INQUIRY INTO PETROLEUM EXPLORATION AND DEVELOPMENT IN NATIONAL PARKS AND NATURE RESERVES

PREPARED FOR THE WESTERN AUSTRALIAN GOVERNMENT

JUNE 1989

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SUMMARY

This report sets out to compare the mineral and petroleum industries with regard to the associated environmental impacts, their management, and appropriate policies in response thereto.

The terms of reference of this Inquiry were developed from the 1986 mineral industry study entitled "Committee on Exploration and Mining in National Parks and Nature Reserves". The terms of reference are:

1. Assess the appropriateness and feasibility of the Government's policies on mineral exploration and mining in national parks and nature reserves for adaptation to petroleum exploration and production in terrestrial and marine conservation reserves.

2. The appropriateness of a specified depth to which reserves can extend below the earth's surface.

3. If the Government policies for mining are inappropriate for petroleum then the work group should develop alternatives.

The study began in August of 1988. It has encompassed the assessment of public submissions, scientific literature and relevant petroleum and environmental legislation. Inspections of seismic and production areas in the north west of the State were made within parks and reserves formally vested in the National Parks and Nature Conservation Authority. Excluded from the study are State forests, unvested reserves for the conservation of flora and fauna and those areas vested with local government authorities.

The report re-iterates the purposes for which national parks and nature reserves are proclaimed and documents the need for those in existence and others yet to be proclaimed. As well, the case for a viable petroleum industry in Western Australia is made.

The following conclusions are drawn:

1. There are significant differences between the potential environmental impacts of the mineral and petroleum industries.

2. The current policies on mineral exploration and mining in national parks and nature reserves are not directly transferable to the petroleum industry.

The biggest departures are in marine areas where there is little precedent in the mineral industry, but where petroleum activities are becoming increasingly important.

The technical sections are based upon the study of the literature on terrestrial and marine impacts and concluded that the latter are perhaps more complex, difficult to control and at times more damaging. A review of the legislation and current mechanisms which regulate and monitor the activities of the industry highlighted some areas in need of change, which the recommendations below seek to address.

In introducing the recommendations, the major issues, as highlighted in the submissions are seen to be:

1. Perceptions of the general public.

2. A conflict between petroleum activities and conservation interests in parks and reserves.

3. The concept of multiple and sequential land use in parks and reserves.

4. Appropriate practices and procedures.

The recommendations made by the Committee of Inquiry are:

1. The Committee believes that the protection afforded to terrestrial national parks and nature reserves by the petroleum and environmental protection legislative systems is greater than that which was available under the minerals system. Similarly it recognises the relatively benign nature of petroleum exploration and development operations when compared with mineral exploration and development. It also acknowledges that the weather window for petroleum operations in the north of the State (the area of greatest activity) limits exploration and that because of the relative shortness of Parliamentary sessions a need to obtain Parliamentary consent for entry into national parks and nature reserves would unnecessarily further impede the search for oil. In this regard the Committee considers that the Government's policies applicable to mineral exploration and mining in national parks and nature reserves, particularly the requirement for Parliament to decide access into these areas, are not appropriate nor feasible for petroleum operations. The Committee therefore recommends that the policies not be applied to petroleum exploration and production in terrestrial conservation reserves.

2. As an alternative policy, the Committee recommends that the existing procedures under the petroleum and environmental protection legislation be tightened as follows:

2.1 That terrestrial national parks and nature reserves remain closed to petroleum exploration and development (as provided for under Section 15 of the Petroleum Act 1967) unless specifically opened in whole or in part according to the procedures outlined in this report. This recommendation does not prevent the granting of an exploration permit over a national park or nature reserve but the area remains closed until the appropriate procedures are undertaken.

2.2 Areas fully approved for reservation as national parks or nature reserves by Government should be treated administratively as if they were so reserved, once agreement as to their boundaries has been approved by Cabinet. In the interim, relevant proposals should continue to be referred to the Environmental Protection Authority under its legislation.

2.3 That marine parks, marine nature reserves and other marine conservation reserves (including any island parks and reserves contained therein) be closed to petroleum exploration and development activities. This prohibition would not extend to the undertaking of seismic operations within the boundaries of the conservation area where this could be shown to be necessary to the interpretation of geological structures in areas outside, but adjacent to the boundary of the conservation reserve, provided that approved equipment were used, and appropriate conditions were observed. These would be approved under a special prospecting authority issued by the Minister of Mines, with the concurrence of the Minister for Conservation and Land Management. Furthermore, this prohibition would not extend to existing petroleum tenements which would be subject to the normal provisions of the Environmental Protection Act 1986, the Petroleum Act 1967 and the Petroleum (Submerged Lands) Act 1982.

2.4 The advertising of areas for the granting of petroleum tenements in the maritime areas in the vicinity of the potential marine conservation reserves designated in Figure 2 should not occur until more precise boundaries have been defined and the contained areas reserved. This process should occur over a 12 month period in two stages; the first of which would define interim boundaries which would hold until the completion of the reservation. The final boundaries should be chosen so as to include an adequate buffer zone to ensure that any threatening pollution can be dealt with before contaminating the core area.

2.5 A committee comprising the Department of Conservation and Land Management, Department of Mines and the Environmental Protection Authority should be

established to undertake the boundary definition of core and buffer zone areas referred to in Recommendation 2.4 as a priority.

2.6 The Government should require the petroleum industry to share wherever practicable infrastructure, facilities and islands so as to minimise the use of island parks and nature reserves (by, for example, leasing an island to more than one company or, where feasible, relocating to the mainland).

2.7 If the proponent believes that access into a particular terrestrial national park or nature reserve or part thereof is necessary for the purpose of petroleum exploration or development then it should refer the proposal to the Department of Mines, which in turn should refer it to the Department of Conservation and Land Management and the Environmental Protection Authority. The environmental acceptability of the proposal should then be determined by the Environmental Protection Authority under the provisions of its Act, after full consultation with interested parties.

2.8 In reporting to Government the Environmental Protection Authority may recommend:

- that the area in question not be proclaimed Crown Land for the purposes of the Petroleum Act 1967 if it is demonstrated to be a core area of the highest biological, landscape or wilderness value; or

- that the areas in question be proclaimed Crown Land under the Petroleum Act 1967 and declared open for access by the proponent only for the duration of that proposal, subject to appropriate conditions; or

- that the area in question be removed from the national park and nature reserve system if it is considered to be sufficiently degraded that it no longer contributes to the reserve's values.

1. INTRODUCTION

In response to public concern regarding exploration and mining in national parks and nature reserves, the Government established a committee in 1985 to receive submissions and make recommendations on this matter. In December 1986 the committee reported on its findings via a document entitled 'Committee on Exploration and Mining in National Parks and Nature Reserves' also known as the 'Bailey Committee Report' after its chairperson. Following a period for public comment, and subsequent to receipt of the Environmental Protection Authority's (EPA) report (1987); the Government adopted a policy for exploration and mining in national parks and nature reserves (see Appendix I), the main points of which are summarised in Section 2.6.

The "Bailey Committee" restricted its enquiries to the mineral industry as covered by the Mining Act 1978, and to parks and reserves formally vested in the National Parks and Nature Conservation Authority (NPNCA). At that time it was forseen that there would be a need for a similar study into petroleum exploration and production activities, and this need was addressed in August 1988, when the Government commissioned an inquiry into petroleum exploration and production in national parks and nature reserves.

The membership of the committee of inquiry is as follows:

Dr John Bailey (Chair)	Member of the EPA
Mr Frank Batini	Manager of Environmental Protection, Department of Conservation and Land Management (CALM)
Mr Ian Fraser	Director of Petroleum Division, Department of Mines (Mines Department).

The Committee was assisted in its work by Mr Douglas Betts, who was engaged to research, collate and analyse relevant information, and was also involved in the preparation of this report.

The terms of reference of this Inquiry were developed from the 1986 mineral industry study and sought to establish whether the recommendations for that industry could be adapted to the petroleum industry. The terms of reference are as follows:

1. The appropriateness and feasibility of extending the principles established by the Government's policies on mineral exploration and mining in national parks and nature reserves and adapting the associated review mechanisms to petroleum exploration and development activities as they relate to terrestrial and marine conservation reserves.

2. REVIEW OF THE CONSERVATION ESTATE - PARKS AND RESERVES IN WESTERN AUSTRALIA

This chapter draws from and quotes extensively the relevant sections of the report of the Committee on Exploration and Mining in National Parks and Nature Reserves.

2.1 THE ROLE AND VALUES OF CONSERVATION RESERVES

National parks and nature reserves are two categories of what can broadly be described as conservation reserves. The World Conservation Strategy (International Union for the Conservation of Nature and Natural Resources (IUCN), 1980) defines conservation as "the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations". Implicit in this objective of maintaining the potential for meeting future needs, is the maintenance of the earth's natural diversity. Conservation reserves are therefore areas of land and water that are set aside for the protection of nature and natural resources, thus ensuring that natural diversity is maintained.

Conservation reserves fulfil several specific roles including:

1. The protection of an appropriate range of ecosystems representative of the different types of ecosystems present in a region.

2. The protection of any unique ecosystems, and

3. The protection of significant landforms.

In so doing, the diversity and integrity of plant and animal communities within natural ecosystems is conserved for present and future use, and the genetic diversity of species on which their continuing evolution depends is safeguarded. This largely utilitarian concept of conservation reflects an interest in preventing the extinction of species and argues the benefit of maintaining genetic diversity to agriculture, fishing, forestry and medicine. Conservation reserves also perform other incidental functions, as in the case of reserves preventing dune encroachment or protecting the yield and quality of water catchments.

In addition to the above which might generally be described as ecological arguments, the development of a conservation reserve system is also based upon the following social arguments. Natural areas and the species they protect are of great aesthetic value, providing a source of inspiration and pleasure for people. Recreational and tourism activities that are based on the

natural environment are not only of great social and emotional benefit but are also of increasing economic benefit to our State provided they are properly managed and controlled. Conservation reserves, therefore, in addition to conserving representative environments, have the role of protecting and maintaining environments of outstanding scenic or landscape value. Related to this benefit is the concept of wilderness which is gaining support within the community. Many people have a desire to retain areas that are accessible to the public but where it is possible to experience the natural environment without obvious evidence of any technological impact.

Conservation reserves also perform important scientific and educational functions. They provide significant opportunities for teaching in relation to nature and the environment, and cater for scientific research and environmental monitoring by acting as benchmarks against which the impacts of technology on the environment can be measured.

These areas can also contribute to the protection of historical and cultural assets of the State by conserving features of significance related to earlier habitation and Aboriginal people.

It is clear from the above list that conservation areas do not have just a single purpose but several, and that claims that they lock away and sterilise land areas are unjustified.

The immensity of the responsibility for conserving natural areas through reservation in this State is evident when the following facts are considered:

1. The State has one third of Australia's land area, and also one third of its coastline.

2. Western Australia has the second highest number of biophysical regions of all states.

3. The most recent assessment shows that some 45% of the rare and threatened species of flora in Australia are from this State.

4. There is an exceptionally high degree of endemism in the State's wildlife; >60% of floral species in the southwest are endemic.

2.2 DESIRABLE FEATURES OF A RESERVE SYSTEM

As indicated, one of the primary functions of conservation reserves is to ensure that representative samples of every significant habitat and community within the State are acquired and protected through reservation. Representativeness is also required at the biogeographical level. Reservation is justified to ensure that the essential features of every major biogeographical region are sampled and included in the conservation estate.

Aesthetic and scientific considerations demand that the sample includes areas of geomorphic diversity, including representative samples of coastlines, river systems and geological features.

Of further consideration is the need for reserves to conserve key areas in the lifecycle of migratory animals, notably wading bird species, when reservation of any particular area would not be adequate to ensure their survival. These reserves should include breeding grounds and areas where animals congregate. Australia as a signatory nation to several international treaties has clear responsibilities in this regard. These are as follows:

- Agreement between the Government of the People's Republic of China and the Government of Australia for the Protection of Migratory Birds and their Environment.
- Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment.
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat.
- Convention on the Conservation of Migratory Species of Wild Animals.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora.
- International Convention for the Regulation of Whaling.
- Convention on Conservation of Nature in the South Pacific.

Related to representativeness is the issue of size. Size is one determinant of the effectiveness of a conservation reserve; the larger a reserve the more diverse the plant and animal communities that it can support. However, if the reserve requires active management then large size can lead to problems in terms of the resources required for management.

On the other hand the remaining small areas set aside in the wheatbelt are vital for the conservation of some smaller animals, plants and birds.

The general principle is that the size of the reserve should be sufficient to ensure that the ecosystems, and plant and animal species being conserved are self-sustaining. The genetic effects of small population sizes of large species confined to small reserves as a result of inadequate reservation are well understood. The consequence is that of extreme sensitivity to normal environmental variables and of eventual decline and degeneration to extinction. Obviously the ideal size of a reserve is dependent upon the specific purpose of reservation and the characteristics of the land involved. There is therefore a need for precise information on habitats and population dynamics when determining areas required for reservation.

Reserves should also be large enough to enable them to be integrated with the surrounding land uses such as has occured with the Fitzgerald River National Park and Biosphere Reserve. Where public access is encouraged or facilitated, reserves should also be large enough to withstand the impacts of human use without any degradation of the resource. Again, the principle is that the

larger a reserve, the greater is the potential for regeneration or rehabilitation following any major impact that may occur, such as wildfire.

In simple terms a larger reserve is always more desirable from a conservation viewpoint than a smaller one.

Related to the issue of size is that of compactness. It is desirable that the ratio of boundary length to reserve area should be low enough to minimise the negative impacts of surrounding land uses. These 'edge effects' include impacts such as fire, invasion of weeds and feral animals, plant diseases, poisons, fertilisers, and changed groundwater levels and drainage patterns. Reserve management is also more effective as far as the impact of public access is concerned when reserves are 'compact'. A further consideration is the existence of privately owned enclaves within reserves which can seriously jeopardize reserve management.

2.3 RESERVE CATEGORIES

There is an internationally recognised categorisation of conservation reserves (IUCN, 1978). The eight categories are as follows:

I. Scientific reserve/strict nature reserve.
II. National park.
III. Natural monument.
IV. Nature conservation reserve/managed nature reserve/wildlife sanctuary.
V. Cultural landscape/heritage landscape.
VI. Resource reserve.
VII. Natural biotic area/anthropological reserve.
VIII. Multiple use management area/managed resource area.

For the purposes of this report three of these IUCN categories are specifically relevant: Category II national park; Category I scientific reserve/strict nature reserve, and Category IV nature conservation reserve/managed nature reserve/wildlife sanctuary.

These correspond to Western Australia's nature reserves, national parks and the proposed category of conservation parks. As the status of the latter is uncertain at the present time this report will assume that this category attracts a similar level of protection as national parks, and that comments on these will apply equally to conservation parks.

In addition, marine conservation reserves also need to be considered. There are three categories either currently included within the Conservation and Land Management Act 1984 or proposed for inclusion, these being:

- marine parks;
- marine national parks; and
- marine nature reserves.

The international criteria for selection and management of national parks include the following (IUCN, 1978):

> "National parks are relatively large land or water areas which contain representative samples of major natural regions, features or scenery of national or international significance where plant and animal species, geomorphological sites, and habitats are of special scientific, educational, and recreational interest. They contain one or several entire ecosystems that are not materially altered by human exploitation and occupation. The highest competent authority of the country has taken steps to prevent or eliminate as soon as possible exploitation or occupation in the area and to enforce effectively the respect of ecological, geomorphological, or aesthetic features which have led to its establishment".

This international definition is consistent with the statement of the Fourth Ministerial Conference on National Parks in Australia in 1970, when all states were represented in establishing an Australia-wide definition.

An analysis of both statements supports the conclusion that national parks should possess the following desirable attributes:

- large area;
- relatively unspoilt by human use;
- protected from exploitation; and
- available for managed public use.

Added to these may be other criteria, such as those following, which are important to ascertain the suitability of an area for reservation as a national park:

- the degree to which the area represents its surrounding region (i.e. representativeness);
- diversity of ecosystem types contained in the area; and
- its effectiveness as a conservation unit.

There is a common misperception that a specific feature, such as a scenic landmark or rare habitat is all that needs to be reserved and managed as national park. It is desirable that the land

systems in which such a feature is placed should be reserved to enable the feature to be adequately managed and protected.

National parks are differentiated from other conservation reserves, in that in addition to having the objective of conserving the natural environment, it is intended that they cater for public use and appreciation. Studies in Australia (Ulph et al., 1978, Bella, 1987) have demonstrated the economic benefit to regional and state economies of national parks through both employment creation and revenue generation (including international income) in the area of tourism. The importance of the contribution of national parks and nature reserves in providing an attraction for tourists is often overlooked.

As indicated earlier, there are two categories of nature reserves within the system established by the IUCN. The management objectives for strict nature reserves are:

> "to protect nature (communities and species) and maintain natural processes in an undisturbed state in order to have ecologically representative examples of the natural environment available for scientific study, environmental monitoring, education, and for the maintenance of genetic resources in a dynamic and evolutionary state. Research activities need to be planned and undertaken carefully to minimise disturbance".

In the case of managed nature reserves the management objectives are:

> "to assure the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment where these require specific human manipulation for their perpetuation. Scientific research, environmental monitoring, and educational use are the primary activities associated with this category".

In the Western Australian context both IUCN categories are relevant, as they represent definitional points at either end of a continuum. Where nature reserves are self-sustaining, natural processes are allowed to take place without human intervention or impact. However, there are also many situations in which management action is necessary to ensure that the objectives of reservation are achieved.

Nature reserves are extremely variable in size, ranging from less than a hectare to many thousands of hectares. Many are less than adequate in terms of size and representativeness because the desire to conserve was preceded by exploitative activities such as clearing for agriculture and pastoralism. This means that in areas such as the wheatbelt and pastoral zone

there are only small fragments of land in a natural condition and they are of great importance to conservation.

Nature reserves are differentiated from national parks in that the level of public access is generally restricted.

While these reserve categories are terrestrial in orientation they are also relevant to the marine situation.

2.4 STATUTORY DEFINITIONS OF NATIONAL PARKS AND NATURE RESERVES

The term national park is defined differently in various acts.

Under the Land Act 1933 the title national park can be used as a purpose of reservation.

The majority of such reserves were vested in the National Parks and Nature Conservation Authority following the proclamation of the Conservation and Land Management Act 1984 (CALM Act). However, there are some reserves with the purpose of national park which are vested in local authorities. The situation is further complicated by the fact that there are significant reserves which are known as, or form part of, national parks but are not reserved specifically for that purpose.

The CALM Act simply defines a national park as land that is vested in the NPNCA for that purpose.

Nature reserves were previously defined by the Wildlife Conservation Act 1950 as any land reserved under the Land Act 1933 for the conservation of flora or fauna, or both.

There are over 1,100 such reserves. However, the CALM Act subsumed that definition, and under that Act now defines them as land vested solely or jointly in the NPNCA for the conservation of flora or fauna or both.

However, under these arrangements there are now approximately 350 reserves with the purpose of conservation of flora and/or fauna, which are either unvested or vested in other than the NPNCA and are therefore technically not nature reserves.

Nature reserves, as with other reserves, can be classified under the Land Act 1933 as of A, B or C-class. The purpose of an A-class reserve can only be changed with the consent of both Houses

of Parliament. Under B-class status Parliament need only be informed of a change in tenure, whilst changes may be made without there being a requirement to inform Parliament if the reserve is of C-class status. As a result of these distinctions A-class reserves have the highest level of protection. It is important to note that the categories do not necessarily relate to the conservation significance of the reserves. So it is possible for a C-class reserve to rate as highly as one designated A-class although its level of protection is considerably less.

As a result of the Government Policy, "Mining and the Environment - Balancing the Scales", a review of all B and C-class nature reserves is being undertaken with the objective of upgrading suitable ones to A-class status and deleting the remainder.

The Department of Mines is conducting a review to ensure that before upgrading occurs the State Government is made aware of the existence of significant mineral and/or fossil fuel resources. There is also a separate review of outstanding EPA 'Red Book' recommendations which is evaluating some 390 areas in the State.(see Section 2.5).

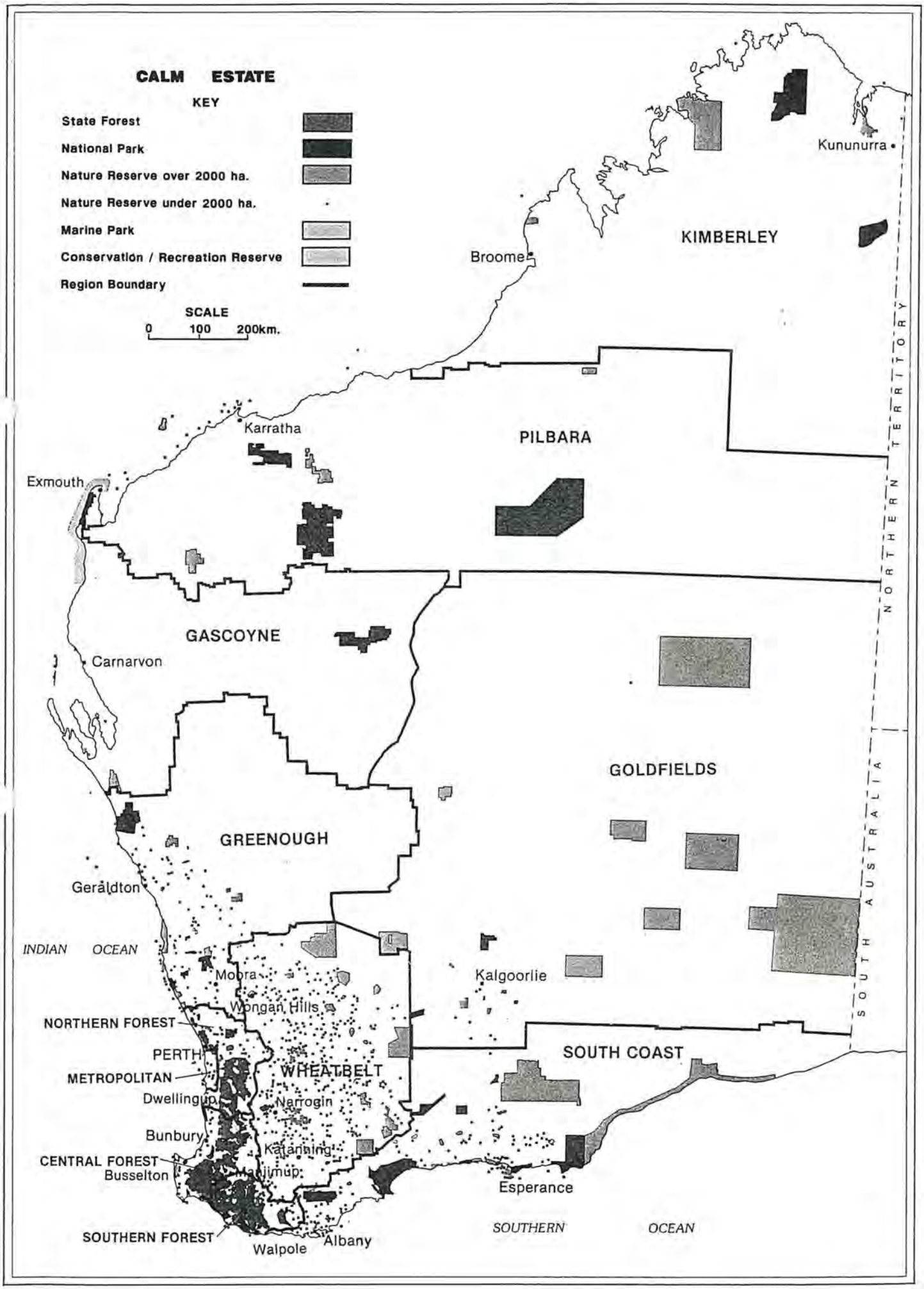
Western Australian waters may be reserved as a marine park or marine nature reserve under Section 13 of the CALM Act. There is the intention to also create marine national parks.

The reservation of a marine nature reserve shall be for the conservation of flora, fauna and habitat. Under the CALM Act marine reserves can only be classified as A-class, i.e. there are no B or C categories; or remain unclassified. The reservation of a marine park shall also be for as much recreation as is consistent with the conservation and protection of the natural environment. Commercial and recreational fishing are also allowed in a marine park but not in a marine nature reserve.

2.5 THE SYSTEM OF NATIONAL PARKS AND NATURE RESERVES IN WESTERN AUSTRALIA

There are a total of 60 national parks vested in the NPNCA with a total land area of approximately 4.95 million hectares. National parks range in size from 33 hectares to 1.5 million hectares. They are widely distributed (see Figure 1) but tend to be smaller and less consolidated in the South West Land Division.

There are about 750 nature reserves vested in the NPNCA. The total land area of nature reserves is 10 million hectares. Again they are widely distributed with the largest number being in the South West Land Division; however, the larger sized reserves are in the more remote areas of the State.


CALM ESTATE
KEY
State Forest
National Park
Nature Reserve over 2000 ha.
Nature Reserve under 2000 ha.
Marine Park
Conservation / Recreation Reserve
Region Boundary
SCALE
0 100 200km.
Kununurra
KIMBERLEY
Broome
Karratha
PILBARA
Exmouth
NORTHERN TERRITORY
GASCOYNE
Carnarvon
GOLDFIELDS
SOUTH AUSTRALIA
GREENOUGH
Geraldton
INDIAN OCEAN
Mobra
Wongan Hills
Kalgoorlie
NORTHERN FOREST
PERTH
METROPOLITAN
WHEATBELT
SOUTH COAST
Dwellingup
Narrogin
Bunbury
Katanning
CENTRAL FOREST
Busselton
Manjimup
Esperance
SOUTHERN FOREST
Walpole
Albany
SOUTHERN OCEAN

Although both national parks and nature reserves have been created over many years, the most significant attempt to create a comprehensive conservation reserve system occurred with the establishment of the Conservation Through Reserves Committee.

A brief historical background on the development of a representative system of conservation reserves in Western Australia is given here, to provide a perspective on the process of investigation and review which led to the development and progressive implementation of these recommendations.

The Western Australian Sub-Committee of the Australian Academy of Science Committee on National Parks produced a report in 1962 entitled "National Parks and Nature Reserves in Western Australia". This report developed the rationale for a comprehensive conservation reserve system.

In December 1971 the Environmental Protection Authority was established to, among other things, "consider and initiate the means of enhancing the quality of the environment" (Environmental Protection Act 1971).

The Environmental Protection Authority recognised that the establishment of an adequate conservation reserves system would be an important mechanism for achieving this objective. Accordingly, it established a Conservation Through Reserves Committee (CTRC) which met for the first time in 1972.

To provide a framework for its consideration of reserve needs, the CTRC divided the State into 12 regions, or systems, each representing as nearly as possible a natural demographic entity.

In identifying reserve needs the CTRC established two main guidelines:

1. To recommend adequate reserves to secure the conservation of representative biological and geomorphic types occurring in Western Australia, as well as features of special scientific significance.

2. To recommend adequate areas of national parks (additional to those in (a) above, where necessary), to meet projected population growth, distribution, and mobility.

The report of the CTRC, titled "Conservation Reserves for Western Australia – Report of the Conservation Through Reserves Committee to the Environmental Protection Authority (1974)" covered all systems but Systems 6 (the Darling Range) and System 7 (the Kimberley) and became known as the Green Book.

System 7 was given special attention, largely due to its remoteness and associated deficiencies in available information and was subsequently the subject of a separate Green Book, released in 1977.

System 6, because of the complexities resulting from the much closer subdivision of land and the range of interacting factors generated by the 77% of the State's population living in this system, was treated slightly differently. A System 6 Committee, supported by six specialist committees representing: commercial and productive users; local government and urban planning; tourism and recreation; conservation and land use; ecosystem and land use inventory; and conservation reserves and national parks was established by the EPA.

The Committee's report titled "The System 6 Study Report to the Environmental Protection Authority" and known as the System 6 Green Book, was released in 1981.

In each case the EPA sought public comments on the Green Books from the private and public sectors of the community. The Authority considered each of the CTRC and System 6 Committee recommendations along with all public and private submissions and other available information in the preparation of its reports to Government. These reports (of which there are four released in 1975, 1976, 1981 and 1983) were entitled 'Conservation Reserves for Western Australia – As Recommended by the Environmental Protection Authority', and became known as the Red Books.

The Red Book recommendations were, as indicated previously, an attempt within limits imposed by existing land use constraints and knowledge, to develop a system of reserves which would be representative of the range of biophysical environments present in Western Australia. To approach this goal the proposed reserve system needs to be fully implemented. Even then, environments that are inadequately represented in the system will continue to be identified as our knowledge of the Western Australian environment becomes more complete.

Up-to-date some 70% of the Red Book recommendations are considered to have been implemented, excluding the System 6 recommendations This leaves a significant 30% yet to be fully implemented, indicating that the State does not yet have a fully representative system of reserves.

Of the recommendations not yet implemented, a number are well advanced toward implementation, others are awaiting land exchange, pastoral leases to expire, resolution of Aboriginal interests, or biological surveys before they can be progressed. A proportion of the other outstanding recommendations have not been implemented because of mineral resource issues

that remain unresolved*. Significantly all outstanding recommendations in System 7, the Kimberley region, come into this category. However, the issue is by no means confined to the Kimberley region**.

It is also to be noted that the CTRC recommendations were formulated some years ago and the information on which they were based has been upgraded. There is therefore need for a detailed review of the recommendations in the light of more recent knowledge. This is illustrated by the fact that there have been some additional national parks proposed which were not recommended by the CTRC, a prime example being the Bungle Bungle National Park in System 7.

To date, three marine parks, Marmion, Ningaloo and Alfred Cove have been reserved. This system is clearly inadequate to cover the range of environments found along the extensive coastline of this State. Proposals are being prepared to establish a comprehensive system of marine and estuarine protected areas (marine parks and marine nature reserves). These will be representative of the various communities of marine environments to be found in Western Australia.

2.6 RELATIONSHIP TO MINERAL EXPLORATION AND MINING

Prior to the "Bailey Committee" report conservation areas were open to mineral activities, with licences and leases being granted subject to certain conditions regarding safety and rehabilitation.

A consequence of the above mentioned report and its adoption by Government is that an increased level of protection from mineral development pressures has been gained for national parks and nature reserves. This has been achieved by adopting the position that conservation areas should be closed to exploration and mining activities, but that approval may be sought from both Houses of Parliament to have them opened. Exploration licences and mining leases may then be granted, but under a more environmentally rigourous set of conditions than before.

The main points of the current Government Policy on mining in national parks and nature reserves are summarised below:

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* Subsequent to the release of the Government Policy on Mining and the Environment, an interdepartmental committee was set up with the objective of accelerating the review and implementation of all EPA Red Book recommendations. The committee has been operating since May 1988 and has prepared two reports for Cabinet's consideration.

** A major review of land use in the Kimberley is currently being undertaken by the State Planning Commission. CALM has made a major input to this study.

1. National parks and A-class nature reserves will be closed to exploration and mining activities unless individually opened for the granting of an exploration licence, or reclassified.

2. Areas of the highest biological or landscape value should remain closed.

3. Geoscientific (non-destructive) surveys may be allowed under permit with approval from the Minister for Conservation and Land Management, with appropriate conditions attached.

4. Proposals to open a park or reserve to exploration are to be referred to the Environmental Protection Authority by the Department of Mines. A committee would then be convened to carry out a non-destructive programme of research (into the conservation values of the area); the results of which are referred back to the EPA who make a recommendation to Government. If a company initiated the proposal then it would be expected to meet the costs of the above study.

5. If the Government decides, upon advice from the EPA, to open a park or reserve (or a part of one) then it must gain the approval of both Houses of Parliament. (Parliamentary approval was previously required only prior to the granting of mining leases)

6. Areas vested in the National Parks and Nature Conservation Authority as B or C-class reserves will be individually reviewed and either:
   - reclassified as a national park or A-class nature reserve; or
   - have their NPNCA vesting status removed;
   - further, the review will encompass reserves vested in bodies other than the NPNCA, which are considered worthy of national park or nature reserve status.

7. Exploration and mining tenements in parks and reserves will only be granted on the condition that damage to the environment is prevented, or minimised and repaired; AND that the Minister for Mines will be able to impose additional environmental conditions at any time.

8. Holders of exploration licences and/or mining leases in opened parks and reserves will be required to submit to an EPA review every 5 years. As well, the Government is pursuing ways of providing a mechanism to close parks and reserves to exploration after a certain period of time.

3. THE PETROLEUM INDUSTRY IN WESTERN AUSTRALIA.

3.1. BRIEF HISTORY

Exploration for oil in Western Australia commenced soon after the turn of the century, when supposed traces of oil were reported from the Warren River area, near the south coast. Three holes were drilled during the period 1902-1904, but without success. It was not until 1967, 65 years after the first well was drilled that commercial production began at Barrow Island.

The main turning points for oil exploration in Western Australia were the discoveries at Rough Range in 1953 and at Barrow Island in 1964. Prior to the Rough Range find many sceptics maintained that oil could not be found in this State, and this discovery did a lot to encourage people, not only among the general public, but also among the industry that commercial fields could indeed be found. Barrow Island was of course even more important as it was the first oil discovery to be proved commercial.

Modern exploration commenced in Western Australia in 1952 when West Australian Petroleum Pty. Ltd. (Wapet) began operations. The company had dramatic success in December 1953 with its first well, Rough Range 1. Great hopes were held that large commercial fields would be proved in the Exmouth Gulf area. However, subsequent drilling showed that the Rough Range field covers only a few hectares and is non-commercial. Had the well been drilled on the original site selected by geologists it would have been dry, but it was moved a few tens of meters for easier site preparation thus placing it exactly over the tiny field. Although Rough Range was not a commercial success, it spurred exploration throughout Australia.

Over the next eight years exploration gradually tailed off, until a trough was reached in 1961. Then, in that year, oil was discovered at Moonie in Queensland, and just as with Rough Range, this discovery stimulated exploration throughout Australia. The Moonie discovery was followed by an increase in exploration expenditure in Western Australia, and this led up to the Barrow Island discovery in 1964. Barrow Island proved to be the State's first commercial field; the initial shipment of crude oil leaving the island in 1967. A few months before this discovery oil and gas had been found at Yardarino in the Perth Basin. These discoveries initiated the third period of exploration in Western Australia which led to several further onshore discoveries including gas at Dongara, Gingin, Mondarra and Walyering and oil at Mt Horner.

In 1968 the discovery of oil in Legendre 1 in the offshore Carnarvon Basin initiated an extensive offshore exploration effort which is continuing today. This has resulted in major gas/condensate discoveries at North Rankin, Goodwyn, Angel, Scott Reef, Gorgon and numerous other structures. More recently discoveries of oil at Harriet, Saladin, North Herald, South Pepper,

Chervil, Talisman and others have upgraded the oil potential offshore as have the Jabiru and Challis discoveries in the Ashmore-Cartier area of the Bonaparte Gulf Basin.

Since 1902 a total of 516 exploration wells have been drilled in Western Australia. Of these 294 were drilled onshore and the remaining 222 offshore.

This drilling has resulted in the discovery of 18 producing fields with a further 25 fields at present considered sub-economic due largely to market forces.

The original recoverable reserves estimated for these 43 fields was 90 million kilolitres of oil, 143 million kilolitres of condensate and 1,824,000 million cubic meters of gas collectively valued at approximately $174,250 million (in 1988 dollars). Allocating the value of these petroleum reserves to the acreage required to produce them yields an approximate value of $1,742 million per square kilometer.

In frontier exploration areas like Western Australia, which is essentially underexplored, initial exploration tends to concentrate in the more easily accessible areas close to existing infrastructure. Thus the spread of areas under permit for exploration does not necessarily reflect the prospectivity of the state as a whole.

In 1988 a total of 340,000 square kilometers was held under onshore exploration permits representing 34 percent of the total prospective onshore area. Offshore permits for exploration covered 140,000 square kilometers or 8 percent of the total offshore area.

3.2 STATISTICS RELATED TO THE PETROLEUM INDUSTRY

3.2.1 Exploration Statistics

Accurate expenditure figures for exploration are difficult to obtain however to date, more than $5,000 million has been spent on exploration in Western Australia. A significant proportion of this expenditure has directly benefited the people of this State. A significant number of jobs are also provided by the petroleum exploration industry.

About 490,000 line kilometers of offshore and 120,000 line kilometers of onshore seismic lines have been completed in Western Australia. This total of onshore seismic operations assuming a 5 meter wide line represents approximately 600 square kilometers of directly, though temporarily disturbed land which is less than 0.06 percent of the State's sedimentary basin area or alternatively less than 0.4 percent of the area of the State currently held as national parks and nature reserves. This area is actually considerably less than 600 square kilometers as much of the

seismic was shot along existing roads and tracks. Overall the total land area temporarily affected by exploration and development in Western Australia is less than 0.03 percent. A negligible figure when compared with land affected by agriculture or urban development.

3.2.2 Production Statistics

Since 1964 a total of 39,491,272 kilolitres of oil, 3,051,894 kilolitres of condensate and 29,433,340,000 cubic meters of gas have been produced in Western Australia. The value of production to the end of 1988 was close to $5,000 million, representing a yield of $50 million per square kilometer of land used for petroleum production.

Production forecasts to 1994 indicate that production will yield a further $8,500 million (in 1988 dollars, based on an oil price of $20 per barrel). This production will generate revenue to Government of some $420 million of which some $181 million will be payable to Western Autralia. This increase will represent a further $1.8 million per square kilometer of land required for production. In 1988 a total of $60,945,871 in royalties was paid by Western Australian producers.

Revenue in excess of $1,200 million dollars has been generated from producing areas located within A-class reserves. Had these reserves been closed to exploration and production, Government would have had to forgo this income.

The North West Shelf Liquid Natural Gas (LNG) Project using offshore gas as feedstock is expected to generate discounted revenues of approximately $22,000 million over a 20 year period. Revenue of this order of magnitude would be lost if companies were not able to explore for and develop such prospects.

The LNG project is one of the largest and most expensive development projects undertaken in Australia. So far, in excess of $2,500 million has been spent on the Domgas phase of the project and a further $11,600 million will be spent on fully developing the LNG phase; including $1,700 million on the development at Goodwyn and $900 million for additional LNG facilities. The amount committed so far to the LNG phase is almost $4,000 million and 72 per cent of the money spent to date has been in Australia. During the construction phase employment reached 4,500 in Karratha and the operation workforce will exceed 1,500. Operation and maintenance expenditure will exceed $12,000 million over the life of the project. The North West Shelf Development is expected to generate an annual cash flow of up to $1,500 million over the 20 year life of the project.

Other smaller projects including Woodada, North Herald, South Pepper, Harriet, Mt Horner, Blina and Talisman have involved design, construction and development expenditure in excess of $250

million. Since 1964 Wapet have spent more than $250 million on development and production in the Barrow Island and Dongara areas and a further $140 million will be spent on development of the Saladin field. Operation and maintenance expenditure by Wapet so far exceeds $250 million. In addition construction of pipeline and port facilities has contributed considerably to both employment and expenditure in Western Australia. Future potential projects include the Bonaparte Gas project which could involve development expenditure in excess of $650 million and the Gorgon gas/condensate development which could involve further expenditure of around $7,000 million in the forseeable future.

A total of 1627 people were directly employed by the production industry in field operations in 1988. It is estimated that every $1 million spent on development activity supports approximately 20 industry support jobs through a multiplier effect. In Western Australia this would represent some 14,000 additional jobs. These figures do not include people involved on the construction side of the industry.

As a rough approximation these developments represent an investment expenditure, excluding operating and maintenance, of more than $22,000 million or $220 million per square kilometer of land required for production.

In addition, approved and proposed projects including the Wesfarmers Liquefied Petroleum Gas Extraction plant, CSBP Sodium Cyanide plant, Du Pont Sodium Cyanide plant and Ammonia-Urea and methanol (Scott Reef) production represent a further $3700 million of expenditure on petroleum related projects. All of these projects depend upon Western Australian petroleum feedstock

3.3 THE LAND REQUIREMENTS OF EXPLORATION

A matter of considerable concern to the Western Australian natural resources industry is the increasing pressure being exerted on exploration and development operations. There is no doubt that there is a need for adequate safeguards to ensure that any damage to the environment is minimized. Any human activity, however, will have some effect on the environment, and this has to be accepted if economic development is desired.

The environmental consequences of petroleum exploration and production are clearly less than those of agriculture, the pastoral industry and urban development; moreover, it disturbs less of the land surface of the State, than the other activities mentioned. The resource industry has become increasingly aware of its responsibilities in environmental protection and in recent times has played a leading role in developing and applying rehabilitation techniques.

The long term future of the petroleum industry will depend on a range of factors including the explorers skill, local and world political climates and market opportunities. Without access to land however these factors are academic.

The Tenement Map, published by the Department of Mines, shows the extent of Western Australian sedimentary basins and the distribution of petroleum exploration and production tenements as at December 1988. Areas alienated from general usage for petroleum production purposes are also shown on this tenement map. Collectively these petroleum production tenements occupy less than 100 square kilometers of onshore acreage compared to the 150 000 square kilometers of the State already allocated to national parks and nature reserves. Of the 100 square kilometers currently required for development and production purposes more than 80 square kilometers are within an A-class reserve and in the 25 years of operations in that area no unacceptable environmental impacts are known to have occurred.

Areas considered prospective and worthy of petroleum exploration are many times larger than the economic deposits that are sought. Indeed in exploration many prospects may have to be examined and tested before an economic petroleum deposit is located. In oil exploration, areas explored and abandoned by one or more companies have subsequently yielded major oil accumulations substantiating the premise that new ideas and technological advances may upgrade the prospectivity of even relatively well explored areas.

Many early oil discoveries overseas were made by following up surface evidence of petroleum occurrences. The era of easily discovered deposits has unfortunately passed. Petroleum exploration in its initial stages now leans heavily on remote sensing, field geology and airborne geophysical techniques. The definition of drilling targets originally dependent upon geological mapping is now almost totally reliant upon sophisticated geophysical (seismic) mapping of subsurface structures. The existence of a petroleum deposit can only be proven by drilling and a number of wells are usually required to determine if a discovery is of economic significance. New exploration techniques, new geotechnical concepts and modern data processing techniques can lead to discoveries in areas once thought to be non-prospective. The giant Scarborough and Scott Reef gas discoveries are examples of petroleum discoveries in areas originally thought to be unprospective.

Areas currently considered as unprospective because of limitations on technology, geological concepts or market availability may well become highly prospective as technology, concepts and markets develop.

Seismic techniques used to map the Earth's subsurface are increasingly capable of revealing previously unknown potential oil bearing structures even in areas which had received extensive exploration in the past. It is evident therefore that the economic potential of an area cannot

generally be assessed except by a continuing intensive exploration effort in geology, geophysics, geochemistry and drilling, If access is denied, the consequent loss of exploration investment and scientific knowledge important in developing regional concepts must be considered as well as the denial of other benefits that would flow to the community from a major resource development.

It has been suggested that certain areas of Western Australian sedimentary basins are not prospective for oil and gas. The same was said a few years ago about the Eromanga Basin in Queensland and South Australia, now one of Australia's most prolific onshore oil producing basins. As technologies evolve, new concepts appear and a better understanding of the geological environment is developed, then the prospectivity of any area can change dramatically. For this reason, all sedimentary basins in Western Australia both offshore and onshore should be regarded as prospective.

3.4 FUTURE PROSPECTS

The economic future of Western Australia is linked to its mineral and petroleum resources. Approximately half of the 150,000 square kilometers of existing national parks and nature reserves occupy areas prospective for petroleum resources. Just 1 per cent of this area could contain 20 accumulations the size of the oilfield on the Barrow Island Nature Reserve, and today this 1 per cent could have a net value of some $170,000 million.

4. ENVIRONMENTAL IMPACTS OF PETROLEUM EXPLORATION AND DEVELOPMENT

4.1 INTRODUCTION

The oil industry is comparatively young in Australia. This has benefited it in as much as it is not compromised with old, second rate technology, which has led to major accidents elsewhere. For example, early North Sea platforms were often underdesigned, so that structural components became overstressed. This coupled with infrequent inspections is said to have led to the failure of the "Alexander Keeland" platform in the North Sea. The "Piper Alpha" disaster was predicted to occur by Norwegian oil experts because of cost – cutting measures, as a result of which subsea isolation valves were not installed. With the failure of a containment system in a seabed pipeline excess gas at pressure was released to the platform, resulting in a catastrophic explosion. As a consequence of this incident all production platforms may be required to be equipped with subsea isolation valves.

One drawback of having a comparatively young industry is that there is less locally specific data available to structure operating criteria or relevant contingency plans in the event of accidents.

Another factor is the inherent differences between terrestrial and marine oil exploration and production, and their potential impacts. Land-based activities are discrete in extent and their effects are therefore easier to predict and control than those offshore. For example, drilling a well on land is an activity for which the significant environmental impacts can be predicted (and minimised with appropriate measures) and the results can be monitored after the event. The effects of spills and blow-outs can be forseen and controlled with available technology, and rehabilitation of the site (even after a spill) is possible and practised routinely in some areas. The effects may be much more localised and containable than in a comparable marine scenario.

Marine spills have the potential to impact on much more than just the adjacent biotic community because the oil is subject to the influence of currents, winds and waves. It may thus be able to travel large distances from the spill (up to 50km in 24 hours – DCE Bull 71) impacting on several, interrelated marine communities in its path. Marine impacts then are more complex and more difficult to predict than terrestrial ones.

The Committee had to use data and conclusions drawn from localities in the USA, the North Sea, the Middle East and elsewhere, (where the type of crude oil, the climatic conditions and the physical and biological environments are different to those in W.A.), because there are few if any comprehensive local studies on the effects of a marine spill upon the environment. So while the

Western Australian industry can benefit from lessons learnt elsewhere, it has had to make educated guesses as to what the specific effects of certain activities or a major accident might be on the local environment. There is, for example, little data available for use on seismic impacts on local marine life, or for use in the event of a marine oil spill off our coastline, because the effects of previous ones have been of a minor nature and have not been studied.

Oil exploration has concentrated on the sedimentary basins of WA (see Tenements map); particularly in the Perth, Carnarvon and Canning Basins, with offshore activities mainly taking place in the Bonaparte Basin and North West Shelf areas. Impacts therefore occur in both the terrestrial and marine environments and encompass the entire spectrum of activities from initial reconnaisance through to production, storage and transport facilities.

4.2 IMPACTS FROM EXPLORATION

4.2.1 Terrestrial Seismic Surveys

Seismic reflection is the most widely used geophysical exploration method for identifying potential oil or gas bearing structures in Australia. Early surveys followed specially dozed straight traverse lines which ran for kilometres across whatever terrain was encountered, with no regard for the immediate or potential future impacts (erosional, visual) caused by removal of the topsoil and the vegetation it supported. The dozed lines were made wide enough to allow easy two-way progress of heavy vehicles, and sometimes parallel tracks, clearings and random routes would be created where not strictly necessary. People opting for short cuts across terrain between survey lines would add to the problem because if it occurred after rains and the ground was soft, wheel ruts would be created and compaction of the ground would result. Ruts and dozed seismic lines provide a preferred route for the flow of water, leading to the formation of deeper ruts and gutters, and may ultimately result in deep gullies and loss of considerable amounts of soil. With soil loss goes the contained root and seedstock, so that these erosion channels are unlikely to revegetate by natural processes and thus remain prone to continued seasonal erosion.

Examples of these worst-case scenarios were not seen on the lines inspected by the Committee, where erosion does not appear to have been a significant problem. However, the visual impacts of many long, straight and, in places, close-spaced lines runnning in several directions (as, for example, in the Rough Range area) cannot be disregarded, because regrowth along lines, especially on those where the topsoil was removed, is sparser than, or differs from that of the surroundings. Where lines remain cleared they attract recreational vehicles which may lead to further damage and inhibit regrowth of vegetation.

Seismic surveys record signals reflected/refracted back from sub-surface formations as a consequence of energy input, either from a charge of dynamite emplaced down a shot hole and exploded, or nowadays from a series of 'Vibroseis' trucks which move along lines in convoy and transmit energy to the ground via heavy plates in contact with the earth, timed to vibrate in unison. The method of emplacing a charge down a hole has been abandoned in favour of the quicker Vibroseis trucks, so that it is now generally unnecessary to employ a drill rig to drill holes for this purpose. Thus the inhibiting effects of drill chips around hole collars on vegetation regrowth, and the more serious danger to animals and humans from ground subsidence have been largely removed, now that there remains only a requirement to drill more widely spaced 'upholes', with reduced amounts of explosives,for near-surface data.

Recently work has become more attuned to the often fragile environment through which it passes, and the Australian Petroleum Exploration Association Ltd (APEA) has published a Code of Practice (APEA, 1988) which makes specific recommendations on how to minimise the environmental impacts of seismic surveying. The reader is referred to pages 14-19 of the APEA Code for the details. Some significant aspects are:

1. Forward planning so that especially sensitive areas can be avoided, or disturbance minimised, using appropriate low impact vehicles (such as bikes etc.) to transport geophones.

2. Avoiding sensitive areas during the breeding season.

3. Prevention of introduction of weeds or domestic animals to conservation areas.

4. Avoidance of over-designing access tracks and lines.

5. Allowance for minor deviations in the survey route to avoid removing large trees, or to negotiate sensitive creek crossings, steep topography or sand dunes at an appropriate angle to minimise erosion of banks.

6. Avoidance of removal of topsoil by skimming, slashing or rolling over vegetation. This leaves root and seed stock in situ and the dead vegetation provides a trap for soil and moisture, conducive for more rapid regrowth after rain. This technique also avoids the creation of windrows (in the absence of a dozer blade pushing aside soil) which tend to divert and channel run-off, aggravating soil erosion, and has been found to work well on Barrow Island.

More recently still a committee called the "Work Party on Conservation and Rehabilitation in the Mining Industry" and comprised of members from Government agencies, the mining industry, pastoralist and conservation groups have drafted the "Report on Conservation and Rehabilitation in relation to Seismic Lines". This report is being used by the Department of Mines to set conditions for permit and lease holders.

Despite the general improvement in performance, there are some areas to which attention needs to be directed. Problems have arisen because there is more than one standard code, which gives rise to inconsistencies and potential for conflict. Further, these codes are written in formats which do not readily lend themselves to field usage by machinery operators. A more graphically explicit booklet is required for field operators, and closer on-site monitoring by environmentally experienced personnel.

With improvements in seismic technique, there is a higher degree of flexibility in line placement and configuration. Environmentally sensitive areas may therefore possibly be avoided. The flexibility of the siesmic crew is not always made clear to the landholder by company staff at the time the survey is being proposed.

Another concern is in the way a seismic line is disguised or closed off after use, at its intersection with a public road. Where this has been ineffective there is increased risk of damage, such as failure to revegetate, erosion and spread of dieback disease, caused by subsequent traffic along the line.

Particularly in the Perth Basin where there is a dieback problem and several species of rare flora, there is insufficient appreciation of the issues involved and the measures required to minimise the impacts.

Lastly, follow-up monitoring of regeneration along lines is sometimes inadequate. Many of these issues under discussion by committees formed to review these practices (for example, the "Work Party on Conservation and Rehabilitation in the Mining Industry").

4.2.2 Marine Seismic Surveys

As on land, the surveys consist essentially of two activities: a mechanism to produce sufficient energy in the form of a shock wave to penetrate geological strata to a depth of several thousand feet; and the means to collect and process the reflected/refracted returning energy signal. The latter requires long lines or "strings" of geophones to be towed by surface vessels and has little or no impact on marine organisms. The former is of greater concern, depending on the size and form of the energy source and where it is set off.

Two broad kinds of energy source have been developed. Formerly, explosives were used, either implanted beneath the sea bed, or set off in the water column from a trailing explosive "flex" (Geoflex, Primacord). More recently, non-explosive sources were developed, of which the most commonly used is the seismic airgun (98% of all seismic operators use airguns). The latter is the most commonly utilized approach offshore in WA (the 'Aquapulse' system), except where water depth is less than about three metres. In this system seismic energy is created by detonating a mixture of propane and oxygen in an elastic-walled container. Commonly four units are towed in a rectangular array behind a vessel and are fired simultaneously at depths ideally from 10m-15m. In shallow water the trailing explosive flex has been used in the recent past (Le Provost, Semeniuk and Chalmer, 1986) but it is understood that this technique is no longer in use in W.A. Telemetric advances have given rise to a method called 'Telseis' in which the energy source can be sited up to 10km distant from the geophone stations, thus enabling data acquistion in environmentally sensitive areas, with minimal environmental impact.

A literature review of studies to assess the effects of discharges on marine organisms shows that few have been conducted off West Australian coastlines, and even less is available on the impact of seismic airguns. Only two studies were found, one on the effects of seismic explosions on pearl oysters (Le Provost, Semeniuk and Chalmer, 1986), and the other on prawns (Le Provost, Semeniuk and Chalmer, 1988) in the North-West Shelf area. Both these reports did not use control samples for comparisons; thus their conclusions have limited value.

The other studies reviewed have been conducted in the USA and variability in the quality of the data and in the way in which it was presented makes it difficult to draw general conclusions. The applicability of some of these broad principles to WA is uncertain. Linton et al. (1985:18-20) considered that there are four factors influencing the severity of impacts:

(a) Characteristics of the shockwave produced and its zone of influence

The setting off of an explosive charge results in the formation of a gas bubble. As the gas bubble expands it sends a shock wave outward from the source, with which peak pressures are associated. This is rapidly followed by a rarefaction as the bubble is forced to collapse by the pressure of water upon it. Because of the very rapid pressure changes creatures with swim bladders (such as fish) cannot adjust quickly enough and their internal organs are ruptured. When the pressure wave hits the surface of the water it is partly or totally reflected, but as a rarefaction event. This phase is more destructive than the primary wave because the sudden external pressure drop causes swim bladders

to explode, and it does most damage in the near surface zone which many species of fish and larvae frequent.

Non-explosive sources, such as seismic airguns, have less sudden pressure effects than high explosives and,although information is conflicting, it has been concluded that their effects are unlikely to cause serious harm as a result (Linton et al., 1985:15). In a 1988 study on prawns off the W.A. coast (Le Provost, Semeniuk and Chalmer, 1988) mortality rates of 93% of prawns at a distance of 50m from the discharge of the airgun array after 24 hours were recorded, but it must be noted that there was no control population of prawns for comparison.

Non-explosive devices (and there are many different principles in use) have become much more widespread. Some (US) regulatory authorities and governments have banned the use of high explosives for marine seismic purposes (Linton et al., 1985:15).

(b) The shape and nature of ocean floor

A configuration such as a submarine canyon with steep rocky sides is possibly the worst place to discharge an explosive device because of the confining and concentrating effects of the walls on the shock waves. These areas are frequently heavily populated with marine life.

(c) Proximity of the organisms to the site of discharge

In general, the closer to the point of the explosive discharge, the greater are the effects. In one study (St.Amant, 1981) using Primacord explosive flex it was recommended a minimum distance of 500 feet (150m) be kept from oyster areas, and that effects were worse in shallow waters and confined bays or lakes.

(d) Seasonal variations

Juvenile stages such as eggs and larvae are more susceptible to injury. A study of seismic airgun discharges on northern anchovy larvae produced a maximum variation of 33% in survival rates of 4 day old larvae (Holliday et al., 1987), however, the levels of energy were said to be 3 to 4 times that which would occur for a full seismic array passing directly over a specimen at a distance of only 10 feet. Linton et al. (1985) noted that 'damage' to fish eggs occurred when a source at 2050 psi level was detonated at a distance of 5m.

A knowledge of the breeding cycles of marine populations to plan the timing of seismic surveys in susceptible areas may be helpful in reducing impacts. In W.A. waters seismic surveys are generally planned to take place outside of the fishing season in those areas (but may still impact upon the breeding phase).

A point that needs to be made with respect to all of the studies mentioned is that they are concerned only with fatalities or visible damage to organisms, not with potential upsets to behaviour patterns which may affect migrating, feeding and breeding cycles, and so caution must be exercised until more is known about these more subtle effects.

There is general agreement among biologists (says Myrberg, 1978 in Pierce, 1984) that the acoustic sense of aquatic animals is probably their most important, by providing the owner with information on a variety of functions related to food, competitors, potential mates and predators. Increased or excess environmental noise could affect animals that rely on acoustic signals to maintain biological functions such as those mentioned above (Turl, 1982 in Pierce, 1984). It is not known whether seismic noise masks communication and echo location signals in marine mammals.

> "The limited data available make it clear that marine mammals do respond to seismic exploration noises by producing observable changes in behaviour within at least a several mile range. Although population trends (in these areas) would indicate that no severe effects are occurring, less measurable disturbances have been substantiated in the literature" (Pierce, 1984:59-60).

There is some evidence that scared fish will not bite for several days in the vicinity of a survey, thus compromising fishing activities (Crawford et al., 1982 in Pierce, 1984).

Although concerns are mainly centred around effects on marine life by the seismic energy source, some attention should be given to the long towed cables connecting geophones, which may be up to 5km in length. Although damage may occur to this line and to incident fishing gear and catches at any time, it is most likely at the end of a seismic line when the towing vessel turns around. As the cable tends to "cut the corner" it is prone to snag and cut trap lines, pots and nets in its path. For this reason seismic surveys are timed to fall outside of the fishing season. Anecdotal evidence does not give immediate cause for concern that this is a significant factor.

4.2.3 Terrestrial Drilling.

While seismic exploration activities are of short duration, drilling a well is not. The typical well takes weeks to months to set up, drill and equip or cap off. Thus impacts are more intensive and would be likely to include:

1. 'Temporary' access roads becoming 'permanent' for various reasons.

2. Increased vehicular traffic, noise, dust, erosion risks. If saline groundwater (produced from the drillwell) is used to wet the road to reduce dust this run-off is likely to damage adjacent vegetation.

3. Risk of pollutant spills, rubbish and human wastes.

4. Damage to vegetation via large cleared areas, possibly leading to erosion. The standard size of area required is 1.5 hectares, however, the Committee was shown larger clearings of up to 3 hectares in size.

5. Impact on resident wildlife during drilling operations.

6. Large unlined sump area to receive cuttings and water flows. If large amounts of water are encountered this may pose a disposal problem, due to its entry into the near-surface groundwater regime, especially if it is saline (brine is more damaging than oil and less easily recovered, US Deptartment of Agriculture, 1985).

7. If exploration camps are sited in sensitive areas the recreational preferences of workers have to be controlled as they often favour outdoor type pursuits. Four-wheel drive vehicles can have widespread impacts on flora and fauna and so can untended fires.

8. The visual and aesthetic impacts of all the above.

In national parks and nature reserves these effects will be more significant than elsewhere. Many people expect to visit the former because of their exceptional natural attractions and they have an expectation to find an area of unspoilt beauty. This is incompatible with the visual and aural impacts of a drill rig, and associated support vehicles, mobile vans and personnel. In nature reserves the impacts on rare and endangered species are much more likely to be critical.

APEA and government codes of environmental practice have addressed the realities of this situation and will be mentioned in Section 4.4.2.

4.2.4 Offshore Drilling

On an offshore drill rig although impacts are concentrated around the immediate vicinity of the structure there is the potential for winds and currents to carry pollutants far beyond the area of activity. As several holes may be drilled from the same location the platform may remain in the same location for many months.

Domestic wastes on board are separated into two categories - solid, non biodegradable; and solid and liquid biodegradable. The former (items such as packages, drums, paper, glass etc.) are removed in containers to the mainland while the latter (food and human wastes) are jettisoned down the inside of one of the platform's legs, there to be slowly degraded and dissipated into the water near the ocean floor.

Drilling activities present the major threats, from the risk of a blowout, to the effects of the discarded drill cuttings on the sea floor. Blowouts are less common today worldwide because of effective automated shutdown mechanisms which monitor back pressure and react rapidly to the intersection of a zone of high pressure gas or oil. The Committee is aware that there have been only two blowouts to date in Australia and none in Western Australia. The risk is considered to be lower in Western Australia than elsewhere because of the lower formation gas pressures encountered at shallow depths. However the effects of a failure could be severe, depending on a number of factors. This scenario is more fully discussed in Section 4.3.4.

Drill cuttings (from which the drilling mud has been removed for recycling down the hole) are discarded from the rig and drift down to the sea floor. Their disposal depends on the size of the cuttings, the depth of water and the strength of the prevailing current, but usually they do not drift far, and tend to concentrate in one area. They contain significant amounts of impurities from the drilling muds and drilling fluids, thus the composition of the muds is an area which has received attention and led to the development of water-based and low-toxicity muds to reduce the impacts of diesel-based muds. The compositions of the 3 groups are:

- diesel based: water in oil emulsion, 70-80% diesel oil and water, polymers, clays, barite;
- kerosene-based: water in oil emulsion 70-80% kerosene and water, polymers, clays, barite; and
- water based: water, polymers, clays, barite.

Diesel based muds contain significant amounts of toxic aromatic hydrocarbons (such as naphthalene, fluorene and phenanthrene) while kerosene-based muds contain less. Water based muds are the simplest of the three groups; their organic content is low and the environmental impact from hydrocarbon enrichment onto the seafloor is less significant than with the others. They are also more easily dispersed by water. However, they are at a disadvantage in deep angled wells (less lubrication when this is more critical) hence the use of oil-based muds persists in certain situations.

In the event that oil is discharged with the cuttings it undergoes chemical and biological weathering and physical dispersion. The major factor is thought to be microbiological, with the number of hydrocarbon-consuming microbes increasing in the immediate surrounding area. This is an aerobic phenomenon but it is selective, and the partial biodegradation results in a new set of compounds being formed, some of which are toxic. (Saunders and Tibbetts, 1987).

On the sea floor aerobic reactions can only occur in the top few centimetres of the pile of cuttings. Below this anaerobic bacteria operate to produce toxic sulphides. This means that there is a high likelihood for further reactions to occur, the most significant being those of a corrosive nature. This presents a risk to nearby metal structures and pipelines.

The effects of petroleum on organisms are very poorly researched to date, according to Menzie (1983). He claims that some groups are in general more sensitive than others, for example the phytoplankton and copepods (floating populations of small plants and animals) because they are unable to avoid oil slicks on the surface, generated by the jettisoned oil-soaked drill cuttings. As well, larval stages and animals in moult are more susceptible as these are traditionally vulnerable periods in the development of most, if not all, organisms.

A number of mobile species such as bottom-dwelling fish and crabs show an increase in population, despite a decrease in the number of infauna* (Menzie, 1983). It is suggested that the buildup of bottom feeders comes as a consequence of there being more to eat as a result of the nutrient-rich outflow from the human and food wastes generated by platform personnel. This may lead to higher populations of species further up the food chain over time, such as seals and larger fish, which corresponds to the subjective impressions of many platform workers.

The decrease in infauna population is most likely caused by the toxic and anaerobic effects of the growing pile of discarded cuttings on the sea floor.

Section 4.3.3 contains a more detailed discussion of the effects of oil on marine environments.

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* Species that live in the bottom sediments

4.3 IMPACTS FROM DEVELOPMENT AND PRODUCTION

The impacts from these stages are more concentrated and intensive than those from exploration. Their presence may be felt over a period of decades and may be regarded as being essentially permanent over a human generation. In addition to the production wells there will be pumps, pipelines necessary to transport petroleum and water, powerlines, access roads, separators and storage tanks, workshops, offices, accommodation and messing facilities, rubbish disposal sites, a loading jetty and, possibly an all-weather airstrip and related infrastructure. There is little that can be done to hide the visual effects, either during construction or development, but most of the other (primary and subsequent) impacts can be minimised by judicious planning, and education of the workforce.

Facilities offshore have to be considerably more compact and risks and hazards are increased commensurately.

Whenever there is oil produced there is a risk of a major leak from pipelines, separating facilities, storage tanks or from ships. In the case of the development of offshore resources nearby islands have been developed as oil storage and/or accommodation - workshop bases to reduce costs and risks. These islands are frequently pre-existing nature reserves managed by CALM. Development operations and management plans have been mindful of the potential disturbance to the flora and fauna in and around these islands, but inevitably there has been destruction of habitats in order to build the facilities. On the other hand the presence of a staffed facility can help to ensure that damage likely to be caused by casual visitors (and their pets) in boats is minimized, since uninvited access is prohibited. Often too, a better environmental data base is acquired via regular monitoring carried out by company staff.

4.3.1 Sources of marine petroleum pollution

An estimate by the National Academy of Sciences (USA) (Gerlach, 1981:81) reports that marine transportation (including terminal operations and bunkering) accounted for 35% of the total input of hydrocarbons entering the oceans in 1970. Approximately half of this resulted from deliberate discharge of oily waters (flushing of tanks) and one tenth resulted from tanker accidents (i.e. 3.5% of the total input into the oceans). This is not meant to imply that such sources are of little importance. Clearly, as the recent incident involving the Exxon Valdez in Alaska shows, major oil spills from tankers can have massive and devastating impacts on the marine environment. The main point, however, is that attention must also be given to the other less obvious sources in terms of their cumulative impacts.

The International Maritime Organization (Kay, 1987) analysed reports of significant spills from ships during 1976–1985. Of the 289 incidents reported in that period, about 75% were caused by grounding, collison or contact; about 8% by operational errors whilst loading, discharging or cleaning, and about 17% were due to rough weather, fire and other causes. Geographically, 50% of the (reported) incidents were in restricted waters, 25% in ports and 25% in open sea conditions.

In some locations there is natural seepage of oil from the seabed and where this has been studied (as in the Santa Barbara Channel off California) there appear to be no harmful effects. Faunal assemblages are the same as in other areas where there is no seepage or pollution, (although individual species are different), except that there are more oil digesting organisms living off the seeps.

Hydrocarbons also return in diluted form to the earth and sea in rain. Their sources are unburnt fuels and chemical manufacturing industries.

The largest source of oil from land is via run off which goes into rivers and ultimately into the oceans. Oil can be found floating in all the seas and oceans, except in very isolated areas. In some seas (for example the Mediterranean) the concentration of tar balls is now estimated to be $500mg/m^2$ (in the near surface zone) though a global average might be around $0.1mg/m^2$.

Table 1 indicates the relative importance of the various sources.

TABLE 1
Input of Petroleum Hydrocarbons in the Global Marine Environment

Source	Input Rate (million metric ton/year) Best Estimate	Percentage
Natural Sources		
Marine Seeps	0.2)	7.8
Sediment Erosion	0.05)	
Offshore Production	0.05	1.6
Transportation		
Tanker Operations	0.7)	
Dry docking	0.03)	
Marine Terminals	0.02)	45.9
Bilge and Fuel Oils	0.3)	
Tanker Accidents	0.4)	
Non-Tanker Accidents	0.02)	
Atmosphere	0.3	9.3
Municipal and Industrial Wastes and Run-off		
Refineries	0.15)	
Municipal Wastes	0.7)	
Non-Refining Industrial Wastes	0.2)	35.6
Urban Run-off	0.03)	
River Run-off	0.04)	
Ocean Dumping	0.02)	
TOTAL	3.2	

APEA, 1989 (adapted from Goodman, 1985)

4.3.2 Oil on the Surface of the Ocean

The fate of oil on the surface of the ocean depends on many factors which relate back to its composition, and the prevailing conditions at the time of the spill, (Gerlach (1981) and Kagi et al., 1988).

1. Spread: light oils spread faster than heavy ones. The magnitude of the spill has an impact on the performance of the slick - larger ones are more likely to overload the dispersive capacities of the water body and a more persistent record of the event is likely.

   Australian 'crudes' are considered to be much lighter and more volatile than oils derived from the Middle East or the North Sea, therefore their effects could spread from the scene of an accident more quickly. However, degradation of over 80% within six hours

has been reported from some Western Australian crude oils (Le Provost, Semeniuk and Chalmer, 1988c)

Under still conditions hydrocarbons spread rapidly on water to give a thin even layer in a circular pattern. This is modified by wind, waves and currents – the shape is irregular and the thickness may be uneven (from microns to several mm in windrows, and at the leading edge of a slick). A slick moves under the influence of wind at 2–4% of the wind speed when winds are between 20–35 km/hr, largely independently of the oil viscosity (unless it is a tarry, semi-solid material). At wind speeds above 35 km/hr the onset of whitecaps changes its mode of movement. Slicks also move under the influence of currents at a rate of about 60% of their speed. Thus the resultant slick movement is a vector sum of the two influences.

The accurate prediction of the movement of an oil slick is vital to the success of any contingency plan or cleanup operation.

2. Evaporation: loss by evaporation is approximately 100 times faster than by dissolution into the water of even the most soluble aromatics, and is strongest during the first few hours after a spill. Spilt oil can only catch fire in the first hour, after which all of the readily available volatiles have evaporated. However, the total weathering process takes months or years and eventually leads to more viscous or tar-like clumps. The process is temperature dependent. When cold only a small quantity evaporates. In Australia's relatively warm waters (especially off the north west coast) the evaporative effect is probably the major one to account for the eventual dispersion of the spill*. Wave activity promotes vapourisation, but also leads to more water-in-oil emulsions. The onset of white capping results in much higher evaporation due to the agitation leading to increased air turbulence and increased surface area of the spill. Oil which is no longer on the surface (as in an emulsion) can no longer vaporise.

3. Dissolution: depends on the number of carbon atoms in the compound. The situation is more complicated when there is a complex mixture of different compounds.

4. Emulsification: water can be absorbed by the oil under the combined physical effects of wind, wave and spray. Up to 80% by weight of the oil can be absorbed water, to form an effect called 'chocolate mousse'. It then breaks up into smaller clumps. As well, oil-in-water emulsions (or dispersions) can form. Neither of these two effects helps to remove oil from the water mass, and its poisonous effects persist.

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* However, oil which evaporates from the sea will exist as a diluted atmospheric pollutant until it falls with rain somewhere else.

5. Biodegradation: when oil is decomposed by ultra-violet light, oxidation takes place and forms water soluble fatty acids and fatty alcohols which are more easily biodegraded than the original hydrocarbons. Many strains of fungi and bacteria, as well as some algae have the ability to biodegrade. Most are found in areas that suffer regularly from oil pollution and are rare in uncontaminated water. In the event of a spill it takes a while for their numbers to increase. For biodegradation to occur nitrogen, oxygen and other nutrients are required. Because the amount of the latter in clear tropical waters is lower than in estuaries and coastal waters, it takes longer for the process to occur in the former. Microbial degradation can only begin to occur once the poisonous volatiles have evaporated. Degradation can be encouraged if the oil is dispersed finely as droplets throughout the water. This can be achieved by the use of low toxicity biodegradable chemical dispersants on the oil slick, also, many organisms that biodegrade oil release compounds that act as natural dispersants. Refined products (light distillates and petrol) weather rapidly and leave minimal residues, but the heavier fractions weather to tarry clumps.

6. Sinking: the level of particulates in the water (inorganic, organic and micro-organisms) affect the oil: adsorption onto particles aids in dispersion of oil and may lead to sedimention. Ingestion by micro-organisms will enhance microbial attack, and lead to excretion in changed form and thence sedimentation. Examples are life forms which use calcareous shells as a base, which may attach to oil clumps and sink; and filter feeding plankton which ingest fine oil droplets, the excretment balls of which sink to the bottom, taking with them the oil.

7. Beaching: oil can easily get worked into beach sands, (more so if dispersants have been used), and may persist under the sand where conditions turn anaerobic. Oil has been predicted to seep out as fresh wellings, up to over 150 years (Gerlach, 1981:78) after the initial impact.

4.3.3 Effects of Oil on Marine Environments

There are so many factors that affect the outcome that it is difficult to generalise, and many studies have looked only at rates of mortality rather than more subtle effects which may ultimately have just as much of an impact.

According to Thorhaug (1987), the effects of pollution are far more severe on tropical than on temperate organisms. At the same concentrations the effect is greater on critical tropical habitat

species, and as well natural restoration takes at least an order of magnitude longer than in temperate systems. The implications of this are that policies, regulations and management plans developed for the temperate zone cannot be transplanted in toto to tropical systems.

Most damage is done when oil is driven onto the shore. Depending on its configuration the shore may be regarded as low, medium or high sensitivity. Least vulnerable are rocky exposed headlands and sheer cliffs as they have minimal horizontal areas and are usually exposed to high energy wave action. They are usually less hospitable to colonisation by plants and animals. Mangroves are the most vulnerable. There are still no signs of recovery, for example, in an area of mangroves off Tanzania's Dar es Salaam destroyed in 1981 by a single oil spill (UNEP, 1988:12). Salt marshes are biologically productive areas also, and being flat, are assigned a high sensitivity as well.

The vulnerability of sandy shorelines depends on the grain size, the strength of wave action and the degree of shelter, level of colonisation by biota and degree of rocky outcrops. Coarse sands are worse as oil can penetrate them more easily. In rocky areas with tidal pools where oil may remain for some time if wave action is slight, there is likely to be considerable destruction of flora and fauna.

The risk in a marine community is that major shifts in dominance in an ecosystem of a particular species may occur. For example, massive regrowth of kelp off Baja California because the kelp browsers had been killed off by a spill, and increases in algal cover due to limpet populations being decimated at Milford Haven after the Torrey Canyon spill.

The sensitivity of organisms in the environment can vary quite dramatically, both between different species and within one species at different stages in its life cycle. Eggs and larvae are particularly susceptible because they float at the surface and are unable (unlike their mobile parents) to avoid an oil slick.

Simulated lethal dose tests under laboratory conditions cannot take into account factors such as avoidance mechanisms, synergistic or antagonistic effects of other pollutants present and sublethal effects. These last may include the ability to detect and escape predators, to resist other forms of stress, or to seek out sexual partners (pheromone action is inhibited by the presence of hydrocarbons in seawater and it is not known whether organisms learn to adapt to this, as in the case of chronic pollution around refineries or in the Santa Barbara Channel, off California).

Oil accumulated in an organism can be passed on through several links in the food chain with bio-concentration occurring, and eventually may lead to lethal levels in predators. The filter

feeders, such as oysters, mussels and scallops will concentrate oil, and even at sublethal concentrations they will taste tainted. Thus, these fishing industries could be affected.

As well as direct effects there are indirect ones. The destruction of seagrasses, used as breeding areas or habitats by higher species is one example.

A tabulated summary of the effects of oil on shorelines, and on tropical marine habitats and populations is included as Appendix II. It provides data on the impacts on coral reefs, seagrass beds, mangroves, mudflats, sediments, birds, benthic communities, fish and mammals.

Oil dispersant mixes are usually more toxic than oil on its own, (except on mangroves where it is the opposite, Le Provost, Semeniuk and Chalmer, 1988b). Other studies have, however, been less conclusive. In tests using the medium - low toxicity dispersant Corexit 9527 (a glycol-ether based formula similar to that used in WA) to disperse oil on Rhizopora mangle in the Caribbean Basin, results were statistically indistinguishable from the control group of mangroves which were not polluted with oil (Teas et al., 1987, in Thorhaug, 1987). In a second test Corexit 9527 was mixed with Prudhoe Bay crude oil and a 50ppm solution was applied to mangroves for 24 hours. The trees did not die but 28% defoliated (Getter and Ballou 1987, in Thorhaug, 1987).

It should be noted that only one mangrove species of the 50 known worldwide has been tested for dispersant toxicity, and only with Corexit 9527 (Thorhaug, 1987). Also, relatively short exposure times (1 day or less) were used, compared to the several days or weeks expected in a real spill.

An oil spill can damage the gear used for catching or cultivating marine species. Floating equipment and fixed traps extending above the sea surface are more likely to be contaminated by floating oil, whereas submerged nets, pots, lines and bottom trawls, although usually protected, may sometimes be affected by submerged or sunken oil.

A spill can cause loss of market confidence since the public may be unwilling to buy marine produce from the region, whether or not it is actually affected. Bans on the fishing and harvesting of marine products may be imposed following a spill.

The situation is summarized by Le Provost, Semeniuk and Chalmer (1988b):

> "The scientific literature on effects of oil on marine resources ..... is often confusing and conflicting, and it is impossible to generalize about the effects of oil on tropical marine organisms, except with respect to mangroves and sea birds. For these reasons and because the effects are so dependent on local prevailing conditions it is difficult to predict the impact of an oil spill", and by White (1987):

"While it is comparatively easy to determine oil spill mortalities in a cultivated stock of known size, the situation in the case of naturally occurring species is frequently far more difficult since accurate stock assessment is impossible and any dead individuals are likely to be eaten by scavengers".

4.4 MANAGEMENT OF IMPACTS

4.4.1 Exploration in Terrestrial Conservation Reserves

An explorer is given the opportunity to take guidelines prepared by the Departments of CALM and Mines, either before or at the time an exploration permit is granted for areas which include conservation reserves. CALM requires information in advance of proposed surveys, which will show all intended traverses, access routes, campsites and details of landforms, water supplies, flora and fauna to be disturbed. Vehicles are restricted to those routes shown, at all times. The explorer must specify the timing and duration of activities and target dates for the rehabilitation of all areas to be disturbed, including how this is to be done. Any changes to the original proposals have to be communciated to CALM at least seven days in advance.

The conditions include measures to minimise the introduction of exotics and the spread of soil-borne diseases by attention to equipment hygiene; domestic animals or firearms are not permitted; and no soap, detergents, foaming agents or rubbish are allowed to be used or deposited in or near a water course or rockhole. The company (or its contractors) is not permitted to establish any camp, fuel depot, etc., without the prior approval of CALM officers, and CALM may direct the permit holder to rehabilitate specified areas (at the holder's expense) which were disturbed by previous exploration activity.

The CALM conditions require that a company and all its contractors are aware of and comply with the APEA Code of Practice as well as the relevant sections in the Conservation and Land Management Act 1984, the Bush Fires Act 1979, the Wildlife Conservation Act 1959, the Petroleum Pipelines Act 1969 and the Department of Mines Guidelines for Onshore Seismic Operations.

Details of how these conditions and clauses are translated into action are discussed in Section 4.4.2.

4.4.2. Development and Production in Terrestrial Conservation Reserves

Because of the nature of the industry, exploration may continue at the same time as development and production is underway, as on Barrow Island. As well, abandonment and restoration activities are ongoing, so that at the end of the life of a field there is no huge backlog of reparation to be tackled.

The APEA Code of Practice has guidelines similar to those which CALM have negotiated, and the salient points will be discussed here with examples drawn from Barrow and Varanus Islands, both of which are gazetted nature reserves.

1. Location: plant facilities, satellite operations, pipeline routes, offices, accommodation, roads, airstrips, borrow pits and waste disposal sites. Consideration needs to be given to whether proposed sites for the above are coincident with or near to environmentally sensitive locations. Can roads and pipelines be rationalised so as to minimise the number needed or the distances travelled? Can facilities be located on degraded land? How is waste to be disposed of and where? On Barrow Island a compromise has been reached with respect to the disposal of metal scrap (drums, unusable drill rods, pipes etc.) because of the cost of removal from the island to a suitable mainland site. It was decided to fill up suitable blind valleys with this debris, periodically covering each level with a layer of fill from the adjacent hillside. When the valley was full up the surface was contoured with banks, to reduce run off and promote vegetation growth. This is probably one of the most environmentally "expensive" operations on the island in that it is changing the topography of fairly large areas (some hectares) permanently, and habitats for flora and fauna which may be more suited to the protected conditions in a valley are being lost. It is a moot point whether this is more environmentally acceptable than dumping it at sea in a suitable location.

2. Access: should be designed to suit the anticipated type and volume of traffic, and should not obstruct natural drainage lines. To limit the need for borrow pits the guidelines suggest that steep cuts and large fills are balanced out wherever practicable. Roads have to be designed so as to minimise erosion due to run off with suitably placed spur drains and avoidance of cuts directly up or down slopes.
   Partial rehabilitation of early airstrips has occurred on Barrow Island with the regrowth of vegetation over most of the cleared area. With the heavily compacted ground on the strip it is likely that ripping of the surface prior to topsoil dressing would have encouraged more rapid regrowth.
   One problem associated with traffic is dust. This can coat vegetation quite heavily, especially on the down-wind side of roads and airstrips. As rain (to wash off dust) is

often uncommon out of season in the majority of the state it is possible that vegetation growth will be stunted for most of the year, unless the dust is washed away. There appears to be no practical solution to the dust problem. The use of salty water to dampen busy routes would be expensive on larger areas like Barrow Island, and on Varanus Island where this was tried the effect of salty water on roadside vegetation was far more severe than the dust problem, causing vegetation to scald.

On Varanus Island access by vehicles is restricted to the tracks. As well, human access is limited to certain parts to avoid damage to fragile dunes and nesting areas. As a result of effective personnel education programmes it has not been found necessary to erect physical barriers to access; a cord strung between fence droppers/star pickets suffices. This is important as it avoids the visual impact of a substantial structure and also allows the free passage of the fauna. It is also very cheap and is a good example of the value of worker education.

3. Education: personnel are screened at the stage of the job interview for their receptiveness to the concept of environmental responsibility, and upon signing on with the company they undergo a thorough briefing on environmental practices and emergency procedures (such as the handling and disposal of hazardous chemicals) so that they fully understand why it has to be done in a certain way. Importantly, for the scheme to be successful, every employee needs to be made responsible for his/her own actions, rather than allow the situation where the company assigns environmental responsibility to a separate team, which is then made accountable for the actions of the rest of the labour force.

4. Facility design: those which minimise accidents and hazards. This will be more effective if the worker education schemes are integrated into accident prevention and/or contingency plans in case of an emergency. People in the field need to know what to do if they discover a burst oil pipeline, rather than to waste time by summoning help from afar. Backup measures such as earth banks or bunding and traps across drainage courses are vital in minimising the effects of a leak or a spill and have been used to good effect in the past on Barrow Island. The use of dispersants on land is not recommended.

It may be possible to minimise visual impacts by siting appropriate facilities in hollows rather than on hilltops, where they may be visually very intrusive. Being sited in a hollow also minimises the risk of a spill escaping, if every direction from the tanks is uphill, however it also brings the spill closer to groundwater.

Some wildlife can be distracted by bright lights, so that where possible, they should be shielded from shining where they are not needed, such as in adjacent dune or beach areas. This has been incorporated into the design on Varanus Island to minimise the impact on wedgetailed shearwaters and turtles laying eggs.

On Barrow Island pipelines transporting crude from the wells to the processing facilities are not buried. Although this is visually an eyesore, the impacts associated with their burial are likely to be even higher. Laying on the surface they are less likely to be inadvertently ruptured in the event of heavy digging equipment being used in the area. Also, if there is a break the effects are immediately apparent, thus helping to minimise the loss. Aerial surveillance is an effective and rapid method of locating spills. To minimise the effect of spills, pipelines ought to be routed away from drainage systems (and environmentally sensitive areas) although they may have to cross them from time to time.

At the well head, consideration should be given to installing 'donkeys' which have minimal noise intrusion, and leaks of oil in the pumping or plumbing mechanisms should be promptly attended to before having a chance to soak into the ground.

5. Wastes: sumps need to be large enough to accept all the drilling residue from a hole as well as rainwater, and the drilling mud should be water-based or of a low toxicity where possible. Where wastes do contain toxic oils or other hazardous chemicals, disposal should be by incineration or other suitable methods. Saline cuttings, or those which are liable to oxidise into an acidic or otherwise toxic material need to be properly contained and buried. Only where the wastes contain no hazardous materials should the material be allowed to dry out in-situ, after which it is covered with the previously excavated fill, recontoured and topsoiled. If vegetation will regrow spontaneously then there is no need for artificial reseeding, provided the area is not eroded by rain in the meantime.

Produced saline formation water may constitute a high proportion of the volume extracted from the reserve and the most acceptable way to deal with this waste is via reinjection into the oil bearing formation, so that formation pressures can be maintained and oil recovery rates can be improved. However, this does mean that there needs to be a network of high pressure pipelines to return the water to ground via suitably located injection wells. As mentioned before, saline water is often more hazardous than crude oil, as it is much harder to contain and recover once it has escaped, and its effect on vegetation (which is often stressed under prevailing harsh climatic conditions) can be very destructive.

The use, control and disposal of hazardous chemicals is of increasing importance as the inventory of chemicals used by industry grows. They should only be used if less toxic options are proved unsuitable after evaluation, and the likely effects on current disposal methods of other wastes should be canvassed prior to their deployment – thus an environmentally acceptable method of disposal should be organized before they are begun to be used. Decision making authorities such as the Departments of CALM and Mines should be notified, via advance planning of these proposals.

Domestic and industrial wastes may need to be disposed of separately if there are particular items which require special disposal methods. All conventional wastes should be buried in specially designated* areas with adequate fencing to prevent wind-blown litter scatter. An incinerator to burn combustible and edible material before burial may help to reduce bulk; the design of the incinerator should ensure that combustion is efficient.

Liquid wastes should be disposed of as above, but attention also has to be given to the size of the ponds, which should be sufficient to enable filtration of liquids without surface ponding.

6. Exotics: on islands there is great importance in keeping weeds and mainland vegetation out. Islands, because of their isolation, have not been degraded to the same extent as mainland areas due to the absence of feral animals and exotic flora.

There are strict policies incorporated in all management plans to ensure that mistakes made on the mainland in these respects are not repeated on the islands. Were animals to be introduced (such as rats, cats or dogs) the indigenous wildlife, at present abundant and unafraid, could be decimated in a very short time.

Control of human impacts, such as fire and recreational activities, is also important

4.4.3 Environmental Management of Offshore Operations

(a) Monitoring

The concept of environmental monitoring is based on the fact that human activities impact on the environment and that these changes should be observed, measured and evaluated. Careful

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* Of low environmental significance and well above the water table to avoid contamination of ground and surface water.

consideration must also be given to monitoring the natural variability in the system as a background to superimposed impacts. These are known as baseline studies. A fundamental problem with data interpretation is separating observed effects (that could be due to pollution) from effects due to natural factors*.

Our understanding of the tropical marine coastal environment is generally poor when compared with the level of understanding of the cool temperate coastal marine areas (Kinsey and Ottesen, 1987). The reason is held to be related to higher priority being given to areas of high human population and investment values. Studies of the W.A. marine environment have a considerable way to go to catch up to the rapid developments which have occurred in the last decade or so.

Coral reefs and most other tropical shallow water systems are biologically diverse and very dynamic. They are subject generally to low levels of environmental stress, except for the physical stresses of storms; they appear to fluctuate considerably rather than exhibit stable ecology; they are resistant initially to outside stress but collapse easily beyond certain thresholds; and they tend to be resilient in the absence of chronic stress. These characteristics make monitoring of particular events very difficult (Kinsey and Ottesen, 1987).

Biological links, via dispersal of eggs, seeds, spores and larvae are maintained within and between ecosystems via water circulation. This is determined largely by winds, tides and ocean currents modified by islands, reefs and shoals. Recent studies are indicating that the importance of exchanges between reefs (interconnectedness) needs to be recognized as perhaps being essential to the maintenance of reef function and diversity. Thus events on one reef should not be assumed to have no effects on others and monitoring points need to be sited in order to take this into account (Kinsey and Ottesen, 1987).

The present base of knowledge on the effects of oil in tropical coastal environments is quite extensive, but inadequate in many respects. In particular there is a need for studies that will lead to a capability to predict overall community structure, response and recovery. At present this data may only be gleaned slowly from actual spill occurrences, rather than from manipulative research (Kinsey and Ottesen, 1987).

(b) Clean up procedures

When oil is spilt far enough from the coast the most appropriate response will often be confined to aerial surveillance to monitor the movement and dissipation of the oil (White, 1987).

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* In the event of a major oil spill where impacts are severe and obvious, this may not be a problem.

When an active response to a spill is considered likely to be effective, two main options are available: containment and collection via booms and skimmers, or chemical dispersal. Whilst the former would be the ideal solution, most devices so far developed will only operate satisfactorily in relatively calm conditions (White, 1987:25.3) and most are only effective for a limited range of oil types. To compound the problem, most oils spilt on the sea spread so rapidly and slicks become so fragmented that the rate at which the devices encounter oil at their slow operating speed will almost invariably be so low that collection of significant quantities will be rare in the open sea.

Using chemical dispersants to break down surface oil into small droplets to aid natural dispersion remains controversial (White 1987:25.3) despite the low toxicity of modern products. This stems mainly from the fact that the use of dispersants represents not only a deliberate introduction into the sea of an additional pollutant but can also result in increased hydrocarbon concentrations in the water which may lead to biological damage if it persists enough. Thus the potential for dilution is a key factor in deciding whether dispersants should be used without risking undue damage. In shallow waters close to the shore where water exchange is poor, high concentrations may persist for long periods. Because of the relatively unknown effects of dispersants on marine life most cleanup policies minimise their use.

An important limitation of dispersants is their ineffectiveness against viscous oils and water-in-oil emulsions (mousse). Since most crude oils spilled at sea rapidly become untreatable by dispersants through evaporation of the lighter components, fast, accurate response and high treatment rates are essential (White, 1987:25.4). It is necessary also to counter the rapid spread of a slick. For these reasons the aerial application of concentrated dispersants is now commonly considered to be the most cost-effective response for large offshore spills, although vessels remain more suited to dealing with small spills close to shore.

Very little testing has been carried out on Australian marine species and there is no national list of approved dispersants. In W.A. only those which have passed the toxicity and efficiency tests of the UK Government, the USEPA, or an authority recognised by the Western Australian EPA will be recommended by the seven member Technical Advisory Committee, which reports to the State Committee for Combating Oil Pollution. Currently, a dispersant known as '9527' is the only one in use in Western Australian waters.

Booms are mandatory for offshore drilling in the Environmentally Sensitive Localities (ESL), Immediate Protection Zone (IPZ) and the inner 22km of the Special Conditions Zone (SCZ)*. In circumstances where containment by booms is impractical the approach is to do nothing or to use

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* Defined in Jones, Field and Hancock, DCE Bulletin, No.104, 1984.

dispersants sufficiently distant from the shore, or in waters of sufficient depth to ensure considerable dilution (not favoured within 8km of a shoreline or within water 10m deep).

An approved oil spill contingency plan is a requirement for all developments.

5. LEGISLATION

5.1 INTRODUCTION

This chapter aims to identify and summarise the salient ideas incorporated in legislation relevant to the petroleum industry and appropriate to the terms of reference of this inquiry.

Petroleum exploration and development in Western Australia and its adjacent offshore areas is authorised under the:

- Petroleum Act 1967 which refers to onshore areas including islands and areas of internal waters other than those within the jurisdiction of the Petroleum (Submerged Lands) Act, 1982;

- Petroleum (Submerged Lands) Act, 1982 applying to the submerged lands of the territorial sea and in certain circumstances areas of internal waters;

- Commonwealth Petroleum (Submerged Lands) Act 1967 relating to the submerged lands of the continental shelf adjacent to Western Australia but beyond the territorial sea (this Commonwealth legislation is administered jointly by Western Australia and the Commonwealth).

These three statutes share a common mining code except that provision for pipelines is not included in the Petroleum Act but contained separately in the Petroleum Pipelines Act 1969. This common mining code relies on the basic premise that all petroleum resources of Western Australia and its adjacent submerged lands are reserved to the Crown, as is the right of access for the purpose of searching for and recovering those resources.

It also provides for a title system on a graticular base of 5 minutes of longitude by 5 minutes of latitude (these graticules referred to as blocks are approximately 78 sq km each and are individually identified by number on a series of map sheets covering the State and its adjacent areas).

5.2 PETROLEUM TITLES

5.2.1 Exploration Permits

The first of these titles is the exploration permit which is awarded on a work oriented competitive bid basis. From time to time as areas become available or interest is expressed in them the Minister for Mines releases areas of up to 200 blocks under the Petroleum Act and 400 blocks under the Petroleum (Submerged Lands) Acts and invites applications for permits over them.

In deciding the successful applicant consideration is given to the extent and appropriateness of the work program, and the applicant's technical expertise and financial ability to undertake the proposed program. By this procedure considerable control can be exercised firstly over the areas to be released and the quality of companies involved in the W.A. oil search. This procedure coupled with the high cost of petroleum exploration tends to rule out potentially fly-by-night companies and irresponsible activities.

Upon accepting an offer of an exploration permit the applicant is virtually entering into a contract with the State to explore for petroleum in accordance with the proposed program and the conditions attaching to it. Should a permittee wish to opt out of that contract it must seek the consent of the Minister to do so.

Exploration permits are granted for an initial term of 5 years under the Petroleum Act and 6 years under the Petroleum (Submerged Lands) Acts. There are subsequent rights of renewal (if the conditions of the preceding term have been fulfilled) for 5 year periods on a reducing area basis.

5.2.2 Legislative Controls on Exploration

While permits are granted subject to conditions, these are usually of a general nature in respect to environmental matters and this is because specific environmental conditions are to be applied to the actual petroleum operation to be undertaken. Under the standard directions enforced under the petroleum legislation each and every petroleum operation needs to be approved by the Mines Department before it can be commenced. A permittee would, for example, apply to conduct a seismic survey by serving notice on the Department, detailing the location of the survey lines, the method of operation and other relevant details.

It is important to note here that the authority of an exploration permit under the Petroleum Act 1967 does not extend to reserved land (including national parks and nature reserves) unless that

reserved land is proclaimed by the Governor to be Crown Land for the purposes of the Petroleum Act. Accordingly when an application to conduct a particular operation is received it is examined to ascertain if any reserved land is affected. If such is the case the authority in which the reserve is vested is consulted as is the Minister responsible for the administration of the Wildlife Conservation Act 1950. The application is ultimately referred to the Governor to decide if the reserve should be "opened" and deemed Crown Land for the purposes of the Petroleum Act.

Under the existing terms of the legislation this proclamation may be revoked by the Governor at any time.

While similar provisions in respect to reserves do not exist under the Petroleum (Submerged Lands) Act this is because at the time the system originated no marine reserves existed in our offshore areas.

5.2.3 Production Licences

Following a petroleum discovery the permittee has the right to retain it either by way of a Retention Lease if the discovery is not yet commercially viable or as a Production Licence. This important principle of the explorer being able to retain any discovery made is vital to the exploration effort particularly in the petroleum industry where the capital risk is substantial.

Production Licences are granted for 21 years with rights of renewal if need be. Presently the State legislation provides for licences to be confined to a nominated block, usually the discovery block and the 8 immediately adjoining blocks. It is likely however that the new Commonwealth system of requiring a licence only over the blocks in which the field is located will be adopted.

The directions and conditions of a licence require that approval be obtained before construction of any facilities for production are undertaken. Prior to such approval being given and indeed usually before the application for a production licence is made an environmental study is commissioned and presented to the Environmental Protection Authority for clearance.

5.2.4 Special Prospecting Authorities, Access Authorities, Scientific Investigations

While exploration is primarily undertaken by way of the previously mentioned titles, other limited exploration is enabled through:

- special prospecting authorities, designed to allow certain work (geophysical surveys) preliminary to a more permanent title being entered into and are limited in time to six months;

- access authorities which allow geophysical operations to be undertaken by a titleholder outside the boundaries of the title, generally to enable the tie into some known geophysical control; e.g. a well; and

- scientific investigations allowing limited work for the testing of new theories, techniques and equipment associated with petroleum exploration.

All of the above authorities are short term and are usually limited to the duration of the particular survey or study being undertaken.

5.2.5 Pipeline Licences

Incidental to the production of petroleum are pipeline licences. Submarine pipelines are accommodated under the Petroleum (Submerged Lands) legislation and are generally applied for by the holders of a production licence and are granted for a commensurate term. These licences authorise construction and operation of the lines in accordance with the various Australian and international standards. As pipelines are usually applied for at the same time as the production licence which they serve they are included in the overall environmental study referred to the EPA.

There is also provision for these licences to be declared "common carriers" which enables them to be used by another party for the conveyance of petroleum.

Onshore pipelines for the conveyance of naturally occurring hydrocarbons are licensed under the Petroleum Pipelines Act 1969. The definition of pipeline under this act includes storage tanks and associated facilities.

Similar to the submarine pipelines situation, onshore pipelines are usually applied for by the holder of a production title and as such are included in the environmental study and referral to the EPA.

Upon receipt of a pipeline licence application details of the route are made publicly known and are referred to local authorities and any party likely to be interested.

Pipelines which affect reserved land are required to have an easement or lease over that land from the authority responsible for the reserve. Should agreement as to an easement or lease not be reached the matter is referred to the Governor for determination.

5.3 THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

Where developments are of environmental concern, the Environmental Protection Act 1986 provides for environmental impact assessment (EIA) by means of the preparation and review of appropriate documentation.

Part IV of the Environmental Protection Act 1986 contains the head powers for the EIA process. This part of the legislation is brought into use where proposals for developments appear likely if implemented, to have a "significant effect" on the environment. In this context the terms "proposal" and "environment" are defined in the act:

> "proposal" means project, plan, programme, policy, operations, undertaking or development or change in land use, or amendment of any of the foregoing;
>
> "environment", subject to subsection 2, means living things, their physical, biological and social surroundings and interactions between all of these.

The term "significant" is not defined in the Act, but one interpretation of "environmental significance" is given in "The Environmental Protection Act 1986: A New Era in Environmental Impact Assessment in Western Australia" (Sippe, 1987) as follows:

> "Environmental significance in the EIA context is a judgment based upon the degree of acceptability of anticipated change imposed on the environment by a proposal. The degree of acceptability is conditioned by the potential to modify existing environmental systems to the point where permanent or long term instability exists or the capabilities (resilience) of a system are exceeded."

Implicit in this statement is the concept of environmental sensitivity, because sensitive areas may be more susceptible to change and less resilient than others.

The marine resources of W.A. have been mapped by the Department of Fisheries and Wildlife (Jones et al., 1984) in order to delineate environmentally sensitive areas. These areas are known to the Government and proposals for activities such as offshore drilling, production and transportation of crude oil are assessed with these in mind.

A proposal may be referred to the EPA for assessment by the proponent, by a member of the public and by the Minister for the Environment. Decision-making authorities concerned with a proposal must refer it to the EPA if it appears likely to have a significant effect on the environment.

Referral (by the proponent) can occur simply by means of a letter or via a more comprehensive document known as a Notice of Intent (NOI). This is designed to provide enough information to allow a preliminary evaluation to be made. Having determined the potential environmental significance of a proposal the EPA must then decide whether to assess the proposal and, if so, at what level. The available options are:

1. Not to further assess the proposal. This choice is reserved for proposals considered to have no significant effect on the environment.

2. Assess the proposal informally. Used where the potential impacts are likely to be of some concern. The EPA may advise and make recommendations on ways to mitigate these impacts, and may also attach conditions to such a proposal using Part V of the Act; Control of Pollution.

3. Assess the proposal formally, under Part IV of the Act. An important feature is that once a proposal is subject to formal assessment all relevant decision-making authorities are prevented from making any decisions which could have the effect of allowing the proposal to be implemented until the EIA is completed. There are currently four levels of formal assessment:

   NOI - this provides a forum for assessing proposals for which the potential impacts are not very large in extent or intensity. This form of assessment allows for the attachment of binding conditions, under Part IV of the act, to small proposals that do not require public input, although advice from other Government agencies may be sought.

   Managed NOI - this is used in the assessment of projects where the EPA considers that public review of the proposal is justified, but that the nature of the project is such that it would only be of concern to, or affect, the local community and particular interest groups. Therefore, while participation by other groups is not prohibited, opinion is sought from a targeted sector of the community only.

   NOIs may also be used to assess changes in proposals which have already undergone assessment at the higher PER or ERMP levels (see below).

   Public Environmental Report (PER) - this aims to provide a level of assessment with a public review of proposals which do not warrant the scope and comprehensiveness of an ERMP (see below). PERs are prepared in accordance with guidelines issued to the

proponent by the EPA and are usually available for an eight week public review period. Circumstances which would likely warrant the preparation of a PER might include:

- proposals where potential impacts are less complex or significant than those requiring an ERMP, but more than for an NOI or Managed NOI;

- where modifications to a proposal which has already been subjected to an ERMP are contemplated;

- where details of a proposal are already subject to public review through some other process (such as a planning process) but insufficient data on environmental matters is given; and

- proposals (by a second proponent) ancillary to one already subject to an ERMP which do not themselves require an ERMP (for example, transmission lines to an aluminum smelter).

Environmental Review and Management Programme (ERMP). These are the most comprehensive and detailed level of assessment used and are prepared pursuant to guidelines issued to the proponent by the EPA. They must contain a description of the proposal, the receiving environment and a discussion of the predicted impacts. Of particular note is the requirement to contain a management programme which must detail the unavoidable environmental impacts, propose a plan of management (including provision for research, monitoring, periodic re-assessment and reporting) and contain a commitment by the proponent to amend management in the light of ongoing monitoring results. ERMPs are available for public review and comment, normally for a period of ten weeks.

There is a right of appeal to the Minister for Environment against the EPA's decision on whether to undertake EIA and, if so, at what level. If the Minister upholds an appeal then s/he may direct the Authority accordingly, but such directions can only raise the level of assessment; either to a more full or a more public status, or both.

Public review of a proposal is mainly through written submissions to the EPA on the EIA document. Less common are public meetings and invitations to speak directly with the EPA. After the public review period the proponent is required to respond to the submissions from the public and Government agencies. The EPA then begins its assessment of the proposal, using the original documentation on the proposal as well as the public submissions and the proponent's response to them. Upon completion of its assessment the EPA submits a report and

recommendations on the proposal to the Minister for Environment, who must then publish and circulate the report as soon as is reasonable. There is a general right of appeal to the Minister against the EPA's report and recommendations.

As was mentioned before a feature of the act is that once a proposal is subject to formal assessment all decision-making authorities are prevented from making any decisions that could cause or allow the proposal to be implemented until the environmental impact assessment is completed. When this has happened the Minister for Environment then becomes a joint decision-maker and negotiates with the other relevant decision-making authorities as to whether the proposal should proceed and, if so, under what conditions. These are usually drawn from the recommendations in the EPA's report and once imposed have the force of law.

If the Minister for Environment and the other decision-making authorities are in agreement, then that accord is given effect by the Minister. Otherwise the area of disagreement is resolved by referral to the Governor if another Minister is involved, or to an appeals committee whose decision is final, where no other Minister is involved. A third right of appeal is given to the proponent only against the imposed environmental conditions. This is made to an appeals committee whose decision is final.

The Minister for Environment has wide powers to ensure compliance with the imposed conditions. These include issuing orders requiring the proponent to take steps to comply and causing such steps to be taken if the need arises.

There is a strong emphasis on the management of environmental impacts associated with development proposals. Thus, proponents are usually required to prepare an environmental management programme (EMP) for submission to the EPA once formal assessment has occurred. These consolidate and expand upon the management proposals forwarded during the assessment and are not subject to public review. This procedure can be regarded as a form of staged assessment in which the major environmental questions are considered in the first stage, leaving the details to be dealt with in the EMP. An advantage of staged assessment is that public involvement is assimilated into the initial stages of proposal decision-making, thus ensuring more meaningful public participation in the assessment.

Additional environmental controls can be imposed under the Wildlife Conservation Act 1950, administered by the Department of Conservation and Land Management. Under this act all fauna are protected although this protection may be lifted. Some fauna with special needs can be given additional protection. Similarly all flora is protected by proclamation in the Government Gazette. Some flora may have additional protection; e.g. declared rare flora. To "take" rare flora on any land, ministerial approval is required.

It should be noted that in the Conservation and Land Management Act 1984 Section 4 states that ".... nothing in this Act shall derogate from the operations of the Mining Act 1978, the Petroleum Act 1967, the Petroleum (Submerged Lands) Act 1982, any other Act relating to minerals or petroleum ....". When leases are negotiated with companies for bases on island nature reserves, these leases are arranged under the Pipelines Act 1969.

6. SUMMARY OF PUBLIC SUBMISSIONS

The Committee received 27 submissions in response to its request for comments on issues relating to its terms of reference. Some of these were sought from Government agencies interstate, via invitations to comment. These were regarded as sources of information on their policies and practices, rather than submissions arguing for or against the issues raised by this Inquiry. The full list of those who offered submissions is given as Appendix IV

To recapitulate, the terms of reference are:

1. The appropriateness and feasibility of extending the principles established by the Government's policies on mineral exploration and mining in national parks and nature reserves and adapting the associated review mechanisms to petroleum exploration and development activities as they relate to terrestrial and marine conservation reserves.

2. The appropriateness of a specified depth to which reserves can extend below the surface of the earth.

3. If the above investigation reveals that mechanisms established by the Government's policies on exploration and mining cannot be successfully adapted to suit the requirements of petroleum exploration and development, then the working group should proceed to consider alternatives.

The submissions received were distributed as shown:

	Western Australian	Interstate	Total
Petroleum Industry	9	1	10
Government Organisations	3	4	7
Private Individuals	4	0	4
Non-Government Organisations*	3	0	3
Industry Consultants	3	0	3
	22	5	27

* Primarily Conservation Groups

A number of companies wrote advising of their interest in the Inquiry but said that their views had been expressed through the APEA submission, which represented the industry's collective

stance. Those companies which tendered an independent submission were in favour of promoting exploration and production in conservation areas via the multiple and sequential land use concept, but differed in the degree to which they considered these activities should be regulated, and by whom.

Conservation groups and most individual submissions were uncompromising in their opposition to any form of petroleum activity in these areas and as a consequence chose not to address the second and third terms of reference.

Because of the perceived similarity between the broader issues raised in this Inquiry and the former one on minerals, many of the arguments used to defend both sides of the debate were the same.

In reading this summary chapter it should be kept in mind that the points raised in the submissions do not necessarily correspond to the views of the Committee.

6.1 FEASIBILITY OF EXTENDING THE RECENTLY DEVELOPED PRINCIPLES ON MINERAL EXPLORATION AND MINING IN PARKS AND RESERVES TO PETROLEUM ACTIVITIES.

Almost without exception those who addressed the first term of reference thought it inappropriate to apply mining principles to petroleum, and many detailed their perceived distinctions. The distinctions raised are as follows:

Petroleum	Minerals
Occurs traditionally in one type of geological environment (sedimentary basins). Therefore the industry can specify areas in which it has no interest.	Occurs in different geological settings and therefore the industry is unable to declare areas in which it has no interest.
Strategic and economic importance to nation.	Some minerals also have strategic value.
Exploration permits are awarded by invited application on a graticular system of blocks. No fieldwork is required to secure the area.	Applications are not specifically invited and ground access is required to peg prospecting licences and mining leases.
Higher capital investment needed to produce results which have a higher level of uncertainty than for mineral exploration.	Lesser outlay for expensive and specialty equipment.
Extracted via wells from considerable depths. No major disturbance to land surface, and on-site equipment restricted to relatively unobtrusive pump at well head, plus pipeline.	Mining results in large permanent disturbance to land surface via extensive excavations using heavy machinery, resulting in large waste dumps, noise and potential dust problems.
Nothing visible need be left behind if wells are capped off below land surface, pumps and pipelines removed, and land rehabilitated.	Open cut pits and tailings left behind at cessation of operations. Not usually rehabilitated.
Does not require extensive processing facilities on site. A valved wellhead (with or without pump) connected by pipeline to the separator (which separates oil from gases and water), storage tanks, and a gas flare are all that are commonly required in the field.	Processing facilities are extensive. Usually required are crushers, separators, flotation circuits, leach tanks and ponds, and conveyors, or combinations of the above. (However a conveyor or trucks may be used to transport the ore large distances to a central processing site which may be removed from an environmentally sensitive area.)
Few toxic chemicals are used. Wastewater may be re-injected into the oil bearing formation to aid extraction of the petroleum.	Chemicals used in the processing circuits are usually environmentally hazardous and may be discharged with the tailings.
Commonly transported by pipelines which may be buried.	Reagents used in process, and the mined product usually transported by road or rail. Impacts of noise, dust, pollution.
Because the resource is found usually at considerable depths it may be possible and feasible (via angled wells) to site extraction points outside of a highly sensitive environment.	Mineral resource may be located at or near surface, or at depth (but generally shallower than oil reserves). Therefore positioning mine portal outside of environmentally sensitive area may be inapplicable (in the case of open cut resource) or at prohibitive expense.
Extraction does not result in ground subsidence.	May result in surface subsidence.
Multiple land use (such as pastoral) may be appropriate around wellheads in some areas.	Access on mining leases is restricted in the vicinity of the mine, therefore multiple use is inappropriate.
Guidelines via Code of Environmental Practice are in place, consistent with the high risk to worker safety in the event of a blow out.	Lower degree of acceptance of environmental responsibility in some sectors of the mining industry.

Conservation groups which disagreed with the application of the first term of reference did so on the grounds that any exploitative activity conducted within a park or reserve was at odds with the essential elements in recognized definitions of the functions of parks and reserves, listed as:

. conservation of species, maintenance of gene pool;

- recreation;
- scientific research and education;
- conservation of geological and historic sites;
- areas free from exploitation.

These submissions maintained that there should be greater recognition of the value of national parks and nature reserves to a highly urbanised society, such as exists in this State. One submission made the point that, despite the Government's endorsement of IUCN and CONCOM definitions of national parks*, it had downplayed these in favour of economic development above all else. The submission emphasised that the above definitions embrace the concept of sustainable development, and that mining and petroleum production do not fit into this category because the resources are not renewable and are eventually used up. Parks and reserves were still regarded as "free goods" and lacked adequate protection, management and resources to maintain ecological viability, even though the proportion of land dedicated to national parks in W.A. is only 1.8% (or 6.2% if nature reserves are included).

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* CONCOM is the acronym for 'Council of Nature Conservation Ministers'. Western Australian government departments are members of both this and the IUCN organziation and it is believed (by some groups) that the State has adopted their definitions for the purpose of national parks.

12. While impacts on land may be contained, there are no barriers to movement of pollutants at sea. Thus, even if, for example, drilling activities are prohibited within park boundaries it would be possible for toxic substances to drift into environmentally sensitive areas within the park, unless adequate buffer zones are observed. The appropriate size for a buffer zone is often difficult to estimate, as many assumptions and speculations are required. Harmful effects on marine organisms may not be immediately apparent due to the complexity of the marine ecosystem, and the interdependence of its species. As well, little is known about the natural rehabilitative capacities of its components.

13. One submission made the points that the inadequacy of present procedures, whereby the NPNCA and Department of CALM are sometimes not informed of industry work programmes in vested reserves until too late, thereby rendering ineffective the present system of imposing appropriate operating conditions on permit holders. As a consequence environmental damage from (for example) seismic exploration may occur in remote areas and, without notification to the relevant authorities it may remain undetected for months or years. Although the damage may be minor it is often so widespread that repair work is made very expensive.

14. A lack of opportunity (within the present legal framework) for the NPNCA to comment on proposals; to raise questions regarding the environmental costs and economic benefits. It was suggested that NPNCA reserves should be excluded from blocks advertised (by the Mines Department) for petroleum exploration until proposals for exploration/production have been evaluated by the EPA.

15 In contrast to general industry opinion, conservation groups wished the EPA to become more involved in the process of selection of the appropriate operating conditions than at present. It was suggested that a compilation of areas of the highest biological, landscape and wilderness values should be undertaken, then published to allow for public review and modification, if appropriate.

16. The strength of the petroleum legislation, which enables exploration to be carried out on all proclaimed Crown lands, whether or not they are vested parks or reserves was deemed inappropriate. A full inquiry into the legislation has been called for in one conservation submission to address the present perceived one sided approach to development.

17. Areas under consideration for access to exploration should be submitted for public comment before the decision is made (if it is to be permitted at all) and an environmental bond required from all permit holders.

Many submissions addressed the existing petroleum legislation and procedures and offered suggestions for their improvement. These are offered below without comment, as they will be addressed in the following Chapter.

Members of the oil industry, while professing to be generally satisfied with current policies, expressed dissatisfaction with delays in obtaining approvals for proposals. Some of the specific points drawn to the attention of the Committee are:

1. Improvements are needed to better integrate review by various Government departments, in order to reduce delays (specifically - better liaison between CALM/NPNCA and the Mines Department).

2. Some companies went further and requested that exploration and development should be controlled and coordinated by the Mines Department only, which would be responsible for preserving the interests of other Government departments and the public, and setting the conditions under which activities may be carried out (subject to appeal by the proponent). Oil companies at present respond to State and Federal legislation, but there are no guidelines for such multiple control and various requirements may conflict at times, making compliance difficult.

3. Current procedures for environmental impact assessment should be expanded to include a requirement for Government itself to carry out the process of EIA when it declares areas reserved for a single use.

4. Applications to explore or develop should be evaluated on a reserve-by-reserve basis. However, the environmental sensitivity within any one park or reserve varies, and it may be appropriate to permit petroleum activities in some parts while restricting it in others.

5. A review of the location of the State's potential petroleum reserves should be undertaken. By this means reserves in non-prospective areas may be granted immunity to exploration. For the remainder of the parks and reserves (i.e. those with potential for oil) a multiple and sequential land use policy should be adopted. The EPA should develop and make known the typical environmental operating conditions which would apply if access to the above-mentioned reserves is required by the petroleum industry.

buried natural gas pipeline from Dampier to Perth was put forward as one where rehabilitation of disturbed ground along the pipeline route has been complete.

12. Several companies pointed out the value of Australian oil to the continued high standard of living enjoyed by most citizens and warned that unless access continued to be granted to parks and reserves to explore for petroleum, the decline in Bass Strait reserves would be likely to create an unfavourable balance of payments in the near future.

13. Some submissions compared the potential impacts to marine systems by oil exploration and production with the apparently far greater damage inflicted by natural events such as cyclones. The point was made that systems are capable of recovery in a relatively short time from such events, and that by inference, so should they be in the event of lesser, human impacts.

In closing this chapter it is repeated that the opinions expressed within it do not necessarily coincide with those of the Committee.

7. DISCUSSION OF ISSUES AND RECOMMENDATIONS

Submissions from the petroleum industry were careful to point out the differences between their industry and those of the minerals sector. It is apparent that much of the general public does not appreciate such a clear distinction. Therefore, it is not surprising that many of the points raised in response to the inquiry into mineral exploration and mining in parks and reserves have arisen again.

Upon reflection, the Committee accepts that there are significant differences between the practices of the two industries. These are fully detailed in Section 6.1, but the most important differences are seen to be:

1. There need be no permanent or major disturbance to the land surface from petroleum exploration and development if rehabilitation is carried out. Mineral production, however, almost always leaves behind unfilled holes and/or tailings and waste dumps.

2. Production of crude oil does not require extensive processing facilities onsite. However, there may be considerable visual disturbance from wellhead equipment such as pumps and extensive pipelines which lead to separators and storage tanks. Few toxic chemicals are used. In contrast, the refining of minerals is usually carried out on site, requires extensive processing, and large amounts of chemicals are used and discarded.

3. The environmental impacts of petroleum exploration and development are inherently more predictable than those associated with the minerals sector given the limited number of resources that are searched for and the limited number of production techniques available in the former case when compared with the latter.

4. The financial burden involved in petroleum exploration is greater than in the case of mineral exploration and therefore there is a need for the uncertainties associated with the approval of production to be reduced as much as is possible.

5. Much Australian crude oil is won from offshore fields, necessitating that policies be developed to address activities in marine parks and reserves. So far there has been little offshore mineral activity although this may change in the near future.

Based upon the above and other less substantial considerations, the Committee concludes that:

1. There are significant differences between the potential environmental impacts of the mineral and petroleum industries.

2. The current policies on mineral exploration and mining in national parks and nature reserves are not directly transferable to the petroleum industry.

On the basis of these conclusions the Committee proceeded to develop a set of recommendations appropriate to the petroleum sector in accordance with its third term of reference.

Issues raised with respect to this term point to the area of legislation and policies, where both members of the industry and conservationists contributed suggestions to improve the existing procedures. Of particular concern was the marine environment which both groups felt is in need of more attention.

As a framework for the development of our recommendations the following key issues are discussed:

- perceptions of the general public;

- the conflict between non-sustainable and sustainable development: specifically the competition between petroleum activities and conservation and/or recreation in national parks and nature reserves;

- whether the multiple and sequential land use concept is valid for petroleum exploration or production in parks and reserves
  (a) in the terrestrial environment and
  (b) in the marine environment; and

- appropriate practices and procedures.

The second term of reference, which sought to quantify the depth to which parks and reserves should extend below the earth's surface, drew a divided response from petroleum industry members although most would prefer to regard this as an issue to be assessed on a case by case basis. We will return to this issue later.

7.1 PERCEPTIONS OF THE GENERAL PUBLIC

There is a tendency to regard any kind of exploitation within national parks and nature reserves as undesirable, even if deemed necessary. This concern has included the petroleum industry, arguably with some justification, partly because of environmentally insensitive and dangerous practices in the past. These include heavily bulldozed seismic lines left unrehabilitated to erode and blow outs of wells and drill platforms resulting in extensive oil spill damage and extreme risks to the personnel involved. Whether or not these risks and effects have diminished is important, but the public perception of whether this is so is a factor which also needs to be considered. Due to the remoteness of many of this State's petroleum provinces and despite promotion in the media to enhance the industry image, a significant proportion of the general public is unaware of the current, upgraded standards of environmental practice. Many are justifiably influenced by incidents, such as petroleum-related disasters, even when they occur outside of Australia. This is not unreasonable, given that the technology is international and human error cannot be eliminated.

Another public concern involves the profit motive, which underwrites our free market economy, although there is no intention here to single out the petroleum industry for special attention. Many businesses have dismissed work practices which add to the cost of a product as being undesirable because profitability and competitiveness are eroded. Environmental considerations have often been perceived to be in this category. An example is where seismic companies tender for contracts let by the proponent. All other things being equal a quote has to be competitive or the tender will most likely be rejected for a cheaper one. It is therefore important for both the proponent and its contractors to reach a full mutual understanding of the standard of work expected, considering the environmental sensitivity of the area, and resulting constraints on the mode of operation. This should be reflected in the quote. If this understanding and commitment is not given there is a tendency for some companies to restrict their commitment to a certain degree of "window dressing" where necessary.

With a growing recognition from people that unaddressed environmental debts will place greater burdens on our society in the future has come calls for tighter legislation, environmental monitoring and more active roles for Government agencies. Ensuring that a more responsible attitude to the environment is adopted has become a concern for many members of our community.

Self-regulation would be likely to heighten anxiety among concerned members of the public as to what constitutes an acceptable standard of practice, and even if this could be mutually agreed upon, are these standards likely to be applied in the remoter parts of WA, where most people are unlikely to go? A greater level of confrontation and uncertainty between industry members and

the general public would not further the long term interests of the petroleum industry. An example to illustrate the point was offered in one submission, in which it was argued that the industry should be allowed to self-regulate. It was claimed that environmental management plans and procedures would be of a higher standard than if Government-imposed conditions had to be met. The reality is that there is nothing to prevent individual companies from exceeding (i.e. improving upon) Government stipulations if they wish to do so. Some however, are satisfied to carry out the minimum requirements under the terms of the permit or licence, and if these standards are no longer 'state of the art' then the environment may suffer unnecessarily.

Still other companies are reluctant to depart from traditional (environmentally damaging) practices at all, and will only do so if closely supervised in the field. This may happen despite a commitment by senior management personnel to undertake environmentally responsible methods if there has been no in-house educational training to alert employees and contractors in the field to the appropriate practices.

7.2 PETROLEUM ACTIVITIES COMPETING WITH CONSERVATION IN NATIONAL PARKS AND NATURE RESERVES.

Industry and conservation group views diverge strongly over the issue of exploitation versus conservation, especially in parks and reserves. The former adopt the position that to maintain Australia's level of self-sufficiency in petroleum reserves is fundamental to our current high standard of living and therefore access to all areas to determine their potential has to be guaranteed.

Conservationists on the other hand believe that national parks and nature reserves should, by definition and by intent, be excluded from exploitative activities, regardless of their resource potential. They point to the small area of the State vested as parks and reserves with the NPNCA (6.2%), and the environmental damage which has occurred as a result of petroleum activities, even where environmental guidelines were in place. Much of the 6.2% of Western Australia vested in the NPNCA is considered unprospective for petroleum.

The Committee believes that our natural resources, such as national parks and reserves, have values that go far beyond the sphere of direct economic benefits. Nevertheless, it is worth comparing them with the economic returns to society of the State's petroleum reserves because this reason is often given to justify the search for petroleum. The balance is presently heavily in favour of the latter but we repeat that they are finite resources with a limited time left to run, while national parks and reserves, if managed appropriately, will be self-sustaining, and permanent. Thus they are capable of generating large amounts of income by the indirect multiplier effects from our growing tourist industry, provided that adequate money is spent on

protecting and managing them. Several examples world-wide show how viable a sustainable natural resource can be when developed to its full potential.

Common interests do exist between conservationists and developers. Neither faction completely dismisses the validity of the other's viewpoint, but disputes arise where there are differences of opinion as to the use to which certain areas are put.

For example, some conservation-minded people are aware of the benefits (and disadvantages)* of petroleum to our society, and rely on its continuing availability to enjoy a high standard of living. It is recognized that, under exceptional circumstances, the value of an exploitable resource such as petroleum (which must assume a strategic value when its price inevitably rises) may exceed the conservation values of part of a particular park or reserve, and that it might be appropriate to extract it under stringent conditions of operation.

On the other hand the notion that areas of the highest biological, landscape or wilderness value should be closed to exploration is one which has been conceded by members of the petroleum industry. There remains the problem of how these areas would be classified and by whom, and to this end both industry and conservation groups are anxious to have an inventory compiled. Industry members suggest that the resource potential of the areas must also be determined and conservationists are in favour of the inventory being made public. By this means areas belonging to the people of Australia could be reviewed by a wider cross section of the population, and decisions on them could be modified if necessary to reflect public opinions.

The differences between the modes of operation of the mining and petroleum industries, and their environmental impacts have been outlined elsewhere in this report. While there may be no tailings and waste dumps, the area of many oil fields is extensive. Even on some small fields, such as Barrow Island, there are several hundred producing wells and thousands of kilometres of connecting pipeline laid on the ground surface. Although the intensity of these impacts is (environmentally) relatively light, and the area can be rehabilitated when no longer needed, there can be no discounting of the visual intrusion of such developments. This may be permissible in nature reserves because animals are apparently unaffected, but this degree of aesthetic intrusion to humans in a national park may well be unacceptable to some.

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* By disadvantages we mean the increasing levels of atmospheric and marine pollution which can be attributed to the use and distribution of fossil fuels such as oil. Atmospheric emissions from power stations, industries and vehicle exhausts are a major cause of smogs and the greenhouse effect, the costs and consequences of which are rapidly becoming more apparent.

7.3 MULTIPLE AND SEQUENTIAL LAND USES FOR NATIONAL PARKS AND NATURE RESERVES.

In the context of petroleum activities in parks and reserves, this concept means that exploration and/or production is an appropriate use at certain times and places within most parks and reserves; while at the same time the primary purpose for which the area was reserved is maintained elsewhere in the park, and in rehabilitated areas once petroleum activities have ceased. This is, of course, the industry view and the Committee's attention was drawn to a number of examples where these apparently conflicting uses are said to co-exist (such as Barrow Island, an A-class nature reserve with a producing oil field occupying about 40% of the island's area).

The point made by industry members is that within any one park or reserve, not all areas have the same environmental significance. Some parts may reflect the highest conservation value while others may be of secondary conservation importance but of value as a buffer zone to protect the core from nearby developmental impacts. Consequently, petroleum companies expect to be able to continue to operate within most parks and reserves (under appropriate environmental guidelines) but would respect the general concept of the inviolability of areas of the highest conservation values within those parks. It is envisaged that drill testing of these areas might, however, be able to be carried on from outside using angled drilling methods to test prospective reservoir formations at depth.

Conservationist submissions unanimously supported a total ban on petroleum activities in parks and reserves using as their argument the IUCN and CONCOM definitions of national parks and nature reserves. Clearly these definitions were designed to exclude exploitative, non-sustainable activities such as the extraction of petroleum from national parks in particular; and with only 1.8% of the State's area so designated it would seem a reasonable expectation. If the purpose of national parks is for the conservation of species and communities and for people to visit to enjoy natural, unspoilt surroundings, then those who visit have an expectation to find these. Their enjoyment must surely be compromised if restricted from some areas or forced to share them with intrusive activities concerned with petroleum exploration or production.

In this context, it is useful to make a distinction between national parks and nature reserves. The latter are areas primarily for the conservation of species and the gene pool, rather than for human recreation. There is no expectation implied in the classification that the aesthetic qualities of the reserve need to be preserved (unlike with national parks) as long as the flora and fauna are not significantly compromised by human activities. On Barrow Island the fauna are plentiful and unafraid of humans or machinery; there is no evidence that they are disturbed or upset by the continued presence of people or the pumps, pipelines and infrastructure which comprise a producing oilfield. Indeed, as detailed in Section 6, there are beneficial impacts associated with

the human presence, namely the opportunity to implement extensive ongoing environmental studies; to eradicate unwanted imported flora and fauna; and to protect the native species from unauthorized visitors to the island.

It is important to correct the misconception in one submission, that parks and reserves can be shifted to areas of no petroleum potential. As with petroleum resources, they are where you find them and there would be little value in relocating a reserve if it were to lose its inherent biological, landscape or wilderness values in the process. Unfortunately, it is not possible to achieve a fully representative system of reserves (a Government undertaking) without including some areas which are prospective for minerals, or fossil fuels.

While in the case of terrestrial parks and reserves environmental impacts have been shown to be transient and superficial where properly regulated and managed, there would seem to be much greater difficulty in offering the same level of assurance for activities in marine areas, where the containment of pollutants is a bigger problem and where much less is known about the complex variables and interrelationships of these ecosystems. Even permitting petroleum activities outside the boundaries of marine reserves and parks needs to be cautioned because of the possibility of the drift of toxic substances into the reserved waters; unless the surrounding buffer zone is sufficiently large to allow for contingency clean up procedures to become operative and effective in the event of a major spill.

Western Australian crude oils are generally very 'light', by which is meant that they flow and spread rapidly and are volatile at ambient temperatures. In the event of a spill they are able to spread much more rapidly across the sea than other, heavier oils. A significant spill could occur during exploration, production or transport phases and in anything but near calm sea and weather conditions, it is impossible to contain and recover much of this oil.

Recent offshore development has utilised nearby islands for facilities such as personnel bases, oil separating and storage facilities, workshops and airstrips. This trend appears to be increasing as more fields are developed and infrastructure is required. Many of the islands are vested in the NPNCA as nature reserves, because they contain a diversity of flora and fauna not matched by areas on the mainland, as a consequence of their isolation, until recently, from European influences and from the depredations of introduced animals and plants. The conservation values of these island nature reserves are therefore extremely high.

Most of these islands are very small and the impacts of such developments are quite significant, even when every attempt is made to minimise them. For example, it is inevitable that many Wedgetailed Shearwater nesting sites are destroyed when dunes are levelled to make way for

storage tanks. There are also risks to the environment from accidental spills and from dust-reducing measures on the island roads (where, for example, salt water may be used).

Notwithstanding the potential beneficial effects of having a permanent base on these islands; the Committee is concerned at the incremental level of usage of these island reserves and very importantly, whether rehabilitation measures will be carried out successfully at the end of operations. How long can a company 'mothball' operations, in the event of an uneconomic production climate, before it should be considered to have been abandoned for good, and will there be sufficient funds available to remove all hardware and rehabilitate the ground surface?

7.4 RECOMMENDATIONS

The Committee clearly stated earlier in the report that it recognises significant differences between operations in the mining and petroleum industries. There are also areas of similarity, and it is seen as desirable that a consistent approach be adopted wherever possible.

There is a need for the IUCN criteria for national parks and nature reserves to be complied with so far as is expedient. There is also a need to continue to implement the Environmental Protection Authority's Red Book recommendations (EPA 1975, 1976, 1980, 1983) for proposed conservation areas. This is necessary if a representative system of parks and reserves is to be secured for WA.

It has been argued (Committee on Exploration and Mining in National Parks and Nature Reserves, 1986:61) that there is little point in securing any new national parks or nature reserves, because insufficient resources are available to effectively manage them. However, the act of establishing a park or reserve provides a level of protection considerably greater than would otherwise exist, independent of a management presence in the field.

If restrictions on access to existing parks and reserves are too severe then the reaction against them would militate against the acquisition of proposed new areas. Thus a flexible approach needs to be adopted, which will allow the creation of new conservation areas as well as selectively permit access to national parks and nature reserves. The proposed approach would not enable broad-scale access to parks and reserves, nor would it condone extensive ground-disturbing activities within them. The general objective would be to reserve areas of the highest biological, landscape or wilderness values (the core areas of a national park or nature reserve) from any interference, whilst permitting closely controlled, environmentally acceptable practices elsewhere.

In consideration of these issues, and bearing in mind the important differences between the petroleum and mineral sectors, together with the particular problems associated with exploration within marine areas; the Committee makes the following recommendations:

RECOMMENDATION ONE

1. **The Committee believes that the protection afforded to terrestrial national parks and nature reserves by the petroleum and environmental protection legislative systems is greater than that which was available under the minerals system. Similarly it recognises the relatively benign nature of petroleum exploration and development operations when compared with mineral exploration and development. It also acknowledges that the weather window for petroleum operations in the north of the State (the area of greatest activity) limits exploration and that because of the relative shortness of Parliamentary sessions a need to obtain Parliamentary consent for entry into national parks and nature reserves would unnecessarily further impede the search for oil. In this regard the Committee considers that the Government's policies applicable to mineral exploration and mining in national parks and nature reserves, particularly the requirement for Parliament to decide access into these areas, are not appropriate nor feasible for petroleum operations. The Committee therefore recommends that the policies not be applied to petroleum exploration and production in terrestrial conservation reserves.**

RECOMMENDATION TWO

2. **As an alternative policy, the Committee recommends that the existing procedures under the petroleum and environmental protection legislation be tightened as follows:**

2.1 **That terrestrial national parks and nature reserves remain closed to petroleum exploration and development (as provided for under Section 15 of the Petroleum Act 1967) unless specifically opened in whole or in part according to the procedures outlined in this report. This recommendation does not prevent the granting of an exploration permit over a national park or nature reserve but the area remains closed until the appropriate procedures are undertaken.**

2.2 **Areas fully approved for reservation as national parks or nature reserves by Government should be treated administratively as if they were so reserved, once agreement as to their boundaries has been approved by Cabinet. In the interim, relevant proposals should continue to be referred to the Environmental Protection Authority under its legislation.**

These recommendations are in effect extending, for terrestrial parks and reserves, the provision presently contained in the Petroleum Act 1967 whereby the Governor can proclaim reserved

Crown land to be Crown land for the purposes of petroleum exploration and production, and thereby permit access to that land.

In the report of the Committee on Exploration and Mining in National Parks and Nature Reserves it was recommended that there should be a level of access to reserved land that would not need to be considered by means of the proposed procedures; this level was referred to as a "geoscientific survey". A geoscientific survey permit was envisaged to apply only to those activities that would not result in ground disturbance. An examination of the Petroleum Act 1967 reveals that there are three possible candidates for a similar simplified access authority; i.e. special prospecting authorities, access authorities and consents to undertake scientific investigations. However, since the activities permitted by such authorities would in general involve seismic survey work and therefore cause ground disturbance the Committee believes that there should be no exceptions made to Recommendation 2.1.

Turning to the marine situation, the Committee's research and deliberations have led to the identification of two important distinctions between onshore and offshore exploration and development of petroleum resources:

1. The understanding of marine ecosystems and the impacts of the exploitation of petroleum on such systems is not as advanced as in the onshore situation.

2. The nature of the marine environment ensures that the extent of environmental harm that could result from , for example, an oil spill (mention need only be made of the Exxon Valdez) may be much larger than in the onshore case.

In view of these factors the Committee has concluded that the environmental risks associated with petroleum exploration in marine conservation reserves are too high to be permitted and therefore makes the following recommendation.

2.3 That marine parks, marine nature reserves and other marine conservation reserves (including any island parks and reserves contained therein) be closed to petroleum exploration and development activities. This prohibition would not extend to the undertaking of seismic operations within the boundaries of the conservation area where this could be shown to be necessary to the interpretation of geological structures in areas outside, but adjacent to the boundary of the conservation reserve, provided that approved equipment were used, and appropriate conditions were observed. These would be approved under a special prospecting authority issued by the Minister of Mines, with the concurrence of the Minister for Conservation and Land Management. Furthermore, this prohibition would not

extend to existing petroleum tenements which would be subject to the normal provisions of the Environmental Protection Act 1986, the Petroleum Act 1967, and the Petroleum (Submerged Lands) Act 1982.

In making this recommendation the Committee is aware that its implementation may militate against the declaration of additional urgently needed reserves as was mentioned earlier in a more general context. However, the Committee views the particular case of offshore parks and reserves as distinct because of the nature of the environmental risks involved. In view of the early stage that W.A. is in so far as the development of a representative system of marine conservation reserves is concerned, it is imperative that this recommendation does not act to prevent the attainment of such a reserve system. To this end the Committee makes the following further recommendations.

2.4 The advertising of areas for the granting of petroleum tenements in the maritime areas in the vicinity of the potential marine conservaion reserves designated in Figure 2 should not occur until more precise boundaries have been defined and the contained areas reserved. This process should occur over a 12 month period in two stages; the first of which would define interim boundaries which would hold until the completion of the reservation. The final boundaries should be chosen so as to include an adequate buffer zone to ensure that any threatening pollution can be dealt with before contaminating the core area.

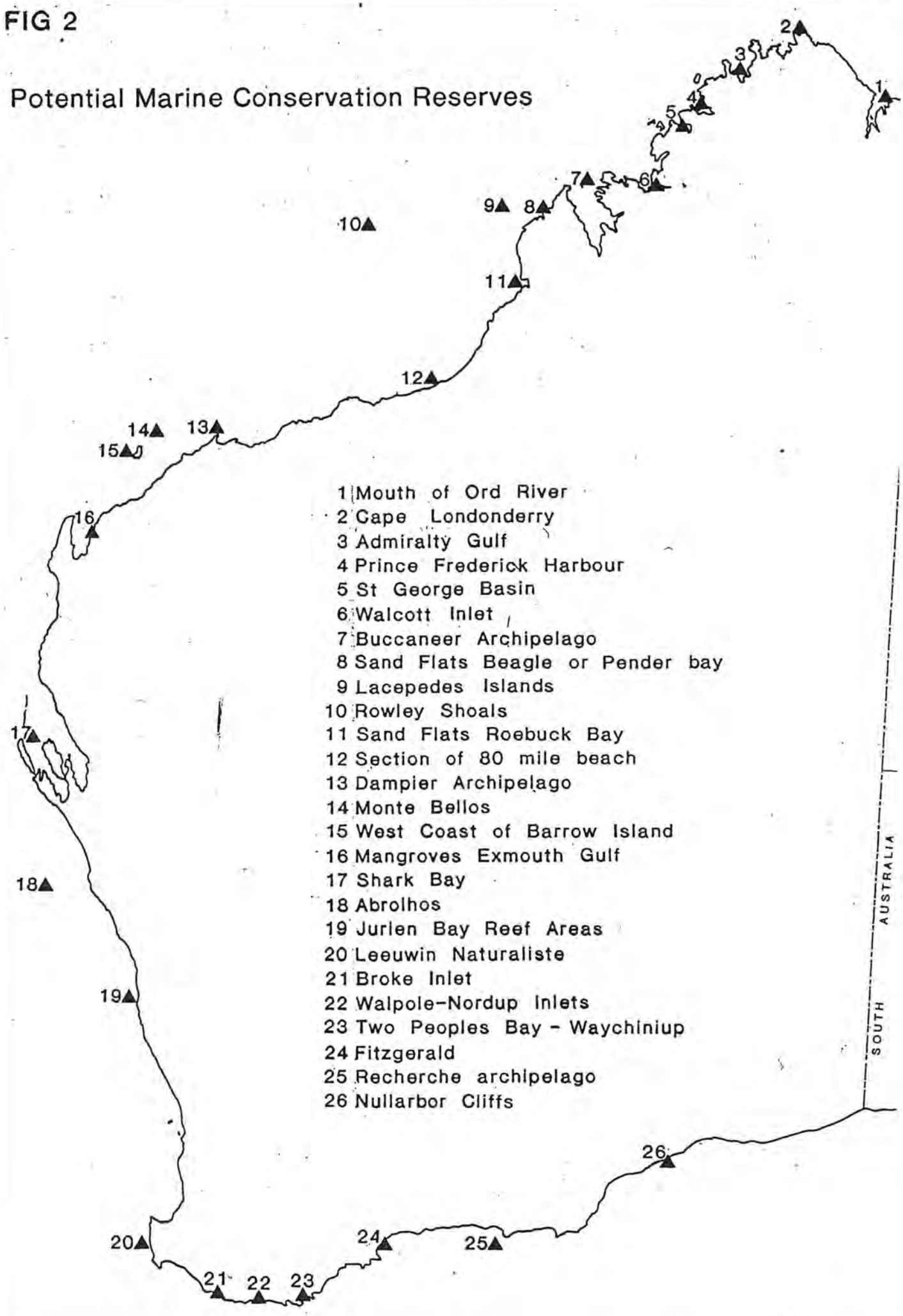
2.5 A committee comprising the Department of Conservation and Land Management, Department of Mines and the Environmental Protection Authority should be established to undertake the boundary definition of core and buffer zone areas referred to in Recommendation 2.4 as a priority.

While not formally recommending that the petroleum industry contribute to the funding of this boundary definition, it would clearly be in their interest to see that the work is completed as expeditiously as possible.

Related to the exploitation of offshore resources is the issue of the use of island conservation reserves for the construction of associated facilities. Such situations may arise where the petroleum resource itself is not contained within or under a marine conservation reserve and is therefore not covered by Recommendation 2.3. It is the Committee's opinion that the use of islands in this way, while not necessarily being inappropriate in that environmental risks can be reduced by so doing, should be minimized, and therefore makes the following recommendation.

FIG 2

Potential Marine Conservation Reserves



2.6 The Government should require the petroleum industry to share wherever practicable infrastructure, facilities and islands so as to minimise the use of island parks and nature reserves (by, for example, leasing an island to more than one company or, where feasible, relocating to the mainland).

In the above Recommendations the Committee referred to procedures for the opening of a terrestrial park or reserve to petroleum exploration and development; these procedures are now considered.

To reassure the public that their inheritance of the State's national parks and nature reserves is made secure against increasing developmental pressures it is necessary to establish more rigorous procedures for granting access for exploration and production in conservation lands. These should be designed to ensure that the advantages and disadvantages of permitting an exploration or development programme to proceed are adequately and explicitly considered, for the benefit of both the petroleum company and the general community.

We have already referred to two important distinctions between the petroleum and mineral sectors that relate to the expense involved in exploration activity and the greater predictability associated with the development of petroleum resources leading to a greater predictability of the consequential environmental impacts at an early stage. The Committee is of the opinion that an appropriate policy level response to these factors is to require fewer procedural requirements in the case of petroleum exploration. In the place of the corresponding sections from the Government's policy on exploration and mining in national parks and nature reserves the following are recommended.

2.7 If the proponent believes that access into a particular terrestrial national park or nature reserve or part thereof is necessary for the purpose of petroleum exploration or development then it should refer the proposal to the Department of Mines, which in turn should refer it to the Department of Conservation and Land Management and the Environmental Protection Authority. The environmental acceptability of the proposal should then be determined by the Environmental Protection Authority under the provisions of its Act, after full consultation with interested parties.

2.8 In reporting to Government the Environmental Protection Authority may recommend:

- **that the area in question not be proclaimed Crown Land for the purposes of the Petroleum Act 1967 if it is demonstrated to be a core area of the highest biological, landscape or wilderness value; or**

- **that the areas in question be proclaimed Crown Land under the Petroleum Act 1967 and declared open for access by the proponent only for the duration of that proposal, subject to appropriate conditions; or**

- **that the area in question be removed from the national park and nature reserve system if it is considered to be sufficiently degraded that it no longer contributes to the reserve's values.**

2.9 The Environmental Protection Authority, Department of Conservation and Land Management and Department of Mines should prepare a set of guidelines to aid in the identification and management of significant environmental impacts which would need to be referred to the Environmental Protection Authority for assessment under the provisions of the Environmental Protection Act 1986.

The system of A, B and C-class nature reserves is currently under review, with the objective of removing the second and third classes. Existing B and C-class reserves are being assessed for elevation to A-class status or for relinquishment. Irrespective as to whether this process continues to completion or not, the Committee is of the opinion that its recommendations should apply to all nature reserves (and national parks) no matter how classified.

An option which may in some cases reduce conflict between petroleum and conservation interests is boundary modification of the park or reserve. While it is not intended that this be seen simply as a convenient option it is true that many boundaries follow cadastral lines and may not reflect natural landforms or divisions. In some cases the boundaries may even militate against efficient park management and compromise the integrity or representativeness of the ecosystem. If modifications can reduce these problems and at the same time enable petroleum interests to be accommodated then there is a strong case to be put for their implementation. However, it is important that boundaries are not changed if the core or surrounding buffer zones within the park will be compromised as a result.

The Government has undertaken to rationalise park and reserve boundaries in its policy document entitled "Mining and the Environment: Balancing the Scales". It would be expedient to consider boundary rationalisation where a proponent has applied to have a park or reserve opened for exploration, as in the scenario discussed above. In this case the boundaries should be studied to assess whether or not they accurately reflect ecological criteria and topographic domains. In the

process it might be possible to adjust boundaries to also avoid highly prospective areas and in this way effect a satisfying solution to both sets of requirements.

In the debate concerning the depth to which a park or reserve should extend there were widely divergent opinions. The main points that need to be addressed would seem to be:

1. The purpose of setting a depth.

2. Should there be a specified depth common to all reserves?

If protection is to be given a park or reserve at surface, then it follows that the same level of security needs to be extended to areas below surface in order to protect the habitats of burrowing animals, the root system of vegetation and the ground-water supply integral to the park, upon which its flora and fauna depend for their existence. In addition, in limestone or dolomite rock formations (in which almost all of the world's major systems of caves are found) known or potentially existing caves would need to be accorded due consideration in the setting of an appropriate depth. Caves frequently offer a specialised habitat for rare and restricted species of animals, and may become a major tourist drawcard in their own right. Drilling which penetrates a cave system could have severe impacts, such as direct damage to fragile and unique cave forms (stalagmites, stalactites, etc) and via the polluting effects of drilling fluids and muds sprayed into the cave area under high pressure.

Drillers prefer to avoid drilling cavities, as it results in difficult and unpredictable conditions, and could end in costly failure of the hole. So it would seem to be desirable from both points of view to avoid exposure to this problem by extending the depth beneath the surface to one which is sufficient to minimise the chances of such an occurrence.

The process of drilling a hole involves penetration of various rock strata. There is a chance that the critical supply of near-surface groundwater may be compromised by this activity, via the introduction under pressure of more saline water previously trapped below in a sealed aquifer.

Provided the above-mentioned is given consideration in the planning of a drilling programme there would seem to be no good reason why it should not be permitted to proceed beneath the specified depth in parks and reserves.

One submission stated that drilling should be permitted within this near-surface zone unless it could be proved that this activity would have a detrimental effect on the environment. To place the onus of proof on the managing authority is not an appropriate option as it is clearly beyond its means to gather evidence of this kind, and an inappropriate use of taxpayer's money.

Moreover, if permission were given to drill, any sub-surface damage would be unlikely to manifest itself in an immediate and direct manner above ground, and establishing any causal relationship would be very difficult.

Several depths were suggested in submissions but the main body of opinion considered that a meaningful blanket limit for all parks and reserves would be impossible to establish, given the large variation in characteristics they possess. It would be more acceptable and appropriate to set depth limits on an individual basis if drilling activities were contemplated. It may even be expedient and appropriate to revise a previously set depth limit if the results of drilling, as part of the agreed exploration programme were able to demonstrate good reasons for doing so.

Marine conservation reserves are a category where depth limits set for terrestrial parks would be inappropriate, because there is not the same critical relationship between fresh groundwater reserves and life above the sea floor. Consequently, the specified depth need only be shallow (to accommodate burrowing organisms in the top few metres of the sea bed).

In consideration of the above the Committee recommends as follows.

RECOMMENDATION THREE

3. **Terrestrial and marine parks and reserves should generally not need to extend beyond 150 metres below the natural ground surface. The specific depth should be detemined for individual cases by the Committee referred to in Recommendation 2.9.**

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GLOSSARY

TERMINOLOGY

Baseline:

The inner margin of the territorial sea (defined in special Commonwealth Gazette No. S29 (1983), where the important points are:

- the baseline follows low water line (LAT) along the coast, except where it is landward of certain straight lines enclosing indentations;
- LAT is the lowest astronomical tide (subject to revision as conditions change);
- the straight baselines enclosing fringing islands are established and a latitude and longitude assigned to each end.

Territorial Sea:

a belt of sea adjacent to the State's coast delineated on its inner margin by the baseline (defined above). The Petroleum acts have nominated a width of 3 nautical miles (5556 m). Islands which form part of WA but are located beyond the 3 mile wide territorial sea nevertheless have their own surrounding territorial sea – for example Rottnest Island.

Internal Waters:

all portions of the sea on the mainland side of the baseline. May be extensive in the case of large bays or nearshore waters within a line of fringing islands (e.g. Exmouth Gulf).

High Seas:

waters beyond the edge of the continental shelf.

Continental Shelf:

the definition used by the Convention on the Continental Shelf is 'the seabed and subsoil of submarine areas adjacent to the coast but outside the area of the territorial sea to a depth of 200 m, or, beyond that limit, to where the depth of superjacent waters admits of the exploitation of the natural resources of the said areas, and to the seabed and subsoil of similar submarine areas adjacent to the coasts of islands'. (Petroleum Div., Dept. of Mines, 1988) Thus, although the cut-off depth is traditionally 200m, if the technology exists to permit exploitation of reserves in deeper waters, then the extent of the continental shelf may be increased to accommodate these areas).

Median Line:

the line equidistant from the nearest points on respective territorial sea baselines (in the case of adjoining territories).

State Adjacent Area:

part of the territorial sea of Australia (including the territorial sea adjacent to any island forming part of WA) enclosed by the area described in Schedule 2 of the Petroleum (Submerged Lands) Act WA, and which includes:

(1) an area which, immediately prior to the commencement of this Act, was the subject of an exploration permit for petroleum under the subsisting Commonwealth 'Submerged Lands" Act, unless that area is no longer under a permit, licence or an application for a licence (in which case it ceases to be part of the adjacent area) AND

(2) is seaward of the coastline of mainland WA at mean low water and landward of the baseline (i.e. the inner limit of the territorial sea of Australia).

Parts (1) and (2) relate to areas within 'internal waters' which were claimed by the Commonwealth Government prior to the Constitutional Settlement in 1979 between the Commonwealth and State Governments (refer to Section 2.2 for details).

Location:

a block or number of blocks nominated by the permit holder or the Minister as being the discovery location, by publishing the details in the Government Gazette (no equivalent in WA Mining Act).

Secondary pipeline:

a pipe or system of pipes for conveying petroleum: (Petroleum (Submerged Lands) Act 1982, Sections 4,5,7, 36–38)

- for returning it to a natural reservoir;
- for the purpose of exploration or recovery of petroleum;
- for the purpose of being vented or flared;
- for conveying it from a well to a terminal station* without passing through another terminal station, whether the terminal station to which the petroleum is conveyed is in the adjacent area or not.

Terminal station:

a pumping station, tank station or valve station in the adjacent area declared to be a terminal station under Section 63 of the Petroleum Pipelines Act, 1969, (via declaration in the Gazette by the Minister).

Instrument:

a notice, usually in writing, which may issue from the Minister or from the committee, licensee or applicant, to the Minister over matters relating to the exploration or production of petroleum.

APPENDIX I

THE WESTERN AUSTRALIAN GOVERNMENT'S POLICY ON EXPLORATION AND MINING IN NATIONAL PARKS AND NATURE RESERVES

APPENDIX I

THE WESTERN AUSTRALIAN GOVERNMENT'S POLICY ON EXPLORATION AND MINING IN NATIONAL PARKS AND NATURE RESERVES.

Section 1

National parks and nature reserves will be closed to exploration and mining activities. This situation will remain unless a specific park or reserve has been either individually opened for the granting of an exploration licence by the process described in this document or reclassified as provided for in Section 5.

Section 2

Areas of the highest biological or landscape value should remain closed.

Section 3

Geoscientific survey work should be permitted without holding an exploration licence in national parks and reserves under permit issued by the Minister of Mines. The Minister must seek and obtain the agreement of the Minister for Conservation and Land Management. The Minister of Mines may attach appropriate conditions to a permit, or, in exceptional circumstances, refuse to issue a permit. Appropriate reports on the results of the survey should be prepared by the permit holder for the Departments of Mines, and Conservation and Land Management.

Section 4

If the Mines Department believes that a particular national park or nature reserve or part thereof is of sufficient prospectivity, then it should formally refer the proposal to open the area for the granting of exploration licences to the Environmental Protection Authority. A programme of non-destructive research should then be carried out with an inter-departmental committee, convened by the Environmental Protection Authority and including representatives of the Department of Conservation and Land Management, and Mines Department. The committee would assess the results of the research and report to the Environmental Protection Authority, which would then recommend to Government. Where a company has lodged a tenement application over a closed area, it should be required to meet the cost of the necessary research.

Section 5

In reporting to Government the Environmental Protection Authority will recommend:

- that the area in question not be declared open for the granting of exploration licences if it is considered to be of the highest biological or landscape value; or
- that the area in question be declared open for the granting of exploration licences subject to appropriate conditions but remain part of the national park or nature reserve if it is considered to be of intermediate biological and landscape value; or

- that the area in question be removed from the national park and nature reserve system if it is considered to be of low biological and landscape value.

Section 6

The following matters will be taken into account by the Environmental Protection Authority, when assessing whether or not to recommend that a national park or nature reserve or part thereof be declared open for the granting of exploration licences:

- the presence of rare or endangered species of fauna and flora, communities or habitats;
- the presence of areas of outstanding scenic or landscape value;
- the presence of significant wilderness or important wetlands;
- the presence of sites of archaeological, cultural, historic, or scientific value, or a geological monument;
- the importance of the area in terms of its role in protecting representative ecosystems;
- the particular importance of islands to nature conservation; and
- any other matter that the Environmental Protection Authority considers relevant.

Section 7

If, after receiving the advice from the Environmental Protection Authority, the Government wishes to open a national park or reserve or part thereof, then it must seek and receive the agreement of both Houses of Parliament.

Section 8

Mining leases will only be granted over national parks or nature reserves if the area concerned has previously been declared open for the granting of exploration licences or the mining lease application covers an area subject to a pre-existing exploration licence or prospecting licence.

Section 9

Existing tenements over national parks or nature reserves which were granted with a no mining condition (or those not granted) should not be considered for mining until the procedures outlined in this policy document (policies 1-8) have been completed.

Section 10

Once a park or reserve has been assessed and refused opening, a new application over the same area will not be considered within five years of the date of refusal. Provision will be made in special circumstances for an appeal to be heard against this recommendation which would require the approval of both the Mines Minister and the Minister for Conservation and Land Management, to be successful.

Section 11

Areas vested in the National Parks and Nature Conservation Authority as B or C class reserves will be individually reviewed and either:

- reclassified as a national park or nature reserve; or
- have its NPNCA vesting status removed.

Further, the review will encompass reserves vested in bodies other than the NPNCA, which are considered worthy of national park or nature reserves status.

Section 12

If an exploration licence application was lodged over a B or C class reserve before the completion of the Section 11 review, then the reserve would need to be reviewed before the application was granted.

Section 13

Areas proposed for reservation as national parks or nature reserves and fully approved by Government will be treated administratively as if they were so reserved.

Section 14

The Government will initiate a public review of the national park and nature reserve boundaries, with a view to rationalisation. The primary objective of this process will be to set ecologically sensible and manageable boundaries while maintaining the values and area of the reserve system. A secondary objective will be to avoid areas of high prospectivity wherever this can be accomplished without prejudice to the primary objective.

The Review will be undertaken by the Department of Conservation and Land Management in liaison with the Mines Department and the Environmental Protection Authority. the Review could be carried out as part of the preparation by the Department of Conservation and Land Management of a management plan for each park or reserve.

Section 15

Insofar as it relates to national parks and nature reserves the Mining Act 1978 will be amended to:

- require that exploration licences and mining leases are only granted subject to the condition that damage to the surface of the land and anything on the surface of the land (eg flora and fauna) is prevented or minimised and repaired; and
- enable the Minister for Mines to impose additional environmental conditions at any time.

Section 16

Applications for exploration licences over national parks and nature reserves and the assessment of exploration programmes will be processed according to the procedures illustrated in Figure 1.

Section 17

Applications for mining leases over national parks and nature reserves and the assessment of mining proposals will be processed according to the procedures illustrated in Figure 2.

Section 18

Reports will be prepared by the holders of mining tenements over national parks and nature reserves at appropriate intervals describing the environmental management of their activities. Such reports should be forwarded to the Mines Department, Department of Conservation and Land Management and other departments and authorities where appropriate.

Section 19

Access to national parks and nature reserves for exploration and mining activities including access for the purpose of marking out a tenement should occur under only three circumstances:

- as authorised by a geoscientific survey permit; or
- in accordance with the terms and conditions of an exploration licence; or
- in accordance with the terms and conditions of a mining lease.

Section 20

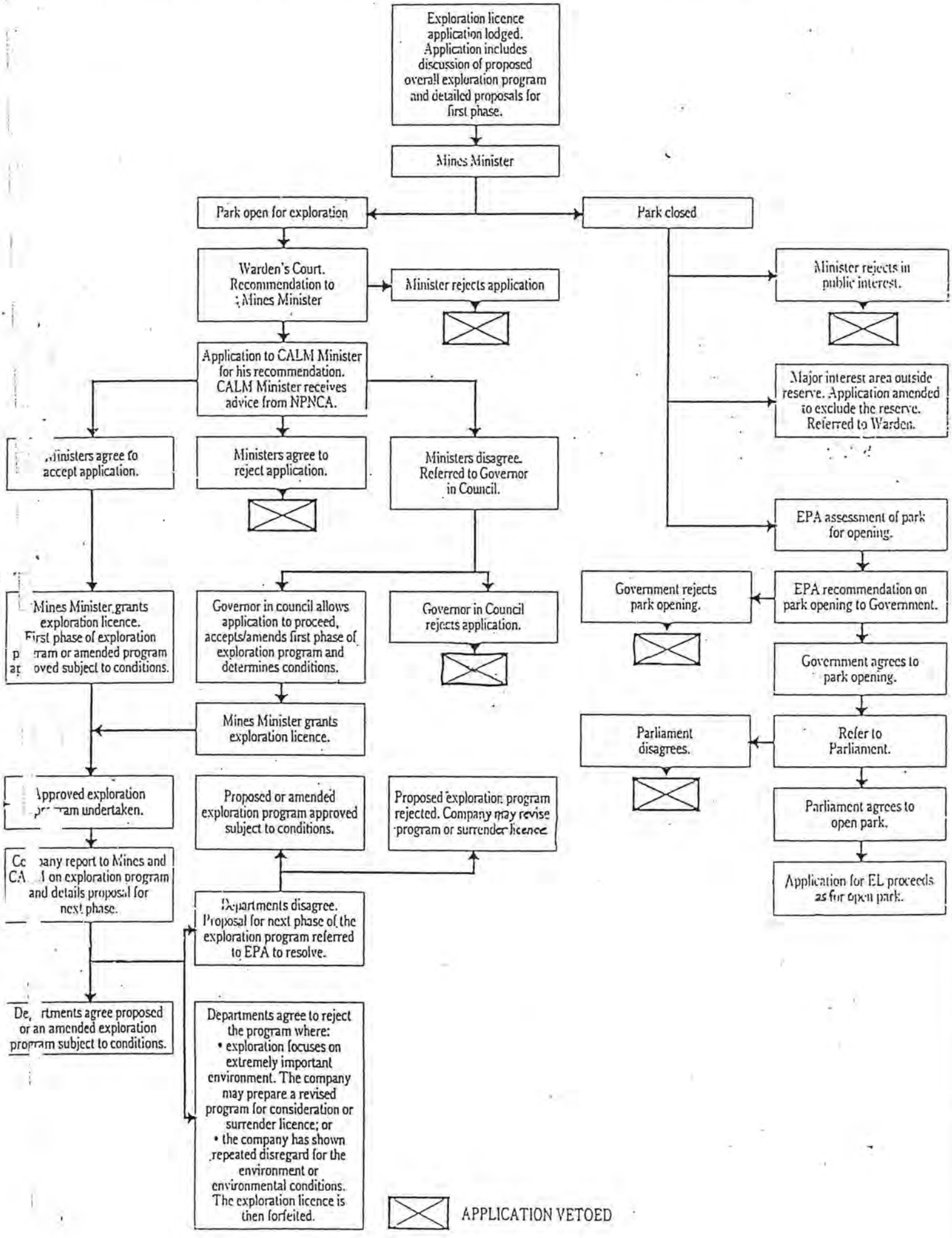
Holders of exploration licences in opened national parks or nature reserves will be required to submit to an Environmental Protection Authority review every five years. Further, the Government will examine ways of providing a mechanism to close parks and reserves to exploration after a certain period of time.

Section 21

Prospecting licence applications will be treated as exploration licence applications under this policy.

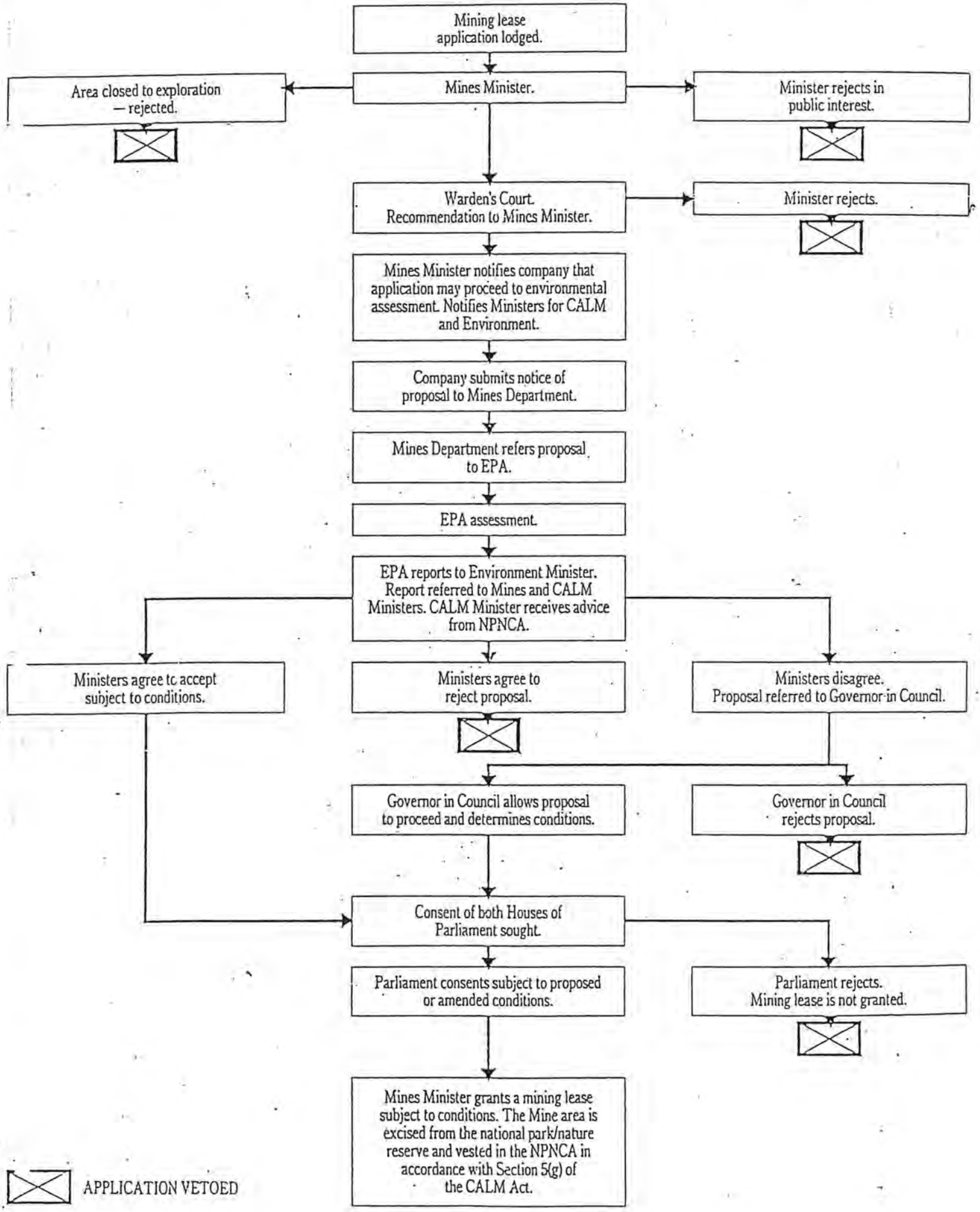
PROTECTION PLAN – EXPLORATION

FIGURE 1



PROTECTION PLAN – MINING

FIGURE 2



APPENDIX II

A SUMMARY OF THE EFFECTS OF OIL ON SHORELINES AND TROPICAL MARINE HABITATS AND POPULATIONS

APPENDIX II

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TABLE 1

A SUMMARY OF THE EFFECTS OF OIL ON SHORELINES

SHORELINE TYPE	COMMENTS	METHODS OF AND SUSCEPTIBITILTY TO CLEANUP
EXPOSED ROCKY HEADLANDS AND ERODING WAVE CUT PLATFORMS	Wave reflection will keep some oil offshore. Landed oil weathers rapidly.	No attempt should be made to clean by artificial means.
FINE-GRAINED SAND BEACHES	Light grade oils penetrate deeply. Asphalt-like pavement may develop, and persist for many years on a low energy beach. On a high energy beach oil may be weathered and removed rapidly, or buried and removed more slowly.	Depending on priority rating, beach may be left to weather naturally or, alternatively, hand or mechanical removal of oily sand may be necessary.
COARSE-GRAINED SAND BEACHES	Light grade oils can sink in rapidly and deeply. Under moderate to high wave energy, oil can be removed rapidly. Buried oil may persist in low energy beaches.	Depending on priority rating, beached oil may be left to weather naturally, or hand or mechanical removal of oily sand may be necessary.
MIXED SAND AND GRAVEL	Oil may undergo rapid penetration and burial. Under moderate to low energy conditions buried oil may persist for years. Under high energy conditions, oil can be removedrapidly.	Depending on priority rating, beached oil may be left to weather naturally, or hand or mechanical removal of oily sand may be necessary.
SHELTERED ROCKY COASTS AND SAND BEACHES	Areas of low wave energy. Oil may persist.	Allow to weather naturally. May be protected by dykes if mangroves present. Booms should be used to keep oil off shore.
MANGROVES	Extremely low energy environment. In muddy sediments little penetration of the substrate occurs. Oil is not rapidly removed and is very persistent. In sediment with a large sand component, oil may penetrate the sediments and persist for years.	Diversion of oil offshore with booms, etc. a high priority. Extremely sensitive area. May be necessary to disperce prior to landfall. Mechanical removal must not be attempted.
INTERTIDAL LIMESTONE PAVEMENT WITH OR WITHOUT SAND VENEER	Landed oil should weather rapidly. May collect in pools and be redistributed on rising tide.	Natural weathering will remove oil with time. Dispersants not recommended, will cause loss of shoreline plants and animals.

Refs: IMCO/UNEP (1892)
Healey (1987)
The International Tankers Owners Pollution Federation Ltd. (1983)

TABLE 2

A SUMMARY OF THE EFFECTS OF OIL ON TROPICAL MARINE HABITATS AND POPULATIONS

HABITAT POPULATION TYPE	DAMAGE AND TYPE OF EFFECT	RECOVERY RATES FOLLOWING DAMAGE	RELATIVE SENSITIVITY TO OIL	DISPERSANT USE
CORAL REEFS	Impacts range from no affect (particularly on corals in deep, well flushed areas) to mortality of entire assemblages in shallow water (dispersed oil). Abortion effects have been reported, direct coating is lethal and corals are expected to be highly sensitive during mass spawning.	Behavioural effects temporary. Recovery rates poorly known. Corals have been observed self cleaning after an acute exposure.	Sensitive	No dispersants in shadow (less than 10m) deep water.
SEAGRASS BEDS	Some species show short term local denuding. Dispersed oil causes severe damage to intertida organisms and produces higher sediment hydro-carbon concentrations than in undispersed areas.	Recovery may be rapid after short term impact. Retention of oil in sediments may cause long term damage.	Sensitive	No dispersant. Increases residence time of oil in sediments.
MANGROVES	Highly susceptible to even light oiling resulting in defoliation and death. Faunal mortalities leading to decrease in population density.	Recovery is slow. Estimates from 10's-100's of years to attain a mature forest. Retention of oil in sediments may cause long-term problems.	Very sensitive. Diversion of spill the highest priority.	Dispersants should not be used in the mangroves. Possible that low toxicity dispersant may be used if impact of oil is inevitable.

....cont'd

TABLE 2 (cont'd)

A SUMMARY OF THE EFFECTS OF OIL ON TROPICAL MARINE HABITATS AND POPULATIONS

HABITAT POPULATION TYPE	DAMAGE AND TYPE OF EFFECT	RECOVERY RATES FOLLOWING DAMAGE	RELATIVE SENSITIVITY TO OIL	DISPERSANT USE
INTERTIDAL MUD AND SAND FLATS	These areas support a great variety of marine flora and fauna and often are spawning or nursery grounds and fish and bird feeding areas. The above components are all highly susceptible to the impacts of oil. Turtles mating in shallow nearshore waters may be seriously affected.	Recoveries vary from rapid (mo/yr) to slow (10's of yrs) depending on the degree of oil retention and availability of recolonising species.	Sensitive	Dispersants should be avoided.
ROCKY INTERTIDAL	Little or no effect. Organisms hardy. Damage caused by coating leading to suffocation or loss of purchase on substrate.	Fast recovery. Rapid recolonisation by more species.	Low sensitivity	Dispersants not necessary.
SEABED SEDIMENTS	Vary from acute to chronic impacts. Increase in abundance of opportunistic species may occur. Offshore oil platforms may produce a 1 000m zone of effect around the platforms.	May form a sink for pollutants. Recovery rates unknown. Persistence depends on the degree of retention of oil by the sediments.	Sensitive, however oil may reach them very slowly.	Dispersed oil will reach sediments faster than undispersed oil.

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TABLE 2 (cont'd)

A SUMMARY OF THE EFFECTS OF OIL ON TROPICAL MARINE HABITATS AND POPULATIONS

HABITAT POPULATION TYPE	DAMAGE AND TYPE OF EFFECT	RECOVERY RATES FOLLOWING DAMAGE	RELATIVE SENSITIVITY TO OIL	DISPERSANT USE
OPEN WATERS	Surface dwelling organisms may suffer (birds, mammals, plankton). Sublethal to lethal effects on fish. Tainting of fish flesh may occur	Unknown. Birds severly impacted. Local breeding populations of larval fish and shellfish may take a long time to recover. Plankton is expected to recover rapidly.	Some components sensitive.	Low toxicity dispersants recommended in deep open water to prevent land fall.
BENTHIC COMMUNITIES	Mortalities lead to decrease in population density and age distributions. Change in species abundance and distrib-ution, imbalance between interacting populations.	Immigration from surrounding areas should speed up recovery.	Some components sensitive.	-
BIRDS	Very easily damaged, oiling of plumage and ingestion of oil result in large mortalities.	Damage to breeding population will cause slow recovery.	Very sensitive.	-
SANDY BEACHES	Severe impact on egg laying turtles and hatchlings, feeding and and breeding wading birds and intertidal fauna.	Recovery of fauna will depend on the time it takes for the sandy beach to be cleansed of oil. Affected breeding populations will be slow to recover.	Some components very sensitive on a seasonal basis.	Dispersants should be applied to a sandy beach. Mechanical or manual clean up methods should be used.

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TABLE 2 (cont'd)

A SUMMARY OF THE EFFECTS OF OIL ON TROPICAL MARINE HABITATS AND POPULATIONS

HABITAT POPULATION TYPE	DAMAGE AND TYPE OF EFFECT	RECOVERY RATES FOLLOWING DAMAGE	RELATIVE SENSITIVITY TO OIL	DISPERSANT USE
FISH	Possible for them to avoid spills. Mortality and tainting of flesh can occur. Greatest danger to breeding populations in confined water ways or benthic fish in heavily polluted substrates.	Fast to moderate recovery rates. Fast immigration of larvae and adults.	Moderate	Dispersants will make oil more available to the fish, however, its use may be necessary to protect higher priority habitats.
MAMMALS	Chances of impact reduced by low abundance of mammals and the ability to escape the area impacted. Conclusive evidence of death due to oil is rare. Possible effects include ingestion of oil during grooming, loss of thermal insulation and/or water-proofing and eye irritation. Indirect effects include destruction of food sources.	Slow if population is seriously affected.	Unknown	Avoid was since effects are not known.

Dicks 1984
Hyland & Schneider 1977
Thorhaug 1987
Knap 1987

APPENDIX III

LEGISLATION CONTROLLING PETROLEUM-RELATED ACTIVITIES

APPENDIX III

LEGISLATION CONTROLLING PETROLEUM RELATED ACTIVITIES

WESTERN AUSTRALIA	ADMINISTERING BODY
Petroleum Act 1923	Department of Mines
Environmental Protection Act 1986	Environmental Protection Authority
Conservation and Land Management Act 1984	Department of Conservation and Land Management
Mining Act 1978	Department of Mines
Health Act 1911	Public Health Department
Agriculture and Relation Resources Protection Act 1976	Agriculture Protection Board
Land Act 1933	Department of Lands
National Trust of Australia (WA) Act 1964	National Trust of Australia (WA)
Aboriginal Heritage Act 1972	Western Australian Museum
Aboriginal Communities Act 1979	Community Welfare Department
Parks and Reserves Act 1895	Various Boards
Plant Diseases Act 1914	Department of Agriculture
Soil and Land Conservation Act 1945	Department of Agriculture
Wildlife Conservation Act 1950	Department of Conservation and Land Mangement
Fisheries Act 1905	Department of Fisheries and Wildlife
Waterways Conservation Act 1976	Waterways Commission
Petroleum Pipelines Act 1969	Department of Mines
Explosive and Dangerous Goods	Department of Mines Act 1961
Prevention of Pollution of Waters by Oil Act 1960	Department of Marine and Harbours

APPENDIX IV

LIST OF SUBMISSIONS

APPENDIX IV

LIST OF SUBMISSIONS

1. ACF
2. AMPLA (letter only)
3. AMPOL
4. APEA
5. Australian Committee IUCN
6. Barrack Energy Ltd
7. Bond Corporation
8. Butler, W.H.
9. Conservation Commission of NT
10. Conservation Council of WA
11. Department of Environment and Planning (SA)
12. Department of Resources Development
13. Esso (letter only)
14. Fisheries Department
15. Great Barrier Reef Marine Park Authority
16. Lapp Resource Consultants
17. Lasmo (letter only)
18. LeProvost, Semenuik and Chalmer
19. Mctana Energy NL
20. Minora Resources
21. National Parks and Nature Conservation Authority
22. Dr J. Poll
23. Queensland Natural Parks and Wildlife Service
24. Ransom, A.I.
25. Robert, M.
26. Rowdon, J.

27. SANTOS

28. WAPET

29. Western Mining Corp.

30. Western Geophysical (letter only)

31. Woodside Petroleum Ltd