POINT GREY PROJECT

MALLINA HOLDINGS LTD.

Report and Recommendations
of the
Environmental Protection Authority

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i SUMMARY AND RECOMMENDATIONS

The Authority has examined the Point Grey Development Project as proposed by Mallina Holdings and described in the ERMP. It has considered issues raised in submissions from members of the public and Government agencies and has sought specialist advice regarding additional nutrient input into the estuarine ecosystem as a result of the proposed development. In addition, the Authority is aware of the revised Town Planning Scheme for the site.

The Authority considered it appropriate when assessing this project to have regard to the magnitude and time scale of the proposal and the present quality of the receiving environment. The Point Grey development is a proposal to create a new township over a period of 30 years approximately three quarters the population of Albany in an environment which is already stressed. The Peel-Harvey Estuarine System's resilience to further development pressures, especially those capable of increasing nutrient flow into the water body, is already jeopardised. These considerations are of concern to the Authority.

Currently the Environmental Review and Management Plan for Stage 2 of the management of the Peel Inlet and Harvey Estuary is nearing completion and a year-long review of the State Planning Commission's Mandurah and District Planning Study is about to commence. In addition, the Peel Harvey Conservation and Development Committee is nearing completion of a review of how best to identify and co-ordinate management of areas of high conservation value around the Peel-Harvey Estuary. These reports will provide the necessary background to determine sustainable management criteria for the estuary and surrounding lands.

At the conclusion of these activities and having received appropriate advice, the Government would be better placed to consider options for the long term environmental management of the Peel-Harvey System. Until that time it would be unwise environmentally to add significantly to existing stresses on the system when so much effort has and is being made to determine ways of reducing the impacts to an acceptable level.

The size of this proposal in an environmentally stressed area for which management options are presently under review by Government is also of concern to the Authority.

The Peel-Harvey System in which the project area is located is immensely important in a regional context in its significance as a waterbird habitat for both trans-equatorial and Australian resident waterbird species, and fish nursery area, as well as its value as an open body of water providing a valuable recreational reserve in close proximity to the Perth and Bunbury metropolitan areas.

In particular, the following potential environmental impacts associated with the project are considered to be of significance by the Authority:

(i) Nutrient Input

The project has the potential to contribute phosphorus and nitrogen into the estuarine ecosystem through the disposal of treated sewage effluent and septic tank waste from the application of fertilizers on domestic lawns and gardens, and from the leaching of agricultural fertilizer already contained in the soil.

Technical advice sought by the Authority considers phosphorus to be the most critical nutrient contributing to the deteriorating water quality of the estuary. Phosphorus can only be applied safely to soils which have an adequate absorption capacity. While the ERMP addresses the overall management of phosphorus levels in the project area, project management should also be concerned with identifying those areas which already contain high levels of leachable phosphorus that would be mobilized if disturbed. As well, areas on which phosphorus fertilizer is unsafe, and levels of applications over soils that would be fertilized should be determined.

The Authority is also concerned regarding the use of septic tanks on 'leisure living lots'; while the output from small domestic septic tanks is relatively small, the amount of phosphorus contained in the waste would be concentrated in a small area. This would result in a high application rate in a small area and phosphorus would be expected to reach groundwater within 2 years (Barrow, 1988). Phosphorus levels in the groundwater would increase over time, and may contribute towards increased nutrient loadings into the estuary.

(ii) Reserves

Open space reserves in the project area as described in the ERMP would be confined to foreshores and adjacent low lying areas. However, the proposed 50 metre reserve would not conform to a 'natural' boundary which takes into account vegetation, topography and ecosystem factors. There is a lack of open space reserve on the ridge area which contain vegetation associations otherwise not well represented within the project area and its hinterland; consequently not all flora and fauna species and their habitats would be adequately represented. The Authority believes that because of its size, the project should be viewed regionally rather than simply in terms of the project. Point Grey is the most significant topographical feature in the Peel-Harvey area, and the value of the area was recognised in the EPA's System Six Recommendations (Department of Conservation and Environment, 1983) as being worthy of major Regional Park Status, with the Peel-Harvey System at its core.

The Authority believes that a regional planning approach should be adopted, as described in its System Six Recommendation, to protect and enhance the concept of regional parks. If this proposal proceeds, many planning options would be pre-empted.

Given the long time frame of the development, the Authority considers that the ERMP does not adequately address the issue of future of reserves in the light of tidal and sea level changes from either the proposed Dawesville Channel or predicted climatic changes in relation to the 'Greenhouse Effect'. Increases in water levels associated with these events would reduce foreshore areas. Impact on wetlands and resident wildlife, in particular waterbirds, as a result of 'people pressure' including recreation activity, exotic weed invasion, domestic pets, and increased incidence of accidential fires, would be detrimental. Management conditions such as those discussed in the Authority's recommendations on Conservation and Reserves (Department of Conservation and Environment, 1983: Chapters 4 and 5) would have to be enforced to ensure protection of these areas. The integrity of Reserves is affected by the close proximity of developed areas, and the Authority considers that a suitable buffer would be required.

(iii) Environmental Amenity

The biological condition of the Peel-Harvey System would have a major influence on the environmental amenity of future residents of Point Grey, primarily in relation to macroalgal accumulations on foreshore areas as a result of nutrient enrichment of the estuary, and from mosquito populations breeding in nearby fringing salt marshes.

Macroalgal accumulations are common along the Robert Bay foreshore and to a lesser extent on the western side of Point Grey. No algal harvesting takes place there at present as the water is generally too shallow to operate harvesters, which require a minimum depth of 0.5 metres. The Peel Inlet Management Authority has insufficient resources to expand its harvesting activities and as there is at present no nearby resident population centre, there is no requirement for it. The introduction of 9 000 permanent residents associated with the project would definitely introduce a demand for algal harvesting, due to the noxious smells and beach fouling associated with decomposition of the algae. If harvesters were used, operations would be limited to the eastern side, as rocky limestone outcrops on the western side would make it difficult for harvesters and front end loaders to operate. During summer months, in particular between December to February, excessive algal growth in Robert Bay can already make boating activity, particularly rowing and sailing, difficult.

Mosquitoes are already a severe problem throughout the Peel Harvey area and their complete eradication is not possible nor desirable. Samphire areas along the Robert Bay foreshore and along man-made drains adjacent to Carrabungup Road are favoured breeding locations for mosquitoes, in particular Aedes vigilax and Aedes camptorhynchus.

Although the situation can be controlled to a certain extent through the use of chemical larvicides as is practised at present, a continuing level of nuisance would be expected if the proposed Dawesville Channel was constructed. This would cause more frequent tidal inundation of foreshore areas, which would create additional areas suitable for mosquito breeding, thereby exacerbating the mosquito nuisance.

Finally, vegetation on the eastern side of the Harvey Estuary provides a natural backdrop to waterviews enjoyed by residents in urban developments along the western shoreline of the Harvey Estuary. The Authority believes that the development of Point Grey, in particular along the western side as proposed in the amended plans, would detract from these views.

Rezoning of the land would be a necessary prerequisite to any development and the Authority has recommended that rezoning of the nature required for the proposed development not proceed on the grounds of environmental unacceptability.

The Environmental Protection Authority therefore concludes that:

- the estuarine ecosystem in which it is proposed to locate the new townsite development is already under considerable stress, and the Government is still actively considering appropriate management options;

- parts of the estuarine environment are fragile, ecologically valuable and therefore need to be adequately protected. Point Grey in particular is the most significant topographical feature in the Peel-Harvey System and attracts a conservation and landscape protection priority; and

- reduced environmental amenity would be experienced by Point Grey residents if the proposal were to proceed as proposed, including significant problems associated with macroalgal accumulations along the foreshores, contributing to odour and beach fouling and high mosquito numbers.

The Authority considers that at this time Point Grey is not suitable for a development of the scale proposed by Mallina Holdings and is unlikely to be so unless solutions are at hand which would manage environmental problems currently experienced in the area.

RECOMMENDATION 1

Given its conclusion that the Point Grey proposal as detailed in the ERMP and subsequent minor amendments is environmentally unacceptable at this time, the Environmental Protection Authority recommends that it should not proceed, and accordingly, rezoning of the land subject of the proposal should not occur.

1. INTRODUCTION

In July 1987, Mallina Holdings Ltd submitted an Environmental Review and Management Plan (ERMP) describing a proposed development scheme for Point Grey.

This proposal included:

. a college and associated residential campus;

. an 18 hole golf course;

. tourist and holiday accommodation sites;

. 3 200 single residential lots;

. 3 000 'rural residential lots'; and

. shopping, education and community infrastructure.

The development would house and accommodate approximately 9 000 people, with a staged development programme extending over a 25 to 30 year period, and would result in the establishment of a township approximately three quarters the population of Albany. The location is shown in Figure 1.

The ERMP was prepared under guidelines prepared by the EPA and released for public comment for a period of 10 weeks, ending on September 21, 1987.

This report has been prepared following consideration of both public and Government department submissions received during the public review of the ERMP, and investigations into several particular aspects of the proposal.

2. EXISTING ENVIRONMENT

2.1 SOIL AND VEGETATION

The project area is dominated by a ridge of Tamala limestone, with a capping of secondary calcite. The area is characterised by shallow grey-brown Karrakatta sands.

Vegetation is predominantly Tuart woodland and open Tuart-Jarrah-Marri forest (Department of Conservation and Environment, 1980). Approximately 66% of the site has been cleared for agriculture. Heathland vegetation is associated with rocky limestone outcrops.

2.2 NUTRIENT STATUS OF THE PEEL-HARVEY ESTUARY

Clearing for agriculture in the Peel-Harvey estuary catchment first began in 1840 on the Serpentine flats. Since the turn of the century, most of the coastal plain has been cleared for cultivation. To alleviate poor drainage and waterlogging of many of the agricultural soils, an extensive drainage network was constructed and this, in conjunction with the development of phosphatic fertilizers, has resulted in the coastal plain becoming the most important primary producing area close to Perth. Unfortunately these mechanisms of increasing agricultural productivity also resulted in large amounts of nutrients (Phosphorus and nitrogen) being leached from the soils

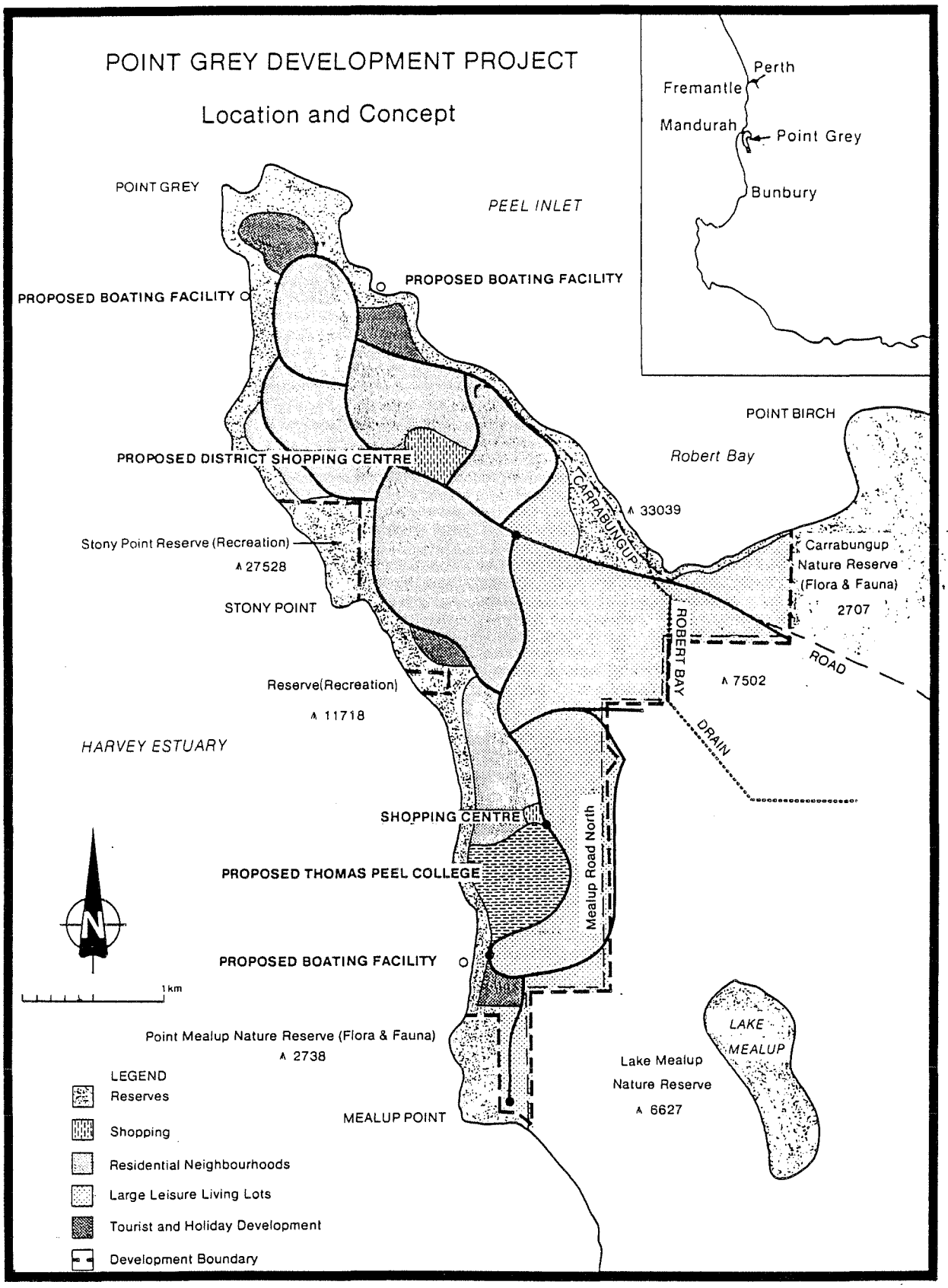


Figure 1. Revised concept plan for Proposed Point Grey Development

leached from the soils, greatly increasing nutrient loads to the Peel-Harvey Estuary System. Of these nutrients, phosphorus (P) has had the greatest impact. This has encouraged excessive algal growth, contributing to extensive loss of seagrass.

The causes and symptoms of P enrichment in the Peel-Harvey Estuary System have been the subject of a wide range of intensive investigative and monitoring programmes. These culminated in the proposal of a management strategy for the estuary and its catchment in the Stage 1 Peel Inlet and Harvey Estuary ERMP. This was considered by the EPA in 1985. The strategies and programmes endorsed by the EPA in its assessment report will be reviewed in a Stage 2 ERMP, and assessed by the EPA.

On average, farmers on the coastal plain have applied approximately 15 kg/ha P to their pastures annually since the mid 1970's. Evidence from agricultural field trials indicates that only 9 kg/ha P application is necessary on 'developed' soils. In 1983 the Department of Agriculture introduced a fertilizer management campaign to promote more cost-effective use of phosphatic fertilizers in the catchment, and also introduced a slow-release P fertilizer with CSBP. Since the implementation of the campaign, P fertilizer use on the entire catchment has been reduced by approximately 30%.

P concentration in river water, and hence P loads into the estuary, has also decreased since the introduction of the fertilizer management campaign. The variability of annual rainfall (quantity, intensity and pattern) means several years of monitoring are necessary to confidently estimate the actual reduction in P loads to the system; however, preliminary estimates indicate that this has been reduced by approximately 20 - 30%. Under present land use, P applications in the catchment cannot be further reduced without loss of productivity. Therefore without a significant change in land use, river P loads are not expected to decrease further.

Since the introduction of the fertilizer management campaign in 1983 there has been a relative decrease in actual P concentrations and loads down the Murray and Harvey Rivers, however, loads in the Serpentine River have increased. This is thought to be due to the increasing number and size of intensive agricultural industries within the Serpentine catchment due to the southerly expansion of the Perth metropolitan region (see Appendix 4). Reduction of P loss from diffuse sources has been offset by increased losses from point sources, such as horticultural gardens, piggeries, and intensive stockholding paddocks. Accumulated P in estuarine sediment has reached levels sufficient to support algal blooms in years of small P input, a condition which can be expected to continue until stores of P in the sediments have been run down. It has been estimated that a 60 - 70% reduction in P load is necessary to return the system to a healthy state.

2.3 WATER QUALITY

Studies over the last 10 years have confirmed that water quality of the Peel-Harvey Estuary System has deteriorated as a result of increased nutrient load from the surrounding catchment areas. The annual nutrient input is dependent on the quantity of river flow and the amount of P applied to the catchment. Concentrations of both phosphate-phosphorus and nitrate-nitrogen in the surface water column are higher over the winter period, leading to the inflow of nutrient-rich river water into the system. Phytoplankton biomass in the water column generally increases during late

winter as diatoms take up the incoming nutrients, and particularly during spring to early summer when the blue-green alga Nodularia spumigena blooms. During periods of high Nodularia biomass an earthy and obnoxious odour is emitted from the estuary. At this time, Nodularia scums accumulate on the foreshore and decompose, contributing to the odour problem and polluting the beaches. Nodularia blooms in Harvey Estuary have been reported since 1973, and are less severe in the Peel Inlet. Poor water quality also occurs when banks of large algae decompose in the estuary.

The fertilizer management campaign conducted by the Western Australian Department of Agriculture has resulted in a significant reduction in phosphate loss from the catchment, however, this programme alone will not reverse the chronic trophic state of the system. The situation is expected to continue as long as intensive agricultural industries within the catchment employ extensive use of fertilizers.

2.4 SYSTEM SIX AREAS AND RESERVES

2.4.1 SYSTEM RECOMMENDATION RESERVES

System Six reserves are designated or recommended to be reserves for conservation of flora and fauna or parkland. In both cases the intent of the recommendations is to protect conservation values, however parklands may have controlled access recreation in the natural setting (ie recreation activities compatible with the conservation values).

The bodies of water which lie adjacent to the project area, including the Peel Inlet, Harvey Estuary and Lakes Mealup and McLarty, are of immense conservation value and are identified in the System Six Report (Department of Conservation and Environment, 1983) as being the 'core' of a potential regional park, to be protected by planning mechanisms.

The Peel-Harvey Estuary is described in the System Six Report as 'probably the most important waterbird habitat in south-western Australia', for both trans-equatorial and Australian migrant species of waterbirds. The estuary also provides an important nursery area for commercial fish species.

Specific System Six Recommendations which lie within the project area include Reserve 27528 (C51). This is currently reserved for recreation and has not been vested. The System Six Recommendation is for the area to be reserved for parkland and vested in the Shire of Murray and ultimately be designated as part of the Regional Park referred to above. Other Reserves in Recommendation C.50 (2707 and 7502) are vested in the National Parks and Nature Conservation Authority (NPNCA) and abut the project area's north east corner.

Reference is made in the ERMP to Lake Mealup (Reserve 6627) within System Six Recommendation C52, however, this is approximately 500 m distant at its nearest point to the south east of the project area. This is also vested in the NPNCA.

2.4.2 OTHER LAND ACT RESERVES

Reserve 11718 is a gazetted recreation reserve, 4 ha in size and is located on the west side of the project area. Reserve 33039 is located in the south east corner of the project area adjacent to Carrabungup Road. This is also gazetted for recreation, and covers an area of approximately 2 ha. Reserve

2738 abuts the south west corner of the project area. This is an A Class Conservation Reserve for flora and fauna.

3. DESCRIPTION OF PROJECT

The Point Grey Project is described in the ERMP as a new residential and holiday settlement. This will cover a total area of 1 083 ha and include:

- the Thomas Peel College - a 50 ha site, which would include associated administration buildings, sports and recreation facilities and student and staff residential accommodation for approximately 1 080 people;

- residential nodes - 2 820 lots covering an area of 469 ha. Blocks would vary in size between 700 and 1 200 square metres, be serviced by reticulated water, deep sewerage and roads, and accommodate 7 200 people;

- approximately 300 special residential living lots, covering an area of 400 ha, with blocks between 1 and 1.5 ha in size. These will be serviced with septic tanks and the area will accommodate 770 people;

- tourist and Holiday accommodation sites, covering an area of 60 ha;

- an 18 hole golf course;

- shopping, education and associated community infrastructure; and

- foreshore and recreation reserves.

These are illustrated in Figure 1. A total population of 9 000 people is envisaged. 9% of the total area would be ceded to the Crown for conservation purposes.

The area considered for development is currently zoned under the Murray Town Planning Scheme as rural. In accordance with State Planning Commission guidelines, an amendment to the planning scheme would be required if the project is to proceed to rezone sections of Point Grey to Special Residential Zone, Conservation and Recreation Zone, Special Use Zone - Holiday Accommodation, Special Use Zone - College, Settlement Centre Zone, and Residential Development Zone. The amendment was subject to a public review period for 90 days, ending on November 26, 1987.

In December 1987 the plan for Point Grey was revised and amended. Although the components of proposed land uses within the project area remained unchanged, the residential component increased by 40 ha, leisure living lots decreased by 30 ha and tourist nodes and open space areas each decreased by 5 ha. The Authority considered then that environmental impacts associated with the project remained essentially the same despite alteration of the original proposal and therefore a further public review period was not considered necessary. However, the change in land use resulted in the planning amendment being opened again for public review for a further period of 28 days. The public review period ended on March 3, 1988.

4. REVIEW OF PUBLIC SUBMISSIONS

The Environmental Protection Authority received 36 submissions; 10 from State Government agencies and 26 from members of the public.

The following list is a summary of the most common issues raised.

Impact on the natural environment:

- development would have a detrimental impact on flora;
- development would have a detrimental impact on terrestrial fauna;
- development would disturb waterbirds;
- development would have a detrimental impact on other aquatic fauna eg fish;
- the proposed 50 m wide foreshore reserve will be inadequate; and
- the proposed development is an unsuitable form of land use in an already stressed ecosystem.

Impact on water quality and water resources:

- inadequate information is provided in the ERMP regarding groundwater resources;
- use of groundwater would detrimental to local wetlands;
- development would increase nutrient input into estuary;
- dredging activity would be detrimental to aquatic organisms;
- inadequate detail is given regarding the disposal of waste and sewage; and
- motor boat activity would be detrimental to the estuary and foreshore.

General comments included:

- assessment of the Point Grey ERMP should be deferred until the Stage 2 Peel-Harvey ERMP is released;
- alternative sites for the development have not been adequately considered;
- mosquito problems for nearby residents will be exacerbated by the development;
- development is contrary to System Six and other conservation reserve recommendations;
- development will lead to the degradation of the Point Grey area in terms of increased pollution, erosion, exotic weed infestation, domestic animals, pesticides, and increased off-road vehicle activity;
- changes to sea level are not adequately considered in relation to the effects of the proposed Dawesville Channel or the Greenhouse Effect;
- effect of the proposed Dawesville Channel is not adequately considered;
- mosquito control measures must be undertaken prior to development;

- natural physical features, eg caves, should be protected;

- insufficient research regarding environmental impact in general on the Point Grey area has been undertaken; and

- project will become expensive to the State Government in relation to increased maintenance of boating facilities, increased mosquito control measures and more extensive algal harvesting.

Suggestions made within the submissions include:

- width of foreshore reserve should be increased;

- conservation reserves should be better protected;

- extensive floral and faunal ecological studies should be undertaken prior to development;

- low density development should be encouraged at Point Grey;

- a land capability study should be undertaken prior to development;

- groundwater resources should be further investigated prior to development, and continuously monitored should the development proceed;

- initial and on-going management costs should be met by the proponent; and

- any development in the Point Grey area should be sympathetic to the local environment.

A summary of the frequency of response to the above issues and a complete list of issues raised in the submissions is listed in Appendix 1.

5. ENVIRONMENTAL IMPACTS

5.1 NUTRIENT INPUT

The proposed development has the potential to increase nutrient input into the estuary through:

- use of fertilizers on lawns, gardens and parks; and

- disposal of sewage treatment plant effluent, and disposal of septic tank effluent.

5.1.1. FERTILIZERS

Fertilizer application on public and private lawns, gardens, and the golf course is acknowledged in the ERMP as potentially increasing nutrient input into the estuary. The proponent plans to implement a number of public education measures to reduce the potential impact of these. These include the promotion of low P fertilizers and encouraging the planting of native plant species. Where possible, low concentration P fertilizers would be used on public parks and gardens.

5.1.2 SEWAGE DISPOSAL

P input into the estuary is proposed to be controlled primarily by the use of a tertiary treatment plant for collected sewage, thus reducing the potential P contribution into the estuary. This would be constructed in two stages an initial temporary treatment plant, and eventually the construction of a permanent plant: timing being dependent on population increases. Chemical treatment for the reduction of P would be used using either iron, aluminium or calcium salts to precipitate phosphate.

Primary and secondary sludge would be disposed of by either selling for use in compost mixes or by burial in an approved sanitary disposal site. However, no mention is made concerning disposal of the chemical sludge.

Tertiary treated effluent at the final stage of the project is estimated to be approximately 590 mega litres per year. While this treated effluent is proposed to be used for irrigating the golf course, there would be an excess of waste water over the projected golf course irrigation requirement. The ERMP states that impervious holding ponds would be used to contain this. Disposal of this excess would require more extensive reticulation of treated effluent and this is not discussed in the ERMP. The location of the golf course is not indicated in maps accompanying the ERMP. This would need to be located on relatively high ground to ensure excess water would not drain from the soil into the estuary.

Leisure living lots would be serviced by septic tanks. These are considered acceptable in the ERMP due to the low density urban development in the lots, lot sizes ranging from 1.0 to 1.5 ha. While the output from these domestic septic tanks would be relatively small, waste would be concentrated in a small area (approximately 2 square metres) and this could lead to increased P input into the estuary via contaminated groundwater.

Disposal of septic tank sludge (required every 5-7 years) is not addressed in the ERMP.

5.2 IMPACT ON CONSERVATION RESERVES AND ADJACENT WETLANDS

5.2.1 SYSTEM SIX AND OTHER RESERVES

The proximity of residential and rural residential types lots abutting the System Six Reserves would have adverse impacts unless stringent management conditions are implemented, given the predicted population levels. Impacts by fire, exotic weeds and domestic animals requires a greater amount of management effort than is practised at present, and will be expensive. The integrity of the Reserves could also be affected by the close proximity of urban areas and a suitable buffer would be required. Neither of these aspects have been addressed in the ERMP.

5.2.2 MANAGEMENT OF RESERVES

The Point Grey development would introduce a large population to the area which would have a significant impact on the conservation values of the Estuary, and in particular nearby Reserves. Carefully considered regional planning, in particular in relation to regional open space, is required.

The ERMP includes statements concerning management without specific references and techniques demonstrated. For example, buffers between residential and conservation areas are not addressed. The management of

weeds, fire and feral and introduced species is given a somewhat superficial response. Both direct impacts on conservation values and on the extra resources required by Government and other management agencies to maintain and enhance these areas in view of the increased pressures on them need to be considered.

The insect, odour and beach fouling problems currently experienced elsewhere around the Peel Harvey Estuary are not addressed. These areas include the Estuary itself and nearby wetlands within current reserves and on freehold land. For example Lakes Mealup and McLarty to the south east are probably significant mosquito breeding locations, as well as Robert Bay Drain and surrounding low lying areas.

5.2.3 ADEQUACY OF OPEN SPACE RESERVES

As previously mentioned, the Peel Inlet and Harvey Estuary constitute open space of regional significance because of their high conservation and recreation value, and close proximity to the Perth and Bunbury metropolitan regions and neighbouring districts, the main population centres in the State.

Discussion regarding regional open space and the management of Reserves in the System Six area was detailed in the Authority's recommendations on Conservation and Reserves in 1983 (Department of Conservation and Environment, 1983). The importance of public planning procedures in the form of town and country planning was emphasised, to provide for conservation of nature, and for public recreation in natural surroundings outside the system of Land Act Reserves and State Forest. The open space reserves system as described in the ERMP has been assessed within this regional context.

Open space Reserves in the proposed development would be confined to the foreshores adjoining low lying areas. While this is desirable in concept, the actual 50 m reserve does not conform to a 'natural' boundary, taking account of vegetation, topography and ecosystem factors.

There is an obvious lack of open space Reserves on the ridge area which contains vegetation associations not well represented within the project area and its hinterland. For example, the Tuart woodland, Banksia/Eucalypt woodland, Banksia over limestone, heath and swamp vegetation associations are not represented in the open space proposed in the project area or nearby Reserves. The fact that Point Grey is also the most significant topographical feature in the Peel-Harvey area is also not given adequate recognition. This deserves a high conservation and landscape protection priority.

The ERMP contains a great deal of information on the flora and fauna but does not describe their representation in the open space system. In view of the absence of Reserves on the ridge area is it is obvious that not all flora and fauna species and their habitats would be adequately protected.

In the longer term, the ERMP does not address the future of the proposed open space Reserves in view of tidal changes from the Dawesville Channel and from predicted climatic changes in relation to the Greenhouse Effect. Increases in water levels of the estuary will reduce the area of foreshore vegetation and the usable area for those recreation activities compatible with the natural vegetation areas.

There is little information on whether the proposed open spaces can accommodate use by increased numbers of people in the area.

The Authority believes that a regional planning approach should be adopted, as described in its System Six Recommendation, to protect and enhance the concept of regional parks. If this proposal proceeds, many planning options would be pre-empted.

5.3 ALGAL HARVESTING

Algal accumulations along the Coodanup, Novara and Cadadup foreshores are currently harvested by the Peel Inlet Management Authority (PIMA) using harvesters and front end loaders. No algal harvesting takes place at Point Grey at present, primarily because there are no nearby population centres. In the event of harvesters being used, they would be limited to the eastern side of Point Grey, as the western side has numerous limestone outcrops which would make the use of harvesters impossible and the use of front end loaders difficult.

Algal accumulation is common along the Robert Bay foreshore. Field officers from the Waterways Commission have reported an increased incidence of macroalgal accumulation in the Point Grey area. It is predicted that, if the proposed Dawesville Channel was constructed, there would be an increase in macroalgal growth in the short term.

Algal harvesting would have to occur along the Robert Bay foreshore if the proposed development is to be implemented. Furthermore, the proposed boat launching facilities on the east and west sides of Point Grey would be fouled by drifting algae, and would require continuing maintenance.

5.4 MOSQUITOES

Mosquito breeding control has been undertaken in the Peel-Harvey area since mid 1986 by the Shire of Murray, however this control is limited to the existing urban population centres. Current control measures include the use of bacteria-based chemicals (Bti), specific to mosquito larvae, and 'Abate', an organo-phosphate larvicide. Breeding site modification has also taken place in some areas. This involves draining residual pools by filling and levelling depressions, hence reducing the number of potential breeding locations.

Mosquitoes in the Point Grey area reach their highest breeding intensity during late winter and early spring. Favourable mosquito breeding locations in the area include Samphire flats along the Robert Bay foreshore and the Robert Bay drain. Other likely breeding areas include tidally inundated areas such as Stony Point, Mealup Point, Point Birch and Lake Mealup. The common mosquito species in the area include Aedes vigilax and Aedes camptorhynchus. In the south west of Western Australia, these are known to be carriers of the Ross River virus and thus pose a threat to human health.

Mosquito control measures would be necessary if development as proposed was to take place.

5.5 WATER SUPPLY

Water for the proposed development would be required for public water supply, and for irrigating:

- college grounds;
- the golf course (until tertiary treatment plant waste is available);

. public parks; and

. gardens.

Water is available from two principal sources, the Leederville Formation, an extensive confined aquifer underlying the region, and the Waroona Mound, an unconfined aquifer 20 kilometres south east of Point Grey, which contains freshwater throughout its thickness over an area of approximately 120 square kilometres. A shallow superficial aquifer also underlies the Point Grey area. The ERMP has identified the Waroona Mound as a feasible source of public water supply and approval for the project is based on this premise.

The Water Authority plans to proclaim parts of the Waroona Mound which have not already been proclaimed in the Murray Groundwater Control Area as groundwater control areas, and will include the project site. This would be for the purposes of protecting the quantity of the groundwater resource for community rather than domestic use, and in the project area where scheme water is available, domestic bores would be prohibited.

5.5.1 PUBLIC WATER SUPPLY

The ERMP estimates a water demand of approximately 1.5 million cubic metres per year for public water supplies for the residential development and leisure living lots, to be partly satisfied by draw from the Leederville Formation. However further investigation is required to determine the extent and availability of freshwater from this Formation. A detailed groundwater investigation would be required to demonstrate the capability of this resource before the Water Authority would approve its exploitation for the Point Grey Project.

5.5.2 COLLEGE IRRIGATION

A water demand of 146 000 cubic metres per year would be required for the irrigation of recreation grounds and lawns at the College site. Based on rates of irrigation recommended by the Department of Agriculture, the Water Authority would only be prepared to allocate up to 90 000 cubic metres per year for this purpose. This is also proposed to be drawn from the Leederville Formation.

5.5.3 GOLF COURSE IRRIGATION

The ERMP calculates a demand of 375 000 cubic metres per year for irrigation of the Golf Course, to be initially satisfied by draw from the Leederville Formation, and eventually by treated sewage effluent.

An initial draw of this magnitude from the Leederville Formation would require on average approximately 200 000 cubic metres per year for at least 20 years, and the capacity of the Formation to support this draw has not been demonstrated. The Water Authority would not permit abstraction of this volume for the golf course without further investigation to forecast whether the Formation could support this draw. The Water Authority would not support rezoning to permit development of the golf course without adequate evidence of a viable source of water supply.

5.5.4 PUBLIC PARKS AND GARDEN IRRIGATION

A demand of 300 000 cubic metres per year is forecast the ERMP for the irrigation of parks and gardens. Again based on rates of irrigation as

as recommended by the Department of Agriculture, the Water Authority would only be prepared to allocate up to 175 000 cubic metres per year for this purpose. The shallow groundwater resource beneath the site is unlikely to sustain a sufficient water supply and other sources of water would be required.

An on-going water monitoring programme, together with a commitment to the development of alternative supplies if the water available in the Leederville Formation prove inadequate, would be required by the Water Authority. On-going monitoring of water draw down effects on nearby wetlands would also be required.

6. CONCLUSIONS

The Environmental Protection Authority has assessed the Point Grey proposal both in terms of its potential impacts upon the already environmentally stressed Peel-Harvey Estuarine System as well as the potential impacts of the environment upon the proposal.

For the reasons outlined in this Assessment Report, the Authority considers that the Point Grey development is premature at this time given that the resilience of the environment to receive the potential impacts is already jeopardised. Accordingly the Authority has concluded that the proposal is environmentally unacceptable.

Currently the Environmental Review and Management Plan for Stage 2 of the Peel Inlet and Harvey Estuary Management Strategy is nearing completion and approximately a year-long review of the State Planning Commission's Mandurah and District Planning Study is about to commence. In addition, the Peel Harvey Conservation and Development Committee is nearing completion of a review as how best to identify and co-ordinate management of areas of high conservation value around the Peel-Harvey Estuary. These reports will provide the necessary background to determine sustainable management of the estuary and surrounding lands.

At the conclusion of these activities and having received appropriate advice, the Government will be better placed to consider options for the long term environmental management of the Peel-Harvey System. Until that time it would be unwise environmentally to add significantly to existing stresses on the system when so much effort has and is being made to determine ways of reducing the impacts to an acceptable level.

RECOMMENDATION 1

Given its conclusions that the Point Grey proposal as detailed in the ERMP and subsequent minor amendments is environmentally unacceptable at this time, the Environmental Protection Authority recommends that it should not proceed, and accordingly, rezoning of the land subject of the proposal should not occur.

7. REFERENCES

Barrow, N J (1988). Point Grey Development Project - Report on Nutrient Enrichment Aspects of the ERMP. (Appendix 6 to this Report)

Department of Conservation and Environment (1980). Atlas of Natural Resources, Darling System, Western Australia. Department of Conservation and Environment, Perth, WA.

Department of Conservation and Environment (1983). Conservation Reserves for Western Australia as recommended by the Environmental Protection Authority. The Darling System - System 6. Part I: General Principles and Recommendations. Department of Conservation and Environment, Perth, WA.

Ho, G (1988). Point Grey Development Project ERMP - An assessment of nutrient contribution from the project and potential impact on the Peel-Harvey System. (Appendix 7 to this Report)

APPENDIX 1

ISSUES RAISED IN SUBMISSIONS

SOCIAL ISSUES

- Detract from favourite spot for picnicing, crabbing and prawning;
- Project will lower the quality of life of Dawesville and Falcon residents;
- No indication that proponent contacted public interest groups as required in the EPA guidelines; and
- No need for further urban expansion as there are already many vacant blocks in Mandurah area as a result of speculative land development.

IMPACT ON FLORA/FAUNA

- Inadequate floral and faunal surveys undertaken in the area;
- Unsuitable form of land use for Tuart woodland and environmental impact will be difficult to monitor;
- Increase in population will lead to degradation of the area and have a destructive effect on estuarine ecology;
- Development of Point Grey is against the principle of protecting and conserving wetlands. Impact will be especially detrimental to 19 Mile Lake, McLarty Lake, Goodale Sanctuary, Austin Bay, Roberts Bay and Lake Mealup;
- Point Grey is a conservation area for water birds of international significance. It is a feeding and breeding ground for many waders including over twenty trans-equatorial migrant species, protected under the JAMBA Treaty. Development will disturb birds and reduce size of feeding area;
- Conservation area of Robert Bay for Great Crested Grebe, Banded Stilt and Red - Necked Avocet overlooked in ERMP;
- Pest control measures, water based recreation, off road vehicles, horses, dogs and dumping of rubbish will increase threat to water bird habitat. ERMP does not include discussion of measures that could be employed to protect wildlife against such impacts;
- Reserve C 7502 is an important breeding site for Black Swans and Carrabungup Reserve (C 2707) is an important breeding site for Cormorants. Human disturbance to these areas may lead to the death of many young birds;
- Removal of fringing and reed vegetation and filling of wetland margins will reduce breeding locality for many bird species. 50 m buffer zone gives inadequate protection for wetlands. At some locations wider reserves may be desirable to maintain biological, physical or geological features. An arbitrary, single width may be impractical;

- The extent of the foreshore reserve needs to be clarified. Area of foreshore which would be inundated in the event of a sea level change needs to be estimated;

- Important fish hatchery and nursing area. Motor boat activity will disturb sediment and have a detrimental impact on larvae and juveniles.

- Increased pressure on fish resources in the estuary;

- Insufficient discussion on impact on terrestrial and aquatic fauna in the ERMP;

- Project will have a big impact on terrestrial fauna in the area, in particular kangaroos and emus; and

- ERMP fails to assess ecosystems in both a local and regional context.

WATER RESOURCES/WATER QUALITY

- Public water demand underestimated;

- Water supplies from the Waroona Mound are inadequate for the development;

- Insufficient study has been undertaken on the impact of use of the Waroona Mound through bores/groundwater extraction on the lowering of the water table. This will jeopardise fragile wetland ecosystems. Adverse affects of pumping need to be defined;

- Management strategy for groundwater use needs to be prepared and will require further investigation;

- Method which will be employed to restrict the installation of private bores is not detailed in the ERMP;

- Methodology for achieving stated targets of phosphorus and nitrogen discharges not detailed in ERMP;

- Achievement of effluent quality criteria claimed for sewage treatment plant is questionable based on the information given in the ERMP. Sewage scheme requires further detail;

- Standards for water quality control and monitoring details need to be defined;

- Urban development and associated sewage treatment will exacerbate eutrophication problems in the estuary and contaminate groundwater;

- Dredging will be costly and have a detrimental impact on aquatic organisms; and

- ERMP gives no indication of where solid waste or excess water disposal that cannot be used on the golf course is to be disposed of.

GENERAL

- Assessment of ERMP should be deferred until the Peel Harvey Environment Management Strategy ERMP is in place. This will be

particularly important in terms of nutrient load assessment. Point Grey must be managed, developed and protected in a regional or statewide context;

- It is unclear in the ERMP as to who will pay for the provision of facilities ie toilets, jetties, foreshore maintenance, possible marina, sewage pump out facilities, mosquito control, sporting facilities, and maintenance of boating channels;

- No details are given as to who will deepen boat channels by 0.5 m if Dawesville Channel proceeds, as promised in ERMP;

- Motor boats and launching facilities will have a detrimental impact on the estuary and foreshore (disturbance, exacerbate erosion, pollution from engine waste). Ecosystem is already stressed;

- Project will lead to the destruction of estuarine vegetation;

- Peninsula surrounded by shallow water flats is not readily suitable for water based recreation;

- Need for multistorey development unjustified. It is an unsuitable site for a college and base for overseas students as the site is isolated, large areas of mud flats will be exposed over long periods of time, therefore unsightly etc. Idea of college for international students just an excuse for further development;

- No assessment has been carried out of alternative sites for proposal;

- Choice of site will be detrimental to the long term agricultural viability of the Shire of Murray;

- Population will be continually bothered by mosquitoes and will lead to the use of chemical mosquito control which will pollute the water;

- Development contrary to System Six Recommendations;

- No further development adjacent to the estuary should be allowed;

- Construction of four additional boat launching sites on shallow platforms is unwarranted. Two rather than four launching sites should be constructed, each with a 50 m wide channel;

- Reserve C 27528 should not be available for recreation;

- Proposal will have an impact on and degrade adjacent reserves and conservation areas;

- Area of reserve within project area is misleading ie 13% of area not 18% as stated in the ERMP;

- Influx of long term visitors and residents into restricted areas adjacent to reserves in Robert and Austin Bay will lead to a reduction in environmental values;

- Urbanisation of Point Grey will have the following impacts on the area:

- increase fire risks;
- increase exotic weed invasion;
- increase dumping of rubbish;
- introduce vandalism;
- introduce domestic animals;
- increase feral animal population;
- increase off-road vehicle use;
- increase risk of chemical spills (eg through mosquito control);
- introduce pesticides; and
- introduce horse riding.

There are no adequate means of controlling these impacts.

. Assessment of the impact of other developments in the area (eg rural subdivision west of Lake McLarty) should also be considered. Assessment should not be made in isolation, but in a regional context;

. Solid waste disposal not adequately considered;

. Stormwater disposal facility not appropriate for residential area;

. Sites for roads and buildings should not be filled due to the possible rise in sea level as a result of the 'Greenhouse Effect';

. Implications of possible changes of water level of estuary not adequately addressed. No figures are presented as to the extent of, for example, the predicted 0.2 m rise in sea level in the event of the Dawesville Channel being constructed;

. No consideration of the possible changes in sea level as a result of the Greenhouse Effect has been made;

. Development/disturbance on tidal flats and low lying areas will exacerbate mosquito problem by creating favourable breeding areas. Assessment of mosquito breeding locations and potential impact on Point Grey population needs to be undertaken. This report must meet the satisfaction of the Mosquito Control Review Committee (MCRC). Mosquito problem will become worse if the Dawesville Channel is constructed due to more frequent inundation of low lying foreshore areas;

. Algal growth in estuary/inlet will increase with nutrient run off;

. Urban development will lead to increased rate of subdivision;

. Management Programme - proponent does not demonstrate the manner in which potential environmental problems can be ameliorated. Proponent should include financial guarantees and bond money;

- Planning control measures should be imposed on leisure living lots to control excessive land clearing;

- Period of position of 'Site Manager' as described in ERMP is not specified, yet management plan is to be implemented over 30 years;

- Project will lead to increased cost to the State for servicing, in particular macroalgae harvesting, boating facilities, mosquito control and foreshore facilities at a location with limited access; and

- Macroalgae harvesting can only take place from the eastern side as shallow banks on the western side have numerous limestone outcrops, making harvesting difficult with frontend loaders.

SUGGESTIONS MADE IN PUBLIC SUBMISSIONS

- Concept of a 50 m wide Regional Park around the estuary will not provide adequate protection for the estuary, in particular with respect to sea level changes. It should be 100 m wide as in other Australian states;

- Underground power lines should be installed so as not to detract from scenic value;

- Carrabungup Nature Reserve (C 2707) and Reserve C 7502 should be given greater conservation status as an 'A' Class reserve and fenced to protect water bird breeding colonies with 1.3 m high cyclone wire fencing;

- Roadside Vegetation Conservation Committee should be consulted to assist in the identification of 'Flora Roads' ie those areas having high conservation value;

- Point Grey area should be declared a park. This would have local amenity value and increase tourist potential in the area;

- Emphasis should be on holiday type accommodation, not small subdivided urban settlements;

- Concept of 'Special Residential Leisure Living' (Section 4.4, ERMP) should be applied to the entire area, apart from designated reserves. This would keep the population and associated impacts on the environment low;

- Proponent should establish a Trust to maintain and enhance reserves and provide funding to continue research relevant to the reserves;

- Reserve C 7502 should be added to Reserve C 2707;

- Area of land immediately east of Reserve A 2738 (15 ha) (proposed 'Special Residential Living Allotment') should be ceded to the Crown by the proponent and become part of the nature reserve;

- No boat launching facilities should be constructed on the shoreline east of Point Grey;

- Design of boat launching facilities should be such that vehicle access to foreshores from launching ramps is not possible;

- Intensive ecological studies should be undertaken to assess the importance of wetlands in the area for waterbirds. Surveys should cover at least one breeding season (July - February);

- Proponent should be requested to fund comprehensive surveys of waterbird usage of the Waroona Mound wetlands to monitor the effects of water drawdown. This survey should be conducted on a monthly basis for a minimum of three years;

- Botanical surveys should be undertaken prior to any development commencing to record presence of any rare or gazetted plant species;

- Increase in population at Point Grey may increase tourist pressure (litter, vandalism etc). Avalon Cave should have a locked gate to control access and be maintained by the Caves Access Committee;

- Water should be piped in from existing dams rather than use shallow local aquifers;

- Environmental Protection Authority should ensure Recommendation 50.4 of System Six Redbook be put into effect urgently;

- Land capability study should be undertaken;

- Groundwater monitoring should be instigated as soon as possible;

- Sympathetic land development should take place at Point Grey which is compatible with local vegetation; and

- Management costs to protect conservation areas should be met by the developer.

SUMMARY OF PUBLIC SUBMISSIONS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
IMPACT ON FLORA	*		*								*	*					*	*	*
IMPACT ON TERRESTRIAL FAUNA	*	*	*								*	*					*		*
IMPACT ON WATERBIRDS	*	*	*			*		*	*		*	*					*	*	*
IMPACT ON OTHER AQUATIC FAUNA (EG FISH)		*	*		*	*						*					*		*
INADEQUATE FORESHORE RESERVE		*					*					*							
UNSUITABLE FORM OF LAND USE IN ALREADY STRESSED ECOSYSTEM	*	*	*		*	*	*	*		*	*	*		*	*		*	*	*
INADEQUATE INFORMATION RE GROUNDWATER RESOURCES		*					*	*			*	*							
USE OF GROUNDWATER DETRIMENTAL TO LOCAL WETLANDS		*						*			*	*			*		*	*	
DEVELOPMENT WILL INCREASE NUTRIENT INPUT INTO ESTUARY	*						*	*		*	*	*			*		*		
DREDGING DETRIMENTAL TO AQUATIC ORGANISMS					*														
ASSESSMENT SHOULD BE DEFERRED UNTIL PEEL HARVEY STAGE II ERMP IS RELEASED							*						*						
INADEQUATE DETAIL RE-SEWAGE/WASTE DISPOSAL		*					*	*				*			*		*		
MOTOR BOAT ACTIVITY DETRIMENTAL TO ESTUARY/ FORESHORE		*			*			*				*							
ALTERNATIVE SITES NOT ADEQUATELY CONSIDERED	*	*						*				*							
MOSQUITO PROBLEMS WILL BE EXACERBATED BY DEVELOPMENT				*			*					*							
DEVELOPMENT CONTRARY TO SYSTEM 6/ CONSERVATION RECOMMENDATIONS	*						*	*			*	*					*	*	
DEVELOPMENT WILL DEGRADE AREA (POLLUTION/ EROSION/WEEDS/DOMESTIC ANIMALS, PESTICIDES, OFF-ROAD VEHICLES)	*		*			*	*	*	*	*	*	*			*		*		*
SEA LEVEL CHANGE NOT CONSIDERED (GREENHOUSE EFFECT/DAWESVILLE CHANNEL)																			
EFFECT OF DAWESVILLE CHANNEL NOT ADDRESSED							*												
MOSQUITO CONTROL MEASURES MUST BE UNDERTAKEN PRIOR TO DEVELOPMENT				*															
NATURAL FEATURES (EG CAVES) SHOULD BE PROTECTED																*			
INSUFFICIENT RESEARCH ON ENVIRONMENTAL IMPACT	*	*	*				*				*								
PROJECT WILL BE EXPENSIVE TO THE STATE (BOATING FACILITIES/MOSQUITO CONTROL/ALGAL HARVESTING)	*						*												
SUGGESTIONS																			
INCREASE WIDTH OF FORESHORE RESERVE							*					*							
CONSERVATION AREAS SHOULD BE BETTER PROTECTED		*						*	*		*	*					*	*	
ECOLOGICAL STUDIES (FLORAL/FAUNAL) SHOULD BE UNDERTAKEN PRIOR TO DEVELOPMENT							*					*							
LOW DENSITY DEVELOPMENT SHOULD BE ENCOURAGED	*																		
LAND CAPABILITY STUDY SHOULD BE UNDERTAKEN																			
GROUNDWATER RESOURCES SHOULD BE FURTHER INVESTIGATED AND MONITORED							*				*								
MANAGEMENT COSTS SHOULD BE MET BY THE PROPONENT	*						*					*							
DEVELOPMENT SHOULD BE SYMPATHETIC TO THE LOCAL ENVIRONMENT								*				*							

	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	TOTAL
IMPACT ON FLORA	*	*			*		*			*					*	*	*	15
IMPACT ON TERRESTRIAL FAUNA				*	*					*							*	11
IMPACT ON WATERBIRDS	*	*	*	*	*		*	*		*		*				*	*	22
IMPACT ON OTHER AQUATIC FAUNA (EG FISH)		*	*		*		*	*		*						*	*	15
INADEQUATE FORESHORE RESERVE							*					*				*	*	7
UNSUITABLE FORM OF LAND USE IN ALREADY STRESSED ECOSYSTEM	*	*	*	*	*		*	*		*		*			*		*	26
INADEQUATE INFORMATION RE GROUNDWATER RESOURCES						*	*				*		*	*				10
USE OF GROUNDWATER DETRIMENTAL TO LOCAL WETLANDS		*			*		*	*			*	*			*	*		15
DEVELOPMENT WILL INCREASE NUTRIENT INPUT INTO ESTUARY	*	*		*			*	*				*		*			*	16
DREDGING DETRIMENTAL TO AQUATIC ORGANISMS		*	*				*											4
ASSESSMENT SHOULD BE DEFERRED UNTIL PEEL HARVEY STAGE II ERMP IS RELEASED														*		*		4
INADEQUATE DETAIL RE-SEWAGE/WASTE DISPOSAL						*	*					*		*				10
MOTOR BOAT ACTIVITY DETRIMENTAL TO ESTUARY/ FORESHORE		*			*		*					*					*	9
ALTERNATIVE SITES NOT ADEQUATELY CONSIDERED		*		*			*											7
MOSQUITO PROBLEMS WILL BE EXACERBATED BY DEVELOPMENT							*											4
DEVELOPMENT CONTRARY TO SYSTEM 6/ CONSERVATION RECOMMENDATIONS		*	*	*	*		*					*			*	*	*	16
DEVELOPMENT WILL DEGRADE AREA (POLLUTION/ EROSION/WEEDS/DOMESTIC ANIMALS, PESTICIDES, OFF-ROAD VEHICLES)		*	*		*		*	*								*		18
SEA LEVEL CHANGE NOT CONSIDERED (GREENHOUSE EFFECT/DAWESVILLE CHANNEL)							*									*		2
EFFECT OF DAWESVILLE CHANNEL NOT ADDRESSED																		1
MOSQUITO CONTROL MEASURES MUST BE UNDERTAKEN PRIOR TO DEVELOPMENT																		1
NATURAL FEATURES (EC CAVES) SHOULD BE PROTECTED															*	*		3
INSUFFICIENT RESEARCH ON ENVIRONMENTAL IMPACT				*	*			*		*		*			*			11
PROJECT WILL BE EXPENSIVE TO THE STATE (BOATING FACILITIES/MOSQUITO CONTROL/ALGAL HARVESTING		*					*						*			*		6
SUGGESTIONS																		
INCREASE WIDTH OF FORESHORE RESERVE							*					*				*	*	6
CONSERVATION AREAS SHOULD BE BETTER PROTECTED		*	*		*		*	*							*		*	14
ECOLOGICAL STUDIES (FLORAL/FAUNAL) SHOULD BE UNDERTAKEN PRIOR TO DEVELOPMENT					*			*		*					*			6
LOW DENSITY DEVELOPMENT SHOULD BE ENCOURAGED															*	*	*	4
LAND CAPABILITY STUDY SHOULD BE UNDERTAKEN												*						1
GROUNDWATER RESOURCES SHOULD BE FURTHER INVESTIGATED AND MONITORED					*	*					*				*			6
MANAGEMENT COSTS SHOULD BE MET BY THE PROPONENT							*						*			*		6
DEVELOPMENT SHOULD BE SYMPATHETIC TO THE LOCAL ENVIRONMENT					*		*								*		*	6

LIST OF INDIVIDUALS AND ORGANISATIONS WHO CONTRIBUTED SUBMISSIONS

The President
Western Australia Speleological Group
NEDLANDS WA

The President
Waterbird Conservation Group
ROLEYSTONE WA

The Secretary
Royal Australasian Ornithologist's Union
WA Branch
CANNING BRIDGE WA

Mr R Jaensch
Royal Australasian Ornithologist's Union
WA Branch
CANNING BRIDGE WA

Mr and Mrs Goodale
SAFETY BAY WA

The Secretary
River Districts Association
Shire of Murray
YUNDERUP WA

The Chairman
Peel Inlet Management Authority
MANDURAH WA

The President
Wetlands Conservation Society
KARDINYA WA

The President
Falcon Progress Association
FALCON WA

Mr D F James
FORRESTDALE WA

Mr O Muller
WEMBLEY DOWNS WA

Mr/Ms B Fremlin
ROLEYSTONE WA

The National Trust
WEST PERTH WA

The Secretary
Lake Mealup Preservation Society
SUBIACO WA

The Secretary
WA Wildflower Society
NEDLANDS WA

Mr L Howard
Peel Preservation Group
FALCON WA

Dr T G D Shannon
Western Australian Naturalists' Club
NEDLANDS WA

The President
Conservation Council of WA
PERTH

Mr and Mrs S Telford
ARMADALE WA

Mr and Mrs H F Sanderson
MANDURAH WA

Mr and Mrs L G Mitchell
DAWESVILLE WA

Mr V Serventy
President
The Wildlife Preservation Society of Australia
SYDNEY NSW

Mr/Ms S Edwards
BEDFORD WA

Mr/Ms J M Start
ROLEYSTONE WA

Ms J Leat
DAWESVILLE WA

The Shire Clerk
Shire of Murray
PINJARRA WA

LIST OF INDIVIDUALS AND ORGANISATIONS WHO CONTRIBUTED SUBMISSIONS (contd)

The Registrar
Department of Aboriginal Sites
Western Australian Museum
PERTH WA

The Director
Western Australian Museum
PERTH WA

The Commissioner
Main Roads Department

General Manager
Department of Marine and Harbours

Managing Director
Water Authority of Western Australia

Regional Manager
Water Authority of Western Australia

Commissioner
Health Department

Director
Department of Fisheries

Director
Department of Agriculture

Executive Director
Department of Conservation and Land Management

DISTRIBUTION OF MACROALGAE IN THE PEEL INLET AND NORTHERN TIP OF THE HARVEY ESTUARY

Data were collected at 30 sampling sites and mapped using the SYMAP programme (Waterways Commission Data, 1986). The data, are divided into six equal size classes, and 'running' means constructed over the mapped area. In each figure, dark shading indicates highest relative concentration.

Figure 1 illustrates the areas where macroalgal accumulations are currently harvested by the Peel Inlet Management Authority.

Figures 2, 2a, 3a, 4a and 5a illustrate the total biomass figures for January, May, September and November 1986. These figures include counts for seagrass and for macroalgae of the following species: Ulva, Chaetomorpha, Cladophora, reds algae, Enteromorpha and browns algae. Figures 2b, 3b, 4b and 5b are included to illustrate the point that seagrass biomass only accounts for a minor percentage of the total biomass in the System. Note concentrations of macroalgae in Robert Bay, particularly during summer months.

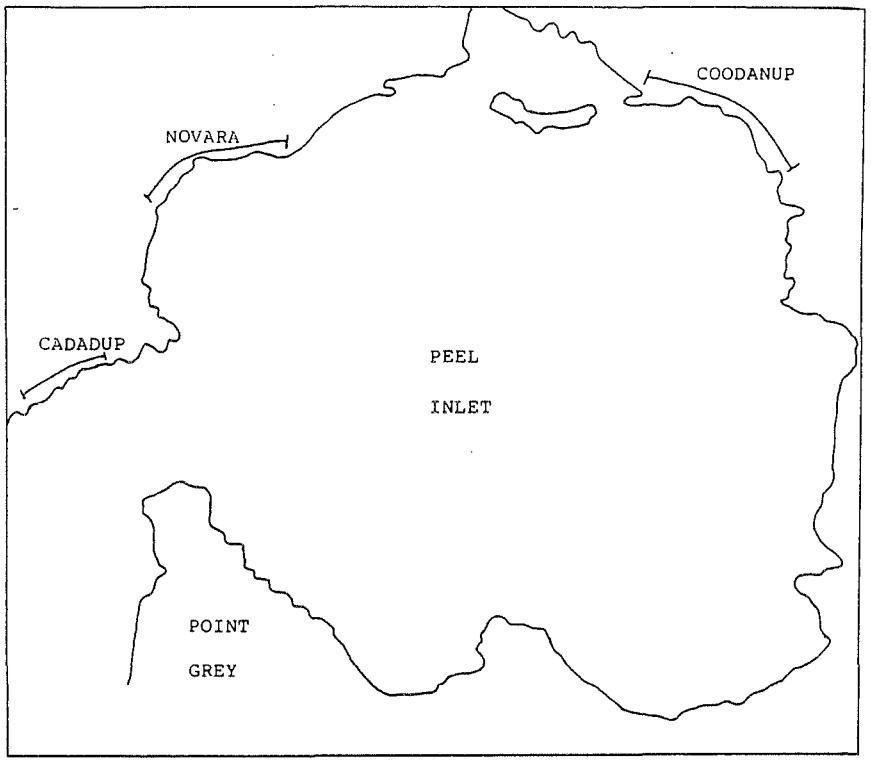
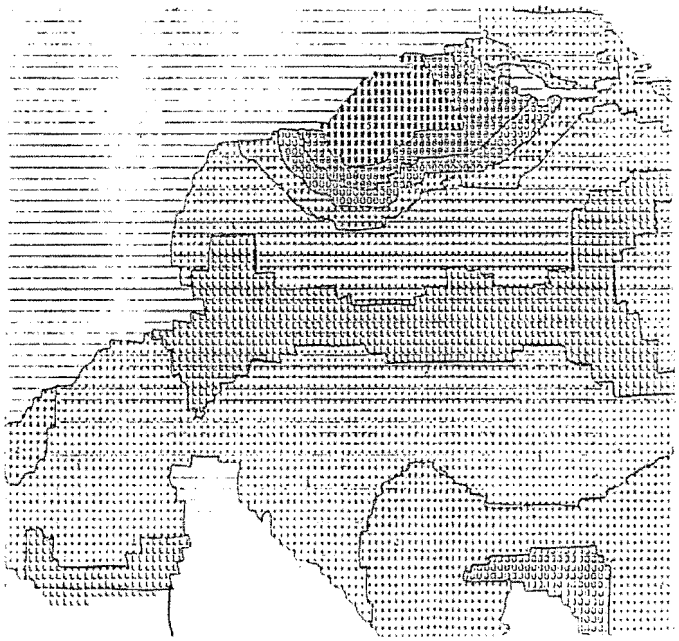


Figure 1. Macroalgal accumulation sites currently harvested by PIMA.

Figure 2a

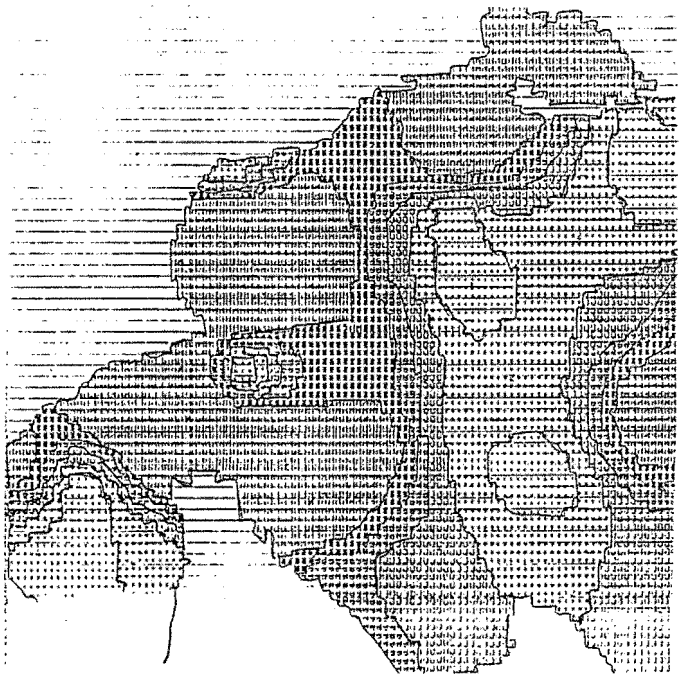
January 1986
SYMAP - Total Biomass

Figure 2b



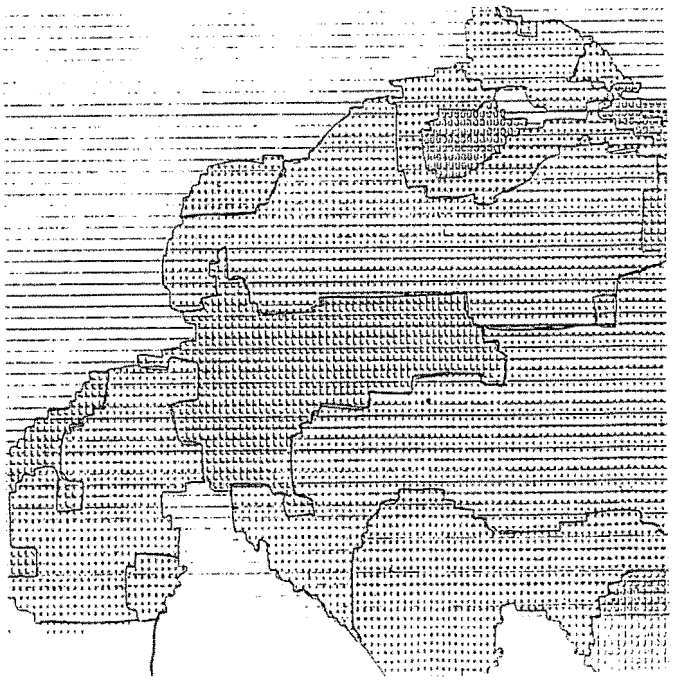
January 1986
SYMAP - Seagrass Biomass

Figure 3a



May 1986
SYMAP - Total Biomass

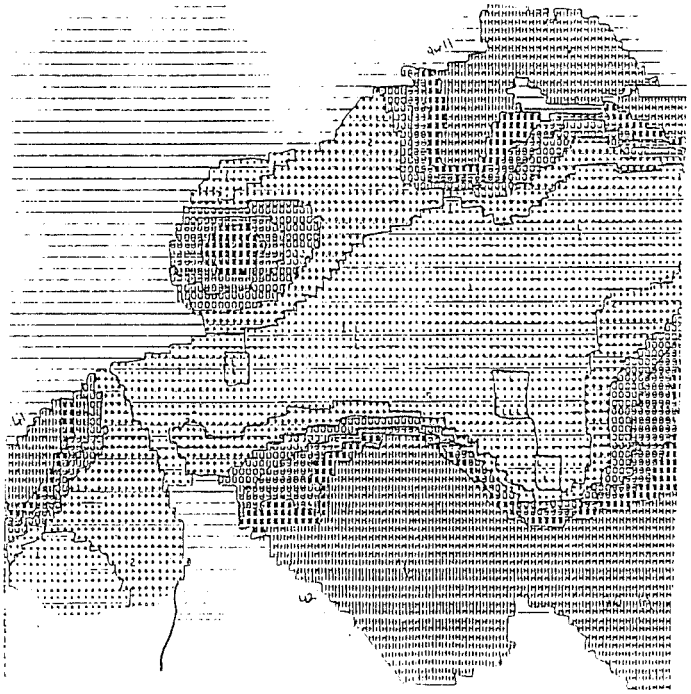
Figure 3b



May 1986
SYMAP - Seagrass Biomass

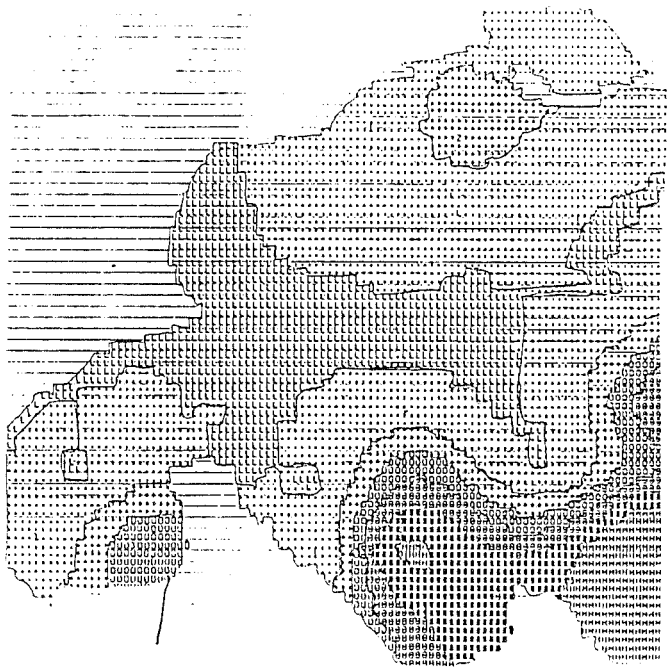
Note: Dark shading represents the highest concentration of macroalgal accumulation.

Figure 4a



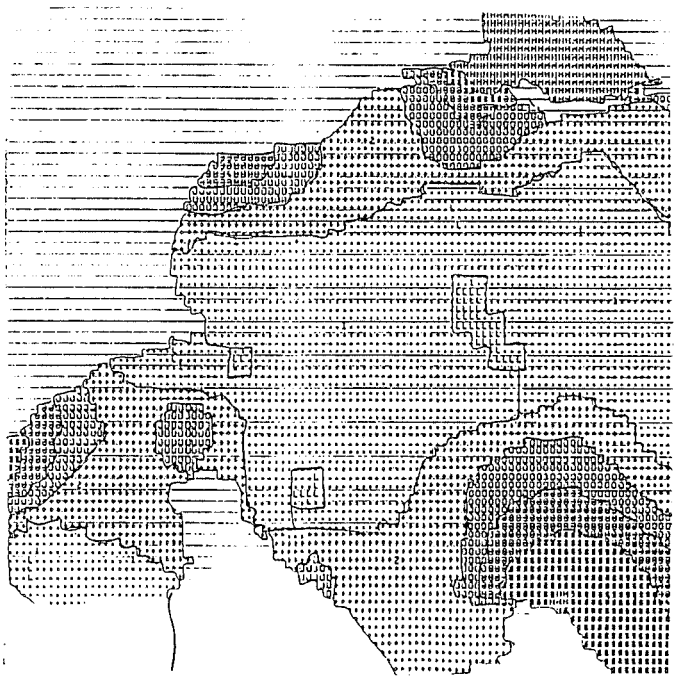
September 1986
SYMAP - Total Biomass

Figure 4b



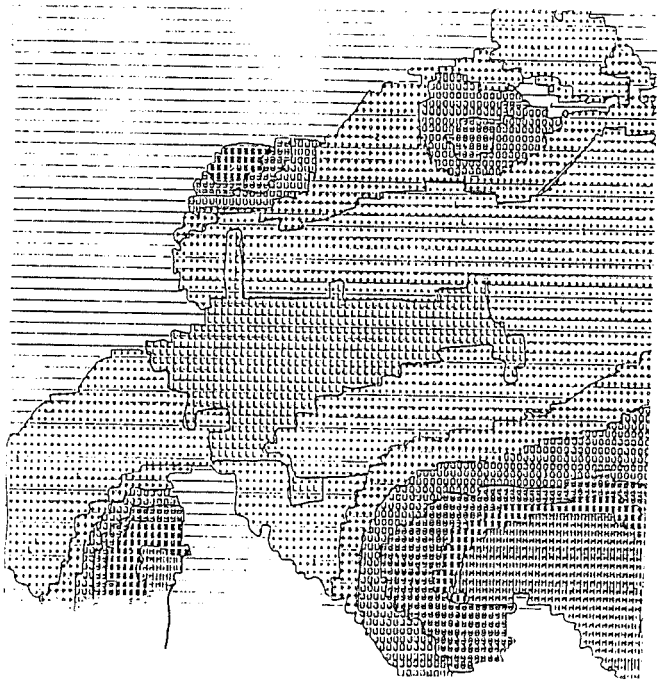
September 1986
SYMAP - Seagrass Biomass

Figure 5a



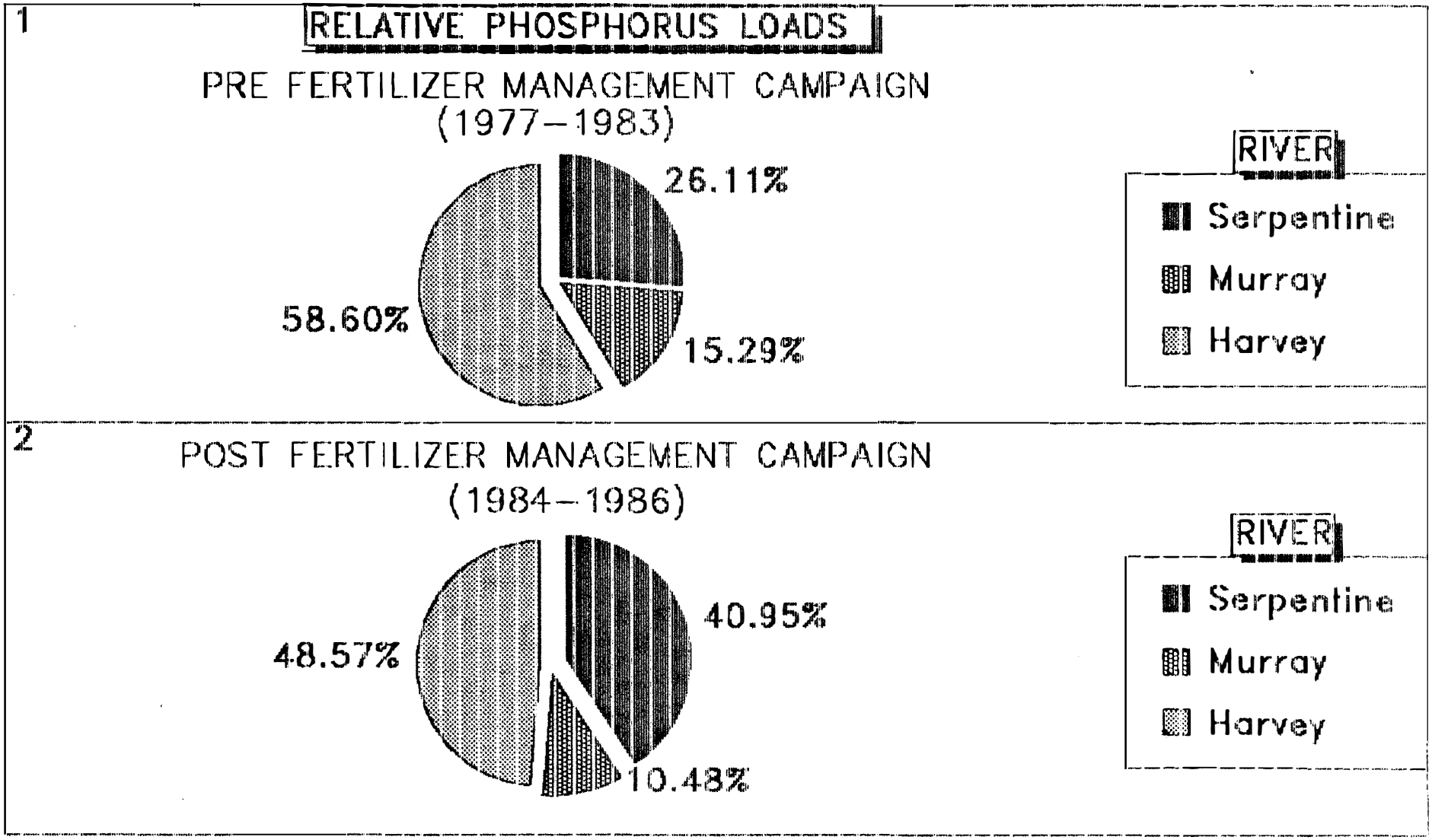
November 1986
SYMAP - Total Biomass

Figure 5b



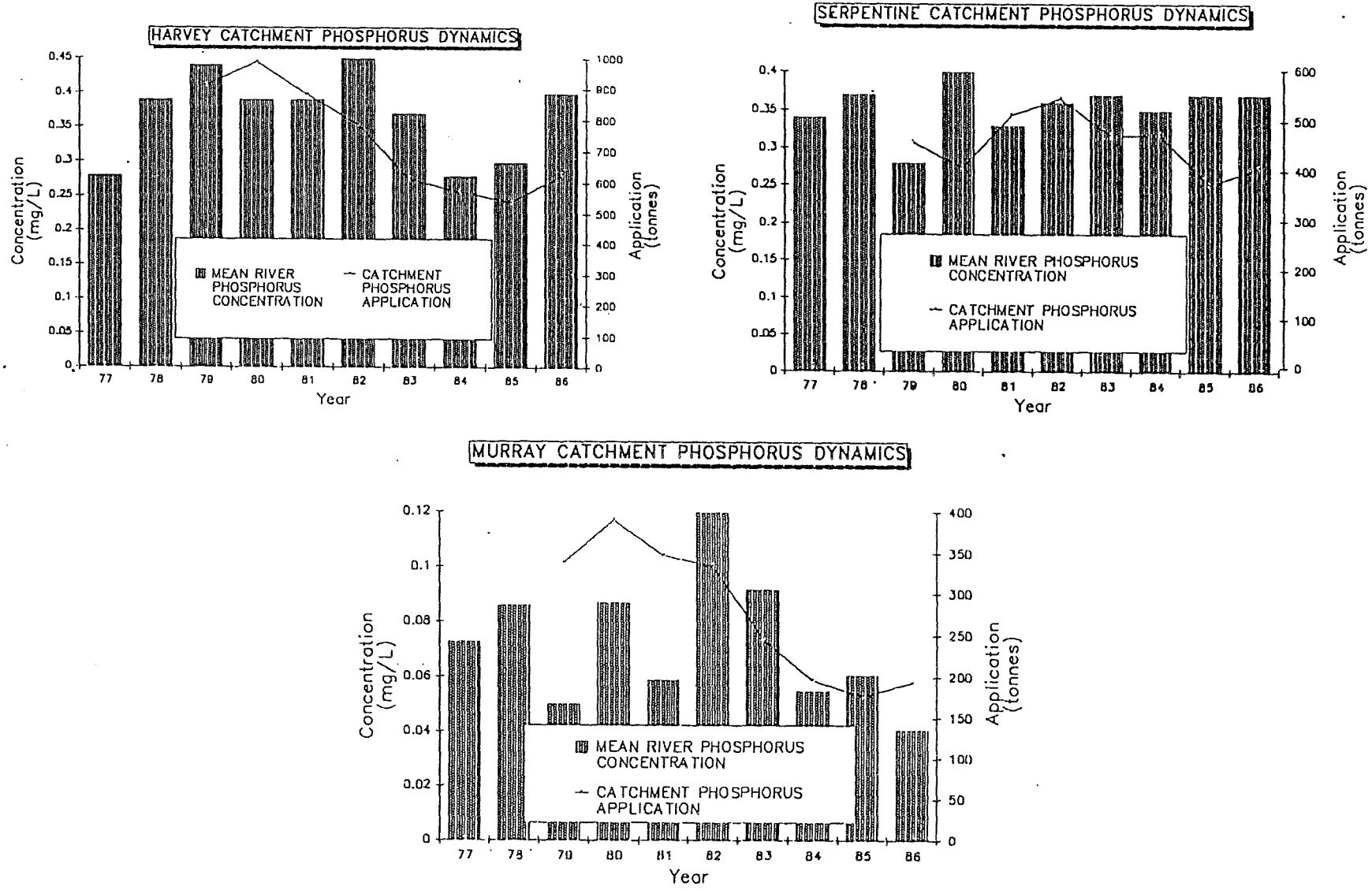
November 1986
SYMAP - Seagrass Biomass

Note: Dark shading represents the highest concentrations of macroalgal accumulation.



APPENDIX 4

Relative phosphorus loads for the Serpentine, Murray and Harvey River systems before and after the fertilizer management campaign.



Phosphorus use and river concentrations for the three major catchments of the Peel-Harvey Estuary.

APPENDIX 6

POINT GREY DEVELOPMENT PROJECT

REPORT ON NUTRIENT ENRICHMENT ASPECTS OF THE ERMP

N.J.Barrow D.Ag.Sc, Ph.D.

SUMMARY

The argument presented in the ERMP is that the total phosphate input for the proposed land use will not be greater than those of probable alternatives. This argument can be disputed because it assumes that phosphate leaching depends on the total input. However the effect of phosphate concentration on leaching is not linear. The same amount applied to a smaller area will be more prone to be leached. Even though this is an important principle, it is over-ridden in importance by the soil properties. P fertilizer can be safely applied to soils that have adequate sorption capacity. This is probably true of most of the site. Management should be concerned with identifying those areas on which P fertilizer is unsafe and either peventing its use there or altering the soil properties with moderate applications of "red mud". Waste water from sewage treatment could also be safely applied provided that the rates were not too high and that sites of high P sorption were used. However, P in water from septic tanks will reach the ground water in a few years. Whether it will then reach the water in the estuary is debatable.

REPORT

The ERMP considers two aspects of the nutrient balance for the site. On the one hand it considers the possible inputs of fertilizer if the land were to remain under grazed pasture. On the other hand, it considers the inputs under the proposed management. It is argued that the proposed management will lead to lower total P inputs. That this would lead to decreased leaching can be disputed on the ground that it is based on total P input. Leaching of P is not linearly related to the amount applied - rather the proportion leached increases with level of application. In general, it is worse, for example, to apply twice as much P to half a site than to spread uniformly over the whole site. The reason for this will be given later. The amounts applied per fertilized ha are indeed higher under the proposed management than under farming. For example, in Appendix F it is estimated that the rates of application to farmland would be 8.7 kg P ha^{-1} but the rate of application to the fairways of the golf course is to be 24 kg ha^{-1}. If these higher local levels of application were to be applied to soils with insufficient ability to sorb P, they would certainly lead to more P leaching to the ground water. However, this conclusion depends on the qualification that the soil has insufficient ability to sorb P. This qualification raises the major deficiency in the ERMP - it takes no acount of the kind of soils to which the fertilizer is to be applied. It is probable that most of the soils on the site have adequate ability to sorb P and that most of the management proposals are not as crucial as they seem.

When P is added to soil as a soluble fertilizer it dissolves as soon as the soil is moistened and begins to react with the components of the soil. As result of that reaction, the P is partitioned between the solid phase and the liquid phase. Only that P in the liqid phase can move. Of course, should the soil solution be displaced - taking the P in solution with it - some of the P from the solid phase will be desorbed and partly replenish the soil solution. Nevertheless, it is the partitioning between the solid phase and the liquid phase that determines the potential for leaching. This partitioning can be estimated in the laboratory and expressed as curves in which the P in the solid phase (sorbed) is plotted against the concentration in solution. Figure 1 shows such a curve for a Karrakatta sub-soil. Futher details of the soil and of the experiment were published by Barrow (1983). Also shown on the graph are approximate curves for the highest and lowest sorptions observed by Whelan and Barrow (1984) for Karrakatta soils. These curves are measured after a specific period of contact between soil and phosphate - in these cases one day. With longer periods of contact, the reaction continues and the amount of sorption at a given concentration increases. The values are therefore very much an underestimate of the long-term sorption. However the rates of the continuing reaction are fairly consistent within a given region and values measured after one day correlate well with longer-term values. Note that we are indeed dealing with curves. Their shape is such that, as the amount of P increases, the proportion in the solution phase increases. This is why leaching potential increases as the level of application increases.

The equation to the curve of Fig. 1 is:

$$\text{Sorption} = 33\ \text{conc}^{0.3}$$

The value "33" indicates the sorption at a concentration of 1μg/ml. As the

exponent term (here 0.3) is fairly consistent between soils, it is this linear term that is useful for characterising the sorption behaviour. Sometimes soil sorption has been characterised by quoting the sorption at another concentration - such as 0.2 μg/ml (e.g. Whelan and Barrow 1984). Provided the value of the exponent is constant, values at one concentration are linearly related to values at another and can be transformed using the value for the exponent. The value of the linear term is very useful in summarising the behaviour of soils and in predicting the relative leaching potential on soils. For convenience let us represent it by "a".

Consider an application of 10 kg of P per ha as a soluble fertilizer. This represents 100 $\mu g\ cm^{-2}$. Let us also assume that the bulk density of the soil is 1 $gm\ cm^{-3}$ and that the volumetric water content is 10 percent. (These numbers are chosen for convenience.) Let us now consider the reaction of the 100 μg of P with a 1 cm deep layer of soil - that is with 1 g of soil. Figure 2 shows the partition of the P between the solid phase and the solution. It shows that, at a value of the sorption characteristic "a" of 30, only 5 percent of the P is in solution and capable of moving to the next 1 cm layer of soil. Under reasonable conditions of leaching all of the P would stay in the top few cm of soil. However the values of "a" become very critical as they become smaller and, at a value below 5, most of the P is in the soil solution. Values of less than 5 occur on the Bassendeen sands - such as Gavin sand - and it is on such soils that P leaching is a serious problem. This is a very simplified model. It does not consider the continuing reaction which makes movement of P even slower nor does it consider repeated applications or the complexities of desorption. More sophisticated models are required for these aspects (Barrow 1987). Nevertheless the important point is that leaching of P applied at agricultural levels is only a problem on soils with very low

sorption capacity. This conclusion also applies to P contained in treated effluent from sewerage works. Provided that the level of application per ha does not exceed "agricultural" levels, and that the application is made to soils with a high "a", there should be little chance of P leaching to the ground water.

No measurments of sorption are quoted in the ERMP. However Fig. 10 of the ERMP shows that most of the soils of the study area are classified as Karrakatta sands. This map is more detailed than that of McArthur and Bartle (1980) on which it is based but agrees with it in that most of the soils are classified as Karrakatta sands. I have therefore accepted this as correct without making an independent check. The colour in these soils is largely due to iron oxides and these are also the components that are involved in P sorption. Provided that the soil profile contains a couple of meters of well-developed yellow sub-soil it a fairly safe bet that P leaching from agricultural applications will not be a problem. That is, an eye estimate of the colour of the sub-soil may provide a good estimate of the safety of the soil. If there should be any areas on which the colour is not well developed, measurements of sorption may be advisable. They should be made by an independent analyst; I would be prepared to advise on the appropriate methods and the interpretation of the results. If sorption is insufficiently developed, there are two management options. One is to devote the area to a use that does not require P fertilizer; the other is to increase the sorption of the soil by incorporating a moderate application of "red mud" suitably treated with gypsum. The "a" value for red mud is more than 1000 and so incorporation of as little as 5 percent would prevent leaching. As, at most, small areas would be involved, this is a feasible option. It could also be considered as a safety net on the areas to be watered with sewerage effluent.

In this report so far I have been concerned with applications of P at "agricultural" levels - that is, at levels of say 10 to 20 kg ha^{-1}. When we consider the proposed septic tanks for the large lots, the arithmetic is a little different. While the output might be only about 3 kg P per tank, and there will be an average of less than one tank per ha, that amout of P is, in fact, applied to an area of about 2 m^2. The high application rate to this area ensures that the P will reach the ground water in a couple of years even on deep, yellow, Karrakatta sands (Whelan and Barrow 1984). This will not be prevented by the retention of trees - desirable though that may be. The study by Whelan and Barrow was done in suburban Perth and the sites were very well supplied with trees. Whether the P that reaches the groundwater will eventually reach the estuary is however problematical. The groundwater in this area appears to be held in calcareous beds and this would be expected to greatly decrease the rate of movement of the P. Further, flow lines of the ground water do not seem to be known. Hence we do not know whether this water seeps into either of the estuaries or directly into the ocean. Thus the installation of septic tanks will increase the inflow of P to the groundwater but it is questionable whether it will increase the inflow to the estuary. The worst case that could be considered is that all of the P could find its way to the estuaries (improbable though that is) and the amounts which would be involved are given in the ERMP.

Much of the management plan in the ERMP is concerned with decreasing the input of P. The general thrust of the present report is that, on many of the soils, leaching of P will not be a problem provided it is not applied at excessive levels. It is worth repeating that it is the level of application on the fertilized area that matters - not the overall total application. This is illustrated in Fig. 3 which uses the same simplifying assumptions as Fig.

2. It shows that, as the level of application increases, the proportion in the solution phase increases and so the depth of soil affected by a particular application increases. It is therefore important to avoid high application rates. Thus, if water from the sewage treatment plant is to be used for irrgation, its P content will cause fewer problems if the area treated is as large as practicable. It is also good practice to adopt most of the managment proposals suggested to decrease P input even though I argue that inputs of P are not nearly as critical as is implied an the ERMP. Finally I note that I have confined this critique to P. This is because I accept the argument that this is the critical nutrient in causing algal growth in the estuaries.

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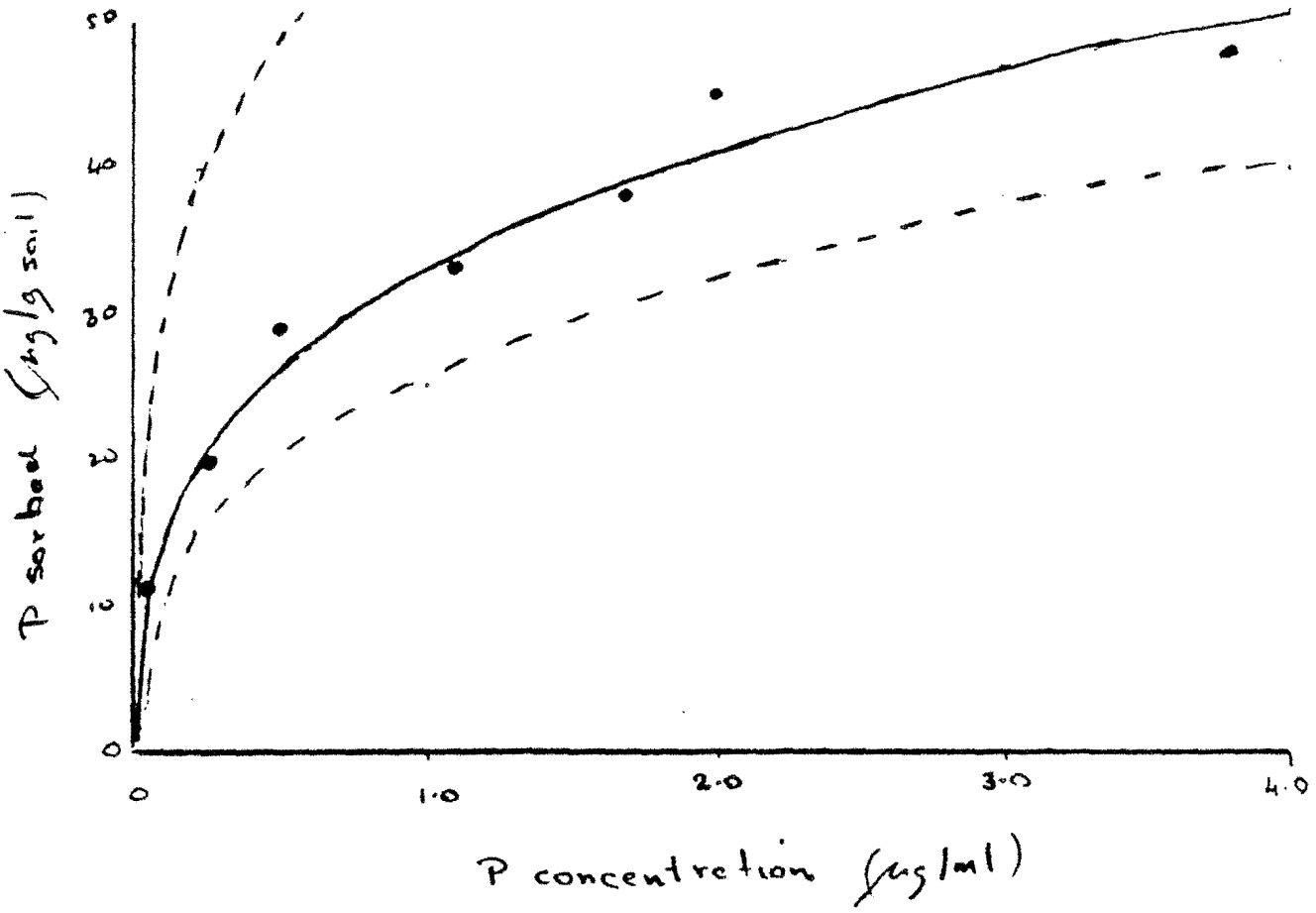

Fig. 1. Some P sorption curves for samples of Karrakatta sand. The full line and the data are for "soil 4" of Barrow (1983). The broken lines indicate approximate high and low values for soils investigated by Whelan and Barrow (1984).

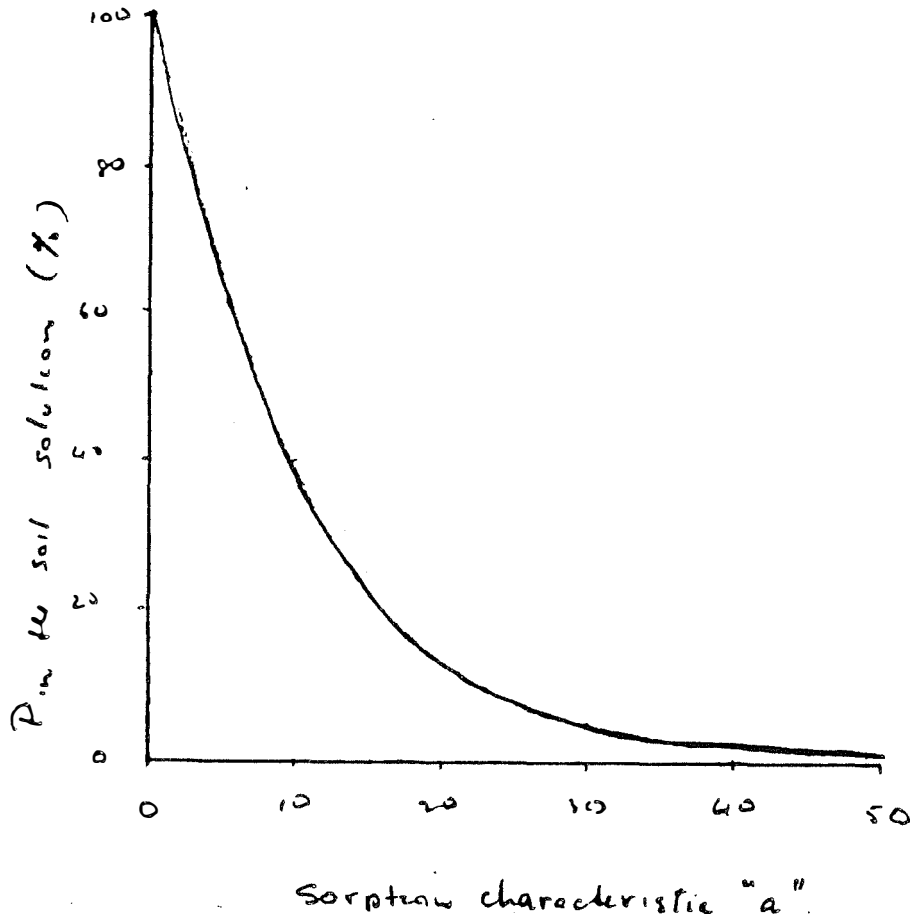

Fig. 2. Effect of the soil sorption characteristic on the modelled value for the proportion of P applied at 10 kg ha^{-1} which is in the soil solution in the top 1cm of soil.

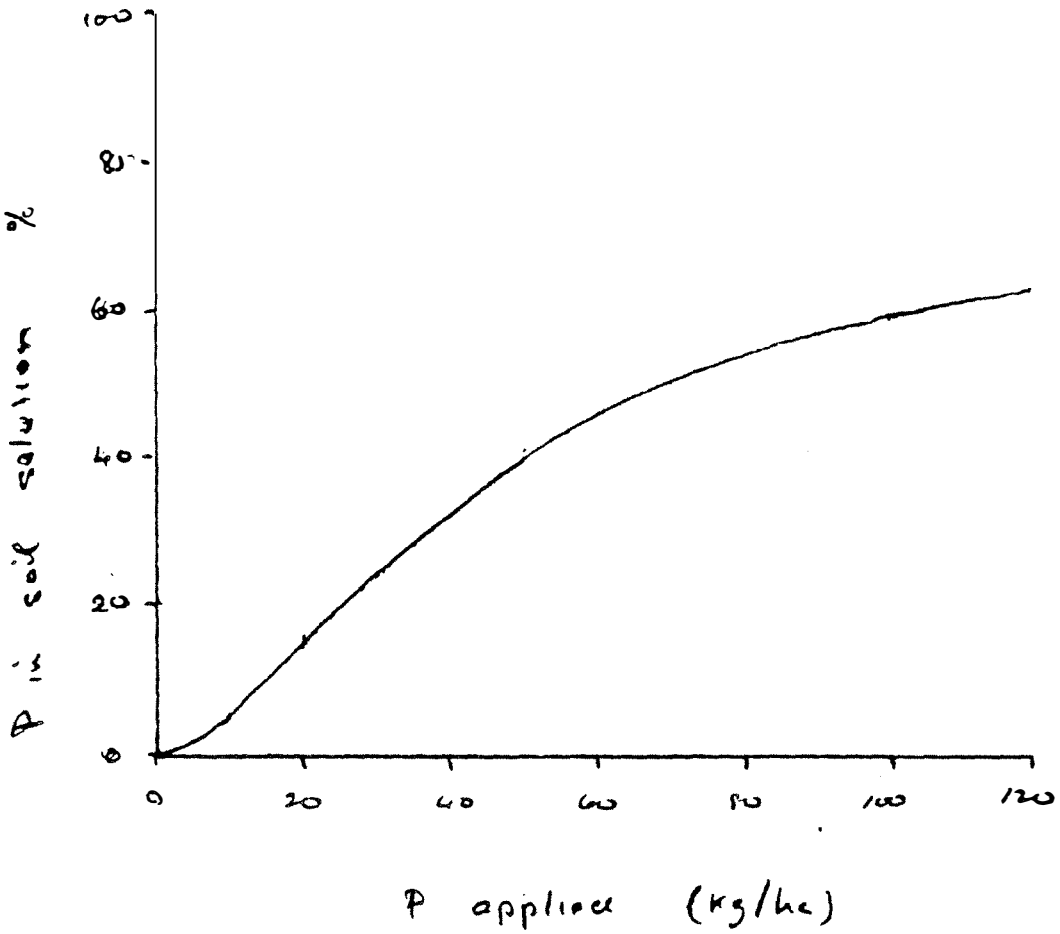

Fig. 3. Effect of level of P applied on the proportion of the applied P in the solution phase in the top 1 cm of soil when the sorption characteristic "a" was 30 μg P per g of soil.

Point Grey Development Project ERMP
An assessment of nutrient contribution from the project and potential impact on the Peel-Harvey system.

by
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1. Introduction

The Point Grey Development Project (Ref.1, referred to as the ERMP in this report) would involve the construction of a tertiary education college, tourist and holiday nodes, 'leisure living lots' and residential development. It is envisaged that up to 9,000 people would live permanently in the area.

The Environmental Protection Authority of Western Australia feels that the impact of such a proposal adjacent to an already stressed estuarine ecosystem requires careful consideration. The potential nutrient leaching and loading into the estuarine system in particular needs to be assessed. The Authority has therefore sought critical advice from the author regarding the information presented in the ERMP on nutrient contribution from the proposed project and potential impact on the Peel-Harvey estuarine system if the proposal is implemented.

The author has therefore made an assessment of the arguments put forward in the ERMP regarding quantities of nutrients and possible effects on the estuary.

1.1 Nutrient contribution from alternatives considered in ERMP

Three alternatives are considered in the ERMP where nutrient contribution has been evaluated. These are listed below with the estimated nutrient loadings.

	P (t/y)	N (t/y)
Existing farming activity	6 - 11	140
Intensified farming activity	11 - 19	210
Proposed development	5 - 7	70

The ranges in phosphorus (P) loading reflect whether good fertilizer management practices are adopted. It is essential that good practices be adopted in an area such as Point Grey, which is

adjacent to an estuarine system very much stressed with nutrient.

With broadscale farming activity it is not difficult to adopt good practices, since it would only involve a small number of people and a relatively simple soil testing procedure. Thus the lower figures in the ranges for the nutrient loadings in the two farming alternatives above could conceivably be achieved. So the baseline figure for comparing other alternatives with the existing activity in terms of P loading is 6 t/y. More intensive agricultural activity, as suggested in the ERMP, should perhaps not be pursued, because this would mean a higher P loading to the Point Grey area.

As elaborated in the ERMP nitrogen plays a less important role in contributing to the eutrophication problem of the Peel-Harvey estuary, since P is the controlling nutrient in algal growth. The proposed development at Point Grey would also eliminate much of the nitrogen fixing legumes used in the farming activity and therefore only P needs to be considered in terms of impact. I agree with this asssessment.

The P input to the proposed Point Grey development project appears at first sight to be low considering that there would be up to 9,000 people permanently residing there. A closer examination shows that this is achieved primarily by the proposed use of tertiary treatment for collected sewage thus reducing the P contribution from the disposal of treated sewage effluent from 5 t/y to only 1 t/y.

My comments will therefore be directed firstly at the question of sewage treatment and the disposal of the treated effluent and the sludge produced from treatment. This will be followed by comments on other management strategies designed to reduce P loading to the site. Finally a more realistic approach to calculating the amount of P leaching from the site to the estuary under a changed hydrological condition is presented.

2. Treatment of sewage and disposal of treated effluent and sludges

The proponent has made an undertaking that tertiary treatment of sewage would be implemented at the proposed Point Grey development area reducing P concentration to 2 mg/L and N concentration to 10 mg/L. For comparison purposes secondary treatment produces a P concentration of about 10 mg/L and about 25 mg/L of N (Ref.2).

No details on the proposed tertiary treatment of sewage are given in the ERMP, though it has been suggested that chemical treatment for the reduction of P will be used using either iron, aluminium or calcium salt to precipitate the phosphate (section 4.8.3 of ERMP).

My comments relate to the cost of treatment, the disposal of the (chemical) sludge and the use of the treated effluent.

2.1 Tertiary treatment

Tertiary treatment of sewage is costly in terms of both capital and operating costs (Ref.3), and explains why there are so few treatment plants utilizing tertiary treatment. As far as I am aware there is only one plant in Australia removing P (Lower Molonglo, Canberra). The proponent is to be commended for undertaking to construct a tertiary treatment plant at Point Grey.

2.2 Disposal of sludges

Primary and secondary sludges will be disposed of either by selling for use in compost mixes, as is currently done in Perth, or by burying in an approved sanitary landfill site (ERMP, section 4.8.3). No mention is made about the disposal of the chemical sludge. If it is to be diposed of by sanitary landfilling precaution must be taken so that conditions (eg. pH) will not change to remobilize P. This remark also applies to the biological sludge if disposed of by sanitary landfilling.

2.3 Reuse of effluent

The tertiary treated effluent is to be disposed of by re-using it for irrigating a golf-course. This proposal is commendable because it means reduced water requirement for irrigation and reduced phosphorus requirement for fertilizing greens and fairways. The proponent has shown that there will be an excess supply of P to the golf course compared to requirement when the project is fully developed (1.0 t/y available compared to 0.5 t/y required, Appendix F of ERMP).

There will also be an excess in the availability of treated effluent compared to requirment: 590 million L/y from 9,000 people irrigated over 25 ha of fairways and greens is equivalent to 2370 mm/y of water, and this is over and above rainfall of 880 mm/y. The estimated evaporation rate at Point Grey is 1400 mm/y.

The above calculation shows the necessity of disposing excess effluent above the requiement of the golf course by irrigating the College oval (5 ha), lawn (5 ha) and 'wet' public parks and garden (20 ha) with the treated effluent as well, and would necessitate more extensive reticulation of the treated effluent; this point is not brought out in the ERMP.

As indicated in the ERMP impervious holding ponds for treated effluent will be required, since most rainfall occurs in winter when irrigation is undesirable. No size for the holding ponds is indicated in the ERMP, but they need to be sizeable and not overflow during heavy storms.

The location of the golf course is not indicated in the text or maps in the ERMP. I am rather disappointed with this, because the proposed golf course is large (50 ha, the same size as the college), and as a receiving environment for the treated effluent its location should be finalized early. It should be on fairly high ground, so that excess water will not run-off to the estuary. The 'wet' public parks and greens should also be on relatively high grounds.

3. Other sources of nutrient

Other nutrient sources besides sewage are listed below with their estimated contributions

	P (t/y)
Fertilizer application to college, public parks	0.5
Effluent from septic tanks	0.9
Fertilizer application to gardens	2.1-4.1

Fertilizer application to college oval and gardens, public parks and gardens is not necessary in the long terms if treated effluent is used (see 2.3 above).

Effluent from septic tanks is difficult to control, unless the effluent is used for watering gardens in the leisure living lots. Small package plants are available that will enable septic tank effluents to be used (eg. Ref. 4). These are costly from the point of view of the householders in terms of capital and operating costs when compared to the use of inorganic fertilizers. This illustrates the difficulty in dealing with the management of small quantities of nutrients from many sources.

With septic tanks there must also be the provision for the disposal of the septic tank sludge. Even with properly operated septic tanks

there is the need to empty the tanks of sludge every 5 to 7 years (Ref. 5). If the sludge is disposed of in the property than this will mean additional nutrient load to the area. No discussion is given in the ERMP on this point.

The management of fertilizer application to private residential gardens illustrate very well the point mentioned above on the management of nutrient when many (over 3000) people are involved. The commitment by the proponent to encourage householders to use less fertilizer is very commendable, but I doubt if the lower target of 2.1 t/y could be realistically achieved. I would be more inclined to adopt a figure of between 3 to 4 t/y of P.

Total P application to the Point Grey area in the long term is therefore between 5 to 6 t/y, depending on whether treated effluent is reticulated to the college and public parks and gardens. This application rate is slightly less than or equal to the P application to the existing farming activity with good fertilizer management practice.

4. Leaching of P from Point Grey to the Peel-Harvey estuary

I agree with the proponent that it is difficult to determine quantitatively the movement of P applied to the Point Grey Area to the Peel-Harvey Estuary (Appendix F, ERMP).

An estimate of P leaching to the estuary is made in the ERMP by assuming that it is equal to to the net recharge multiplied by the concentration of P in the shallow unconfined aquifer. This assumes that there is no change in either water and P storage in the soil and groundwater system, and is a reasonable assumption when annual water and nutrient balances are considered.

Phosphorus outflow = Recharge x P conc. in shallow groundwater

4.1 Existing farming activity

Recharge = 10% of annual rainfall. No explanation is given in the ERMP on how this figure is derived, but it appears not to be inconsistent with the ratio of the conductivity of the shallow groundwater relative to rainwater (Appendix G of ERMP).
P conc. in shallow groundwater = 0.07 mg/L (measured).
Phosphorus outflow under present farming activity = 0.04 t/y.

This is very low figure indeed compared to the amount of P applied, but can be explained by the fact that there is no direct

run-off or drain from the farms to the estuary thus excess rainfall has to percolate through the soil. Spearwood soil has been kown to be able to remove P because of the presence of goethite in the soil.

4.2 Proposed development

For the proposed development the amount of P leaching to the estuary has been calculated based on the same net recharge of 10% rainfall, and a decreased P concentration in the shallow groundwater. The latter is based on the reduced P application to the area with the development. These two assumptions are, however, questionable, because the hydrology of the area will change with the proposed development.

The construction of houses and roads (urbanization) has been shown to increase net recharge (Ref. 6). This is particularly so when road run-off is directed to compensating/recharge basins. Net recharge can increase up to 25% of rainfall (Ref.7).

In addition there will be import of water to the Point Grey area of 2.1 million cubic meter per year, equivalent to an additional 210 mm of rainfall either through irrigation of gardens or irrigation using treated effluent.

The irrigation of parks and gardens over the summer means that even though there would be little recharge over the summer, the soil conditions are fairly saturated such that during the next winter more rainfall will become groundwater. The consequence of this is that there will not only be more groundwater discharge to the estuary, but that this water has been in contact with fertilized areas. Another consequence is that because of the higher flow the contact time between the water and the soil is reduced. And since the adsorption of P by soil components is time dependent the shorter contact time means that less P would be adsorbed.

Recharge = 20% of rainfall and imported water.
P concentration in shallow groundwater = 0.2 mg/L (very rough estimate).
P leaching to estuary = 0.4 t/y.

This figure is a very rough estimate. An accurate figure can only be obtained by conducting soil column experiments to determine the removal rate and removal capacity of the soil for P. With continuous application of P the capacity of the soil for P adsorption will be exhausted, and P applied to the area and not exported via biomass harvesting will end up in the estuary.

5. Discussion

The proposed development at Point Grey would mean that the P input to the area would be similar to P input to the area with the existing farming activity with good fertilizer application practices (6 t/y). This would be achieved, despite a projected population of 9,000 permanent residents, because tertiary treatment of sewage would be carried out at the site with land based disposal of the treated effluent for irrigating the golf course, college and public parks and greens, thus making good use of the 1 t/y of P in the treated effluent. Sludges from the tertiary treatment plant containing over 5 t/y of P would be disposed of outside the area.

Phosphorus from other sources would amount to between 4 to 5 t/y. Reduction in these sources would not be impossible, but because of the number of people (over 3000) involved to achieve the desired objective, would I feel be difficult to achieve.

With the proponent committed to undertaking a programme to carry out tertiary treatment of sewage, reuse of the treated effluent for irrigation of the golf course, college and public parks and greens, and other initiatives as outlined in the ERMP to reduce fertilizer application, the total input of P to the area would be similar or less than the base line figure of 6 t/y.

P leaching from the area to estuary will, however, increase compared to the baseline due to increased rainfall recharge and less contact time between the percolating water and the soil. It is difficult to quantitatively estimate the increase because there is no data on the adsorption rate and capacity of the soil at Point Grey for P and how much P has been adsorbed in the last hundred years or so the area has been opened up for agriculture. When the soil capacity is exhausted all the P applied minus accumulation in biomass and biomass export from the area will leach to the estuary. It is essential that a soil column experiment be conducted now to determine the P adsorption rate and capacity of the soil(s) at Point Grey.

A very rough estimate of P leaching from the proposed development area is 0.4 t/y. This is very small compared to the input of P to the estuary of 120 t/y, and the proposed development therefore would have very little impact on the eutrophication status of the estuary. This has only to be qualified by our lack of knowledge as to when the adsorption capacity of soil for P will be exhausted.

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