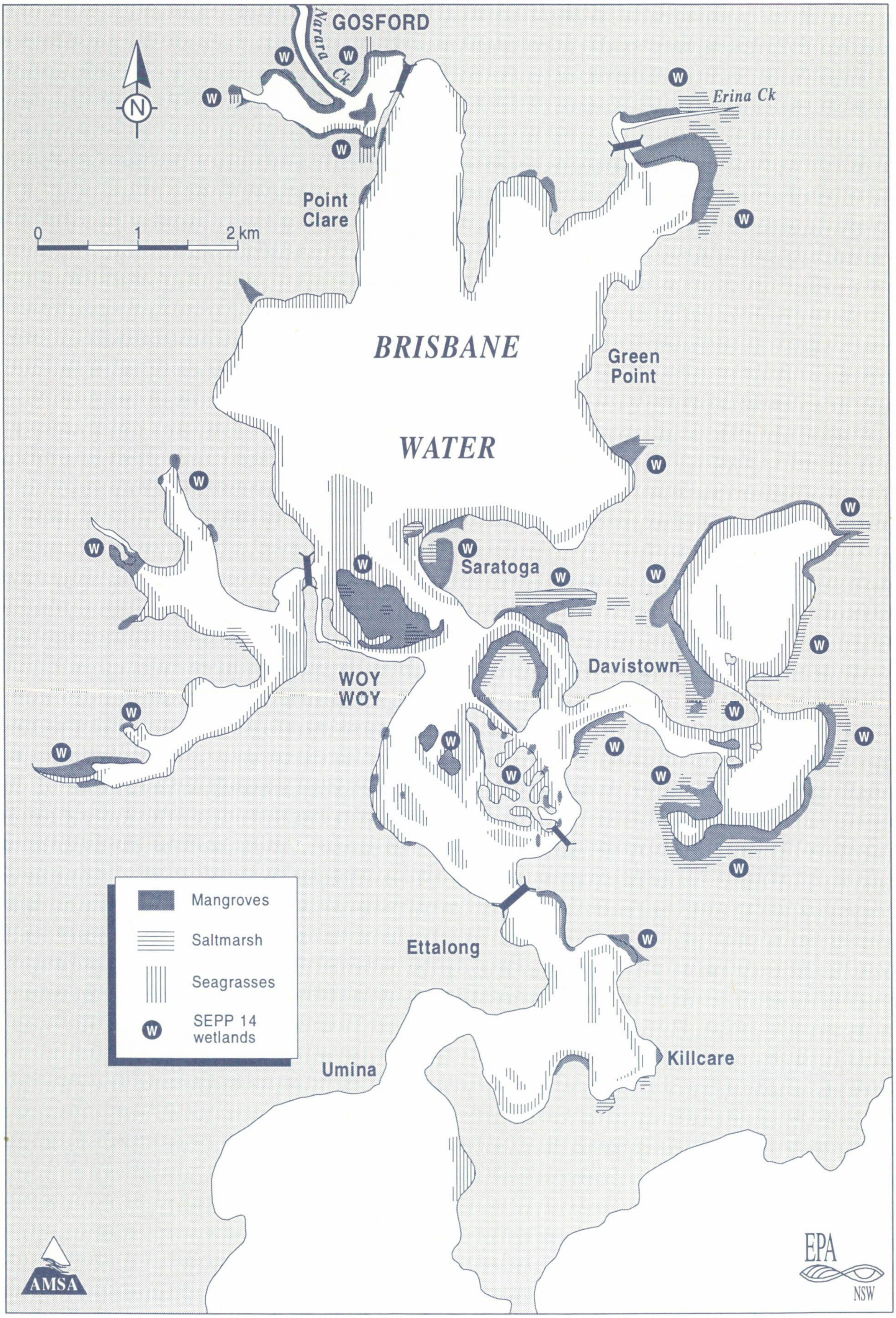


Figure 4

Distribution of mangroves, saltmarsh and seagrass in Brisbane Water *(modified from West et al 1985, Gosford City Council 1992)*



Bay (DEP 1983). Many of the areas of saltmarsh are included in State Environmental Planning Policy 14—Coastal Wetlands, and are now either included in the recently gazetted Cockle Bay Nature Reserve or in proposed additions to that reserve.

2.1.4 Intertidal seagrass beds

Seagrass beds can occur in extremely shallow water and may be exposed at low tides. At such times, the beds may be entirely covered by oil and must be considered extremely sensitive. There are areas of seagrass exposed on extremely low tides on the mudflats adjoining Pelican and Rileys islands and in some areas of Cockle Broadwater (Figure 4).

2.2 High sensitivity

Resources that are categorised as highly sensitive to oil spills generally have one or more of the following characteristics:

- they have high potential for retention of oil and can be seriously damaged by oil spills
- they are of national or regional significance
- they would require a difficult and protracted clean-up operation that may be only partially successful
- they would be difficult and/or expensive to replace or restore after an oil spill.

Highly sensitive resources include subtidal seagrass beds, oyster and mussel leases, and birds that are not protected under international treaties or listed in Schedule 12 of the National Parks and Wildlife Act.

2.2.1 Birds not protected under international treaty nor listed in Schedule 12

There is a great diversity of birdlife not protected by international treaty or Schedule 12 that may be affected by an oil spill. While all native birds are protected under the National Parks and Wildlife Act 1974, most are not considered threatened or rare and endangered. Although they are no less sensitive to oil spills, they are not protected by international agreements and, as such, are only classed as highly sensitive. This is a political rather than biological definition, which emphasises the status of internationally protected birds.

Birds of particular importance under this heading are the little penguin and the four main cormorant species, the pied, little pied, black and little black cormorant. All these birds feed along the coast, generally off rocky headlands, with the cormorant also feeding in bays and port areas. All species are at risk from ingestion of oiled food.

Because penguins spend most of their time in the water, they are at greatest risk. Diving birds (like the cormorants) are also vulnerable, as are other birds which feed by reaching below the surface. Oil quickly affects the plumage, reducing water-proofing on the feathers and thus causing waterlogging, which leads to loss of buoyancy and insulation.

Although the survival of these birds is important, ensuring their protection would require the whole of the region's waters to be zoned as highly sensitive.

The best protection these birds can be offered is quick response to a spill and diversion of oil before it can reach known feeding areas.

The little pied and little black cormorants are reported to breed in the area and roost on oyster leases and trees surrounding the estuary while pelicans nest on one of the small islands in the estuary (Morris 1983). Several species of ibis, heron and spoonbill feed in the shallows and nest in mangroves, trees, rushes and reeds in the estuary. A number of waterfowl also visit the estuary to feed and rest in fringing vegetation (DEP 1983) (Appendix 1).

2.2.2 Subtidal seagrass beds

Subtidal seagrass beds are classed as highly sensitive to oil pollution. They have several roles in maintaining the ecology of marine ecosystems. They provide an important habitat for fish and invertebrate species, both as a nursery area and as a lifelong habitat. The seagrasses act as sediment traps, resulting in substantial accretion of sediment. They are a major source of primary production in the estuarine system and support high levels of secondary production (Adam 1984). Seagrass beds are generally not as susceptible to oil spills as mangroves, as they are not exposed on most tides.

Ruppia (sea tassel) is a submerged seagrass that produces surface flowers in summer and autumn and is most susceptible to oil spills at those times. Ruppia is generally found in lagoons with lowered salinities (Sainty & Jacobs 1986), where it is eaten by many species of water birds.

Seagrass (*Zostera*, *Posidonia* and *Halophila* species) beds are generally confined to the shallower fringes of the estuary (Figure 4) and cover approximately 5.5 km^2 (West et al 1985). The largest areas of seagrass are found around Pelican, Rileys and St Huberts islands, and in Cockle Broadwater and Cockle Bay (West et al 1985, DEP 1983).

2.2.3 Oyster and mussel leases

Oyster and mussel leases are highly sensitive to oil pollution. Severe economic damage may result from a spill, but because leases are artificially constructed, they can be cleaned and restocked. Brisbane Water is an important estuary for the production of Sydney rock oysters (*Saccostrea commercialis*). A substantial area (1.2 km^2 of lake area and 11 km of foreshore) of the central and southern area of Brisbane Water is taken over by oyster leases (115 leases) (NSW Fisheries 1991) (Figure 5). The oyster leases in the area produced over 6,000 bags of oysters in 1991–92 valued at over $2 million (NSW Fisheries pers. comm.).

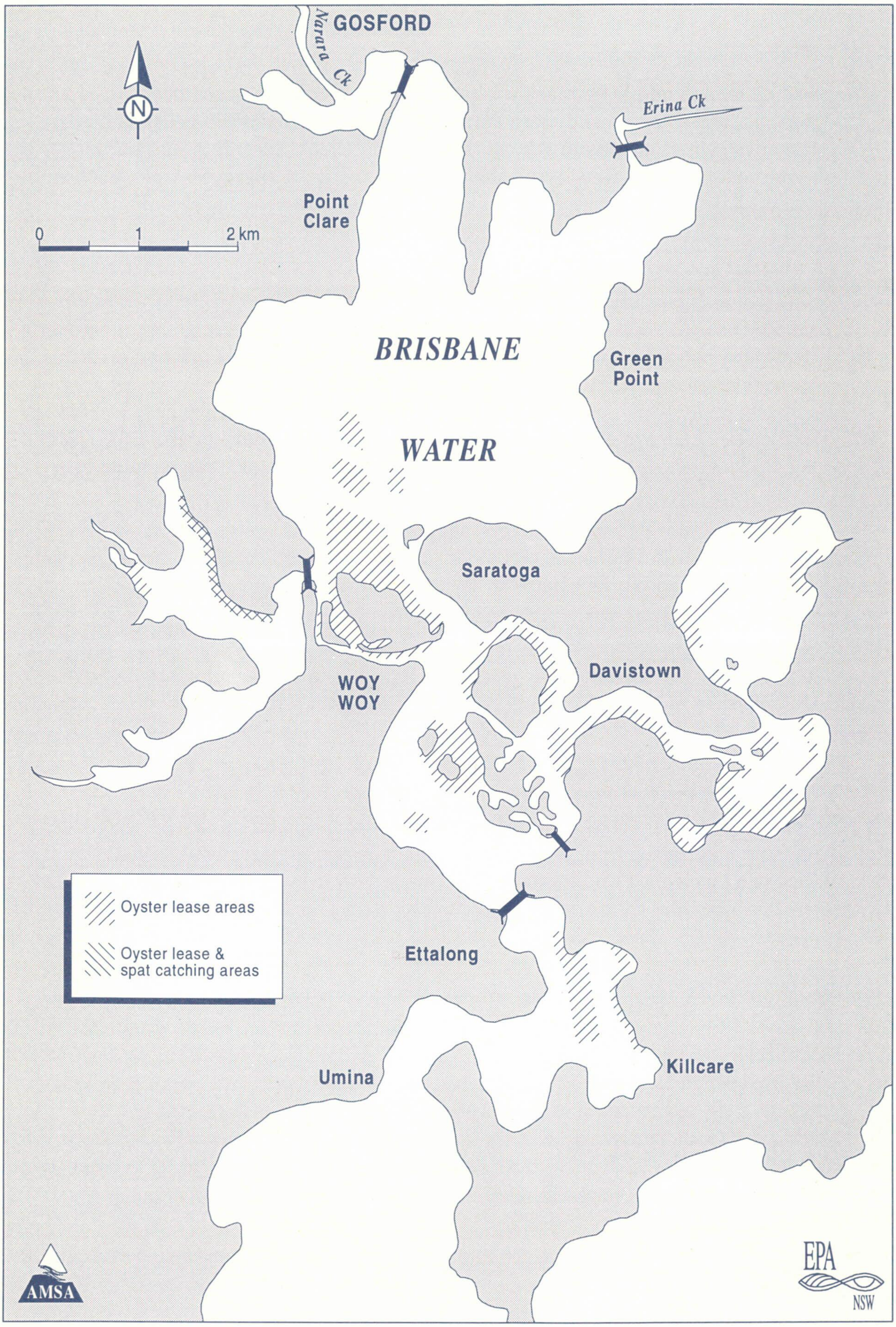
Oyster spat collection occurs throughout the estuary, with Waterfall Bay in Woy Woy Bay being a particularly important site (S. Fields, pers. comm.).

2.3 Moderate sensitivity

Resources that are categorised as moderately sensitive to oil spills generally have the following characteristics:

- they have a low potential for retaining oil and will recover rapidly if damaged by oil

Figure 5
Oyster leases on Brisbane Water



- they can be cleaned reasonably effectively and economically
- they do not normally come in contact with floating oil, but may be damaged during the clean-up operation by land-based equipment.

Moderately sensitive resources include commercial and recreational fisheries, fish nursery and spawning grounds, sheltered rocky shores, heritage sites, recreational beaches, and boats and moorings.

2.3.1 Commercial fisheries

Commercial fisheries are moderately sensitive to oil spills, mainly because they are based on seabed resources that do not come into direct contact with floating oil. They may be damaged by the suspended droplets of dispersed oil and this must be considered when using dispersants in shallow water. Oil can affect a fishery directly (tainting) or indirectly (damage to larvæ, eggs or habitat, or damage to fishing gear).

Tainting of the flesh of commercial species can cause loss of income for commercial fishermen. Tainting is caused by contact *with* or ingestion *of* oil or fractions of oil or oil-affected food. The lighter fractions cause tainting at lower concentrations than the heavier fractions (e.g. petrol causes tainting at concentrations of 0.005 µg/L, kerosene at 0.1 µg/L, emulsifiable oil at >15.0 µg/L (ANZECC 1992)). Damage to eggs, larvæ or habitat may have long-term effects on future catches of adult fish.

NSW Fisheries prohibits commercial net fishing in Brisbane Water.

2.3.2 Recreational fishery

Recreational fisheries are widely distributed throughout the region and are moderately sensitive to oil pollution. Recreational fishing in NSW, mainly based on estuarine species or estuarine dependent species, is worth over $500 million per year (NSW Government 1992).

Fishing is an important recreation on Brisbane Water. This is reflected in the large number of boat ramps in the area (*see* Figure 7) and the presence of fish-cleaning tables on many of the private wharves in the estuary. The most popular boat-based fishing areas are around the main islands upstream from the Rip Bridge, and in the channels that link the major bays (Figure 6). Shore-based fishing is popular from the many jetties and wharves, the seawalls in the upper reaches, and along the beaches and headlands around the mouth of the estuary. Popular target species are bream, whiting and flathead throughout the estuary, bream and mud crabs around the oyster leases, blackfish near the seawalls, and mud crabs and bream near the mangroves. Blue swimmer crabs are scooped near the Rip Bridge as the tides run out. Mud crabs are caught in Erina Creek and Fagans Bay, in upper Brisbane Water, Woy Woy Bay and in the Broadwater, using hook and line as the estuary is closed to the use of all nets, except scoop or landing nets. Yabby digging, for bait, is carried out along the fringes of some of the bays (Figure 6) (S. Fields, pers. comm., Federal Publishing 1989).

2.3.3 Nursery and spawning grounds

Although classed as moderately sensitive due to ease of recolonisation, the fish

Figure 6
Recreational fishing in Brisbane Water

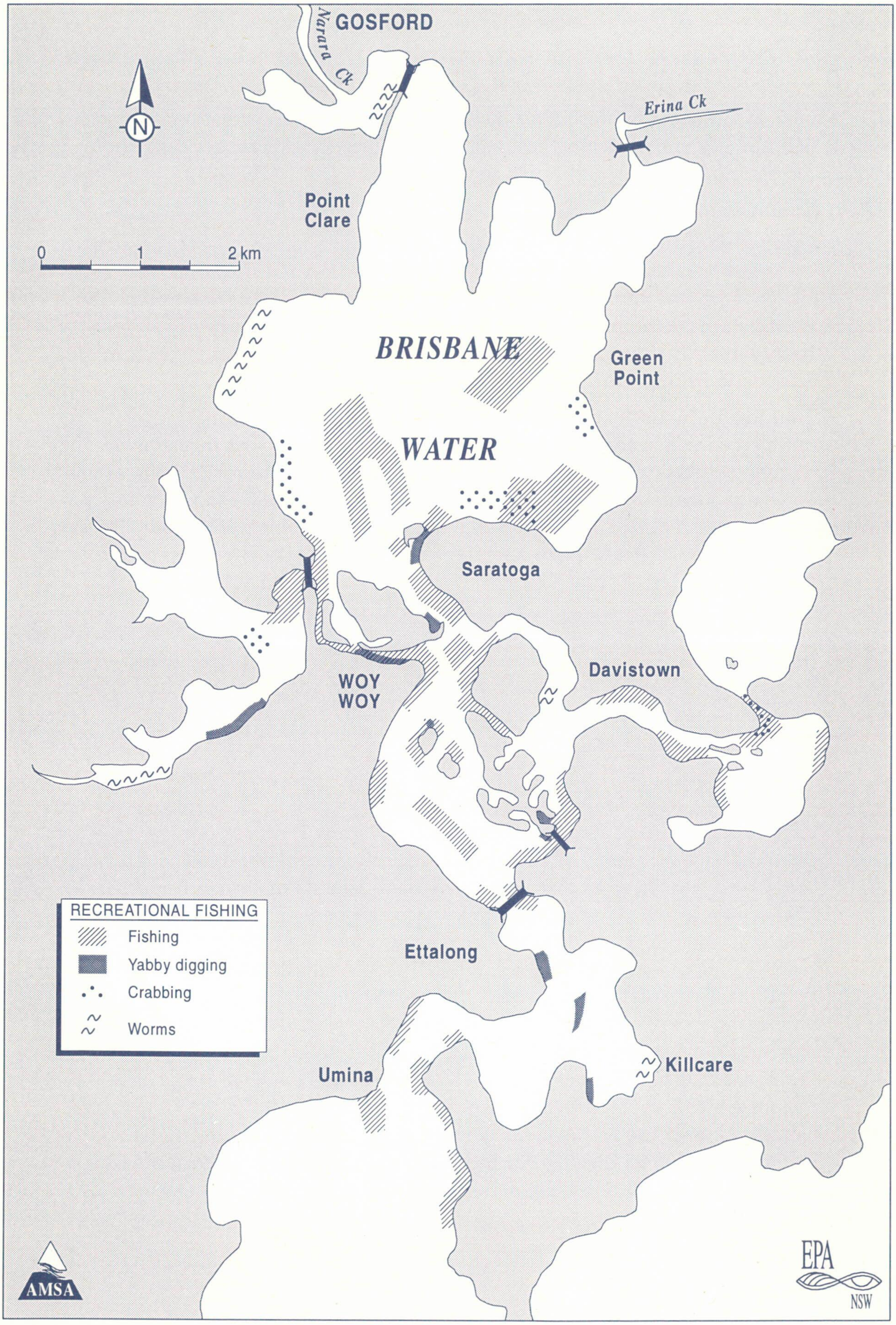
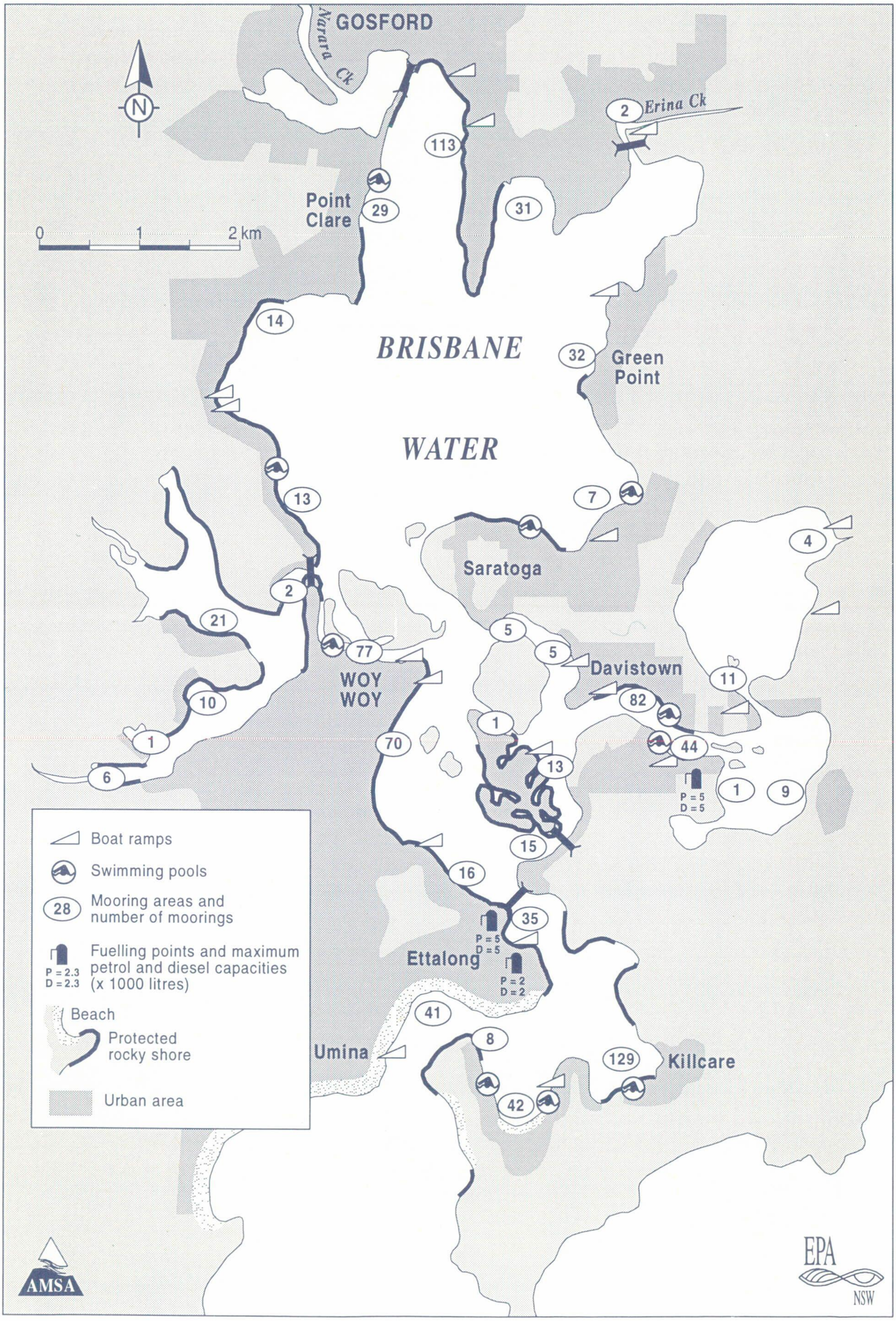


Figure 7
Rocky shores, beaches and urban areas in Brisbane Water



nursery and spawning areas may be damaged by dispersants and dispersed oil droplets during oil spill response operations. Most seagrass beds and mangroves should be considered as spawning and nursery grounds for a variety of fish and crustaceans.

2.3.4 Boats and moorings

Boats and moorings are considered to be of moderate sensitivity to oil pollution. Cleaning is expensive and time consuming but there is likely to be little lasting damage.

There are 918 recreational and 83 commercial boat moorings registered in Brisbane Water (MSB Waterways, pers. comm.). Major areas with moorings (Figure 7) are Hardys Bay (129), Gosford to Point Frederick (113), Saratoga (84), Davistown (82), Woy Woy Channel (74) and Blackwall Channel (69). There are also numerous private jetties and wharves throughout the estuary.

2.3.5 Recreational resources

Beaches. Recreational beaches are of moderate sensitivity. Although a spill may cause short-term inconvenience to the recreational users, it is possible to clean beaches without causing any serious long-term damage to their recreational value. However, the effects on beach fauna is not known.

The main beaches in the region are in the estuary entrance (Figure 7). Umina Beach and Ocean Beach are relatively exposed to wave action from a south-east swell, whereas Ettalong and Pretty beaches are well protected. The visitors to these beaches are generally local people, as tourism in the area is concentrated more in the coastal region than the estuary.

Swimming enclosures. There are a few public and many private swimming enclosures in Brisbane Water (Figure 7), mostly of timber construction.

2.3.6 Sheltered rocky shores

Natural and artificial sheltered rocky shores are moderately sensitive to oil spills. As wave action decreases, so does the natural degradation and dispersal of oil. The biota of these shores is at particular risk from inappropriate clean-up measures, and clean-up operations in such areas should follow the recommendations of the State Pollution Control Commission (1981).

All of the shoreline in Brisbane Water can be considered as sheltered. There are expanses of rocky shore where the higher sandstone ridges come to the water's edge, e.g. Woy Woy Bay, and much of the shoreline adjoining urban areas (Figure 7) has been modified by seawalls and can also be considered as rocky shoreline.

2.3.7 Heritage sites

Heritage sites are classified as moderately sensitive areas because they are considered culturally and historically important to society in terms of Aboriginal, cultural, scientific or educational value. They are most likely to be put at risk by mechanical disturbance during clean-up operations, but Aboriginal shell middens on the water's edge may also come into contact with floating or storm-driven oil.

A 'Register of Aboriginal Sites' is kept by the National Parks and Wildlife

Service. There are currently more than 23,000 registered sites in NSW, and the great majority of these sites are on the coastal fringes (J. Duncan, pers. comm.). Aboriginal sites are protected under the National Parks and Wildlife Act 1974, and permission must be sought in writing before a site or relic is disturbed. Owing to time constraints, this will not be feasible in the event of a spill, but all steps must be taken to avoid contact with possible sites. Unfortunately, many sites are not yet mapped, including buried middens, surface scatters of stone artefacts, burial sites, open camp sites and axe-grinding grooves. If a beach or shoreline needs to be accessed and there are no constructed roads, the National Parks and Wildlife Service should be consulted. Do this by contacting the Senior Duty Officer, Central Coast District, National Parks and Wildlife Service, Gosford. The officer will be able to help the Scientific Support Coordinator to determine the best possible access. Aboriginal middens occur along extensive stretches of the Brisbane Water shoreline (Figure 8).

The City of Gosford Local Environmental Plan has several European heritage sites listed for protection (Figure 8), and these could also be affected by an oil spill or clean-up operation. The majority of these sites are historic wharves or their remains.

2.4 Low sensitivity

Resources that are considered to be of low sensitivity to oil spills generally have the following characteristics:

- they have little or no potential to retain oil and will suffer relatively little damage from an oil spill
- they have little or no commercial or recreational value
- they have high potential for natural recovery or recolonisation
- they have high potential for natural degradation of contaminants but may be damaged by inappropriate clean-up measures.

These resources may include boat ramps.

2.4.1 Boat ramps

Artificially constructed boat ramps are not very sensitive to oil spills, but the environment surrounding the boat ramp can still be a cause for concern. Boat ramps should be cleaned using the appropriate procedure (SPCC 1981) to avoid damaging these areas.

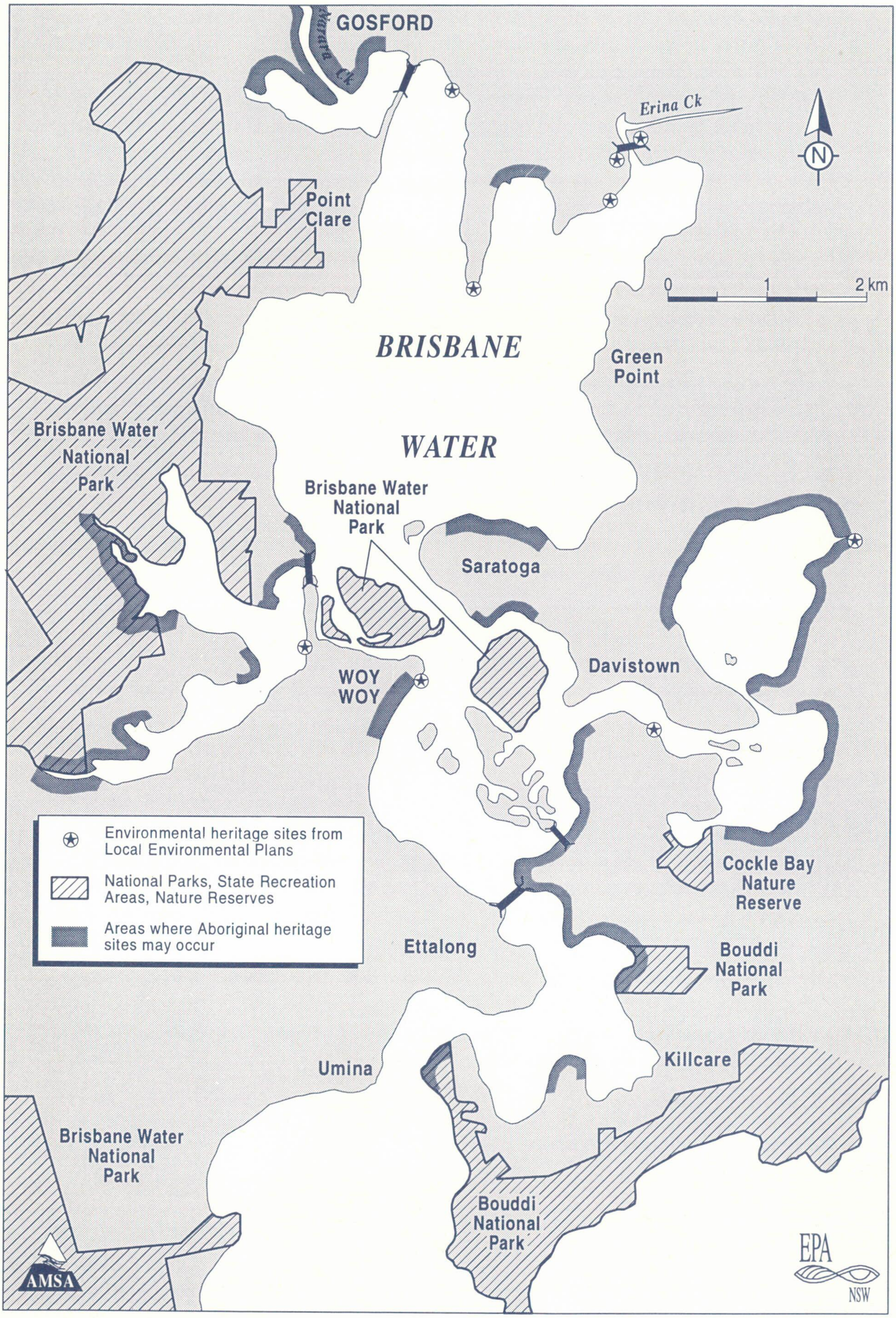
There are 20 boat ramps on Brisbane Water (Figure 7). They range from single lane ramps that may be silted up and shallow, to double lane concrete ramps with facilities. The ramps at Gosford are generally better than ramps elsewhere in the estuary (Lucas 1989).

2.5 Other resources

2.5.1 National Parks and Nature Reserves

The coastal resources within the National Parks and Nature Reserves have been dealt with separately in the sensitivity outlines. However the locations of the

Figure 8
Aboriginal and European heritage sites and National Parks and Nature Reserves in Brisbane Water



areas operated by the National Parks and Wildlife Service (NPWS) must be distinguished, to allow the NPWS to implement its own contingency plans and procedures in the event of a spill (Figure 8).

2.6 Summary of resources at risk

Brisbane Water contains many resources that may be adversely affected by an oil spill. It is important to identify priority areas for protection in order to avoid wastage of resources and effort.

First priority must go to resources that are extremely or highly sensitive, i.e. birds and their habitat, oyster leases, mangroves, seagrasses and saltmarshes.

Some resources are much more sensitive to oil dispersants and dispersed oil droplets than they are to floating oil, e.g. subtidal seagrass beds, commercial and recreational fisheries, fish nurseries and spawning areas, and diving areas. Being subtidal, these resources are relatively protected from floating oil. Dispersants should not be used in areas where these resources are in water less than 5 metres deep nor should they be used on intertidal vegetation (mangroves, saltmarshes and seagrasses) which is extremely sensitive to oil *and* dispersants. These restrictions lead to the recommendation that dispersant should not be used in Brisbane Water.

3. ASSESSMENT OF THE THREAT

3.1 Potential sources of an oil spill

Brisbane Water is a shallow enclosed waterway that has no commercial shipping movements. The only threat from shipping-related oil spills would be if a spill occurred outside the entrance to Brisbane Water and the slick was swept by wind or carried by tide into the mouth of the estuary. The most likely source of any significant land-based spill in the region is a road-tanker accident, with spilt fuel entering storm water drains and then the waterways. The spills could be contained by booming around the outlet of the stormwater drains where they enter the waterway.

There are a number of commercial vessels on Brisbane Water that serve as commuter and tourist vessels. Brisbane Water Ferries operates two commuter ferries, and there are three other commercial vessels used for sight-seeing or restaurant cruises. These vessels carry varying quantities of diesel fuel (400 litres maximum), but each may be a source of a spill if there is a collision or accident.

There are only three refuelling sites for commercial and private vessels, each with a maximum capacity of 5,000 litres of diesel and petrol. All three have a delivery point that is higher than the storage tanks and this helps to minimise the chances of major loss.

3.2 Factors relating to oil movement

The behaviour of a particular type of oil depends on the physical and chemical characteristics of the oil and the prevailing environmental considerations. As not all factors can be considered in an atlas of this size and scope, a selection of environmental conditions is discussed, including wind direction and velocity, and tidal and current movements.

3.2.1 Wind

Oil on open water will move more rapidly than the water directly beneath it due to the difference in friction. This will result in the oil on the leeward side of the slick becoming thicker than oil on the windward. The slick will also rapidly elongate and form windrows parallel to the wind direction. Typically this oil will move downwind at 3% of the surface wind speed, so long as there are no strong surface currents (IMO 1988). Meteorological records for surface winds in the region indicate the following general patterns:

- in summer, predominantly southerly winds to 20 km/h in the morning, swinging to north-easterly in the afternoon with gusts up to 30 km/h
- in winter, the morning wind is from the north-west at 10 km/h, swinging to southerlies up to 20 km/h in the afternoon.

3.2.2 Tidal currents

The strength and direction of tides will influence the movement of the slick in the short term. In the absence of surface winds, oil moves at the same speed as the surface current. The movement of tides is cyclical, but tidal currents rarely cancel each other out completely, allowing a net movement of the slick (IMO 1988). Because of the variety of topography, tidal velocities vary considerably in estuaries, and Brisbane Water clearly demonstrates this. In areas where the channel is narrowed, the tidal currents increase in velocity. This is particularly noticeable at the Rip Bridge with tidal currents commonly up to 5 knots, whereas water moving in and out of Woy Woy Bay only moves at speeds of up to 2 knots, and water through the channel south of St Huberts Island moves at about 1.5 knots (MSB Waterways, pers. comm.).

The strong tidal flow increases the importance of rapid response in the event of a spill, and also increases the damage a spill could cause in the estuary. Considering the strong tidal velocities, booming the narrows of the estuary is impractical, while minimal tidal flows in some sections eliminate the use of dispersants. With all factors considered, dispersant use is not recommended in Brisbane Water (Figure 1).

3.2.3 Predicting slick movement

With information on prevailing winds and current it is possible to estimate the movement of a slick on the surface. With the wind and current acting together, the movement of the slick can be determined by using vectors, with the following simplified formula (IMO 1988):

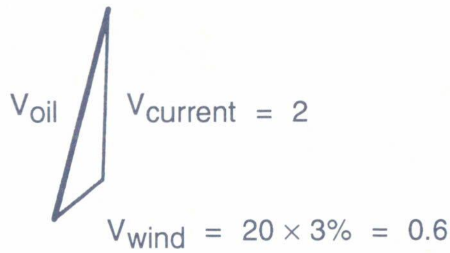
$$V_{oil} = V_{current} + (V_{wind} \times Q)$$

in which:

V_{oil} = velocity of the oil
$V_{current}$ = velocity of current
V_{wind} = velocity of wind
Q = empirically derived wind speed factor (usually 3%)

Example

$V_{current} = 2$ km/h south
$V_{wind} = 20$ km/h north-east
$Q = 3\%$



3.3 Hypothetical spills

Although it is important to understand the inter-relationship between the physical and chemical characteristics of different oils, it is impractical in the context of this atlas to predict the fate of a particular type of oil spill. In the following hypothetical spills (Figure 9) there is no attempt to differentiate between oil types and it is assumed that floating oil moves at 3% of the wind-speed and at the same speed as the surface current. Prevailing winds for specific seasonal periods have been based on 30 years of local meteorological data. The hypothetical spills are:

1. Two large pleasure craft collide in Booker Bay and release diesel fuel. The tide is coming in at 5 knots (9.25 km/h) and the wind is from the south at 13 km/h (May to September afternoon).
2. A pleasure craft and a commercial vessel collide in Cockle Channel and release diesel fuel. The tide is running out at 1 knot (1.85 km/h) and the wind is from the north-east at 23 km/h (summer afternoon).
3. A motor vehicle accident involving a road tanker occurs on the Pacific Highway, allowing diesel fuel to escape into Narara Creek. The tide is running out at 1 knot (1.85 km/h) and the wind is from the north-west at 10 km/h (autumn or spring morning).

4. REVIEW OF RESOURCES TO COUNTER OIL SPILLS

4.1 Introduction

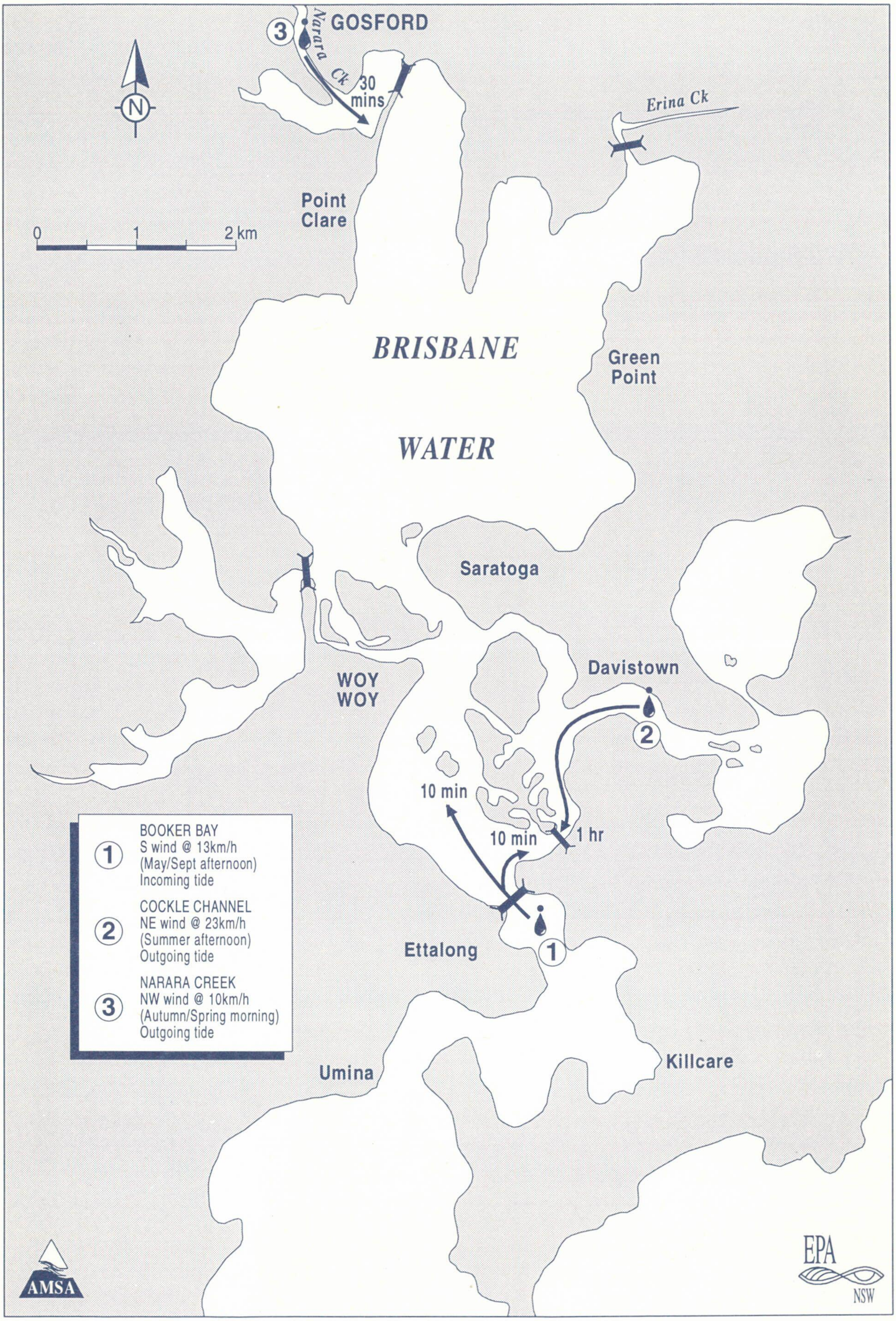
As in previous atlases, no attempt is made here to duplicate existing manuals/plans to deal with an oil spill along this section of the coast. These manuals include the Operations and Procedures Manual of the National Plan, the State Supplement to the National Plan, the Marine Oil Spill Action Plan (MOSAP) produced by the Australian Institute of Petroleum, and the Maritime Services Board's 'Oil Stop' Manual. This atlas seeks to complement those documents by providing information about environmentally sensitive areas and posing clear and unequivocal guidelines on countermeasures to protect resources.

4.2 Oil and its behaviour

Because of their different physical and chemical composition, different types of oil vary in behaviour and toxicity. As a result, different countermeasures are often required. The major spills in Brisbane Water are likely to be limited to petrol, kerosene or diesel.

Figure 9

Trajectories of three hypothetical spills in Brisbane Water



Petrol has a flash point of about –45°C and is very hazardous because of the risk of fire and explosion. Petrol should never be contained in booms because concentrating large amounts in a small area increases the risk of explosion or breathing vapour. Dispersants and absorbents are unlikely to be effective, so their use is not recommended either. Petrol spills move quickly, but they are unlikely to spread far because petrol evaporates very rapidly.

If petrol on the water surface approaches sensitive resources, deployment of booms in defensive positions (to direct the spill away from a resource, not contain it) may minimise damage, but because of the dangers associated with petrol, the booms must be in place before the spill arrives.

Kerosene (power kerosene, light kerosene and jet fuel) is hazardous and evaporates quickly. It should not be contained in booms and is not amenable to dispersant spraying. Absorbents are generally ineffective. Being of low viscosity, kerosene rapidly spreads across the sea surface, but information about effects on coastal resources is scarce because kerosene usually evaporates before reaching shore.

Diesel oil (heating oil and dieseline) is more persistent than petrol and kerosene and is less prone to fire and explosion. Containment in booms is an option. Small spills may not persist long enough in the environment to cause damage and in many cases the appropriate response is to promote evaporation and dissipation. Diesel is sometimes difficult to disperse. If turbulent mixing of dispersant and oil is inadequate, dispersed droplets may return to the surface and reform a slick.

4.3 Countermeasures

Once a spill has occurred, five countermeasure options are normally available:

1. do nothing but monitor
2. contain and recover the oil close to its source
3. deploy booms defensively
4. use dispersants
5. undertake shoreline clean-up.

4.3.1 Do nothing but monitor

The first option, to do nothing but monitor, would only be resorted to if the oil is highly volatile, of no great volume, some distance from shore, or not expected to threaten sensitive resources. If a decision is made to allow the oil to degrade naturally, it is important to monitor the slick to ensure it does not change direction and move towards shore or sensitive resources.

Generally this option is not recommended in Brisbane Water because of the proximity of resources to potential spill sites. However saltmarsh, mangroves and Aboriginal heritage sites should be left alone to recover naturally after oiling, as clean-up operations may cause more damage than the oil itself.

In the case of spilt petrol, naphtha, kerosene and other volatile refined products, containment should never be attempted, as the risk of fire and explosion is far too great. These products should be allowed to disperse and evaporate naturally.

4.3.2 Contain and recover

Successful handling of spills of heavier oils requires initial containment by booms, followed by the use of skimmers and other collecting devices to remove it. Generally this is the preferred option if a spill is approaching the shoreline as oil is easier to collect if it is floating on the water and the collected product can be recycled.

The success of a recovery operation at sea after a major spill will depend on sea conditions and currents, the speed at which response vessels can reach the spill site and the presence of aerial support. Because oil spreads rapidly after the initial release, the number of locations with high concentrations of oil decreases over time. Although booms are capable of containing oil under specific conditions, strong wave action will carry oil over the booms and strong currents or high towing speeds can lead to oil passing under the booms. It is difficult to deploy booms in strong tidal flows or in open water where there is a heavy ground swell. Nor can booms contain oil against water velocities much in excess of 1 knot acting at right angles to the boom (IMO 1988). However, they could be effective in Brisbane Water if used to contain oil or to divert it away from sensitive resources. Possible sites for deployment of booms are shown in Figure 10.

The Maritime Services Board, in conjunction with the Australian Maritime Safety Authority and the petroleum industry have stockpiles of equipment in Port Jackson and Port Botany. Port Jackson has 6,440 metres of boom and four skimmers, while Botany Bay has 3,140 metres of boom and three skimmers (SPEAR 1993). These locations also house a variety of combat equipment and trained personnel. No marinas within the study area have booms or skimmers available.

Gosford Council currently possesses a small quantity of absorbent boom, mainly used to contain oil escaping from stormwater drains.

4.3.3 Defensive boom deployment

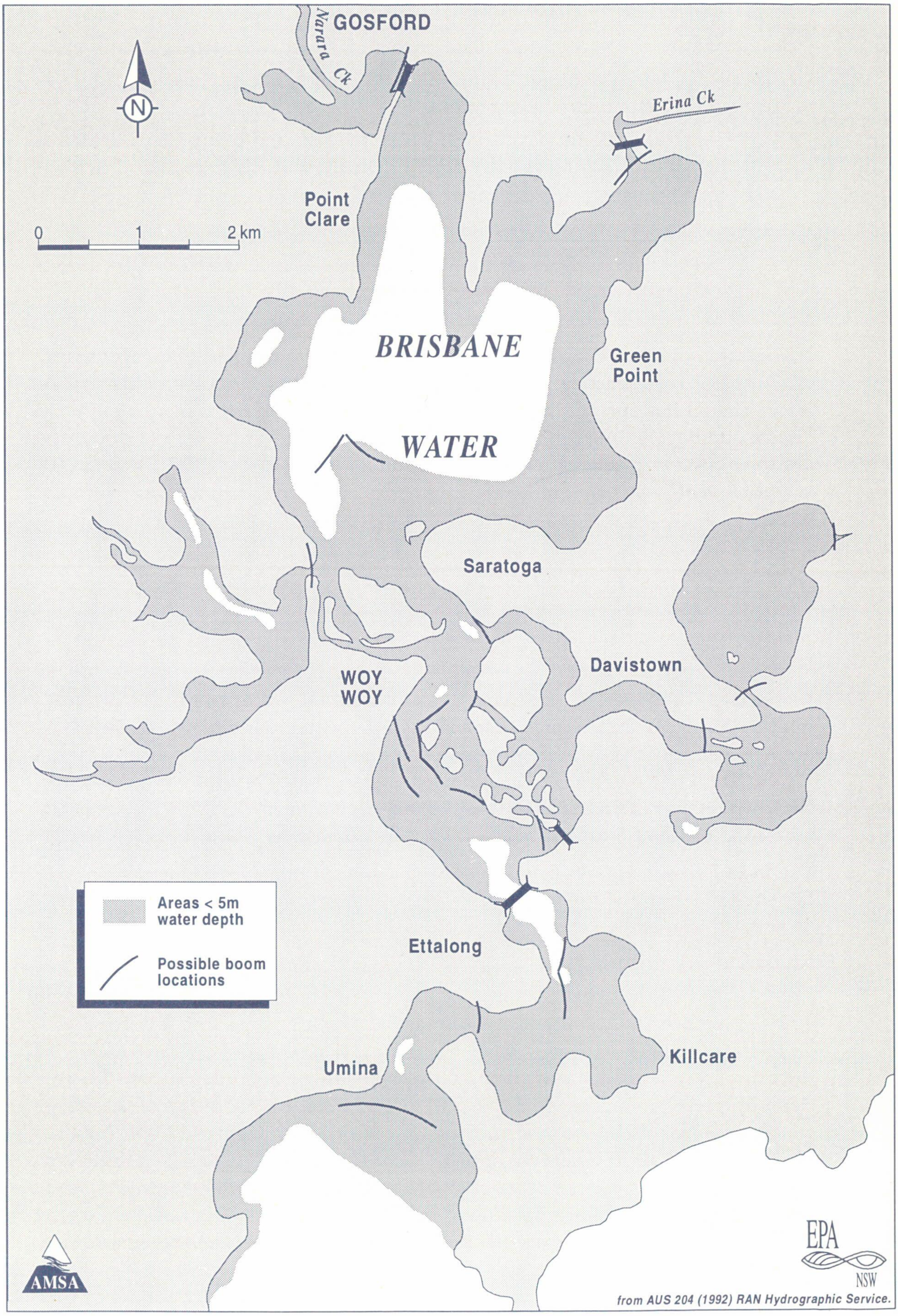
As with the use of booms at sea, current speed and wave action make it difficult to deploy booms defensively (to deflect oil away from sensitive resources) in exposed waters in the estuary. The main channels in Brisbane Water are characterised by high tidal velocities, generally too strong for boom use. However, many of the bays and creeks in the estuary could be protected by booms (Figure 10), and booms could also be used in the main channels to deflect oil away from sensitive resources.

Detailed information on the placement and operation of booms is beyond the scope of this report, but a number of points are important to ensure their effectiveness in protecting environmentally sensitive resources:

- Booms must be deployed without delay. Oil may reach sensitive areas in a matter of hours after a spill. The booms must be in place before the oil arrives.
- Successful deployment requires careful planning, preselection of booming locations, and perhaps construction of permanent mooring points.

Figure 10

Areas less than 5m deep, and possible locations for defensive booms



- Except in ideal conditions, some oil will escape past the booms, and in bad weather the booms may fail completely. Once oil passes the booms, absorbent material may be used to minimise impact on sensitive resources.
- Successful deployment will require suitable boats, communications and well-trained and experienced personnel.
- It is essential that equipment is provided to skim and pump the collected oil, and that the oil is subsequently stored, transported and disposed of in an environmentally approved manner.

4.3.4 Dispersant use

Some spills of crude fuel oils are amenable to dispersants, which can be used if containment and recovery are impractical. They could be very effective in breaking up an offshore oil spill that threatens the coast.

The spraying of dispersant must begin as soon as it is decided that mechanical containment is impractical. The best chance of success with dispersants will be before the oil has spread or weathered. The possibility of the early formation of viscous, undispersable water in oil emulsions (mousse) means that if dispersants are to be used they should be applied within 24 hours of the spill. Particular attention should be given to the aerial application of dispersant from helicopters, but care should be exercised when spraying in areas of abundant bird life (SPCC 1982).

Dispersants and spraying equipment are stored at Port Jackson and Botany Bay and two helicopter spray buckets are stored at Moores Wharf in Port Jackson. The nearest commercial airports in the region are at Mascot (Kingsford Smith Airport), Wyong and Swansea. There is a helipad at Erina.

Dispersants, however, do not remove the oil from the water but break it down into fine droplets that become suspended in the water column. These tiny droplets can reach greater depths than the undispersed oil and may pose a greater threat to marine life. Consequently, dispersants should not be used in shallow waters. The State Pollution Control Commission (1981) recommends a minimum depth of 5 metres before dispersant should be used.

The use of dispersants in Brisbane Water is not recommended (Figure 10), due to the shallow nature of the estuary, its proximity to resources that are sensitive to dispersant use, and the low levels of tidal flushing.

4.3.5 Shoreline clean-up

Once an oil slick has been stranded on the shore, there is little need for urgent action, provided that tidal and meteorological conditions are unlikely to relocate oil to other areas. However, prompt clean-up action on sandy beaches can avoid the complication of oiled sand being buried by natural sand deposition. Shoreline clean-up procedures depend on the type of shoreline, the condition of the oil when it reaches the shore, and the quantity of oil. The On-Scene Coordinator, in consultation with the Scientific Support Coordinator if appropriate, should have ample time to consider the clean-up operations, using guidelines set down in the Operations and Procedures Manual of the National Plan to Combat Pollution of the Sea by Oil, the NSW State Supplement to the Manual (Department of

Transport 1993), and by the State Pollution Control Commission (1981), the Australian Marine Safety Authority (AMSA 1992), and the International Tanker Owners' Pollution Federation Ltd (1983).

Shoreline clean-up is not a preferred option, because it means that large quantities of oily debris have to be disposed of in landfills. Much of the shoreline in Brisbane Water has residential buildings occupying the land to the waterline and many of these properties have private jetties, which taken together restrict access and interfere with shoreline clean-up. However, if the shoreline clean-up option is exercised, Gosford Shire Council has earth-moving equipment (at Erina and Woy Woy) which could be used to clean up a shoreline oil spill in the region. The use of heavy machinery in clean-up operations must be supervised to minimise damage to sensitive environments and habitats caused by careless traffic movements.

4.4 Constraints

4.4.1 Operational constraints

There are several constraints facing a clean-up operation in this region.

Owing to the high population density throughout the region and the importance of the estuary for recreation, there will be considerable political and public pressure for a rapid and successful clean-up operation. This may tend to exert pressure to 'over-clean' a resource, and makes it hard to leave some areas to clean themselves. This problem will need to be addressed on an incident-by-incident basis.

Access to many areas in the estuary is restricted by private property and housing encroaching on the shoreline. Access to a spill that comes ashore in a National Park in the area may be limited to service trails. The presence of culturally and environmentally important resources throughout the parks means that the National Parks and Wildlife Service should be consulted to ensure that countermeasures comply with their Plans of Management for the parks and reserves under their jurisdiction.

4.4.2 Oiled wildlife

In most spills there is a possibility that animals will come into contact with the floating or stranded oil. Most animals need treatment to remove the oil as they cannot clean themselves adequately or rapidly enough to ensure survival. Self-cleaning also contributes to ingestion of oil. In any case where oiled wildlife is found during a clean-up operation, the Scientific Support Coordinator should be advised and there are several organisations that can be called in to coordinate the cleaning and rehabilitation of oiled animals.

National Parks and Wildlife Service
Central Coast District
207 Albany Street
Gosford 2250.

Wildlife Division
Taronga Zoo
Mosman 2088.

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APPENDIXES

Appendix 1

Scientific names of mammals, reptiles and fish referred to in text

Fish	
Bream	*Acanthopagrus australis*
Flathead	*Platycephalidae*
Rock blackfish	*Girella elevata*
Whiting	*Sillago* species
Invertebrates	
Oyster	*Saccostrea commercialis*
Eastern king prawns	*Penaeus plebejus*
School prawns	*Metapenaeus macleayi*
Yabbies	*Callianassa australiensis*
Blue swimmer crab	*Portunus pelagicus*
Mud crab	*Scylla serrata*

Appendix 2

NSW Birds protected by JAMBA, CAMBA and/or Schedule 12 of the National Parks and Wildlife Act 1974, and unprotected species discussed in text

Common Name	Species	Status
Little penguin	*Eudyptula minor*	—
Great egret	*Egretta alba*	J,C
Australian pelican	*Pelecanus conspicillatus*	—
Black cormorant	*Phalacrocorax carbo*	—
Little pied cormorant	*Phalacrocorax melanoleucos*	—
Little black cormorant	*Phalacrocorax sulcirostris*	—
Pied cormorant	*Phalacrocorax varius*	—
Pacific golden plover	*Pluvialis dominica*	J,C
Grey plover	*Pluvialis squatarola*	J,C
Mongolian plover	*Charadrius mongolus*	J,C,12B
Ruddy turnstone	*Arenaria interpres*	J,C
Whimbrel	*Numenius phaeopus*	J,C
Eastern curlew	*Numenius madagascariensis*	J,C
Bar-tailed godwit	*Limosa lapponica*	J,C
Sharp-tailed sandpiper	*Calidris acuminata*	J
Sanderling	*Calidris alba*	J,C
Curlew sandpiper	*Calidris ferruginea*	J,C
Red-necked stint	*Calidris ruficollis*	J,C
Broad-billed sandpiper	*Limcola falcinellus*	J,C,12B
Pied oystercatcher	*Haematopus longirostris*	12B
Grey-tailed tattler	*Tringa brevipes*	J,C
Common sandpiper	*Tringa hypoleucos*	—
Bush stone curlew/ bush thick-knee	*Burhinus magnirostris*	12A

J = Birds protected under JAMBA
C = Birds protected under CAMBA
— = Birds not listed

12A = Threatened Fauna under Schedule 12
12B = Vulnerable and Rare Fauna under Schedule 12

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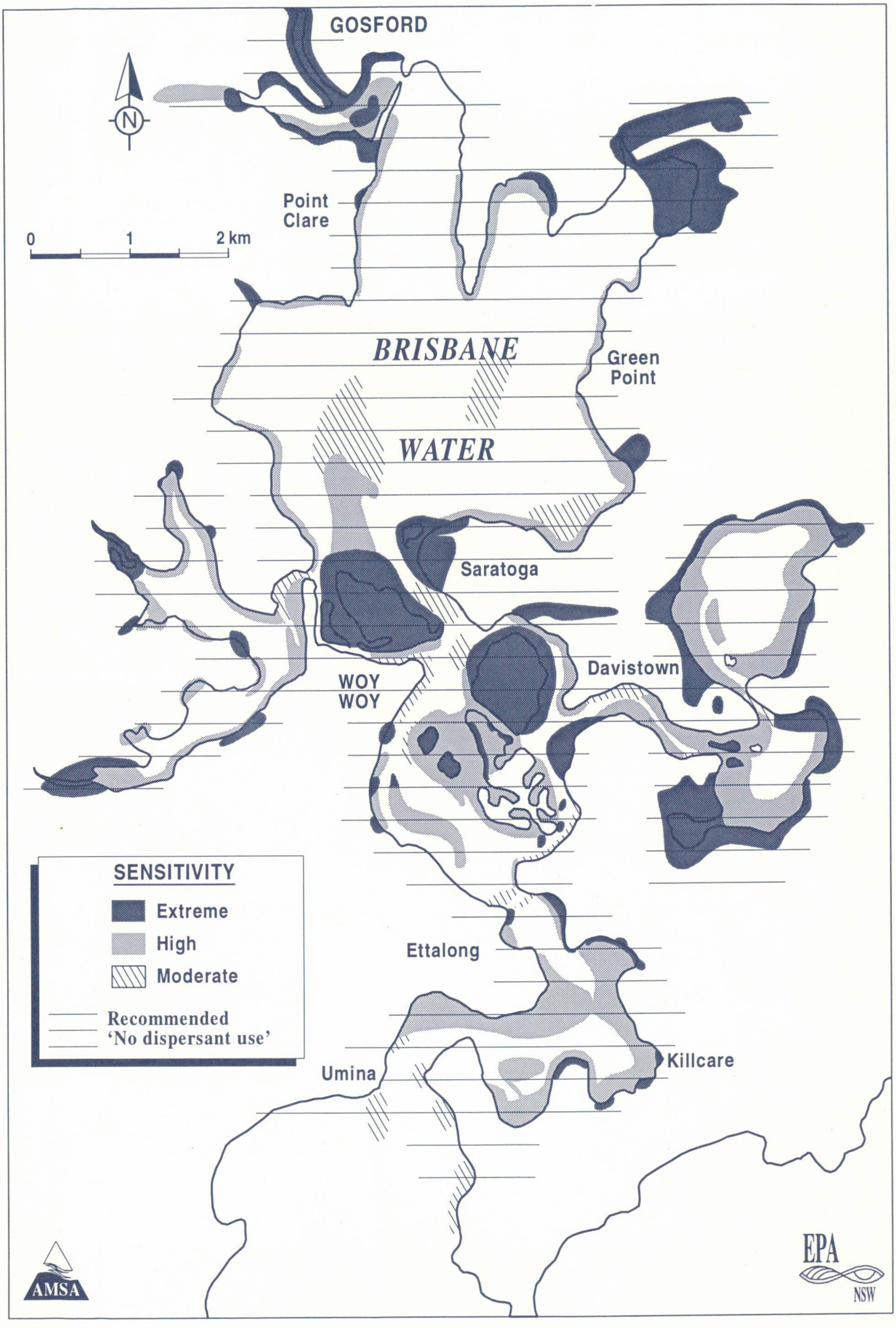

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