Shire of Murray Town Planning Scheme No 4
Amendment No 104 (Point Grey)

Shire of Murray

Report and recommendations
of the Environmental Protection Authority

Full document
available
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Environmental Protection Authority
Perth, Western Australia
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MEETING No: 80
DATE: 5 March 1998

ENVIRONMENTAL ASSESSMENTS COMMITTEE BRIEFING NOTE

Subject:	Shire of Murray TPS No 4 Amendment No 104 Rezoning from "Rural" to "Special Development" Lots 75, 137-139, 293, 299, 322, 672, 727, 729, 738, 1132, 1133 & 1145, Point Grey
Stage of Assessment:	Received responsible authority's response to submissions, EPA report due 27 March 1998.
Briefing Officer(s):	Garry Middle, Shelley Edwards
Purpose:	To gain endorsement for: 1. the relevant environmental factors, objectives, proposed recommendations and assessment strategy for the proposal; and 2. the delegation of the finalisation and release of the report to the Chairman,

Background:

Background information was provided at a previous Environmental Assessments Committee meeting on 22 January 1998 (Attachment 1).

Amendment 104 to the Shire of Murray Town Planning Scheme No 4 was referred to the EPA on 16 January 1997. The amendment is to rezone the area known as the Point Grey Peninsula from "Rural" to "Special Development". The Point Grey Peninsula is located opposite the Dawesville Channel on the eastern shores of the Peel Inlet and the Harvey Estuary in the Shire of Murray (Attachment 2). The area to be rezoned is approximately 1 159 ha and is adjacent to System 6 areas C50 and C51, and near to Lake McLarty and Lake Mealup which constitute System 6 area C52 (Attachment 3). The Peel-Harvey estuary is internationally recognised as a wetland of ~~international~~ importance (Ramsar Convention) and ~~consequently~~ is on the Register of the National Estate. Lakes McLarty and Mealup are also Ramsar listed.

The rezoning will allow the development of the area in accordance with an Outline Development Plan (ODP) (Attachment 4).

Important Issues:

The following are considered to be the environmental factors relevant to the proposal:

a) Vegetation - significance of remnant vegetation

b) Declared Rare and Priority Flora;

c) Fauna - impact of proposed development on waterbirds;

d) Wetlands - impact of proposed development on nearby wetlands;

e) Estuarine vegetation and fauna habitat - impact of proposed development;

f) Cave - impact of proposed development;

g) Estuarine water quality - loss of nutrients to the estuary; and

h) Mosquitoes - public amenity.

Approved by
DEP Director

These factors were identified from consideration and review of all environmental factors (preliminary factors) generated from the environmental review document and the submissions received. The identification process is summarised in Table 1.

a) Vegetation - significance of remnant vegetation

Remnant vegetation remains on nearly one third of the site as around two thirds of the site is cleared or parkland cleared, to allow for grazing (Attachment 5). The amendment area also directly abuts reserves ↑33039, ↑4990, ↑27528, ↑11718, and ↑2738.

It is proposed that 18ha of remnant vegetation will be cleared for development, around 5% of the existing remnant vegetation. This includes the removal of 10ha of parkland tree vegetation cleared from an area of around 50ha to facilitate the special residential development and 8ha of banksia woodland to allow construction of the marina and associated developments.

This vegetation on the proposed marina site is between 120 to 200m in width and represents a notable portion of uncleared vegetation in the amendment area, which has been largely cleared for farming. The proposed marina site has been nominated for conservation in the recently released Inner Peel Region Structure Plan (IPRSP) and is proposed to be included in the Peel Regional Park (PRP). The foreshore vegetation also provides a valuable corridor for fauna, linking the northern tip of Point Grey with the foreshore areas along the eastern side of the Harvey Estuary and Reserve 27528.

Other significant areas of remnant vegetation include a large portion of the southern area of the site which is proposed for conservation and rural-residential development, and areas of foreshore including the most northern point of the site, which is proposed for conservation and the development of a wilderness lodge and chalets.

Concerns were raised in submissions that the project would result in increased pressure on the existing reserves within and adjacent to the development area through indirect impacts. It is the opinion of the Department of Conservation and Land Management (CALM) that the responsible authority, the Shire of Murray, has not demonstrated that these potential impacts would be manageable.

Some public submissions claimed that the environmental review provided no information on the management of indirect impacts, deferring the above issues to the development phase.

The Foreshore Reserve Boundary was considered by WRC to be inconsistent in certain areas with remnant vegetation, landforms and soil characteristics. Ministry for Planning (MfP) recommend that the ODP be modified to include the foreshore reserves identified in the final Inner Peel Region Structure Plan (IPRSP). Inconsistencies with the PRP include the areas proposed for development of the marina, sailing club, and wilderness lodge chalets; the area proposed for special residential development in the extreme south of the amendment area; the site for the proposed constructed wetland; and the width of some of the foreshore reserve boundaries or Public Open Space around the amendment area.

Some public submissions claimed that the flora and fauna survey for the environmental review, undertaken on only 2 days in April, was not adequate to determine the diversity of species present. Consequently the survey may seriously underestimate the biodiversity of the site.

To sum up, the Department of Environmental Protection (DEP) considers that the level of information supplied in the ODP, environmental review and the response to submissions is not adequate to determine (a) the significance of the banksia woodland on the site of the proposed marina development; (b) the value of the foreshore vegetation as a corridor; and (c) that the foreshore reserve and proposed conservation areas can be managed so as not to cause unacceptable degradation. Consequently, it cannot be determined whether the EPA's objective can be met for this factor.

It is argued that due to the uncertainty surrounding the information on the vegetation, the EPA's objectives may be compromised if the whole amendment was allowed to proceed at this time. Consequently, the DEP recommends that a portion of the amendment area around the edge of the site plus an adequate buffer area and ~~some~~ areas of remnant vegetation, should not be rezoned at this time (Attachment 6). These areas include:

- areas proposed for development of the marina, sailing club, and wilderness lodge chalets;
- the area proposed for special residential development in the extreme south of the amendment area; and
- the proposed foreshore reserve and conservation areas around the amendment area to a minimum width of 150m, consistent with the final criteria of environmental acceptability for landuse proposals within the catchment of Lake Clifton (EPA Bulletin 864).

Prior to submitting a rezoning proposal for the area stated above, further work is required to determine (a) the significance of the banksia woodland on the proposed marina site; (b) appropriate management measures; and (c) the importance of the vegetation as a wildlife corridor.

M. lingulata Open Heath possible T.E.C.

b) Declared Rare and Priority Flora

Biological surveys did not find any Declared Rare and Priority Flora on the site.

As stated in the previous section, it is considered that the flora and vegetation survey was inadequate in terms of scope, duration and timing. The inappropriateness of the timing of the flora survey is well illustrated by the fact that 13 of the 21 DRF and Priority Flora listed from CALM's database as being potentially detected in the area, would not have been evident at the time of survey, as six species are aquatics or semiaquatics and seven are annuals or geophytes.

Had 3 years to do proper survey

Eucalyptus planmata Salicornia subs. p. Found by DEP

The majority of the areas of remnant vegetation, however, are proposed to be retained in reserves, public open space, or private conservation areas and consequently, it is considered that the further work required above would provide adequate protection for any Declared Rare and Priority Flora on the site.

Rivers Boundary in Wetland area.

c) Fauna - impact of proposed development on fauna and habitat

The amendment will allow the development of an area of land with a significant amount of foreshore within the Peel-Harvey Estuary. The significance of the Peel-Harvey Estuary as a waterbird habitat has been recognised by its designation as a wetland of international importance through the Ramsar agreement. The Ramsar wetland area extends to the high water mark of the estuary and includes nearby Lakes Mealup and McLarty. In terms of total numbers, Peel Inlet and Harvey Estuary comprise the most important area for waterbirds in south-western Australia (Ramsar Convention, 1990).

In addition to this, the intertidal flats in Robert Bay, on the eastern side of the development, provide feeding and loafing habitat for trans-equatorial migratory waterbirds, many of which are protected under international agreements with China and Japan (JAMBA & CAMBA). Concern was raised that the area of important habitat for the waterbirds could extend to the west side of Point Grey as well.

Important shallows.

Concern was expressed in submissions with regard to potential direct and indirect impacts on waterbirds arising from the proposed development. For example, the intertidal flats in Robert Bay directly abut an area proposed for rural-residential development. It was observed that there was no discussion of the management of impacts on the waterbirds from pedestrians, domestic pets, off-road vehicles or boats in the environmental review. And response to submissions.

It was stated by CALM that the environmental review did not provide adequate information or discussion on bird utilisation of the proposal area or potential impacts of the project on bird life during the construction and post-construction stages.

The fauna study of 20 hours without trapping was considered by submitters to be too brief to be called adequate. Research at the nearby Goodale Sanctuary south-east of Point Grey and at Lake Mealup suggests that the Point Grey Fauna list is far from complete.

The Pt Grey area has both national and international significance as waterbird habitat and consequently it must be shown that impacts on both the waterbirds and their habitat resulting from the proposed development can be adequately managed. It is the DEP's opinion that the importance of the area as habitat, primarily for waterbirds, the potential impact on the waterbirds from a population of 7 000 people both directly and indirectly, and the interaction between the habitat areas of Pt Grey and Lake McLarty and Lake Mealup in terms of bird usage (ie feeding, loafing, breeding etc) was not adequately considered in the environmental review. Consequently, it cannot be determined whether the EPA's objective can be met for this factor.

It is the opinion of the DEP that areas of significant habitat value should be identified and the width and management of the adjacent foreshore adjusted accordingly on advice of CALM, WRC and PIMA. It is argued that due to the uncertainty surrounding the information on the areas of significant habitat, the EPA's objectives may be compromised if the whole amendment was allowed to proceed at this time. Consequently, the DEP recommends that a portion of the amendment area around the edge of the site to a minimum of 150m, should not be rezoned at this time (Attachment 6).

The rezoning of this land should be proposed in a separate amendment and include the following information:

- the importance of the area of estuary adjacent to the site as habitat, primarily for waterbirds;
- a more detailed and extensive fauna survey;
- the potential direct and indirect impacts on waterbirds from an increase in resident population;
- proposed management of the foreshore areas, including discussion of the potential impacts of the proposed development on waterbirds. Potential impacts include rubbish dumping, threats from domestic pets, degradation of the environment from off-road vehicles, and management of human pressures.
- the interaction between the habitat areas of Pt Grey and lakes McLarty and Mealup in terms of bird usage (ie feeding, loafing, breeding etc);

d) Wetlands - impact of proposed development on nearby wetlands

A large wetland complex exists along the north-eastern side of the development area, containing sumplands, damplands and a small estuarine wetland. The amendment area is also within 1km of the Ramsar listed Lake McLarty and Lake Mealup (Attachment 3) and directly abuts NPNCA Nature Reserve 4990 which also contains a significant wetland area.

The wetland area in the north-eastern part of the amendment area is quite degraded due to unrestricted access by stock. This wetland area is proposed to be utilised to improve the water quality of the Robert Bay Drain by diverting the drainage waters through a series of constructed wetlands. The construction of this lake system will allow the building of a new access road through the area and the development of an associated eco-tourist village. These artificial wetlands should be designed and constructed to improve and enhance the ecological function of the degraded wetland area, on advice of WRC.

Concerns were raised in submissions that the Government may be in breach of the RAMSAR Convention if the development was allowed to proceed. The Point Grey development was seen to threaten the integrity of Lake McLarty and Lake Mealup, which are RAMSAR listed wetlands (as is the Peel-Harvey Estuary). There is an international obligation by the Australian Government under the Ramsar Convention to ensure that Ramsar wetlands are not damaged.

Concerns were raised in submissions that the potential impacts of the development on Lake Mealup and Lake McLarty was not adequately addressed. Submitters considered that the assumption that the

expected drawdown of the Leederville aquifer would not significantly impact shallow water table levels or groundwater-dependent vegetation and wetlands, was not adequately explained.

The potential impacts threatening the adjacent Ramsar wetlands that are of most significance are the possible indirect impacts to water levels caused by groundwater drawdown from the domestic use of groundwater, and a potential change in the quality of surface water and groundwater inputs to the wetlands.

The site is located downgradient of both surface and groundwater flow of Lake Mealup and Lake McLarty (Figure A5 Engineering Report 2 of the ODP). This, in combination with the very high phosphorus retention capacity of the Deep Spearwood Soils west of the wetlands should result in no nutrient transport to the lakes (Response to submissions, BBG, 1998).

Numerical modelling of groundwater abstraction was utilised by the consultants to predict drawdown in both the superficial and Leederville aquifers. As groundwater is proposed to be abstracted from the upper Leederville aquifer, no abstraction will occur within the superficial aquifer which is the groundwater source supplying the local wetlands. It was predicted that due to the discharge characteristics of the Leederville aquifer in this area, groundwater abstraction from this formation should cause minimal impact on shallow water table levels or groundwater dependent vegetation and wetlands. Advice is currently being sought from WRC regarding the accuracy of the above opinion and the potential for connectivity between the Superficial and Leederville aquifers.

Wetlands can be classified as recharge, discharge or flow-through types (Nield, Townley & Barr, 1994). Independent advice presented to the DEP indicated that as this classification was not performed on Lakes Mealup and McLarty, the prediction that groundwater abstraction will not impact the wetlands or vegetation is qualitative rather than quantitative (Gerritse, 1998, Attachment 7). Further investigation as to the hydrological performance of the wetlands should be made, after which time the relevance of their interaction with the Leederville aquifer can be explored.

Consequently, the amendment should contain the provision that either (a) prohibits the use of on-site water supply until further work detailing the quantitative nature of the potential impact of drawdown on Lakes Mealup and McLarty is performed; or (b) prohibits the supply of water from a groundwater source beneath the amendment area.

e) Estuarine vegetation - impact of proposed development on seagrasses

Pt Grey forms a physical division between the Harvey Estuary, which lies on the site's western shore, and the Peel Inlet, which lies on the site's eastern shore. The Peel-Harvey Estuary supports a highly productive and diverse ecosystem which has been significantly effected by human activities within the estuary and its catchment. Seagrass meadows are important components of the Peel-Harvey Estuary and there are many areas around the Pt Grey peninsula where seagrasses are flourishing.

A marina is proposed for a site on the promontory on the north-west flank of the Pt Grey peninsula. The marina and associated tourist development encompasses an area of 28ha, which includes the marina basin and pens, created through the excavation of 4.7ha from the shoreline. The development of the marina may also require the dredging of a channel to allow access to the Dawesville Channel and ocean, resulting in additional loss of seagrass. The creation of fringing islands from the excavated dredge spoil is proposed to aid in the shielding of the marina and to recreate habitat lost through construction of the marina.

The area of the shoreline and estuary bed that is proposed to be dredged for the construction of the marina is considered by WRC to be highly sensitive and valuable in terms of providing habitat and feeding grounds for the low order marine and estuarine creatures which inhabit the Peel-Harvey Estuary.

In their submission, WRC and PIMA raised concerns about the scale of the proposed marina development. It was felt that the overall impact of the development was unacceptable in terms of loss of significant foreshore vegetation, the breach in the vegetation corridor, loss of seagrass and estuarine environment, and impact of dredging on the environment. It was also noted that the "Boating facilities study for the Peel Region" (1996) by the Department of Transport identified the need for regional boat launching ramps and finger jetties at Point Grey rather than a boat harbour or marina.

Since the opening of the Dawesville Channel, the water quality in the estuary has improved so significantly that an almost pure marine habitat has resulted in a portion of the Harvey Estuary. As a consequence of the introduced sea water, seagrass and beach regeneration are occurring through natural processes. This natural regeneration of seagrass is infrequent and consequently, WRC considers that it should not be disturbed.

A sailing club for shallow-draft yachts is also proposed to be located on the north-eastern shore of the peninsula. The development will include a club house, apartment style accommodation, a sandy beach and a shallow draft launching ramp. A channel may need to be dredged to allow access to the sailing club.

Depth requirements for the proposed sailing club would be approximately 0.5m below low water to allow navigation by outboard powered rescue craft. As the low water mark is approximately 100m offshore, the rescue boat channel from the launching ramp needs to extend about 50m offshore of the LWM, a total distance of 150m. It is considered that approximately 2000m^2 surface area would need to be deepened with a total volume of approximately 750m^3 of spoil removed, necessitating further loss of seagrass. A submission by the Department of Transport observed that the presumed power boat depth would be some 250m offshore and consequently the dredging of the channel for powered craft may involve some 3 000 sq.m of surface and 2 000 cu.m of spoil.

It is the opinion of the DEP that the scale of the proposed marina would significantly impact the integrity and function of the Peel-Harvey Estuary in the area of the Pt Grey peninsula. The loss of habitat and seagrass that would eventuate from the development proposed in the ODP is considered to be an unacceptable impact on the dynamic environment of the estuary, in terms of area of seagrasses lost and scale of dredging required. The replacement of lost water habitat by creating islands from the dredge spoil is not considered to be an acceptable trade-off.

It is the DEP's opinion that the marina as proposed could cause unacceptable impacts on estuarine vegetation and habitat, and should be excluded from the amendment. The proponent should submit, at a later time either (a) a revised proposal for a boating facility on the site; or (b) an alternative site for the boating facility for consideration for assessment under Section 38 of the *Environmental Protection Act* 1986.

The scale and design of the boating facility should be finalised in consultation with PIMA, WRC, and the DEP. Consideration of cumulative impacts and nature of proposed land use is imperative. Access to the sandy beach must be tightly controlled to reduce impact on foreshore vegetation and the impact of the proposed tourist development should also be considered.

f) Cave - impact of proposed development; 220m long at least

A cave is present within the amendment area. The cave, named Avalon Cave, was discovered in 1959 by Lex Bastion. The cave is considered to be the most spectacular formation cave between Yanchep and Cape Naturaliste. It contains stalactites, stalagmites, flow pools and other forms of decoration. The full extent of the cave is not yet known, as it has been sealed for the past 12 years. The cave is thought to be quite extensive and an agreement between the Speleological Society and the owners of the land will allow it to be mapped in the near future.

The cave should be protected and consequently, it is the opinion of the DEP that no development should be allowed within a 200m radius of the cave entrance until the full extent of the cave has been determined and adequate protection and safety measures agreed. It is the opinion of recent explorers

that the cave extends for around 150m (Mr M Bradley, pers comm). The location of the development exclusion area is depicted on Attachment 6.

g) Estuarine water quality - loss of nutrients to the estuary

All effluent, including sewage from the proposed Pt Grey development, will be collected, treated and disposed of on-site. Consequently, nutrients could potentially be transferred to the estuary as a result of activities on site, through infiltration of the disposed effluent to the superficial aquifer and discharge of this groundwater to the estuary.

The majority of the site will be serviced by a reticulated sewerage network and tertiary treatment plant incorporating Biological Nutrient Removal (BNR) technology. The proposed final effluent concentration will be 1 ppm total phosphorus and 5 ppm total nitrogen.

Treated effluent will initially be used to irrigate the proposed eucalypt woodlot until such time as the volume of effluent is sufficient to irrigate the golf course. Disposal of wastewater in winter will be to the woodlot.

The Peel-Harvey Estuary has historically been subjected to a high level of nutrient input from runoff of surface water from its catchment and the flow of superficial groundwater. Consequently, the Peel-Harvey Estuary is eutrophic and has suffered severe algal blooms since the 1970's. The nutrient associated algal blooms are caused mainly by accumulation of particulate phosphorus in sediments and the occurrence of a significant resuspension of sediments, which greatly increases the availability of phosphorus to algae.

In 1994, the Dawesville Channel was opened, creating increased tidal exchange between the Peel-Harvey Estuary and the ocean. The increase in flow of sea water into the estuary aids in the flushing of nutrients from the estuary and increases the salinity of the estuary water. This increased salinity inhibits the growth of blue-green algae. The long term benefits of the Channel have yet to be determined, however, water quality problems have declined since its opening in 1994.

Concerns were raised in submissions about the accuracy of the assessment of potential nutrient contributions (both phosphorus and nitrogen) to the estuary from the proposed development. It was noted that some issues required further consideration, including:- variations in nutrient loading of the final effluent produced by the BNR plant; different options of disposal of effluent from the treatment plant; and various options of irrigation of the golf course, active recreation areas and landscaped areas including associated fertiliser, pesticide and insecticide applications.

Further concerns were raised with regard to the woodlot's capacity to absorb the volume of effluent proposed to be applied to the area without surface runoff or tree failure. The issue of winter storage to accommodate rainfall was mentioned. Already surface water in this area in winter.

An independent review of the phosphorus and nitrogen export models commissioned by the DEP (Attachment 7) revealed that the onsite disposal of effluent would not result in a discharge of phosphorus to the estuary in excess of requirements as stipulated in the Environmental Protection (Peel Inlet-Harvey Estuary) Policy, 1992 for some time (Gerritse, 1998). The worst possible case scenario for a depth to groundwater of 2m would result in travel times for phosphate (Gerritse, 1996) of about 70-80 years for the tourist/foreshore and effluent disposal sites (Gerritse, 1998). Consequently it is estimated that it would take 70 to 80 years for phosphorus from the proposed development to leach through to the groundwater and an even longer period of time to reach the estuary. At such time, however, the transfer of phosphorus to the estuary will result in off-site discharge of nutrients in excess of the levels stated in Environmental Protection (Peel Inlet-Harvey Estuary) Policy, 1992.

The Peel Harvey Estuarine System (Catchment Management) EPP does not provide for any specific limitation of nitrogen loadings to the estuary waters nor is any catchment target identified. The

Minister for the Environment has, however, requested that the EPA determine limits for nitrogen loadings in an update of the Environmental Protection (Peel Inlet-Harvey Estuary) Policy, 1992.

Nitrogen inputs at Pt Grey will move rapidly through the soil to the estuary and consequently need to be controlled from the outset. The estuary has more than likely become nitrogen limited for algal growth as a result of intensive flushing with sea water entering through the Dawesville Channel (Gerritse, 1998). Consequently, local discharges of nitrogen along the shoreline at Pt Grey may trigger algal blooms. The Southern Metropolitan Coastal Waters Study (1991 - 1994) emphasised the problem of elevated levels of nitrogen in coastal waters resulting with marked increases in phytoplankton populations.

The environmental review estimates that around 42 tonnes of N will be applied to the site each year at full development. Literature states that between 4 and 10% of this N may leach to the groundwater and consequently an export figure of around 4.2 tonnes/annum is expected. The independent review found that assuming no vegetation (grass clippings etc) to be exported, a transmission rate of nitrogen to groundwater of *at least* 10% may be assumed (oxic soils, oxic groundwater), resulting in groundwater concentrations (assuming no denitrification of groundwater) ranging from <0.5 mg/L N - NO_3 under low density residential areas to about 1 mg/L under the neighbourhood village and waste water treatment area and up to 5mg/L under the golf course (Gerritse, 1998).

When current and proposed nutrient inputs are compared, it is clear that total inputs of phosphorus are only increased marginally (from 5.3-8.5 to 6-10 tonnes/annum), yet total inputs of nitrogen are at least doubled (6.3-16.5 to 30-34 tonnes/annum) as a result of change in land use. The majority of the nitrogen input results from the golf course and the traditional neighbourhood village (Gerritse, 1998).

This increase in nitrogen loads is contradictory to Recommendation 1 of the Southern Metropolitan Coastal Waters Study (1991 - 1994), which has the objective of minimising nutrient inputs to marine waters within the catchments of the Swan-Canning and Peel-Harvey Estuary.

It is the opinion of the DEP that the scheme amendment should be modified to ensure that the development proposed in the ODP for the amendment area will not utilise on-site disposal of effluent.

h) Mosquitoes - public amenity

The Peel-Harvey region contains a significant area of samphire marshes which act as a breeding ground for mosquitos. The Point Grey peninsula contains areas of samphire marsh, notably at Robert Bay and between Stony Point and Mealup Point, and is well within the flight radius of mosquitoes breeding outside the amendment area. The development proposal outlined in the ODP includes the option to build a constructed wetland in the degraded wetland area near Robert Bay.

Since the opening of the Dawesville Channel, mosquito carriers have begun to breed all year round in the Peel-Harvey Estuary and surrounding areas. Consequently, the frequency of spraying has increased from 4 to 17 per year and this has necessitated a five fold increase in the use of insecticide.

The Peel Region is known as the worst area in the state for the occurrence of Ross River virus, which is now endemic in the district. It appears that macropods are the carriers for Ross River virus, transferring the disease to mosquitos. Kangaroos are prevalent on the Pt Grey Peninsula and are likely to remain within the boundary of the golf course.

The saltmarsh mosquito control program carried out by the Health Department of WA (HDWA) in collaboration with the Shire of Murray and other Peel Region local governments is fully stretched and cannot be expanded to include the Pt Grey area without the availability of additional financial resources. In addition, Pt Grey is currently not monitored for mosquito and Ross River virus activity and the HDWA funded surveillance team at the University of WA is fully stretched and could not expand their activities to include Pt Grey without the allocation of additional resources.

Concerns were raised in public submissions that the exposure of potential residents to mosquito-bourne disease had not been adequately addressed. It was felt that no consideration was made of insect movement from areas outside the development within a 5km radius, as potential mosquito breeding sites were identified within the development area only. It was also noted that the constructed wetland near Robert Bay may create a new mosquito breeding ground.

WRC noted that mosquito control measures may lead to the contamination of local water resources and wetlands. Management measures such as the filling of wetlands or damplands, or drainage of such areas are not supported by WRC and would be inconsistent with the objective for this factor.

The issue of mosquitoes is a regional problem. The proponent has agreed to manage mosquitos within the amendment area, however, cannot be responsible for mosquitos that breed elsewhere and travel to the peninsula. It is probable that the proponent would fund mosquito control, in the form of spraying or runnelling, (estimated at between $ 10 000 and $ 25 000 per year) within the amendment area. Covenants on titles notifying the prospective buyer that the land is within an endemic mosquito area is also a possibility.

The Robert Bay artificial wetland will potentially create a new mosquito breeding ground. The environmental review states that this potential mosquito habitat can be managed through habitat modification and other measures, however, the Health Department maintains that there are no proven mosquito control measures which are effective in constructed wetlands.

The Peel-Harvey Estuary is internationally recognised as a waterbird habitat. Chemical management of mosquitos may have a detrimental effect on bird breeding, associated wetland habitat and feeding areas in and adjacent to the amendment area. Until the effect of insecticide spraying on these environmental considerations is determined, it is not recommended that mosquitoes in the amendment area be controlled with chemicals. Runnelling would appear to be effective if correctly installed and maintained, with minimal impact on habitat areas (Mr T Wright, HDWA, pers comm).

As the issue of mosquitoes is a regional problem, it is the opinion of the DEP that the provisions to create no additional mosquito breeding habitat within the amendment area and to design water management plans with the objective of reducing mosquito breeding habitat would be adequate to meet the EPA's objectives.

Conclusion

The discussion of the relevant factors above reveals that insufficient information has been provided to the EPA at this time to determine whether the proposal is capable of meeting the EPA's objectives. It can be argued that the information provided in the environmental review and response to submissions is not sufficient to show that the amendment will not result in significant environmental impacts, and consequently, the amendment may be seen to be environmentally unacceptable at this time.

An alternative is, however, to approve the rezoning of a core area of land (depicted in Attachment 6), as, with the exception of water supply, effluent disposal and Avalon Cave, the major unresolved environmental issues relate to the areas of foreshore and remnant vegetation. This would allow the resubmission of a rezoning application for the foreshore area following the completion of further work as requested in the discussion above.

There are a number of issues affecting the proposed zoning of the whole of the amendment area, however, the DEP considers that urban development could be an acceptable landuse for the core of the land, providing issues of effluent disposal and water supply are resolved.

Reference Material:

1. EAC Meeting No 78, Agenda Item 2.3 Briefing Note.

2. Location of the Point Grey Peninsula and area proposed to be rezoned in Shire of Murray TPS 4 Amendment 104.

3. Location of adjacent System 6 areas C50 and C51 and aerial photograph showing reserves and existing remnant vegetation.

4. Outline Development Plan for the proposed development of the area to be rezoned in Shire of Murray TPS 4 Amendment 104.

5. Aerial photograph of the Pt Grey peninsula showing remnant vegetation.

6. Core area of land recommended for rezoning at this time.

7. Gerritse, R. G. (1998). Evaluation of the nutrient export model for the Point Grey development. An evaluation of the nutrient export models used in the Environmental Review of Bowman Bishaw Gorham, Report No 98-14 January 1998. Attachment 1.

Outcomes Statement:

1. The acceptance of the recommendations below will allow the EPA's report and recommendations to the Minister for the Environment to commence following the receipt of the responsible authority's response to submissions by the EPA.

Recommendation(s) to Committee:

The EAC recommends that the EPA:

1. adopts the assessment strategy summarised in Table 2, including the relevant environmental factors and objectives, as the basis for its report and recommendations to the Minister;

2. resolves that either:
   a) the proposal is able to be managed to meet the EPA's objectives for the relevant factors, provided that:
      i) the scheme amendment is modified to exclude areas of foreshore to a minimum of 150m, areas of remnant vegetation proposed for conservation within the amendment area, and a 200m radius around the entrance to Avalon Cave (refer Attachment 6).;
      ii) the amendment contain the provision that either (a) prohibits the use of on-site water supply until further work detailing the quantitative nature of the potential impact of drawdown on Lakes Mealup and McLarty is performed; or (b) prohibits the supply of water from a groundwater source beneath the amendment area, and the provision that the development proposed in the ODP for the amendment area will not utilise on-site disposal of effluent;
      iii) the area recommended to be excluded from this rezoning application be resubmitted subsequent to performing the following further work:
         - the determination of the significance of the foreshore vegetation;
         - the importance of the area of estuary adjacent to the site as habitat, primarily for waterbirds including the potential direct and indirect impacts on waterbirds from an increase in resident population;

- proposed management of the foreshore areas, including discussion of the potential impacts of the proposed development on waterbirds. Potential impacts include rubbish dumping, threats from domestic pets, degradation of the environment from off-road vehicles, and management of human pressures.
- the interaction between the habitat areas of Pt Grey and lakes McLarty and Mealup in terms of bird usage (ie feeding, loafing, breeding etc);
- the mapping of the extent of Avalon cave and proposal of protection and safety measures; ; its surface catchment. ↑ cave ↑ management

iv) a revised proposal for a boating facility on the site; or (b) an alternative site for the boating facility should be submitted to the EPA for consideration for assessment under Section 38 of the *Environmental Protection Act* 1986.

b) the proposal is considered to be environmentally unacceptable at this time due to the cumulative effect of impacts described in Table 2.

3. delegate the finalisation and release of the EPA's report and recommendations to the Chairman.

Cave seems to be in shallow hollow doline

Surface catchment & the cave extends to south of the 200 m circle from entrance - This area should also have question re management of surface flows. (See Topo Map Fig 2.1 in env review)

* How is it ~~that~~ this cave (known to exist since 1950's not documented/identified in the environmental review. + some indication ~~that~~ the consultants angry ~~that~~ speleologists informed DEP. of its existance.

Approved by
DEP Director

Table 1: Identification of Environmental Factors Requiring EPA Evaluation

Preliminary Factor	Proposal Characteristic	Government Agency and Public Comments	Identification of Relevant Factors
Biophysical			
Vegetation communities - significance of remnant foreshore vegetation	Remnant vegetation remains on nearly one third of the site as around two thirds of the site is cleared or parkland cleared to allow for the grazing of sheep. There will be a continuous system of recreational and conservation areas around the entire Pt Grey peninsula with the exception of coastal breaches at the proposed marina and sailing club sites. Areas of private land will also be set aside for conservation. 18ha of remnant vegetation will be cleared for development, around 5% of the existing remnant vegetation.	• The project will result in increased pressure on the existing reserves within and adjacent to the development area from inflated public access and recreation. The responsible authority has not demonstrated that these impacts will be manageable (CALM). • Further discussion of the potential impacts of the proposed development, such as fire, rubbish dumping, threats to wildlife from domestic pets, weeds, degradation of the environment from off-road vehicles, management of human pressures, and dieback, on existing nature reserves adjacent to the amendment area is required. • The Foreshore Reserve Boundary is considered to be inconsistent in certain areas with remnant vegetation, landforms and soil characteristics. • The proposed location of the marina is in a very valuable and sensitive area as it contains a significant strip of remnant vegetation (PIMA & CALM).	*Requires further evaluation. Considered to be a relevant factor.*
Declared Rare and Priority Flora -	The biological surveys commissioned by the owner of the land, TS Plunket Pty Ltd, did not find any Declared Rare and Priority Flora on the site. The proposed development will impact areas of remnant vegetation, primarily within the parkland vegetation to the south and the banksia woodland on the north-west flank of the peninsula.	The flora and fauna survey for the environmental review, undertaken on only 2 days in April, is not adequate to determine the diversity of species present. The large area of land involved in this proposal and the presence of ten different vegetation types suggests more time would have been required for an adequate plant census. The flora survey should have been conducted in spring to allow accurate identification of plants using floral structures and to observe species which would be dormant over summer and early autumn. Thus the survey must seriously underestimate the biodiversity of the site. (WSWA).	*Requires further evaluation. Considered to be a relevant factor.*
Fauna - impact of proposed development on fauna and habitat	The Peel-Harvey Estuary is a wetland of international importance, recognised by the Ramsar Convention. The Ramsar wetland area extends to the high water mark of the estuary and includes nearby Lakes Mealup and McLarty. The intertidal flats in Robert Bay, on the eastern side of the development, provide feeding and loafing habitat for many water birds including trans-equatorial migratory waders, many of which are protected under international agreements with China and Japan (JAMBA & CAMBA).	• The environmental review does not provide adequate information or discussion on bird utilisation of the proposal area and potential impacts of the project on bird life during the construction and post-construction stages. (CALM). • The area that directly abuts the intertidal flats is proposed for rural-residential development. No discussion of management of impacts on the waterbirds from pedestrians, domestic pets, off-road vehicles or boats is made in the environmental review (LMPS). • No specific actions were proposed in the environmental review to minimise impacts on waterbirds in the System 6 areas and other reserves due to the proposed increase in human population (LMPS).	*Requires further evaluation. Considered to be a relevant factor.*

Preliminary Factor	Proposal Characteristic	Government Agency and Public Comments	Identification of Relevant Factors
Declared Rare Fauna - impact of proposed development on fauna and habitat	The distribution and habitat of the following Declared Rare Fauna occur within the amendment area: • Peregrine Falcon • Carnaby's Cockatoo • Baudin's Cockatoo • Southern Brown Bandicoot • Carpet Python	• The fauna study of 20 hours without trapping is too brief to be called adequate. Research at the nearby Goodale Sanctuary south-east of Point Grey and at Lake Mealup suggests that the Point Grey Fauna list is far from complete. • Inadequate management measures are proposed to protect the potential habitat for the carpet python (LMPS).	No Declared Rare Fauna or any evidence of their recent presence was found during field surveys of the amendment area. Two areas of habitat which could support gazetted rare fauna were identified as limestone outcrops on southern parts of the western shoreline, and remnant tall Tuart trees. The mature Tuart trees are proposed to be retained within the golf course and the limestone outcrops have been precluded from development. Further investigation will be made to determine the presence or absence of the Carpet Python and provisions incorporated into the Foreshore and Conservation Area Management Plan as required. *No further evaluation required.*
Wetlands - impact of proposed development	A large wetland complex exists along the eastern side of the development area, however, the wetland is somewhat degraded. It is proposed that a series of artificial wetlands be constructed on this site. Ramsar lakes McLarty and Mealup are within 1.5km of the amendment area and NPNCA Reserve 4990, containing a wetland, is directly adjacent to the proposed woodlot area.	• The development threatens significant wetlands, including Lake McLarty and Lake Mealup. These wetlands are RAMSAR listed wetlands and consequently if this proposal was approved, the Government may be in breach of the RAMSAR Convention (CCWA). • The environmental review does not deal at all with the potential impacts of the development on Lake Mealup and Lake McLarty as required by the EPA's Environmental Review Instructions (LMPS).	*Requires further evaluation. Considered to be a relevant factor.*
Estuarine vegetation - loss of seagrass	Seagrass meadows are important components of the Peel-Harvey Estuary and there are many areas around the Pt Grey peninsula where seagrasses are flourishing. The construction of the marina requires the excavation of 4.7ha from the shoreline and seagrass beds on the north-western side of the peninsula. Fringing islands will be created from the excavated dredge spoil to shield the marina and to provide habitat.	• The area of the shoreline and estuary bed that are proposed to be dredged for the construction of the marina contain seagrass beds that are considered valuable in terms of providing habitat and feeding grounds for the low order marine and estuarine creatures which inhabit the Peel-Harvey estuary (PIMA & WRC). The proposal to use signage to protect seagrasses from boating is totally inadequate (LMPS). • The habitat of the proposed constructed dredge spoil islands is too high for optimal value to ground nesting species such as pelicans and fairy terns. In addition, the proposed jetty for public access to these islands totally negates their value as waterbird habitat (LMPS).	*Requires further evaluation. Considered to be a relevant factor.*
Groundwater quantity - availability of potable water supply	Potable water for the development is proposed to be supplied through the abstraction of groundwater from the Leederville aquifer. The development is planned to be supplied with water in stages, consistent with construction . At full development, the level in the Leederville aquifer is predicted to drop by 1.5m.	• The impact of increased bore-water use on the bores and land of neighbouring land users has not been addressed (AgWA). • The information presented in the environmental review is inadequate to sufficiently characterise the hydrology of the area to justify claims that the development will not have unacceptable environmental effects. There is a lack of site-specific detail upon which to base and verify the modelling (LMPS). • No information is provided to support the claim that lowering the Leederville aquifer will not affect the superficial aquifer (LMPS).	Modelling suggests that there is sufficient water in the Leederville aquifer to supply the amendment area at full development with minimal impact of existing groundwater resources. Groundwater is proposed to be abstracted from the Leederville unconfined aquifer. There are no other users of the Leederville aquifer in the surrounding area. All existing bores and wells abstract from the unconfined Superficial aquifer which should not be impacted. *No further evaluation required.*

Briefing suggests impact of abstraction [illegible] 17 [illegible] to be tested.

This should remain a factor.

Preliminary Factor	Proposal Characteristic	Government Agency and Public Comments	Identification of Relevant Factors
Pollution Management			
Groundwater quality - impact of on-site effluent disposal	All effluent, including sewage from the Pt Grey development, will be collected, treated and disposed of on-site. The majority of the site will be serviced by a reticulated network, culminating in a tertiary treatment plant incorporating Biological Nutrient Removal (BNR) technology. The proposed final effluent concentration will be 1 ppm total phosphorus and 5 ppm total nitrogen. Treated effluent will initially be used to irrigate the eucalypt woodlot until such time as the volume of effluent is sufficient to irrigate the golf course. Disposal of wastewater in winter will be to the woodlot.	• The aquifer from which drinking water is proposed to be abstracted is unconfined and as such is vulnerable to contamination. • A modelling exercise was undertaken to determine the estimated length of time before phosphorus would leach through the soil to the drinking water aquifer, however this exercise was not performed for nitrogen. An estimate of time before the aquifer begins to become contaminated with nitrates is needed so preventative and protection measures can be considered (PIMA & WRC). • Both the potable and irrigation water descriptions do not account for the potential salinisation of groundwater as consumption increases (AgWA). Salinisation of the groundwater is also possible if 'salty' water from the proposed artificial wetland at Robert Bay is utilised for irrigation of the golf course and landscape vegetatio (PIMA & WRC).	Potable water exists, and will be extracted from, the confined Upper Leederville aquifer at a depth of around 140 m. This water source is separated from the superficial unconfined aquifer by impermeable clays and consequently will not be influenced by superficial aquifer water quality factors. In addition, hydraulic heads in the Leederville indicate upward heads which will act against downward flow from the superficial aquifer. Reverse osmosis desalination equipment will be deployed in the event that salinity levels increase in the potable water supply. Groundwater supply projections have accommodated the potential for increasing salinity. *No further evaluation required.*
Estuarine water quality - impact of on-site effluent disposal	All effluent, including sewage from the proposed Pt Grey development, will be collected, treated and disposed of on-site. The majority of the site will be serviced by a reticulated network, culminating in a tertiary treatment plant incorporating Biological Nutrient Removal (BNR) technology. The proposed final effluent concentration will be 1 ppm total phosphorus and 5 ppm total nitrogen. Treated effluent will initially be used to irrigate the eucalypt woodlot in the south-eastern portion of the amendment area until such time as the volume of effluent is sufficient to irrigate the golf course. Disposal of wastewater in winter will be to the woodlot.	• The provision of a sewer by the Water Corporation is recommended, given the scale of the proposed development (HDWA). • The calculations for the proposal were based on the lower extremity of effluent concentrations expected from a BNR plant. Consequently the estimated nutrient loads to the estuary as stated in the environmental review may be lower than what are actually achievable (PIMA & WRC). • The environmental review gives no indication of the woodlot's capacity to absorb the volume of effluent proposed to be applied to the area without surface runoff or tree failure and does not consider rainfall during winter (LMPS). • The environmental review states that N export from the development area to the Peel-Harvey estuary are to be 4.2 tonnes/annum, which equates to approximately 1% of the total N export from the estuary to the ocean. One of the overall objectives of the Peel-Harvey EPP is to reduce nutrient inputs to the estuary. The Point Grey proposal is considered to be contrary to that objective as the development proposes a significant and unacceptable amount of N export to the estuary (PIMA & WRC).	*Requires further evaluation. Considered to be a relevant factor.*
Odours - impact of waste water treatment plant	Odours may be experienced from the waste water treatment plant and from algal accumulations.	none	The waste water treatment plant is located at least 500m away from residential development. Due to the improvement in water quality of the estuary, excessive odours from algal accumulation is not expected to effect residents. *No further evaluation required.*
Noise and dust - impact of construction	Noise and dust should be taken into consideration during the construction phase.	none	Prior to construction, a Construction Management Plan shall be prepared for each stage in consultation with the EPA on advice from the Shire of Murray (Scheme provision 12). *No further evaluation required.*

Preliminary Factor	Proposal Characteristic	Government Agency and Public Comments	Identification of Relevant Factors
Turbidity - impact of dredging	Potential turbidity impacts include plume generation, resulting in water discolouration and smothering of benthic fauna in settlement areas. This may occur during then construction of the marina and sailing club as a result of dredging.	none	A Dredge Spoil Management Plan will be prepared in accordance with PIMA requirements and a Water and Sediment Quality Monitoring Plan implemented. *No further evaluation required.*
Social Surroundings			
Aboriginal heritage - potential for heritage sites	An archaeological and ethnographic aboriginal heritage study was undertaken. One sacred tree was identified in the vicinity of the residential village and a skeleton may be located in the area proposed for the Wilderness Lodge.	It was noted that no Aboriginal site will be impacted and the recommendations put forward by the consultants to the proponents are endorsed by the Aboriginal Affairs Department. The developers should continue to recognise and involve Aboriginal people during the development (AAD).	All site works will be carried out in accordance with the provisions of the Aboriginal Heritage Act 1972 and continued consultation with the local Aborigines is intended.
Mosquitoes - regional issue	The Point Grey peninsula contains areas of samphire marsh, notably at Robert Bay and between Stony Point and Mealup Point, which act as a breeding ground for mosquitos and is well within the flight radius of mosquitoes breeding outside the amendment area. Since the opening of the Dawesville Channel, mosquito carriers have begun to breed all year round in the Peel-Harvey Estuary and surrounding areas. The proposal includes the provision to create no additional mosquito breeding areas and to design water management plans with the objective of reducing mosquito breeding habitat.	• The exposure of potential residents to mosquito-bourn disease has not been adequately addressed. The long term effects of fortnightly spraying on the ecology of the area and resident population are also not known. • The Robert Bay wetland will potentially create a new mosquito breeding ground, however, as no commitment has been made to construct the wetland, a full assessment of the risk cannot be made (AgWA). There are no proven mosquito control measures which are effective in constructed wetlands (HDWA). • No consideration is made of insect movement from areas outside the development within a 5km radius, as the environmental review identifies potential mosquito breeding sites within the development area only (LMPS). • Mosquito control measures may lead to the contamination of local water resources and wetlands. Should chemical management be utilised, it may have a detrimental effect on bird breeding and associated wetland habitat and feeding areas. The WRC does not support management measures such as the filling of wetlands or damplands, or drainage of such areas (PIMA & WRC).	*Requires further evaluation. Considered to be a relevant factor.* Text suggests it is ok. ✓
Risk and hazards	Areas such as the waste water treatment plant and the groundwater abstraction bores are potentially hazardous.	none	Adequate buffers separating potentially hazardous facilities will be established in accordance with EPA criteria for individual fatality risk and the DME's requirements in respect of public safety. *No further evaluation required.*
Other			
Unresolved management issues		• The responsible authority has indicated that management plans for many environmental issues have been deferred until the project is approved, however, there is no guarantee that satisfactory management plans will be developed or even if it is possible to provide adequate protection for the environment. Any management plans prepared by the responsible authority should be available for public review. • A decision should be made on the construction of the Robert Bay Wetland. If the construction is not to proceed, what will happen to the proposed site?	The requirement for Management Plans to be prepared in consultation with appropriate regulatory agencies will be incorporated in the Scheme Amendment Special Provisions. Management Plan preparation will therefore be a legal requirement of development. *No further evaluation required.* — Needs also to include discussion of aspects of development to facilitate management.

Dredging Consideration not approved

Preliminary Factor	Proposal Characteristic	Government Agency and Public Comments	Identification of Relevant Factors
Scale of development		• Concerns were raised in regard to the huge impact that an additional 7 000 people would have on such a sensitive environment. Impacts would include threats to wildlife from domestic animals, the introduction of exotic species into the bushland from garden plants, rubbish dumping, degradation of the environment from off-road vehicles etc and the impact of fire on the surrounding environment (CCWA). • The placement of a new town of 7 000 people only 20km from Pinjarra, in an area that has poor infrastructure, seems inappropriate due to the duplication of essential services and cost of the provision of these services (MEAC).	The indirect environmental effects of establishing a population of 7,000 residents at Point Grey over the next 20 years must be considered in the context of growth which is expected in the Inner Peel Region over the next 50 to 60 years, and the increase in environmental management effort in the region which will be needed to protect the environment under the pressure of this growth. There will not be a duplication of services. The services provided will be at the local level such as local shopping, primary school, and public open space. The requirements for district level services (eg high schools, district hospital) will still be provided at Pinjarra. *No further evaluation required.*
Loss of rural/ agricultural areas		• Limited consideration has been given to the impact of the proposed development on neighbouring land uses. Adequate vegetation and suitable buffers separating the development from nearby rural properties is essential, as agricultural activities should not be inconvenienced or limited as a result of the development proceeding. The requirements of urban zonings, such as odour and noise controls, should not be imposed on neighbouring rural landholders as a result of urban development (AgWA). • Once this development is established, there will be a tendency for expansion of residential areas, encroaching into good agricultural land.	Apart from around 1500m boundary length of areas proposed for zoning as Rural Residential/Landscape Protection and adjacent land, the ODP proposes that only land zoned as Conservation space will abut neighbouring land. The focus of tourist and residential uses is in the centre and far north of the site. The smallest separation distance between land proposed for residential uses, and rural land is approximately 1km. *No further evaluation required.*
Other alternatives		The environmental review does not discuss any alternatives or compromises. Developments which allow a small increase in international and local tourism without major alterations to the natural attributes could be researched in a feasibility study (GS).	The Outline Development Plan is the result of a four year programme of research. The ODP has been continually revised to take into account issues as they have arisen. The ODP is considered to be the best alternative that achieves the desired outcome of the proponent. *No further evaluation required.*

Preliminary Factor	Proposal Characteristic	Government Agency and Public Comments	Identification of Relevant Factors
Previous assessment		In 1987, the EPA rejected an earlier development proposal for the same area of Point Grey (EPA Bulletin 306). The area has not changed and is no more suitable for a development today, ten years later. The impact of the Point Grey development on surrounding nature reserves would still be severe and unacceptable and the impact on the water quality of the estuary itself remains of concern (CCWA). A summary of the report and recommendations is as follows: • The development was seen to have the potential to contribute phosphorus and nitrogen into the estuarine ecosystem through the disposal of treated sewage effluent and septic tank waste, the application of fertilisers on domestic lawns and gardens, and the leaching of agricultural fertiliser already in the soil. • The proximity of residential and rural residential type lots abutting the System 6 reserves was seen to have adverse impacts, given the proposed population levels, unless stringent management conditions were implemented. • The foreshore reserve and proposed open space areas were not seen to be adequate as all vegetation associations were not thought to be adequately represented in conservation areas. • Point Grey was seen to be the most significant topographical feature in the Peel Harvey system and consequently requiring conservation and landscape protection priority. • Reduced environmental amenity would have been experienced by Point Grey residents if the proposal progressed, including significant problems associated with macroalgal accumulations along the foreshores, contributing to odour and beach fouling and high mosquito numbers.	Significant advances have been made over the last decade in understanding and describing the movement of phosphorus and nitrogen through sandy soil profiles on the Swan coastal plain. The ODP provides for the retention of major tracts of land for the purpose of conservation, including a continuous core area of foreshore and upland vegetation forming a link between Harvey Estuary and Peel Inlet totalling around 100ha. The arrangement of land uses proposed by the ODP and the requirement for foreshore and conservation area management plans to be finalised and implemented prior to construction leads the conclusion that existing reserves can be acceptably managed under the influence of the proposed land uses and additional local population. The earlier land use proposal was put forward at a time when water quality in the adjacent estuarine waters was poor leading to problems with blooms of macroalgae and phytoplankton. The completion of the Dawesville Channel in 1994 has brought about a dramatic improvement in water quality off Point Grey, in particular on the western shores, but also on the eastern shores. *No further evaluation required.*
System 6 update		The development should be halted until the finalisation of the System 6 update as it is believed by local residents that parts of the Pt Grey area may be recommended for conservation by the EPA.	No area of land within the amendment area has been identified in the System 6 Update at this time. *No further evaluation required.*
Regional planning considerations		• The proposed development as outlined in the environmental review and the ODP is not consistent with the recommendations for regional planning. • The 'Boating facilities study for the Peel Region (1996)'by DOT identified the need for regional boat launching ramps and finger jetties at Point Grey rather than a boat harbour or marina. Further investigation should be made into the appropriateness and the location of the proposed marina and sailing club developments (PIMA & WRC).	These issues are outside the jurisdiction of the EPA as they relate to planning considerations. The issues should be considered by the WAPC. *No further evaluation required.*
Public costs of the development		• The cost of treating water by reverse osmosis is more than twice the cost of water treatment in the Perth metropolitan area. As potable water is proposed to be provided privately (ie not by the Water Corporation), all costs will need to be met by either the residents of the Point Grey area or via a subsidy paid by ratepayers in the Shire of Murray (LMPS). • The operating cost of the treatment system proposed for the development may be at least three times the cost of metropolitan waste water treatment. Further costs include maintenance of the waste water collection system (LMPS). • Other ongoing costs that need to be considered and allocated funding include long term maintenance of drainage systems, road maintenance, dredging to maintain boat launching facilities, general marina maintenance, mosquito control, removal of algal accumulations (at least in the short to medium term), and fire control (LMPS).	These issues are outside the jurisdiction of the EPA as they do not relate to environmental considerations. The issues should be considered by the Shire of Murray. *No further evaluation required.*

Table 2: Summary of Assessment of Relevant Environmental Factors

Environmental Factor	Relevant Area	EPA Objective	Assessment	EPA advice
Biophysical				
Vegetation communities - significance of remnant foreshore vegetation	The Swan Coastal Plain.	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	The DEP and CALM considers that the level of information supplied in the ODP and the environmental review is not adequate to determine the significance of the banksia woodland on the site of the proposed marina development and the value of the foreshore vegetation as a corridor. Consequently it cannot be determined whether the EPA's objective can be met for this factor. The areas recommended for conservation and reservation as outlined in the final Inner Peel Region Structure Plan (IPRSP) are supported by the DEP, CALM, MfP and WRC.	Having particular regard to: a) the inadequate consideration of the significance of the vegetation on the site of the proposed marina development; b) the lack of information regarding the value of the foreshore as a corridor; c) the inconsistencies of the areas of remnant vegetation proposed to be retained in the ODP with the reserves in the final IPRSP; d) the uncertainty that the foreshore reserve and proposed conservation areas can be managed so as not to cause unacceptable degradation; it is the EPA's opinion that the proposal outlined in the ODP to develop the amendment area may not meet the EPA's objective to maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities. For the EPA's objective to be met, the scheme amendment will need to be modified to exclude a portion of the amendment area around the edge of the site plus an adequate buffer area and some areas of remnant vegetation from the rezoning application. These areas include: • areas proposed for development of the marina, sailing club, and wilderness lodge chalets; • the area proposed for special residential development in the extreme south of the amendment area; and • the proposed foreshore reserve and conservation areas around the amendment area to a minimum width of 150m, consistent with the final criteria of environmental acceptability for landuse proposals within the catchment of Lake Clifton (EPA Bulletin 864).. Prior to submitting a rezoning proposal for the area stated above, further work is required to determine (a) the significance of the banksia woodland on the proposed marina site; (b) appropriate management measures; and (c) the importance of the vegetation as a wildlife corridor.
Declared Rare and Priority Flora	The amendment area and all conservation reserves directly adjacent to the amendment area.	Protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act 1950.	It is considered that the flora and vegetation survey was inadequate in terms of scope, duration and timing. The inappropriateness of the timing of the flora survey is well illustrated by the fact that 13 of the 21 DRF and Priority Flora listed from CALM's database as being potentially detected in the area, would not have been evident at the time of survey. The majority of the areas of remnant vegetation, however, are proposed to be retained in reserves, public open space, or private conservation areas.	Having particular regard to: a) the proposed retention of the majority of remnant vegetation; and b) the request for further information regarding the significance of the vegetation on the proposed marina site; it is the EPA's opinion that the development outlined in the ODP for the amendment area will meet the EPA's objective to protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act 1950 as it is considered that the further work required above would provide adequate protection for any Declared Rare and Priority Flora on the site.

Environmental Factor	Relevant Area	EPA Objective	Assessment	EPA advice
Fauna - impact of proposed development on fauna and habitat	The habitat areas of the trans-equatorial migratory waders within Australia, including the amendment area and conservation reserves directly adjacent to the amendment area, the Peel-Harvey estuary and Lakes McLarty and Mealup.	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna and fauna habitat.	The Pt Grey area, in particular Robert Bay on the north-eastern side of the amendment area, has both national and international significance as waterbird habitat. Consequently it must be shown that impacts on both the waterbirds and their habitat resulting from the proposed development can be adequately managed. It is the DEP's opinion that the importance of the area as habitat, primarily for waterbirds, the potential impact on the waterbirds from a population of 7 000 people both directly and indirectly, and the interaction between the habitat areas of Pt Grey and lakes McLarty and Mealup in terms of bird usage (ie feeding, loafing, breeding etc) was not adequately resolved in the environmental review. Consequently, it cannot be determined whether the EPA's objective can be met for this factor.	Having particular regard to: a) the limited information regarding the potential impacts of the proposed development on an international and nationally recognised waterbird habitat; b) the limited discussion of the potential impacts of the proposed development on bird life during the construction and post-construction stages; and c) the limited fauna study; it is the EPA's opinion that the development outlined in the ODP for the amendment area may not meet the EPA's objective to maintain the abundance, species diversity and geographical distribution of terrestrial fauna. For the EPA's objective to be met, areas of significant habitat value should be identified and the width and management of the adjacent foreshore adjusted accordingly on advice of CALM, WRC and PIMA. Due to the uncertainty surrounding the information on the areas of significant habitat, the EPA's objectives may be compromised if the whole amendment was allowed to proceed at this time. Consequently, the DEP recommends that a portion of the amendment area around the edge of the site to a minimum of 150m, should not be rezoned at this time. The rezoning of this land should be proposed in a separate amendment and include the following information: • the importance of the area of estuary adjacent to the site as habitat, primarily for waterbirds; • a more detailed and extensive fauna survey; • the potential direct and indirect impacts on waterbirds from an increase in resident population; • proposed management of the foreshore areas, including discussion of the potential impacts of the proposed development on waterbirds. Potential impacts include rubbish dumping, threats from domestic pets, degradation of the environment from off-road vehicles, and management of human pressures. • the interaction between the habitat areas of Pt Grey and lakes McLarty and Mealup in terms of bird usage (ie feeding, loafing, breeding etc);

Environmental Factor	Relevant Area	EPA Objective	Assessment	EPA advice
Wetlands	The Swan Coastal Plain	Maintain the integrity, functions and environmental values of wetlands.	The most significant impacts threatening the nearby Ramsar wetlands, Lake Mealup and Lake McLarty, are potential indirect impacts to water levels caused by groundwater drawdown from the use of groundwater within the development, and a potential change in the quality of surface water and groundwater inputs to the wetlands. The site is located downgradient of both surface and groundwater flow of Lake Mealup and Lake McLarty. This, in combination with the very high phosphorus retention capacity of the Deep Spearwood Soils west of the wetlands should result in no nutrient transport to the lakes (Response to submissions, BBG, 1998). Numerical modelling predicted that due to the discharge characteristics of the Leederville aquifer, groundwater abstraction from this formation should cause minimal impact on shallow water table levels or groundwater dependent vegetation and wetlands. This prediction was considered by an independent reviewer to be qualitative rather than quantitative, as no consideration was given to hydrological performance of the wetlands. Further investigation into the wetland classification should be made, after which time the relevance of their interaction with the Leederville aquifer can be explored.	Having particular regard to: a) the potential indirect impacts to water levels in nearby Ramsar wetlands caused by groundwater drawdown from the supply of groundwater to the development; and b) the qualitative rather than quantitative evaluation of hydrology of the wetlands; it is the EPA's opinion that the development outlined in the ODP for the amendment area may not meet the EPA's objectives to maintain the integrity, functions and environmental values of wetlands. For the EPA's objective to be met, the scheme amendment will need to be modified to include the provision that either: (a) prohibits the use of on-site water supply until further work detailing the quantitative nature of the potential impact of drawdown on Lakes Mealup and McLarty is performed; or (b) prohibits the supply of water from a groundwater source beneath the amendment area. The amendment should also propose that the artificial wetland be designed and constructed to improve and enhance the ecological function of the degraded wetland area, on advice of WRC.
Estuarine vegetation	The Peel-Harvey Estuary.	Maintain the ecological function, abundance, species diversity and geographic distribution of seagrasses.	It is the opinion of the DEP that the scale of the proposed marina would significantly impact the integrity and function of the Peel-Harvey Estuary in the area of the Pt Grey peninsula. The loss of habitat and seagrass that would eventuate from the development proposed in the ODP is considered to be an unacceptable impact on the dynamic environment of the estuary, in terms of area of seagrasses lost and scale of dredging required. The replacement of lost water habitat by creating islands from the dredge spoil is not considered to be an acceptable trade-off. The marina, as proposed, could cause unacceptable impacts on estuarine vegetation and habitat, and should be excluded from the amendment.	Having particular regard to: a) objections raised by PIMA, WRC and CALM with regard to the scale of the proposed marina; b) the loss of seagrass and associated estuarine habitat; c) national and international significance of the Peel-Harvey estuary; and d) the impact on the estuary that would result from large scale dredging; it is the EPA's opinion that the development outlined in the ODP for the amendment area may not meet the EPA's objective to maintain the ecological function, abundance, species diversity and geographic distribution of seagrasses. For the EPA's objective to be met, the proponent should submit, at a later time either: (a) a revised proposal for a boating facility or alternative landuse on the site; or (b) an alternative site for the boating facility for consideration for assessment under Section 38 of the *Environmental Protection Act* 1986.. The scale and design of the final boating facility should be agreed in consultation with PIMA, WRC, and the DEP. Consideration of cumulative impacts and nature of proposed land use is imperative. Access to the sandy beach must be tightly controlled to reduce impact on foreshore vegetation and the impact of the proposed tourist development should also be considered.

Environmental Factor	Relevant Area	EPA Objective	Assessment	EPA advice
Cave - impact of proposed development	The amendment area	Maintain the environmental, scientific, cultural and recreational values of cave landforms.	A cave is present within the amendment area. The cave, named Avalon Cave, was discovered in 1959 by Lex Bastion. The cave is considered to be the most spectacular formation cave between Yanchep and Cape Naturaliste. It contains stalactites, stalagmites, flow pools and other forms of decoration. The full extent of the cave is not yet known. The cave is thought to be quite extensive and an agreement between the Speleological Society and the owners of the land will allow it to be mapped in the near future. It is the opinion of recent explorers that the cave extends for around 150m (Mr M Bradley, pers comm).	Having particular regard to: • the unknown extent of the cave; and • the lack of protection and safety measures proposed in the environmental review; it is the EPA's opinion that the development outlined in the ODP for the amendment area may not meet the EPA's objective to maintain the environmental, scientific, cultural and recreational values of cave landforms. For the EPA's objective to be met, no development should be allowed within a 200m radius of the cave entrance until the full extent of the cave has been determined and adequate protection and safety measures agreed.
Pollution Management				
Estuarine water quality	The Peel-Harvey Estuary to the high water mark.	Meet environmental quality objectives for the Peel Inlet-Harvey Estuary specified in the Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992 and water quality guidelines specified in EPA Bulletin 711 for the protection of aquatic ecosystems.	An independent review revealed that onsite disposal of effluent would not result in a discharge of phosphorus to the estuary in excess of requirements as stipulated in the Environmental Protection (Peel Inlet-Harvey Estuary) Policy, 1992 for a minimum of 70-80 years. After this time, the phosphorus leaching through the soil profile will breakthrough to the water table, seeping into the estuary. Nitrogen inputs at Pt Grey will move rapidly through the soil to the estuary and consequently need to be controlled from the outset. The estuary has become nitrogen limited for algal growth as a result of the Dawesville Channel. Consequently, local discharges of nitrogen along the shoreline at Pt Grey may trigger algal blooms. The Southern Metropolitan Coastal Waters Study (1991 - 1994) emphasised the problem of elevated levels of nitrogen in coastal waters resulting with marked increases in phytoplankton populations. The environmental review estimates that around 42 tonnes of N will be applied to the site each year at full development. A transmission rate of nitrogen to groundwater of *at least* 10% may be assumed, resulting in groundwater concentrations ranging from <0.5 mg/L N - NO_3 under low density residential areas to about 1 mg/L under the neighbourhood village and waste water treatment area and up to 5mg/L under the golf course (Gerritse, 1998). When current and proposed nutrient inputs are compared, it is clear that total inputs of phosphorus are only increased marginally (from 5.3-8.5 to 6-10 tonnes/annum), yet total inputs of nitrogen are at least doubled (6.3-16.5 to 30-34 tonnes/annum) as a result of change in land use (Gerritse, 1998). This increase in nitrogen loads is contradictory to Recommendation 1 of the Southern Metropolitan Coastal Waters Study (1991 - 1994), which has the objective of minimising nutrient inputs to marine waters within the catchments of the Swan-Canning and Peel-Harvey Estuary.	Having particular regard to: a) the proposed on-site disposal of all effluent, including sewage; b) the two-fold increase in nitrogen inputs as a result of the proposed development; and c) the nitrogen limiting capacity of the Harvey Estuary; it is the EPA's opinion that the development outlined in the ODP for the amendment area does not meet the EPA's objectives to meet environmental quality objectives for the Peel Inlet-Harvey Estuary specified in the Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992 and water quality guidelines specified in EPA Bulletin 711 for the protection of aquatic ecosystems. For the EPA's objective to be met, the scheme amendment will need to be modified to ensure that the development proposed in the ODP for the amendment area will utilise off-site disposal of effluent.
Social Surroundings				
Mosquitoes	The amendment area.	Control the breeding of mosquitoes without adversely affecting other flora and fauna.	The issue of mosquitos is a regional problem. The proponent has agreed to manage mosquitos within the amendment area, however, cannot be responsible for mosquitos that breed elsewhere and travel to the peninsula. The proposal includes the provision to create no additional mosquito breeding areas and to design water management plans with the objective of reducing mosquito breeding habitat.	Having particular regard to: a) the issue of mosquitos being a regional problem; b) the provision to create no additional mosquito breeding areas within the amendment area; and c) the agreement to design water management plans with the objective of reducing mosquito breeding habitat; it is the EPA's opinion that the development outlined in the ODP for the amendment area will meet the EPA's objectives to control the breeding of mosquitoes without adversely affecting other flora and fauna.

MEETING No: 78
DATE: 22 January 1998

ENVIRONMENTAL ASSESSMENTS COMMITTEE BRIEFING NOTE

Subject:	Shire of Murray TPS No 4 Amendment No 104 Rezoning from "Rural" to "Special Development" Lots 75, 137-139, 293, 299, 322, 672, 727, 729, 738, 1132, 1133 & 1145, Point Grey
Stage of Assessment:	Public review period ended 16 December 1997, awaiting responsible authority's response to submissions, due 24 February 1998.
Briefing Officer(s):	Garry Middle, Shelley Edwards
Purpose:	To provide the Environmental Assessments Committee with a project briefing of above proposal.

Background:

- In July 1987, Malina Holdings Ltd submitted an Environmental Review and Management Plan to the Environmental Protection Authority (EPA) that described a development proposal for the Point Grey area. The proposal included a college and associated residential campus; and 18 hole golf course; tourist and holiday accommodation sites; 3 500 residential and rural residential lots; open space and foreshore reserves; and basic community infrastructure. This proposal became known as the "College Town" proposal.
- In May 1988, the Minister for the Environment rejected the College Town proposal on advice from the EPA (Bulletin 306) (Attachment 1). The main grounds for refusal were:
    - potential contribution of nutrients (phosphorus and nitrogen) to an already stressed environment (the Peel-Harvey estuary);
    - potential adverse impacts on existing System 6 reserves as a consequence of the proposed population levels and the proximity of residential and rural residential type lots to the reserves;
    - the allocation foreshore reserve and proposed open space areas were not seen to be adequate; and
    - reduced environmental amenity due to significant problems associated with macroalgal accumulations along the foreshores, contributing to odour and beach fouling and high mosquito numbers.
- In 1994, the Dawesville Channel was opened, creating increased tidal exchange between the Peel-Harvey estuary and the ocean. The increase in flow of sea water into the estuary aids in the flushing of nutrients from the estuary and increases the salinity of the estuary water. This increased salinity inhibits the growth of blue-green algae.
- The long term benefits of the Channel have yet to be determined, however water quality problems have declined since its opening in 1994.

The Proposal:

Amendment 104 to the Shire of Murray Town Planning Scheme No 4 was referred to the EPA by the on 16 January 1997. The amendment is to rezone the area known as the Point Grey Peninsula from "Rural" to "Special Development". The Point Grey Peninsula is located opposite the Dawesville Channel on the eastern shores of the Peel Inlet and the Harvey Estuary in the Shire of Murray (refer

Approved by DEP Director

Attachment 2). The area to be rezoned is approximately 1 159 ha and is adjacent to System 6 areas C50 and C51, and near to Lake McLarty and Lake Mealup which constitute System 6 area C52 (Attachment 3). The Peel-Harvey estuary is internationally recognised as a wetland of international importance (Ramsar Convention) and consequently is on the Register of the National Estate. Lakes McLarty and Mealup are also Ramsar listed.

The rezoning will allow the development of the area in accordance with an Outline Development Plan (ODP) (Attachment 4). The ODP submitted to the DEP allows for the development of:

- 1500 fully serviced residential village allotments, ranging in size from 500m^2 to 2 000m^2;
- 200 low density Special Residential lots (180 serviced and 20 unserviced lots) and 20 unserviced Rural-Residential lots;
- tourist accommodation and associated facilities, including a wilderness lodge and chalets, and waterfront and harbourside villages;
- a marina and sailing club;
- reserves for conservation, recreation and open space;
- an 18 hole golf course ;
- an eco-tourist village on the margin of the proposed constructed wetland at Robert Bay; and
- a sewerage treatment plant and a eucalypt woodlot irrigated with treated effluent.

The development will be serviced with underground power and telecommunications. The provision of natural gas is not available at this time. The provision of water by the Water Corporation is not available and the development has been planned around the principle that the water supply should be drawn from the site. Potable water will be drawn from the Leederville aquifer and water for irrigation may be provided by a number of sources, such as treated effluent, run-off from the Robert Bay Drain Catchment. All effluent, including stormwater and sewage, will be collected, treated and disposed of on-site.

The Instructions for the above amendment were issued on 14 March 1997 and the Environmental Review was submitted on 9 July 1997. The Executive Summary from the Environmental Review is included as Attachment 5. The public submission period for the Environmental Review commenced on 17 October 1997 for a period of 60 days, ending on Tuesday 16 December 1997. A total of 46 environmental submissions were received by the Shire of Murray and forwarded to the Department of Environmental Protection (DEP). The DEP, after considering issues raised, requested further work from the responsible authority in regard to nutrients and foreshore and reserve management. The DEP is currently awaiting the response to submissions.

A 28 day extension of the time period for the responsible authority to respond to issues raised in submissions was granted by the Minister for Planning, and consequently, the EPA must now request an extension from the Minister for the Environment for the time period allowed under Section 48D (1) of the *Environmental Protection Act* 1986 to report to the Minister on the environmental factors relevant to the scheme and the conditions, if any, to which the scheme should be subject. A 28 day extension is requested, consistent with the 28 day extension granted by the Minister for Planning.

Important Issues:

Fifteen factors were identified by the EPA in the Instructions (Attachment 6). They are as follows:

1. Vegetation
2. Declared Rare and Priority Flora
3. Fauna
4. Declared Rare Fauna
5. Wetlands
6. Estuarine vegetation and fauna habitat

Approved by
DEP Director

7. Groundwater quantity
8. Surface water quality
9. Estuarine water quality
10. Odours
11. Noise and Dust
12. Turbidity
13. Mosquitoes
14. Aboriginal Heritage
15. Risk and Hazards

Reference Material:

1. EPA (1988) Point Grey Project, Malina Holdings Ltd. Report and Recommendations of the Environmental Protection Authority, Bulletin 306, Perth WA.

2. Location of the Point Grey Peninsula and area proposed to be rezoned in Shire of Murray TPS 4 Amendment 104.

3. Location of adjacent System 6 areas C50 and C51 and aerial photograph showing reserves and existing remnant vegetation.

4. Outline Development Plan for the proposed development of the area to be rezoned in Shire of Murray TPS 4 Amendment 104.

5. Bowman Bishaw Gorham (1997) Executive Summary: Shire of Murray TPS 4 Amendment 104 (Point Grey) Section 48 Environmental Review. Perth, WA.

6. Instructions for the Shire of Murray TPS 4 Amendment 104, issued by the EPA on 14 March 1996.

Outcomes Statement:

1. Briefing and familiarisation of the EAC with the amendment and the environmental issues likely to be associated with the amendment.

Recommendation(s) to Committee:

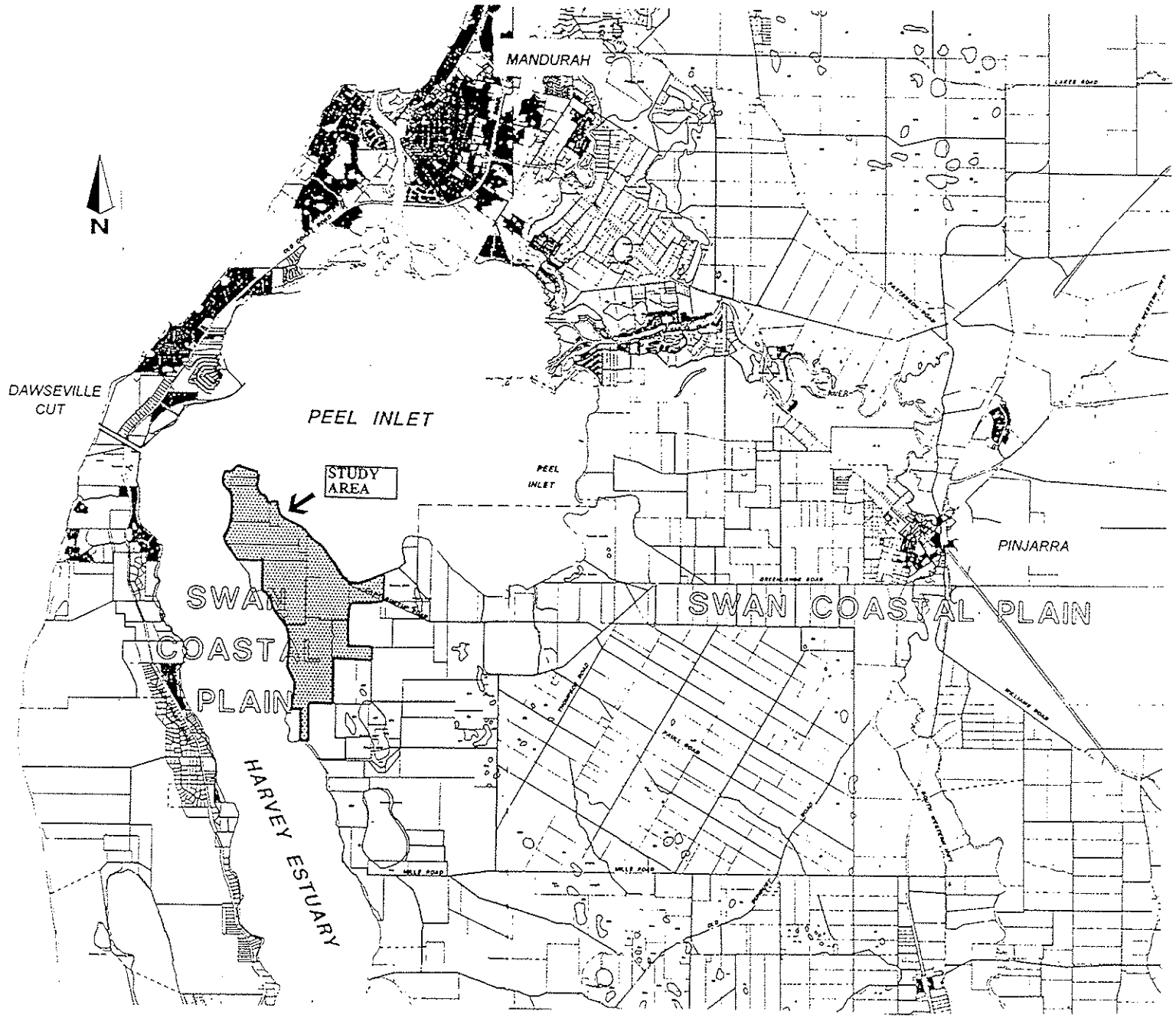
The EAC recommends that the EPA:

1. writes to the Minister for the Environment requesting a 28 day extension to report to the Minister on the environmental factors relevant to the scheme and the conditions, if any, to which the scheme should be subject, under Section 48D (1) of the *Environmental Protection Act* 1986;

2. notes the briefing on the project; and

3. notes that an assessment strategy for the proposal will be presented at a future EAC meeting.

Approved by
DEP Director



SITE LOCATION

(Source: RUST PPK)

Scale: 1:115,000

BOWMAN BISHAW GORHAM
ENVIRONMENTAL MANAGEMENT CONSULTANTS

ATTACHMENT 2

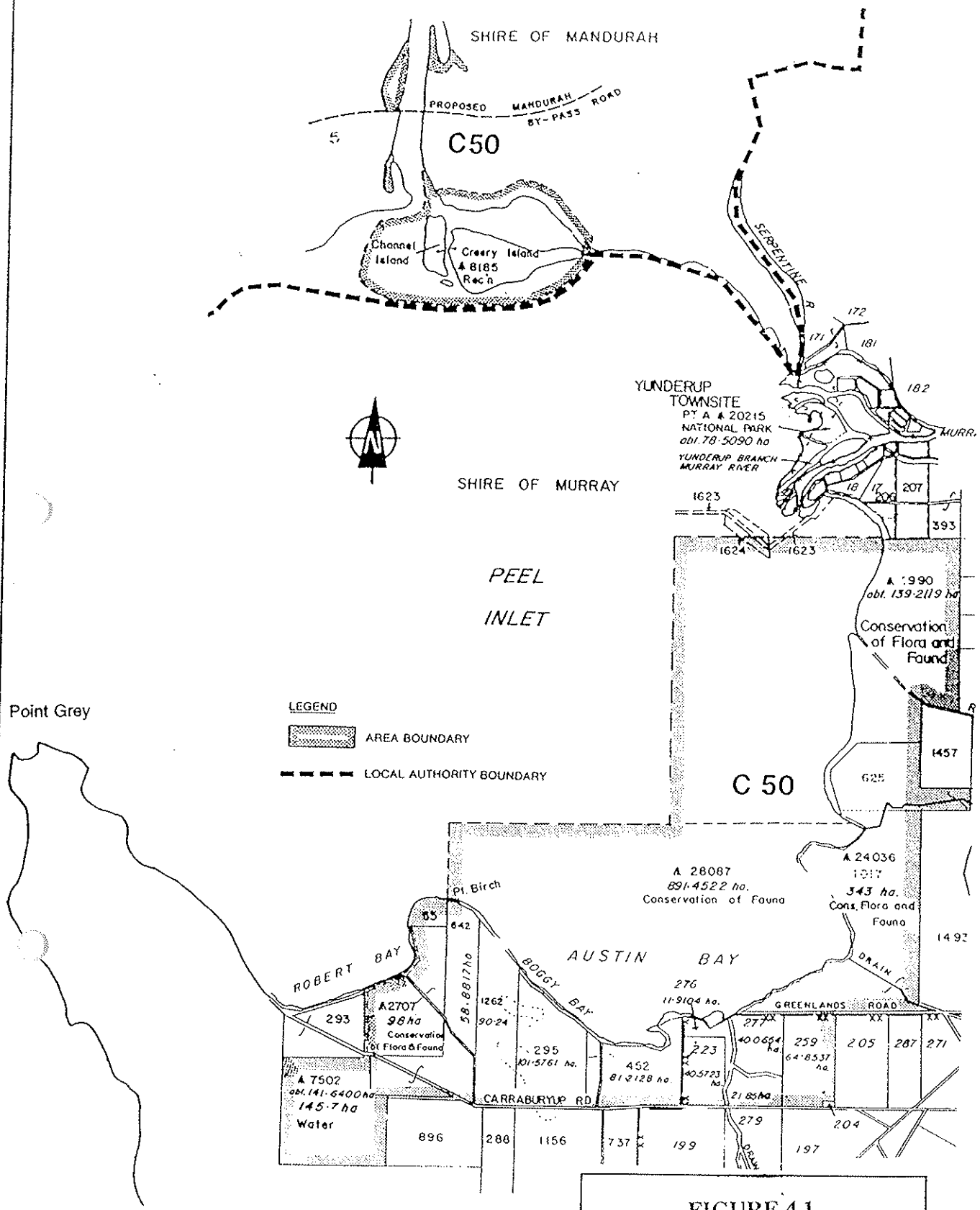


FIGURE 4.1

System Six Areas

Scale: 1:70,000

Source: Department of Conservation and Environment

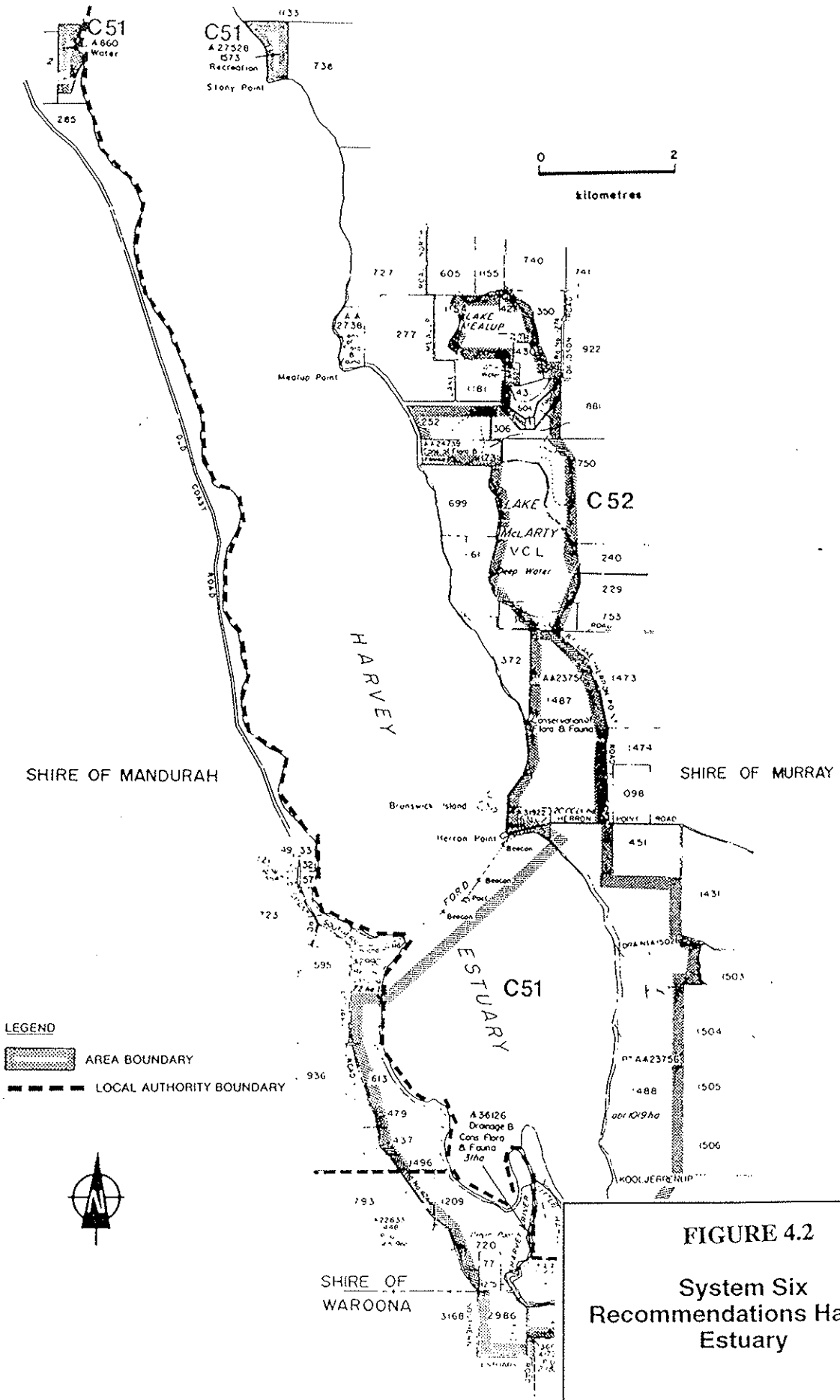


FIGURE 4.2

System Six Recommendations Harvey Estuary

Scale: 1:70,000

Source: Department of Conservation and Environment

BOWMAN BISHAW GORHAM
ENVIRONMENTAL MANAGEMENT CONSULTANTS

LAND USE ELEMENTS

	LAND USE	AREA	LOT/ LOT EQUIVALENT
	TOURIST		
1.	Wilderness Lodge/Chalets	12ha	30
2.	Waterfront Tourist Village	56ha	350
3.	Marina Precinct	28ha	200
4.	Harbourside Tourist Village	65ha	300
5.	Golf Course Tourist Estate	104ha	380
6.	Sailing Club	7ha	-
7.	Golf Course	90ha	-
8.	Eco-Tourist Village	10ha	20
	RESIDENTIAL		
	Traditional Neighbourhood Village	220ha	1500
	RURAL-RESIDENTIAL		
1.	Special Residential	83ha	200
2.	Rural-Residential/Landscape Protection	120ha	20
	CONSERVATION/OPEN SPACE	362ha	-
	WASTE WATER TREATMENT PLAN	2ha	-
	TOTAL:	1159ha	3000

N

PEEL

INLET

GOLF COURSE TOURIST ESTATE

POSSIBLE TEMPORARY WASTE WATER TREATMENT PLANT

DISTRICT RECREATION

POTENTIAL CONSTRUCTED WETLAND SYSTEM

ECO-TOURIST VILLAGE

IRRIGATION DAM

WASTE WATER TREATMENT PLANT

SANCTUARY/CONSERVATION LINK

SPECIAL RESIDENTIAL

WATERFRONT TOURIST VILLAGE

SAILING CLUB

WILDERNESS LODGE/CHALET

MARINA

HARBOURSIDE TOURIST VILLAGE

TRADITIONAL NEIGHBOURHOOD VILLAGE
- COMMUNITY CENTRE
- NEIGHBOURHOOD SHOPPING
- VILLAGE GREEN
- PRIMARY SCHOOL

HARVEY

ESTUARY

CHALETS

MEALUP POINT VILLAGE

ATTACHMENT 4

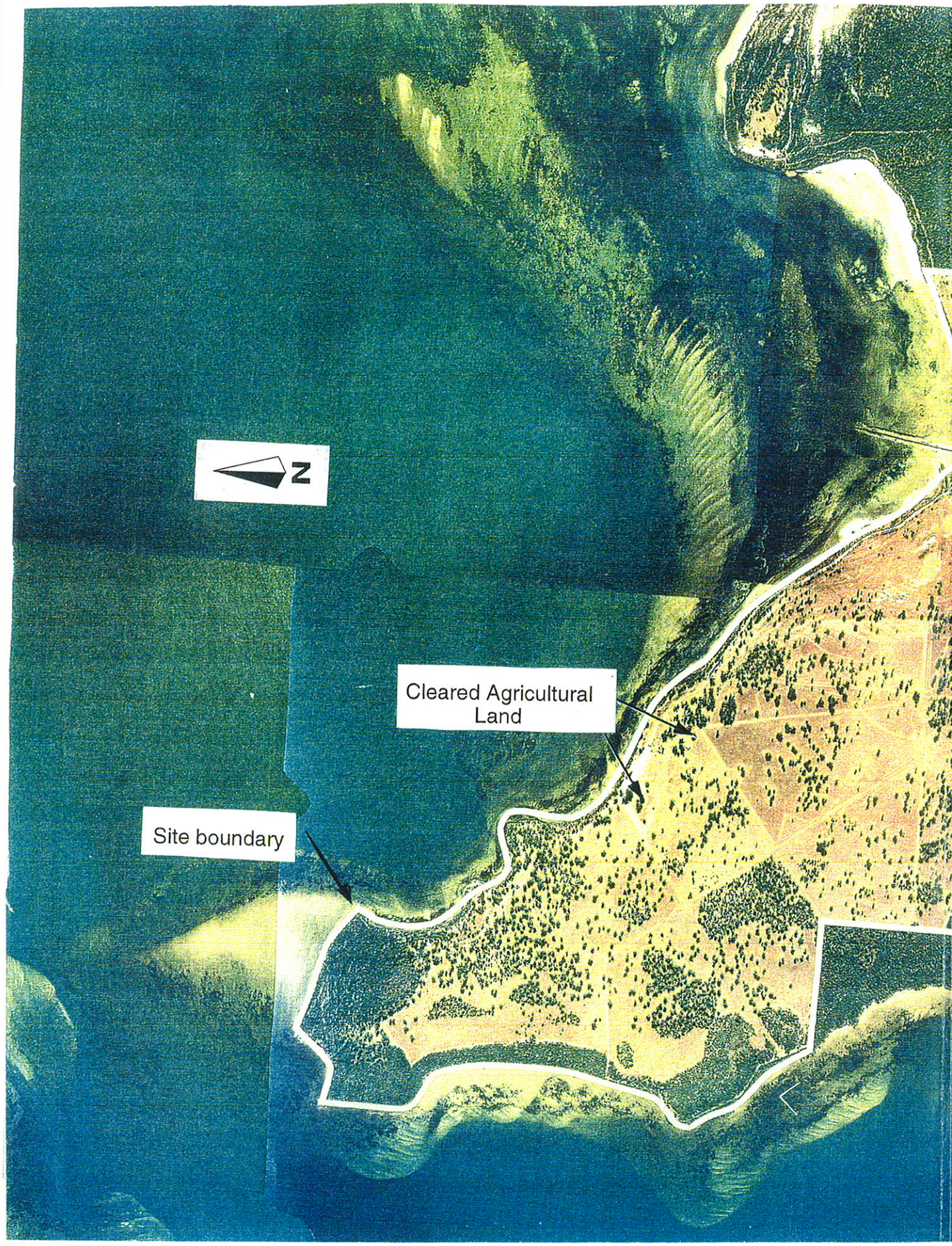
OUTLINE DEVELOPMENT PLAN

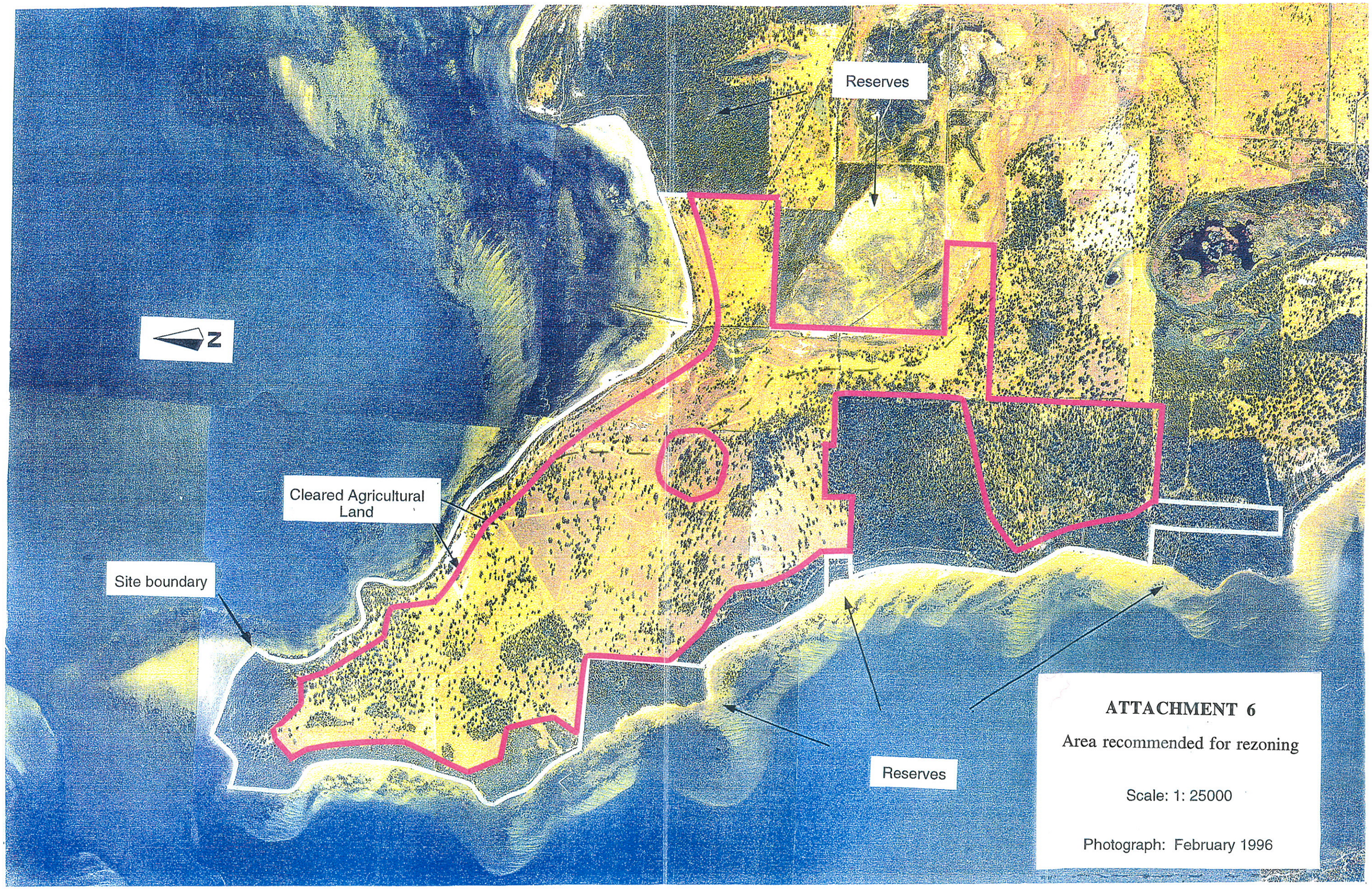
Scale: 1:20,000

Source: Roberts Day Group

BOWMAN BISHAW GORHAM

ENVIRONMENTAL MANAGEMENT CONSULTANTS


N
Cleared Agricultural Land
Site boundary



ATTACHMENT 6

Area recommended for rezoning

Scale: 1: 25000

Photograph: February 1996

BOWMAN BISHAW GORHAM
ENVIRONMENTAL MANAGEMENT CONSULTANTS

CSIRO LAND and WATER

Evaluation of Nutrient Export for the Point Grey Development

An evaluation of the nutrient export models used in the Environmental Review of Bowman Bishop and Gorham Pty Ltd

by Robert G Gerritse

Report No 98-14, January 1998

Evaluation of nutrient export for the Point Grey development

An evaluation of the nutrient export models used in the Environmental Review of Bowman Bishop and Gorham Pty Ltd.

by Robert G. Gerritse
CSIRO Land and Water
Floreat WA 6015

prepared for the Department of Environmental Protection and the Environmental Protection Authority.

February 20 1998

Evaluation of nutrient export for the Point Grey development

General observations

Calculations in the Environmental Review of BBG of nutrient exports suggest that exports of phosphorus from the proposed Point Grey development are not likely to be significant for at least the next 100-200 years and probably much longer. Export of P through groundwater discharge from soils, when it occurs, will be mainly as dissolved phosphate and, because of the ephemeral nature of the groundwater lens at Point Grey, cease during the summer months. A large part of the existing inputs of P from rivers and drains to the Peel-Harvey Estuary is in particulate matter. The nutrient associated algal problems in the shallow estuary are mainly caused by accumulation of particulate P in sediments and a significant resuspension of sediments, which greatly increases availability of P to algae. Regular flushing with fresh ocean water through the Dawesville Channel is depleting sediments of P. Phosphorus leaching to the estuary from residential areas near the estuary can be scavenged by particulates from riverine inputs as well as resuspended sediments and add to the total store of P in the estuary in those areas of the areas that are not well flushed. The western side of Point Grey appears to be well flushed with ocean water from the Dawesville Channel. And even if P (and N) are leached from soils in this area, subsequent dilution is likely to prevent algal problems. **Flushing patterns on the eastern side of Point Grey are not clear and a possibility of local impact of nutrients exists, particularly towards Robert Bay. In this respect potential inputs to this area from proposed development (sewage disposal) should be compared with existing rates of accumulation of nutrients (from the Robert Bay Drain and Murray River).**

Nitrogen inputs at Point Grey will move rapidly through soils to the estuary and need to be controlled from the outset. Intensive flushing with ocean water will make the area around Point Grey N-limited for algal growth and local discharges of N along the shoreline can become triggers for algal blooms (Thompson & Hosja, 1996). **In particular the possibility of discharge of N from the sewage effluent disposal site on the eastern side should be more closely investigated in this respect through a more detailed study of the local hydro(geo)logy**

In order to put the potential impacts of exports of nutrients from the Point Grey development on the surrounding estuary in perspective, the report should have covered existing and past inputs in the area and the existing quality of the fresh groundwater and exports of nutrients from drains to the south and east of the development

Detailed comments on the nutrient export calculations

Fundamental to a nutrient export model is a detailed understanding of the local **hydrology** in relation to the spatial variability of soils. The "macro" hydrology of the area surrounding Point Grey is well described in the Environmental Review of BBG. Extrapolation to the "micro" hydrology for Point Grey is not sufficient to enable prediction of discharge characteristics of the ephemeral groundwater in relation to the proposed developments. Because of the presence of outcrops of lime stone, discharge of groundwater along the shoreline can be spatially highly variable. Preferred pathways (dual porosity, springs) could exist, leading to local discharge "hot spots". A survey of the shoreline for groundwater seepage areas in the winter would be useful in this respect. The diagram of the ephemeral freshwater aquifer (Fig.2.2) is not very informative and infact hydrostatically incorrect. Recharge to the freshwater aquifer, as given in Table 6, is probably an overestimate. Apparently recharge rates of 60-70% have been applied to the total of irrigated and precipitated water. It is very likely that none of the irrigated water is recharged in the summer and that in residential areas actual recharge rates are closer to 20-30% (Cargeeg *et al.*, 1987). Recharge of rainfall at the effluent disposal site will also decrease with increasing canopy cover. Applying lower rates of recharge would increase the estimated travel times, so that in this respect estimates of travel times from the data in the Report can be considered conservative.

The **phosphorus** input rates quoted in the BBG Report are somewhat low (see Gerritse *et al.* 1991 and 1992) for the residential estates and the tourist villages (see Table 1 of this review). Fertilizer inputs on public open spaces (POS) should be taken into account as well (see Table 2). A recalculation for a 5 metre profile results in travel times of P of about 200 years. Though the estimated travel times for P in the soils of Point Grey are correct for the parameters used in the Report, the effects of different average depths to groundwater at the sites should have been considered in more detail. For instance the tourist/foreshore village and effluent disposal sites would be much closer to groundwater than the other developments. And the depth associated travel times would be more than proportionally shorter because of the exponential nature of the effect of residence time on the fixation of phosphate in soils (which is not quite evident from Table 10). Worst possible case scenarios for a depth to groundwater of 2m result in travel times for phosphate (Gerritse, 1996) of about 70-80 years for the tourist/foreshore- and effluent disposal sites. It is also important to know to what extent the solids from the treated sewage sludge will be exported or recycled as they would contain 80-90% of total P and perhaps 50% (depending on extent of denitrification) of total N generated with sewage (equivalent to about 10 t of P and 25 t of N for 3000 households, assuming year round occupation). Rate of accumulation in soil of P at the waste water treatment site will be decreased by uptake in bluegums.

The **nitrogen** inputs in relation to land use are not given in the Report in Table format as was done for the P inputs (this would have been convenient). From Gerritse *et al.* 1991 and 1992, a somewhat lower **total annual input of N** was estimated (see Table 2). The non-agricultural contribution of fixation of atmospheric N by native vegetation is not taken into account, but

can probably be assumed similar before and after development. **Nitrogen in sewage sludge (25t/a), if not exported, will of course contribute substantially to the total N input if it is not used to replace an equivalent amount of inorganic fertilizer.** Assuming no vegetation (grass clippings etc.) to be exported, a transmission rate of N to groundwater of *at least* 10% may be assumed (oxic soils, oxic groundwater), resulting in **groundwater concentrations** (assuming no denitrification in groundwater) ranging from **<0.5 mg L^{-1} $N-NO_3$ under low density residential areas to about 1 under the neighbourhood village and waste water treatment area and up to 5 under the golf course** (areas in Table 2 and 50% recharge to groundwater).

The waste water treatment area can be operated with a leaching fraction of much less than 10%. To achieve this, effluent should be irrigated no more than once a week and will have to be stored during June and July (Dr Brian Myers, CSIRO Forestry and Forest Products, Yarralumla). Net maximum N uptake by bluegums is about 80 kg/ha/year, which is more than will be added with the proposed irrigation (≈45 kg/ha/year). It is thus possible to balance input and uptake of N. Most of the N (and P!) input will be stored in the leaves, which, when harvesting the trees, have to be exported (e.g. as mulch) to prevent a massive pulse of N (and P) entering the soil.

A comparison of estimated and existing nutrient concentrations in the groundwater lens is not possible as the BBG Report gives no data on the existing quality of the groundwater lens (pH, nitrogen species, phosphate, chloride, sulphate, organic carbon, iron, manganese). A comparison of existing nitrate concentrations in the freshwater lens with inputs from pasture (Table 1) would put inputs of N from the proposed development (Table 2) in a better perspective.

Comparison of nutrient inputs associated with existing and proposed land use

In Table 1 possible inputs of nutrients at Point Grey for pasture are estimated from Gerritse *et al.* (1992). No animal feed inputs are assumed other than from lupin seed produced on site.

Table 1 Possible ranges of inputs of N and P for existing land use

Land use	area	P rate	N rate	P inputs	N inputs
	(ha)	(kg/ha/a)	(kg/ha/a)	(t/a)	(t/a)
Medium quality pasture	650	5-10	5-10	3.3-6.5	3.3-6.5
Lupins	100	20	30-100	2	3-10
Native vegetation	400	0	?		
Totals	1150			5.3-8.5	6.3-16.5

In Table 2 inputs of nutrinets associated with land use for the proposed development are estimated from Gerritse *et al.* (1990 & 1992).

Table 2 Ranges of inputs of N and P associated with proposed land use

Land use	area	P rate	N rate	P inputs	N inputs
	(ha)	(kg/ha/a)	(kg/ha/a)	(t/a)	(t/a)
Golf course	40	20	200	0.8	8
Golf course	0.5	20	560	0.01	0.28
Residential (7 houses/ha)	220	10-30	40-60	2.2-6.6	8.8-13.2
Special residential (2.5 houses/ha)	83	4	15	0.3	1.2
Rural residential (0.6 house/ha)	120	4	20	0.5	2.4
Tourist housing (4.5 houses/ha)	225	4	15	0.9	3.4
Waste water treatment area	65	8.8	44	0.6	2.9
Public Open Space	(50)	5-10	50	0.25-0.5	2.5
Conservation areas	312	0	?		
Totals	1065.5			6-10	30-34

By comparing Tables 1 and 2, it is quite clear that **total inputs of P are only increased marginally by the changes in land use. Total inputs of N, however, are at least doubled and are dominated by the golf course and "traditional neighbourhood village".**

Other observations

No analysis data are given for concentrations of phosphate and nitrate in groundwater from the Leederville upper aquifer. Recharge to the Leederville aquifer is in an area with agricultural land use and some contribution of nitrates can be expected.

Nutrient exports from Robin Bay Drain should be given. The potential impact from the proposed development in that area can then be put in perspective.

The statement (p.95 of BBG Report) that it is likely that groundwater abstraction from the Leederville aquifer at Point Grey will not impact on wetlands and vegetation is qualitative and

should perhaps be made more quantitative in relation to neighbouring wetlands and vegetation. In this respect wetlands can be classified as recharge, discharge or flow-through types (Nield, Townley & Barr, 1994), after which the relevance of their interaction with the Leederville aquifer can be further explored with data on the local hydrogeology.

If the Leederville aquifer is to be used as a source of drinking water, then, in addition to iron and chloride, processing of the water should perhaps also have to deal with (potentially) high levels of radon and associated radionuclides.

The soil survey could have included data on pH, Fe+Al oxides, total/inorganic P, calcite, silica, sulphur (pyrites) and organic matter. And recharge at the sites of soil sampling could have been estimated by comparing mean chloride concentration in rainfall with extractable chloride and moisture content in the sampled soil profiles (Gerritse & Schofield, 1989).

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LAKE MEALUP PRESERVATION SOCIETY (INC)

Correspondence to Secretary:

S U B M I S S I O N

to the

ENVIRONMENTAL PROTECTION AUTHORITY

regarding the

POINT GREY DEVELOPMENT PROJECT ERMP

Proposed by Mallina Holdings Ltd
(Dames & Moore, July 1987)

Point Grey Submission

12 September 1987

LAKE MEALUP PRESERVATION SOCIETY (INC.)

SUBMISSION TO THE ENVIRONMENTAL PROTECTION AUTHORITY
ON THE ENVIRONMENTAL REVIEW AND MANAGEMENT PLAN
FOR THE POINT GREY DEVELOPMENT PROJECT AS PROPOSED
BY MALLINA HOLDINGS LTD (DAMES AND MOORE, JULY 1987)

CONTENTS

Summary

1. Statement of principle

2. Major objections to the proposal

3. Alternatives

4. Proposals for reserves adjoining the development site

5. Reserves within the development site

6. Sewage treatment

7. Water supply

8. Impact of population increase

9. Format of ERMP

10. Conclusion

References

SUMMARY

The Lake Mealup Preservation Society considers that the proposed Point Grey Development Project is incompatible with the maintenance of the important natural values of the Peel-Harvey Estuary and its surrounds. A major increase in population at Point Grey would lead to unacceptable pressures on the natural environment of nearby wetlands and reserves. This deleterious impact would come directly through human activities and indirectly through the need to provide services such as water. The Society therefore submits that the proposal should not be approved.

Section 1 of this submission contains a brief statement of the natural values of the Peel-Harvey area which we believe will be affected by the proposed development. Specific major objections to the proposal as outlined in the ERMP are listed in Section 2.

Section 3 discusses alternatives to the proposal while Section 4 contains recommendations for the establishment of reserves near the development site

Sections 2-5 discuss specific items in the ERMP with respect to reserves, sewage treatment, water supply and management of impacts of increased population . Section 6 is a general comment on the format of the ERMP. Section 10 contains the conclusion.

1. STATEMENT OF PRINCIPLE

The Peel-Harvey Estuary is the most important site for waterbirds in the south-west of WA and is of international significance. The area supports tens of thousands of waterbirds (P Jaensch, in press). Large numbers of waterfowl use the estuary as a summer drought refuge, while many species of waders (including trans-equatorial migrants) feed in the estuary during the summer months. The lakes and swamps fringing the estuary are important breeding locations for species including cormorants and some waterfowl.

Areas of natural bushland adjoining the estuary, in both public and private ownership, are valuable for the retention of terrestrial flora and fauna, while the estuary itself has importance as a fish nursery.

The Lake Mealup Preservation Society believes that the maintenance of the outstanding natural values of the Peel-Harvey Estuary and its surrounds is incompatible with extensive development within the area.

2. VALUE ATTACHING TO THE PROPOSED DEVELOPMENT

2.1 The proposal is not appropriate for Point Grey for several reasons:

a) It would be located next to the most important waterbird habitat in the south-west of WA.

b) There are no adequate means of controlling the substantially destructive impacts of development of this magnitude on the adjacent aquatic and terrestrial environment. Specific effects of the increased population would include greater fire risk, disturbance of native fauna by domestic and feral animals, use of mosquito control measures, and disturbance by a large population possessing motor vehicles and boats.

c) There may be damage to wetlands of currently unknown importance in the Warnona Mound groundwater extraction area.

d) The achievement of the effluent quality criteria claimed for the sewage treatment plant is questionable based on the information provided in the ERMP.

e) An isolated bushland setting is inappropriate for a sub-tertiary business college such as the proposed Thomas Peel College.

3. ALTERNATIVES TO THE PROPOSED DEVELOPMENT

3.1 No information is presented in the ERMP on the evaluation of alternative development options for the site apart from the farming option. It is stated in section 3.1 of the ERMP that a variety of other land uses were evaluated [illegible] in detail is presented.

3.1 We propose several alternatives for the site. These are outlined below, in order of preference, based on degree of impact on the natural environment.

a) Preservation of Existing Environment

i) Existing reserves would be consolidated as outlined in section 4 of this submission.

ii) The present agricultural land use would be maintained at the current level. Private discussions have indicated that this land use is at present economically viable and that the levels of fertiliser needed for its maintenance are lower than those quoted in the ERMP.

b) Low Density Development

i) Existing reserves would be consolidated as outlined in section 4 of this submission.

ii) The concept of Special Residential Leisure Living Allotments (Section 4.4 of the ERMP) would be applied to the whole of the remaining area. This option would have the advantage of reducing the population in the development and its associated impacts on the surrounding environment.

c) Development without the College

i) Existing reserves would be consolidated as outlined in section 4 of this submission.

ii) Development would be essentially as proposed in the ERMP but excluding land adjacent to reserves.

iii) The college would not be built. We question the wisdom of such an isolated location for overseas students accustomed to a city environment. Many such students can be expected to experience problems of adjustment to the quiet lifestyle of this location. Furthermore, an urban location is more appropriate to the "applied" nature of the courses to be run at the college. Regular contacts with the business and commercial sector would be facilitated, and access to the resources of other tertiary institutions such as libraries would be easier.

4. <u>RECOMMENDATIONS FOR RESERVES ADJOINING THE DEVELOPMENT SITE</u>

4.1 The following recommendations are made to improve the viability of reserves adjacent to the development site and to provide greater security for the native flora and fauna . We feel that these proposals are necessary irrespective of whether the Pt Grey Development Project proceeds or not.

4.2 Carrabungup Nature Reserve (C2707)

This reserve adjoins the north-east corner of the Point Grey development project area. The 186 ha nature reserve is vested in the Crown for the purpose of conservation of Flora and Fauna.

Data collected by the Royal Australasian Ornithologists Union for the South-West Waterbird Project have shown that the wetland on Carrabungup Nature Reserve was one of the largest cormorant breeding colonies in the south-west of WA (R Jaensch, in press). Counts have recorded 1 000 Little Black Cormorants and 1 200 Little Pied Cormorants. In recognition of the importance of this reserve it should be upgraded to 'A' class.

A Road Reserve presently passes through the middle of Carrabungup Nature Reserve. The road need not be constructed because there is suitable alternative access to Lot 55 (Point Birch). Accordingly, the Road Reserve should be closed and the land added to the Nature Reserve.

4.3 Reserve C7502

Reserve C7502 is situated immediately south-west of Carrabungup Nature Reserve. The System Six Report has already recommended that the Reserve be vested in the NPNCA for Conservation of Flora and Fauna. The RAOU has waterbird usage information to support the change of purpose (R Jaensch, pers. comm.).

We urge the EPA to expedite the addition of Reserve C7502 to Carrabungup Nature Reserve.

4.4 Reserve A2738

The piece of land immediately to the east of Reserve A1715, which is proposed for Special Residential Leisure Living Allotments (Figure 1 of the ERMP) should be ceded to the Crown by the Proponent. It should become part of the Nature Reserve. The native vegetation on the land in question is in good condition and its preservation will enhance the viability of the Nature Reserve.

The amount of land involved is about 15 ha, or 1.4% of the total area of the development site as described by the Proponent in the ERMP.

5. RESERVES WITHIN THE DEVELOPMENT SITE

5.1 Area of reserves in proposed development

a. At section 4.6 of the ERMP it is claimed that 150 ha (over 15% of the site) will be reserved. The sum of land ceded by the Proponent is listed as 'about 100 ha', comprising 40 ha at the tip of Point Bren, 10 ha east of the College site, and 'smaller parcels of land' to make up the continuous foreshore reserve (presumably about 11 ha). The implication is, therefore, that existing reserves already total a further 130 ha. However, the only reserves contained in the project boundary (Figure 1 of the ERMP) are 31715 (4.15 ha), 27503 (34.2 ha) and 30039 (1.3 ha). These reserves total only 41.1 ha. It follows that the total area of reserves under the Proponent's proposal would be 140 ha or 13% of the site, and not 15% as claimed. This is clearly misleading.

b) The EPA needs to clarify whether the "50 m Foreshore Reserve" will be land owned by the Crown or 50 m into the titles owned by the Proponent. 50 m of the Proponent's land is required towards a continuous foreshore reserve (Section 4.6 of the ERMP). This would create a foreshore reserve 100 m wide from the high water mark, a reasonable width for adequate protection.

5.2 Fencing of reserves

Foreshore areas must be fenced if they are to be retained in the long term. Fencing of important areas (eg. Robert Bay) needs to be completed before any site construction starts. The Alfred Cove Nature Reserve is a classic example of how damage could have been averted if the Reserve had been fenced before constuction commenced. The most environmentally sensitive areas will need 1.3 m high "Cyclone" fencing.

5.3 Management Fund

The Proponent should establish a Trust of sufficient magnitude to properly maintain and enhance all reserves. The Trust should also be sufficient to fund continuing research relevant to the reserves.

6. SEWAGE TREATMENT

6.1 The statement in Section 4.8.3 of the ERMP that the activated sludge sewage treatment process produces an effluent low in total dissolved solids (TDS) is incorrect. The TDS of the process effluent is essentially determined by that of the raw sewage being treated. Presumably the Proponent means suspended solids (SS).

6.2 The design effluent quality for the sewage treatment plant is 10 mg/L nitrogen and 2 mg/L phosphorus (Section 4.8.3 of the ERMP). These are low levels in comparison to sewage treatment plants where nutrient removal is not practised. Temporary package plants generally receive limited operator attention and performance monitoring, and hence the consistent achievement of these levels is questionable.

6.3 Details of how the 10 mg/L effluent nitrogen level would be achieved if the chosen sewage treatment process was oxidation ponds (a suggested alternative in Section 4.8.3) should be provided. Nitrogen removal by biological nitrification/denitrification, which could be used in the activated sludge process, is not possible with oxidation ponds.

6.4 A perspective on the nutrient load contributed by the sewage treatment plant effluent if nutrient removal is not practised, or is not consistent, can be obtained by considering the typical nitrogen and phosphorus concentrations in sewage effluent without nutrient removal. A conservative estimate would be 50 mg/L nitrogen and 10 mg/L phosphorus; five times the proposed levels in the effluent from the Point Grey sewage treatment plant.

based on these levels, the percentage contribution of phosphorus from STP effluent would rise from 17.8% of the total managed load (Appendix F, figure 3a to 53%. The total mass loading of phosphorus from all sources would rise from 4.32 tonne/year to 8.58 tonne/year. This level is of similar magnitude to the phosphorus loading predicted for agricultural development (EPMP, Table 1).

By similar logic the nitrogen contribution from the sewage treatment plant without nutrient removal would increase from 21% to 57% of the total managed load. The total imported nitrogen load would increase from 14.5 tonne/year (Appendix F, p9) to 45 tonne/year. This would raise the total nitrogen load to the site (imported nitrogen plus fixed atmospheric nitrogen) from 68 tonne/year (Appendix F, p14) to 88 tonne/year.

6.5 Tertiary treatment to the level described in the EPMP is not practised anywhere in WA at present. We cannot accept that the proposed effluent quality criteria will be achieved when the treatment process is not specified and details of the necessary human and material resources needed to operate the plant are not provided.

6.6 The consistent achievement of reduced nutrient loadings to the development site claimed in the EPMP is doubtful. Accordingly the proposed development cannot be considered more attractive than the present land use with respect to nutrient input to the estuary.

7. WATER SUPPLY

7.1 Waroona Mound

a) The simulation performed to model the effects of groundwater abstraction from the Waroona Mound (Appendix G) apparently showed that drawdowns would be "a few metres in the vicinity of the borefield" and that effects would be "localised" (Appendix G, p13). Furthermore, the predicted radial influence would be less than 0.05 m at 1.5 km from the borefield under worst case end of summer conditions.

These drawdowns, both in terms of depth and radial influence are not 'insignificant'.

b) We are concerned about the effects of groundwater extraction from the Waroona Mound on wetlands in the area. Looking at Figure 14 in the EPMP, it is difficult to see how 3 bores could be placed 1.5 km away from any wetland.

Two wetland systems on the Waroona Mound are known by the Society to be of importance to waterbirds. One is Blue Mile Lake, already identified in the EPMP. The second is Goodale Sanctuary, a privately owned nature reserve which supports a significant Darter breeding colony (R Goodale, pers. comm.). No information is available on the large number of other wetlands in the area.

The Proponent should be required to undertake an evaluation of the ecological importance of the wetlands on the Waroona Mound before any decision is made on the location of bores.

c) The "adverse environmental effects" of pumping from the Wanneroo Mound (EPMP Section 7.4) need to be defined, as does the action that would be taken if such effects were observed.

d) The results of further testing to locate the proposed borefield in the Wanneroo Mound should be forwarded to EPA for assessment of environmental impacts before licences are issued by the Water Authority.

7.2 Leederville Formation

a) The proponent states that "... if necessary the supply will be monitored for changes in salinity, drawdown and pumpage (EPMP p133). Agreed standards must be laid down as to

1) frequency of monitoring
2) limits to acceptable changes in salinity and drawdown

Furthermore, the action to be taken should monitoring indicate that the acceptable limits are being exceeded should be defined.

7.3 Point Grey Surficial Aquifer

a) Standards must be defined for assessment of the results of water quality testing as proposed on p141 of the EPMP.

7.4 Lake Mealup Catchment

a) The EPMP does not give any information to support the statement that the Lake Mealup catchment is outside the development site. The Lake Mealup catchment, and the catchment areas within the development site which may contribute runoff to Lake Mealup (EPMP Section 7.2.3), should be identified in the document.

8. IMPACTS OF POPULATION INCREASE

8.1 Waterbird sites in Robert Bay

a) An increase in the presence of boats, dogs and people would place unacceptable pressure on the waterbirds of Robert Bay. The limited information given in the EPMP on waterbird usage of the inlet adjacent to the site is particularly disturbing given that it receives special emphasis in the EPMP Guidelines (EPMP, p164). This has implications for the siting of boat ramps and the location of zoning to protect waterbird roosting sites.

b) The statement "Birds feeding on the waterways far out on the flats are not likely to suffer significant disruption by dogs" (EPMP p 111) is clearly incorrect. One needs only to make a weekend visit to the three main waterbird sites on the Swan River to see the constant disturbance the birds have to endure.

c) Given the importance of Robert Bay to waterbirds we consider that no boat launching facilities should be built on the shorelines east of Point Grey.

3.3 Effects of intrusion by humans and introduced animals onto reserves

a) The adverse effects of introduced animals are identified at Section 4.4.1 of the ERMP. It is stated that the largest and most important reserves, located west of Peel Inlet and south of Harvey Estuary, are not likely to be affected by domestic animals because of their size and remoteness from the development.

Presumably the reserve referred to as being 'west' of Peel Inlet is the important Austin Bay Reserve (part of System Six Reserve M31), which is actually located to the south east of the Inlet. This reserve is especially vulnerable since its western boundary is less than 1 km from the eastern edge of the development site. The 'remoteness' of this and reserves such as Harvey Estuary (System Six M31) is illusory when the ready availability of motor vehicles is considered. In the case of M31, access is available along tracks such as that alongside the Serpentine Drain off Greenlands Road. Furthermore, in summer vehicles can and will be driven along the dry estuary foreshore into the Reserve.

b) The great increase in population and the attendant increase in use of reserves for exercising dogs, driving off-road vehicles and so on must have a significant effect on these important reserves.

3.4 Boat launching facilities

a) The design of boat launching facilities should be such that vehicle access to foreshores from launching ramps is not possible.

3.4 Fires

a) The ERMP states that the development is not likely to increase the frequency of fires in the project area. We dispute this, as the essentially uncontrolled activities of 7 000 people must increase the fire risk (as admitted by the Proponent in the very same section). The risk to reserves, both the small ones within the project area and the larger ones outside it, is of particular concern.

3.5 Rubbish

a) An adequate rubbish collection system which would take all waste (including garden rubbish) is essential to protect reserves from illegal dumping.

3.6 Mosquito control

a) The need for mosquito control is foreshadowed in Section 4.3 of the ERMP. The use of control techniques such as filling, drainage and chemicals, as outlined in Section 7.3 of the ERMP, will have deleterious effects on wetlands and waterbirds, and are therefore unacceptable. This is a further reason why such a development is inappropriate for this area.

4.7 Future Developments

a. The ERMP makes no mention of the proposed special rural subdivision west of Lake Mollatt, just 3 km south of the Point Trev development. The effect of a further large increase in population in the area, and the associated issues of water supply, nutrient inputs and effect on nature reserves, are not considered. The assessment of developments in such an environmentally sensitive area should not be considered in isolation.

b. Any large development will increase the pressure for subdivision of neighbouring land, leading to an increase of the problems identified elsewhere in this submission.

5. FORMAT OF THE ERMP

a. We found the ERMP to be repetitive and diffuse.

b. Information on specific issues was scattered throughout the document, which made assessment of their treatment in the ERMP difficult.

6. CONCLUSION

In conclusion, the Lake Mealup Preservation Society strongly objects to the Mallina Holdings Point Trev Development Project. Preservation of the internationally significant wetlands of the Peel-Harvey Estuary and the surrounding remnant bushland constitutes a more important higher land use in the long term than housing and recreation, which can be placed in less sensitive areas. The Society relies on the Environmental Protection Authority to evaluate alternative uses and to protect areas which are irreplaceable.

REFERENCES

1. Jaensch, R (in press). Report on South-West Waterbird Survey 1981-1985. Department of Conservation and Land Management.

2. Department of Conservation and Environment (1981). Conservation Reserves for Western Australia,as recommended by EPA; The Darling System - System 6. Report No. 11. DCE, Perth.

Shire of Murray Town Planning Scheme No. 4
Amendment No. 104

Submission by the
Lake Mealup Preservation Society (Inc)

December 1997

Contents

Page

Part 1. Introduction 3

Part 2. Executive summary 4
Planning considerations
Adequacy of the Environmental Review
Major environmental factors inadequately addressed by the Environmental Review
Comparison to the 1987 proposal
Conclusion

Part 3. Planning considerations 5
High conservation value land near the proposed development
Planning implications
Criteria for desirable development
Need for residential land
Access roads
Protection of agricultural land
Strategic planning documents and the proposed development
Peel Regional Strategy. A Strategic Statement and Land Use Plan
Draft Inner Peel Region Structure Plan
Peel Regional Park. Proposals for Establishment, Administration and Use

Part 4. Public costs of the development 12

Part 5. Does the Environmental Review address the EPA's Instructions for the Environmental Review? 13
Vegetation (ER Section 4.1); Declared rare and priority flora (ER Section 4.2); and Fauna -waterbirds (ER Section 4.3) 13
Declared rare fauna (ER Section 4.4) 15
Estuarine vegetation and fauna habitat (ER Section 4.5) 16
Estuarine water quality (ER Section 4.6) 16
Wetlands (ER Section 4.7) 16
Groundwater quantity (ER Section 4.8) 17
Use of groundwater without harmful effects not demonstrated
Specific problems with the data
Surface water quality (ER Section 4.9) 20
Pesticides
Nitrogen application on the site
Nitrogen exports
Nitrogen concentration in wastewater effluent
Loading variations on BNR plant
Marina sullage effects on BNR plant
Monitoring equipment for BNR plant
BNR plant sludge disposal
Wastewater effluent disposal

Contents, cont.

Disposal of saline reject water from reverse osmosis plant
Odours (ER Section 4.10) 23
Noise and dust (ER Section 4.11) 23
Turbidity (ER Section 4.12) 23
Aboriginal Heritage (ER Section 5.1) 23
Mosquitoes (ER Section 5.2) 23
Mosquito breeding habitat
Mosquito buffer zones
Mosquito control

Part 6. Comparison with the 1987 proposal: has anything changed? 26
The EPA's concerns with the 1987 proposal still apply to the current proposal

Part 7. Alternative options for Point Grey 28

Part 8. Conclusion 29

Part 9. References 30

Part 1. Introduction

This submission was prepared by members of the Lake Mealup Preservation Society, Inc. (LMPS) which owns 120 ha of land in and around Lake Mealup, including most of the water body. The Department of Conservation and Land Management (CALM) owns two blocks at Lake Mealup (adjoining the LMPS blocks) which also protect the lake and its fringing vegetation. CALM's blocks are vested in the NPNCA.

The Society's aim is to restore and conserve Lake Mealup and the surrounding bushland in its natural state, as a wildlife sanctuary.

As land owners and ratepayers in the Shire of Murray, LMPS has carefully reviewed the Environmental Review (ER) prepared by Bowman, Bishaw and Gorham on the Shire's Town Planning Scheme Amendment No. 104 (Point Grey). This amendment represents a major change in land use in the Shire. Our submission addresses the planning and engineering reports contained in the Outline Development Plan (ODP), and the Environmental Review prepared as required under Section 48 of the Environmental Protection Act.

Structure of the submission

Part 1, Introduction

Part 2, Executive summary

Part 3, Planning Considerations, discusses the appropriateness of the location for the scale of development proposed, details the existing high conservation values of the development location and adjacent environment, and considers the statements about, and suggestions for Point Grey, of some strategic planning documents on the Peel Region.

Part 4, Costs associated with the development, considers costs that will be borne by the public, especially the Shire of Murray.

Part 5 reviews the Environmental Review's discussion of Environmental Impacts and Management and considers how the project documentation deals with environmental issues associated with the development. This section assesses how the Environmental Review responds to the Environmental Review Instructions issued by the EPA, as well as discussing aspects of the development not specifically covered by the Instructions.

It should be noted that comments on the environmental significance of the development are not limited to this section of the submission, and the whole submission is relevant to the EPA's determinations on environmental acceptability of the proposal.

Part 6 compares the impacts of the Mallina Holdings proposal in 1987 to those of the current proposal. It reviews the relevance in 1997 of the EPA's reasons for rejecting the 1987 proposal, and considers whether the Environmental Review's discussion of advances in estuary and catchment management supports the proponent's claim that the current development proposal is environmentally acceptable.

Part 7, Alternative options, proposes other environmentally acceptable uses for the Point Grey site.

Part 8, Conclusion

Part 9, References

Part 2. Executive summary

Planning considerations

The scale of the development is inappropriate for the location. It would place a new town of 7000 people in an isolated location. Provision of infrastructure will be expensive.

This development will be the catalyst for strip development along the eastern shore of the Harvey Estuary, similar to the poorly planned sprawl from Mandurah to Clifton. It will also encourage residential encroachment into good agricultural land.

The high nature conservation value of the eastern side of the Harvey Estuary has been recognised in every report and review since 1960, many calling for it to become a national park.

Key nature reserves, including Austin Bay, Lake Mealup and Lake McLarty are close to the Point Grey site. All the water, mud flats and samphire beds of the Peel-Harvey Estuary as well as these wetlands are Ramsar wetlands and on the Register of the National Estate.

- They are threatened by the largely unmanageable impact from the development's proposed large population, through fire, rubbish, domestic pets, weeds and off-road vehicle use.
- They will be further threatened by pressure for additional roads into the area, and consequent additional development .

Adequacy of the Environmental Review

The Environmental Review is seriously flawed. It does not deal at all with the potential impacts of the development on Lake Mealup and the reserves of the Peel-Harvey Estuary as required by the EPA's Environmental Review Instructions.

The Environmental Review does not address environmental issues. It proposes instead to produce impact management plans after the proposal is approved, for many of the key environmental factors it was required to address by the EPA. Human impacts on conservation reserves, water supply, wastewater treatment and disposal, mosquitoes, turbidity and construction effects are all treated this way.

It is not acceptable for this major regional development to be approved

- without providing evidence that the environmental problems can be solved;
- without a public review of the proposed management plans; and
- with no allocation of responsibility and estimates of costs.

Major environmental factors inadequately addressed in the Environmental Review

The human impacts on adjacent conservation reserves of 7000 people at Point Grey are discounted by implying that the impacts are simply incremental increases beyond those due to the tiny population currently living at and using Point Grey. No meaningful management is described, this being deferred to a number of post-approval management plans.

No conception of the impact of a large mobile residential population on adjacent foreshores, shallow estuarine waters or bushland is apparent in the Environmental Review. Flora and fauna studies are

short and superficial. Management proposals to protect reserves are non-existent or weak (for example, erection of signs; assumptions that domestic animals will not roam from residential areas).

The Environmental Review states that there will be no significant impacts from water supply and wastewater disposal practices on wetlands and associated vegetation. No information is provided to support this statement, even though a drawdown of 1 to 2 m in the Leederville aquifer is predicted, linkages between the superficial and Leederville aquifers are admitted, and increased recharge to the Leederville aquifer from the superficial aquifer are expected.

The assessment of impact of groundwater extraction for water supply is quite inadequate. The lack of site-specific data means that the conclusions have not been scientifically validated. The model presented is based only on regional considerations and assumed hydrological processes. The use of regional stratigraphy data in predictions is inappropriate given the locally complex stratigraphy determined in a study currently being carried out at Lake Mealup under the direction of the V&C Semeniuk Research Group.

Calculations of nitrogen exports from the site are sensitive to assumptions which should have been based on a better database of information, given their significance. The wastewater treatment plant is claimed to be able to achieve nutrient levels lower than those being achieved at any other plant in Western Australia, yet no appreciation of the operating and maintenance requirements, or difficulties associated with treating the variable loadings from such a development is demonstrated. The impacts of onsite disposal of wastewater effluent are not considered, despite the effluent disposal site being within 1 km of Lake Mealup.

Disposal mechanisms for wastewater sludge and saline reject water from reverse osmosis water treatment are discussed superficially. For example, onsite disposal of saline reject water (706 kL per day) is proposed, but no potential site appears to have been investigated.

The Environmental Review admits the requirement for extra mosquito control measures. However, it fails to demonstrate that the controls will be effective, or that control measures will not have adverse environmental impacts, as required under the EPA's instructions. The ER discusses control measures for the development site itself superficially, merely listing options. It completely fails to consider the effectiveness, costs and environmental impacts of mosquito control measures on areas adjacent to the development site, including internationally important nature reserves. Given the health concerns associated with mosquito-borne viruses, including Ross River virus, this is a serious deficiency from a public health perspective, in addition to the concern over environmental impacts.

Comparison to the 1987 proposal

The Environmental Review claims that the current proposal is environmentally acceptable, in contrast to the 1987 Mallina Holdings proposal. However, EPA's 1987 concerns still apply to this proposal:

- The adverse effects of human pressures on nature reserves are unchanged;
- absence of adverse effects from water supply and wastewater disposal have not been demonstrated;
- the effectiveness and environmental impacts of mosquito control is probably a larger issue now than it was in 1987; and

- the recovery of the Peel-Harvey Estuary has not been conclusively demonstrated yet. In any case, recovery should not be used as a justification for further development which may place stress on the estuary.

Conclusion

The rezoning proposed should not be approved.

Large scale residential development under an urban zoning is not appropriate for such an environmentally important area. It would lead to unacceptable impacts on the conservation values of the east and south Peel-Harvey Estuary and foreshore reserves, which are a key component of the Peel Regional Park.

Proposals for water supply, wastewater disposal and mosquito control have not been demonstrated to be environmentally acceptable.

Costs associated with water and wastewater management, which appear substantial, have not been considered. Who will bear these costs, whether residents or all ratepayers in the Shire of Murray, is uncertain.

Alternative less intensive land uses for the site should be considered, such as low impact, small scale tourist facilities and agroforestry.

Part 3. Planning considerations

The scale of the development is inappropriate for the location. It would place a new town of 7000 people in a relatively isolated location which has little significant infrastructure and is immediately adjacent to high value conservation reserves. It is 18 km from the region's centre, Pinjarra, which currently has a population of approximately 6000 (Ministry for Planning, 1997), less than that proposed for Point Grey.

The eastern side of Harvey Estuary is the last remaining area of the Peel-Harvey Estuary which has not been subject to intensive residential development. Point Grey, the northern tip of the eastern Peel-Harvey foreshore, has regionally significant open space, and is adjacent to areas of recognised outstanding conservation value.

High conservation value land near the proposed development

Several areas recognised in the System 6 Report (DCE, 1983) are very close to the development area. The south-eastern corner of the development area is within 750 m of the surface water expression of Lake Mealup, part of System 6 Locality C52, and even closer to the small lake to the west of Mealup. Stony Point Nature Reserve, part of Locality C51, directly abuts the development area, as does Reserve 4990, part of Locality C50. All three of the nature reserves are vested in the National Parks and Nature Conservation Authority, for the purpose of Conservation of Flora and Fauna. The part of Lake Mealup not vested in the NPNCA is owned by the Lake Mealup Preservation Society, which manages the Lake and adjacent woodland as a wildlife sanctuary.

Reserve 4990 is a large nature reserve (1658.8 ha), 1 km to the east of the development area, encompassing Austin Bay. This is a rich area for waterbirds, one of the two or three most important within the Peel-Harvey Estuary, where at least 67 species have been recorded, including at least 18 species of trans-equatorial migratory waders. Counts of over 41,000 individual waterbirds have been recorded (Jaensch, et al., 1988).

The waters of the Peel-Harvey Estuary and Lake Mealup, Reserves 2738 and part of Reserve 4990 (the part which was formerly Reserve 2707) are included in the Ramsar List of Wetlands of International Importance (ANCA, 1995). They all directly abut the development area, apart from the Lake Mealup water body, which is within 500 m of the development area (Lake Mealup's catchment would be closer). Good quality banksia-eucalypt woodland to the west of Lake Mealup is within 150 m of the south-eastern boundary of development area.

Lake Mealup is a *Melaleuca* spp. fringed freshwater wetland, listed in the Directory of Important Wetlands in Australia (ANCA, 1995). The Department of Conservation and Land Management (CALM) in a 1986 internal recommendation to purchase Lot 430 at Lake Mealup, noted that the lake's fringing vegetation was some of the best on the Swan Coastal Plain. The recommendation also noted that the lake had great importance for waterbirds, including two rare and one restricted species (Ryan, 1996). 119 species of birds, including 46 waterbird species have been recorded on the lake and adjacent bushland owned either by the Lake Mealup Preservation Society or the Department of Conservation and Land Management (CALM).

To the south of Lake Mealup is Reserve 39404 (Lake McLarty) and Reserve 24739, both vested in the NPNCA. Both are included on the Ramsar listing, and are included in the ANCA Directory of Important Wetlands in Australia.

Nature reserves on the Peel-Harvey Estuary, together with Lakes Mealup and McLarty, are listed on the Register of the National Estate.

The statement in Section 1.7.2.6, p7 of the Environmental Review for the Scheme Amendment that "...the proposed Scheme Amendment will assist in the implementation of the EPA's management recommendations for these [System 6] areas" is misleading. The System 6 Red Book's major recommendation was for consolidation of reserves into a regional park (DCE, 1983). The development has some positive effects but significant negative effects on the Peel Regional Park: some private bushland will be retained, but the development places a large population adjacent to high conservation areas including Lake Mealup and the important waterbird areas in Austin and Robert Bays. The quality of the Point Grey bushland would be rapidly degraded by such a large neighbouring population.

There are saltmarshes along the north-eastern shore of Robert Bay, and along the Robert Bay Drain (McComb, A.J. et al., 1995). Smaller areas of saltmarshes also exist on the eastern shore of the Harvey Estuary, adjacent to and to the south of the development area. These important parts of the estuarine food web and biological filters for nutrient laden water entering the estuary are declining in quality and quantity. McComb et al. report a 40% reduction over 40 years in saltmarshes in the region.

Saltmarshes provide mosquito breeding habitat, which makes residential development in their proximity undesirable. There are other areas in and near the development area subject to inundation which also provide possible mosquito breeding habitat (EPA, 1988).

Planning implications

Criteria for desirable development

The Planning Report in the proponent's Outline Development Plan quotes from the draft State Planning Strategy (1995), listing the key factors to guide development as "... the need for nodal development based on community focus and employment centres, good transport linkages and the protection of the major environmental areas."

The Planning Report claims that the Point Grey development will meet all three key factors. While a case can be made that the development will have a distinct identity, there will obviously not be work for 7,000 people at the site. It will function to some extent as a dormitory settlement, and its residents will need to travel to work.

We do not consider that Point Grey is well situated with respect to major transport linkages. Proposed major bus and rail links to Mandurah and Rockingham terminate at Pinjarra (Ministry for Planning, 1997). The Peel Deviation of the Perth to Bunbury Highway is not yet approved. It may not be approved, and is not planned for construction for 10 to 20 years (Ecologia, 1997). The site will be reliant on private cars for transport, which puts it at a disadvantage when the future of private road transport is increasingly uncertain in a world where cheap, readily available petrol is about to decline rapidly (Fleay, 1995). This concern also applies to the Peel Deviation Highway itself.

The Planning Report's statement (p 20) that "...the sensitive approach to planning design and development as contained within the Outline Development Plan ensures the protection of environmental values and the mechanism for their successful long-term management" is not borne out by the ODP or the Environmental Review, as we discuss in Part 5. The positioning of such a

large development in the midst of the adjacent high conservation areas makes degradation of the environmental values of those areas inevitable.

Hence the proposed Point Grey development does not meet any of the three key factors in the draft State Planning Strategy, despite the proponent's claims. Rezoning to urban is not acceptable.

Need for residential land

The ODP Planning Report (p 18) states that the development will provide needed residential land in the Shire. The Inner Peel Region Structure Plan (Ministry for Planning, 1997) identifies 804 ha of existing and future urban land in the Town of Pinjarra, providing a population potential of 21,710. The existing population of the town is only 6000.

Surely it is more sensible to have people sited near existing services, rather than to site people in an isolated area, which will be expensive to service and may drain community resources from Pinjarra. Furthermore, urban villages at Ravenswood, Furnissdale, Yunderup and Murray Lakes are identified in the Structure Plan with an ultimate population capacity of 35,000, and are much closer to existing infrastructure than Point Grey.

This clearly shows that there is considerable residential land available. We note that the reference to Point Grey as a residential centre in the Draft Inner Peel Regional Structure Plan (Ministry for Planning, 1996) has been removed from the final Structure Plan (Ministry for Planning, 1997), which describes Point Grey solely as a tourist centre. Furthermore, p 40 of the final Structure Plan, while accepting tourist development at Point Grey as "...an important land use element in the overall context of the structure plan", states that "...the scale of the development at Point Grey should be re-assessed once the results of the environmental review process are known".

Access roads

Engineering Report 3 in the ODP considers the development of the primary access road utilising Greenlands Road in some detail. Discussion of other potential access roads is limited to p 12 of the Executive Summary of the Outline Development Plan, where it is stated that "...southern access out from the site provides a link between Point Grey and adjacent landowners to the south". No further detail is given on the location of this road. No reason why the link is needed is given. Whether the landowners referred to are on rural properties on the to the south-east, or residents of the Birchmont development to the west of Lake McLarty is unclear.

This road has the potential to be extremely destructive, as it is likely to be routed close to Lakes Mealup and McLarty, and would split lengthwise the adjacent high quality bushland proposed for the Peel Regional Park. This fragmentation inevitably leads to degradation of reserves.

This road is not required for landowners at Birchmont, who have access via Mills Road. The southern access road, which was shown as a district road in the draft Inner Peel Region Structure Plan (Ministry for Planning, 1996), was removed from the final version of the Plan (Ministry for Planning, 1997).

The failure of the ODP to consider the impacts of other access roads as part of the Scheme Amendment is a major deficiency.

The Lake Mealup Preservation Society is extremely concerned about the future development of roads to the south of the development. Given the impact of roads on the Peel Regional Park, proposals for future access roads should be considered now, as part of this proposed Amendment.

Protection for agricultural land

The Inner Peel Region Structure Plan (Ministry for Planning, 1997) has an objective that "...conflicting land uses, including some forms of intensive subdivision shall not be permitted in areas which are likely to detract from the primary production potential of the land" (p 46). The Plan proposes that no encroachment of residential development into broadscale agriculture to the east of the Harvey Estuary should occur. The development at Point Grey will be the catalyst for just such development.

The development is likely to lead to an increase in land prices in the West Murray area. The associated increase in rates and the pressure for further subdivision will limit the viability of farming, which is a major activity in the Shire.

Strategic planning documents and the proposed development

The Planning Report in the proponent's Outline Development Plan (ODP) refers to documents produced by state and local government, and quotes from them to demonstrate that the proposed development is in accordance with established plans for the area. While several of these documents anticipate some form of development at Point Grey, we believe that the ODP implies an advocacy of the development that is not present in the documents. Development at Point Grey is not a requirement by government!

The following examples demonstrate the recognition in key planning documents of the environmental significance the south and east Peel-Harvey Estuary and bordering bushland and wetlands, and the need to plan land use accordingly.

Peel Regional Strategy. A Strategic Statement and Land Use Plan (1994)

For example, p 21 of the proponent's Outline Development Plan mentions that in the Peel Regional Strategy (DPUD, 1994) "...specific reference (p 37) is made to development at Point Grey and the need to protect environmental and landscape values associated with the site". The ODP does not mention the following paragraph, also from p 37 of the Peel Regional Strategy: "The eastern foreshores of the estuary are already under significant recreational pressure. When the [Perth to Bunbury] highway is constructed, access to the area will be easier and pressure for urban development and recreational use will increase. The relatively pristine nature of existing conservation areas, in addition to the impacts of the Dawesville Channel on the ecology of the estuary, exacerbate these conflicts. Important migratory bird habitat occurs in the area. **The emphasis of future uses in this locality should be conservation**" [our emphasis].

Inner Peel Region Structure Plan – Draft (1996) and Final Plan (1997)

The ODP also refers to the draft Inner Peel Region Structure Plan (Ministry for Planning, 1996). quoting two potential populations for the Point Grey listed in that document: a "small town" of 4,000 (p 25) and a "small urban village" of 3,000 (p 86), although on p 19 of the ODP the latter figure is changed to 3,000 *lots* (it is not apparent that this is what was meant in the Structure Plan). We note that the ODP proposes a population of 7,000 people at Point Grey.

We also note that references to Point Grey as an urban village for residential development have been omitted from the Final Structure Plan, which merely describes Point Grey as a tourist centre.

Peel Regional Park. Proposals for Establishment, Administration and Use (1992)

Point Grey was included in draft proposals for the Peel Regional Park (DPUD, 1992). Foreshore areas were recommended for "...natural environment uses, ...walking trails and cycle trails." Other land uses included "...some development of facilities associated with education and research", "...other uses compatible with conservation' and '...rehabilitation and habitat protection".

Other land at Point Grey was proposed to be zoned for "...Proposed Rural Landscape and Conservation Areas through local rural strategies". This zoning called for land use controls which "...recognised the value of existing rural use while providing for retention of landscape and conservation features".

The Draft Inner Peel Region Structure Plan states on pp 99-100 that "...it is intended that the eastern side of the Harvey Estuary, together with the Austin Bay Nature Reserve, be considered the major fauna refuge in the Peel Regional Park. Its importance being (sic) the only consolidated areas of remnant vegetation remaining on the eastern side of the Peel-Harvey Estuary." We note that this is virtually the only significant fringing vegetation around the whole Estuary still in substantially natural condition.

The Final Inner Peel Region Structure Plan (Ministry for Planning, 1997) includes most of the 1992 proposals in the boundaries of the proposed Peel Regional Park. The Structure Plan includes the site of the proposed 'Ecotourist Village' in the Park, as well as the land west of Mealup Point Nature Reserve proposed for Special Residential use as part of the Point Grey proposal. The Regional Park boundaries also includes foreshores which would be lost if the marina is built.

Part 4. Public costs of the development

The Shire of Murray and state government bodies will inherit substantial ongoing costs in servicing the development, which will have to be met by Shire ratepayers and the general public . These may include:

- Long term maintenance of water supply. The cost of treating water by reverse osmosis is around 50c/kL, which is more than twice the cost of water treatment in metropolitan Perth. As water supply is likely to be provided privately, the additional cost will need to be met directly by the residents, or otherwise via a subsidy by all ratepayers within the Shire of Murray. The ER and the ODP make no mention of how this additional cost (potentially up to several hundred dollars per service per annum) will be met.

- Long term maintenance of sewerage systems. Very few communities in Western Australia are currently served by such high standard of wastewater treatment as is proposed for this development. The cost of such treatment are very high. The capital cost of similar plants of a comparable size in Western Australia, such as those on Rottnest and at Australind, are at least $300 to $500 per capita (Domurad and Edmonds, 1997). This implies a capital cost of $1 million to $2 million or more for Point Grey.

  Operating costs for small treatment plants of this type are typically $0.5 to $1 per cubic metre of wastewater, and have been higher for some plants (Domurad and Edmonds, 1997), at least three times the cost of metropolitan wastewater treatment. To these costs must be added the costs of maintenance of the wastewater collection system. When the population is lower at the early stages of the development, unit costs will be higher. No consumers in Western Australia are currently paying the full cost of such sophisticated wastewater treatment, as the costs of the small proportion of the state's wastewater undergoing such treatment is distributed across consumers served by the Water Corporation (Albany is a partial exception, with residents there progressively bearing an additional 50% rate increase, and this for a treatment system which is larger and less sophisticated, and hence cheaper per capita, than that proposed for Point Grey). Who will pay these costs - Point Grey residents, or all Shire of Murray ratepayers?

Other ongoing cost include:

- Long term maintenance of drainage systems;
- Road maintenance;
- Dredging to maintain boat launching facilities, and general marina maintenance;
- Mosquito control (see Part 5 of this submission);
- Removal of algal accumulations, at least in the short to medium term; and
- Fire control.

Part 5. Does the Environmental Review address the EPA's Instructions for the Environmental Review?

Note: Page number and section references relate to the Section 48 Environmental Review (ER) for the Scheme Amendment prepared by Bowman Bishaw Gorham. References to other documents within the Outline Development Plan are indicated specifically.

The Lake Mealup Preservation Society is concerned to find that the Environmental Review is seriously flawed.

Although DEP Officers have assured us that the EPA did not changed their *Environmental Review Instructions*, the EPA's *Environmental Review Instructions* as quoted in the Environmental Review are less searching and more general than EPA's original (14 March 1997). This misleading rewrite has weakened the overall environmental rigour of the Environmental Review.

The Environmental Review (Section 4.7) does not deal at all with the potential impacts of the development on Lake Mealup and minimally with adjacent reserves on the Peel-Harvey Estuary, as required by the EPA's *Environmental Review Instructions.*

The EPA required the developer to address key environmental factors (*Environmental Review Instructions*). For many of these problems, the Environmental Review gives no detail but offers instead to produce impact management plans after the proposal is approved (see Table below).

It is not acceptable for this major regional development to be approved

- **without providing evidence that these environmental problems can be solved;**
- **without public review of the proposed management plans; and**
- **with no allocation of responsibility and estimates of costs.**

We have prepared Tables which list the EPA's Environmental Factors and the proponent's response.

Vegetation (Section 4.1); Declared Rare and Priority Flora (Section 4.2); and Fauna - Waterbirds (Section 4.3)

Sections 4.1-4.3 are considered together, as the environmental impacts are interrelated, and the ER itself discusses impacts on waterbirds in section 4.1.

Section 4.1 lists the potential indirect impacts of the development due to the large population on the adjacent System 6 and other conservation reserves. As listed, these include

- drainage and edge effects;
- 'wear and tear' from pedestrians and fishermen;
- impacts of boating traffic;
- disturbance of wildlife from domestic animals;
- increased fire risk;
- dieback; and
- illegal dumping of garden refuse.

The ER states that "...most of these [impacts] are increases in existing impacts, which are currently unmanaged." This statement implies that the development will simply cause an incremental increase in impacts already occurring. This is highly misleading, as it ignores the change in human presence in the area and immediate surrounds from at most a few tens of permanent working residents and a small number of occasional visitors, to an ultimate population of 7000, most of whom will spend considerable time at the site, and whose access will be improved by boating facilities, paths and roads.

The document does not give specific details on management of most of these impacts, which is not surprising as they are extremely difficult to manage. Where the impacts and management are discussed, the problems are either dismissed, or minimal management is proposed, or planning is deferred until after the proposal is approved.

For example, the ER states that impacts of domestic animals will be "...generally confined to the close proximity of the residential areas" (p 70), which ignores the well established habits of domestic pets, especially cats, to roam widely (Potter, 1991). A study in New South Wales urban areas adjoining bushland showed domestic cats range and hunt several kilometres into natural habitats (ABC Quantum, 1997). In addition, dogs or horses will be taken by their owners to more distant locations for exercise. Likely exercise locations will include the shoreline around reserves within the development site, and into Austin and Robert Bays. A visit to Alfred Cove on the Swan River demonstrates the constant disturbance to which roosting waterbirds are exposed from dogs roaming loose and being exercised by their owners in such areas.

Waterbirds

Section 2.4.4.2, Waterbirds - Local Perspective, states that "...whilst some waterbird activity occurs on the [Point Grey] peninsula perimeter, by far the most important waterfowl habitat in the vicinity of the site is located at the extreme southern limit of Robert Bay where extensive intertidal flats provide feeding and loafing habitats. Most trans-equatorial migratory waterbird flocks congregate in this area. These intertidal flats are not proposed for development." This statement ignores the fact that these flats directly abut the rural residential areas and will be very vulnerable to pedestrians, domestic pets, off-road vehicles and boats from the development.

Due to tidal movements, the flats of Robert and Austin Bays will at times be suitable for off-road vehicles, including motor cycles and four wheel drives. This activity is not new to the area, but the Point Grey development will place a large population close to these and other reserves. The negative impact of this on roosting and breeding waterbirds not considered in the ER.

The effects of human pressures have already been demonstrated at waterbird sites along the Swan River. Records kept by Birds Australia members over 20 years have shown significant reductions in the numbers of migratory waders at Pelican Point. Environmental consultant Dr Mike Bamford, working with CALM at the Milyu Nature Reserve in South Perth, commented on the reduction in wader numbers over the last 15 years from "thousands" to "a few hundred" (The West Australian, 13 December ,1997), because of human impacts.

EPA Environmental Factor	**Developer's response**
Fauna - waterbirds	Waterbird monitoring program plan deferred to post-approval No specific actions proposed to minimise population impacts on key reserves including System 6 areas

Vegetation in reserves

The retention of existing natural vegetation on the site is commendable. The 95 ha reserve south of the neighbourhood village is particularly pleasing. However, residential settlements immediately adjacent to both private bushland and existing reserves such as Stony Point introduces human pressure on the reserve vegetation from physical damage, fire and weeds. In addition the value of these areas as fauna habitat is greatly minimised by the proximity of uncontrolled domestic pets.

The EPA's Instructions for the Environmental Review required that "...particular attention should be given to the interface between [conservation] areas adjacent to the development, management of human pressures... Attention should also be given to criteria used which trigger implementation of specified management measures".

The ER's response to this is to admit the problems of human pressures and attempt to minimise their extent, as discussed above. The approach to dealing with problems is to defer them to the development phase. For example, the ER states that human pressure will be dealt with in a Foreshore and Conservation Reserve Management Plan, which simply states that the plan will address human pressure (Table 6.1). No further detail is given.

EPA Environmental Factor	**Developer's response**
Vegetation in reserves	Plays down negative effects of greatly increased population and does not propose any specific actions to minimise impact. Foreshore and Conservation Reserves management plan deferred to post-approval. Inadequate onsite vegetation assessment based on 2-day survey during autumn (April) which under-represents the flora. System 6 Update data not used.
Declared rare and priority flora	None identified in inadequate survey (see above) Likely species: rush; donkey orchid

Declared Rare Fauna (Section 4.4)

The fauna study of 20 hours without trapping was too brief to be called adequate. Research at nearby Goodale Sanctuary south-east of Point Grey and at Lake Mealup, suggests that the Point Grey fauna list is far from complete.

The proposal to reserve existing vegetation such as the 95 ha block, and potential carpet python habitat is commended.

The proponent indicates in Section 2.3.2 on p 30 that all of the specialist fauna consultant's recommendations were adopted. This is not the case as the proposal for the constructed wetland at Robert Bay is conditional on further technical validation, and on funding external to the developer (section 3.3.3, p 53).

The 95 ha reserve south of the neighbourhood village is good bushland and its preservation is to be commended, but its value for birds and small mammals and reptiles will be greatly reduced by the presence of nearby residential areas, with the impacts of fire, feral animals and general disturbance. This comment also applies to habitat reserved for the carpet python.

EPA Environmental Factor	**Developer's response**
Declared rare fauna	Superficial fauna observation (20 hours, no trapping) found no rare fauna. Research at nearby Goodale Sanctuary suggests the Point Grey fauna list is far from complete. Inadequate management measures proposed to protect habitat for carpet python.

Estuarine vegetation and fauna habitat (Section 4.5)

This section discusses the value of the constructed islands offshore from the marina as habitat for seagrasses and fauna: "...the newly created habitats will be managed to ensure minimal disturbance by humans and will afford protection from feral predators" (p 82). However, according to section 3.2.2 (p 49), "Provision is made for a possible jetty which could provide a pedestrian link between the beach and one of two artificial islands." A jetty would destroy the value of the islands as a replacement waterbird bird habitat, which are proposed "...to balance the loss of subtidal habitat in the creation of the marina" (Section 3.3, p 50). It would allow human disturbance and provide access to the island for feral and domestic animals. This hardly seems to be management to ensure minimal disturbance by humans and feral predators, as claimed by the ER. It actually makes us wonder about the proponent's grasp of the environmental issues.

In addition, at 1.75 m above high water, the islands are too high to be of value to ground nesting species in need of secure breeding habitats, such as pelicans and fairy terns.

The statement (section 4.5.3, p 83) that in the event of "...significant damage to seagrasses due to increased fishing activity.... the Sailing Club and Marina operators would cooperate with PIMA to install appropriate signs advising of the concern and recommending environmentally sensitive practices" is an admission that such damage is essentially unmanageable. We contend that the impact of 7000 people living next to high conservation land is largely unmanageable.

EPA Environmental Factor	Developer's response
Estuarine vegetation and fauna habitat	Constructed island habitat are too high for optimal value to ground-nesting species such as pelicans and fairy terns. In addition, the proposed jetty for public access to these islands totally negates their value as waterbird habitat. Foreshore and Conservation Reserves management plan deferred to post-approval. Proposal to use signage to protect seagrasses from boating is totally inadequate.

Estuarine water quality (Section 4.6)

EPA Environmental Factors	Developer's response
Estuarine water quality	Water quality monitoring program deferred to post-approval. Outline of staging of management responsibility over time deferred to post-approval. The ER does not appear to address the effects on constructed islands on hydrological flows and algal boom frequency.

Wetlands (Section 4.7)

The EPA's instructions required the ER to consider the impact on Lake Mealup, a wetland forming part of the RAMSAR-listed wetlands of the Peel-Harvey Estuary.

Nowhere in Section 4.7 is Lake Mealup mentioned, even though the effluent disposal site for the wastewater treatment plant is located 1500 m to the north of Lake Mealup. Part of the irrigated woodlot runs down the south-eastern boundary of the development, to within 750 m of the surface expression of Lake Mealup water body, and within 500 m of the boundary for the small lake to the west of Mealup (Figure 3.8), which has a surface water connection with Mealup in wet winters.

In addition, four of the six potable water bores are located within 1250 m of the surface expression of Lake Mealup (Figure 3.6). These bores access the Leederville aquifer. Modeling results in Figure 4.3 of the ER shows that drawdown in this aquifer of 1 to 2 m could occur over most of the project area after 50 years. Figure 4.3 indicates that the Leederville aquifer under Lake Mealup could experience a drawdown of about 1.8 m. Section 4.8.3 of the ER indicates that "...this drawdown would have the effect of allowing increased recharge of the Leederville aquifer from the Superficial aquifer, *but is not expected to have any significant impact on shallow water table levels or groundwater-dependent vegetation and wetlands*" [our italics]. No evidence is given in the ER or the ODP to support this statement (see the section below on groundwater quality). Lake Mealup is a shallow, seasonal wetland, with a maximum depth of 1 to 1.5 m. Changes of the order of 1 m or less in its water level regime would drastically alter its ecological function.

Section 4.7.3 of the ER states that "...the impact of the proposed development on the shallow groundwater regime, which could potentially affect wetlands, is expected to be minor". Again there is no justification for this statement, and the ER cites the post-approval Water Supply Management and Monitoring Program, suggesting that any long-terms changes will be detected, enabling "appropriate remedial action" to be carried out. What action is possible? Who will do it? Who will pay for it?

We contend that making an unsupported claim that there will be no negative effects, relying on a monitoring program which would be defined post approval to detect negative impacts, and making vague comments about "remedial action" without indicating what is possible, is entirely inappropriate for RAMSAR wetlands such as Lake Mealup or Lake McLarty.

In 1996 the Lake Mealup Preservation Society initiated a five-year study of the hydrology of Lake Mealup under the direction of Dr Vic Semeniuk of the V&C Semeniuk Research Group, to assess the likely impact of adjacent land use on the quality and quantity of water in the wetland, and help determine rational buffer zones around the lake. Monitoring bores were installed in June 1996 and regular monitoring is in progress. The significance of this work is discussed in the following section.

EPA Environmental Factors	**Developer's response**
Wetlands protection	Impacts on Lake Mealup and Austin Bay Nature Reserve are not addressed. Wetlands management plan deferred to post-approval Basis for proposed buffer widths is not described. Buffers are inadequate; Davies and Lane (1995) recommendations are ignored.

Groundwater quantity (Section 4.8)

The EPA's Instructions for the Environmental Review require that "...the likely demand and management of the demand for water from the development needs to be discussed in the context of a sustainable yield from the Leederville aquifer without unacceptable environmental impacts, such as aquifer compression or lowering of the superficial aquifer".

Section 4.8.2 of the ER indicates that modelling predicts that at projected rates over 50 years "...an eventual drawdown of up to 2.2 m in the potentiometric level of the upper Leederville aquifer immediately beneath the centre of the borefield. Over most of the project area, the potentiometric drawdown would be less than 1.5 m after 50 years. This drawdown would have the effect of allowing increased recharge from the superficial aquifer, but is not expected to have any significant impact on shallow water table levels or groundwater-dependent wetlands."

Use of groundwater without harmful effects not demonstrated

As the discussion on Section 4.7 above indicated, the proponent was required to demonstrate that there would be no detrimental effects on Lake Mealup and the Peel-Harvey Estuary.

The critical aspect of hydrology in this area comes down to whether altering the watertable through urbanisation or water disposal, altering the hydrochemistry through nutrient enrichment, or altering the regional to local hydrology through water extraction from the Leederville Formation will have any effect on the Lake Mealup wetland system, or on the Peel-Harvey Estuary. If the hydrologic model is incorrect, then predictions in relationship to aquifer inter-relationships will be flawed. The key question is whether the consultants have shown, through scientific data, the working of the hydrology of this area so that they are in a scientifically valid position to interpret and predict the effects of their proposed developments.

In this context, in regard to the Lake Mealup wetland systems, ***there is insufficient information presented in the Environmental Review or in Engineering Report 2 of the ODP to substantiate the conclusions reached by the consultants***. The following basic scientific information is required to support the hydrologic model presented in the reports:

- plan of bore locations to document the database on which conclusions are reached;
- bore logs of the stratigraphic sites to document the site-specific and the regional framework of aquifers;
- position and depths of piezometers to assess the database on which conclusions have been reached, and depth of water levels in piezometers to document head differences in the various piezometers;
- water level fluctuations over time in the various depth-related and aquifer-related piezometers to verify their inter-relationships and their recharge mechanisms; and
- salinity of water or cationic information on the water within the various depth-related and aquifer-related piezometers to substantiate their inter-relationships and their recharge mechanism.

While there are data presented on bore pump tests, and salinity and chemistry of water extracted during these pump tests, firstly, these data are not presented adequately to be independently reviewed, and secondly, such data do not necessarily provide a realistic picture of the hydrology of an area. Much of the information listed above as being required to formulate and verify a hydrologic model is missing, except for bore logs in Appendix 2C of Engineering Report 2. Therefore the models and hypotheses that may not be valid in the site-specific area of the proposed development.

The potential adverse effects of the proposed development on the regional-local hydrology, and specifically on wetlands in the area, are too large to be risked without real, substantive data.

For instance, Figures A2 to A7 are regional pictures. The site-specific information may show different patterns to the inferred regional trends, and it is this local variation that may affect Lake Mealup.

Even the stratigraphic section centred on Point Grey, determined by Dames and Moore (Figure 2.2 of the Environmental Review) is unsatisfactory. The cross section shows a lenticular "limestone" cross section on the Point Grey peninsula, but the gaps in the stratigraphic sections (due presumably to loss of material while coring or boring) leave large questions. These gaps in the cross-section,

presumably of unlithified materials, are the very essence of what makes a system potentially complicated hydrologically.

The cross section presented in the Engineering Report 2 as Figure A3 is unsatisfactory for determining the small-scale local hydrological relationships. The Lake Mealup Preservation Society have a series of monitoring bores in place, and their stratigraphic and piezometric patterns show features different from the supposed regional pattern (V & C Semenuik Research Group, 1997, 1996). While rainfall may recharge the wetlands, there also is a component of subartesian upwelling at times of the year, and this across-aquifer relationship needs to be ***rigorously determined*** before prognoses on environmental impacts are made.

The numerical modelling presented in the Engineering Report 2 may be valid, if the hydrologic framework is correct. If the framework is in error, then the numerical modelling is meaningless. The lack of site-specific data in the area means that the conclusions of the consultants have not been scientifically validated. The model presented is based only on regional considerations and assumed hydrologic processes.

Specific problems with the data

- There is no established stratigraphic/hydrologic framework. Detailed work at Lake Mealup by Dr Semeniuk shows small scale complications.
- There is only one bore upon which the conclusions are based.
- Gamma logging for lithology is inappropriate for the detail required in hydrology in this study.

Given the complexities of the relationships of the limestone peninsula to yellow sand, the relationships of the Guildford Formation, the estuarine formations, and the wetland-fill sediments to the limestone and yellow sand, and all these formations to the underlying Osborne and Leederville formations, the data presented in these reports cannot be used to convincingly conclude that there will be no impact from the development due to water abstraction or wastewater disposal.

There are no data such as stratigraphic cross sections and clay content of yellow sand upon which to rationally predict the effect of nutrient loading of groundwater in this area through wastewater disposal, fertilising of gardens, golf course, public open space and recreation areas. The prognosis for nutrient flow is that nutrient enriched water will seep into the shore on the west and east side of the peninsula where such disposal sites are proximal to the shores, and will also affect the Mealup wetlands.

Two of the six water supply bores are located within the woodlot area for effluent disposal (Figure 3.6). These will be accessing the Leederville aquifer, but given the likely increase in recharge into this aquifer (Section 4.8.2), it seems possible that wastewater effluent may contaminate the aquifer, which is being used for potable water extraction. The wastewater effluent will contain nitrate nitrogen, at concentrations of least several mg L^{-1}. Nitrate nitrogen concentrations above 10 mg L^{-1} would not be considered acceptable for potable use (NH&MRC/ARMCANZ, 1996). Naturally there would be dilution within the aquifer, but given the apparent potential for this water source to be compromised chemically with nitrate, and also microbiologically, the proposal should not be approved unless this concern is addressed adequately.

EPA Environmental Factor	**Developer's response**
Groundwater quantity - Leederville aquifer	Information presented inadequate to sufficiently characterise hydrology to justify claims that the development will not have unacceptable environmental effects. Lack

	of site-specific detail upon which to base and verify the modelling. No information provided to support the claim that lowering the Leederville aquifer will not affect the superficial aquifer. Stratigraphic/hydrologic framework for site not established. Date does not support claim that nutrient loading of groundwater and damage to Lake Mealup will not occur.

Surface water quality (Section 4.9)

Pesticides

This section fails to address pesticide management measures, as required by the EPA Instructions.

Nitrogen application on the site

Total nitrogen application to the site is estimated at 42 tonnes per year (pp 105-108). This is composed of applications to domestic gardens, the golf course and public open space, and disposal of wastewater effluent. The proponent claims a very high retention of nitrogen on the site.

Nitrogen exports

Nitrogen export from the site is predicted to be about 4.2 tonnes per year, or less than 1% of the current estimated total export from the Peel-Harvey Estuary to the adjacent ocean waters. This small incremental increase is based on two questionable points:

- Fertiliser use on domestic gardens is claimed to be the single largest factor, contributing 24 tonnes/a, or 57% of the total of 42 tonnes per year (p 107 of the ER). This is the biggest component of the nitrogen application. Its calculation is based on a single reference on nitrogen inputs to domestic gardens, transformed to achieve a mass load per household. Given the sensitivity of the estimate of total nitrogen application to the amount applied to domestic gardens, we contend that this estimate should be based on a wider information base, including consultation with relevant industry groups.

- The estimated percentage of applied nitrogen potentially entering the groundwater is quite small (4 to 10%). While we do not necessarily dispute this percentage, we note that it is based on only two references, of which only one is local and recent. Again, until a wider information base for this estimate is provided, we contend that the proponent has not conclusively demonstrated that Point Grey will not contribute significant additional nitrogen to near-shore marine waters.

  In addition, the estimate of nitrogen passing root zones is based on information from domestic gardens. The ER does not indicate the justification for applying this estimate to other situations such as golf course irrigation or wastewater effluent disposal.

A higher rate of nitrogen pass-through would potentially increase the discharge of nitrogen to the Peel-Harvey Estuary, and hence to the ocean. It is essential that the likely discharges are reliably and scientifically calculated, given the concern over the effect of nitrogen loads from the Peel-Harvey on nearshore ocean waters near Perth. To do this requires a broader set of information than that presented in the ER.

Nitrogen concentration in wastewater effluent

The estimated nitrogen loading from wastewater effluent, 2.7 tonnes per year, is based on continuous achievement of 5 mg L^{-1} total nitrogen in the treatment plant effluent. While this effluent quality is achievable by an appropriately designed biological nutrient removal (BNR) wastewater treatment plant, no Water Corporation BNR plant in Western Australia is achieving this level on a continuous basis. An average near 10 mg L^{-1} for the most advanced plants (such as Rottnest or Pemberton) is more typical. This would double the nitrogen load from the BNR plant.

To achieve the effluent quality claimed in the ER, the BNR plant would require daily attendance for several hours by a skilled operator. Staffing may be reduced somewhat if at least two continuous online nitrogen monitors were installed. These would raise the BNR plant capital cost (conservatively estimated to be $1 million to $2 million), by an additional 10 to 15% (Domurad and Edmonds, 1997). No plants in Western Australia currently have such monitors.

Loading variations in BNR plants

A disadvantage of small BNR plants is that loadings vary significantly over the day and week, due to different levels of human activity. This is important in the operation of a nutrient removal plant, where cycle times must be carefully controlled to ensure the biological nutrient removal processes are optimised. The changing loadings make this difficult, and point to the need for comprehensive monitoring of the plant. Given Point Grey's proposed tourist facilities, the loadings would be even more variable than expected from a purely residential development.

Marina sullage effects on BNR plant

Sullage from the marina will be pumped into the sewage collection system, and hence to the wastewater treatment plant (Section 4.6). It is not apparent from the calculations shown for the treatment plant that the loading from this waste has been considered in wastewater treatment and effluent disposal considerations. In addition, sullage may contain salt, which is undesirable from an effluent reuse point of view, and chemicals such as glutaraldehyde which are biocidal to the microorganisms in the BNR plant.

The significance of sullage waste to wastewater treatment plant operation depends on the amount, but given that the plant is a sensitive biological system, and would be required to treat to a very high quality level, the impact of sullage should be further investigated.

Monitoring equipment for BNR plant

The variable loadings on the plant mean that effluent quality will vary, especially in nitrogen and phosphorus content. Effluent monitoring by the simple collection of instantaneous grab samples is inappropriate. Flow proportional composite samples would be required to obtain data needed for proper plant operation and to ensure that the target effluent quality is being achieved. This requires the installation of refrigerated automatic samplers, which should be a requirement of the wastewater treatment plant's DEP operating licence.

The ER (sections 3.4.4 and 4.9.3) simply states that wastewater will be treated to a high standard, and provides little or no evidence to show that the issues raised above have been considered.

Effluent nitrogen discharge is a relatively small component of the total estimated nitrogen load to the development site, but the estimate of 2.7 tonnes per year appears conservative, as it assumes attainment of an effluent quality not being achieved consistently at any similar Water Corporation

BNR plant, and the proponent's documentation gives no indication that the operation and maintenance requirements, and the capital and operating costs of such a plant have been considered.

BNR plant sludge disposal

The ODP is contradictory over the disposal of sludge from the wastewater treatment plant. Page 117 of the Engineering Services Report says that the 1.5 cubic metres per day of dewatered sludge could be used onsite "...**for landscape development in suitable areas, or disposed of at the Shire's solid waste disposal site**" [our emphasis]. However, on p 142 of the ODP it is acknowledged that the sludge "...would have considerable quantities of phosphorus. Because of this, dewatered sludge is expected to be disposed of offsite". Onsite disposal is undesirable due to the potential for release of nitrogen and phosphorus which may enter groundwater and runoff.

Wastewater effluent disposal

Wastewater effluent will be disposed of by irrigation onto a woodlot during winter, when effluent is not required for irrigation of the golf course (Section 3.4.4). There is no indication that the area of the proposed irrigation site or the underlying soils have been assessed for their ability to absorb the amount of wastewater proposed to be applied to the site.

The approximate area of the irrigated woodlot, based on our calculations from Figure 3.8 of the ER, is about 42 ha. At an ultimate daily effluent volume of 1500 cubic metres per day (section 4.9.2, p 106), this equates to about 36 cubic metres per hectare per day. For comparison, the Albany treatment plant, with a daily flow of 3000 cubic metres, has an irrigated area of 300 ha, representing a volumetric loading of only 10 cubic metres per hectare per day. Hence, the Point Grey woodlot is receiving nominally 3.6 times the volume that Albany receives.

Although Point Grey has a different soil type, and perhaps half of the annual effluent production will be used on the golf course, this represents a significantly higher nutrient loading.

Perhaps more significantly, the Albany site has a holding dam able to retain about 100 days' effluent to store effluent during winter, when the trees do not require irrigation. The Albany irrigation scheme is computer controlled, with soil probes that continuously monitor the soil to prevent overwatering (Water Corporation, 1997).

No holding dam is proposed at Point Grey, and yet it is during the winter that effluent irrigation onto the woodlot is proposed. The ER gives no indication that the woodlot's capacity to absorb this volume during winter without surface runoff or tree failure has been assessed. No details are given on woodlot operation or monitoring of correct irrigation practices.

Disposal of saline reject water from reverse osmosis plant

Up to 706 kL per day of reject water from the reverse osmosis plant (used to produce drinking water for the development) is projected (Section 6.2 of Engineering Report 1 of the ODP). This water will have a dissolved solids content of 3000 to 4000 mg L^{-1}. The report simply suggests that this will either be disposed of in "...a suitably positioned soakage pit" (the size and location of which are not indicated), or "...a suitable site will be found for direct injection...to a salt-tolerant aquifer". No indication is given whether sites and technology have been determined, or approvals for direct injection investigated.

EPA Environmental Factor	Developer's response

Surface water quality	On-site nutrient management plan deferred to post-approval Determination of on-site effluent treatment for rural lots deferred to post-approval. Superficial description of sewage treatment. Operating and maintenance requirements of BNR plants and effect of changing loadings not discussed. Effluent nutrient concentrations are optimistic compared to current plants at Rottnest and Pemberton. Geotechnical info on suitability of sewerage effluent disposal areas is not provided. Disposal of saline reject water from reverse osmosis plant not considered.

Odours (Section 4.10)

EPA Environmental Factors	Developer's response
Odours	Algal odour management plan deferred to post-approval

Noise and dust (Section 4.11)

EPA Environmental Factor	Developer's response
Construction noise/dust	Construction management plan deferred to post-approval

Turbidity (Section 4.12)

EPA Environmental Factors	Developer's response
Turbidity	Dredge Spoil Disposal Management Plan deferred to post-approval.

Aboriginal heritage (Section 5.1)

EPA Environmental Factor	Developer's response
Aboriginal heritage	LMPS cannot assess the ER on this point.

Mosquitoes (Section 5.2)

Mosquito breeding habitat

The proposed development area both contains and is adjacent to mosquito breeding habitat. One of the predicted consequences of the opening of the Dawesville Channel was an increase in mosquito breeding habitat. This has been the case (Wright, 1995) with mosquitoes now breeding all year round in the Peel region. Mosquito numbers and cases of Ross River virus have increased substantially since the opening of the Channel, despite increased control measures.

All of the development area is within 5 km of areas identified as saltmarsh by McComb, et al. (1995). We note that Figure 2.8 of the ER fails to show saltmarshes on the western shore of the development, particularly the area on the southern side of Stony Point Nature Reserve, although this is referred to in the text and is shown in the original figure in McComb et al.

The saltmarsh mosquito *Aedes camptorynchus,* the major vector of Ross River virus, can readily disperse up to 5 km (Wright, 1995). A related species *Aedes vigilax,* which can disperse up to 20 km, is a serious nuisance because of its habit of biting viciously at most times of the day (Wright, 1995). Mosquitoes may also breed in tidally inundated areas abutting the development area such as Stony Point, Mealup Point and Point Birch (EPA, 1988).

The presence of these species makes residential development in mosquito prone areas, such as Point Grey, highly undesirable.

Mosquito buffer zones

Buffer zones of up to 800 m are recommended around wetlands to reduce the risk from nuisance insects such as midges (Davies and Lane, 1995). These must be vegetated, to provide physical barriers to pest species and provide habitat for their predators. Such buffers may have to be wider in wetlands where suitable mosquito habitat is available (Davies and Lane, 1995).

Mosquito control

The ER accepts that the establishment of a large population centre at Point Grey will require the extension of mosquito monitoring and control measures to this area (Section 5.2.3). This will mean additional expense for the Shire of Murray and the Health Department of Western Australia. The Shire will have to meet 50% of the cost of spraying within its boundaries (the Health Department meets the rest), as well as carrying out monitoring of mosquito breeding sites.

Abate®, an organophosphate insecticide, is a major component of present mosquito control measures. Abate® applications along the western shoreline of the Harvey Estuary have increased from one to four per season prior to the opening of the Dawesville Channel, to 12 in 1994/5 and 17 in 1995/6. This involves fortnightly aerial spraying Abate®, at a cost of about $5000 per flight. Despite the increased spraying, the mosquito hazard is still considerable.

Spraying is not currently carried out on the eastern shoreline of the Harvey Estuary as there are not sufficient people living there. This type of mosquito control could cause a repeat of the 1984 Lake Forrestdale incident when hundreds of migratory wading birds were killed by Abate® spraying. The Austin Bay mudflats, extensive saltmarsh along the Estuary foreshores, Lake Mealup and Lake McLarty, which are recognised as internationally significant habitat in the Peel-Harvey Estuary for waterbirds, are adjacent to the development.

The EPA's Instructions required that "...the Environmental Review should demonstrate that the breeding of mosquitoes and midges can be adequately controlled without adversely affecting other flora and fauna, with particular reference being directed to potential impacts on areas with regionally significant vegetation, fauna habitats and wetlands".

In response, with respect to potential mosquito breeding areas in the Robert Bay wetland, the ER simply lists the available mosquito control measures. The likely effectiveness, and environmental impact of mosquito control measures for breeding habitat adjacent to the development, are not discussed at all, other than stating that it is not the proponent's responsibility.

An urban development which increases the requirement for mosquito control measures in critically important waterbird habitat, of which the spraying of an organophosphate pesticide is a key component, is not environmentally acceptable. Spraying will probably only be partially successful in controlling the problem, as mosquito numbers appear to have been relatively constant in those areas

of the Peel-Harvey Estuary that are currently subject to control measures, despite increases in spraying.

EPA Environmental Factor	Developer's response
Mosquitoes and midges	Identifies breeding sites within development only. Ignores insect movement from sites within 5 km of development. Control measures for proposed constructed wetland on Robert Bay drain deferred to post-approval Wetland Management Plan. No assessment on impact of increased Abate® spraying on adjacent Ramsar and National Heritage wetlands Austin Bay, Lake Mealup and Lake McLarty. Satisfactory control of mosquito hazard from either public health or environmental impact perspectives not demonstrated.

Part 6. Comparison with the 1987 proposal: has anything changed?

In 1987, Mallina Holdings proposed a development at Point Grey catering for an ultimate population of 9000 people (Dames and Moore, 1987). That proposal included a residential village, rural residential lots, a golf course, holiday/tourist accommodation, boating facilities and a sub-tertiary college. The current proposal for 7000 people includes all the elements of the 1987 proposal except the sub-tertiary college.

The Environmental Protection Authority rejected the 1987 proposal as environmentally unacceptable (EPA, 1988) for the following reasons:

- The large population introduced into the area "...would have a significant impact on the conservation values of the Estuary, and in particular nearby reserves". The EPA identified the need for "...carefully considered regional planning, in particular in relation to regional open space." It also was concerned over the loss of vegetation associations, including tuart woodland, and the absence of recognition that Point Grey is "...the most significant topographical feature in the Peel-Harvey area." The uncertainty of the impact of the Dawesville Cut on open space reserves was also raised.
- The costs associated with algal harvesting (in the short term, at least) and of mosquito control.
- The availability of a suitable water supply from the Leederville Formation was not demonstrated.
- Buffer zones, and the impacts of fire and introduced flora and fauna were not adequately addressed.
- Sewage disposal, including excess quantities beyond those able to be disposed of by irrigation; disposal of chemical sludge from phosphorus removal in the village treatment plant; disposal of septic tank sludge from the rural residential lots; phosphorus loadings to the estuary – none of these were satisfactorily addressed.

The EPA concluded in 1987 that as the Estuary was already under significant stress, and the development was located amongst ecologically valuable features of the estuarine environment, the development should not proceed.

The EPA's 1987 concerns still apply

- The impact of a large population on nearby reserves are the same for both proposals. We have discussed in earlier sections the undesirability of locating a large population centre close to high value conservation areas, the difficulty of controlling human impacts, and the fragmentation of the Peel Regional Park.
- The absence of unacceptable environmental impacts from groundwater abstraction for water supply has not been demonstrated. The proponent has assumed an absence of environmental effects on the basis of inadequate data.
- There are still concerns over the impact of water wastewater disposal. The proponent gives a very superficial description of the proposed treatment plant. No appreciation of the level of operational control needed to achieve the claimed effluent quality, and of the difficulties associated with operating a BNR plant receiving variable loadings, is demonstrated. The material in the ER does

not support the claimed effluent quality, and effluent and sludge disposal have not been satisfactorily addressed.

- The expected increase in mosquito numbers with the opening of the Dawesville Cut (EPA, 1988) have been confirmed (Wright, 1995), and the negative impacts of control measures on the natural environment remain. Nothing in the current proposal indicates that the mosquito hazard can be controlled effectively and efficiently, nor is there any indication that controls will not adversely affect the nature reserves.

- There will still be substantial costs associated with servicing the development, which are not addressed by the ER or associated documents.

- EPA considered that the development was premature, as "...the resilience of the environment to receive the potential impacts is already jeopardised" (EPA, 1988). Our enquires to government departments responsible for monitoring the condition of the Estuary (Water and Rivers Commission, CALM, PIMA, Health Department of WA, Fisheries Department and Department of Transport) have indicated that water quality has improved since the opening of the Dawesville Cut, although this trend needs to be confirmed through several wet winters, mosquito numbers have increased, and it is too early to make judgements on aspects such as waterbird populations and vegetation. This is not unexpected, as changes in the estuary created by the Dawesville Cut and the effect of improved catchment management practices on the condition of estuary will be gradual. We understand that a two-year all-agencies report is due shortly. Claims that the Dawesville Channel will allow a massive increase in population without nutrient pollution have not been substantiated yet.

- Land use planning for the Peel Region has advanced significantly since 1987. The Peel Regional Strategy was published in 1994 and the Peel Regional Park Study was conducted in 1990-1992. These studies identify the conservation values of Point Grey, and while the possibility of development is considered, the overall thrust of both documents is toward maintaining existing conservation and rural uses. The Inner Peel Regional Structure Plan (Ministry for Planning, 1997) does not show residential development at Point Grey. The Structure Plan contains the latest boundaries for the Peel Regional Park, major components of which abut the development. The implications of these documents for land use at Point Grey were discussed in Part 3 of this submission.

Part 7. Alternative options for Point Grey

Land use at Point Grey should take into account the following factors:

- The unique location adjacent to high conservation value land, which will be a centrepoint of the Peel Regional Park
- The southern Peel Inlet and the Eastern Harvey Estuary are the last parts of the Peel-Harvey Estuary not subject to intensive residential development, and the last substantial foreshore areas in a relatively natural condition.
- The value of Point Grey as a buffer to important conservation areas, and the presence of valuable natural bushland and foreshore vegetation on the site itself.

The outstanding scenic potential of high land at Point Grey could be utilised in a small tourist village, supported by a flora and fauna sanctuary. Access to foreshores should minimise loss of foreshore vegetation. Limited access for small boats may be considered; intensive powerboat facilities, such as a marina, are not appropriate.

Intensive residential use is not appropriate, as most of the problems associated with the current proposal, such as human impacts on nature reserves, water and wastewater management, and mosquito control, are associated with the large population this land use would involve.

Very low density residential lots could be considered. To reduce the impact of human population on adjacent high conservation value areas, such lots must have strict clearing controls, building covenants regarding wastewater and drainage arrangements, a ban on domestic pets, strict limits on livestock, and limits on fertiliser and groundwater use. Covenants should also indicate that the area is subject to a mosquito hazard, and that residents accept this risk when they choose to live at the site.

The area has versatile, good quality agricultural land (Shire of Murray, 199?). Continued agricultural use may be appropriate. Agroforestry may also be an option.

The land west of Mealup Point Nature Reserve, proposed for special residential development, should not be developed, but should be added to the Peel Regional Park. The site of the Ecotourist Village should also be added to the Park.

LMPS believes that at the most, no development of Lake Mealup Road beyond the status of minor road along its current route should be accepted. Any southern access road, if required, which we doubt, should be routed to the east of both Lakes Mealup and McLarty.

Part 8. Conclusion

The Lake Mealup Preservation Society considers that the development as proposed is unacceptable for the following reasons

- Unavoidable impacts of the large population on the adjacent high conservation value wetlands, foreshores and bushland.
- Fragmentation of the proposed Peel Regional Park.
- Public health risks from mosquitoes, and the costs and environmental impacts on adjacent reserves of mosquito control measures.
- The adequacy of proposed water supply and wastewater treatment systems has not been demonstrated. Their potential detrimental effects on conservation values have not been addressed.

The Environmental Review document is seriously flawed. Its treatment of major environmental issues is superficial. The impacts of groundwater extraction for water supply are predicted on the basis of inadequate, regional information. The ER gives no indication that the requirements for operation of the sophisticated wastewater treatment and disposal system have been considered. The problems of human impacts on high conservation value land, and the management of public health and environmental aspects of mosquito control, are essentially ignored.

Detailed consideration of environmental issues is repeatedly deferred to management plans to be prepared post approval of the proposal. This gives no confidence that the issues can be satisfactorily addressed, or that the proponent has given them serious attention.

The concerns with the present proposal are essentially unchanged from those associated with the 1987 Mallina Holdings proposal which was rejected by the EPA.

Alternative land uses as proposed in Part 7, should be considered, with intensive residential development and large-scale marina facilities excluded.

The Scheme Amendment as proposed should be rejected.

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FLORA AND VEGETATION SURVEY

POINT GREY DEVELOPMENT SITE

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CONTENTS

1. INTRODUCTION

2. METHODS

3. RESULTS

3.1 Flora

3.2 Vegetation

3.2.1 Eucalypt/Banksia Woodland
3.2.2 Tuart Woodland
3.2.3 Spearwood Thickets
3.2.4 Beach Ridge Mosaic
3.2.5 Flooded Gum Woodland
3.2.6 Banksia Woodland
3.2.7 Shoreline Communities
3.2.8 Melaleuca Thickets
3.2.9 Acacia Thickets
3.2.10 Paperbark Swamps

4. DISCUSSION and RECOMMENDATIONS

5. REFERENCES

APPENDIX: CHECKLIST OF THE VASCULAR FLORA

FLORA AND VEGETATION SURVEY
POINT GREY - PROPOSED DEVELOPMENT SITE

1. INTRODUCTION

This report presents the results of a brief survey of the flora and vegetation on the proposed development site at Point Grey in the Shire of Murray.

Although all of the suitable woodland areas have been cleared/partially cleared for pasture in the past, the site has significant stands of remnant vegetation. The vegetation falls within the Spearwood and Bassendean vegetation systems as delimited by Beard (1979, 1981). Beard mapped the vegetation of the area as Tuart Woodland, which would certainly have been predominant on the site prior to clearing.

Previous work on the site (Dames and Moore, 1987) delimited and mapped ten vegetation types on the site. These ranged from Tuart and Jarrah/Banksia Woodland to Grass/Sedge Salt Flats.

2. METHODS

The site survey was undertaken over two days in April. The first visit in the company of Ninox Wildlife Consulting was essentially a familiarisation visit and to ascertain Fauna habitat types. The second day and more detailed survey encompassed all of the perimeter of the site and also several foot transects in selected remnants of the different vegetation types.

Note was taken of the dominant species present, and of the condition of the remnant vegetation. A record of associated species was made opportunistically, and where identification of a species could not be made in the field, a voucher specimen was taken for later identification / verification at the Western Australian Herbarium.

Prior to the site visits, reference was made to the Department of Conservation and Land Management's data base of Rare and Priority listed flora for the area. Particular attention was paid in the field to noting the presence of any of the species on the lists which would be visible or identifiable at the time of the survey.

3. RESULTS

3.1 Flora

A total of 110 taxa from 35 families of vascular flora were recorded during the survey. These are presented as a checklist in the Appendix. The families best represented in this opportunistic survey are the Myrtaceae with 17 species and the Proteaceae with 12 species. The Chenopodiaceae, Papilionaceae and Cyperaceae are also well represented.

Groups most likely to be under represented in the checklist because of the opportunistic nature and seasonal timing of the survey include some of the Monocotyledonous families (eg. Anthericaceae and Haemodoraceae), and possibly also the rush and sedge families (Cyperaceae

TABLE 1 DECLARED RARE AND PRIORITY LIST FLORA WITH DISTRIBUTION RANGES WHICH ARE CLOSE TO OR ENCOMPASS THE POINT GREY SITE.

TAXON	DISTRIBUTION /HABITAT
Rare or Threatened Flora *Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection.*	
Aponogeton hexatepalus	Perth-Bussleton. Ephemeral fresh water
Centrolepis caespitosa	Perth and sth of Pinjarra. Damp locations
Diuris drummondii	Nearest Pinjarra. Seasonally wet shrubland
Diuris micrantha	Nearest Yunderup. Swampy flats
Diuris purdiei	Nearest Pinjarra. Seasonally wet shrubland
Drakea elastica	Perth-Ruabon. Spearwood in low lying areas
Drakea micrantha	Perth southwards. Banksia/Jarrah woodland
Schoenus natans	Eastern Swan Coastal Plain. Aquatic.
Priority One Flora - Poorly Known Taxa *Taxa which are known from one or a few (generally <5) populations which are under threat.*	
Grevillea manglesii subsp. ornithopoda	Murray River, Pinjarra
Priority Two Flora - Poorly Known Taxa *Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.*	
Boronia capitata subsp. gracillis	Nearest Yarloop, seasonally waterlogged areas
Jacksonia sericea	Perth-Pinjarra, calcareous sandy soils
Priority Three Flora - Poorly Known Taxa *Taxa which are known from several populations at least some of which are not believed to be under immediate threat.*	
Acacia semitrullata	Nearest Yarloop, sand near swamps
Blenospora sp.	Nearest Kooljerrenup NR.
Dillwynia dillwynioides	Perth southwards, damp heath.
Microtis media subsp. quadrata	Nearest Pinjarra, clay-based swamps
Myriophyllum echinatum	Nearest Waroona, annual herb, aquatic
Rhodanthe pyrethrum	Perth-Harvey, wet clayey areas.

Only evident in Spring

Annuals

TABLE 1 (Continued)

TAXON	DISTRIBUTION
Priority Four - Rare Taxa *Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors*	
Conostylis pauciflora subsp. pauciflora	Sth of Mandurah, Spearwood sands nr. Estuary
Drosera occidentalis subsp. occidentalis #	Gingin-Pinjarra, winter wet peaty soils
Eucalyptus rudis subsp. cratyantha	Murray River flats, Pinjarra-Mandurah
Villarsia submersa (#)	Nearest south of Pinjarra, freshwater pools

and Restionaceae). Members of the Dicotyledonous genera Drosera, Isotoma, Lobelia, and Stylidium as well as several orchids and annual Asteraceae would be encountered on the site during a visit in Spring.

A summary of the Rare and Priority flora (eight species of Declared Rare / Threatened Flora and 13 taxa in the various Priority categories) which could possibly be present on the site given existing distribution records is given in Table 1. None of these species was encountered during the survey, or has been recorded on the site during previous surveys.

Habitat similar to that known to support the two species of Drakea is present on the site, but intensive surveying in Spring would be necessary to confirm their presence. Similarly, the Priority taxa *Jacksonia sericea, Dillwynia dillwyioides, Consostylis pauciflora* subsp. *pauciflora, Drosera occidentalis* subsp. *occidentalis* and *Villarsia submersa* could possibly be present

Weedy exotics were only recorded if they were present in remnant bushland (ie. not in the pastured areas). Sixteen taxa were identified which makes up just under 15% of the total in the checklist. Many weedy species are also annuals, and several more tuberous/bulbous plants as well as grasses and medic species would be identifiable in late Winter or Spring.

3.2 Vegetation

The vegetation on the site can be classified in broad terms into 10 units. These are based on physiognomy and species composition except for the composite units representing the shoreline communities, and the Beach ridge mosaic vegetation. The units are listed below with a brief description of the structure and dominant species. The units are listed in descending order (by approximation) of the size of intact, or nearly intact remnants remaining on the site. The vegetation types recognised have been mapped along with an indication of their condition in Figure 1.

In general the vegetation remnants that have not been cleared for improved pasture are mostly in a good to fair condition. Even where grazing has taken place, there is a diversity of understorey species still present. Some of the shoreline areas which are used for fishing and crabbing are

more disturbed, and would be described as fair to poor (see legend to Figure 1 for definitions of condition categories).

3.2.1 Eucalypt/Banksia Woodland (see Plate 1)

Distribution: A major remnant of this woodland type occurs across the centre and again right at the southern extension of the site.

Structure: This woodland type is generally fairly dense with a multi-layered canopy. The understorey is dense and diverse, consisting mostly of shrubs under a metre in height and a range of sedge and rush species

Main Species: The canopy is formed by a mixture of Jarrah (*Eucalyptus marginata*) and Marri (*Eucalyptus calophylla*), with Sheoak (*Allocasuarina fraseriana*) and various Banksias also present as a second stratum. Important shrubs in the understorey include *Conostephium pendulum*, *Conospermum stoechadis*, and *Hibbertia hypericoides*.

Condition and importance: The remnant of this woodland type on the site is of significance due to its fairly substantial size, shape and condition, which is excellent. Woodland/low forest with a similar canopy composition occurs to the south along the edge of the Harvey Estuary (much of it in the Kooljerrenup Nature Reserve). However, this area tends to be lower lying than on the survey site, and the understorey composition would show definite differences if a comparative survey was undertaken.

3.2.2 Tuart Woodland (see Plates 2 and 3)

Distribution: Prior to clearing, Tuart (*Eucalyptus gomphocephala*) Woodland would have been the principal vegetation type present, and remnants occur throughout the study site.

Structure: The Tuart Woodland generally has a fairly open canopy with mature trees well spaced. The understorey is low, and even when not grazed as it has been on the study site, tends to be more open in structure than in the adjacent Eucalypt/Banksia Woodland.

Main Species: Tuart is the dominant and sometimes the only species present in the canopy. However, in areas where there is limestone outcrop, Sheoak and Candle Banksia (*Banksia attenuata*) may become predominant. Important shrubs in the understorey include *Acacia pulchella, Hakea lissocarpha, Leucopogon pauciflorus*, and *Melaleuca acerosa*.

Condition and importance: Remnants of intact Tuart Woodland are rare locally, and not well represented on the east of the Peel-Harvey Estuary in general. None of the Tuart Woodland on the site is in a natural condition. The condition of the large remnant to the south of the Eucalypt/Banksia Woodland varies between fair, with a suite of native understorey species still present, to poor, where most of the understorey has been grazed out. All other areas which supported this woodland are under improved pasture, although mature Tuarts have been retained.

3.2.3 Spearwood Thickets (see Plate 4)

Distribution: These thickets occur quite extensively just inland of the Shoreline Communities along much of the western edge of the site.

Structure: This is a dense thicket of multistemmed shrubs (broombush type) to about four metres in height. At maturity there are very few understorey species present.

Main Species: Spearwood (*Kunzea ericifolia*) is the dominant species. Other species such as Sheoak, Candle Banksia, Swamp Banksia and *Acacia saligna* may occur as occasional individuals. In Spring orchids and other small herbaceous species may occur.

Condition and importance: This vegetation type on the site has mostly remained uncleared, and due to its impenetrable nature is generally little disturbed. Spearwood thickets of a similar structure and composition are found in comparable habitat southwards along the shores of the Harvey Estuary, and are not uncommon on the coastal plain from Perth southwards.

3.2.4 Beach ridge Mosaic (see Plate 5)

Distribution: Beach ridge Mosaic vegetation occurs on the northernmost part of the point, and also adjacent to the shoreline communities near the south-western end of the site.

Structure: This is a shrubland of varying density and height where the species distribution forms a pattern associated with the variations in topography caused by the old beach ridges.

Main Species: A diverse suite of shrubs, sedges and occasional low trees occurs. Important shrubs include *Jacksonia furcellata, Acacia saligna, Regelia ciliata* and also Spearwood. *Lyginia barbata*, several Lepidosperma species and *Carpobrotus edulis* are common low shrubs. *Banksia littoralis* occurs as an occasional low emergent.

Condition and importance: Except for areas close to access tracks to the water, at both the Point and the southern boundary of the site, this vegetation is in good condition and relatively weed free. This is a diverse community type, and quantitative survey would possibly result in the recognition of several different associations. Similar mixed shrublands occur sporadically along the eastern edge of the Harvey Estuary. However, occurrences are usually small in extent. More detailed surveys would be needed to determine both its extent regionally and variations in species composition

3.2.5 Flooded Gum Woodland (see Plate 6)

Distribution: Flooded Gum (*Eucalyptus rudis*) Woodland occurs on lower lying sites where fresh water is close to the surface. On the study site it is found just inland of the Shoreline Communities on the eastern side of the point, and on the sandy terraces and estuarine alluvium at the north-eastern end of the site.

Structure: This is an open woodland, both in terms of tree spacing and of density of canopy. Small thickets of one of the associated canopy species may also occur, and have been mapped as part of this vegetation type. The undertorey is low and dense.

Main Species: Flooded Gum is the dominant canopy species, although Swamp Banksia (*Banksia littoralis*) and Swamp Paperbark (*Melaleuca raphiophylla*) are also sometimes present. The understorey is mainly one of sedges and rushes and occasionally of samphires and other Chenopod shrubs including *Suada australis* and *Atriplex prostrata*.

Condition and importance: Flooded Gum Woodland is not uncommon regionally, as it occurs along all of the major rivers and on many of the flats around the Peel Inlet. However it is almost universally altered and in only a fair to poor condition. There are small areas on the site where it is in good condition, with a dense rush and samphire understorey. These should be retained if possible.

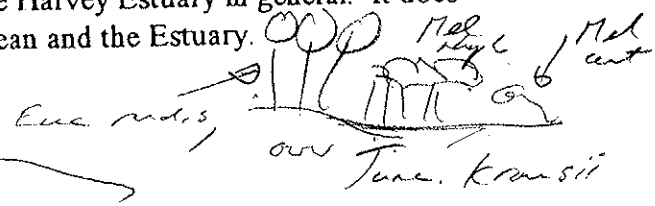
3.2.6 Banksia Woodland (see Plate 7)

Distribution: Banksia Woodland occurs on the crest and upper slopes of the rise at Point Grey, and also just to the north of the Eucalypt/Banksia Woodland about half way along the western boundary of the site.

Structure: This is a woodland/low woodland of varying density and with a fairly open understorey.

Main Species: Candle Banksia (*Banksia attenuata*) is the principal tree present, although several of the Eucalypts may occur occasionally as stunted trees. The understorey when mature as it is on the site is very open and relatively species poor. The main shrub species are *Acanthocarpos preissii, Macrozamia riedlei, Hibbertia hypericoides, Clematis microphylla* and several species of Leucopogon.

Condition and importance: Most of this vegetation type on the site is in good condition although rabbits were noticed here on the Point. There were some deaths on the slopes of the rise facing the Estuary and at its foot which should be investigated for dieback infection. Banksia Woodland is not common on the site, or along the eastern edge of the Harvey Estuary in general. It does occur more prolifically on limestone areas between the ocean and the Estuary.



3.2.7 Shoreline Communities (see Plates 8 and 9)

Distribution: These salt tolerant communities occur in a narrow band along the whole shoreline of the project with their development dependant on the local topography.

Structure: They consist of dense beds of rushes or low shrubs with occasional individuals or clumps of trees.

Main Species: *Juncus krausii* in dense beds is the most noticeable species. In places the rush beds are replaced by samphires and other Chenopod shrubs such as *Sarcocornia blackiana*,

Halosarcia pergranulata, Halosarcia indica subsp. *bidens, Halosarcia halocnemoides, Atriplex hypoleuca*, and *Suada australis*.

Condition and importance: For most of the length of the shoreline this community type is in good condition. There are stretches along Robert Bay which are used for fishing and crabbing where disturbance has led to the loss of some vegetation and the invasion of weedy species. These communities are ubiquitous along the edge of the Estuary and Inlet margins. They are important for shoreline stability and should be maintained wherever possible.

3.2.8 Melaleuca Thickets (see Plate 10)

Distribution: Remnants of these thickets are found on the seasonally wet flats and estuarine alluvium at the north-eastern end of the site, and also around the small swamp along the eastern fenceline.

Structure: In a natural state these thickets have an almost closed canopy to about four metres in height. There are few, if any, understorey species present.

Main Species: Three species form these thickets, with their presence probably dependant on the degree and timing of inundation. These are *Melaleuca viminea, M. uncinata* and *M. raphiophylla*

Condition and importance: Most of the thickets on the flats have been altered extensively with pasture and other weedy species forming a dense groundcover, or cleared completely. Similar thickets are not uncommon on flats around the eastern edge of the Peel inlet

3.2.9 Acacia Thickets (see Plate 11)

Distribution: Only one occurrence was noted on the site. This was at the south and eastern foot and lower slopes of the rise on Point Grey

Structure: These thickets are formed by closely spaced shrubs/small trees, and at maturity form a closed and dense canopy which may reach almost to ground level.

Main Species: *Acacia rostellifera* is the dominant, and sometimes the only species present.

Condition and importance: Rabbits were present in this vegetation type. Otherwise it appeared to be undisturbed. Similar thickets are not uncommon in the sub-coastal environment and around the Peel-Harvey Estuary.

3.2.10 Paperbark Swamps (see Plate 12)

Distribution: There are several basin swamps present on the Point and near the northern corner of the Eucalypt/Banksia Woodland which support a woodland of Paperbarks.

Structure: The trees tend to be well spaced and may reach eight to ten metres in height. The understorey is very open and is mostly of sedges

Main Species: Modong or Stout Paperbark (*Melaleuca preissiana*) occurs where inundation is moderate, and Swamp Paperbark where the water is deeper or longer lasing. Some *Pericalymma elipticum* may occur close to the edge, or where the tree density is not too high. Various sedges form a sparse understorey.

Condition and importance: Both of the major occurrences of this vegetation type have undergone some disturbance due to grazing. Paperbark Swamps with similar vegetation occur throughout the Swan Coastal Plain. However, due to local differences in topography and hydrology, each tends to have a unique species composition and zonation of species.

4. DISCUSSION and RECOMMENDATIONS

Most remnants on the site where clearing for improved pasture has not taken place are in a good to fair condition. The remnant of Eucalypt/Banksia Woodland is particularly significant both for its size and condition, and because similar diverse mixed woodland is becoming increasingly scarce on the Swan Coastal Plain.

An attempt should be made in planning for the proposed development to retain as great a diversity of vegetation types as possible. This can be achieved by creating a shoreline buffer of intact vegetation along with the remnant of the Eucalypt/Banksia Woodland and the Paperbark Swamps. Planning for linkages between the remnants which are conserved should also receive priority. These linkages should be of vegetation which still has a diversity of understorey species present if this is possible.

Prior to any significant earthworks on site, a survey for the presence of Dieback infection should be undertaken, and siteworks should be planned to include dieback hygiene strategies if the survey indicates that this is required.

5. REFERENCES

Beard J S 1979. The vegetation of the Pinjarra area Western Australia. Vegetation Survey of Western Australia 1:250 000 series. Vegmap Publications Perth.

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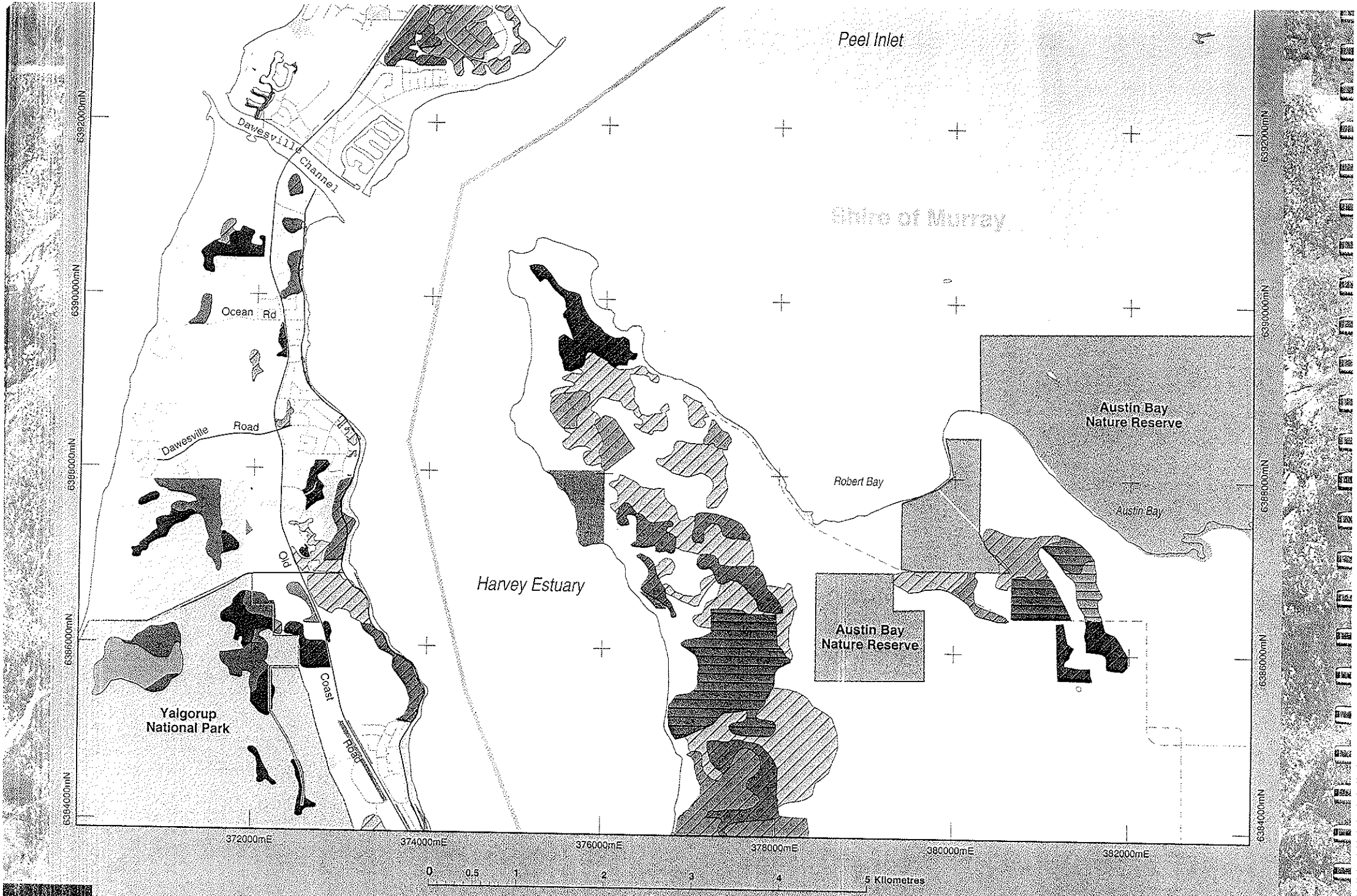
Peel Inlet
Shire of Murray
Dawesville Channel
Ocean Rd
Dawesville Road
Old
Harvey Estuary
Robert Bay
Austin Bay
Austin Bay Nature Reserve
Austin Bay Nature Reserve
Yalgorup National Park
Coast
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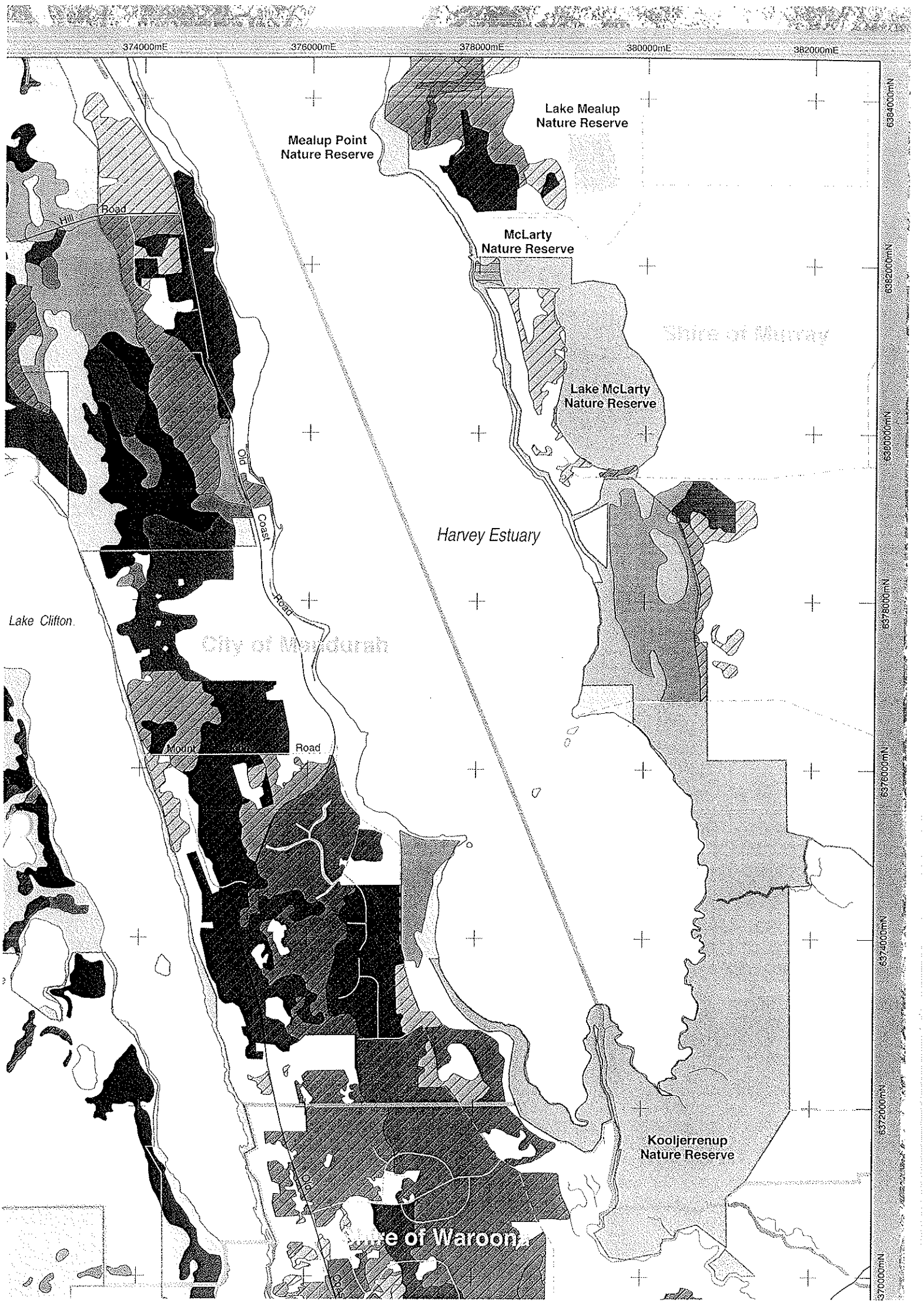
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Lake Mealup Nature Reserve
Mealup Point Nature Reserve
McLarty Nature Reserve
Shire of Murray
Lake McLarty Nature Reserve
Harvey Estuary
Lake Clifton
City of Mandurah
Hill Road
Old Coast Road
Mount Road
Kooljerrenup Nature Reserve
Old
Shire of Waroona

DEPARTMENT OF ENVIRONMENTAL PROTECTION

TO:	-	SHELLEY EDWARDS
FROM:	-	BRONWEN KEIGHERY, CONSERVATION BRANCH
SUBJECT:	-	DRAFT COMMENT ON: SHIRE OF MURRAY TOWN PLANNING SCHEME NO. 4 AMENDMENT NO. 104 (POINT GREY)
DATE:	-	FEBRUARY 1998

Comment in this document principally addressees issues related to the conservation of vegetation and flora in the above document (Bowman Bishaw Gorham 1997) and information presented at the Point Grey Workshop (3/2/98). These issues are addressed in two sections; those relating to general issues and specific comment on the document.

Overall I am concerned with the superficial treatment of the study area's conservation values and the potential impact of the 7,000 people and improved access will have both within and outside the study area. In my opinion the region will not be able to sustain a development approaching this size and intensity. The apparent positive outcomes of the Dawesville Cut should not be seen as reasons for an inappropriately scaled development. If the development is only viable at this scale then it is inherently environmentally unacceptable.

DRAFT COMMENT ON: SHIRE OF MURRAY TOWN PLANNING SCHEME NO. 4 AMENDMENT NO. 104 (POINT GREY)

Section A: General Issues

1. Biological Information Necessary to Address Regional Significance on the Swan Coastal Plain

1.1 Standard Information Set

A set of standard biological information needs to be provided to enable consideration of regional significance. This information can then be assessed against the criteria established to determine regional significance in Draft Perth's Bushplan . These are not 'new' information sets and need to be collated to do a comprehensive determination of an area's regional values.

REGIONAL INFORMATION
LANDFORM AND SOIL

VEGETATION AND FLORA
Vegetation Complex (Heddle *et al* 1980)
Floristic Community Types (Gibson *et al* 1994; Note- in this case additional work by DEP is not applicable as additional floristic community types have not been identified in this area)

WETLANDS
Wetland Types (Hill *et al* 1996a, Hill *et al* 1996b)
Consanguineous suite (Hill *et al* 1996a, Hill *et al* 1996b)
Wetland Management Objective (Hill *et al* 1996a, Hill *et al* 1996b)
Lake EPP

SPECIFIC SITE DETAIL (the limitations of any survey work should be clearly stated)
Landscape features

Vegetation and Flora (any existing information and own survey)
Structural units (should be mapped and related to individual located site descriptions with sufficient replicates to identify the variation in each unit)
Scattered native vegetation (in this context refers to non bushland areas with scattered natives, may be trees, shrubs, herbs, grasses or sedges)
Vegetation Condition (should be mapped)
Total Flora, including total flora, significant flora (DRF, priority taxa, range extensions, species at geographic limits etc.)

Fauna (any existing information and own survey)

Linkage (adjacent bushland areas)

Other Attributes (including recommendations from previous studies on significance)

INTERNATIONAL AND NATIONAL SIGNIFICANCE
Reference to international treaties, listing on the register of the National Estate etc.

1.2 Biological information supplied in the document

1.2.1 Limited scope of flora and fauna survey

The background documents on the vegetation and flora (Goble-Garratt June 1996) and fauna (Ninox August 1996) of the study area are necessarily limited in their treatment of the study area's biological attributes. This is the case as field work for both studies was performed at an inappropriate time of the year (April) and over a very limited period (two days for flora and 20 hours for fauna).

The inappropriateness of the timing of the flora survey is well illustrated by the fact that 13 of the 21 DRF and Priority Flora listed from CALM's database would not have been evident at the time of survey as six species are aquatics or semiaquatics and seven are annuals or geophytes. It is difficult to understand why a spring flora and vegetation survey was not done when this is clearly the most suitable time for such a survey and the development plans for the study area were done over a three year period (Martin Bowman, Workshop 3/2/98). This is especially puzzling when the direction to

the consulting team was to focus on conservation in the development plans (Martin Bowman, Workshop 3/2/98). **Detailed flora and vegetation survey is needed to adequately identify conservation values, place the area in a regional context and to prepare credible flora and fauna management plans.**

1.2.2 Remaining vegetation and vegetation condition

A condition map is supplied in the document (Figure 2.5) however in consideration of the time of the year in which the vegetation work was done this map of vegetation condition should be seen as a guide to condition rather than a definitive map. These difficulties in assessing condition were compounded by the description of the study area as being predominantly cleared in 1910 (Martin Bowman, Workshop 3/2/98). However aerial photograph mosaics in Glasson *et al.* (1995) indicate that the entire peninsular was vegetated in 1957, the majority of the clearing occurring over the twenty years between 1957 and 1977 (perusal of the actual mosaics, not the reproductions in the report will be necessary to confirm this). The relative recent nature of the vegetation clearing indicates that there could well be substantial regeneration if disturbance (especially grazing and trampling) was removed.

The condition mapping is particularly relevant to interpretation of the wetland condition. The condition of wetlands, especially those on clay soils, is difficult to interpret as the proportion of natives annually renewed plants to weeds cannot be assessed in autumn. Many of the wetlands areas described as in 'poor' or 'depauperate' condition may well recover rapidly in the absence of grazing. Such changes may well have been the cause of the changes in samphire distribution in the Roberts Bay (south) area mapped by Glasson *et al.* (1995). To propose to clear and then form ponds in the wetlands adjacent to Roberts Bay without some detailed mapping is unacceptable on conservation grounds.

1.2.3 Inadequate consideration of regional significance of the flora and vegetation

The study area contains a diversity of plant communities associated principally with the two landforms units, Vasse Estuarine and Lagoonal Deposits and Spearwood Dunes (Bowman Bishaw Gorham 1997, Section 2.1.2). As the patterning of plant communities and species distribution on the Swan Coastal Plain is related to the major geomorphic units these give an initial guide to the regional significance of the flora and vegetation in the study area. This very general information indicates that the study area is unusual in that region as it contains a large proportion of the only area of Spearwood Dunes on the eastern side of the Peel-Harvey Estuary. In addition, the interface between the Spearwood Dunes and the Vasse unit occurring here is, necessarily, rare on the eastern side of the Estuarine system. While the presence of Spearwood Sands is a focus for the area's development potential (Section 4.9) the regional significance of this outlier of Spearwood Sands and associated Tamala Limestones is not discussed or investigated. Neither is the regional significance of the Vasse unit and the interface of the Spearwood and Vasse units considered.

Vegetation

The regional floristic study of Gibson *et al.* (1994) provides a context for assessment of the vegetation on a regional level on the Swan Coastal Plain. In the Mealup Point Nature Reserve Gibson *et al.* (1994) identified two regional floristic groups (Table 1). Both groups are associated with the Spearwood Dunes - floristic community type 25 with deeper sands over limestone and floristic community type 26b with shallow sands over limestone. It would be expected that these two community types would occur in the study area; floristic community type 25 represented by the Eucalypt/*Banksia* Woodland and Tuart mapping units and floristic community type 26b by the *Acacia* Thickets mapping unit and possibly the *Banksia* Woodland mapping unit.

Several of the plant communities mapped on the Spearwood Dunes appear unusual in a regional context. The Spearwood (*Kunzea ericifolia*) unit appears to be associated with some areas of outcroppping limestone (steep contours) which is unusual on the Plain. The *Banksia* Woodland on beach ridge (proposed marina site) is also unusual as at other locations on the eastern margin of the estuarine system the sands on the beach ridges are considered to be of Bassendean Dune origin and are generally in a location where they may be influenced by changing water levels associated with the Dawesville Cut.

The plant communities of the Vasse unit are more difficult to place without more detailed flora information. The wetlands of the Vasse unit vary greatly depending on the proportion of sands and clay in the soils, the period on inundation and the relationship between salt and fresh water (this ranges from salt to fresh and combinations of these - in some areas the flora reflects saline conditions in late spring/early summer and fresh water in winter/spring). Such complexity results in a complex of communities (Table 1). Previous to the survey work for the regional floristic study (Gibson *et* al. 1994) the complex nature of these wetlands was not well appreciated. Seven wetland floristic community types have been recorded on the eastern side of the Peel - Harvey Estuarine System and at least one other would be expected to be found in the region (Table). Three of these community types are threatened ecological communities (Table 2). All of these types could be found in the study area but types 4, 7, 11, 15 and 16 are considered most likely. Community types 7 and 15 are threatened ecological communities (English and Blyth 1997).

No sampling was done by Gibson *et al.* in the interface between the Spearwood and Vasse Systems and it is possible that there may be types associated with this interface that have not been identified previously. On current knowledge the most likely type to be associated with this interface is community type 18, Shrublands on calcareous silts, a threatened ecological community (English and Blyth 1997).

The study area and south to the area of the Mealup Point Nature Reserve represent the only areas of Spearwood Dunes and their associated vegetation on the eastern side of the estuarine system. As such they form an integral part of a sequence of Spearwood/Bassendean/Vasse units of regional significance on the Swan Coastal Plain. Reserves to the north and south of the study area contain vegetation typical of the Vasse/Bassendean units (Table 1), that is: Vasse (Austin Bay Nature Reserve (ABNR)), Vasse/Bassendean Systems (Kooljeneerup Nature Reserve (KNR) and Lake McLarty Nature Reserve (LMNR)) and possible the Spearwood/Bassendean/Vasse (Carabungup Nature Reserve - CNR). Four of the wetland floristic community types associated with the heavy soils (clays and loams) Vasse unit are threatened ecological communities (English and Blyth 1997).

In consideration of the regional significance of the vegetation in the study area and the high levels of clearing in the Peel -Harvey region all intact areas of vegetation, and those that would regenerate in the absence of grazing/trampling, should be included in conservation areas. This is consistent with previous regional planning for the study area (Peel Regional Park). That is the area of the sailing club, wilderness lodge and marina and areas of the rural-residential lands should be conservation areas.

Flora

The regional treatment of flora (DRF and Priority Species consideration) is also limited (see above, Section 1.2.1). The adjacent Carabungup Nature Reserve is expected to have a flora of over 400 taxa. While it would not be expected that the study area would contain this diversity of flora (absence of Bassendean Sands and large clay based wetlands)it would be expected to be well over that recorded for the area. Detailed survey in spring is necessary to determine if Declared Rare and Priority flora are absent from an area.

As is expected the flora list indicates that the area contains taxa associated with the Spearwood Dunes and Vasse Estuarine and Lagoonal Deposits. One species, *Pittosporum phyllyraoides*, is of interest as populations of this species are uncommon in mainland Spearwood units (best populations on Garden and Rottnest Islands). More detailed survey could have located other significant taxa.

Sixteen weed taxa are listed but their abundance in relationship to management issues is not considered.

1.3 Relationship to Internationally, nationally and regionally significant natural areas

As discussed above the study area forms an integral part of a sequence of Spearwood/Bassendean/Vasse units of regional significance on the Swan Coastal Plain and is central

to a major aquatic ecosystem of international and national significance. Currently the eastern side of the estuaries and the eastern shores/hinterland are somewhat isolated from the main centres of population in the region by poor road access and limited boat launching facilities. Even so all areas already show the impacts of people (four wheel drives in sensitive wetlands, weed invasion associated with campsites, wood gathering etc) and gross ecosystem changes associated with past clearing and nutrient enrichment. **However the impact of generally improved access, large boating facilities and the number of people (greater than Pinjarra) proposed to be housed in the core of this highly significant area will be devastating. While there is some level of theoretical commitment to managing the impact within the study area there is no commitment to managing the impact outside the study area.** These issues represent major environmental implications

In addition the study impacts that are not currently addressed. potentially very damaging

1.4 Buffers to conservation areas (bushland, estuary and wetlands)

In general the conservation areas do not appear to be buffered, development is proposed to the edge of the intact vegetation. As discussed above these areas should be considered of regional conservation value and the configuration of the areas should be designed to maximise areas value as long term conservation areas. That is **each conservation area should be buffered. Buffer widths will depend on the nature of the area to be buffered and adjacent landuses.**

Buffer design for wetlands should take into account the most recent synopsis on buffer width on the Plain by Davies and Lane (1995). Twelve buffer functions are referred to in boundary determination. Each relevant buffer function should be considered in determining the recommended buffers in the study area.

The concept of a 50m buffer/foreshore reserve/estuarine reserve should be seen as the minimum (as specified in numerous guidelines) and then other factors be considered in designing the buffer and or width of the reserve.

1.5 Linkage

It is well established in conservation reserve design that conservation areas should be linked to allow for movement of fauna and gene flow between plant populations. Currently the foreshore/hinterland vegetation links the sequence of reserves on the eastern side of the estuarine system. This linking corridor needs to be retained. Canopy linkage occurs across the peninsular and this should be enhanced by fencing and restoration to consolidate this linkage.

1.6 Management of Natural Areas

A theoretical commitment to management is unacceptable. Currently the document presents too little information from which to develop management plans and significantly underplays the potential impact of 7,000 people. This document is proposing a completely new land use with the potential to grossly impact vegetation in the study area as well as vegetation in surrounding conservation reserves. Associated with these 7,000 people will be the following disturbance factors in relation to vegetation: groundwater supply, waste water disposal, domestic and garden refuse disposal, service corridors, dogs, cats, illegal off road vehicle use, illegal wood cutting, more frequent fire, pressure to reduce fuel loads in bushland, weed invasion, horses, dieback, trampling, incremental edge mowing etc.

While confidence is expressed in the ability to manage the impacts examples of successful maintenance of conservation area under similar pressures are not given.

The references to current degrading processes (Workshop) in the study area is misleading. Under current landuse some simple management practises such as fencing out stock and limiting access points to the estuary would dramatically improve the vegetation condition. Under the current zoning there can be no clearing of vegetation and management of remnant vegetation should be part of standard land use management.

It is difficult to comment on the theoretical management plans but several issues require comment:

- Many of the intact areas proposed for conservation areas are narrow and additional disturbance should not be proposed for within these areas. Any paths should be located outside these areas within the buffer area and the buffer area be designed to accommodate the path.

- Conservation areas should have hard boundaries, especially to housing, these hard boundaries (often roads) can then act be used for fire access and act as a buffer to incompatible land uses.

- The source of funds for management should be clear and management in the study area should be the responsibility of the landholders. In addition some contribution should be made by the landholders to the management of surrounding areas. The value of land in this proposed 'urban centre' will get added value from the location but will only contribute to the degradation of the surrounding lands.

1.7 Replacement of habitat

With current knowledge we are not able to effectively replace habitat (for example as proposed Bowman Bishaw Gorham 1997 Section 4.1.3, p73), it ~~may be~~ is possible to ~~mimic~~ restore some functions but the costs involved are substantial. The focus of conservation should be to restore and manage existing habitat.

Part B: Specific Comments

2.3.4.3
Wetland classification not given, how they could have been assessed against Bulletin 689 without more detailed information not known.

3.4
Proposed road assessment should be part of the proposal as adjacent to significant conservation reserves. All impacts should be addressed.

3.4.3
Modelling is not adequate need sufficient basic information on local conditions especially when adjacent wetlands are of such high conservation value. In addition any drawdown should consider the effect on upland vegetation. It is understood that the Dawesvile Cut has resulted in increasing salinity of groundwater, this is not considered but is perhaps this is the source of need for desalination. If desalination is required the disposal of hypersaline water becomes a significant issue.

4.1.3 (ii)
A series of issues associated with the waste water irrigation area and the Blue Gums (Martin Bowman 3/2/98) woodlots proposed are not addressed. Some of these issues are:
- Potential to become weeds in the adjacent Nature Reserve .
It is well established that Blue Gums are potential weeds in wet areas and it should not be recommended that they be planted immediately adjacent to a Nature Reserve.
- Lack of any habitat function
Blue Gums will not provide significant habitat for native fauna. The location of this lot in a possible linkage corridor is poor.
- Nutrient influx into adjacent wetlands
Lake Meelup to south and wetland to east are regionally significant, possible effects nutrient enrichment compromise these.
- Fire problems
Need protection from fire will increase pressure to burn adjacent reserves

Table 1. Generalised description of community types and most frequent landforms on which they occur. An * indicates this type was inferred as being present, not by analysis of plot information. An # indicates that the type is a 'threatened ecological community' (English and Blyth 1997).

Floristic community	Generalised description type	Location by plots on eastern side of the Estuarine system	Predominant landform ty mapped by Churchward : McArthur 1980)
#3b	*E. calophylla - E. marginata* woodlands on sandy clay soils	KNR	Pinjarra Plain
4	*Melaleuca preissiana* damplands	KNR	Bassendean
5	Mixed shrub damplands	ABNR	Bassendean / Pinjarra
#7	Herb rich saline shrublands in clay pans	ABNR, CNR	Pinjarra Plain
#10a	Shrublands on dry clay flats	KNR	Pinjarra Plain
11	Wet forests and woodlands	ABNR, CNR	Bassendean / Pinjarra
13	Deeper wetlands on heavy soils	LMNR	Bassendean / Pinjarra
#15	Forests and woodlands of deep seasonal wetlands	CNR	Pinjarra Plain
*16	Highly saline seasonal wetlands	ABNR, CNR, KNR	-
21a	Central *Banksia attenuata - E. marginata* woodlands	KNR	Bassendean /Spearwood
25	Southern *E. gomphocephala - Agonis flexuosa* woodlands	PMNR	Spearwood
26b	Woodlands and mallees on limestone	PMNR	Spearwood

Meeting Notes

Name	Folio No.
Bronwyn Keighery	
Branch	**File No.**
Subject	**Date** / **Time**
Point Grey - 2Ra ~~Pt~~	31 / 3 / 98

People in attendance
Shelley Shepherd + BJK

Items	Action required	Action by
Sampling for floristic community types - 10 x 10m plot - record all species in Spring, at least 2 visits (one may be before Spring) (data sheets as for Gibson et al. 1994, copy in Keighery 1994, 1998 printing) - analysis through PATN to get classification (contact Dr Neil Gibson CALM Woodvale to do analysis. Tod Griffin at AgWA can also do analysis if he has access to the database) - at ~~least~~ Point Grey 2 plots (at least) should be done		

'POINT GREY'

3/2/98

Principle aim - EPA normally does not protect what they own
- Can you own/post or ignore most subdivisions
- Owner - Town Planner (25-30 yrs)
- 80% green space out of 11,000 ha

- 1995 Zoning Urban planning
- Urban Forestry
- 'Second Reflects' can secondary
- ridge needed for 'N facing views
- roads on contours - minimize pathways
- traditional
- development 'Forest Edge' above (1)
- 'Upland' looking to 'conventional' (2)
- (3) Marine
- (4) conventional on ridge

All cleared since ?1910 (NO see Stanley study)

FUNDING - issues to be resolved

- New info
- Ongoing Management

3/2/98

Marina:

Issues

- Loss of veg (land)
- Dredging
- loss sea grass
- regional values

RMA - against islands

WRC: Jason (observations) 'Principle to retain habitat' (ie BOG in development sense), large foreshore reserves not returned in all area (precautionary principle - no certainty all models) = environmental sustainability

removing - habitat
'create' - no demonstrated success (sand islands no vegetated mat

∴ NO MARINA (BOG keep saying RMA said could be Marina)

Times Plan (1992) under review ? longer would be

Fairclose MP 3/2/98

Key Issues

- 3,000 people (can we manage?
  vegetation
  Need - reserves enlarged
  - modification

waterbirds
- insufficient info
- 'core area' for development
- 'Yes in principle'
BUT scale outside need new info
- waterbird info.
- vegetation
- extra to scale boating facilities

NEED integrated with mosquito control this determines viability

STAGED DEVELOPMENT —

- But clear that subsequent stages may be rejected NO approvals

- LINE MAP & LISTS

Point Grey

Shire of Murray TPS 4 Amendment 104
to Rezone from Rural to Special Development Lots 75, 137-139,
293, 299, 322, 672, 727, 729, 738, 1132, 1133 & 1145

WORKSHOP

Tuesday 3 February 1998
9.00am - 5.00pm

The Celtic Club - upstairs
43 Ord Street, West Perth

PROPOSED AGENDA

1. Welcome
2. General overview of the proposed development
3. Marina and associated issues
4. Foreshore reservation and management plan
5. Lunch
6. Nutrient modelling
7. Mosquitoes
8. additional items

& CONSERVATION AREA

FORESHORE/CONSERVATION MANAGEMENT PLAN

TABLE OF CONTENTS

See 'Zones'

Approval CALM

Page No.

1.0 INTRODUCTION

2.0 RESERVE AREA

3.0 KEY ENVIRONMENTAL ISSUES
- 3.1 Designated Conservation Reserves
- 3.2 Waterbird Protection
- 3.3. Control of Public Access and Pressures
- 3.4. Protection of Archeological Sites (Ethnographic)
- 3.5 Mosquito Breeding Habitat
- 3.6 Vegetation Protection – weeds, – fire
- 3.7 Erosion + Accretion (Sediment transport)

4.0 DESIGN AND MANAGEMENT OBJECTIVES

5.0 PROPOSED RESERVE DESIGN
- 5.1 Overview
- 5.2 Conservation Precincts
  - 5.2.1 Objectives
  - 5.2.2 Protection of Existing Significant Areas
  - 5.2.3 Landscape Objectives
  - 5.2.4 Rehabilitation and re-vegetation of degraded foreshores
  - 5.2.5 Public Access And Information Facilities
  - 5.2.6 Vermin Proof Fencing
  - 5.2.7 Weed Control
  - 5.2.8 Conservation Signage
- 5.3 Recreation Precincts
  - 5.3.1 Objectives
  - 5.3.2 Rehabilitation and re-vegetation of degraded foreshores
  - 5.3.3 Public Access, including Dual Use Pathways and Cycleway Plans
  - 5.3.4 Provision of Facilities
  - 5.3.5 Fencing
  - 5.3.6 Weed Control
  - 5.3.7 Signage

Identify and show be managed

MCP

ALL existing vegetation retained

TABLE OF CONTENTS
(CONT'D)

Page No.

5.0 PROPOSED RESERVE DESIGN (cont'd)

5.4 Ecotourism Opportunities and Education

5.3.1 Objectives

5.3.2 Promotion of Educational and Scientific Uses of the Foreshore

5.3.3 Promotion of Community Involvement in Management

5.4 Mosquito Management

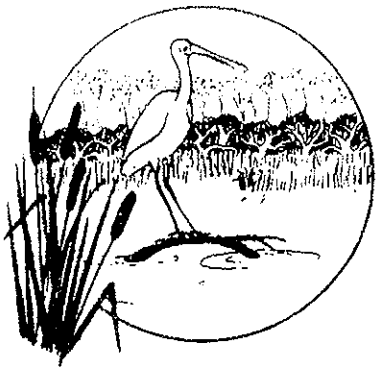
6.0 RESERVE MANAGEMENT

6.1 Implementation and Management

6.2 Vesting

6.3 Management and Monitoring

7.0 REFERENCES



LAKE MEALUP PRESERVATION SOCIETY (INC)

Correspondence to Secretary:

Celine –
copy for you –
cheers!
Jan

29 January 1998

6/53 Ramsdale St
Doubleview 6018
Ph/Fax (08) 9244 3015

Mr Tom Day, Chairman
National Parks and Nature Conservation Authority
c/ Department of CALM
Locked Bag No. 104
Bentley Delivery Centre 6983

Dear Mr Day

The Lake Mealup Preservation Society would like you to have a copy of our submission to the Shire of Murray on their Town Planning Scheme No. 4 Amendment No. 104. This relates to the major regional rezoning of Point Grey for a new town of 7000 people. The environmental impacts will be huge, as it abuts Ramsar and National Estate wetlands and estuary. The regional planning impacts are also extensive, as the developer seeks permission to rezone without laying down methods of minimising impact or setting indicators. This is the first project under Section 48 Environmental Review in EPA's legislation, and will be used as a precedent by other developers.

We understand that there is to be a meeting between the developer and representatives of all government agencies affected by the proposed rezoning on Tuesday, 3 February. If your agency is represented at that meeting, your representative may find some of the technical information and environmental concerns outlined in our submission useful.

We also understand that the Shire will receive a report from their Planner at their 29 January Shire Council Meeting, and the proposal and submissions will be discussed at the Planning Committee meeting on 11 February. We believe that the Council will decide on the proposal at their 26 February Council meeting.

Thank you very much for your consideration.

Yours sincerely

J Knight

J L Knight and P Wilmot

Department of Environmental Protection

THE NEW PLANNING LEGISLATION AMENDMENT BILL - INFORMATION ON THE ENVIRONMENTAL ASSESSMENT OF SCHEMES - TOWN PLANNING AND REGION SCHEMES

The information included in this package summarises the procedure and statutory process to be followed involving the EPA assessment of schemes. Part 1 is a summary of the process. Part 2 is a flow chart showing the statutory process. Part 3 summarises the statutory process and but show the "informal" EPA/DEP procedures prior to referral, during & after assessment of a scheme (if required).

The information mainly focuses on those schemes subject to assessment by the EPA. It is anticipated that there will be considerable consultations with the developer/responsible authority (Local Authority or Ministry for Planning for the WAPC) prior to formal referral.

Limitation

This information is provided as a guide to the new process of environmental assessment of planning schemes under the new legislation for officers at the Ministry for Planning, local authorities, planning and environmental consultants, and the general community. It has been produced by the Department of Environmental Protection and has not received EPA endorsement. The statutory parts of the process are fixed by law. The timing of the non-statutory parts may vary depending on the nature of the proposal, timing of EPA meetings and available resources at the DEP. The DEP will endeavour to mange workloads to fit in with this process. Any variation will be negotiated with the relevant parties.

Part 1 EPA Assessment of Planning schemes summary

Principles

Joint processes.

Retain integrity of each.

Retain independence of EPA

Scheme assessment.

More certainty.

What can be assessed

Region Schemes,

Town Planning Schemes,

Redevelopment Schemes

amendments to all of the above.

and Statement of Planning Policy

Process summary

1. Responsible authority resolves, refer;
2. EPA assessment needed;
   - issue instructions;
   - prepare environmental review
   - It should meet instructions.
   - Scheme plus environmental review advertised;
   - submissions to RA.
   - Environmental submissions copies to EPA;
   - RA response to EPA.
   - EPA report published;
   - Ministers consult on conditions
   - Min Env determines appeals, sets conditions
   - RA may request review of conditions via Min Planning.
   - Scheme must comply with conditions before Min planning issues approval.
   - Proposals under scheme not referred unless new issues; new info;or non-compliant with scheme & conditions.

Garry Middle, Manager, Environmental Planning Branch, Department of Environmental Protection, Westralia Square, 141 St Georges Tce, Perth, WA 6000. Ph - 222 7069; Fax - 322 1598; Email - gmiddle@IRIS.DIALix.oz.au

Part 2 - Simplified process chart - Statutory

Planning process	Environ assessment	Appeals	Timelines	Dispute resol'n
Responsible Authority (RA) resolve, refer	EPA decide need to assess		28 days from referral	
1	not assessed no advice		issue advice 28 days from referral	
2	not assessed with advice		issue advice 28 days from referral	
3	can not be made environmentally acceptable		issue advice 28 days from referral	RA - to Environment Minister and responsible Minister
4	assessed - process below followed			
	EPA issue instructions for env. review	RA and public can appeal	60 days from referral	
RA prepare draft scheme with environmental review	EPA check review meets instructions			RA - to Environment Minister and responsible Minister
Scheme advertised - submissions to RA	Env submissions to EPA		7 days from end of review period	
RA consider response to submissions	Submissions response to EPA		42 days from end of review period	
	EPA report to Min Env on Scheme	RA and public can appeal	i) which ever the longer (a) 60 days from referral (b) 30 after receiving response to subms but no more than 72 from end of review period; ii) minister can extend	Minister for the Environment and responsible Minister can specify another time-line

Garry Middle, Manager, Environmental Planning Branch, Department of Environmental Protection, Westralia Square, 141 St Georges Tce, Perth, WA 6000. Ph - 222 7069; Fax - 322 1598; Email - gmiddle@IRIS.DIALix.oz.au

Planning process	Environ. assessment	Appeals	Time-lines	Dispute resolve
	Min Env consult Min Plan on conditions & relevant appeals			Minister for the Environment and responsible Minister to agree
	Min Env decide appeals, set conditions			
RA incorporate conditions				RA may request review of conditions
WAPC consider, Min Plan determine scheme				
RA implement scheme				RA may request review of conditions

Garry Middle, Manager, Environmental Planning Branch, Department of Environmental Protection, Westralia Square, 141 St Georges Tce, Perth, WA 6000. Ph - 222 7069; Fax - 322 1598; Email - gmiddle@IRIS.DIALix.oz.au

Part 3 - flow chart of EPA assessment of planning schemes showing "informal" procedures (statutory process in italics)

Local Authority/ developer	DEP involvement	EPA role	Timing	Appeals
Developer/Local Authority wants to initiate scheme	Discuss with DEP 1. initial list of environmental factors generated - scoping form completed, 2. possible scope of environmental work identified 3. information required at time referral identified 4. MfP and relevant LA kept informed	Chairman may be briefed if scheme could have signif env factors		
Responsible Authority (RA) resolve to initiate, refers to EPA along with available information	DEP (& MfP) provide additional info for deciding level of assessment and makes recommendation to Chair EPA - filtering form completed	*EPA decide need to assess -* *level 1 - not assessed;* *level 2 - advice only;* *level 3 - env review;* *Quick "no" required?*	*28 days from time of referral*	
	Standard letters prepared including advice on level 2 assessments	*EPA sends standard letters (delegated to DEP)*	*28 days from time of referral*	
	DEP prepares draft instructions & consults widely	1st EPA meeting - briefed on scheme, env factors and draft instructions		
		EPA issue instructions for env. review	*60 days from time of referral*	*RA and public can appeal*
RA/developer consults with DEP during ER preparation	Advice given on drafts of ER document			
RA prepare draft scheme with environmental review	DEP to advise chairman on acceptability of ER	*EPA check review meets instructions*		

Local Authority/ developer	DEP involvement	EPA role	Timing	Appeals
Scheme advertised	DEP prepares briefing for EPA	2nd meeting of EPA - RA/developer can brief EPA		
Submissions to RA *Env submissions to EPA*	DEP can advise on which submissions relate to the environmental review		*7 days from end of review period*	
RA consider response to submissions *Submissions response to EPA*	DEP reviews submissions, RA response to submissions and any other advice. Significant env issues identified and RA/developer notified		*42 days from end of review period*	
	DEP draws up draft recommendations to EPA on assessment; draft Environmental Conditions drawn up in consultation with Local Authority and affected agencies. Any recommended "programmes" negotiated	3rd EPA meeting - to finalise recommendations. Instructs DEP to draft a report. *EPA report to Min Env on Scheme*	*REPORT - i) which ever is longer (a) 60 days from referral (b) 30 after receiving response to subms but no more than 72 from end of review period; ii) minister can extend*	*REPORT - RA and public can appeal*
	DEP manages consultation	*Min Env consult Min Plan on conditions & relevant appeals*		
	DEP can advise Minister for the Environment on appeals	*Min Env decide appeals, set conditions*		
RA incorporate conditions - RA may request review of conditions	DEP can assist in translation from Environmental Conditions to planning response			
WAPC consider, Min Plan determine scheme				
RA implement scheme				

Attachment 3 - Filtering form

INFORMATION FOR USE IN DETERMINING LEVEL OF ASSESSMENT FOR SCHEMES AND SCHEME AMENDMENTS UNDER SECTION 48A

FACTORS	COMMENTS AND POSSIBLE IMPACTS	FACTORS	COMMENTS AND POSSIBLE IMPACTS
SECTION A **Does area covered by the scheme/amendment impact on areas of highest conservation value?** YES ✓ NO (Please indicate Yes or No by placing a tick in the box. If the answer is 'Yes' please proceed to 1. below; if the answer is 'No' proceed to Section B) **1. Does the area covered by the scheme/amendment include** **a) land identified for conservation of natural resources (include wetland and dryland areas)?** YES ✓ NO or **b) land adjacent to an area identified for conservation of natural resources?** YES ✓ NO (Please indicate Yes or No by placing a tick in the boxes. If the answer is 'Yes' please indicate below the appropriate category(s) by ticking the boxes; if the answer is 'No' then proceed to 2.) The area covered by the scheme/amendment involves or is adjacent to:	Peel-Harvey Estuary LS1 (Foreshore reserve for Manna etc) CS1 & Harvey Estuary	• Land covered by recommendations for protection in the System 'Red Book' report ☑ • Land vested in NPNCA for the purpose of: conservation of flora and fauna ☐ National Park ☐ Conservation Park ☐ • Other areas recommended for reservation by CALM and endorsed by Govt. for inclusion in CALM's Estate ☐ • land reserved as "Parks and Recreation" under the MRS ☐ • areas managed for multiple use where conservation is one defined use ☑ • areas with rare vegetation communities or assemblages considered by the EPA not adequately represented in secure conservation areas ☐ • land known to contain declared rare flora and fauna ☐	System 6 CS1, CS2 Foreshore reserve

INFORMATION FOR USE IN DETERMINING LEVEL OF ASSESSMENT FOR SCHEMES AND SCHEME AMENDMENTS UNDER SECTION 48A

FACTORS	COMMENTS AND POSSIBLE IMPACTS	FACTORS	COMMENTS AND POSSIBLE IMPACTS
2.2 Does the area covered by the scheme/amendment include any estuaries or inlets and associated wetlands of highest conservation value? YES ☑ NO ☐ (Please indicate Yes or No by placing a tick in the box. If the answer is 'Yes' please indicate below the appropriate category(s) by ticking the boxes; if the answer is 'No' then proceed to 2.3) The area covered by the scheme/amendment includes: • an estuary or inlet in an area identified in 1 above ☐ • an estuary covered by an EPP: Peel Harvey Estuary ☑ Swan Canning Estuary ☐ • Any other estuary or inlet ☐ Name of estuary or inlet: --- **2.3 Does the area covered by the scheme/amendment involve any sections of watercourses or rivers which are:** **a) of highest conservation value** YES ☐ NO ☑		or **b) which drain into wetlands of highest conservation value?** YES ☑ NO ☐ (Please indicate Yes or No by placing a tick in the box. If the answer is 'Yes' please indicate below the appropriate category(s) by ticking the boxes; if the answer is 'No' then proceed to 2.4) The area covered by the scheme/amendment includes: • a section of a watercourse or river in an area identified in 1 above ☐ • a watercourse not within a declared public water source area but part of a broader catchment ☐ • a section of a watercourse which drains into a lake protected by the Swan Coastal Plain Lakes EPP Gazetted in 1992 ☐ • a section of a watercourse which drains into a lake protected by the draft EPP for Lakes and Swamps of the South West Agricultural Zone ☐ • Watercourse drains into Peel-Harvey estuary ☑	

INFORMATION FOR USE IN DETERMINING LEVEL OF ASSESSMENT FOR SCHEMES AND SCHEME AMENDMENTS UNDER SECTION 48A

FACTORS	COMMENTS AND POSSIBLE IMPACTS	FACTORS	COMMENTS AND POSSIBLE IMPACTS
GENERAL COMMENTS ON 2.5		SECTION B.	
2.6 Does the area covered by the scheme/amendment include catchments or capture zones (surface and ground water) with special requirements? YES ☐ NO ☒		**The scheme/amendment involves land-uses and practices as described below which require special management.**	
(Please indicate Yes or No by placing a tick in the box. If the answer is 'Yes' please indicate below the appropriate category(s) by ticking the boxes; if the answer is 'No' then proceed to B below)		**1. The scheme/amendment involves an industry or land-use which produces one or more of the following off-site impacts:**	waste water treatment plant
The area covered by the scheme/amendment includes:		Gases ☑	
• Lake Clifton ☐		Noise ☑	
• Lake Forrestdale ☐		Dust ☐	
• Thompsons Lake ☐		Odour ☑	
GENERAL COMMENTS ON 2.6		Risk ☑	
		(A brief description of the industry/landuse: waste water treatment plant.)	
		and it is:	
		• a new industry/landuse adjacent to or near a new residential area; ☑	
		• a new industry/landuse adjacent to or near an existing residential area; or ☐	
		• an existing industry/landuse and a new residential area is planned adjacent to or near to it ☐	

INFORMATION FOR USE IN DETERMINING LEVEL OF ASSESSMENT FOR SCHEMES AND SCHEME AMENDMENTS UNDER SECTION 48A

FACTORS	COMMENTS AND POSSIBLE IMPACTS	FACTORS	COMMENTS AND POSSIBLE IMPACTS
GENERAL COMMENTS ON 2		**vegetation on private property for:** • derivation of woodchips ☐ • establishment of plantations ☐	
3. The scheme/amendment allows for the dredging of rivers for: • developmental dredging ☑ • disposal of dredge material within a river system ☑	Marina & sailing club.	GENERAL COMMENTS ON 4 **5. The scheme/amendment allows for land-use changes within the Kwinana EPP area for Atmospheric Wastes which are inconsistent with the Policy including:** • dwellings for residential purposes ☐ • short stay accommodation ☐ • a development that compels the public to remain on the lot for long periods eg school, hospital ☐	
GENERAL COMMENTS ON 3 **4. The scheme/amendment allows for the clearing of remnant native**			

LIST OF ENVIRONMENTAL FACTORS ON WHICH EPA HAS A POLICY/POSITION

BIOPHYSICAL IMPACTS

Terrestrial vegetation

Vegetation in existing conservation estate

Regionally significant vegetation

Locally significant vegetation

Declared rare flora

Non-endemic (introduced) vegetation

Vegetation diseases

Terrestrial Fauna

Fauna and habitat in existing conservation estate

Regionally significant fauna and habitat

Locally significant fauna and habitat

Declared rare fauna

Non-endemic (introduced) fauna

Subterranean fauna (stygo and troglobitic fauna)

Land systems (geomorphology, vegetation, landforms, soils and hydrology)

Surface water

Surface water hydrology

Dependant ecological systems

Flood management

Wetlands

Regionally significant wetlands

Locally significant wetlands

Ground water

Ground water hydrology

Dependant ecological systems

Water conservation

Decommissioning

Rehabilitation

Mangroves

Dredging

Reclamation

Marine vegetation

Marine vegetation in marine conservation reserves

Seagrass

Regionally significant marine vegetation

Locally significant marine vegetation

Declared rare marine flora

Non-endemic (introduced) marine vegetation

Marine fauna

Marine fauna and habitat in existing conservation areas

Regionally significant marine fauna and habitat

Locally significant marine fauna and habitat

Declared rare marine fauna

Non-endemic (introduced) marine fauna

Coastal areas

Storm surge

Foreshore stability

Dune protection

SUMMARY OF ENVIRONMENTAL FACTORS RELEVANT TO THIS SCHEME/AMENDMENT (DERIVED FROM ABOVE QUESTIONNAIRE)

ENVIRONMENTAL FACTORS	POSSIBLE IMPACTS
Regionally significant vegn ; fauna + habitat.	weeds, disturbance, reduced habitat availability,
Surface water hydrology + Groundwater hydrology	Water balance changes (hard surfaces, removal of vegetation, infiltration of stormwater and sewerage, marina surface water.
Flood management	Need to keep houses safe.
Regionally significant wetlands	
Dredging / Reclamation / Seagrass	Loss of marine habitat, creation of islands near marina
Surface + Groundwater quality	See above under hydrology
Waste minimisation	Extra wastes from new population
Visual impacts	From mandurah
Heritage	May be aboriginal site.

RECOMMENDED LEVEL OF ASSESSMENT:

Level 1 Assessment - Not assessed, no advice given ☐

Level 2 Assessment - Not assessed, non-binding advice given ☐

Level 3 Assessment - Assessed, Environmental Review Required ☑

SIGNATURES:

Project Officer(s): R. Van Delft

Director (Evaluation):_____

Manager:

Director (Pollution Prevention):_____
(Where applicable)

Director (Policy):_____
(Where applicable)

EPA Chairman:_____

SUMMARY FOR INCLUSION IN REPORT TO CHAIRMAN:

ENVIRONMENTAL FACTORS	POTENTIAL SIGNIFICANT EFFECTS	ENVIRONMENTAL SIGNIFICANCE	TICK SELECTION
regionally significant vegn. fauna and habitat, and wetlands Flood management Dredging / Reclamation / seagrass surface + Groundwater quality + visual impacts Heritage	- Habitat removal + degradation (land and marine) - Reef Harvey - additional nutrient load - Hydrological changes - Visual impacts MANAGEMENT Hydrology * Draft but achievable both monitoring!	LOW MEDIUM (HIGH)	

* The point Grey development is being assessed under S38 + it is likely that managem of env impacts would need a planning response through the T.P.S. Formal assessment required to ensure that scheme implements ...

Attachment 4 - Recommended format for the report

It is recommended that the environmental review document have the following sections:

SUMMARY

The document should contain a brief summary of:

- salient features of the Scheme;
- brief description of the local receiving environment and potential impacts of the Scheme on that environment;
- any environmental monitoring and management programs, safeguards and commitments; and
- a table summarising the above using as a guide the headings shown below.

Environmental factor	Present state of the environment	Proposed change resulting from Scheme	Proposed management	Predicted outcome

INTRODUCTION

The document should include an explanation of the following:

- identification of the responsible authority;
- background and objectives of the Scheme;
- brief details of the scope and timing of the Scheme; and
- relevant statutory requirements and approvals.

NEED FOR THE SCHEME/AMENDMENT

The document should BRIEFLY describe the need for the Scheme so the public can understand why it is being proposed at this time. Cross referencing to the main Scheme documents would cut down the size of this section.

LOCATION

This section should briefly outline the location of the Scheme. A map is essential.

DESCRIPTION OF THE EXISTING ENVIRONMENT

The existing environment should be clearly described including the physical, biological and human environment. The factors identified above should be used as the main heading for this section.

POTENTIAL ENVIRONMENTAL IMPACTS AND MANAGEMENT

The factors identified above should be used as the main headings for this section. This section should discuss the relevance of each factor to this level of planning. Where the factor is not considered relevant, the level of planning at which it is appropriate should be identified.

CONCLUSION

Conclusions of the overall environmental impact of the Scheme, including proposed ameliorative measures should be stated together with an assessment of the environmental acceptability of the project as seen by the Responsible Authority.

ENVIRONMENT MANAGEMENT COMMITMENTS *(ONLY IF REQUIRED)*

It is very useful to give, wherever appropriate, specific commitments regarding all components and procedures of the environmental management program.

All specific commitments to protect the environment should be separately listed, numbered and take the form of: the responsible authority (who) will prepare a plan or take action (what) to meet an objective, to the timing for its achievement (when), and to which agencies will be consulted or to whose requirements, if not the DEP, the action/plan will be prepared.

Other commitments show that the responsible authority is dedicated to good environmental management of the Scheme, and the DEP expects that the responsible authority will audit these commitments by internal processes under an Environmental Management System. Though not

subject to routine audit, the DEP may request that compliance with, or the in-house audit of, these commitments be demonstrated, so as to verify satisfactory environmental performance. The commitments define the goals/objectives for the environmental management programme and procedures (the details of how the commitment will be met), which should be described in as much detail as possible.

HOW TO MAKE A PUBLIC SUBMISSION
The document should include instructions to members of the public as to how they can make a submission. It is a standard item of information in all public review documents.

REFERENCES
All references should be listed.

INSTRUCTIONS
A copy of these instructions should be included in the document.

GLOSSARY
A glossary should be provided in which all technical terms, and unfamiliar abbreviations and units of measurement are explained in simple language.

APPENDICES
Where detailed technical or supporting documentation is required, this should be placed in appendices.

Officer copy

BOWMAN BISHAW GORHAM

ENVIRONMENTAL MANAGEMENT CONSULTANTS

SHIRE OF MURRAY
TOWN PLANNING SCHEME N0. 4
AMENDMENT NO. 104 (POINT GREY)

SECTION 48 ENVIRONMENTAL REVIEW

Prepared for:
TS Plunkett Pty Ltd
84 Colin Street
WEST PERTH WA 6005

Prepared by:
Bowman Bishaw Gorham
1298 Hay Street
WEST PERTH WA 6005
Telephone: (09) 481 8588
Facsimile: (09) 481 8338

June, 1997

Bowman Bishaw Pty Ltd (ACN 009 238 706) as Trustee for the Bowman Bishaw Unit Trust trading as Bowman Bishaw Gorham

EXECUTIVE SUMMARY

In January 1997 the Shire of Murray resolved to initiate an amendment to its Town Planning Scheme No. 4, following the submission of an Outline Development Plan (ODP) for a large landholding at Point Grey by TS Plunkett Pty Ltd.

The ODP describes a proposal to rezone the Point Grey Peninsula, located opposite the Dawesville Channel on the eastern shores of Peel Inlet and Harvey Estuary in the Shire of Murray,on the eastern shores of Peel Inlet and Harvey Estuary in the Shire of Murray, for tourism, recreation and residential purposes. Figures 1.1, 1.2 and 1.3 respectively show the ODP, the location of Point Grey and an aerial photograph of the site.

The project site is private land totalling approximately 1,159 ha and includesing all of the Point Grey Peninsula and part of the adjoining mainland and foreshore. Most of the site has been cleared, although some significant areas of native vegetation remain in the south of the site and around the estuarine margin. The vegetation and fauna of the site are typical of the general region and contain no known occurrence of rare or threatened species.

Point Grey has been cleared and used for agriculture over the last 30-40 years following its settlement before the turn of the century. At present the property is used for sheep agistment.

Background

The Peel-Harvey Estuary is a major conservation and recreation resource for the Peel Region and Western Australia as a whole. The Estuary has a history of algal blooms and other water quality problems brought about by excessive inputs of plant nutrients (chiefly phosphorus) from its catchment.

In July 1987, Mallina Holdings Pty Ltd prepared an Environmental Review and Management Program (ERMP) for a land use plan for Point Grey which became known as the "College Town" proposal. The main features of this proposal were an educational college, residential neighbourhoods, tourist and holiday facilities, large leisure-living lots, a golf course and open space and foreshore reserves.

The College Town proposal was rejected by the Minister for the Environment on advice from the EPA (Bulletin 306), on grounds deriving from consideration of nutrients, reserve allocation and environmental amenity. The ERMP and EPA assessment report are available for public examination at the DEP library. TS Plunkett Pty Ltd was not a party to the College Town proposal.

More than a decade of intensive research into the problems of the Peel-Harvey Estuary led, in 1994, to the opening of the Dawesville Channel. The Channel is designed to increase tidal exchange between the Estuary and the ocean, thereby flushing nutrients from the Estuary and raising its salinity to inhibit the growth of nuisance algae.

While the long-term influence of the Channel has yet to be fully determined, total nutrient levels and water quality problems have declined markedly since the Channel was opened (Rose, 1995). In particular, the Channel has yielded immediate and significant benefits to water quality around Point Grey, with particular improvement evident on the western shore of the Peninsula, which lies directly opposite the channel's outlet to the estuary.

Along with the improvements brought about by the Dawesville Channel, significant advances have been made in understanding and reducing the export of phosphorus from the catchment. These include:

- research by CSIRO and other organisations into phosphorus transport processes, which have shown that the yellow Spearwood sand profiles that dominate Point Grey are the best soils on the Swan Coastal Plan for phosphorus retention;

- advances in sewage treatment technology to produce a final effluent containing very low levels of phosphorus and nitrogen; and

- the introduction of catchment management practices (including clearing and drainage controls and the use of slow-release fertilisers) to reduce phosphorus export.

As a result of these advances, it is considered that the proposed development of Point Grey can coexist comfortably with, and indeed complement, the future management of a healthy Peel-Harvey Estuary.

The Proposal

The land uses proposed to be permitted under the amended scheme are:

- tourist accommodation and associated facilities;
- a marina and sailing club;
- residential village allotments;
- reserves for conservation, recreation and open space;
- low-density Special Residential and Rural-Residential lots;
- a golf course; and
- a sewage treatment plant and a eucalypt woodlot irrigated with treated effluent.

Each of these land uses has been designed using the most up-to-date knowledge regarding water sensitive urban design, water conservation and nutrient management, in order to maximise its environmental compatibility.

The tourist and recreation components, including the tourist accommodation, golf course and marina, have the potential to provide a recreational resource of State significance.

In excess of 30% of the site (362ha) is proposed as green space combining areas for recreation, foreshore and conservation/sanctuary purposes. This does not include the existing foreshores and government reserves (80ha), the 90ha golf course, nor the 10% public open space attributable to the residential development, all of which result in a total green space area at Point Grey in excess of 560ha (45% of the total land area).

The development will be serviced by underground power, water, telecommunications and reticulated sewerage (except rural-residential lots). Potable water will be sourced from the Leederville Aquifer beneath the site by means of a private borefield. Irrigation water for the golf course and landscaped areas will be sourced from either the Leederville Aquifer, treated sewage effluent, a constructed wetland on the Robert Bay drain in the east of the site, or a combination of two or more of these.

Sewage will be treated to a high standard including nutrient removal and disinfection and fully disposed on-site. Initially, treated effluent will be irrigated onto a new woodlot located on soils with confirmed phosphorus binding properties. The woodlot will be surrounded by a 30ha unirrigated tree buffer to guard against the migration of water and nutrients away from the disposal area.

In future, as the volume of sewage increases, treated effluent will be used for irrigation of the golf course in order to reduce the requirements for "new" irrigation water and fertiliser inputs to the site.

Environmental Impacts and Management

In formulating instructions for the assessment of this proposal, the issues identified by the EPA were:

- protection of System 6 areas, conservation reserves and remnant vegetation;
- protection of rare flora and fauna;
- protection of waterbirds and habitats gazetted under international agreements such as Ramsar, CAMBA and JAMBA;
- construction and operation of the marina and sailing club in a way that minimises impacts on the water quality and physical stability of the Estuary;
- protection of wetlands;
- provision of foreshore buffers;
- management of water supply development to avoid environmental impacts;
- minimisation of nutrient exports from the site and compliance with phosphorus export targets set by the EPA;
- management of nitrogen exports from the development to the ocean, in light of the findings of the *Southern Metropolitan Coastal Waters Study* (DEP, 1996);
- stormwater management practices and design criteria;
- management of odours from the sewage treatment plant and the Estuary;
- control of noise and dust during construction;
- impacts on Aboriginal heritage sites and values;
- control of mosquito breeding; and
- risks and hazards posed by water and wastewater treatment plants.

The approach taken to management of each of these issues is discussed below.

System 6 Areas, Conservation Reserves and Remnant Vegetation
The development will have no direct physical impacts on System 6 Areas or conservation reserves. Potential indirect impacts resulting from the increased human presence in the area could include disturbance of foreshores by pedestrians, crabbers and boat wash, predation by feral animals and increased fire risk.

These matters will be managed as follows:

- Land constituting 45% of the total site will be set aside for conservation, recreation and other "green space" uses. Management plans for these conservation areas will be prepared and implemented in consultation with appropriate government agencies.

- Increased human pressure on foreshores and estuarine margins will be managed by control of foreshore access, public education and provision of buffer zones in accordance with management plans developed with appropriate government agencies.

Roads and other service corridors into the site have been located so as to minimise direct and indirect disturbance to System 6 Areas and other conservation areas. The infrastructure corridors do not directly impact any System 6 Areas or reserves, although Carrabungup Road does pass within an existing, cleared road reserve through System 6 Area C50.

Indirect impacts to the reserves such as drainage alteration and edge effects will be mitigated by implementing environmental design objectives established in a Construction Management Plan, which will be prepared prior to construction.

Although Point Grey is mostly cleared, it contains some areas of remnant vegetation. Under the ODP, approximately 18ha of remnant vegetation constituting approximately 1.5% of the total site will be cleared for construction. The area of land requiring clearing has been minimised by concentrating the more intensive developments in already-cleared areas, and will be offset by new plantings of tree and shrub vegetation in the golf course, public open space, effluent irrigation woodlot, constructed wetland and landscaped areas. Overall, the total area of deep-rooted vegetation is planned to increase by about 234ha across the site.

Rare Flora and Fauna

Biological surveys carried out during the preparation of the PER did not identify any gazetted rare flora or fauna populations within the site. Two potential habitats for gazetted rare fauna exist:

- Remnant tall Tuart trees in the north of the site may provide nesting hollows for Black Cockatoos and the Peregrine Falcon.

- Limestone outcrops in the south-west of the site may provide refuge for the Carpet Python.

The ODP aims to increase the total amount of potential habitat for rare and other fauna, as well as protecting that which already exists. Specific measures will include:

- retention of habitat which could support rare fauna;
- planting of Tuarts and other indigenous trees to increase the long-term availability of nesting hollows; and
- careful planning of pedestrian routes, restriction of clearing on rural-residential lots and fire management.

Water Birds and Habitats

An avoidance strategy has been incorporated in the siting of marina and sailing club facilities in relation to core water bird habitats, which are focussed in Robert Bay. Indirect disturbance to waterbird feeding, breeding and refuge areas will be mitigated by the provision of a near-continuous foreshore buffer around the site, which will be interrupted only by the marina and sailing club. Habitat lost for the marina and sailing club will be re-created on two artificial islands which will be constructed from dredge spoil immediately offshore from the marina.

Construction and Operation of the Marina and Sailing Club

Construction of the marina and sailing club will be undertaken in accordance with established PIMA policies and regulations relating to dredging, excavation and water quality protection in the Peel-Harvey Estuary. Construction will occur under the guidance of a Construction Management Plan and a Dredge Spoil Disposal Management Plan.

Operation of the marina and sailing club will be carried out in accordance with objectives and procedures set out in the following management plans:

- a Water and Sediment Quality Monitoring Plan;
- a Foreshore and Conservation Reserve Management Plan; and
- a Waterbird Monitoring Programme.

These plans will cover ongoing management of the facilities including issues such as maintenance of water quality, prevention of fuel spills, sullage and bilge pump-out, removal of macroalgal accumulations, maintenance dredging and regulation of boating traffic.

Wetlands

Wetlands in the project area are few in number and mostly degraded. Those that exist have been assessed using the procedures set out in EPA Bulletin 686, and management priorities have been identified.

The existing wetlands will be retained and managed to:

- maintain and enhance their remaining ecological values;
- minimise impacts from construction activities; and
- minimise changes to the hydrological regime (including groundwater levels and water quality).

The possibility exists, given satisfactory arrangements with other interested parties, to create a constructed wetland system within the site near the mouth of the Robert Bay Drain. This wetland would fulfil the functions of:

- reducing nutrient inputs to the Estuary via the drain, from agricultural land east of Point Grey;
- providing habitat for birds and other fauna;
- irrigation water supply (holding winter drain flows for use in summer); and
- landscaping.

A near-continuous foreshore buffer zone will be created around the site. Apart from breaks at the marina and sailing club, the foreshore buffer will be interrupted only by pedestrian footpaths and cycleways.

Water Supply

Abstraction for potable and irrigation water supply at Point Grey will be undertaken on the basis of the most up-to-date knowledge of groundwater behaviour and groundwater-dependent ecosystems. Abstraction rates, groundwater levels and water quality will be closely monitored to prevent adverse effects of abstraction.

Groundwater modelling carried out for the project indicates that the water requirements for the project at ultimate development can be met from available supplies without significant adverse impacts. However, in the event that future monitoring or modelling reveals potential for undesirable impacts from abstraction, the potential exists for part or all of the project's water requirements to be supplied from off-site by a third party such as the Water Corporation.

Nutrient Exports

Catchment phosphorus export objectives set by the EPA in the Peel-Harvey EPP (1992) require a total phosphorus export from Point Grey to the Estuary of less than 482kg per year. The current phosphorus export from the site under its present land use is estimated at 70kg/yr.

Computer modelling of phosphorus export from the site under the proposed ultimate development, based on on-site soil mapping and soil profile analysis, conservatively predicted that the net phosphorus export from Point Grey would not significantly exceed its current level for at least 160 years following full development. Practical management measures which could significantly increase this term have been identified.

Preliminary calculation of nitrogen exports was carried out from the site at full development based on the known composition of treated sewage effluent, typical nitrogen application rates for lawns and gardens, domestic nitrogen input rates estimated by Gerritse *et al* (1991) and nitrogen leaching rates measured by Sharma *et al* (1996) and Kolenbrander (1972).

The calculations suggested that, at full development, between 1.7 and 4.2 tonnes of nitrogen per annum might be leached to the groundwater beneath Point Grey. Assuming that all of this nitrogen was exported to the Estuary and thence to the ocean, this would represent between 0.2% and 1% of the Estuary's total annual output of nitrogen to the ocean. This amount is not considered significant, and is regarded as an over-estimate in the light of the very conservative assumptions used in its calculation.

Nutrient inputs at Point Grey will be managed through a Nutrient and Irrigation Management Plan (NIMP), which will be prepared prior to development. The NIMP will address issues including:

- water sensitive design of the development;
- sewage collection, treatment and disposal;
- soil profile sampling to confirm phosphorus storage performance;
- groundwater sampling to measure phosphorus and nitrogen movement; and
- possible use of treated sewage effluent for golf course irrigation.

Odours

The sewage treatment plant will be surrounded by a 500m buffer zone to protect residents from odour impacts. This accords with EPA guidelines on odour buffers for sewage treatment plants.

Odour impacts from algal accumulations on the Estuary shore will be minimised by the provision of foreshore buffers and the concentration of residential land uses on the higher inland parts of the site.

Noise and Dust

Noise generated during construction will comply with the draft *Environmental Protection (Noise) Regulations*, published by the DEP in January 1997. Dust will be controlled during construction so as to comply with Guidelines published by the DEP for the prevention of dust and smoke pollution from land development sites (*Land Development Sites and Impacts on Air Quality*, DEP, 1996).

Aboriginal Heritage

Archaeological surveys and discussions with local Aboriginal representatives have identified only one item of Aboriginal significance (a possible scarred tree) at Point Grey. It is intended to include this item within the provision of public open space.

The development of Point Grey will comply with all requirements of the *Aboriginal Heritage Act 1972*.

Mosquitoes

No new mosquito breeding areas will be created by the development. If a constructed wetland system is established near Robert Bay, mosquito breeding will be controlled by design measures and active controls such as are currently employed elsewhere in the Estuary.

Mosquito breeding near populated parts of the Estuary is currently controlled by frequent monitoring and spot applications of the larvicide ABATE (Temephos). This type of control may need to be extended to the Point Grey area as the population increases.

Proposed Scheme Provisions

The proposed amended Scheme contains specific provisions to achieve the environmental management objectives set out in this report and the EPA Guidelines. These provisions address the following specific factors:

- Compliance with Government policy and legislation;
- Access road and infrastructure corridors;
- Mosquito breeding habitat;
- Water-sensitive design;
- Marina design, construction and management;
- Sewage collection, treatment and disposal;
- Foreshore and conservation reserve management;
- Water supply management;
- Nutrient exports;
- Landscape management;
- Waterbird monitoring;
- Construction management;
- Constructed wetland on Robert Bay drain; and
- Water quality management and monitoring.

Given these provisions plus the design and management strategies proposed in the ODP and the findings of technical analyses described in this document, it is considered that the proposed Point Grey project can proceed in an environmentally acceptable manner to provide a facility that is of substantial benefit to the local community and the State as a whole.

A brief summary of the environmental factors relevant to the proposed TPS Amendment, the potential impacts of the proposal, proposed management measures and predicted outcomes is presented in Table 1 on the following pages.

TABLE 1

Summary of the Environmental Assessment, Management Strategies and Outcomes

Environmental Factor	Receiving Environment	Proposal in the Scheme which could potentially impact the environment	Potential Impacts	Environmental Management	Predicted Outcomes
BIOPHYSICAL					
Vegetation and Fauna					
• Terrestrial Vegetation	• Existing vegetation on the site composed of a range of woodlands and thickets	• General land use plan	• Reduction of vegetated area	• Conform to the Peel Catchment Centre planting guidelines by maximising or increasing vegetation • Create a local greenbelt system • Rehabilitate the degraded vegetation • Revegetate unused cleared land • Prepare a Landscape Management Plan prior to construction	• Protection and management of important vegetation can be achieved
• Estuarine Vegetation	• Foreshore and fringing vegetation specifically at Southern end of Robert Bay and the Northern tip of Point Grey	• Estuarine margin of land use plan • Marina • Sailing Club	• Direct loss of flora and fauna • Reduction of habitat integrity and continuity • Erosion fro boatwash • Construction phase impacts	• Identify habitat areas • Implement avoidance strategy in land use planning • Provide foreshore buffers based on ecological boundaries • Control recreation uses in the foreshore reserve • Establish adequate development setbacks • Maintain hydrological regimes in foreshore buffers • Develop of islands from dredge spoil to mitigate habitat loss from the marina • Prepare a Foreshore and Conservation Reserve Management Plan prior to construction	• Ecologically important estuarine areas will be adequately protected and replacement and remediation strategies can maintain habitat availability and function, • Foreshore buffers and Reserves can be implemented to meet PIMA, DEP, CALM and Shire objectives
• Existing conservation areas: Reserves 2738 and 2707 and System 6 areas C51 and C52	• Estuarine fringing and upland vegetation flora and fauna	• General landuse plan	• Physical and biological degradation, reduction of areas, reduction of linkages • Fire, pedestrian access, feral animals, weeds	• Retain as reserves and link to proposed green space • Increase effective size by management of adjacent private land for conservation • Incorporate development setbacks • Control pedestrian access in consultation with PIMA/Shire of Murray • Fire management plan • Feral animal control • Prepare a Foreshore and Conservation Reserve Management Plan prior to Construction	• Acceptable retention of reserves • New expanded connected reserve system • Improved security of tenure for conservation • Improved management control
• Rare and Priority Flora and Fauna	• Existing flora, fauna and habitats	• General land use plan	• Degradation of habitat • Direct loss of individuals or populations	• Define and survey vegetation, flora and fauna • Identify development exclusion zones and appropriate management of areas proposed for public access • Protect limestone outcrop that could provide a habitat for the Carpet Python • Retain and planting Tuart trees to increase potential habitats for the Peregrine Falcon	• The requirements of the Wildlife Conservation Act can be met
• Waterbirds	• The Peel/Harvey Estuary is a RAMSAR wetland and subject to Japan/Australia and China/Australia Migratory Bird Agreements • Habitat areas including; fringing vegetation, shallow estuary margins and adjacent open water	• Marinas • Recreational boating • Recreation activity in foreshore reserves and estuary margins	• Physical disturbance/loss of habitat • Disturbance of waterfowl	• Identify important habitats • Incorporate development buffers • Control pedestrian access • Construct replacement habitat at marinas and new islands • To be consistent with the objectives of the RAMSAR convention and the Japan/Australia and China/Australia Migratory Bird Agreements • Preparation of a Waterbird Monitoring Plan in consultation with the EPA on advice from CALM and PIMA	• Maintenance of total habitat areas • Maintenance of habitat function • Augmentation of habitat areas and function

TABLE 1 (Continued)

Environmental Factor	Receiving Environment	Proposal in the Scheme which could potentially impact the environment	Potential Impacts	Environmental Management	Predicted Outcomes
Estuarine and Water Quality					
• Estuarine water quality	• Marina water • Adjacent estuary	• Marina area and surface drainage catchment	• Deterioration of water quality • Contaminant spillages	• No routine stormwater discharge to marina • Employ appropriate hydrological design principles to the marina to optimise internal water quality • Develop appropriate contingency plan for contaminant spillages • Prepare a short and long term Water and Sediment Quality Monitoring Programme designed to maintain waters in and around the marina • Prepare a Dredge Spoil Disposal and Management Plan in accordance with published policies • Water quality criteria to be consistent with the Peel-Harvey Estuary, the WAPC Policy DC 1.8 and EPA Bulletin 711 • Prior to construction an agreement to define responsibilities for the physical maintenance and management will be developed • Post construction the depths of the marina and entrance channel will be monitored to ensure adequate flushing and safe navigable depths	• Marina water quality will be capable of meeting appropriate beneficial uses
• Groundwater Quantity	• Underlying aquifers • Shallow groundwater • Estuarine water	• Residential areas • Tourist facilites • Golf course • Public recreation areas	• Over abstraction from aquifer • Groundwater quality and deterioratin • Estuarine water quality deterioration	• Recognise water supply capacity limits • Utilise to sustainable yield • Re-use drainage water • Re-use treated effluent • Implement water sensitive design • Prepare a Water Supply Management and Monitoring Plan before construction	• There is adequate ground and surface water supply to sustain the development • Stormwater and effluent re-use can minimise demand
• Wetlands	• Robert Bay flood plain • Individual wetlands • Lake Meelup (not on site)	• Access roads • Woodlot Irrigation Scheme	• Physical damage to wetland • Changed hydrological regime • Water quality deterioraiion	• Access road and infrastructure corridors aligned to minimise physical impact to Robert Bay wetlands • Design roads to maintain hydrology • Examine water table change potential • Maintain groundwater quality • Maintain acceptable hydrological regime • Formulate constructed wetland concept for Robert Bay area • Prepare a Wetland Management Plan for the constructed Robert Bay Wetland to detail ongoing management and monitoring	• Existing wetlands protected within reserves and open space • Existing hydrology enhanced or maintained • Wetland habitats and ecological functions maintained • Robert Bay constructed wetland concept

TABLE 1 (Continued)

Environmental Factor	Receiving Environment	Proposal in the Scheme which could potentially impact the environment	Potential Impacts	Environmental Management	Predicted Outcomes
POLLUTION					
Surface Water Quality					
• Nutrients - General	• Peel-Harvey Estuary • Robert Bay Drain • Shallow groundwater	• Treated effluent disposal • Stormwater management • Residential areas • Golf corse • Grassed open space	• Export of phosphorus to Estuary in excess of catchment target • Export of nitrogen to ocean in excess of assimilative capacity	• Identify phosphorus export allocation • Identify phosphorus export processes • Prevent direct surface water discharge • Implement water sensitive urban design • Focus development on best soils for P retention • Treat effluent for high efficiency P removal • Irrigate wastewater to soil profiles with high P adsorption capability and lifetime • Validate phosphorus management strategy by mathematical modelling of the landuse plan and water management processes • Comply with phosphorus loading targets specified in the Environmental Protection (Peel-Harvey Estuarine System) Policy 1992 and the Statement of Planning Policy No 2 1992 (The Peel-Harvey Coastal Plain Catchment) • Prepare a Nutrient and Irrigation Management Plan (which will detail monitoring) in consultation with the EPA	• Peel-Harvey phosphorus export targets can be met
• Nutrients from Sewerage Effluent Treatment and Disposal	• Peel-Harvey Estuary	• Effluent treatment and disposal	• Maintenance of excessive nutrient levels in estuarine water and sediments	• Tertiary sewage treatment plant with phosphorus removal • Disposal to irrigated woodlot • P management by soil storage, biological uptake • Contingency options to be developed	• Tertiary treatment, woodlot/golf course irrigation/disposal and soil storage of phosphorus can be monitored and managed so as to meet phosphorus export target. • P removal in treatment plant could be increased if needed • Soil amendment can be carried out for additional soil storage if needed • Sewage could be exported from the site in future
• Stormwater management	• Peel-Harvey Estuary	• Stormwater drainage system including Robert Bay drain	• Excessive nutrients in estuarine water and sediments	• Collect all stormwater for re-use or infiltration • Capture Robert Bay drain flow for re-use • Employ best practice measures as outlined in Planning and Management Guidelines for Water Sensitive (Urban) Residential Design 1994	• Nutrients from stormwater will not enter the estuary at rates which exceed catchment target.
• Odours	• Residential land	• Treatment Plants • Peel Harvey estuary algal blooms	• Odour nuisance from treatment plants and algae	• Identify primary odour sources • Determine buffer needs with reference to prevailing winds • Implement appropriate setbacks to residential areas	• Land use planning can minimise the potential for excessive odour nuisance.
• Noise, dust and turbidity	• Estuary margins • Estuary basin to Dawsville Channel • Terrestrial environment	• Marinas • Road access • Golf course • Residential and community facilities • Services	• Turbidity plumes • Erosional damage to shores • Impact on flora and fauna	• Manage impacts during construction to relevant standards in accordance with management plans	• Construction phase impacts can be managed within acceptable limits

TABLE 1 (Continued)

Environmental Factor	Receiving Environment	Proposal in the Scheme which could potentially impact the environment	Potential Impacts	Environmental Management	Predicted Outcomes
SOCIAL ENVIRONMENT					
• Aboriginal Heritage	• Heritage sites (1)	• Site preparation and construction	• Damage to site	• Endeavour to protect within Public Open Space • Permission to disturb may be sought if necessary	• Scarred tree protected • Compliance with the Aboriginal Heritage Act 1972
• Mosquitoes	• Community areas and private land	• Drainage design and management • Treated effluent disposal • Peel Harvey estuary	• Insect nuisance • Ross River virus	• Manage water to prevent the creation of new breeding habit and reduce the area of existing breeding habitats	• Mosquito habitat for breeding will not be increased by the development
• Risks and Hazards	• Residential land	• Treatment plants (Chlorine storage)	• Risk of individual injury or death	• Provide appropriate buffers to meet EPA risk criteria	• Risk of public injury or fatality due to chlorine within acceptable level

TABLE OF CONTENTS

Page No.

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

1.1 The Proposed Amendment 1

1.2 Location of the Scheme Amendment 1

1.3 Scope and Timing of the Scheme 2

1.4 Responsible Authority 2

1.5 Background to the Scheme Amendment 2
1.5.1 Previous Development Proposals for Point Grey 2
1.5.2 Advances in Estuary and Catchment Management 3

1.6 Statutory Requirement for the Scheme Amendment 4

1.7 Legislative and Regulatory Framework 5
1.7.1 Decision Making Authorities and Involved Agencies 5
1.7.2 Existing Policies and Guidelines 5

1.8 The Section 48 Environmental Approval Process 10

2.0 THE EXISTING ENVIRONMENT OF POINT GREY 11

2.1 Terrestrial Physical Environment 11
2.1.1 Climate 11
2.1.2 Topography, Landforms and Soils 11
2.1.3 Geology and Shallow Stratigraphy 13
2.1.4 Surface Water 14
2.1.5 Groundwater 14

2.2 Estuarine Physical Environment 16
2.2.1 Introduction 16
2.2.2 Inflows and Outflows 17
2.2.3 Water Levels 17
2.2.4 Circulation 22
2.2.5 Mixing and Stratification 22
2.2.6 Estuarine Sediments 23
2.2.7 Shoreline Stability 23
2.2.8 Water Quality 24

TABLE OF CONTENTS (CONT'D)

		Page No.
2.3	**Terrestrial Biological Environment**	**27**
	2.3.1 Vegetation and Flora	27
	2.3.2 Terrestrial Fauna	29
	2.3.3 Rare Flora and Fauna	30
	2.3.4 Wetlands	31
	2.3.5 Foreshores	33
2.4	**Estuarine Biological Environment**	**34**
	2.4.1 Introduction	34
	2.4.2 Estuarine Flora	35
	2.4.3 Estuarine Fauna	37
	2.4.4 Water Birds	38
	2.4.5 Mosquito Breeding Habitat	40
2.5	**Social Environment**	**41**
	2.5.1 Landscape	41
	2.5.2 Foreshore Reserves	42
	2.5.3 Existing and Proposed Conservation Areas	42
	2.5.4 Aboriginal Heritage	43
3.0	**DESCRIPTION OF THE PROPOSED SCHEME**	**45**
3.1	**Residential Land Uses**	**47**
	3.1.1 Traditional Neighbourhood Village	47
	3.1.2 Rural-Residential Retreat	47
3.2	**Tourist Facilities**	**48**
	3.2.1 Wilderness Lodge/Chalets	48
	3.2.2 Waterfront Tourist Village	49
	3.2.3 Marina Precinct	49
	3.2.4 Harbourside Tourist Village	51
	3.2.5 Sailing Club	51
	3.2.6 Golf Course	51
	3.2.7 Golf Course Tourist Estate	52
	3.2.8 Eco-Tourist Village	52
3.3	**Conservation Areas**	**52**
	3.3.1 Foreshore Reserves	53
	3.3.2 Foreshore Access	53
	3.3.3 Robert Bay Drain Rehabilitation	53
	3.3.4 Private Conservation Areas	55
3.4	**Services and Infrastructure**	**56**
	3.4.1 Access Road	56
	3.4.2 Energy and Telecommunications	57
	3.4.3 Water Supply	58
	3.4.4 Wastewater Treatment and Disposal	64
	3.4.5 Stormwater Disposal	67

TABLE OF CONTENTS

Page No.

4.0 ENVIRONMENTAL IMPACTS AND MANAGEMENT 69

4.1 **Vegetation** 69
4.1.1 EPA Objective 69
4.1.2 Potential Impacts 69
4.1.3 Environmental Management Strategy and Management Plans 71
4.1.4 Environmental Management Recommendations 74

4.2 **Declared Rare and Priority Fauna** 75
4.2.1 EPA Objective 75
4.2.2 Potential Impact 75
4.2.3 Environmental Management Strategy and Management Plans 75
4.2.4 Environmental Management Recommendations 75

4.3 **Fauna - Waterbirds** 76
4.3.1 EPA Objective 76
4.3.2 Potential Impacts 76
4.3.3 Environmental Management Strategy and Management Plans 77
4.3.4 Environmental Management Recommendations 78

4.4 **Declared Rare Fauna** 79
4.4.1 EPA Objective 79
4.4.2 Potential Impact 79
4.4.3 Environmental Management Strategy and Management Plans 79
4.4.4 Environmental Management Recommendations 80

4.5 **Estuarine Vegetation and Fauna Habitat** 80
4.5.1 EPA Objective 80
4.5.2 Potential Impact 81
4.5.3 Environmental Management Strategy and Management Plans 81
4.5.4 Environmental Management Recommendations 83

4.6 **Estuarine Water Quality** 84
4.6.1 EPA Objectives 84
4.6.2 Potential Impacts 84
4.6.3 Environmental Management Strategy and Management Plans 84
4.6.4 Environmental Management Recommendations 88

TABLE OF CONTENTS

Page No.

4.7	**Wetlands**	**89**
	4.7.1 EPA Objective	89
	4.7.2 Potential Impacts	89
	4.7.3 Environmental Management Strategy and Management Plans	90
	4.7.4 Environmental Management Recommendations	94
4.8	**Groundwater Quantity**	**94**
	4.8.1 EPA Objective	94
	4.8.2 Potential Impacts	95
	4.8.3 Environmental Management Strategy and Management Plans	95
	4.8.4 Environmental Management Recommendations	98
4.9	**Surface Water Quality**	**98**
	4.9.1 EPA Objective	98
	4.9.2 Potential Impacts	98
	4.9.3 Environmental Management Strategy and Management Plans	112
	4.9.4 Environmental Management Recommendations	114
4.10	**Odours**	**114**
	4.10.1 EPA Objectives	114
	4.10.2 Potential Impacts	114
	4.10.3 Environmental Management Strategy and Management Plans	115
	4.10.4 Environmental Management Recommendations	116
4.11	**Noise and Dust**	**116**
	4.11.1 EPA Objective	116
	4.11.2 Potential Impacts	116
	4.11.3 Environmental Management Strategy and Management Plans	116
	4.11.4 Environmental Management Recommendations	117
4.12	**Turbidity**	**117**
	4.12.1 EPA Objectives	117
	4.12.2 Potential Impacts	117
	4.12.3 Environmental Management Strategy and Management Plans	118
	4.12.4 Environmental Management Recommendations	119

TABLE OF CONTENTS

Page No.

5.0 SOCIAL IMPACTS AND MANAGEMENT 120

5.1 Aboriginal Heritage 120
5.1.1 EPA Objective 120
5.1.2 Potential Impact 120
5.1.3 Environmental Management Strategy and Management Plans 120
5.1.4 Environmental Management Recommendations 121

5.2 Mosquitoes 121
5.2.1 EPA Objective 121
5.2.2 Potential Impacts 121
5.2.3 Environmental Management Strategy and Management Plans 122
5.2.4 Environmental Management Recommendations 122

5.3 Risk and Hazard 123
5.3.1 EPA Objective 123
5.3.2 Potential Impact 123
5.3.3 Environmental Management Strategy and Management Plans 123
5.3.4 Environmental Management Recommendations 123

6.0 SUMMARY OF ENVIRONMENTAL MANAGEMENT TO BE SPECIFIED BY THE SCHEME AMENDMENT 125

7.0 REFERENCES 137

LIST OF TABLES

Table No.		Page No.
2.1	Astronomical and Meteorological Tides	18
2.2	Estimated Water Levels Post-Dawesville Channel	18
2.3	Predicted Water Levels	19
2.4	Design Water Levels	21
3.1	Land Use Elements	46
3.2	Project Total Potable Water Demand	59
3.3	Preliminary Estimate of Irrigation Water Requirements	61
3.4	Estimate of Water Volume Available for Irrigation	62
3.5	Sewage Treatment Performance	65
4.1	Water Quality Criteria Applicable to Point Grey	85
4.2	Results of Phosphorus Adsorption Modelling	104
4.3	ODP Compliance with Statement of Planning Policy No. 2	109
6.1	Environmental Management Recommendations	125
6.2	TPS Amendment 104 Special Provisions	131

LIST OF FIGURES

Figure No.	
1.1	Outline Development Plan
1.2	Site Location of Point Grey
1.3	Aerial Photograph of the Point Grey Peninsula
2.1	Topography and Dominant Soil Boundaries
2.2	Shallow Geology and Hydrogeology
2.3	Groundwater Regional Flow
2.4	Classification of Vegetation
2.5	Vegetation Condition
2.6	Wetlands
2.7	Seagrasses surrounding the Point Grey Peninsula
2.8	Samphire Marsh Distribution in the Peel-Harvey Area
2.9	Existing and Proposed Public Foreshore Reserves
3.1	Marina Village Tourist Resort
3.2	Sailing Club
3.3	Total Green Space
3.4	Robert Bay Wetland
3.5	Access Route
3.6	Potable Water Supply
3.7	Irrigation Supply
3.8	Waste Water Collection, Treatment and Disposal
3.9	Odour Dispersion Contours
4.1	System 6 Recommendations - Peel Inlet
4.2	System 6 Recommendations - Harvey Estuary
4.3	Predicted Potentiometric Drawdown in the Leederville Aquifer

LIST OF APPENDICIES

A EPA Instructions
B Climate Records
C Flora and Vegetation Survey
D Vertebrate Fauna Assessment
E Phosphorus Export Model

DETAILED TECHNICAL REPORTS AVAILABLE FOR INSPECTION AT THE DEP AND SHIRE OF MURRAY LIBRARIES

1 Planning Report
2 Landscape Analysis
3 Environmental Assessment and Management Summary
4 Engineering Services
Engineering Report 1: Water and Wastewater Treatment
Engineering Report 2: Groundwater Assessment
Engineering Report 3: Access Road
Engineering Report 4: Peel-Harvey Extreme Water Levels and Hydrodynamics
Engineering Report 5: Robert Bay Drain and Wetlands
Engineering Report 6: Point Grey Marina and Sailing Club

1.0 INTRODUCTION

1.1 The Proposed Amendment

TS Plunkett Pty Ltd proposes to rezone the Point Grey Peninsula, south of Mandurah, Western Australia for tourism, recreation and residential purposes. The Shire of Murray resolved in January 1997 to initiate an amendment to its Town Planning Scheme No. 4 to rezone the site from Rural to Special Development in order to accommodate the development.

The land uses that would be permitted at Point Grey under the Special Development zoning are:

- tourist accommodation including a wilderness lodge and tourist villages;
- a marina and sailing club;
- a residential village incorporating private residential lots, neighbourhood shopping and community facilities;
- areas set aside for conservation, recreation and open space;
- low-density rural lifestyle lots;
- a golf course;
- a stand-alone water supply based on artesian groundwater; and
- on-site effluent disposal incorporating a reticulated sewerage network, a sewage treatment plant and a eucalypt woodlot irrigated with treated effluent.

An Outline Development Plan prepared by TS Plunkett Pty Ltd for the site is presented on Figure 1.1. Scheme provisions which accompany the Outline Development Plan are provided in Section 6.0 of this document.

1.2 Location of the Scheme Amendment

Point Grey is a peninsula located between the Peel Inlet and Harvey Estuary opposite the Dawesville Channel, some 80km south of Perth (Figure 1.2).

The Scheme Amendment comprises Murray Lots 75, 137-139, 293, 299, 322, 672, 727, 729, 738, 740, 1132, 1133 and 1145, which include all of the Point Grey Peninsula and part of the adjoining mainland and foreshore. With the exception of existing reserves and a small amount of vacant Crown land, the site is privately owned by entities represented by TS Plunkett Pty Ltd.

Point Grey has been developed and used for agriculture over the last 30-40 years, following its settlement before the turn of the century. At present it is used for sheep agistment. In the past it has been used for hay cropping and broadacre sheep and cattle grazing. Figure 1.3 presents a recent aerial photograph of the site and shows the distribution of cleared land, remnant vegetation and the estuarine shoreline.

1.3 Scope and Timing of the Scheme

The scope of the Scheme Amendment includes all new land uses and associated services identified in the ODP for Murray Lots 75, 137-139, 293, 299, 322, 672, 727, 729, 738, 740, 1132, 1133 and 1145.

The timing of the Scheme Amendment will be determined by Statutory Processes for local Town Planning Scheme amendments established under the *Planning Legislation Amendment Act 1996* and the *Environmental Protection Act 1986* (as amended).

1.4 Responsible Authority

The Responsible Authority for the proposed Town Planning Scheme Amendment No. 104 is the Shire of Murray.

1.5 Background to the Scheme Amendment

1.5.1 Previous Development Proposals for Point Grey

The Peel-Harvey Estuary has a history of algal blooms and other water quality problems created by excessive input of plant nutrients (chiefly phosphorus) from its catchment. Nevertheless, significant conservation, recreation and economic values are recognised for the Estuary and its catchment. These include its roles as a waterfowl habitat of international significance and as a landscape and recreational resource for the local and regional community, and the economic values associated with fisheries, tourism, recreation and residential development.

In July 1987, Mallina Holdings Pty Ltd published an Environmental Review and Management Program (ERMP) for a land use plan for Point Grey which became known as the "College Town" proposal. The main features of this proposal were an educational college, residential neighbourhoods, tourist and holiday facilities, large rural living lots, a golf course, open space and foreshore reserves.

That proposal was rejected by the Minister for the Environment on advice from the EPA (Bulletin 306), on grounds deriving from consideration of nutrients, reserve allocation and environmental amenity. The ERMP and EPA assessment report are available for public examination at the DEP library.

The TS Plunkett Pty Ltd proposal currently before Council is unrelated to the "College Town" proposal. TS Plunkett Pty Ltd was not associated with the earlier proposal.

1.5.2 Advances in Estuary and Catchment Management

In the decade that has passed since the Mallina Holdings proposal was refused, community and government attention has focussed on environmental management and land care requirements of the Estuary and its catchment. Numerous legislated planning policies, remedial projects and land use management programs have been promulgated and implemented with the intent of improving the estuarine water quality and thereby recovering the region's environmental and socio-economic values.

The most recent of these is the construction of the Dawesville Channel, which was opened on 5 April 1994 following more than a decade of research. While the long-term influence of the Channel has yet to be determined, total nutrient levels and water quality problems have declined since the Channel was opened (T. Rose, PIMA, 1995 pers. comm).

In particular, the Channel has yielded immediate and significant benefits to water quality around Point Grey, with particular benefit evident on the Harvey Estuary shores which lie directly opposite the channel's outlet to the Estuary.

In addition, there have been significant advances in several technical areas which place this proposal in a strong position in regard to meeting appropriate environmental objectives. These include:

- Soil research carried out by CSIRO, the Chemistry Centre of WA, the WA Department of Agriculture and tertiary institutions has yielded a substantially improved understanding of phosphorus transport through South-Western Australian soil profiles. This research has also found that the yellow sandy soil profiles which dominate the Point Grey site are the best sands on the Swan Coastal Plan for phosphorus retention.

- Technology for sewage treatment which can remove phosphorus and nitrogen to much lower levels than could be achieved 10 years ago is now readily available.

- Catchment management programs to reduce phosphorus export to the Estuary are now in place.

Recognising the grounds upon which the Mallina Holdings' proposal was rejected, detailed attention has been given to ensuring that the environmental concerns noted in regard to the previous proposal have been addressed and that all relevant environment management objectives for Point Grey and the Peel-Harvey Estuary can be achieved.

1.6 Statutory Requirement for the Scheme Amendment

The Shire of Murray considers that the development plan put forward by TS Plunkett Pty Ltd represents an opportunity to achieve the orderly development of Point Grey in accordance with the principles and objectives of all existing policies for the region, including the Shire of Murray Local Rural Strategy (1994), the Peel Regional Strategy (1994) and the Peel Inlet Management Plan (1992).

In particular, the tourist and recreational components, including the golf course, tourist accommodation and marina, have the potential to create a recreational resource of State significance.

The existing Rural zoning of Point Grey under TPS No. 4 does not permit the types of land use envisaged by the ODP. In order to enable the development to proceed, it is necessary to rezone the land.

Therefore, the Shire of Murray has resolved to initiate an amendment to TPS No. 4 to rezone the site to "Special Development", which would best accommodate the Outline Development Plan under Town Planning procedures.

1.7 Legislative and Regulatory Framework

1.7.1 Decision Making Authorities and Involved Agencies

A number of government authorities will be involved in the decision making process with regard to the proposed Amendment and subsequent development. These include the:

- Shire of Murray;
- Department of Environmental Protection (DEP);
- Environmental Protection Authority (EPA);
- Department of Conservation and Land Management (CALM);
- Peel Inlet Management Authority (PIMA);
- WA Planning Commission;
- Ministry for Planning;
- Water and Rivers Commission;
- Office of Water Regulation;
- Western Australian Water Corporation;
- Department of Transport (Marine & Harbours); and
- Department of Aboriginal Affairs.

1.7.2 Existing Policies and Guidelines

1.7.2.1 Existing Zoning - Shire of Murray Local Rural Strategy (1994)

The *Shire of Murray Local Rural Strategy* (*p.124*) specifies a 'Planning Precinct No. 21—Point Grey' which covers the entire land holding. The principal objective for the precinct is:

> To maintain the current land uses until such time as the area's unique development potential in relation to residential/tourist activities can be realised through an environmentally acceptable development.

The Precinct Statement refers to a number of planning, environmental, engineering and landscape matters which have been addressed in this document.

1.7.2.2 Proposed Zoning

Point Grey is proposed to be rezoned under Town Planning Scheme No. 4 to 'Special Development Zone' to allow for the development of the site. The use of a Special Development Zone is the preferred mechanism for rezoning the property as it provides the Shire of Murray and the community with an assurance of the content of development and ensures that it can only proceed in accordance with an Outline Development Plan endorsed by Council and approved by the Western Australian Planning Commission, while still maintaining flexibility in its implementation.

1.7.2.3 Statement of Planning Policy (SPP) No 2 (1992)

SPP No. 2 introduces statutory requirements concerning drainage and nutrient retention, effluent disposal systems, development density, vegetation retention, planting and management, and the management of public open space. The amended Scheme will contain provisions to ensure that development at Point Grey will comply with these requirements.

1.7.2.4 Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992

This policy, generally known as the ìPeel-Harvey EPPî, sets guiding principles for the planning and management of land use and development within the Peel-Harvey Coastal Plain Catchment, including annual phosphorous export targets for the major river catchments. The amended Scheme contains provisions to ensure that development at Point Grey will comply with the requirements of the Peel-Harvey EPP.

1.7.2.5 Draft Guidelines for Subdivision and Development in the Shire of Murray

Draft guidelines for drainage, nutrient and vegetation management have been formulated to define the basic approach to nutrient reduction management within the Shire of Murray, in keeping with the general recommendations and guidelines of SPP No. 2 and the Peel-Harvey EPP. The amended Scheme contains provisions to ensure that development at Point Grey will comply with these guidelines.

1.7.2.6 Conservation Reserves for Western Australia - System 6 ("Red Book")

The Peel-Harvey Estuary and foreshore immediately to the east of the project area are designated within System 6 Area C50 and are considered to have high conservation significance for waterbird habitat and recreation uses. In addition, System 6 Areas C51 and C52 abut the southern extremity of the project area. The proposed Scheme Amendment will assist in the implementation of the EPAís management recommendations for these areas.

1.7.2.7 International Conventions

Australia is a signatory to the:

- *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (Ramsar Convention, 1971);

- *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment* (JAMBA, 1981); and

- *Agreement Between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment* (CAMBA, 1988).

These agreements, which were ratified under the Commonwealth *National Parks and Wildlife Conservation Act 1975*, place an obligation on Australia to preserve important waterbird habitats.

The Peel-Harvey Estuary is one of 40 Australian wetlands specified in the Ramsar convention, although areas of private ownership are not included. Thirty four species of waterbirds listed under the CAMBA and/or JAMBA treaties have been recorded from the Peel-Harvey Estuary (ANCA, 1993). The amended Scheme contains provisions to ensure that development at Point Grey will comply with these agreements.

1.7.2.8 Draft Inner Peel Region Structure Plan (1996)

The draft Inner Peel Region Structure Plan has been prepared by the Ministry for Planning and was released for public comment on 23 July 1996.

The stated objectives of the Structure Plan are to:

- give effect to the aims, objectives and action statements of the Peel Regional Strategy (September 1994) in so far as these can be interpreted into physical land use arrangements;
- be accurate and specific enough to provide the basis for development control decisions and form the basis for future reviews of Local Town Planning Schemes;
- provide the basis for a Regional Town Planning Scheme for the Peel Region; and
- define land requirements for major infrastructure corridors and future regional open space.

1.7.2.9 Peel Regional Strategy

The Peel Regional Strategy was released by the Ministry for Planning (then the Department of Planning and Urban Development) in September 1994 and provides a strategic policy statement and land use plan for the Peel-Harvey region.

The amended Scheme contains provisions to ensure that development at Point Grey will comply with the environmental, economic, social and infrastructure objectives proposed by the Strategy.

1.7.2.10 Peel Regional Park Planning Study

The 1993 draft Peel Regional Park Planning Study (DPUD, 1993) outlines a proposal for the establishment of a regional park through the provision of guidelines for the administration, use and management of proposed parks and reserves in the Peel-Harvey region.

The amended Scheme contains provisions for the transfer of areas of vacant Crown land at Point Grey to the Peel Regional Park under CALM management.

1.7.2.11 Peel Inlet Management Program

In 1992, PIMA and the Waterways Commission released a management plan for the Peel Inlet and Harvey Estuary which presents recommendations for the management of

particular areas throughout the estuarine system. Primary Objective 4 of the Management Program is to:

> Provide for a range of tourist facilities which are compatible with the conservation of the waterway and benefit from the estuarine location.

Within the above, a specific objective was to identify areas which could be developed as attractive tourist locations without environmental loss. The Management Program acknowledges the proposed development of Point Grey for tourism and residential purposes and provides the following recommendations for the area:

- the need to manage mosquito breeding areas;
- the acquisition of foreshore reserves as a condition of rezoning or subdivision;
- the requirement for the developer to prepare a Foreshore Management Plan to protect and rehabilitate salt marshes; and
- the need to protect wildlife and landscape values while providing for future public access.

The amended Scheme contains provisions to ensure that development at Point Grey will comply with the recommendations of the Peel Inlet Management Program.

1.7.2.12 PIMA Management Policies

PIMA has produced a number of Policy Statements related to the general principles that should be applied to development which would impact the Peel-Harvey Estuary. Policies applicable to development at Point Grey are:

- Policy No. GE 1.1 Strategic Goals for Estuarine Management;
- Policy No. GE 1.8 Clearing and Vegetation Protection;
- Policy No. GE 1.9 Multiple Use of Waterways;
- Policy No. GE 1.10 Waterways Protection - Operational Philosophies;
- Policy No. PD 2.1 Foreshore Management;
- Policy No. PD 2.7 Flood Prone Land;
- Policy No. PD 2.3 Stormwater Management;
- Policy No. PD 2.11 Fire Management;

- Policy No. PD 2.14 Artificial Waterways and Canal Estates;
- Policy No. WS 4.1 Dredging of Riverine and Estuarine Waterbodies: Guidelines for the Preparation of Dredge Spoil Disposal Management Plans - A Guide for Proponents;
- Policy No. WS 4.2 Dewatering; and
- Policy No. EN 3.1 Revegetation and Protection of Remnant Vegetation.

The amended Scheme contains provisions to ensure that development at Point Grey will comply with all applicable PIMA policies and guidelines.

1.8 The Section 48 Environmental Approval Process

The Shire of Murray referred the proposed rezoning of Point Grey from "Rural" to "Special Development" to the EPA in January 1997, in accordance with the requirements of Section 48(c) of the *Environmental Protection Act 1986 (as amended).* The development proposal put forward by TS Plunkett Pty Ltd had previously been referred to the EPA under Part IV of the *Environmental Protection Act 1986*, and a Public Environmental Review (PER) level of assessment had been set.

Following the Section 48 referral, the EPA determined that the Scheme Amendment should be formally assessed and prepared instructions for the assessment. The EPA Instructions are attached in Appendix A.

This document has been structured in accordance with the EPA Instructions and has the purpose of describing the existing environmental characteristics of the site, the proposed Amendment, anticipated environmental impacts of developments permitted under the Scheme, and Scheme provisions to ensure the implementation of appropriate environmental management strategies and Best Practices as part of those developments.

Detailed technical reports covering planning, landscape assessment and engineering, which are the basis for summarised information in this document, have been made available for inspection at the Environmental Protection Authority Library and at the Shire of Murray Offices in Pinjarra. A list of these reports is presented in the Contents section at the front of this document.

2.0 THE EXISTING ENVIRONMENT OF POINT GREY

2.1 Terrestrial Physical Environment

2.1.1 Climate

The area has a temperate Mediterranean climate, with hot dry summers and mild wet winters. For engineering design purposes described later in this document, climatic data from the weather station at Medina south of Perth have been used. Medina was selected as a source of data because, in addition to having a good set of records, it is situated a similar distance inland to Point Grey and would adequately approximate the Point Grey rainfall and evaporation.

The average annual rainfall during 1983-1995 from the Medina weather station was 853mm. Rainfall occurs mainly from March to October. Evaporation is high, averaging 1655mm/yr.

A summary of the seasonal wind pattern at Point Grey based on 1965-1985 wind analysis data from Mandurah is as follows:

- During the summer months, moderate land breezes from the eastern sectors with strong south-westerly afternoon sea breezes;

- During the winter months, winds derive mainly from east to north-western sectors with periodic storms mainly from the north-west.

A detailed set of climatic records describing rainfall and evaporation is provided in Appendix B.

2.1.2 Topography, Landforms and Soils

The Point Grey peninsula is formed by a limestone ridge rising from narrow low-lying coastal fringes at 1-5m AHD to 25-38m AHD on the ridge crests. The central parts of the site comprise gently undulating valleys and sandy ridge crests with some limestone outcrops. Figure 2.1 depicts the site's topographic contours.

Figure 2.1 also shows the distribution of the landform and soil units present at Point Grey. Excepting minor variations, the site is typical of the regional landform and soil descriptions as follows:

(i) Spearwood Dune Landform System

This landform/soil system consists of gently to moderately inclined low hills and gently undulating plain located west of the Bassendean System and associated with Pleistocene Tamala Limestone. Hills consist of a core of aeolianite, capped by secondary calcite and overlain by variable depths of rapidly drained siliceous yellow brown sands.

The soils of this unit which occur at Point Grey are:

- **S1**: Gently to moderately inclined dune ridges with shallow to deep siliceous yellow brown sands with rare to common limestone outcrops.

- **S2**: Level or moderately inclined lower slopes of dune ridges with shallow to deep siliceous yellow brown sands with minor or common limestone outcrops.

- **S4**: Flat to gently undulating sand plain with pale bleached sands with yellow brown subsoils.

Each of these soil types is identifiable at Point Grey, although soil type boundaries drawn at a regional scale were found to vary slightly when site specific investigations were carried out.

The existence of extensive deep yellow soil profiles and the substantial separation distance between ground level and the superficial water table are significant elements of the site's suitability for development.

The focus of soil research on nutrient retention capability in recent years has identified yellow Spearwood sands as the best of the coastal plain sands for phosphorus retention.

Background environmental management investigations leading to the present Outline Development Plan (ODP) involved extensive soil profile sampling, soil type boundary definition and laboratory testing of soil profile phosphorus retention.

These investigations have confirmed the considerable value of the site's yellow Spearwood sand soil profile as a resource for phosphorus management.

(ii) Vasse Estuarine and Lagoonal System

Low lying poorly drained terraces, flats and beach ridges fringing Peel Inlet, Harvey Estuary, the coastal lake system and major river mouths. Soils are extremely variable, being formed on unconsolidated Holocene estuarine alluvium and lagoonal deposits, and are often highly saline and subject to periodic inundation.

Soils of this unit occurring at Point Grey are:

- **V6**: Upper level sandy terraces and gently undulating beach ridges with deep grey sands.

- **V6a**: Gently undulating beach ridges with deep, grey acidic siliceous sands overlying an iron-organic hardpan.

(iii) Bassendean Dune and Plain System

Very low relief, leached grey siliceous Pleistocene sand dunes with intervening sandy and clayey swamps and gently undulating plains; occurring immediately west of, and partly overlying, the Pinjarra Plain.

The soil type of this unit occurring at Point Grey is:

- **B4**: Broad, poorly drained plain with deep grey siliceous sands and bleached sands with an iron-organic hardpan, underlain at depths generally not greater than 1.5m by a mottled grey clay layer supporting a perched water table.

2.1.3 Geology and Shallow Stratigraphy

Figure 2.2 presents a typical shallow geological cross section and identifies the following features:

- Leached sands derived from Tamala limestone (Spearwood Sands) with an average depth of 7m form the surface sediments.

- Tamala limestone forms the core of the ridge landform and extends from at or near surface level on the higher ridges to about 10m below surface level.

Regional geological and hydrogeological data indicate that the Tamala Limestone is underlain at Point Grey by the Osborne Formation and the Leederville Formation.

2.1.4 Surface Water

There is little naturally-occurring surface water at Point Grey. The vast majority of the site is elevated, gently undulating sandy terrain which has no effective runoff and therefore does not create any significant surface drainage.

The Robert Bay drain, which exports surface water and shallow groundwater drained from low lying Bassendean dunes and alluvial plains to the east and south of the site, passes through the site near its eastern boundary and there are remnants of former natural drainage channels which have been modified by drainage to the Robert Bay drain.

Limited areas of low-lying Vasse landform areas adjacent to Robert Bay exhibit periodic ponding of surface water during the wetter months.

There are small seasonal groundwater wetlands along the eastern margin of the Spearwood landform. These are dry during summer and flooded but shallow during winter.

2.1.5 Groundwater

Unconfined Aquifer System

An unconfined aquifer is developed in the sand and Tamala limestone that make up the superficial formations at Point Grey.

The Superficial aquifer is recharged directly by rainfall and also by upward leakage from the underlying Leederville Formation where the confining Osborne Formation clays are not present (Figure 2.3). Groundwater flow in the Superficial aquifer is generally north-westerly along the length of the peninsula, although at a smaller scale it is likely that radial flow outwards to the Estuary waters occurs along the length of the peninsula (Figure 2.3).

Within the low-lying nearshore fringe, the water table is almost flat and very shallow, at about the same level as the Estuary. Tidal movements and storm surges would produce

regular small variations in the water table level close to the shore. A saline "wedge" is likely to exist close to the shore beneath the overlying fresh groundwater.

Confined Aquifer System

The upper part of the Leederville Formation is the aquifer of interest for water supply to Point Grey. It subcrops beneath clay and sand of the Guildford Formation and Jandakot Beds to the east of the Peel Inlet and Harvey Estuary, and dips westwards beneath the Peel Inlet and Harvey Estuary towards the ocean. The thickness of the aquifer beneath the project area ranges from approximately 180m to 220m.

The Leederville Formation has been investigated by numerous exploratory and production bores located mainly in the Mandurah/Pinjarra region. These bores have confirmed that a green clay horizon divides the Leederville Formation into two parts (the upper and lower Leederville aquifers), each with different hydrogeological conditions. Hydraulic heads measured in the formation north of Peel Inlet ranged from 4m above to 8m below the green clay horizon, indicating that the clay horizon forms a continuous confining layer (Wharton, 1990). In the west, including part of the Point Grey peninsula, the Leederville Formation is overlain by the confining Osborne Formation.

The upper Leederville aquifer is recharged by downward infiltration of groundwater from the Superficial aquifer in an area to the south-east of Point Grey, as shown on Figure 2.3.

The reverse occurs in the area between the Osborne Formation and the western boundary of the recharge area (Figure 2.3) where an upward hydraulic gradient causes upward leakage of water from the Leederville to the Superficial aquifer. Water balance calculations indicate a net downward leakage from the Superficial to the Leederville aquifer of about 4,500kL/day.

Where the Superficial aquifer is underlain by the Osborne Formation, there is effectively no leakage between the two aquifers.

Groundwater flow in the Leederville aquifer is westwards. Discharge is inferred to occur offshore as well as to the Superficial aquifer (as described above).

The upper Leederville aquifer contains zones of different salinities ranging from fresh to brackish. The fresher water most likely originates from downward leakage from the

Superficial aquifer. The brackish zones regions probably originate from sideways intrusion of a saline estuarine "wedge".

2.2 Estuarine Physical Environment

2.2.1 Introduction

The Peel-Harvey Estuary is a shallow coastal lagoon with an area of 133km^2. Since the 1960s the water quality of the Estuary has become seriously degraded as a consequence of high nutrient inputs from agricultural land and an inherently slow rate of flushing. The Dawesville Channel, opened in April 1994, was designed to improve water exchange between the Estuary and the ocean. The hydrodynamics and water quality of the Peel-Harvey Estuary have changed significantly since the opening of the Dawesville Channel.

Point Grey forms a physical divide between the Harvey Estuary, which lies on the site's western shore, and Peel Inlet, which lies on the site's eastern shore (see FIgure 1.2).

Eutrophication of Estuary and river water has been attributed to excessive input of phosphorus from the catchments of the Estuary's three main tributary rivers (Serpentine, Murray and Harvey) and agricultural drains.

Management of land use in the catchment aimed at reducing phosphorus export has been implemented during the last decade under both planning and environmental legislation.

The Dawesville Channel was designed to reduce eutrophication by flushing nutrient-rich water to the ocean and to preclude blooms of the blue-green alga *Nodularia* by modifying the salinity regime in the Peel-Harvey Estuary.

Point Grey lies directly opposite the Dawesville Channel and the water quality adjacent to its western shores, in particular, has improved significantly in regard to clarity, reduced phytoplankton levels and more marine conditions (Wilson and Latchford, 1995).

Due to its proximity to the Dawesville Channel and the predominant circulation patterns, the Point Grey land and adjacent estuarine environment is the best placed within the Peel-Harvey system in regard to the rate and degree of water quality improvement due to improved oceanic exchange.

2.2.2 Inflows and Outflows

Fresh water flows into the Peel-Harvey Estuary from the Harvey, Serpentine and Murray Rivers, several major agricultural drains and direct groundwater inflow. Large volumes of seawater flow into and out of the Estuary via the Mandurah Channel and Dawesville Channel. These inflows and outflows exert the primary influence over the hydrodynamics and water quality of the Peel-Harvey Estuary.

The total annual freshwater inflow averages $855 \times 10^6 m^3$, most of which enters in the winter months of June to September. This freshwater inflow is about 5.8 times the Estuary's total volume of $148 \times 10^6 m^3$.

The Dawesville Channel has significantly improved tidal exchange between the Estuary and the ocean, as predicted in Kinhill (1988) and discussed more recently by the Department of Transport with the benefit of more detailed input data (Department of Marine and Harbours, 1993, 1994). The Dawesville Channel alone has an average tidal prism entering the Estuary which is three times that which previously existed for the Estuary via the Mandurah Channel. For example, the Department of Transport's model indicates that for a 0.4m ocean tidal range, the tidal prisms entering the Estuary from the Dawesville and Mandurah Channels are $17.5 \times 10^6 m^3$ and $5.5 \times 10^6 m^3$ respectively.

The total tidal exchange between the Peel-Harvey Estuary and the ocean is now approximately $8.4 \times 10^7 m^3$ per year, which is estimated to be four times the exchange prior to the Dawesville Channel. Thus annual tidal exchange is now ten times the annual average freshwater inflow and 56 times the Estuary's total volume. The greatly improved flushing that has resulted from the Dawesville Channel has mostly affected Harvey Estuary, with a lesser but still significant effect on Peel Inlet (Department of Marine & Harbours, 1993, 1994).

2.2.3 Water Levels

A review of previous studies in the Peel-Harvey Estuary and calculations of wind wave generation and run-up have been completed by Halpern Glick Maunsell. The results are summarised below and are presented in full in the accompanying Technical Reports.

2.2.3.1 Astronomical and Meteorological Tides

Table 2.1 summarises the average tidal levels before and after the construction of the Dawesville Channel. The data show that the Dawesville Channel has increased the average tidal range in Harvey Estuary from 0.1m to 0.38m, which is approximately three quarters of the ocean range. The average tidal range in Peel Inlet has similarly increased to 0.28m, which is approximately half of the ocean tidal range.

Table 2.1
Astronomical and Meteorological Tides

LOCATION	WATER LEVEL		
	MHHW (mAHD)	MLLW (mAHD)	Source
Ocean	+0.24m	-0.26m	DMH Chart 307
Peel-Harvey (Pre-Dawesville Channel)	+0.05m	-0.05m	DMH Chart 307
Peel Inlet (Post-Dawesville Channel)	+0.135m	-0.14m	DMH Report D10/92
Harvey Estuary (Post-Dawesville Channel)	+0.17m	-0.21m	D10/92

DMH Chart 307 indicates that meteorological conditions (ie wind and barometric pressure) may increase a predicted tide height by 0.3m. Data collected by Lewis (1990) near Yunderup Canals indicate that meteorological conditions can change mean water levels in the inlet/Estuary by at least 0.5m over 5-7 days.

DMH Report No D10/92 also presents estimated maximum and minimum water levels after construction of the Dawesville Channel. These levels are described in Table 2.2.

Table 2.2
Estimated Water Levels Post-Dawesville Channel

LOCATION	WATER LEVEL	
	Maximum (mAHD)	Minimum (mAHD)
Peel Inlet (Post-Dawesville Channel)	+0.64m	-0.48m
Harvey Estuary (Post-Dawesville Channel)	+0.65m	-0.61m

These maximum and minimum levels are consistent with the variations observed by Lewis (1990).

2.2.3.2 Flood Events

The impacts of flooding of the Serpentine, Murray and Harvey Rivers have been moderated by the Dawesville Channel.

DMH Report No D10/92 provides predicted water levels for the 1 in 25 year and 1 in 100 year flood events as described in Table 2.3.

The modelling work indicated that flood levels will now recede to tidal levels within five days, compared to 10-14 days pre-Dawesville Channel.

Table 2.3
Predicted Water Levels

LOCATION	WATER LEVEL (mAHD)	
	1 in 25 year	**1 in 100 year**
Peel Inlet (Pre-Dawesville Channel)	+1.25m	+1.80m
Harvey Estuary (Pre-Dawesville Channel)	+1.25m	+1.80m
Peel Inlet (Post-Dawesville Channel)	+0.75m	+1.12m
Harvey Estuary (Post-Dawesville channel)	+0.73m	+1.00m

2.2.3.3 Cyclonic Storm Surge

The Dawesville Channel will allow oceanic storm surges to be more readily transmitted to the Estuary. DMH Report No D374/96 provides predicted combined tide and storm surge water levels in the Peel-Harvey Estuary of +1.15m on the basis of 1 in 100 year ocean water levels.

2.2.3.4 Wind Set-up

Strong and persistent winds blowing over the Peel-Harvey Estuary are known to result in significant wave setup. Hodgkin (1978) observed a differential water level along the length of Harvey Estuary during Cyclone Alby of 1.2m. This implies a set-up/set-down from still water level of 0.6m.

Wind set-up may occur concurrently with normal astronomical tidal conditions, extreme cyclonic surge conditions or extreme flood events.

2.2.3.5 Greenhouse Effects

An allowance for sea level rise, one of the Greenhouse effects, is included in the design water level for the Point Grey Project. Guidelines for the design of coastal engineering projects with respect to Greenhouse effects recommend an allowance for mean sea level rise of +0.18m and +0.30m by the years 2030 and 2050 respectively (The Institution of Engineers, Australia, 1991) . These guidelines are currently incorporated into designs for coastal projects. However, more recent modelling by Wigley and Raper (1992) provided revised best guess scenarios indicating a rise of +0.14m and +0.22m for the years 2030 and 2050 respectively.

2.2.3.6 Design Water Level

The combination of the 1 in 100 year flood event with the strong and persistent wind conditions required to generate a set-up of +0.6m would produce an event of significantly greater return period than 1 in 100 years.

Selection of a 1 in 100 year design still water level involves consideration of the storm surge, flood and wind set-up events such that the combined probability of occurrence is 1 in 100 years.

Design water levels estimated for Peel Inlet and Harvey Estuary (post-Dawesville Channel) by the Water Authority (1994) are shown in Table 2.4.

Table 2.4
Design Water Levels
(Water Authority, 1994)

LOCATION	100 YEAR STORM SURGE(S) (m)	WIND SET-UP (W) (m)	DESIGN WATER + W (mAHD)
Peel Inlet (Post-Dawesville Channel)	+1.15	+.45	+1.6
Harvey Estuary Eastern Shore (post-Dawesville Channel)	+1.15	+.15	+1.3

2.2.3.7 Design Structure Level

In addition to the maximum water levels predicted above, structures constructed on or close to the shoreline may be subjected to wave action and wave run-up.

Assuming an average water depth along the Peel Inlet shoreline of 1.6m, a typical wave height of 1.0m can be expected in conjunction with an average wind speed of 35m per second, and a fetch of 4km. Wave period will be about 3.2 seconds and top of wave level approximately +2.15 AHD.

Wave run-up on a breakwater type structure of 1:2 slope and rock armour will be approximately 0.7m above +1.6 AHD water level, that is up to +2.3 AHD. The required duration of the wind speed which would generate this wave run-up will be less than 1.5 hours.

Permanent structures set back from the Estuary shoreline with fringing vegetation protection will not experience run-up of this magnitude. As a consequence, a minimum building level of +2.3 AHD is proposed adjacent to the Peel Inlet shoreline, including an allowance of 0.2m for greenhouse-induced water level rise.

Minimum building levels adjacent to the Harvey Estuary shoreline are proposed at +2.0m AHD, due to the reduced 1 in 100 year water levels and reduced fetch for wave generation.

2.2.4 Circulation

Coincident with the improved tidal exchange, the Dawesville Channel has had a dramatic impact on the circulation of the Harvey Estuary. The impact of the Channel has been less in Peel Inlet, where circulation continues to be predominantly driven by the Mandurah Channel.

Prior to the Dawesville Channel, circulation in the Harvey Estuary was minor and mainly wind-driven. The Dawesville Channel now acts as a nozzle during flood tides to jet the incoming seawater into the Estuary. The alignment of the channel and the topography of the Estuary combine to sweep the bulk of the incoming flow directly across the Estuary then south along the west coast of Point Grey and down the eastern side of the Harvey Estuary.

During ebb tides the channel acts as a sink and flow is less defined. However, the general circulation pattern in the Harvey Estuary is clockwise due to the flood tide forcing, and the peak return flows are along the western shore of the Estuary.

The west coast of Point Grey is thereby strongly influenced by marine water, even during winter when large volumes of fresh water enter the southern end of the Harvey Estuary via the Harvey River.

Circulation on the east coast of Point Grey is mainly clockwise, predominantly driven by tidal flows in the Mandurah Channel. Circulation in the Peel Inlet increased significantly after the Mandurah Channel was dredged in 1986.

2.2.5 Mixing and Stratification

The Peel-Harvey Estuary is normally well mixed by wind and tidal currents. However, in winter and spring, calm periods and high freshwater inflows can result in density stratification (salinity layering) of the water column into two and occasionally three separate layers. Fresh river water flows out across the surface while denser, saline seawater forms a bottom "wedge" which varies in thickness with the tide. This stratification is common in other estuaries.

In late summer, stratification may occur in the Harvey Estuary when incoming seawater flows over hypersaline estuarine water.

The Dawesville Channel has increased stratification in the Harvey Estuary during winter, but has reduced it in summer. These effects were predicted prior to construction of the Dawesville Channel (Tong, 1985). The water in the immediate vicinity of the Dawesville Channel appears to be stratified throughout the year (Elliot, pers. comm.).

2.2.6 Estuarine Sediments

Extensive sand flats border the shorelines of Point Grey. The shallow subtidal and intertidal shelf adjacent to the beach is 200-1,000m wide.

Sediment in the Peel-Harvey Estuary ranges from clean, oxygenated sand to anoxic black ooze in deeper water and under the macroalgal mats in shallow areas such as Robert Bay. The sediments are both a sink and source for nutrients, depending on their oxygen content.

Sediments along the western shoreline of Point Grey are generally oxic to a depth of about 0.5-2.5cm (Rose, 1994). The depth of the oxic layer varies with season and year. In Robert Bay on the eastern shoreline the oxic layer is very shallow and is absent in some places.

Indications are that the increased flow of highly oxygenated seawater through the Dawesville Channel has significantly improved the oxygen status of the bottom sediments on the western coast of Point Grey. The sediments on the eastern side of Point Grey (in Robert Bay) appear to be less affected and remain less oxygenated than those on the western side, although improvement is evident.

2.2.7 Shoreline Stability

Aerial photographs taken between 1965 and 1996 indicate that the shorelines on both sides of Point Grey are stable and have no significant movement of sediment along the shore.

Field inspection of the Point Grey shoreline similarly found no indication of significant shoreline erosion or accretion, with the exception of a small section of beach on the central west coast (at the southern end of the proposed marina), where localised erosion has exposed the fringing *Melaleuca* roots. Given the small area concerned and its location directly opposite the Dawesville Channel, this erosion is likely to have resulted from the faster tidal currents associated with the opening of the Dawesville Channel, combined with the effects of wind waves in south-west wind events. It is believed to represent an adjustment to the altered tidal and current regime following the opening of the channel, rather than an indication of ongoing littoral movement.

Calculations based on the measured current velocities and sediment grain sizes which occur in the area also strongly suggest that there would be insignificant sediment resuspension and transport (Halpern Glick Maunsell, 1996). This is supported by the observations of Department of Transport and PIMA personnel since the opening of the Dawesville Channel, who have described the loss of fine organic sludge from the sediments in subtidal shallows along the Point Grey west coast but have otherwise found the region to have remained physically stable.

Tidal currents along the east coast of Point Grey experience a reduction in velocity, causing fine sediment to accumulate in this area.

2.2.8 Water Quality

2.2.8.1 Salinity

The salinity of the Peel-Harvey Estuary varies with river flow, oceanic inflow and evaporation.

The salinity regime of the Harvey Estuary has changed substantially since the Dawesville Channel opened. Prior to the opening of the Channel, the Harvey Estuary salinity ranged from brackish (5 parts per thousand (‰) TDS) in late winter to hypersaline (50‰) in late summer. Since the opening of the Dawesville Channel, the salinity in the northern part of the Harvey Estuary has generally remained within the range 10-40‰ at the surface in winter. Maximum salinities at the southern end of the Harvey Estuary have continued to reach pre-Dawesville Channel levels.

The salinity of the Harvey Estuary in the vicinity of Point Grey varies with tides and seasons, but is more similar to the ocean now than before the Dawesville Channel.

Salinity in the Peel Inlet always varied less than in the Harvey Estuary, and the Dawesville Channel has had a much smaller impact there. The Peel Inlet salinity now generally ranges between 10‰ in winter and 45‰ in late summer (Wilson and Latchford, 1995).

2.2.8.2 Water Temperature

Prior to the Dawesville Channel, water temperatures in the Harvey Estuary ranged from 10-14°C in winter to 25-27°C in summer. Preliminary monitoring data (Wilson & Latchford, 1996 unpublished data) suggest that water temperatures now remain higher in

winter under the influence of the Dawesville Channel, but that summer temperatures have not changed significantly. Water temperatures in the nearshore areas of the Harvey Estuary at Point Grey are now more similar to the ocean and seem to vary less throughout the year than they did before the Dawesville Channel was opened.

Water temperatures in the Peel Inlet generally range from 15°C in winter to 27°C in summer (Wilson and Latchford, 1996 unpublished data) and are unlikely to have been significantly affected by the Dawesville Channel. Nearshore waters within the expansive shallows of Robert Bay are likely to reach higher summer maximum temperatures than the offshore waters of the Peel Inlet.

2.2.8.3 Dissolved Oxygen

Dissolved oxygen levels in the Peel-Harvey Estuary vary with the oxygen content of incoming waters, mixing of the water column and algal population dynamics. Prior to the Dawesville Channel, seasonal stratification of the water column and the accumulation of decaying macrophytes on the bottom led to deoxygenation of the bottom waters, causing the release of phosphorus from the sediments.

Monitoring data since the opening of the Dawesville Channel have shown a very marked improvement in dissolved oxygen concentrations. Summer concentrations have remained at or above saturation throughout the water column. In winter, the bottom waters in the Harvey Estuary continue to carry less oxygen than the surface waters but have generally remained more than 50% saturated (Wilson and Latchford, 1995). An episode of anoxia was recorded in bottom waters in the southern Harvey Estuary, but all other data indicate greatly improved water quality since the Dawesville Channel was opened (Wilson and Latchford, 1995).

2.2.8.4 Water Clarity

Water clarity in the Peel-Harvey Estuary is affected by phytoplankton blooms, tannin-stained river water and suspended sediments. Water clarity is generally highest in late summer and lowest in late winter and early summer with the advent of algal blooms.

Following the opening of the Dawesville Channel, water clarity in the Harvey Estuary increased immediately and has remained higher than before the channel, except during sediment resuspension events in summer (Wilson and Latchford, 1995). Phytoplankton

concentrations have never reached bloom conditions and are generally very low (Wilson and Latchford, 1995; Lavery *et al.*, 1995).

Water clarity strongly influences the growth of benthic macrophytes. Clear water entering through the Dawesville Channel has been predicted to stimulate increased growth of benthic macroalgae (eg *Cladophora*) and seagrass (eg *Halophila*) due to increased light penetration. No data are yet available to ascertain whether this has occurred.

2.2.8.5 Nutrients

The Peel-Harvey Estuary is eutrophic due to excessive nutrient inputs from its catchment. The Estuary has suffered from severe algal blooms since the late 1970s, driven by an annual influx of phosphorus from the catchments and by the release of phosphorus from the sediments to the water column during periods of anoxia.

The algal bloom cycle in the Estuary has been well described elsewhere (eg Gorham *et al.* 1988; Kinhill 1988; EPA 1985, 1988).

The Dawesville Channel and the prior dredging in the Mandurah Channel have improved the nutrient status of the Peel-Harvey Estuary through enhanced export of nutrient-rich river water. The increased salinity of the Harvey Estuary has also inhibited *Nodularia* blooms, thereby reducing phosphorus uptake and deposition in sediments. The continued flushing of the Estuary by the Dawesville Channel is likely to cause a progressive decrease in stored and available nutrients.

Ongoing nutrient management in the catchment will continue to reduce nutrient inputs into the Estuary. The Peel-Harvey EPP (EPA, 1992) sets a target phosphorus loading for the Peel-Harvey Estuary of 75 tonnes per annum.

The net result of these influences is expected to be a substantial long-term improvement in the trophic status of the Estuary.

2.3 Terrestrial Biological Environment

2.3.1 Vegetation and Flora

As shown by the aerial photograph in Figure 1.3, the majority of the site has been wholly or parkland cleared for grazing. Parts of the site, predominantly the fringing estuarine vegetation but also a large area of upland vegetation, remain uncleared.

With the benefit of previous baseline vegetation and flora survey data, the entire site has been re-surveyed by specialist botanical consultants in order to provide an up-to-date data base of floristic composition, vegetation types and conservation values. The findings are presented in full in Appendix C and summarised below.

No Declared Rare or Threatened Flora species were encountered during the current or previous surveys.

Ten vegetation types are recognised from the property (Figure 2.4). These are listed below in descending order of the size of remnant stands within the site.

(i) Eucalypt/Banksia Woodland: A mixed canopy of Jarrah, Marri, Sheoak and Banksia species with dense and diverse understorey of shrubs under a metre in height. A substantial remnant stand in excellent condition remains within the site.

(ii) Tuart Woodland: Open woodland with dominant Tuart canopy. The understorey, even when not grazed, tends to be open in structure. Prior to agricultural development this would have been the dominant vegetation but is now restricted to small remnants throughout the site. None of these remnants are in natural condition, with a general finding of fair to poor condition for the site and no regeneration in grazed areas.

(iii) Spearwood Thickets: These occur quite extensively immediately behind (inland) the shoreline communities along much of the site's western edge, and are dominated by Spearwood (*Kunzea ericifolia*), Sheoak, Candle and Swamp Banksias and wattle (*Acacia saligna*). Due to its impenetrable nature, this vegetation is generally physically undisturbed.

(iv) Beach Ridge Mosaic: This is a shrubland of varying density and height which occurs in the northern extent of the site and also in the south-western margin.

Shrubs include *Jacksonia furcellata, Acacia saligna, Regelia ciliata* and Spearwood. Although limited in extent this vegetation is generally in good condition with the exception of foreshore areas close to tracks.

(v) Flooded Gum Woodland: This vegetation type occurs on low lying sites with fresh water very close to the ground surface, predominantly immediately inland of the shoreline communities on the eastern side of the point and on the sandy terraces and estuarine alluvium at the north-east margin. The open woodland structure is dominated by flooded gum (*E. rudis*) although Swamp Banksia (*B. littoralis*) and Swamp Paperbark (*Melaleuca rhaphiophylla*) are sometimes present. Small stands in good condition occur within the site although in general the Flooded Gum Woodland is in fair to poor condition.

(vi) Banksia Woodland: A woodland/low woodland formation with Candle Banksia dominant but also occasional stunted eucalypts occupies crests and upper slope habitats in specific parts of the site. Generally in good condition within the site.

(vii) Shoreline Communities: Salt tolerant communities which occur in a narrow band along the entire shoreline. Dense beds of reeds dominated by *Juncus* with occasional individuals or clumps of trees. Generally in good condition, with heaviest disturbance in areas used for crabbing and fishing.

(viii) Melaleuca Thicket: Dense stands of *Melaleuca viminea, M. uncinata* and *M. rhaphiophylla* create an almost closed canopy to about 4m in height with few if any understorey species, on the seasonally wet flats at the north east of the site and around a small seasonal wetland along the eastern boundary. Most of this vegetation type has been extensively altered by complete clearing or pasture and weed invasion.

(ix) Acacia Thicket: One limited stand of thicket dominated by *Acacia rostellifera* occupies the south eastern toe and lower slopes of the rise at the northern extent of the site. Apart from the presence of rabbits the vegetation appears undisturbed.

(x) Paperbark Swamp: Two small wetland areas at the far north of the site support a woodland of *M. preissiana* and *M. rhaphiophylla*. Trees tend to be well spaced, reaching a height of 10m and have an open sedge understorey. Both remnants exhibit damage by stock.

The vegetation condition is illustrated on Figure 2.5.

2.3.2 Terrestrial Fauna

With the benefit of previous published information describing the site's fauna, re-surveying of the site and the adjacent Estuary has been carried out by specialist fauna consultants. The findings of the investigations are described below and are presented in full in Appendix D.

Clearing and agricultural uses have resulted in the removal of the majority of the habitat and fauna populations which would have originally utilised the site. However, important elements of the habitats and fauna populations remain.

There is a remote possibility that the declared rare Southern Brown Bandicoot could occur in vegetated land in the far north of the site associated with seasonally damp sedgelands, although searching did not reveal any of the typical diggings which would indicate this species' presence.

The area proposed for the marina does not exhibit any terrestrial habitats of particular significance, and no fauna species are likely to be restricted to this location.

At certain locations near the shoreline within the coastal reserve on the western shore there are low limestone ridges with numerous small caves which might provide refuge for the rare Carpet Python. However, no sightings or other evidence of the species' existence were identified during the survey.

Large mature trees form the remnant vegetation in the central parts of the site where farming has been focussed, including Tuart, Peppermint and, in lower lying fringing areas, Flooded Gum, Paperbark and Sheoak. These trees are used by a large number of bushland bird species for shelter and feeding (nectar, insects) with the potential for the large deep hollows provided by mature Tuart trees to be used by parrots, brushtail possums and several species of duck.

The rare Peregrine Falcon might utilise this mature tree habitat for nesting, although no sightings or other evidence of this species have been identified during any of the site surveys carried out to date.

A large tract of woodland vegetation is located in the southern part of the site, and is flanked to the south by parkland-cleared agricultural land. This tract of land contains good examples of the woodland understorey habitat which has been lost from the remainder of the site and provides habitat for a wide range of bushland birds, mammals and reptiles.

Remnant fringing habitat along the eastern margin provides mature tree habitats in parkland cleared condition, including Tuart, Flooded Gum, Marri and Paperbarks, with increasing degradation towards the south where recreational activities have been more intense.

The report presented by the specialist fauna consultant made a number of recommendations for conservation and habitat protection, each of which has been adopted and is incorporated in the Outline Development Plan.

2.3.3 Rare Flora and Fauna

A biological survey for rare flora and fauna of the Point Grey region was conducted in 1987. Additional survey work was carried out for this PER during May and June 1996. Distribution patterns, habitat preference and records of the Western Australian Museum and the CALM rare flora database were consulted. Specific field investigations were also conducted.

No gazetted rare flora or fauna or any evidence of their recent presence were found during field surveys of the site. However, the distribution and habitat of some gazetted rare species occur on the site and therefore these species may occur at Point Grey even though none were sighted. Gazetted rare fauna which could potentially occur on the site are:

- Peregrine Falcon *(Falco peregrinus)*. A highly mobile bird, with little apparent habitat specificity and an Australia-wide distribution, including the Point Grey region.

- Carnaby's Cockatoo *(Calyptorhynchus funereus latirostris)*. This cockatoo lives mainly in the Wheatbelt region but occasionally breeds as far south as Bunbury. This species requires the hollows that develop in mature Eucalypts for nesting. Large Tuart trees with hollows on the site provide potential breeding sites.

- Baudin's Cockatoo *(Calyptorhynchus baudinii)*. This cockatoo is still distributed throughout most of its earlier known range in south-western Australia. Its habitat is typically Eucalypt forests dominated by Jarrah, Marri and Karri. This species

also depends on nest sites in Eucalypt hollows, and the Tuart trees in the project area may provide breeding sites.

- Southern Brown Bandicoot *(Isoodon obesulus fusciventer).* This mammal requires a dense understorey, typically in wet or damp areas. Areas of vegetation on the peninsula may provide suitable habitat.

- Carpet Python *(Morelia spilotus imbricatus).* This subspecies of the Carpet Python occurs only in the south-west of Western Australia. The limestone outcrop in the southern parts of the western shore of Point Grey provides potential habitat for this species.

2.3.4 Wetlands

Although wetlands are not a dominant feature of Point Grey, there are limited examples of several types of wetlands at the site including damplands, sumplands, estuarine wetlands and flood plains (Figure 2.6). Wetlands are restricted to small areas on the peninsula and along the eastern boundary of the Spearwood Dune ridge landform, and in the stranded estuarine embayment inland of Robert Bay (Figure 1.3). The description of the wetland types in the Point Grey site is divided into two sections: wetlands within the stranded estuarine embayment which form low-lying land around Robert Bay, and wetlands outside of this area.

2.3.4.1 Wetlands in the Stranded Coastal Embayment

Sumplands

These basin-shaped wetlands are inundated during winter and spring but are generally dry during summer and autumn. The native vegetation has been cleared and replaced with exotic pasture grasses or bare sand.

Damplands

The damplands are basin-shaped and seasonally waterlogged. The vegetation has generally been cleared and replaced by pasture species or bare sand. The dampland adjacent to Robert Bay drain supports thickets composed of *Melaleuca viminea, M. uncinata* and *M. rhaphiophylla.* The understorey of these thickets is mainly grasses.

Estuarine wetland

This wetland is inundated through tidal movement and supports salt-tolerant vegetation. Samphire and rush species were the main flora type identified in the area. These areas have been disturbed (probably by recreational fishers and crabbers), which has led to the loss of some vegetation and invasion by weeds.

Floodplain

Floodplains form a large part of the coastal embayment around Robert Bay and form during winter and spring when the embayment is periodically inundated. The natural species have been replaced by grasses, most of which have been grazed and, consequently, large areas of the floodplains are cleared of all vegetation.

2.3.4.2 Wetlands in the Remainder of the Site

Sumpland

There is a small sumpland about 1,500m to the southwest of Robert Bay that is surrounded by a dampland. This sumpland has a significant vegetation buffer composed of *Melaleuca rhaphiophylla* and *M. preissiana.* The understorey has been virtually destroyed.

Damplands

Damplands are located at the tip of the Point Grey peninsula and surrounding the sumpland to the south-west of Robert Bay (Figure 2.6). The overstorey of these damplands is dominated by *Melaleuca rhaphiophylla* and *M. preissiana.* The wetlands at the tip of the peninsula have a dense understorey dominated by sedges and rushes. The understorey of the dampland in the south-west is virtually destroyed.

2.3.4.3 Classification of Point Grey Wetlands

EPA Bulletin 686 describes a wetland evaluation and classification method by which specific wetlands may be classified into one of five environmental management categories, based on the human and environmental values evident in their natural attributes. For each of the five management categories there are complementary management objectives as outlined below.

Category H - High Conservation

Active management to maintain and enhance wetland attributes, particularly natural attributes. This would require a detailed management plan to be prepared and

implemented. This category is recognised as having the highest priority for establishment and implementation as regional park wetlands.

Category C - Conservation
To maintain and enhance natural attributes and functions.

Category O - Conservation and Recreation
To provide for human uses whilst maintaining and enhancing the existing natural attributes.

Category R - Resource Enhancement
To maintain and enhance the existing ecological functions. The term enhancement indicates that opportunities may exist for commercial developments to enhance conservation values of wetlands.

Category M - Multiple Use
Objectives should be considered in the context of catchment and land use planning, in terms of the current value of the wetland and the potential value to the community if rehabilitated. Sections of these wetlands may only have a hydrological function. Development and management within these areas should address the key issues of water management and off-site impacts.

Classification of each of the site's wetlands according to the procedures of Bulletin 686 has been carried out in order to establish appropriate environmental management objectives. As could be reasonably expected recognising current land use, most of the site's wetlands are identifiable as Category M-Multiple Use, as a result of the absence of their original vegetation. Wetlands with higher management priorities were also identified. The damplands at the tip of the peninsula were Category C - Conservation and the sumpland outside of the embayment as Category R - Resource Enhancement.

2.3.5 Foreshores

The site's foreshores have values for landscape, vegetation, habitat and as water quality buffers for water draining to the Estuary at the surface or as shallow groundwater.

The site's foreshores vary in both their natural characteristics and their current condition. Generalised foreshore types which may be recognised include:

- shoreline vegetation communities, backed by a narrow band of Flooded Gum, Paperbark and Sheoak, then a band of parkland cleared land supporting pasture, with gentle grades between the intertidal and the fringing plain and an abrupt change in grade at the transition to limestone dune terrain;

- shoreline communities backed by thickets and rising steadily into either Banksia woodland, Tuart woodland or pasture;

- shoreline communities and thickets backed by a steep limestone scarp with either Spearwood thicket or Banksia woodland vegetation; and

- shoreline communities and thickets backed by broad expanses of parkland-cleared Tuart woodland and Banksia woodland.

The existing impacts of agriculture and recreational uses (particularly crabbing) at and near the foreshore are greatest on the eastern shores of the site.

In general terms, the shoreline vegetation communities remain uncleared, the fringing tree vegetation is present with pasture understorey, and the upland vegetation has been cleared completely or to parkland format.

Where limestone outcrops occur very close to the foreshore, the natural vegetation tends to remain in place as these areas have little agricultural value and have not previously been cleared, although the effect of stock on understorey vegetation is evident throughout the site.

2.4 Estuarine Biological Environment

2.4.1 Introduction

The Peel-Harvey Estuary supports a highly productive and diverse ecosystem which has been significantly affected by human activities in the Estuary and its catchments.

Substantial changes to the biota have been observed since the opening of the Dawesville Channel and more are expected with the change to a more marine system. The following sections describe the biota of the estuarine system.

2.4.2 Estuarine Flora

2.4.2.1 Seagrasses

Seagrass meadows are important components of the Peel-Harvey Estuary and are synonymous with an ecologically healthy Estuary. The decline in the health of the Estuary during the 1970's and 1980's was marked by a broadscale reduction of seagrass meadows and a concomitant increase in macroalgae (seaweed) and phytoplankton (floating algae). Figure 2.7 shows the current distribution of seagrass meadows in the vicinity of Point Grey.

The major species of seagrass near the west coast of Point Grey is *Halophila ovalis*, which forms dense meadows on the shallow sand banks. Smaller meadows of *Zostera mucronata* and *Ruppia megacarpa* are interspersed with the *H. ovalis* meadows. *Heterozostera* and *Lepilaena cylindrocarpa* have also been reported in other parts of the Peel-Harvey (Lavery *et al.*, 1995).

The marked improvement in water clarity, the reduction in nutrients and the winnowing of fine "ooze" sediments from the shallows on the west coast of Point Grey since the opening of the Dawesville Channel are expected to have significantly improved conditions for seagrass growth in this area. A steady increase in the distribution and density of seagrass meadows is considered likely. Point Grey, being directly opposite the Dawesville Channel, will be among the first to enjoy this benefit of the improved health of the Estuary. Preliminary observations indicate rapid spread of *Halophila ovalis* meadows on the sandbanks in the north-western part of the site.

On Point Grey's east coast and in Robert Bay, seagrasses are limited to patches of *Halophila ovalis* and *Ruppia megacarpa* (Figure 2.7). *R. megacarpa* meadows generally occur only in the shallows closest to shore. Epiphyte (attached algae) growth on seagrasses in this area is often heavy, but is likely to be reduced with the improving nutrient status of the Estuary.

Halophila ovalis is a resilient and dynamic species which is able to recover quickly from disturbance. *H. ovalis* meadows are often destroyed by wave action and salinity changes, but can rapidly re-colonise from sediment seed stocks and drifting fragments. However, mature meadows of *H. ovalis* take some years to form, and are a habitat of major importance in the estuarine ecology.

2.4.2.2 Macroalgae

Macroalgae in the Peel-Harvey Estuary are mainly unattached species of the genera *Cladophora, Chaetomorpha, Polysiphonia, Ceramium, Ulva* and *Enteromorpha,* which drift throughout the Estuary under the influence of wind and tidal currents.

Throughout the 1970s and 1980s, accumulations of decaying macroalgae (mainly *Cladophora*) on downwind beaches caused problems for residents around Peel Inlet. The biomass of macroalgae was usually much lower in the Harvey Estuary than in the Peel Inlet, mainly because low water clarity due to blooms of the blue-green alga *Nodularia spumigena* limited macroalgal growth in the Harvey Estuary.

The Dawesville Channel was predicted to increase the biomass of macroalgae, especially in the short term and in Harvey Estuary, as a result of increased water clarity. However, to date there has been no significant effect observed on the biomass of macroalgae in the Harvey Estuary (T. Rose, WRC, pers. comm.).

The clear water and clean sediments along the western beaches of Point Grey indicate that this coast is not frequently subject to the accumulation and decay of significant amounts of macroalgae. The shallows on the east coast of Point Grey are depositional and receive appreciable amounts of macroalgal detritus.

2.4.2.3 Phytoplankton

The phytoplankton assemblage in the Peel-Harvey Estuary is dominated by diatoms and blue-green algae (cyanobacteria). Phytoplankton concentrations and the frequency of blooms have historically been much higher in the Harvey Estuary than in the Peel Inlet.

Prior to the opening of the Dawesville Channel, blooms of the blue-green alga *Nodularia spumigena* were virtually an annual occurrence in both the Peel Inlet and the Harvey Estuary, and caused significant ecological and human health concerns. The dynamics and effects of *Nodularia* blooms are well described elsewhere (eg. Kinhill, 1988; Lavery *et al.*, 1995).

In the two years since the Dawesville Channel was opened, phytoplankton blooms have been limited to a few very small and isolated blooms of diatoms during the winter months, with no evidence of a summer bloom of *Nodularia* (Wilson and Latchford, 1995).

Although this apparent success of the Dawesville Channel can only be confirmed following several years of above-average rainfall (1994 and 1995 were both below average), it is fully consistent with the predicted effects of the channel (Kinhill, 1988).

2.4.2.4 Saltmarshes

Figure 2.8 shows the distribution of saltmarshes surrounding the Peel-Harvey Estuary. In the vicinity of Point Grey there is a large saltmarsh at the mouth of Robert Bay Drain, dominated by *Halosarcia* spp. Only minor areas of samphire occur along the western shore, the largest being along the southern edge of Stony Point.

The total area of saltmarsh vegetation surrounding the Peel-Harvey Estuary declined by 17% in the 37 years to 1994 (McComb *et al.*, 1995). The Robert Bay saltmarsh declined by 48%, from 155ha in 1957 to 81ha in 1994. This area was identified by the Waterways Commission (1992) as being ecologically significant and was recommended for retention, conservation and management.

2.4.3 Estuarine Fauna

Prior to the opening of the Dawesville Channel, the estuarine fauna of the Peel-Harvey Estuary was characterised by high abundances but relatively low diversity (eg compared with the Swan River or Leschenault Inlet). Detailed descriptions of the estuarine faunal assemblage are provided elsewhere (eg. Kinhill Engineers, 1988; Rose, 1992).

No data on the faunal assemblages of the Estuary have been published since the opening of the Dawesville Channel. The predicted effects of the channel were described in Kinhill (1988), which anticipated that the change to a healthier and less extreme environment (lower propensity for deoxygenation, less extreme salinity variations, improved water quality) would allow the incursion of additional marine species of animals, without significant detrimental effects. These conclusions were supported by evidence available from Leschenault Inlet, where a new channel had been cut to the sea in 1951, and from the Swan River Estuary, from which the bar and tidal delta had been removed in the 1890s. The fauna of both these estuaries are more representative of an ecologically healthy and resilient estuarine system than the pre-Dawesville Channel Peel-Harvey system.

2.4.4 Water Birds

2.4.4.1 Regional Perspective

Peel Inlet is listed as the fourth most important area in Western Australia in terms of the number of shorebird species for which it is internationally and nationally important (Watkins, 1993), and is recognised as the most important habitat in south-western Australia for waterbirds. It has Ramsar Convention listing as a wetland of international significance, and a number of reserves are located around its edge.

The high usage of the Peel-Harvey Estuary by waterbirds is the highest conservation value of the area. The protection of waterbird habitat from potentially conflicting uses is a primary aim of both the Peel Inlet Management Plan (Waterways Commission, 1992) and the Peel Regional Park Strategy (DPUD, 1993).

The Peel-Harvey Estuary normally supports more than 20,000 waterbirds, including 27 species cited in Japan/Australia (JAMBA) and China/Australia (CAMBA) Migratory Birds Agreements (Ninox, 1996). A significant portion of the Estuary is contained within a System 6 area (C51) which is recommended for reservation for conservation, including waterbird protection.

Eighty four waterbird and associated species have been recorded at the Estuary and its peripheral wetlands (Ninox, 1996). Surveys by the RAOU (Jaensch *et al.*, 1988) have recorded over 100,000 individual waterbirds using the Estuary during a single month. Seven species have been recorded breeding in the Estuary, including black swans, grey teals, black ducks and Australian Shelduck (Ninox, 1990). These waterfowl predominantly utilise the shallows of the eastern and southern shores of Peel Inlet and southern Harvey Estuary. Wading birds use these areas and the shallows of the northern shore of the Estuary as feeding grounds.

The Estuary is also considered to be important as a refuge area during drought conditions when inland wetlands dry out. Very high concentrations of wading birds, such as the banded stilt, have been recorded at the Estuary during such conditions.

2.4.4.2 Local Perspective

Previous reports have identified the Peel Inlet region as having high conservation significance to waterbirds, however no specific studies of the relative waterbird usage of the respective habitats of the Point Grey peninsula have previously been conducted.

In order to provide site-specific information, field surveys and scientific literature reviews were undertaken in April 1996 by Ninox Wildlife Consulting to assess the significance of the project site and adjacent estuarine environment for waterbirds (the complete vertebrate fauna assessment report is presented as Appendix D). The results of the surveys were combined with those undertaken by the Department of Conservation and Land Management (unpublished), South-West Waterbird Surveys (Jaensch *et al.*, 1988) and the Mosquito Control Review Committee (Ninox, 1990) to provide an extensive survey database.

Most, if not all, of the 84 waterbird species recorded to date in the Peel-Harvey Estuary are expected to occur at Point Grey (Ninox, 1996). However, because of the narrowness of the zone and the comparatively small area of habitat available, the abundance of most species around most of the site is low.

The most important waterfowl habitat in the Peel-Harvey system is the intertidal zone, which is the critical habitat for migratory waterbirds recognised by the Japan Australia Migratory Bird Agreement (JAMBA) and the China Australia Migratory Bird Agreement (CAMBA).

Whilst some waterbird activity occurs on the peninsula perimeter, by far the most important waterfowl habitat in the vicinity of the site is located at the extreme southern limit of Robert Bay where extensive intertidal flats provide feeding and loafing habitats. Most trans-equatorial migratory waterbird flocks congregate in this area. These intertidal flats are not proposed for development.

The lowest waterbird activity was recorded on the western edge of Point Grey, where waterbird numbers where estimated by Ninox (1990) as being one third that of the eastern shoreline.

The intertidal habitat at the peninsula's eastern shoreline is much narrower than around Robert Bay, and waterfowl congregation is principally associated with rocky points and areas where low limestone rocks emerge in shallow water, and where the shoreline

supports tree vegetation with dead limbs suitable for opportunistic perching. Common cormorant species and pelicans dominate these areas and migratory species are poorly represented.

Remnant fringing vegetation and a seasonal wetland in the vicinity of the lower reaches of Robert Bay drain support large numbers of ducks and swans in winter and is likely to provide protected refuge during high winds in the inlet. This area is not considered to have any significant value as a summer drought refuge.

2.4.5 Mosquito Breeding Habitat

Twenty two species of mosquito breed in the region, with two biting species (*Aedes camptorhyncus* and *Aedes vigilax*) causing the greatest nuisance. *Aedes vigilax* breeds in saltmarshes, with breeding limited by low temperatures and confined to the period November to April. *Aedes camptorhyncus* breeds all year round in saline, brackish or fresh water.

Both species are major vectors of epidemic polyarthritis (Ross River Virus). Both species lay desiccation-resistant eggs in dry saltmarsh wetlands which can lie dormant for indefinite periods until temporary stagnant pools are formed by tidal inundation. The eggs hatch within one to two days after inundation and larval development commences.

The rate of hatching and larval development is largely dependent upon temperature. The life cycle from egg to adult may be completed within approximately one week in summer, but may take three times longer in winter.

One of the critical conditions for mosquito development is the presence of shallow stagnant pools that persist for longer than 7-10 days in summer and from three to four weeks in winter. The area of mosquito breeding grounds within the Estuary has increased markedly since the construction of the Dawesville Channel, as a result of the increased tidal range. Development in accordance with the ODP will not result in the creation of additional breeding habitat.

Mosquito breeding grounds are surveyed and mapped frequently (up to 3 times weekly) by the Murray, Waroona and Mandurah local authorities. Helicopter spraying with the larvicide ABATE (Temephos) is carried out regularly (up to once per week) by the Health Department in areas identified as breeding sites by the surveys.

No regular surveying or spraying is known to be carried out in the area of Point Grey at present, however survey should be considered as the population of the area increases.

2.5 Social Environment

2.5.1 Landscape

Detailed investigations of the site's landscape characteristics have been carried out by a specialist Landscape Architectural Consultant in order to guide planning for the site. The full Landscape Analysis Report has been submitted to the Shire of Murray as part of the Planning Amendment document. This section summarises the findings of the Landscape Analysis.

The majority of the development is situated on cleared agricultural land and the landscape is predominantly pastoral.

The main landscape characteristics comprise areas of open pasture, open rolling parkland, wooded parkland and woodland. Generally, the more wooded areas are considered the more attractive, notwithstanding that open elevated ground often provides good views. The partially wooded slopes and areas of rocky outcrop also contribute strongly to the overall character of the peninsula.

The peninsula has a rich and varied shoreline. White sandy beaches, of which there are principally three, are a particular feature of the peninsula.

A large proportion of the western flank area is intricate and attractive in character. The north-eastern coastal flank is characterised by a sedge and samphire foreshore offering excellent distant views.

Other notable landscape features include rocky outcrops, areas of attractive vegetation and small wetlands.

Views of the peninsula can be seen from Florida (Estuary) to Dawesville and Parkridge, consisting mainly of the white beach line of the western bay and some open elevated land along the western flank.

Views of the peninsula, particularly the shoreline, can also be seen from the immediate Estuary and inlet surrounding the peninsula.

From most off-site areas the strong band of foreshore bush blends against a backdrop of skyline trees, giving an impression of near-continuous tree cover.

Views from the Old Coast Road and land to the west of the highway are not generally possible. Views from low-lying areas east of the Old Coast Road are only visible from the immediate shoreline.

Views from Mandurah, Coodanup and Yunderup are least significant due to the distances being greater than 6,500m. Similarly, views from the southern end of the Harvey Estuary are insignificant due to the distance.

Views from the hinterland east of Point Grey are difficult due to low elevation and heavy tree cover.

2.5.2 Foreshore Reserves

Existing publicly-owned foreshore comprising unvested Crown Land, CALM reserves and local authority reserves, is shown on Figure 2.9.

2.5.3 Existing and Proposed Conservation Areas

The Environmental Protection Authority's System 6 Red Book (DCE, 1983) identified parts of the Peel Inlet, Harvey Estuary and nearby lakes as important conservation areas.

The Red Book report made management recommendations relating to Peel Inlet (Recommendation C50), Harvey Estuary (C51) and Lakes McLarty and Mealup (Recommendation C52).

The important attributes identified by the EPA for these areas were their vegetation and value as waterfowl habitat, fish nurseries and recreation resources. The EPA's overall recommendation was that these areas, and others nearby, should be managed as a regional park. This recommendation is being progressively implemented.

In addition to the existing reserves and other land covered by the System 6 Recommendations, Reserve 2738 (Conservation of Flora and Fauna) is located on the shore of Harvey Estuary at Mealup Point.

The Peel-Harvey Estuary is included on the Register of the National Estate (Australian Heritage Commission, 1995; ANCA, 1993). The area listed includes all of the Estuary to high water mark, including System 6 Areas C50 and C51.

There are no existing conservation reserves in the proposed development area. However, in the Peel Inlet Management Plan (WWC, 1992) PIMA proposed the creation of an extensive foreshore reserve system in the Peel-Harvey Estuary (including parts of the Point Grey estuarine margins), based mostly on the reservation of existing Crown land. The PIMA proposals have yet to be implemented. Rezonings associated with the proposed Point Grey development will provide an opportunity and impetus for the foreshore reserve system proposed by PIMA to be further investigated and implemented where appropriate.

2.5.4 Aboriginal Heritage

Although ethnohistorical information indicates considerable movement of coastal Nyungar groups, the area south of Rockingham is thought to have been the territory of the *Banyowla* Aborigines of the *Pinjarup* tribe (McDonald Hales & Associates, 1994).

The Murray River Aborigines were decimated by disease and conflicts following European settlement of the area. The infamous 'Battle of Pinjarra', which resulted in heavy Aboriginal casualties, took place on the banks of the Murray River in 1834.

The mythology of the region is strongly associated with Wagyl, the Dreaming ancestor. Wagyl, usually manifested as a water serpent, created the Murray and Serpentine River systems and retains a presence in some deep pools of the area.

An archaeological and ethnographic survey of the proposed development area was undertaken in 1996. The findings of the study have been documented and will be submitted to the Department of Aboriginal Affairs in accordance with normal procedure.

The archaeological survey found no stone artefacts in the study area. One scarred tree was noted in the vicinity of the proposed residential village. The study recommends that the tree should be preserved, however acknowledges that if this is not possible, permission can be

sought under the *Aboriginal Heritage Act* (1972) for the tree to be removed. The site will be investigated with a view to incorporating the area into the overall design as public open space.

Consultation is currently taking place with representatives of the Nyungar people through The Winjan Aboriginal Corporation. As nominated sites occur within development areas of low density it is considered that the objectives of the Nyungar people can be achieved within the establishment of a programme to recognise and protect Aboriginal heritage in the relevant area.

3.0 DESCRIPTION OF THE PROPOSED SCHEME

This section describes the land uses and supporting infrastructure that will be incorporated as acceptable uses under the Special Development zoning proposed for the site.

The provisions of Town Planning Scheme No. 4 require that land zoned Special Development be the subject of an Outline Development Plan that "...indicates the manner of subdivision and development of the land". The provisions further require that the Outline Development Plan address a number of design issues to define road layouts, definition of land use (residential, commercial, open space, etc), pattern of subdivision, servicing of the land, landscaping and identification of vegetation.

Figure 1.1 presents the Outline Development Plan (ODP) for Point Grey that has been developed by TS Plunkett Pty Ltd. In general terms, the ODP incorporates residential allotments in a traditional village framework integrated with tourist orientated facilities associated with a waterside village, marina, sailing club, wilderness lodge and golf course. Rural-residential uses are proposed for the south of the site.

In excess of 30% of the site (362ha) is proposed as green space, combining areas for recreation, foreshore and conservation/sanctuary purposes. The sanctuary theme has been developed in response to the Proponent's clear desire to ensure future development recognises, conserves and enhances land use and environmental qualities of the site. The green space area does not include existing foreshores and government reserves (80ha), nor the 90ha golf course, nor the 10% public open space attributable to the residential development, all of which result in a total green space area at Point Grey in excess of 560ha, representing 45% of the total land area.

Table 3.1 lists the area and lot yield associated with each land use component.

Table 3.1
Land Use Elements

Land Use	Area	Lot Yield or Lot Equivalent
Tourism		
Wilderness lodge/chalets	12	50
Waterfront tourist village	56	350
Marina precinct	28	200
Harbourside tourist village	65	300
Golf course tourist estate	104	360
Sailing club	7	-
Golf course	90	-
Eco-tourist village	10	20
Residential		
Traditional neighbourhood village	220	1,500
Rural Residential		
Special-residential	83	200
Rural residential/ landscape protection	120	20
Conservation/Open Space	362	-
Waste Water Treatment Plant	2	-
TOTAL	**1,159**	**3,000**

All of the land use elements described in the following sections have been sited, scaled and engineered with the objectives of:

- preferentially utilising cleared land;
- protecting the existing landscape qualities, estuarine fringe and associated vegetation, flora and fauna habitats from direct and indirect impacts;
- meeting catchment management targets for phosphorus export for the foreseeable future; and
- meeting legitimate conservation objectives.

3.1 Residential Land Uses

3.1.1 Traditional Neighbourhood Village

A residential village is proposed for the site, centred on parkland-cleared or pastured land.

Covering approximately 220ha, the village will contain around 1,500 fully serviced residential allotments ranging in size from 500m^2 to 2,000m^2 and will be the residential core area of the site.

The village will be framed around a traditional neighbourhood centre and will contain community facilities including primary school, neighbourhood shopping and public open space.

Residential allotments will be located within 400m of the village centre (equivalent to a five minute walk), in order to encourage pedestrian transit in preference to vehicular usage.

Subdivision design will seek to yield maximum opportunities for energy efficient housing design.

The village will be connected to an extensive network of pedestrian and cycle trails around the perimeter of the peninsula established in accordance with foreshore reserve management objectives identified in consultation with the Water and Rivers Commission and the Shire of Murray.

3.1.2 Rural-Residential Retreat

The parkland-cleared land in the south of the site is considered to provide an ideal location for a rural-residential development node with strong emphasis on the retention of existing vegetation and maintaining landscape integrity whilst also carrying out selective clearing of understorey vegetation to create attractive vistas to the Estuary. Large trees will be retained to the greatest practical extent.

For the 203ha land area in this part of the site the following uses are proposed:

- 180 Special Residential lots at 1,200-3,000m^2 clustered around a small foreshore village at Mealup Point, fully serviced and covering around 83ha.

- 20 Special Residential lots at 4,000-5,000m^2 (unserviced). This small enclave is buffered to the north and south by conservation links reinforcing the objectives of the major conservation/sanctuary links to the north.

- 20 large Rural Residential/landscape protection lots, ranging in size from 1.5ha to 12ha to cover an area of 120ha (unserviced). The large lots will be provided with building envelopes. Strict development controls, including a restriction on fencing to protect the existing vegetation and the objectives of conservation, will be enforced.

Several rural-residential lots are also proposed for a parcel of land north of the proposed entry road in the site's most easterly extent.

3.2 Tourist Facilities

The tourism component of the Outline Development Plan is principally located on the northern section of the peninsula and comprises over 30% of the site.

An opportunity exists for a high-calibre tourism experience to be provided through the integration of sensitively designed development and linkages to the extensive foreshore and remnant vegetation areas across Point Grey. Eight separate tourist precincts are identified and discussed below.

3.2.1 Wilderness Lodge/Chalets

An area of land totalling approximately 12ha has been identified for a wilderness lodge and associated chalets. The site is located on the north-west point of the peninsula. The important landscape and environmental qualities at the far north-east end of the site will be protected within private conservation areas and foreshore reserves. The development will incorporate the preferential use of previously degraded or cleared land and the restriction of additional clearing to an absolute minimum, consistent with the desire to nestle new buildings within the vegetation to provide visual screening from surrounding areas.

Landscape and vegetation analyses have been carried out to identify potential building sites and architectural parameters that would allow the establishment of this facility whilst properly managing and maintaining landscape and environmental qualities. In addition,

the facility's location has been modified to reflect the findings of the Aboriginal Heritage Study to ensure minimal disturbance to the Point. Consultation continues with representatives of the Winjan Aboriginal Corporation.

3.2.2 Waterfront Tourist Village

A tourist village orientated to the 'weekender' market is proposed on the western foreshore of the peninsula. The village will integrate residential and tourist components within a waterfront community.

The design proposes a modified grid layout, promoting strong pedestrian links to the waterfront through the incorporation of the road system linked into a series of boardwalks. The existing foreshore vegetation will be retained, with boardwalks providing access to the recreational opportunities (both active and passive) afforded by the beach and foreshore. Provision is made for a possible jetty which could provide a pedestrian link between the beach and one of two artificial islands (Section 3.2.3).

The waterfront tourist village comprises an area of approximately 56ha and will yield approximately 350 lots. Residential lots range from 450m^2 near the foreshore reserve and along the radial 'spines' to 1,000-1,500m^2 on the outer edges.

3.2.3 Marina Precinct

A marina is proposed for a site at the base of a promontory on the north-west flank of the peninsula. The proposed marina precinct covers 28ha of land including around 4.7ha of marina basin and pen areas, created by excavation into the shoreline. The marina will have moorings for around 400 vessels with a design size of 8-15m. Figure 3.1 presents the concept plan for the marina precinct.

The site for the marina has been selected following detailed landscape and planning assessment with particular reference to the important environmental features of the fringing vegetation and shallow estuarine margins. The starting point for planning was taken from the Peel Inlet Management Program published by the Waterways Commission (WWC) in 1992.

Testing of the notional plan presented by the WWC found that a superior site for a marina existed to the south of WWC's indicative site. An important factor in the preference for the alternative site was the comparative minimisation of disturbance to shoreline vegetation

and shallow water seagrass habitats. Conceptual design work has proceeded based on the use of this preferred site.

The existing natural depths in the Harvey Estuary permit navigation by shallow draft vessels only. The location of the proposed marina complex requires the dredging of an access channel to deeper water and into the Dawesville Channel to permit access to the ocean. The dredged depth of this navigation channel will be at 2.5m below chart datum, ie 1.0m greater than the draught of the design vessel. The channel will be constructed in accordance with engineering standards applied by the Department of Transport.

The marina entrance channel will be dredged by a cutter-suction dredge. Dredge spoil will be piped to the already-constructed marina basin, which will be temporarily bunded to contain the spoil. Some of the spoil will subsequently be used to create two new habitat islands, located in shallow water immediately offshore from the marina (Figure 3.1). The islands will be constructed to a level of approximately 1.75m above high water, covered with topsoil and planted to provide a suitable habit for local bird species. This will balance the loss of subtidal habitat in the creation of the marina. The islands will also fulfil a useful role as a protective barrier for the marina and a visual barrier from the west side of the Estuary.

An indication of the likely success of the artificial island habitats can be gained from Boundary Island in Peel Inlet, which was created in the late 1980's from dredge spoil during the dredging of the Mandurah Channel. In 1996, Boundary Island was reported to support a healthy foreshore vegetation community and a large number of waterbirds, including approximately 230 breeding pairs of Pelicans (DEP, 1996).

The islands will occupy approximately 17ha of the Harvey Estuary bed with about 6ha above high water level. A possible jetty could provide pedestrian access to the smaller of the two islands, linking the island to the Estuary foreshore. The detailed design specifications for the two islands will be determined in consultation with CALM and PIMA prior to construction so as to optimise the ecological value of the island habitats.

Land use elements associated with the marina will include a resort hotel, serviced apartments and commercial development providing for an ultimate lot yield equivalent of 200 lots. These land uses will extend into higher land surrounding the marina basin.

The marina will be fully serviced with fuel, water supply, sullage pump-out and other necessary facilities.

3.2.4 Harbourside Tourist Village

An area of 65ha adjacent to and rising up the promontory provides the opportunity for a range of lot sizes for terraced housing offering views over the harbour. The harbourside village will be focused on the marina, however it will also have strong visual and pedestrian links to the waterfront tourist village and the traditional neighbourhood village.

It is intended that the harbourside tourist village will facilitate the requirements of the tourist/weekend market where the emphasis is on boating and accessing the natural resources of the Peel-Harvey Estuary. Lot sizes will range from 250m^2 close to the marina to 2,000m^2 in more heavily vegetated areas.

3.2.5 Sailing Club

A sailing club for shallow-draft yachts is proposed for a 7ha location on the north-eastern shore of the peninsula. Figure 3.2 presents the design concept for the Sailing Club.

Plans for the sailing club emphasise siting for minimal impact to existing fringing vegetation and shallow estuarine habitats and have been derived following testing and adjustment of indicative plans published in the Peel Inlet Management Plan (WWC, 1992).

Land use elements include a club house, apartment style accommodation, a sandy beach and a shallow draft launching ramp. The plan includes provision for replanting of local species along the foreshore to guard against erosion.

3.2.6 Golf Course

An 18-hole tournament standard golf course is proposed for a natural valley system located in the north of the site totalling 90ha. In addition to attractive contours for golf, this area offers the benefit of good soil profiles and water table separation for nutrient management, which presents an opportunity to use treated effluent for irrigation and achieve the triple purposes of golf course irrigation, fertilisation and effluent disposal.

It is also intended to retain and restore Tuart vegetation in the areas between fairways. This vegetation type has landscape and conservation importance but has been largely lost due to agricultural land use.

The re-establishment of Tuart vegetation within the golf course is considered to be an important conservation benefit of the project.

3.2.7 Golf Course Tourist Estate

The golf course tourist estate provides for tourist housing located around the proposed golf course. Covering an area approximately 104ha, it will provide a range of lot sizes from 500m^2 to 2,000m^2. The development areas are located on the uplands providing views over the golf course as well as north over the Peel Inlet. The variable lot sizes provide for an ultimate lot yield of approximately 360 lots.

3.2.8 Eco-Tourist Village

An eco-tourist village of approximately 10ha is proposed on the wetland margin adjacent to the proposed Robert Bay wetland. The 10ha area is not suitable as wetland, being elevated ground over 2m AHD. Given its location and that it is easily serviced, it is therefore a logical choice for an eco-tourist development site. It is intended that development be low-key, providing a vantage point for controlled access to the constructed wetlands within an overall ecological experience. The plan also provides for a future environmental research facility in this area. The wetland margin of the village will take the form of elevated platform chalets, thus taking advantage of the unique setting and views whilst minimising intrusion into views, vegetation and wildlife at the water's edge. The equivalent of only 20 lots is proposed for the eco-tourist village.

3.3 Conservation Areas

More than 30% of the site (362ha) is proposed as green space, combining areas for recreation, foreshore and conservation/sanctuary purposes (Figure 3.3). (This 362ha of green space area is in addition to existing foreshores and government reserves (80ha), the 90ha golf course, and the 10% allocated to public open space within the residential development, all of which result in a total green space area at Point Grey in excess of 560ha, representing 45% of the total land area (Figure 3.3)).

The generous provision of green space within the development will assist in the retention of the site's essential landscape character as well as modifying and softening visual impacts from off-site and ensuring the peninsula retains its character and identity within the Peel-Harvey region.

3.3.1 Foreshore Areas

A near-continuous foreshore green space system will be maintained around the shores of the peninsula. The only significant breaks in the green space will be at the marina and sailing club. The system of foreshore green spaces forms part of the proposed total green space areas as shown on Figure 3.3.

The foreshore green space system will incorporate existing crown land and government reserves, and will be complemented by adjacent areas with good vegetation and linkages between the foreshore and inland green space areas.

The foreshore green space system will have conservation and landscape protection as priorities. Recreation and public access will be managed to complement these priorities.

3.3.2 Foreshore Access

In accordance with the general objectives of the Peel Inlet Management Authority, important foreshore access points are proposed in the ODP. Foreshore areas are best accessed by greenway linkages into the main body of the peninsula at certain key points, usually offering good views.

Access to the foreshore surrounding Point Grey is provided by the eco-tourist/heritage trail which provides pedestrian and cyclist access along a parkway system of some 15km. In relevant areas the alignment of the trail will facilitate the management of Aboriginal heritage values at Point Grey.

The foreshore trail is integrated with the pedestrian/cyclist movement system throughout the ODP area and, combined, provides a continuous system in excess of 20km. Major access points to the foreshore are provided at Mealup Point foreshore village, through links provided by the open space valleys of the residential village, at the marina, by the boardwalks at the waterfront tourist village, at the sailing club and from the 1.5km foreshore road along the north-eastern foreshore.

3.3.3 Robert Bay Drain Rehabilitation

Although the Robert Bay drain is outside the ownership and control of the developer or the Shire of Murray (it is owned by the Water Corporation), an opportunity is seen to improve the nutrient stripping, ecological and drainage functions, landscape amenity and water re-

use potential of the drain by the construction of an artificial wetland system at the drain's point of discharge into the Peel Inlet.

A landscape restoration and water management concept for the low-lying cleared land and remnant wetland areas adjacent to the drain has been developed and is presented on Figure 3.4. The concept recognises the area's location in relation to the proposed new entry to the development and the adjacent Robert Bay foreshore. The landscape restoration and water management objectives for this area derive from this location context as well as the environmental attributes of the area, and include:

- preserving and restoring the remnant wetland characteristics of the site;
- integrating the remnant wetland character with a landscape restoration plan which is based upon and extends the area's natural characteristics;
- allowing for a new access road through the area to be constructed;
- development of a design concept for the Robert Bay drain to be re-routed into the property as the water source for a system of constructed wetlands which will be designed for landscape and recreational amenity, waterfowl habitat function, and improvement to the quality of drainage water which presently discharges through the Robert Bay drain into the Estuary;
- staged construction of the wetland system, commencing with landscaping for entry area purposes, and drainage management for mosquito control whilst protecting the wetlands;
- identifying options to implement sophisticated wetland design for specific environmental management purposes including the removal of nutrients and other contaminants, creation of habitat for important waterfowl and other local fauna;
- incorporation of the requirement for control of potential mosquito breeding areas in the design of the constructed wetland system and in its maintenance; and
- identifying land use potential for adjacent land which would be created by these new features, and development of a land use concept plan.

The wetland system would create an attractive entry to the Point Grey development, and the lake system would also perform a significant function in 'polishing' the Robert Bay drain outflows, which currently are believed to discharge a significant load of nutrients to the Estuary, particularly in the 'first flush' phase of early winter.

The water quality of the Robert Bay drain outflow would be improved by incorporation of settling basins, screens and shallow vegetated wetland areas which would be designed to remove a significant portion of suspended solids, nutrients and organic loadings from the winter outflow.

If constructed, the lake system would be arranged in hydraulic connection with the existing natural groundwater to assist lake permanency and the stability of water levels. Water would be progressively drawn from the downstream end of the lake system during late winter and pumped to a nearby impermeable storage pond. During summer, water would be pumped from the storage pond back into the lake system, and also used for golf course irrigation.

Implementation of the constructed wetlands concept plan would be possible only following further technical validation and when discussions with authorities regarding acceptable funding for construction, long term maintenance and staging of management responsibility were satisfactorily resolved.

3.3.4 Private Conservation Areas

Substantial areas of land have been set aside under the ODP as private conservation areas. The main areas are:

- the north-east corner of the peninsula (approximately 25ha) adjacent to the proposed Wilderness Lodge; and

- a large area of approximately 95ha located in the south of the site between the Traditional Neighbourhood Village and the Mealup Point Village.

These areas, while remaining in private ownership rather than being made formally part of reserves, will be managed in perpetuity for the purpose of conservation. They will provide valuable linkages between foreshore reserves and other conservation areas. The larger southern area, in particular, will provide a continuous conservation link across the base of the peninsula between the foreshores of the Peel Inlet and Harvey Estuary.

The private conservation areas will be managed in accordance with a Foreshore and Conservation Reserve Management Plan, which will be prepared in order to facilitate the management of the overall conservation reserve system at Point Grey.

3.4 Services and Infrastructure

3.4.1 Access Road

Point Grey is located 17km from the South-West Highway and is currently accessed via a variety of sealed and unsealed roads constructed in the Greenlands and Carrabungup Road reserves.

Traffic engineering investigations of likely traffic volumes generated by the development have concluded that an ultimate 7,600 vehicles per day are likely when the development is fully developed with a population of approximately 7,000.

Investigation of route alternatives has concluded that there are two suitable route options (refer Figure 3.5):

- existing Greenlands/Carrabungup Road route; or
- Greenlands/Edges/Carrabungup Roads.

A final decision on the preferred route will be made following more detailed investigation and further consultation between TS Plunkett Pty Ltd and the Shire of Murray.

Based on traffic volume estimates, the ultimate access road will be a 6.8m sealed rural standard pavement, although the existing 6.2m wide sealed section of Greenlands Road will be adequate for short to medium term traffic volumes.

Both access route options will require land resumption in order to provide large radius bends suitable for design speeds up to 110km/hr. The Greenlands/Carrabungup Road route option would involve resumption of approximately 4.9ha, mainly at the inside corner of Greenlands and Carrabungup Roads. The alternative route via Edges Road would require resumption of approximately 0.8ha of land.

Access road construction will involve, in places, the modification of existing table drains and construction of new drains as necessary to maintain a satisfactory level of safety from flooding of the pavement. Existing culvert and bridge crossings of main drains will generally require widening to accommodate the wider road formation, and within Edges Road will require construction of new culverts and a minor bridge crossing of a drain. Road drainage and culverting will be designed to preserve the existing hydrology. In the future, if the Peel Deviation Highway is constructed, Greenlands Road will be incorporated as a formal interchange and will provide improved access to the site.

3.4.2 Energy and Telecommunications

Power Supply

Western Power has advised that a 12.5km extension of 3-phase power will be required to service the Point Grey development. Underground distribution of power services within the Outline Development Plan area will not pose any problems. The supply route will follow the main access road route.

Gas Supply

AlintaGas has advised that extension of a reticulated mains gas service to the development site is not currently viable. The viability of provision of gas to the development will be evaluated by the developer at a later time. As gas supply is not considered an essential service, the timing of supply is not considered important at this time. Ducting of future gas pipeline road crossings will be undertaken at the time of road construction to avoid later disturbance.

Telecommunications

Telstra has advised that telecommunications connection of the site will be via optic fibre cable along the main access road route on conventional alignments inside the road reserve.

Within the ODP area the underground route for optic cable will be selected to minimise interference with existing vegetation.

3.4.3 Water Supply

The two principal uses of water within the development will be for potable uses in the residential areas and for irrigation in the residential areas, tourist facilities, golf course and public recreation areas.

Water supply planning for the development was based on the principle that the water supply should be drawn from the site provided that water quality objectives for potable water could be met and that groundwater quality and local wetlands important for conservation were not detrimentally affected.

Accepted groundwater investigation and modelling techniques were employed to examine the potential for underlying aquifers to supply sufficient water of acceptable quality whilst meeting environmental objectives for the Superficial aquifer. The findings of these investigations are summarised below.

3.4.3.1 Potable Water

Production and monitor bore installation, stratigraphic borehole logging and pump testing investigations carried out on the property during 1995 and 1996 confirmed the existence of an upper potable horizon within the Leederville Formation at a depth of approximately 80m (upper Leederville aquifer), and a deeper potable horizon at a depth of 140 to 160m above the green clay marker horizon which separates the upper and lower parts of the Leederville aquifer.

In 1988 an earlier proposal for sourcing of potable water from the Leederville aquifer for a development of the Point Grey site for a population in excess of 9,000 was rejected by the EPA because, among other reasons, the water source had not been subject to detailed investigation and consequently was considered to be not adequately proven.

As a result of recent hydrogeological investigations employing advanced computer modelling calibrated with input from on-site test bores and other pertinent regional information, it has been concluded that a sustainable potable water supply can be provided to serve the ultimate development from the Leederville aquifer below the site.

The following demand/consumption figures have been applied in the engineering and hydrogeological analyses of potable water supply factors:

- peak consumption of 1.14kL/person/day and average consumption of 0.43 kL/person/day;

- population increase rate of 300 persons/annum, reaching total projected population of 7,000 between years 23 and 24; and

- peak demand at population of 7,000 totalling 8000kL/day and average demand of 3000kL/day.

The demand schedule used for modelling studies is set out in Table 3.2.

Table 3.2
Projected Total Potable Water Demand

Year	Population	Peak Day Demand (kL/day)	Average Day Demand (kL/day)	No. of Wells
1	300	342	128	1
2	600	684	257	1
3	900	1026	385	1
4	1200	1368	514	2
5	1500	1710	642	2
6	1800	2052	770	2
7	2100	2394	899	2
8	2400	2736	1027	3
9	2700	3078	1156	3
10	3000	3420	1284	3
12	3600	4104	1541	4
14	4200	4788	1789	4
16	4800	5472	2054	5
18	5400	6156	2311	5
20	6000	6840	2568	6
22	6600	7524	2825	6
24	7000	8000	3000	6
26 - 50	7000	8000	3000	6

The Water Corporation has recently advised that it may be able to supply mains water to the development, but at this time is not in a position to more closely evaluate viability. The viability of this optional supply will be evaluated when detailed information is available from the Water Corporation. In the meantime, planning is continuing based on the use of Leederville aquifer groundwater.

The groundwater resource will be progressively developed by utilising bores located across the south end of the Point Grey peninsula to harvest the Leederville aquifer through-flow. Each bore will deliver approximately 500 to 600m^3 per day on average, with the ability to supply water at rates of up to 1,100m^3 per day during peak demand. This will comfortably meet average daily demand and will draw from aquifer storage during peak daily demand.

Close monitoring of the borefield performance will be necessary to optimise borefield operations so as to maximise water quality, minimise interference between bores, locate future bores with best efficiency and monitor short, medium and long term borefield effects. Ultimately, it is expected that a total of six production and two standby bores will be required.

Water treatment applied to the bore water supply will include some or all of the following:

- chlorination (probably from a 75kg bottled chlorine gas supply);
- fluoridation using sodium fluorosilicate or similar;
- aeration to remove dissolved iron;
- reverse osmosis desalination of a part of the supply (if required), to ensure that dissolved salts stay well within Office of Water Regulation and Health Department standards; and
- pre-treatment prior to reverse osmosis, including sand filtration, acid dosing, anti-scalant dosing, cartridge filtration and degassing.

Chemicals kept on site for water treatment will include:

- chlorine gas;

- sodium fluorosilicate or similar;
- small quantities of sulphuric acid;
- polymath antiscalant; and
- cleaning chemicals for reverse osmosis (mainly acetic acid and sequestering agents).

The storage and handling of these chemicals will comply with all relevant regulatory controls including Dangerous Goods Regulations (for chlorine) and EPA Licences. Liquids likely to have environmental impacts if spilled will be stored and used within sealed, bunded enclosures.

The layout of potable water supply headworks is shown on Figure 3.6. Water supply infrastructure will be progressively constructed as development expands commencing with two upper Leederville production bores at test bore site PCPB1 and possibly Miami 1/80 supplying up to 500kL/day as a first stage, and with complementary storage, treatment and reticulation pipework.

3.4.3.2 Irrigation Water

The proposed development will require a significant supply of water for irrigation of the golf course and landscape vegetation during the 180 to 200 days of the year when evaporation exceeds rainfall. A preliminary estimate of irrigation water requirements is presented in Table 3.3. The major elements of the irrigation water system are shown on Figure 3.7.

Table 3.3
Preliminary Estimate of Irrigation Water Requirements

Stage		Usage m^3 pa.		
		Landscape	Golf Course	Total
Initial	Year 1-5 (including 9 hole golf course)	100 000	250 000	350 000
Medium Term	Year 5-15 (including 18 hole golf course)	150 000	350 000	500 000
Long Term	Year 15-20+	150 000	350 000	500 000

Five potential sources of irrigation water have been evaluated in order to identify the source which can meet irrigation needs in terms of availability and quality while reserving the highest quality water sources for potable use and minimising the environmental impact of irrigation. These are:

- treated wastewater;
- groundwater (Leederville aquifer);
- rainfall from the Robert Bay drain catchment;
- groundwater (Superficial aquifer); and
- surface run-off from developed areas of the site.

Of the above five potential water sources, Superficial groundwater and surface run-off from developed areas are considered not sufficient and/or reliable as sources of water for the whole of the irrigation requirement, but may be used as supplementary sources depending on viability.

The approximate volumes of water available from the three other identified sources are listed in Table 3.4.

Table 3.4
Estimate of Water Volume Available for Irrigation

Source	Volume	Comments
Wastewater Effluent	280 000 m^3	7000 people, 200 days supply
Leederville Aquifer	440 000 m^3	4 bores at 550 m^3/day for 200 days
Robert Bay Drain Catchment	500 000 m^3	Assuming maximum 50% of estimated 1-2 million m^3 run-off pumped to storage during winter for summer re-use.

Of these three sources, treated effluent is ideally suited to irrigation of the golf course fairways and greens, where the nutrients in the effluent are an asset and will reduce the requirement for imported fertilisers. The main disadvantage of this source is that the volume available will be relatively minor in the first few years of development and will require a significant supplementary source to provide the majority of the irrigation water volume.

Investigation of the Robert Bay drain catchment has shown that the catchment is a significant source of run-off, which is collected and transported from the catchment via the existing Robert Bay drain system. The current owner of the drain, the Water Corporation, has advised that it has no objection to the diversion of the downstream end of the Robert Bay drain and the storage and re-use of part of its yield (as shown on Figure 3.7), provided the primary drainage function is not affected.

Investigation of maximum and normal backup levels in the drain has indicated that there would be no change in the existing catchment drainage function if the drain were diverted through a wetland system.

From analysis of flow records from the Robert Bay drain itself and similar and neighbouring catchments, the total catchment area of 13km^2 is estimated to annually yield from 900,000m^3 to over 2,000,000m^3 of outflow for approximate 1 in 10 year recurrence 'dry' and 'wet' years respectively, with virtually all of this outflow occurring May to September.

The use of water from the Robert Bay drain for irrigation would have the environmental advantages of:

- recycling a wastewater stream which is presently unused; and

- intercepting a surface water flow to Robert Bay which occurs under artificial conditions (ie constructed surface drain) and carries an annual load of nutrients which contributes to the excessive nutrient loadings currently entering the Peel-Harvey Estuary.

Sourcing of irrigation water from the Leederville aquifer below the site is the main alternative to using Robert Bay drain water until treated wastewater effluent quantities become significant. Hydrogeological investigation has concluded that there is good

prospect of obtaining a supply of sub-potable (800-1,200mg/L TDS) water in sufficient quantity from below the centre of the development .

There is potential for a degree of interference between the irrigation and potable water borefields, depending on their separation, yield and the hydraulic characteristics of the Leederville aquifer between the two borefields. Ongoing monitoring of aquifer behaviour and bore influence as both borefields are progressively developed should ensure the fields are developed without significant interference, but if necessary irrigation borefield operation would be modified.

Both the Leederville aquifer and Robert Bay drain catchment sources are potentially capable of supplying the whole of the irrigation water requirement for the development from year one up to full development. Future ongoing monitoring of both sources may provide greater confidence to select one source in preference to the other, but at the current state of knowledge, it is considered that a combination of both sources will provide a secure source of irrigation water safeguarded against drought years and other variables such as variation in bore water salinity.

3.4.4 Wastewater Treatment and Disposal

All wastewater, including sewage, from the Point Grey development will be collected, treated and disposed within the site on a self-contained and sustainable basis.

Figure 3.8 shows the layout of the principal components of the proposed sewage collection and treatment system. The system is summarised below.

The small number of lots over 4,000m^2 within the rural-residential development in the southern most area of the Point Grey site will dispose of sewage using appropriate domestic on-site systems such as septic tank/leach drain systems or alternative treatment units including approved amended soil modified leach drain systems and aerated treatment units. Groundwater levels and the type and depth of soil medium over this part of the site are well suited to sustaining on-site disposal without hydraulic, nutrient or health problems.

The majority of the site, including all of the more densely developed areas, will be serviced by a reticulated sewer network which will operate by gravity or, where landform dictates, vacuum sewers and/or pump stations. The design, construction and operation of the

sewerage system will comply fully with relevant Water Corporation and Health Department requirements.

The reticulated sewerage network will be serviced by a state-of-the-art tertiary treatment plant located in the south-east of the project site (Figure 3.8) within a 500m buffer zone.

The sewage treatment plant will incorporate Biological Nutrient Removal (BNR) to achieve maximum phosphorus removal from the effluent. Biological Nutrient Removal is a well proven though relatively recent innovation in wastewater treatment that is ideally suited to the circumstances of the Point Grey site.

As an additional feature to safeguard against any possible temporary shortfall in biological nutrient removal, standby chemical dosing will be provided to minimise phosphorus carry-over into the final effluent. Table 3.5 shows typical values for incoming sewage and treated effluent.

Table 3.5
Sewage Treatment Performance

Contaminant	Concentration	
	Raw Sewage	Treated Effluent
Suspended Solids (ppm)	200-250	< 10
Biochemical Oxygen Demand (ppm)	220-250	< 10
Total Nitrogen (ppm)	30-50	5 max
Total Phosphorus (ppm)	8-10	1 max
Flow (m^3/day)	1,500	1,500

Treated effluent will initially be used to irrigate eucalypt woodlot areas adjacent to the treatment plant site. When effluent quantities justify, effluent will be used to irrigate the golf course during the growing season, with disposal to the woodlot areas during the winter season.

Chemicals used in the treatment process will include alum (or similar), sodium hydroxide and chlorine gas (or sodium hypochlorite). All chemicals will be stored and used in strict accordance with relevant regulatory controls including Dangerous Goods Regulations and EPA Licences.

Sludge from the treatment plant will be thickened and dewatered to produce a sludge cake. The dewatered sludge could be used for landscape soil in selected areas of the development or disposed of at the Shire's solid waste disposal site. The amount of sludge produced at full load 7,000 population will be around 1.5m^3 per day after dewatering.

Odour generation from the treatment plant has been modelled utilising local meteorological data. Figure 3.9 shows the predicted density of odours and their spread. There is a tendency for the odours to be extended in a northerly direction due to the prevailing winds. The seven odour unit contour is accepted by the Water Corporation as the limit of odour acceptance and this corresponds to a 500m buffer distance in the direction of proposed residential development, which has been allowed in the planning.

If surface aerators are employed during sewage treatment, their use will be controlled so that aerosols will not be transported beyond the plant area during periods of high wind.

In the event that development of the tourist/resort area at the north of the site commences at an early stage, a temporary wastewater treatment facility may be installed at the location identified on Figure 3.8. Utilisation of a temporary treatment plant will depend on a viability assessment at the time, with the temporary facility being utilised until the main gravity sewer draining to the permanent treatment plant is sufficiently extended to the north. Temporary treatment, if employed, will likely be of by means of a ìpackagedî treatment plant located within a 500m buffer from residential/tourist/resort areas. Treatment will be to secondary standard or higher, with chemical dosing for phosphate removal and disinfection to ensure that the bacterial and nutrient standard of the effluent is suitable for disposal to the adjacent golf course.

Discussion with the Water Corporation, Water and Rivers Commission and the Office for Water Regulation has confirmed that there is now an opportunity for the private sector to participate, under licence, in the medium and long term operation and maintenance of water supply and wastewater infrastructure in competition with the Water Corporation (previously the Water Authority). The Water Corporation has also indicated its interest in treating and disposing of Point Grey wastewater at the Corporation's future Tims Thicket Wastewater Treatment Plant, via a rising main across the Harvey Estuary. The viability of this alternative will be evaluated when a more detailed assessment is undertaken by the Water Corporation.

At an appropriate time investigations will be conducted regarding the feasibility of contracting the operation and maintenance of water supply, wastewater collection,

treatment and disposal and potentially the lake/artificial wetland area, to a single manager. It is considered that management by a single operator would encourage efficient management of the site's water and nutrient balance.

3.4.5 Stormwater Disposal

Stormwater drainage design for the site will employ water sensitive design principles to maximise the efficient reuse of runoff and the minimisation of pollution. Drainage design and construction standards will conform to Shire of Murray requirements.

Stormwater runoff from roads in developed areas will be collected in gullies and piped to recharge basins strategically located to maximise beneficial re-use of the stormwater for irrigation and groundwater recharge. A significant portion of the stormwater runoff from east of the ridge line will be directed to soakage areas immediately west of the wetland area to maximise recharge of the wetlands during summer, and to inhibit seepage loss of lake water during winter.

The recharge basins will be of sufficient size to retain the predicted runoff from a 1-in-10-year 72-hour storm for at least 3 to 4 days.

Disposal of runoff from roofs and other impermeable areas within residential lots and resort/tourism areas will be largely achieved within the lots by means of soakwells.

Recharge basin area loadings will be designed to achieve more than 200 years' phosphorus storage in the subsoil. Results of research into the site's soil loading characteristics indicate that a total disposal area of approximately 7ha will be sufficient to satisfy hydraulic and nutrient loading requirements for stormwater run-off from the development. These areas can be easily accommodated within and around the downhill perimeter of the development nodes.

In areas where re-use of stormwater from soak basins is not viable or not required, manholes in the upstream catchment area will be designed to maximise local soakage disposal.

Hydrogeological analysis confirms that the height of groundwater mounding beneath soakage disposal areas is not likely to exceed 0.5m under normal surcharge loadings during the winter months. As a consequence, soak areas will be able to be utilised

relatively close to the Estuary waterfront, thereby enabling run-off from almost the entire development site to be collected and disposed via recharge basins.

Stormwater run-off from within the immediate perimeter of the marina will be drained to the Estuary via suitably sized triple interceptor traps to capture oil and other floating pollutants and the majority of settleable solids.

4.0 ENVIRONMENTAL IMPACTS AND MANAGEMENT

This section is structured with direct reference to the environmental factors relevant to the scheme identified in the EPA's Environmental Review Instructions for this amendment (Appendix A).

The discussion of key issues provided in this section addresses each environmental factor under the following headings:

(i) EPA Objective - as discussed in the Environmental Review Instructions.
(ii) Potential Impacts - including direct and indirect impacts of land uses permitted under the scheme and proposed in the ODP.
(iii) Environmental Management Strategy and Management Plans - describes how impact minimisation has been integrated in the project design or will be mitigated during construction and operation phases of development.
(iv) Environmental Management Recommendations - provides a cross-reference to specific environmental management recommendations and TPS Provisions, as listed in Section 6.0, which are designed to address the EPA objectives for each factor. Section 6.0 summarises the scope, detail and term of each management recommendation.

4.1 Vegetation

4.1.1 EPA Objective

For Reserves 2738 and 2707 and System 6 areas C51 and C52:

(i) Protect vegetation in the existing and proposed conservation estate from direct and indirect impacts;

(ii) Maximise or increase the area of vegetative cover consistent with landscape requirements and the Catchment Centre planting guidelines.

4.1.2 Potential Impacts

(i) Conservation Reserves

Figures 4.1 and 4.2 show the locations of Reserves 2738 and 2707 and System 6 areas C50, C51 and C52.

The Point Grey development will have no direct physical impacts on the System 6 areas or conservation reserves adjacent to the development. In particular, upgrading and realignment of access roads required for the development will take place within existing road reserves.

Indirect impacts on conservation areas could arise, mainly as a result of the increased human presence in the area. It is noted that most of these are increases in existing impacts, which are currently largely unmanaged. The types of indirect impact that could arise include:

- drainage alterations and edge effects (including increased susceptibility to dieback and weed invasion) outside the road reserves that cross System 6 Area C50 and Reserve 7502;
- "wear and tear" due to increased pedestrian traffic, mainly around foreshores and wetlands;
- impacts on shallow estuarine flats from crabbers, fishers and prawners;
- impact on shallow estuarine areas from increased boating traffic (including boat wash, exhaust fumes, litter, etc);
- disturbance of birds and other fauna by wandering domestic cats and dogs (generally confined to the close proximity of the residential areas);
- increased risk of fire, either accidentally or deliberately lit;
- introduction of dieback; and
- illegal dumping of garden refuse.

(ii) Vegetation Cover

Development of Point Grey as proposed by TS Plunkett Pty Ltd will not require significant vegetation clearing as, for the majority of land uses proposed, adequate cleared land with suitable characteristics is available.

Specific areas where clearing is proposed include the following:

- In the wilderness lodge precinct, approximately 1ha of Banksia woodland and thickets of Acacia and Spearwood vegetation is proposed to be cleared in around 20 chalet sites of 300m^2 and along the proposed access road alignment.

- At the waterside community a series of pedestrian "boulevard" connections is proposed between the village (which is set in cleared land) and the Estuary shore. For these boulevards to connect to the foreshore, around 1ha of Banksia woodland vegetation will be cleared to provide for a series of pedestrian walkways to the shore.

- Construction of the marina will require the removal of around 2ha of Eucalypt/Banksia woodland and Spearwood thicket, in order to provide a clear link between land-based facilities and the Estuary.

- The harbourside residential precinct will involve the clearing of around 4ha of parkland-cleared and stock-damaged banksia woodland;

-

- For the Point Mealup special residential area, within around 50ha of land proposed for this land use, approximately 20% of the existing parkland tree vegetation is expected to be cleared, totalling 10ha of clearing.

The total area of vegetation proposed to be cleared in these above locations is estimated at 18ha which is approximately 1.5% of the total site area.

4.1.3 Environmental Management Strategy and Management Plans

(i) Conservation Reserves

The importance of existing conservation reserves has been acknowledged, and the recommendations given in the Peel Inlet Management Programme (WWC, 1992) and the System Six Red Book (DCE, 1983) have been incorporated in the ODP and planning philosophy for the site.

All vegetation clearance, including roadworks, will be carried out in accordance with a Construction Management Plan, which will be prepared prior to any clearing on the site. The Plan will address:

- definition and marking of areas to be cleared;
- drainage control and minimisation of disturbance to natural drainage patterns, in accordance with accepted water-sensitive urban design principles;
- dieback hygiene measures in accordance with the CALM *Dieback Disease Hygiene Manual* (CALM, 1992).

Human pressure associated with fishing and crabbing activities will be mostly focussed on the foreshore and shallows. The ODP incorporates measures to control public access to foreshore areas and provides a planning framework and management structure within which recreational activities can be planned, managed and sustained.

Management and monitoring requirements for the reserve system will be identified in the process of developing management plans for the various sections of foreshore reserve and adjacent private conservation land.

Management plans for the various reserves will be prepared prior to construction.

It is anticipated that decisions in regard to:

- reserve vesting and ownership;
- identification of management purpose;
- delegation of management responsibility; and
- funding of management and monitoring

for existing and proposed reserves for the site will be addressed during the evaluation and approval of the Scheme Amendment, and subsequently during the preparation of relevant management plans for the site.

The area of gazetted public reserves within and near the development area will be substantially increased as follows:

- With the exception of coastal breaches at the proposed marina and sailing club, there will be a continuous system of recreation and conservation reserves around the entire Point Grey peninsula, either privately owned or vested in either the Water and Rivers Commission (foreshore reserve), the Shire of Murray (recreation reserves) or CALM (conservation of flora and fauna).

- The foreshore reserve and adjacent recreation areas along the western and southern shores of Robert Bay will form a link with Reserves 7502 and 2707, which in turn will link with System Six area C50.

- The proposed Water and Rivers Commission foreshore reserve at the southern end of the site's Harvey Estuary interface will link to System Six area C52 (Lakes McLarty and Mealup).

Private land set aside for conservation and recreation will complement these statutory reserves at several locations, as summarised below:

- At the site's northern extent, east of the proposed wilderness lodge, existing fringing vegetation in good condition will be retained for conservation of vegetation, flora, fauna and landscape in a large, privately owned conservation area that will abut the government foreshore reserve.

- In the marina precinct and waterside community on the north-west coast, disturbances to the present foreshore will be compensated for by the creation of two new islands immediately offshore. These islands will be constructed from dredge spoil and will be designed and engineered so that their foreshores (and intertidal zones) can be established with local vegetation and flora to replace foreshore habitat affected by construction.

- The area of existing remnant vegetation south of Stony Point will be excluded from development to provide a strong physical and biological linkage between the Stony Point Reserve, the foreshore reserve and Reserve 11718.

- Approximately 95ha of upland vegetation will be maintained as privately owned conservation area and will form a linkage between the Harvey Estuary foreshore and the Peel Inlet at Robert Bay including reserves 7502 and 2707 (System Six area C50).

- South of the Mealup Point village, the 15ha area of fringing and transitional/upland vegetation in good condition behind the foreshore reserve, will be protected from impact by incorporation in large rural-residential lots that will have covenants cited on titles and incorporated in Scheme Text to preclude vegetation clearance except for nominated building envelopes.

- Immediately south of the above area, an area of approximately 10ha will be excluded from housing development to create a conservation link between the Harvey Estuary and Lake Mealup reserve.

Figure 3.3 depicts the conservation areas that are incorporated in the ODP.

(ii) Vegetation Cover

The clearing of remnant native vegetation will be offset by the establishment of approximately 262ha of new plantings, including:

- In the golf course, up to 27ha of land between the fairways will be replanted with indigenous eucalypts, focussing on the maintenance of Tuart as a landscape feature of the site.

- Woodlots totalling 65ha for wastewater irrigation are proposed for the south-east sector of the site.

- A buffer fringe of approximately 30ha of unirrigated vegetation surrounding the wastewater irrigation area is proposed.

- If developed to full potential, the constructed wetland system adjacent to Robert Bay would support around 10ha of vegetation.

- New landscaping in residential areas, along major roads, in suburban parks and in private residential and commercial areas is likely to total around 130ha.

Environmental management plans which will implement vegetation protection measures will include:

- A Landscape Management Plan; and

- A Foreshore Conservation and Reserve Management Plan.

4.1.4 Environmental Management Recommendations

Environmental management recommendations which address the EPA objective relative to terrestrial vegetation and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.1 Outline Development Plan Design
- 6.2 Access Road and Infrastructure Corridor
- 6.7 Foreshore and Conservation Reserves
- 6.10 Landscape Management
- 6.11 Waterbirds
- 6.12 Construction Management
- 6.18 Foreshore and Conservation Reserve Management Plan Reporting
- 6.22 Waterbird Monitoring Plan Implementation.

4.2 Declared Rare and Priority Flora

4.2.1 EPA Objective

Protect Rare and Priority Flora consistent with the provisions of the Wildlife Conservation Act 1950.

4.2.2 Potential Impact

Land use proposals which require remnant vegetation to be cleared or which result in changes to habitat characteristics including the fire regime, weed invasion, soil quality or the hydrological regime could threaten rare flora if they were present on site.

Biological surveys commissioned by TS Plunkett Pty Ltd did not find any Declared Rare or Priority Flora on the site. There is therefore little likelihood of development adversely affecting populations of rare flora.

4.2.3 Environmental Management Strategy and Management Plans

Under the ODP, the more intensive developments such as the residential village are concentrated in areas that have already been cleared for farming. All significant areas of native vegetation are proposed to be retained either in reserves, public open space or private conservation areas.

4.2.4 Environmental Management Recommendations

Environmental Management recommendations which address the EPA objective relating to Declared Rare and Priority Flora and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.7 Foreshore and Conservation Reserves
- 6.10 Landscape Management
- 6.18 Foreshore and Conservation Reserve Management Plan Reporting.

4.3 Fauna - Waterbirds

4.3.1 EPA Objective

Protect important waterbird habitat areas consistent with the broad objectives of the Ramsar convention and the Japan-Australia and China-Australia Migratory Bird Agreements.

4.3.2 Potential Impacts

(i) Marina

The establishment of a marina on the north-west coast of Point Grey may cause the following impacts on waterbirds and their habitats:

- limited physical disturbance to shoreline and shallow offshore habitat during basin construction and access channel dredging (construction phase);
- turbidity plume generation during excavation and dredging (construction phase);
- fuel and oil spillage (construction and operation phases);
- noise disturbance from powerboats (operation phase); and
- bow wave generation and possible shoreline erosion (operation phase).

(ii) Sailing Club

Establishment of a sailing club on the east coast of Point Grey will incorporate the following activities with potential impacts on waterbirds and habitat:

- dredging of a narrow channel from the shore to navigable water in order to allow watercraft access to the shore at low tide (shoreline disturbance, turbidity plume generation);

- construction of a launching ramp for small powerboats associated with sailing club activities (shoreline disturbance, turbidity plume generation);

- creation of a sandy beach between the clubhouse and the launching ramp; and

- ongoing movements of unpowered watercraft with low noise generation and minor bow-wave propagation, and minor small powerboat movements (noise, fuel and oil spills, shoreline erosion).

4.3.3 Environmental Management Strategy and Management Plans

Recognising that the marina and associated boat traffic present the most significant potential impacts to waterbirds and habitats, the site for the marina has been located well away from Robert Bay in order to protect this prime waterbird habitat.

Site selection for the sailing club has recognised that the potential impacts from unpowered craft are less than for powered craft. In particular, sail craft are less able to enter the shallow waters of Robert Bay than powered craft. The requirement to exercise an avoidance strategy in site selection has been considered to be a less critical factor for the sailing club location, in regard to protection of waterbirds and habitat.

While it is logical to anticipate an increase in recreational boating activity in the region as a result of the establishment of the marina, it must be noted that the important shallow-water habitats in Robert Bay will be well protected by virtue of their distance from the main focus of power boating activity (the marina) and by their very shallow water depth, which is not readily accessible by any watercraft except shallow draft, unpowered craft such as canoes.

In the areas directly affected by construction of the marina and sailing club, there will be measurable losses of shoreline and nearshore shallow water habitats. At the marina site, this impact will be mitigated or compensated by:

- siting the marina basin inland from the present shoreline to minimise habitat loss; and

- specific engineering and contouring of the groyne walls and offshore dredge-spoil islands so as to replace ecological functions of the lost habitat.

The impact of the sailing club has been minimised by careful positioning to provide setbacks from known bird roosting areas and important paperbark woodland and samphire.

It is proposed to retain as much of the existing vegetation as possible in the sailing club area and to supplement and reinstate remnant fringing vegetation with new plantings of the indigenous flooded gum, paperbarks and typical understorey.

The removal of grazing stock and the control of future pedestrian transit within marked trails is expected to result in significant regeneration of the foreshore areas, which will create indirect benefits to adjacent waterbird habitat.

Any specific loss of roosting habitat in the form of exposed rocky outcrops or fringing vegetation which results from establishment of the sailing club entrance channel or boat ramp can be offset by new plantings or the establishment of replacement roosting rocks.

The Department of Transport will be responsible for establishing control of watercraft navigation and speed in the vicinity of the site so as to minimise interference with waterfowl and their habitats.

A Waterbird Monitoring Program will be prepared prior to development in consultation with appropriate government agencies. The Program will provide ongoing management and monitoring of the foreshore reserve system, and monitoring and maintenance of replacement habitat established by the new islands to ensure that ongoing viable habitat is maintained.

4.3.4 Environmental Management Recommendations

Environmental Management recommendations which address the EPA objective relating to waterbirds and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.1 Outline Development Plan Design
- 6.7 Foreshore and Conservation Reserves
- 6.11 Waterbirds

4.4 Declared Rare Fauna

4.4.1 EPA Objective

Protect specially protected (threatened) fauna consistent with the provisions of the Wildlife Conservation Act 1950.

4.4.2 Potential Impact

During site surveys commissioned by TS Plunkett Pty Ltd, two areas of habitat which could support gazetted rare fauna were identified:

- In the north of the site, remnant tall Tuart trees could provide nesting habitat for Carnaby's and Baudin's Black Cockatoos and the Peregrine Falcon. No sightings or other evidence of these species were reported.

- In the southern parts of the western shore, limestone outcrop habitat which could suit the rare Carpet Python was identified, although no sightings or other evidence of this species' occurrence were reported.

Physical loss or degradation of habitat, predation by feral or domestic animals, disturbance by pedestrians and motor vehicles could potentially impact any rare fauna if they were present on site.

4.4.3 Environmental Management Strategy and Management Plans

Measures which have been incorporated in the outline development plan and implementation strategy in order to mitigate potential impacts are as follows:

- Detailed planning for the site, both on an overall basis and in regard to specific sites, will seek to retain and protect as many as practically possible of the remaining tall eucalypt trees and will supplement these stands with new plantings.

- An area of remnant vegetation in good condition in the north of the site is proposed for virtual complete retention for the purpose of conservation and will provide a core area of habitat.

- Proposals will be put forward within a Landscape Management Plan, to establish new plantings of Tuart and other indigenous trees in the golf course to increase the total amount of tree habitat available in the long term for birds such as Cockatoos and the Peregrine Falcon, which require hollow limbs for nesting. There is presently no regeneration of Eucalypts within the site due to grazing by stock

- The habitat areas of limestone outcrop which could suit the rare Carpet Python will be excluded from development and managed within the foreshore reserve.

- During the detailed planning phase of the project, follow-up investigations will seek to confirm the presence or absence of the Carpet Python, so as to determine whether special provisions for reserve management to protect python populations are needed within the Foreshore and Conservation Area Management Plan. These might relate to pedestrian path route selection, vegetation condition requirements, feral animals, fencing requirements and fire regime management.

4.4.4 Environmental Management Recommendations

Environmental Management recommendations which address the EPA objective for rare fauna and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.1 Foreshore and Conservation Reserves
- 6.10 Landscape Management.

4.5 Estuarine Vegetation and Fauna Habitat

4.5.1 EPA Objective

Avoid or minimise direct and indirect impacts on ecologically important areas and identify replacement/remediation strategies where ecologically important areas are likely to be impacted. Direct and indirect impacts on ecologically important areas should be avoided or minimised, and replacement/remediation strategies detailed where ecologically important areas are likely to be impacted.

4.5.2 Potential Impacts

(i) Construction of the Marina and Sailing Club

During construction of the marina basin, the navigation channel between the marina and the Dawesville Channel and the limestone groynes, there will be direct loss of approximately 4.7ha of shoreline and intertidal habitat. Construction of the launching ramps, beach and navigation channel at the sailing club will cause the loss of a further 2ha of shoreline and intertidal habitat.

The most ecologically significant aspects of the areas which will be lost or modified by marina and sailing club construction are the seagrass meadows and the bird roosting and foraging habitat.

(ii) Operation of the Marina and Sailing Club

Boat traffic presents the potential for shoreline erosion from bow wave wash and disturbance to shoreline habitats.

Fishing activity in the Point Grey area will probably increase as the population increases. There is some potential for fishers and crabbers to cause damage to shallow seagrass meadows by trampling. Local professional fishers believe that increased activity along the coast interferes with fish behaviour patterns, which affects their fishing efficiency.

4.5.3 Environmental Management Strategy and Management Plans

(i) Construction of the Marina and Sailing Club

The marina and sailing club are both located away from the principal intertidal waterfowl habitat area in the south of Robert Bay. Both have been sited and designed so as to minimise as far as is practically possible the impacts of construction and operation on existing fringing vegetation, shoreline plant communities, local waterbird perching areas and seagrass meadows. The process of selecting optimum sites for the marina and sailing club so as to minimise these impacts was detailed in Section 4.3.

The direct loss of shoreline, intertidal and subtidal habitat during marina and sailing club construction will be compensated by the construction of two habitat islands at the entrance

to the marina. This proposal follows engineering investigations by Halpern Glick Maunsell which confirmed the technical viability of island construction in the proposed locations.

The islands will provide a large intertidal-shallow subtidal area suitable for growth of the dominant seagrass *Halophila ovalis*. The intertidal areas around the islands will provide foraging and roosting habitat for water birds and the supratidal areas may be used for nesting sites.

The proposed islands have been positioned to minimise the loss of important intertidal areas and seagrass habitat while meeting engineering and landscaping design objectives for the marina. Boundary Island, the artificial island created during dredging in Mandurah Channel, is a successful example of the creation of valuable new island habitat (Section 3.2.3).

The newly created habitats will be managed to ensure minimal disturbance of fauna by humans and will afford protection from feral predators. The limestone marina groynes will also be designed to maximise value as waterbird roosting/perching habitat.

Following approval of the proposed development but prior to marina construction, a Foreshore and Conservation Reserve Management Plan will be prepared in consultation with the DEP upon advice from CALM, PIMA and DOT. Amongst other matters the Plan will address:

- methods, design and protection of island foreshores;
- landscape and rehabilitation design and implementation;
- public access and information facilities;
- waterbird monitoring; and
- staging of management responsibility.

(ii) Operation of the Marina and Sailing Club

Given the depth limitations in this part of the Harvey Estuary, it is anticipated that boat traffic will primarily involve transit to and from the Dawesville Channel within the new connecting channel, and also to the Mandurah Channel and the Murray and Serpentine Rivers along established navigation routes determined by water depth and existing dredged channels.

Existing speed restrictions and depth limitations to navigation are sufficient to minimise erosion of the shoreline due to boat wash. Speed limits in the proposed channel linking the marina with the Dawesville Channel would be set by the DOT, with due regard for both safety and shoreline protection.

Additional power boat and sailcraft traffic will be focussed away from the principal waterfowl habitat at the southern extent of Robert Bay, because of the navigation limits imposed by the shallow water in these areas. This is particularly true during periods of low tides when the habitat is at its most accessible for wading waterfowl.

In the event that significant damage to seagrasses due to increased fishing activity were detected, the Sailing Club and Marina operators would co-operate with PIMA to install appropriate signs advising of the concern and recommending environmentally sensitive practices.

Management of the fish and crustacean resources of the Peel-Harvey Estuary is the responsibility of the Department of Fisheries. The Sailing Club and Marina operators will co-operate with the Department of Fisheries to facilitate its data gathering, public education and law enforcement responsibilities.

4.5.4 Environmental Management Recommendations

Environmental Management recommendations which address the EPA objective for estuarine vegetation and fauna habitat in relation to marina and sailing club construction and operation and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.1 Foreshore and Conservation Reserves
- 6.13 Marina Construction
- 6.14 Marina Management Agreement
- 6.15 Habitat Island Construction.

4.6 Estuarine Water Quality

4.6.1 EPA Objectives

Meet environmental quality objectives for the Peel Inlet-Harvey Estuary specified in the Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992 and the water quality guidelines specified in EPA Bulletin 711 for the protection of aquative ecosystems.

4.6.2 Potential Impacts

Inadequate design and operation of the marina could impair water quality within the marina and in adjacent estuary water such that the ability to support designated beneficial uses diminishes.

Water circulation in Harvey Estuary could be impaired by inappropriate design or siting of the marina, entrance channel and habitat islands.

4.6.3 Environmental Management Strategy and Management Plans

The requirement for the marina to meet a range of specific environmental quality objectives has been adopted in the marina site selection and design process. The configuration presented in the ODP is the direct outcome of this process.

Further discussion of more detailed aspects follows under appropriate headings.

(i) Water Quality Criteria

The EPA publication *Western Australian Water Quality Criteria for Fresh and Marine Waters* (Bulletin 711, 1993) sets the general water quality standards to be achieved by marinas and other coastal developments. Bulletin 711 is based on the requirement to maintain water quality sufficient for defined beneficial uses. The beneficial uses applicable to the Point Grey development are:

- Inside the marina: Secondary Contact Recreation (including incidental human contact).

- Outside the marina: Maintenance of Aquatic Ecosystems.

A summary of the water quality criteria most applicable to Point Grey in terms of these Beneficial Uses is shown in Table 4.1. These criteria will be incorporated in environmental management plans for the marina.

Table 4.1
Water Quality Criteria Applicable to Point Grey
(EPA, 1993)

Parameter	**Inside Marina (Secondary Contact)**	**(Aquatic Ecosystems)**	
Microbes:			
Faecal coliforms	median 1,000/100mL	nc	
Enterococci	35/100mL	nc	
Pathogenic protozoans	None	nc	
Nuisance organisms (including algae)	Not excessive	Not excessive	
Clarity	< 10% change	<10% change	
pH	5.0-9.0	<0.2 pH unit change	
Temperature	15-35∞C	<2∞C increase	
Toxic Chemicals	Same as drinking water levels	Various, generally below drinking water levels	
Surface Films (oil and chemicals)	None visible	nc	
Dissolved Oxygen	80-90% saturation	80-90% saturation	
Nutrients:		*In Estuary*	*In Ocean*
Ortho-phosphate	nc	5-15µg/L	1-10µg/L
Nitrate-nitrogen	nc	10-100µg/L	10-60µg/L
Ammonia-nitrogen	nc	<5µg/L	<5µg/L
Chlorophyll-a	nc	1-10µg/L	<1µg/L

nc = no criteria

It is noted that the background water quality of the Peel-Harvey Estuary already is marginal or non-compliant in terms of some of the above parameters, particularly nutrients. However, as discussed in Section 2.2.8.5, the construction of the Dawesville Channel and the progressive introduction of improved catchment management is predicted to cause a substantial long-term improvement in the nutrient status of the Estuary. Preliminary indications are that this improvement is occurring (eg. Wilson & Latchford, 1995).

Where any particular parameter in the above list is found by monitoring to be exceeded in the background water quality at Point Grey ie in the source water for the marina, the

management objective adopted will be to cause less than a 10% increase above that background inside or outside the marina.

(ii) Water Exchange and Flushing

Due to its location almost directly opposite the Dawesville Channel, the marina will be regularly and thoroughly flushed by the tidal currents entering the Estuary through the Channel. As a result, the water quality within the marina is expected to be very high.

Calculations based solely on average tidal exchange suggest that complete replacement of the water in the marina will occur every seven days. The *e-folding* time (equivalent to about 60% replacement) is calculated at 4.2 days. Flushing will be further enhanced by the effects of wind-induced mixing, currents and gravitational (salinity and temperature driven) exchange.

Provided that the correct bottom profile (falling towards the Estuary) is achieved in the marina and that the entrance does not unduly impede flows, the water quality in the marina will be essentially the same as that in the Estuary.

(iii) Control of Pollutants

The potential input of contaminants to the water within the marina, and hence to the Estuary, will be minimised through appropriate design of the surrounding drainage system and management of the marina and other facilities. There will be no routine discharge of stormwater to the marina from surrounding areas.

(iv) Prevention of Fuel Spills

Fuel storage tanks at the marina will be constructed above-ground within a sealed bund capable of holding at least 110% of the entire contents of the tanks (as per EPA policy) without overflowing. This will allow recovery of all fuel in the unlikely event of a leakage or spillage.

Boat refuelling facilities will include manually operated nozzle valves with automatic shut-off, to reduce the likelihood of significant spillages. Minor drips and splashes of fuel are likely to reach the water. Such minor quantities will be rapidly dispersed and biodegraded, and are of minimal environmental concern.

(v) Sullage and Bilge Pump-out Facilities

Sullage and bilge water pump-out facilities will be provided for vessels using the marina. Pump-out direct to the water within in the marina will be prohibited. Sullage will be pumped to the marina precinct's sewer system. Bilge water will be discharged to the stormwater drainage system via hydrocarbon interceptors and trash collectors. Stormwater drainage in the vicinity of the marina is described in Section 3.4.5.

(vi) Antifouling Paints

Tributyl Tin (TBT) based antifouling paints are prohibited by law from use on all vessels less than 25m long and on all marina structures. Vessels using the marina will be advised of this prohibition, to the satisfaction of the DEP. In general, vessels larger than 15m will not be able to access the marina.

It is possible that low-level inputs of antifouling compounds, hydrocarbons, trace metals and nutrients may accumulate in the sediments of the marina over a long period. Appropriate monitoring will be regularly undertaken to monitor sediment contaminant levels. Based on experience of other marina and canal estates in the Peel-Harvey Estuary, contaminant accumulation in the sediment is not anticipated to be significant.

(vii) Macroalgal Accumulation

The clean sand and water in the location of the proposed marina indicates that there is little macroalgal accumulation or decay in this area. The north-westerly orientation of the marina entrance and the presence of the protective islands will minimise the amount of drifting algae which enters the marina. Small quantities of macroalgae and litter which enter the marina or sailing club will be removed to the satisfaction of the Shire of Murray.

(viii) Effect on Estuarine Circulation

Calculations indicate that the cross-sectional area of the marina entrance channel will be minor (<10%) compared to the cross-sectional area of the mean tidal flow into the region. This suggests that the mean flow in the Estuary will not be altered by the channel and that currents near the marina will not be significantly increased. If any increase did occur, one effect would be to marginally improve the tidal flushing of the Harvey Estuary.

(ix) Water and Sediment Quality Monitoring Plans

Regular water and sediment quality monitoring will be conducted during the construction and operation of the marina and sailing club. Monitoring of water quality in marinas and canal developments in the Peel-Harvey Estuary is now well researched and routinely carried out. The monitoring program will be designed and implemented in consultation with PIMA to the satisfaction of the DEP.

Water and sediment quality data will be assessed against relevant water quality criteria (EPA Bulletin 711) and sediment quality criteria (Long *et al.*, 1995). Indications of contamination will be investigated to determine the sources of contaminants and to identify appropriate management responses.

(x) Staging of Management Responsibility

Prior to construction of the marina the Developer, the Shire of Murray and the DOT will enter into an agreement that will define responsibilities for the physical maintenance and management of the marina and entrance channel. The agreement will ensure the efficient handover of management responsibility to public authorities at the appropriate time and in compliance with relevant regulatory controls.

4.6.4 Environmental Management Recommendations

Environmental management recommendations which address the EPA objectives for estuarine water quality and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.1 Outline Development Plan Design
- 6.5 Marina Design for Water Quality Protection
- 6.14 Marina Management Agreement
- 6.24 Marina and Entrance Channel Depth Monitoring Implementation
- 6.25 Water and Sediment Quality Monitoring Plan Implementation.

4.7 Wetlands

4.7.1 EPA Objective

For Lakes protected by the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992, Wetlands of International Importance and Important Wetlands identified by the Australian Nature Conservation Agency including Peel-Harvey Estuary and Lake Mealup:

(a) Maintain the integrity of functions and environmental values of wetlands;

(b) Ensure an adequate buffer between the Peel-Harvey Estuary foreshore and the development taking into account landscape, nutrients and protection of foreshore vegetation.

4.7.2 Potential Impacts

(i) Integrity, Functions and Environmental Values of Wetlands

The ODP incorporates the following land use changes that will have direct physical interaction with the site's wetlands:

- A section of the new entry road will traverse degraded remnant wetland areas adjacent to the south-west corner of Robert Bay.
- The buffer of the woodlot effluent irrigation area will abut a small wetland on the eastern edge of the Spearwood dune ridge landform.
- In places, the proposed foreshore pedestrian and cycle trail will pass close to wetlands in the estuarine fringe.

Indirect impacts which may be caused by the proposed land uses include:

- changes to the hydrological regime including groundwater rise associated with urbanisation or groundwater decline due to abstraction; and
- changes in the quality of surface water and groundwater inputs to the wetlands.

(ii) Buffer to Peel-Harvey Estuary Foreshore

There are certain areas where the land uses proposed will unavoidably require an impact to the foreshore to be sustained, such as at the proposed marina and sailing club where construction will remove the present natural foreshore and create a built environment.

Other potential ongoing impacts include the effect on foreshore vegetation of increased pedestrian traffic and raised or lowered water tables. Issues related to the nutrient buffering function of the foreshore buffers are discussed in Section 4.8.

4.7.3 Environmental Management Strategy and Management Plans

(i) Integrity, Functions and Environmental Values of Wetlands

Classification of each of the site's wetlands according to the procedures of Bulletin 686 has been carried out as detailed in Section 2.3.4.3, in order to establish appropriate environmental management objectives. As could be reasonably expected given the current land use, most of the site's wetlands are identifiable as Category M - Multiple Use, as a result of the absence of their original vegetation. Wetlands with Conservation and Resource Enhancement objectives have also been identified.

Environmental management objectives derived from the above evaluation will be met during the course of construction and implementation of the land use plan for the site. Specific responses to those areas where impacts are likely include:

- The access road alignment through the remnant wetland area adjacent to the southern end of Robert Bay has been selected to avoid crossing low-lying land where possible, and therefore minimise physical impact on wetlands in this locality.

- The road design will incorporate appropriate water management features so that the hydrological regime of the area traversed is not detrimentally altered. Culverts under the road will be positioned so as to enable the existing surface water flow patterns to persist.

- Following construction, rehabilitation of the area including soil stabilisation and revegetation will be implemented. This rehabilitation will be coordinated with the

landscape and drainage management strategy for this area, which also forms the entrance to the development.

- The proposed pedestrian and cycle path around the site's perimeter will be located along alignments which do not require transit through any significant wetland areas. Detailed route planning for this path will be carried out in consultation with appropriate government agencies and the Winjan Aboriginal Corporation.

- The small damplands and sumplands with Multiple Use and Resource Enhancement management objectives located along the eastern margins of the ridge terrain will be protected from physical impact and retained as wetland features. The removal of grazing stock will assist understorey regeneration. Ongoing management will seek improvements in vegetative cover and habitat function.

- The impact of the proposed development on the shallow groundwater regime, which could potentially affect wetlands, is expected to be minor. Ongoing management and monitoring, as set out in the Water Supply Management and Monitoring Plan, will detect any long-term changes in the levels of the Superficial aquifer and enable remedial action to be carried out.

- The quality of groundwater and surface water entering the wetlands will be maintained by the implementation of water-sensitive urban design principles, including the appropriate design and use of settling/recharge basins and stormwater drains, and restriction of fertiliser use and irrigation in park and golf course areas. There will be no direct discharge of stormwater to any existing wetland, unless this is part of a broader stormwater management/wetland enhancement plan approved by WRC and DEP.

- The requirement for wetland protection will be incorporated in the Landscape Management Plans and Construction Management Plans, which will be prepared in consultation with appropriate government agencies.

- For the poorly-drained flats adjacent to Robert Bay, a conceptual design for the establishment of a constructed wetland system has been identified. The core objective of this design is the restoration of wetland functions which have been lost from this area due to clearing and continue to be limited by the presence of stock. In the event that a satisfactory agreement can be reached in regard to the establishment of this constructed wetland system, a Wetland Management Plan will

be prepared in consultation with appropriate government agencies, addressing matters including nutrient removal, habitat creation, mosquito management, maintenance and staging of management responsibility.

(ii) Buffer to Peel-Harvey Estuary Foreshore

The formulation of the ODP has incorporated protection of foreshores and the retention or establishment of vegetated buffers between the foreshore and proposed development areas. This is in accordance with general intent of State and local government management plans for the Peel-Harvey foreshores, and recognises their ecological and landscape values.

A near-continuous vegetated foreshore buffer around the peninsula will be provided by the proposed foreshore green space system described in Section 3.3.1 and shown on Figure 3.3. Features of the system which are of particular relevance to its function as a foreshore buffer zone include:

- The sailing club will be located where the zone of foreshore vegetation is narrow. The buildings and other structures will be sited so as to preserve important stands of vegetation. New plantings of indigenous trees and understorey will be undertaken so that the total area of foreshore vegetation is maintained or increased.

- The waterside village will be connected to the foreshore by narrow linear corridors to provide sight lines and pedestrian access. The corridors will be about 10m wide and will incorporate suitable fencing or barriers to discourage pedestrian access to vegetated areas while not restricting the movement of ground fauna. The corridors will be carefully positioned so as to minimise their visibility from other areas and to avoid damage to sensitive vegetation.

- Although the marina will constitute a substantial break in the foreshore buffer zone, the area of foreshore vegetation lost in its construction will be balanced by the creation of the two habitat islands immediately offshore as described in Section 3.2.3. These islands will also serve as a visual and wave buffer for the marina from the open Estuary.

- Low-intensity development will closely approach the foreshore at the proposed Mealup Point village. Development in this area will be strongly focussed towards already-cleared areas.

- In rural-residential areas close to the coast, the buffering effect of the foreshore reserves will be augmented by the retention of natural vegetation on the private lots, which will be achieved by means of covenants on individual titles restricting clearing to specified building envelopes.

(iii) Control of Recreational Uses in the Foreshore Reserve

Except for the two high-intensity land use nodes at the marina and sailing club, the foreshore reserve will be managed for the purposes of conservation and passive recreation. Management plans will be formulated in consultation with appropriate government agencies.

The pedestrian/cycle path which is planned for the foreshore reserve (Section 3.3.2) will serve not only as a means of access but as a defining boundary, where it is desired to maintain shoreline and fringing vegetation with minimal human presence. The pathway design will discourage and minimise entry to foreshore and conservation areas.

(iv) Maintenance of Hydrological Regimes

Any changes which might take place in relation to superficial groundwater levels in inland parts of the site (due to increased recharge or groundwater abstraction) would be expected to cause minimal change to the water table near the shoreline, given the proximity of the Estuary and the high permeability of the surface sands.

The foreshore vegetation is adapted to the shallow, variable and relatively saline groundwater that exists in the foreshore zone. Given these natural adaptations, it is expected that minor changes to groundwater levels at Point Grey will have negligible impact on foreshore vegetation.

This prediction is supported by the following historical evidence:

- The major clearing of vegetation that occurred when the peninsula was cleared for farming would have caused an increase in recharge and consequently in the amount of fresh water flowing through the aquifer at the shoreline.

- The Dawesville Channel has increased the tidal range in the Estuary and therefore could be expected to have some influence on water table level variations at the foreshore. These matters were considered in the environmental assessment of the

proposal to construct the channel. The shoreline shows evidence of physical changes which may also over time be accompanied by a shift in the zonation of species distribution in response to the new water table regime. The foreshore buffers provided in the ODP provide sufficient space for the establishment of new vegetation zonation patterns which represent an inward intrusion of Estuarine influence on the Superficial aquifer.

A Foreshore and Conservation Reserve Management Plan for the whole of Point Grey, including both foreshore reserves in government ownership and private conservation areas proposed by the ODP, will be prepared to coordinate these management strategies in consultation with appropriate government agencies.

4.7.4 Environmental Management Recommendations

Environmental Management recommendations which address the EPA objective for wetlands and for an adequate buffer between the Peel-Harvey Estuary foreshore and development, and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.1 Outline Development Plan Design Strategy
- 6.2 Access Road and Infrastructure Corridors
- 6.3 Mosquito Breeding Habitat
- 6.7 Foreshore and Conservation Area Management
- 6.10 Landscape Management
- 6.12 Construction Management
- 6.16 Constructed Wetland on Robert Bay Drain
- 6.17 Robert Bay Wetland Management.

4.8 Groundwater Quantity

4.8.1 EPA Objective

For the Leederville Aquifer, maintain the quantity of groundwater so that existing and potential uses including ecosystem maintenance are protected.

4.8.2 Potential Impacts

The potential impacts of groundwater abstraction from the upper Leederville aquifer (as described in Section 3.4.3) are:

- over-abstraction from the Leederville aquifer could lead to water quality deterioration by way of excessive increases in total dissolved solids concentrations (salinity); and
- over-abstraction could also induce drawdown of the Superficial aquifer, which could cause undesirable water level changes in wetlands with conservation value.

These factors are recognised as setting the primary limits to the water supply potential from the local aquifer system.

Hydrogeological investigations have concluded that the Leederville aquifer is presently at its volumetric capacity (ie "full"), as evidenced by high water tables in the superficial deposits and the net export of surface water and groundwater via drains and ditches.

Numerical modelling of groundwater abstraction at projected rates over 50 years has predicted an eventual drawdown (at year 50) of up to 2.2m in the potentiometric level of the upper Leederville aquifer immediately beneath the centre of the borefield. Over most of the project area, the potentiometric drawdown would be less than 1.5m after 50 years (Figure 4.3). This drawdown would have the effect of allowing increased recharge of the Leederville aquifer from the Superficial aquifer, but is not expected to have any significant impact on shallow water table levels or groundwater-dependent vegetation and wetlands.

Over-abstraction from individual production bores may result in increases in salinity, as evidenced during test pumping of bore PGPB1, which increased from 640 to 760mg/L (TDS) over the test period. Pumping the bores at lower rates is expected to reduce this trend. Nevertheless, it is evident that water treatment may be required to maintain the salinity of the water at potable levels.

4.8.3 Environmental Management Strategy and Management Plans

(i) Aquifer Supply Potential

A Water Supply Management and Monitoring Plan will be established to coordinate water supply, groundwater monitoring, data analysis and reporting. As aquifer performance

data accumulate, the numerical aquifer model will be updated and checked to confirm the validity of conclusions reached by the investigations reported here.

Any change in the predicted security of wetlands with conservation values which arise from ongoing numerical modelling will be addressed by the water supply operator. Contingency options include adjustment of plans for production bore location (possibly including offsite locations) or utilising water from another source of supply. The Water Corporation has confirmed that it may be in a position to service the site with potable water in the future.

(ii) Management of Water Demand

Numerous studies of water consumption carried out in Perth in recent years have examined the different uses to which householders put water and have provided a basis for planning future water supply to meet the city's growth in population.

These studies have demonstrated that significant quantities of high-quality potable water are used for irrigation of lawns and gardens. Studies of household appliances which use water have similarly identified potential for water consumption to be reduced.

The planning of new residential and recreational developments on a large scale - effectively a "master planned project" - offers an opportunity to minimise the demand for potable water by means of strategic planning and environmental management procedures.

Achievement of a water-conserving development requires actions at three levels:

- At the detailed design and infrastructure construction stage, both the developer and government service suppliers need to adopt water-sensitive design in the establishment of new landscaped areas such as road reserves, public parks and playing fields, focussing on landscaping styles and plant species with low irrigation requirements.

- At the local authority level, as development and building applications for homes, commercial and civic facilities are submitted, vigilance in the specification of water sensitive design in landscape planning and plumbing fittings is needed by Council and its committees.

- At the individual lot level, householders and businesses need to embrace water conservation in their choices of garden design and plant species, water-using appliances and fittings.

The land developer can commence this process but, as the project proceeds and the authority for decision making expands into government and land purchasers, the developer's influence will diminish. Successful management of the demand for water must ultimately be a community effort.

(iii) Water Supply Development and Management

Regulatory approval will initially be sought for the first stage of water supply development, consisting of two bores abstracting up to 2,200m^3/day in total.

Monitoring of abstraction quantity, water quality, and aquifer responses in the upper Leederville and Superficial aquifers will occur on a monthly basis.

Monitoring will incorporate the following:

- water consumption volumes (average and peak);
- groundwater abstraction (average and peak) for each production bore;
- water levels in the superficial aquifer, within the project area and as required to demonstrate the hydrological integrity of nearby wetlands with important conservation values, measured monthly;
- pressure heads in the upper Leederville aquifer, measured monthly; and
- climatic data including rainfall and evaporation for the site.

The results of this monitoring, which will be reported regularly to relevant government authorities, will be used to optimise the operating regime of the borefield and the locations of future bores.

If the monitoring shows that the projected long term effects of abstraction are acceptable, these findings will be used to support applications for staged expansion of the borefield. In the event that undesirable impacts are detected, alternative borefield designs or sources

of water (such as mains supply) will be investigated until an environmentally and economically acceptable option is identified.

4.8.4 Environmental Management Recommendations

Environmental Management recommendations which address the EPA objective for groundwater quantity and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.8 Water Supply
- 6.9 Nutrient Exports and Irrigation
- 6.10 Landscape Management.

4.9 Surface Water Quality

4.9.1 EPA Objective

For the Peel-Harvey Estuary in general, ensure compliance with the Environmental Protection (Peel Inlet - Harvey Estuary) Approval Order 1992, Statement of Planning Policy No. 2 1992 and The Peel-Harvey Coastal Plain Catchment through the use of best practice particularly for stormwater and sewage effluent management.

4.9.2 Potential Impacts

The export of excessive phosphorus from Point Grey could diminish the effectiveness of land use management in the Peel-Harvey Catchment and flushing through the Dawesville Channel, both of which seek to improve water quality in the Estuary.

Further, outflowing estuary water has been found to be an important source of nitrogen to southern metropolitan coastal waters. Excessive nitrogen discharge from the site to the estuary may cause reduced water quality in adjacent coastal waters.

Assessment of potential impacts has been addressed by examining the export rate for phosphorus at full development compared to the target for the site established in the Environmental Protection (Peel Inlet - Harvey Estuary) Policy Approval Order 1992.

The contribution of nitrogen export from the site to estimates of annual discharge from Peel Inlet - Harvey Estuary into coastal waters is also examined.

Statement of Planning Policy No. 2 - The Peel-Harvey Coastal Plain Catchment (SPP No. 2) establishes planning provisions which specify how development must deal with sewage effluent disposal and stormwater disposal so that environmental quality objectives for the estuary may be met. Assessment of potential impacts also examines compliance of the project to planning provisions established in SPP No. 2.

(i) Phosphorus Exports

The productivity of algae, other aquatic plants and many nuisance insects in the Peel-Harvey Estuary is controlled largely by the supply of available phosphorus. High inputs of phosphorus originating from sources in the catchment of the Estuary have created or exacerbated problems of algal blooms, odours, weed fouling and insect nuisance in the Estuary.

The primary environmental route for phosphorus export from the site is by leaching from the soil profile during groundwater recharge, and subsequent discharge to the Estuary in shallow groundwater flow. All activities which result in the application of phosphorus to the soil surface have the potential to contribute to the leaching of phosphorus and its eventual entry into the estuarine ecosystem. The principal land uses recognised as requiring attention in regard to phosphorus export are:

- treated effluent disposal by eucalypt woodlot irrigation;
- stormwater disposal by soil infiltration;
- residential areas - lawn and garden maintenance;
- golf course irrigation and fertilisation; and
- irrigation and fertilisation of grassed playing areas and public landscaped areas.

At the time of the Mallina Holdings College Town development proposal in 1986, there was relatively little technical knowledge of phosphorus leaching processes in soils on the Swan Coastal Plain. As a result of intense interest in these issues for the purpose of surface and groundwater management, this present study has had the benefit of a considerably increased data base and improved investigative and mathematical modelling methods to apply to phosphorus transport processes in sandy soil profiles.

The unconfined groundwater system which hydraulically links the site to the Estuary contains a natural buffer against contaminant export in the form of the extensive deep Spearwood soils and underlying Tamala limestone sediment in which the aquifer is developed. Published research findings gave early confidence that phosphorus management could be accomplished at Point Grey by reliance on storage in the yellow Spearwood sand profiles.

McPharlin *et al* (1990) examined phosphorus storage under fertilised horticultural land on Spearwood sands of similar type to those at Point Grey. That work recorded soil phosphorus storage of over 1200kg/ha, most (90%) of which was stored in the top 100cm with little evidence of leaching further than one metre. At these storage rates, the Spearwood sand profile at Point Grey could store up to 1,200kg of phosphorus per hectare in the top one metre. Soil investigations have shown an average thickness of seven metres of Spearwood Sand over limestone, indicating a phosphorus storage potential of up to 8,400kg/ha.

A second indicator of phosphorus storage potential in the Spearwood sand profile was obtained from modelling data presented by Gerritse (1990), in which travel times for phosphorus through one metre of yellow Spearwood sand were calculated for varying accumulation and recharge rates.

Research by Gerritse and others has indicated that phosphorus tends to move through soil profiles as a sharp "front". For the period prior to exceedence of the soil profile's ability to adsorb additional phosphorus ("breakthrough"), the concentration (and hence loading) of phosphorus passing completely through the soil profile and into the aquifer remains at close to background levels. This has important benefits in terms of meeting phosphorus export targets at Point Grey.

Calculations based on the Gerritse (1990) method and using groundwater recharge rates and phosphorus loadings applicable to a woodlot irrigated with treated sewage indicated that the advancing phosphorus front would take about 50 years to move one metre through the soil profile, or about 350 years to reach the Superficial aquifer.

These figures were comparable to the McPharlin data, and supported the conclusion that phosphorus storage in Spearwood sands could be relied upon as a means of controlling phosphorus export to the Estuary.

It was also recognised that more definitive, site-specific technical analysis of phosphorus storage would be needed in order to obtain regulatory approvals for the project in the context of meeting the EPA's Peel-Harvey catchment management targets.

Investigations undertaken during the preparation of this Environmental Review to demonstrate compliance of the ODP with the EPA's phosphorus export targets included the following steps:

- The ability of the Spearwood sand profile to arrest phosphorus export was confirmed by literature research, soil mapping and chemical analyses to measure phosphorus retention capacity.

- The phosphorus export target for the site was calculated in accordance with the overall catchment targets published by the EPA.

- The anticipated phosphorus exports from the site were calculated by mathematical modelling of groundwater recharge, phosphorus application and leaching rate for each proposed land use in order to demonstrate that total phosphorus export via leaching and groundwater discharge would meet the catchment target for the site.

These investigations are described in the following sections.

Soil Survey and Chemical Analysis

An initial soil survey examined nine sites selected from existing soil maps and site reconnaissance. At each site soil profiles were sampled to around 3 metres, and representative horizons analysed for phosphorus retention index (PRI) and bicarbonate extractable phosphorus (Bic P). These parameters characterise phosphorus retention and historical applications, respectively.

The analytical results, which are summarised in Appendix E (Tables 1 and 5), confirmed that the yellow phase Spearwood sands have fair adsorption capacity which increases with depth.

A second survey then examined a further 33 sites, focussing on the yellow phase Spearwood sands and on areas where treated effluent disposal was initially proposed. Soil profile examination and sampling to 3.5m yielded a second suite of samples which were

analysed for PRI and Inc P, yielding a reliable data set for use in subsequent modelling and estimation of soil phosphorus storage potential.

The findings of this phase of work established that yellow phase Spearwood sands are distributed over approximately 80% of the more elevated parts of the site (nominally all areas above 3m AHD), and that moderate phosphorus retention increasing with depth is typical for these soils.

Calculation of Phosphorus Export Target

Catchment management objectives for the Peel-Harvey estuarine system have been addressed in a number of State and Local Government documents. The target phosphorus loading for the various coastal plain drainage catchments was established by the EPA in the *Environmental Protection (Peel-Harvey Estuary) Policy 1992* (the EPP).

The EPP specifies that for the Harvey River and Drains component of the coastal plain catchment (in which the site is located), the annual phosphorus loading target is 38 tonnes, or an areal export target of 0.42kg P/ha/a from the whole of this catchment. This equates to an export target of 487kg P/a (maximum) from the 1,159ha of the Point Grey site.

In terms of managing phosphorus export from the site, this target may be interpreted as a requirement to limit the amount of phosphorus which leaches to the superficial aquifer to less than 487kg per year. This interpretation incorporates the conservative assumption that all phosphorus which enters the unconfined groundwater will immediately enter the Estuary water column.

Broad calculations of the current phosphorus export rate from the site under its present land use indicate annual discharge of approximately 70kg.

Phosphorus Export Modelling

Computer modelling of phosphorus exports from the site was carried out using two well-proven models, as follows:

- Phosphorus retention in the yellow phase Spearwood sands was modelled using the Barrow-Shaw equation, based on Freundlich phosphorus adsorption isotherms developed by chemical analyses of soil samples collected from the site. For each soil sorption coefficient used in the model, the most conservative of the range of

values found by analysis was used in order that modelling could derive minimum values for phosphorus storage, so that the assessment of the adequacy of soil storage as a phosphorus management mechanism would represent a 'worst-case' analysis.

- Groundwater recharge was modelled using the MACRO Model (Jarvis, 1994), which is a one dimensional, two domain (micropore and macropore) finite difference solute and water transport model. Historical daily rainfall and pan-evaporation data from the Department of Agriculture's Medina Research Station were used. The Medina data were considered to be an adequate approximation of the Point Grey site's rainfall and evaporation, being approximately the same distance inland and a relatively small distance to the north.

Phosphorus application rates for each proposed land use were derived from the published technical literature. Loading rates of phosphorus for the treated effluent irrigation woodlot were calculated based on an effluent phosphorus concentration of 1mg/L (derived from submissions from commercial sewage treatment technology suppliers) and irrigation at 2.5mm/day.

A detailed description of the modelling inputs, procedures and outputs is presented in Appendix E.

Table 4.2 summarises the results of modelling, expressed as the lifetime over which phosphorus applied to the soil surface as fertiliser or in treated effluent would be stored in the yellow phase Spearwood sand profile underlying each land use.

Table 4.2
Results of Phosphorus Adsorption Modelling

Land Use	Phosphorus Application Rate (kg/ha/annum)	Topsoil P Storage Capacity (years)	Soil Profile P Storage Capacity (years)	Total Soil P Storage Capacity (years)
Golf Course	20[1]	11	200	211
Residential/Golf Course Estate	9	24	374	398
Tourist Facilities	4	55	365	420
Rural/Special Residential	5	44	310	354
Effluent Disposal Area	13[1]	17	143	160

[1] Assumes no re-use of treated effluent for golf course irrigation.

The data presented in Table 4.2 indicate that retention of phosphorus by soil adsorption will prevent any significant leaching of phosphorus to the superficial aquifer for a minimum of 160 years if phosphorus is applied at the rates used in modelling and no further management is applied. For some land uses, soil storage will retain phosphorus for substantially longer periods. During the estimated 160 years or more before breakthrough could occur according to the model, phosphorous export in groundwater from the site is expected to remain at a similar level to the currently estimated 70kg/ha/a.

The findings of the phosphorus export modelling indicate that the export target of 487kg P/a for the site can easily be met for a period of at least 160 years at full development. It should be noted that the calculated phosphorus storage "lifetime" is probably a significant under-estimate, given the use of the following conservative assumptions in the model:

- The modelling assumes that, as soon as phosphorus reaches the superficial water table, it is considered to have entered the Estuary. In practice, phosphorus adsorption will continue within the sand and limestone sediments beneath the water table, and there will be a considerable time lapse before recharge to the aquifer can reach the Estuary. Simple calculations suggest that groundwater recharged at the centre of the site would take approximately 100 years to reach the Estuary.

- The phosphorus sorption model has, for each measured variable, used the lowest value from the measured range. Much higher storage would be indicated by the

model if average values were used. For instance, using the average rather than the lowest "Freundlich A" coefficient measured on the soil profiles would lead to a two-fold increase in the calculated storage capacity of the entire site.

- The model does not account for the probable eventual use of treated effluent for golf course irrigation, which would have the effect of substantially reducing the amount of phosphorus applied to the golf course in the form of chemical fertilisers (currently estimated at 20kg P/ha/a).

On the basis of the findings of the phosphorus export modelling, the elements of conservatism built into the assessment and the availability of practical contingency procedures which can be employed to optimise phosphorus management, it is concluded that the EPA's catchment target for phosphorus export from the site can be readily met by the development proposed in the ODP.

(ii) Nitrogen Exports

In contrast to phosphorus export, the effects of excessive nitrogen export from Point Grey would likely be felt in the nearshore ocean waters surrounding the Dawesville Channel and Mandurah Channel, where additional nitrogen may cause excessive phytoplankton levels and associated effects.

Biological productivity in coastal waters is controlled mainly by the availability of nitrogen. The *Southern Metropolitan Coastal Waters Study* (DEP, 1996) found that tidal outflow from the Peel-Harvey Estuary was an important source of nitrogen to coastal waters, contributing an average of 450-900 tonnes per annum to the coastal waters between Marmion and Dawesville out of a total loading from all sources of about 3,800 tonnes per annum. The annual loading from the Peel-Harvey Estuary was estimated to have increased by more than 450% since the 1960s.

Nitrogen export from urban land uses on the Swan Coastal Plain has received relatively little attention by researchers, as phosphorus is usually of greater concern in terms of environmental impacts on lakes and estuaries.

An approximation of potential nitrogen loading to the superficial aquifer can be developed by firstly summing the annual application rates for the land uses proposed by the ODP.

Transmission rates by groundwater recharge and leaching may be estimated by applying factors determined for Spearwood Dune landforms.

Four generalised sources of nitrogen application are recognised from the ODP. These are:

- Irrigation of Treated Wastewater to Eucalypt Woodlot;
- Fertilisation of Golf Course;
- Fertilisation of Domestic Gardens;
- Fertilisation of Public Open Space and Active Recreation Areas.

Irrigation of Treated Wastewater to Eucalypt Woodlot

At full occupancy the ODP allows for a population of around 7,000 people.

The project engineers' investigations found that maximum wastewater production from this population would be 1,500m^3/day.

The proposed final effluent quality for the sewerage treatment plant is 5mg/L of total nitrogen.

This may be computed to an annual loading of around 2.7 tonnes/annum of nitrogen in the wastewater which will be applied to the eucalypt woodlot.

Golf Course Irrigation

The ODP allows for a 90ha land parcel for the golf course. A conservative estimate of the area of greens, tees and fairways under fertilisation would be 40ha.

An appropriate total application rate for nitrogen of 200kg/ha/annum for fairways and 560kg/ha/annum for greens and tees was adopted for a golf course near Rockingham on sandy soils in a Water and Nutrient Conservation Plan prepared for the course (Bowman Bishaw Gorham, 1994).

At these rates greens and tees (assume 5,000m^2 total for course) would have a 260kg annual nitrogen application, whilst fairways (at 40ha total) would have 8,000kg N/annum. These components total around 8.25 tonnes/annum of nitrogen application.

Fertilisation of Domestic Gardens

Gerritse *et al* (1991) reported mean annual nitrogen application of 80kg/ha for sewered residential lots at a density of 10 houses/ha. In order to apply this number to the Point Grey ODP, which has varying lot sizes, the Gerritse figure is assumed to be transformable to an estimate of 8kg/household/annum.

The ODP proposes a total of 3,000 residential lots of varying size, which yields an estimate of 24,000kg/annum of nitrogen application by this method of analysis.

Public Open Space and Active Recreational Areas

The ODP incorporates a District Recreation Area of around 20ha. In addition, there will be irrigated turf within Public Open Space distributed through the various residential areas. If Public Open Space allocations of 10% are assumed for residential areas, and half is assumed to be irrigated turf, the 282ha of residential land indicated by the ODP would contain 14ha of irrigated turf, at full development.

Gerritse *et al* (1988) found rates of 200kg/ha/annum of nitrogen were applied by local authority parks and gardens maintenance. At these rates the ODP indicates annual total nitrogen application in Public Open Space and active irrigated areas of around 7 tonnes/annum.

Total Estimated Annual Nitrogen Loading

These data indicate that a total of around 42 tonnes of nitrogen will be applied each year to the Point Grey site at full development.

Proportion of Nitrogen Export

The proportion of applied nitrogen which might enter the Peel-Harvey Estuary and from there could flow out to the nearshore ocean waters may be estimated by:

- applying appropriate estimates of the proportion of applied nitrogen which may reach the groundwater by soil leaching processes;
- assuming all nitrogen reaching the groundwater also enters the Peel-Harvey Estuary; and

- assuming all nitrogen entering the Estuary is exported to the ocean via the Dawesville Channel and Mandurah Channel.

Sharma *et al* (1996) found that between 1.2% and 4% of nitrogen applied to residential lawns in Spearwood Dune landforms in Perth could pass the root zone, and (if subsequent nitrification and denitrification are ignored) could then enter the water table.

Gerritse *et al* (1988) noted research by Kolenbrander (1972) which found that nitrogen uptake in the root zone is very efficient and possibly less than 10% applied nitrogen could leach to groundwater if tree loppings and grass clippings were exported.

If the upper limits of these two estimates (ie 4% and 10% export rate) are applied to the nitrogen application estimate of 42 tonnes/a, a potential export rate of 1.7 to 4.2 tonnes/annum is established for the site.

Comparison to Existing Export of Nitrogen from Peel-Harvey Estuary

The *Southern Metropolitan Coastal Waters Study* (DEP, 1996) estimated that between 450-900 tonnes of nitrogen are exported to adjacent ocean waters from tidal outflows from the Peel-Harvey Estuary.

The estimates of nitrogen export made here indicate that Point Grey could be expected to add up to 4.2 tonnes/a of nitrogen to the estuarine water body. If all of the 4.2 tonnes were exported to the ocean, then the total increase due to Point Grey would be less than 1% of the current estimated nitrogen export.

Recognising the conservative assumptions incorporated in the analysis present here, it is reasonable to assume additional nitrogen export to nearshore oceanic waters will be negligible.

(iii) Statement of Planning Policy No. 2

This document establishes general and specific policy provisions which specify the way in which sewage and stormwater drainage must be managed.

Policy provisions which are directly relevant to the Point Grey project are set out in Table 4.3 together with an analysis of the compliance of the Outline Development Plan with the policy provisions, based on the description of the proposal given in section 3.0 of this document, and other potential impact analyses provided in this section.

Table 4.3
ODP Compliance with Statement of Planning Policy No. 2

RELEVANT POLICY PROVISIONS	ODP COMPLIANCE ANALYSIS
5. GENERAL POLICY PROVISIONS *Development, including both material changes in land use and the construction of buildings, in the policy area should relate to land capability and suitability and specific management practices (such as effluent treatment, red mud amendment, revegetation and stocking rates). Moreover some of the policy provisions are likely to be conservative and modifications are likely as knowledge improves and new technology becomes available.*	Appropriate analysis of land capability has been carried out and specific solutions to effluent and stormwater management are incorporated in the ODP, taking into account advancements in technology and soil science since 1992.
5.1 Except in accordance with this policy, land shall not be rezoned for urban purposes (which includes special residential but not rural residential or special rural) unless certification is received from the Water Authority that arrangements have been made so that connection to an adequate sewerage service, or alternative system satisfactory to the EPA and Health Department, will be available to all lots in the subdivision.	Connection of all lots within urban and tourist areas to a reticulated sewerage system is proposed. For large lots, either alternative systems satisfactory to EPA and Health Department or conventional systems will be utilised in accordance with requirements of the Shire of Murray.
5.2 Proponents shall ensure that proposed changes to land zonings take account of land capability/suitability criteria with regard to the net effect that such changes are likely to have on the nutrient load discharging from that catchment into the Peel-Harvey Estuarine System.	The effect of the change in land use proposed by the ODP on phosphorus loads has been shown to meet catchment target.
5.4 The retention and rehabilitation of existing remnant vegetation is to be encouraged. A catchment target of 50% of land area established to deep rooted perennial plants, preferably local indigenous species but including high water using and suitable exotic species, shall be attempted. Remnant vegetation shall be retained along water courses, or the margins shall be replanted to higher water-using vegetation, to maintain the stability of banks and exert some control on sediment and nutrient movement.	The ODP is consistent with this provision as will be the Management plans which will be prepared for Foreshore and Conservation Reserves, Nutrient and Irrigation and Landscape.
5.5 Subdivision proposals shall make provision for a drainage system which maximises the consumption and retention of drainage on site. Biological wetland filters, or other means of drainage water retention or treatment approved by the EPA, will need to be incorporated into the drainage design possibly by amendment of the soils in drainage basins or by the provision of wetland filters with nutrient retentive soil amendments in accordance with drainage management to the satisfaction of the State Planning Commission and the EPA. Conservation reserves are not appropriate as biological wetland filters. Development near conservation reserves may require special constraints to protect and preserve them.	The site has well drained deep sandy soil profiles with strong phosphorus retention capacity which provide the basis for retention of drainage on-site, and long term phosphorus storage in soil profiles. Protection of conservation reserves is accommodated by the ODP and protection measures will be incorporated in future detailed design and management plans for the site.
5.6 Open space recreation areas should be carefully designed to retain native vegetation and water, and plant with water using vegetation to minimise the need to apply fertiliser and water. The treatment of open space soils with nutrient retentive soil amendment should be undertaken where phosphorus retention is low and the necessity for this soil amendment should be identified in nutrient management plans prepared by developers. Drainage should be designed to retain nutrients on site in most years; direct drainage off-site will not be permitted unless to the satisfaction of local government.	Open space recreation areas are focussed in locations which have been parkland cleared and which possess soil profiles with high phosphorus retention. On site nutrient retention from drainage will be addressed by detailed design and within management plans which will be prepared for the site.

5.7 The Commission may consider, upon the advice of the Water Authority, the Health Department and the EPA, small-scale subdivisional developments with alternative wastewater treatment and effluent disposal systems for evaluative purposes. The onus of proof will rest with the subdivider to provide sufficient technical and engineering evidence that alternative systems or site modifications remove any adverse effects on public health, water resources or the environment while not detrimentally impacting on the character of the area.	Alternative systems may be considered for large lots in the southern parts of the site subject to site conditions and the requirements of the Shire of Murray.
5.9 Approvals will be required from the Water Authority with regard to water supply from bores, wells, rivers in proclaimed water management areas and WAWA drains and for connection of private and local authority drains to WAWA drains. The limited availability of water may constrain some types of development.	Hydrogeological investigations have demonstrated sufficient water resources to supply the extent of development proposed by the ODP can be obtained. Approvals for water supply will be sought in due course.
6.0 SPECIFIC POLICY PROVISIONS *6.1 Residential and Special Residential zones with lot size up to 4,000m^2 and tourist development.*	
6.1.1 All lots created in the Policy area for residential and tourist use are to be connected to a reticulated sewerage system unless exempted under the provisions of 5.7	A reticulated sewerage system will be made available for all residential lots and tourist developments. For large lots in the south of the site any proposals for alternative or conventional on-site systems will meet the requirements of the Shire of Murray, EPA and Health Department.
6.1.2 Existing vegetation should be retained except where there are defined building envelopes, approved utility requirements and firebreaks. Replanting should be encouraged - particularly along water courses and drains. Where lots do not have building envelopes, existing vegetation may be removed for the construction of approved buildings.	Existing vegetation will be retained wherever possible. Replanting will be specified within management plans to be developed for Foreshore and Conservation Areas, Nutrient and Irrigation and Landscape.
6.2 Rural residential lots over 4,000m2 *6.2.1 Lots that are created in this category should only use conventional on-site effluent disposal if:* *(a) factors such as slope, soil type, permeability, vegetation cover and system design have been addressed. (The onus of proof rests with the subdivider to justify that on-site disposal and/or any associated site modifications would be acceptable to remove any adverse effects on public health, water resources or the environment while not detrimentally impacting on the character of the area),* *(b) environment acceptability can be demonstrated to the EPA,* *(c) at least a 2m vertical separation existing between the base of the leach drain and the highest known groundwater level or bedrock,* *(d) there is at least 100m horizontal separation between the disposal system and the nearest water body, and* *(e) the land unit is satisfactory for on-site disposal at a density of not more than one domestic system per hectare.*	Site investigations indicate compliance with this provision can be achieved. Alternative treatment units (ATU's) will be utilised in any areas which cannot meet these conditions in accordance with the requirements of the Shire of Murray.

	6.2.3 Because of potential nitrate contamination of the groundwater, on-site effluent disposal will be limited to densities of no more than one effluent disposal system per 1 hectare unless specific investigation of the capacity of the local environment to absorb the effluent is undertaken and subject to alternative systems as set out in Clause 5.7.	The ODP and Scheme Provisions comply with this requirement.
	6.2.4 Existing vegetation should be retained except where there are define building envelopes, approved utility requirements and firebreaks. Where lots do not have defined building envelopes existing vegetation may be removed from an area of up to 1,000m^2 for the construction of approved buildings except where special approval is granted for a greater area of clearing.	The ODP and Scheme Provisions comply with this requirement.
6.3	*Recreational facilities (including golf courses, ovals and large grassed areas).* *6.3.1 Local government authorities and landowners shall develop, in association with appropriate government departments, nutrient management plans which identify appropriate irrigation, fertilisation regimes and vegetation patterns.*	Nutrient and Irrigation Management Plans will be prepared for relevant recreational facilities.

4.9.3 Environmental Management Strategy and Management Plans

The objective of meeting the catchment target for phosphorus export and of minimising nitrogen exports has been a driving principle in the process of identifying and configuring land uses for the site.

Prediction of phosphorus and nitrogen export potential from proposed new land uses has included treated effluent disposal, golf course, tourist and residential areas and public open space.

This modelling has shown that the catchment phosphorus target can be met by the site under the proposed landuses for the foreseeable future, while nitrogen exports are expected to be an insignificant component of the total nitrogen loading from the Estuary to the ocean.

The ability to meet catchment target for phosphorus export derives from the strong phosphorus retention capability of the site's surface soils. Strong phosphorus retention has been demonstrated for the site and the findings are consistent with the findings of research carried out by the Western Australian Department of Agriculture, the Chemistry Centre of WA and the CSIRO's Division of Land Management.

Nutrient export management is also very significantly assisted by the excellent infiltration characteristics of the site's soils. This characteristic supports the disposal of treated effluent to woodlot or golf course irrigation and also creates the opportunity for water sensitive design to be widely employed in the civil engineering services provided throughout the site, removing the need for any stormwater or other wastewater to be discharged directly to the adjacent estuarine waters under normal design specifications for urban and associated landuses. This design focus on stormwater disposal by infiltrtion meets Best Management Practices BMP #1 - Water Sensitive Stormwater Management System and BMP #I10 - Infiltration Retention Basin established in the document Planning and Management Guidelines for Water Sensitive Urban (Residential) Design (EPA, WAWA, DPUD, 1994).

In recognition of the importance of maintaining water quality in the Peel-Harvey Estuary, soil phosphorus storage will be confirmed by soil and groundwater monitoring at least over the initial years of development. Phosphorus management and monitoring will be undertaken in accordance with a Nutrient and Irrigation Management Plan (NIMP), which will prepared in consultation with the DEP and WRC. Elements of this Plan will include:

- Annual soil profile sampling will be carried out within the treated effluent irrigation woodlot, the golf course and residential areas, with soil samples being analysed to confirm that phosphorus storage is proceeding as predicted by the phosphorus leaching model. The data gained from those analyses will be used to re-run the leaching model in order to confirm that the phosphorus storage lifetimes predicted in this document remain valid.

- Monitor bores will be established in the superficial aquifer in the treated effluent irrigation area, the golf course and at the estuarine fringe, and will be sampled every six months to enable phosphorus and nitrogen concentrations in the superficial aquifer to be measured and the effectiveness of soil storage of phosphorus confirmed.

The findings of monitoring, and any contingency measures which might be indicated by the modelling results will be reported to the DEP annually for the first five years following project initiation and triennially thereafter.

Contingency management methods available to extend phosphorus storage lifetimes, if required, include the following:

- Phosphorus removal efficiency in the sewage treatment plant could be increased. A reduction to 0.5mg/L is technically realistic and would effectively double the phosphorus storage lifetime of soils beneath the woodlot.

- Treated sewage could be pumped offsite for disposal to alternative woodlots on virgin soils.

- Surface soils throughout the woodlot and/or golf course may be amended with red mud/gypsum (RMG) from Alcoa's nearby Pinjarra alumina refinery, substantially increasing the phosphorus storage capacity of the soil profile. Calculations using the modelling procedure applied for this investigation show that the addition of RMG at 20 tonnes/ha could provide an extra 100 years of phosphorus storage in the woodlot. By this means, the phosphorus storage lifetime of the woodlot and golf course could be extended indefinitely.

4.9.4 Environmental Management Recommendation

Environmental Management recommendations which address the EPA objective, specify the management requirements and procedures discussed here, and provide the basis of Town Planning Scheme Amendment Provisions have been developed under the following headings:

-
- Water Sensitive Design;
- Sewage Collection Treatment and Disposal;
- Nutrient Export and Irrigation;
- Landscape Management;
- Phosphorus Leaching Monitoring and Modelling Implementation.

4.10 Odours

4.10.1 EPA Objectives

Odours emanating from existing sources or proposed development should not adversely affect the welfare and amenity of nearby land users.

4.10.2 Potential Impacts

Odour nuisances could arise in residential areas if suitable buffers between these areas and potential sources of unpleasant odours, such as the sewage treatment plant, were not incorporated in the Outline Development Plan.

Two potential sites have been considered for the sewage treatment plant:

- the permanent treatment plant site, located on the site's eastern boundary in the centre of the proposed treated effluent irrigation woodlot; and

- a temporary sewage treatment plant site, located on the eastern coastal side of the golf course, which might be used in the event that development commenced in the far north of the peninsula, and which would facilitate the re-use of treated effluent on the golf course.

Figure 3.8 shows the locations of these sites and the boundaries of nearby residential land.

Odour generation from accumulations of decaying algae would have the greatest potential to create nuisance along the south-eastern shore of the peninsula, where summer easterly winds can deposit drifting algae along the shallow edges, and adjacent to the intertidal expanses at the south of Robert Bay.

On the western and northern shores, faster water currents, a different wind pattern and a different estuarine water circulation pattern indicate that odour risk from decaying algae would be much lower than on the south-eastern shore.

4.10.3 Environmental Management Strategy and Management Plans

The buffer zones between residential land and potential odour sources such as sewage treatment facilities will meet all appropriate regulatory agency requirements.

A 500m odour buffer around the permanent sewage treatment plant is provided by the Outline Development Plan. The plant's location at the centre of the proposed effluent irrigation woodlot will enable the majority of the 500m buffer to be provided by the woodlot itself.

The potential site for the temporary sewage treatment plant is located well away from proposed urban zoned-land on land proposed to be golf course fairways. Recognising that any plant located on this site would be temporary, minor encroachments (around 50 to 75m) into the buffer are proposed to the south-east and south-west of the temporary plant site.

The future operator of sewage treatment plants constructed on the site will operate the plants in accordance with appropriate wastewater engineering practice, including the minimisation of odours.

In regard to potential areas for algal accumulation on the estuary shoreline, the achievement of setbacks to residential zoned land has been assisted by siting most residential land on higher, inland parts of the site to take advantage of the views and the yellow Spearwood sand profiles available in those areas.

The only area where residential development will closely approach the shoreline is in the marina precinct, where any short-term odour nuisance from accumulating algae can be

dealt with by direct engineering works including physical removal of stranded algae from popular areas.

Management of any odour nuisance potential will be carried out in cooperation with government agencies which have the responsibility for managing algal accumulations on the Estuary shoreline.

4.10.4 Environmental Management Recommendations

Environmental management recommendations which address the EPA objectives for odours and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.1 Outline Development Plan Design Strategy
- 6.6 Sewage Collection, Treatment and Disposal
- 6.7 Foreshore and Conservation Reserves Management.

4.11 Noise and Dust

4.11.1 EPA Objective

Ensure that noise and dust levels generated from activities associated with the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements and acceptable standards.

4.11.2 Potential Impacts

Inappropriate scheduling and implementation of construction activities which generate dust, noise or smoke could cause nuisance to nearby residents during the project commencement phase and during the sequential establishment of future stages adjacent to previously developed areas.

4.11.3 Environmental Management Strategy and Management Plans

The Shire of Murray is responsible for the approval of engineering works within the ODP area.

Construction will be carried out so as to observe guidelines for the prevention of dust and smoke pollution produced by the Department of Environmental Protection (DEP, November 1996) and in compliance with Environmental Protection (Noise) Regulations published in draft form by the DEP in January 1997.

Future developers and associated consulting engineers and contractors will be responsible for the development and implementation of air quality and noise management programs.

The Construction Management Plan to be prepared by the ultimate developers in consultation with consulting engineers, environmental management consultants, contractors, the Shire of Murray and the DEP will incorporate procedures for managing noise, smoke and dust from construction activities and will identify performance criteria and contingency measures should these performance criteria be exceeded.

4.11.4 Environmental Management Recommendations

Environmental management recommendations which address the EPA objective for noise and dust and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following heading in Section 6.0:

- 6.12 Construction Management.

4.12 Turbidity

4.12.1 EPA Objectives

Minimise construction impacts and the potential for ongoing turbidity problems by complying with relevant statutory requirements, Peel Inlet Management Authority policies, and sound design.

4.12.2 Potential Impacts

Turbidity plume generation, resulting in water discolouration and smothering of benthic fauna in settlement areas, is the principal potential impact.

4.12.3 Environmental Management Strategy and Management Plans

Turbidity control during dredging will be a primary consideration during construction of the marina and sailing club.

Dredging associated with marina construction will be minimised by dry excavation of the marina basin using conventional earth moving machinery. The marina site will need to be dewatered to allow dry excavation. Water extracted during dewatering will be directed to a settling pond to reduce suspended solids concentrations prior to discharge into the Estuary or into infiltration basins on land (depending upon its salinity) to the satisfaction of PIMA. When the marina basin is first connected to the Estuary there will be some localised turbidity, which is expected to be dissipated quickly by strong tidal currents associated with the Dawesville Channel and is not expected to have any lasting effect on the estuarine environment. High turbidity is a natural seasonal event in the Peel-Harvey Estuary due to sediment resuspension during strong winds.

Dredging of the sailing club entrance channel will probably be achieved by a tracked excavator or similar machine at a time of very low tides. Spoil from this dredging will be placed either next to the channel or on shore, depending on its composition and the timing of dredging.

All dredging and discharge of dewatering fluid will be conducted in accordance with PIMA requirements, particularly PIMA's Dewatering Policy WS4.2 and Dredging Policy WS4.1.

A Dredge Spoil Disposal Management Plan will be prepared, in accordance with PIMA requirements, for all dredging activities at the site. The plan will:

- describe the dredging operations including the volume and nature of spoil, the placement method for the spoil and the final profiles of the dredged and filled areas;
- describe the measures to be taken to prevent unacceptable impacts on the water quality and other environmental attributes of the Estuary;
- describe criteria to trigger implementation of specified management measures; and
- assist PIMA in assessing the acceptability of the proposed works and issuing appropriate permits for the work.

The potential for erosion of the constructed islands by tidal currents has been addressed by current measurement studies and engineering design.

Current measurements carried out during the field investigations suggested that tidal currents in the vicinity of the marina on the flood tide were in the order of 0.1m/s, which was about 10% of the simultaneous velocity in the Dawesville Channel. A current of this magnitude would be unlikely to cause erosion of any material larger than fine organic ooze. This corresponds with observations made by Department of Transport and PIMA personnel, who have described the loss of fine organic sludge from the sediments in subtidal shallows along the west coast of Point Grey since the opening of the Dawesville Channel but have otherwise found the region to have remained physically stable.

In order to further minimise the potential for erosion of the islands, the northern and western shorelines of the islands will be constructed of limestone and/or coarse sand of a grain size that will not be susceptible to erosion. Ongoing monitoring of the island shorelines will be carried out to ensure that their stability is maintained in the long term.

The marina and sailing club entrance channels will be sited and constructed so as to minimise sedimentation and the need for future maintenance dredging.

If maintenance dredging of the marina or entrance channel were eventually required, the associated turbidity would be localised and would be rapidly dispersed by the tidal currents. Short periods of turbidity are common in the Peel-Harvey Estuary and are not expected to have any significant impact on the estuarine ecosystem. Maintenance dredging would also be subject to approval by PIMA.

4.12.4 Environmental Management Recommendations

Environmental management recommendations which address the EPA Objectives for dredging and spoil management and provide the basis of Town Planning Scheme Amendment provisions are presented under the following headings in Section 6.0:

- 6.13 Marina Construction
- 6.14 Marina Management Agreement
- 6.15 Habitat Island Construction
- 6.24 Marina and Entrance Channel Depth Monitoring Implementation
- 6.25 Water and Sediment Quality Monitoring Plan Implementation.

5.0 SOCIAL IMPACTS AND MANAGEMENT

5.1 Aboriginal Heritage

5.1.1 EPA Objective

Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.

5.1.2 Potential Impact

In the absence of appropriate survey and proper communications with appropriate State Government departments and agreed Aboriginal spokespersons, development may not comply with the Aboriginal Heritage Act.

5.1.3 Environmental Management Strategy and Management Plans

An Aboriginal heritage survey was undertaken by McDonald Hales and Associates during May and June 1996. The survey included archaeological and ethnographic studies. No stone artefacts were located within the study area by the archaeological survey. One scarred tree was noted in the vicinity of the proposed residential village. The study recommends that the tree should be preserved, but acknowledges that if this is not possible, provision can be sought under the *Aboriginal Heritage Act 1972* for the tree to be removed. The site will be investigated with a view to incorporating the area into the overall design as open space.

Consultation is taking place on an ongoing basis with representatives of the Nyungar people through The Winjan Aboriginal Corporation. It is considered that the objectives of the Nyungar people can be achieved within the establishment of a programme to recognise and protect Aboriginal heritage in the relevant area.

All site works will be carried out in accordance with the provisions of the *Aboriginal Heritage Act 1972*. Relevant procedures will be identified within the construction management plan.

5.1.4 Environmental Management Recommendations

Environmental Management recommendations which address the EPA objective for Aboriginal Heritage and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.1 Outline Development Plan Design Strategy
- 6.7 Foreshore and Conservation Reserves Management
- 6.10 Landscape Management
- 6.12 Construction Management.

5.2 Mosquitoes

5.2.1 EPA Objective

Control the breeding of mosquitoes without adversely affecting other flora and fauna.

5.2.2 Potential Impacts

Other than the proposed constructed wetland system, which would incorporate mitigation and control mechanisms for mosquito breeding, no additional potential mosquito breeding habitat will be created on-site. Existing areas adjacent to the site support breeding habitat which could present health and nuisance risks to future residents, in the absence of active management.

There are two main onshore locations in the vicinity of the project area which are potential mosquito breeding areas. These are:

- the Robert Bay drain hinterland; and
- the area of disturbed samphire near the outlet of the Robert Bay drain to the Estuary.

5.2.3 Environmental Management Strategy and Management Plans

(i) Constructed Wetland System

In the event that the construction of the proposed wetland system proceeds, a Wetland Management Plan will be developed which will incorporate structural and operation procedures and equipment for the control of nuisance mosquito breeding. Potential control devices include basin drainage function, water sprays over reed areas and biological and chemical controls.

The management plan will also incorporate the requirement for mosquito numbers to be monitored regularly. In the event that significant breeding of mosquitoes is found to be occurring, control measures will be instituted in cooperation with the local authority programs outside the site, as described below.

(ii) Other Areas

The mosquito monitoring and control measures currently undertaken in populated areas of the Peel-Harvey Estuary by Councils and the Health Department are described in Section 2.4.5. With the increase in population at Point Grey it is envisaged that monitoring and existing control procedures at mosquito breeding sites will need to be extended to the area around Point Grey.

The authority and responsibility for monitoring and control of mosquitoes in areas outside of the project area lies with the Shire of Murray and the Health Department of WA. Any breeding sites identified within the development itself (such as those around the Robert Bay drain) will be the responsibility of the developer until such time as the project is fully developed and management of the site is handed over to relevant government authorities.

5.2.4 Environmental Management Recommendations

Environmental Management recommendations which address the EPA objective for mosquito control and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.3 Mosquito Breeding Habitat;
- 6.17 Robert Bay Wetland Management.

5.3 Risk and Hazard

5.3.1 EPA Objective

Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DME's requirements in respect of public safety.

5.3.2 Potential Impact

The absence of an appropriate buffer separating potentially hazardous facilities from residential areas could create risks to residents which exceed EPA criteria.

5.3.3 Environmental Management Strategy and Management Plans

Chlorine and any other hazardous materials will be stored and used strictly in accordance with all relevant regulatory controls such as the *Dangerous Goods Act 1961* and EPA Licences.

Chlorine gas will be stored and used at the potable water treatment plant and the wastewater treatment plant (located in the south of the site as shown on Figure 3.8). The Operating Licences for such facilities, as well as the *Dangerous Goods Act 1961*, require suitable buffer zones based on individual fatality risk criteria. The size of buffer is based on the position of the ìone in a millionî risk contour, which can be determined by a Quantitative Risk Analysis or, in the case of small plants storing small quantities (eg. a few cylinders) of chlorine and having no nearby residences, by informal means based on experience and local conditions.

In the case of Point Grey, the quantities of chlorine stored will be limited to one or two 75kg cylinders at each treatment plant. Each treatment plant will be surrounded by a 500m development-free buffer zone which encompasses the calculated or inferred position of the one-in-a-million individual fatality risk contour.

5.3.4 Environmental Management Recommendations

Environmental Management recommendations which address the EPA objective for risk and hazard and provide the basis of Town Planning Scheme Amendment Provisions are presented under the following headings in Section 6.0:

- 6.1 Outline Development Plan Design Strategy
- 6.6 Sewage Collection Treatment and Disposal
- 6.8 Water Supply.

6.0 SUMMARY OF ENVIRONMENTAL MANAGEMENT TO BE SPECIFIED BY THE SCHEME AMENDMENT

Environmental management plans that will be prepared during the construction and operation phases of project implementation are described here in Table 6.1. A cross reference is provided to the relevant Scheme provision as proposed in TPS Amendment 104, which will cause these management recommendations to be implemented during the course of development. Table 6.2 reproduces the Scheme provisions for convenient reference.

Table 6.1
Environmental Management Recommendations

Environmental Management Recommendation Number	Environmental Management Recommendation	TPS Amendment Provision Number
6.1	Project Design *Outline Development Plan Design Strategy* The design, construction and management of the development will generally be in accordance with the Point Grey Outline Development Plan and Report, submitted as Amendment 104 to the Shire of Murray Town Planning Scheme No. 4, including commitments detailed in (B) *Special Provisions Relating to the Specified Land* (Schedule 7), or any variations as approved by the Shire of Murray and the Western Australian Planning Commission, subject to advice from the EPA and PIMA.	1a
6.2	*Access Road and Infrastructure Corridors* The access road and infrastructure corridors, including all pedestrian and cycle paths, will be aligned so as to minimise physical impact to the wetlands of Robert Bay, as determined in consultation with the EPA with advice from DEP.	1a
6.3	*Mosquito Breeding Habitat* No additional mosquito breeding areas will be created. Detailed design of water management will seek to reduce mosquito breeding habitat. The conceptual design of any constructed wetland system that might be constructed in the Robert Bay area will incorporate mechanism to mitigate of potential nuisance from mosquito breeding, as determined in consultation with the Shire of Murray.	1a, 4

Table 6.1 (continued)

Environmental Management Recommendation Number	Environmental Management Recommendation	TPS Amendment Provision Number
6.4	*Water Sensitive Design* The development will incorporate water sensitive design for irrigation and stormwater management as determined in consultation with WRC.	1a
6.5	*Marina Design for Water Quality Protection* The marina design will incorporate the EPA objectives for water quality and beneficial use protection described in Table 4.1 of this Environmental Review as determined in consultation with the WRC.	1a, 8
6.6	*Sewage Collection Treatment and Disposal* Sewage generated within the Point Grey project area will be collected, treated and disposed within the site on a self-contained and sustainable basis as proposed in the Outline Development Plan, in accordance with environmental management and public health protection requirements established in current legislation and State Government policy, as determined in consultation with the EPA upon advice from the WRC and Health Department.	1a
6.7	<u>Pre-Construction and Construction</u> *Foreshore and Conservation Reserves Management* Prior to construction, a Foreshore and Conservation Reserve Management Plan shall be prepared in stages for those areas affected, following consultation with the EPA, PIMA, CALM and the Shire of Murray. The Plan will address: (i) the interface between the development and adjacent areas; (ii) management of human pressures; (iii) dieback; (iv) hydrological impacts; (v) the tenure, detailed design and management of Private Conservation Reserves; (vi) the establishment and ongoing management of private conservation areas to provide links to public Reserves; (vii) the protection of areas of limestone outcrop that could provide habitat for the Carpet Python; (viii) the retention of the majority of remnant fringing vegetation and the provision of foreshore buffers and adequate setbacks from waterbird roosting areas; (ix) the design and siting of the proposed dredge spoil islands opposite the marina; (x) the design and construction of the access road to the site; and (xi) water management to reduce mosquito breeding habitat.	4

Table 6.1 (continued)

Environmental Management Recommendation Number	Environmental Management Recommendation	TPS Amendment Provision
6.8	*Water Supply* Prior to construction, a Water Supply Management and Monitoring Plan shall be prepared in consultation with the EPA on advice from the WRC. The Plan will address: (i) groundwater monitoring, data analysis and reporting; (ii) ongoing aquifer modelling to ensure that the growth and ultimate population of the development area is sustainable in terms of the available water supply; and (iii) the identification of appropriate contingency options for water supply.	9
6.9	*Nutrient Exports and Irrigation* Prior to construction, a Nutrient and Irrigation Management Plan shall be prepared in consultation with the EPA, in order to limit phosphorus export from the site to the Estuary so as to comply with the phosphorus loading targets specified in the *Environmental Protection (Peel-Harvey Estuarine System) Policy 1992*. The Plan may be prepared in three steps and will address: (i) irrigation and nutrient management of the Golf Course and other landscaped areas; (ii) management practices and nutrient-related objectives for the on-site treatment and disposal of sewage; and (iii) ongoing monitoring and reporting of phosphorus concentrations and movement in the groundwater beneath the site.	5
6.10	*Landscape Management* Prior to construction, a Landscape Plan shall be prepared in consultation with the EPA. The Plan will address: (i) methods proposed to supplement existing vegetation and increase fauna habitat, particularly in areas of degraded remnant vegetation, in accordance with landscaping requirements, habitat replacement priorities and Planting Guidelines published by the Pinjarra Community Catchment Centre; and (ii) planting of Tuart trees in strategic locations (focussing on the golf course) to enhance the site's landscape and increase the area of potential habitat for the Peregrine Falcon.	10

Table 6.1 (continued)

Environmental Management Recommendation Number	Environmental Management Recommendation	TPS Amendment Provision Number
6.11	*Waterbirds* Prior to construction, a Waterbird Monitoring Plan shall be prepared for important waterbird habitats adjacent to the site, in consultation with the EPA on advice from CALM and PIMA.	11
6.12	*Construction Management* Prior to construction, a Construction Management Plan shall be prepared in consultation with the EPA on advice from the Shire of Murray. The Plan will address: (i) the minimisation of clearing and vegetation disturbance; (ii) the protection of foreshore buffers; (iii) the control and monitoring of dust, noise and smoke; and (iv) the incorporation of environmental protection specifications in all construction-related contracts.	12
6.13	*Marina Construction* Construction of the marina, including the disposal of dewatering fluids and dredge spoil, will meet PIMA requirements regarding the preparation of management plans including a Dredge Spoil Disposal and Management Plan in accordance with published policies, on advice from the WRC.	8
6.14	*Marina Management Agreement* Prior to construction of the marina, an agreement with the Shire of Murray and DOT will be developed that will define responsibilities for the physical maintenance and management of the marina and entrance channel. This agreement will be prepared on advice from the Shire of Murray and DOT.	8
6.15	*Habitat Island Construction* Dredge spoil from the marina will be used to create two offshore islands in accordance with the Foreshore and Conservation Reserve Management Plan. The design of the islands will emphasise the creation of waterbird roosting, feeding and breeding habitats, and will be prepared in consultation with the EPA on advice from CALM and PIMA.	8

Table 6.1 (continued)

Environmental Management Recommendation Number	Environmental Management Recommendation	TPS Amendment Provision Number
6.16	*Constructed Wetland on Robert Bay Drain* In the event that satisfactory arrangements can be reached in regard to funding, ownership and management, and subject to technical validation, a constructed wetland will be developed adjacent to the lower reaches of the Robert Bay Drain, under agreement with PIMA and the Shire of Murray for its ongoing management.	13
6.17	*Robert Bay Wetland Management* Prior to construction of the Robert Bay Wetland, a Wetland Management Plan shall be prepared in consultation with the EPA on advice from PIMA, the Shire of Murray and the Water Corporation. The Plan will address: (i) maintenance of existing drainage functions of the drain; (ii) minimisation of mosquito breeding areas; (iii) maximisation of ecological and habitat functions of the wetland; and (iv) ongoing monitoring of wetland water quality and ecological functions.	13
6.18	Ongoing Management and Monitoring *Foreshore and Conservation Reserve Management Plan Reporting* Annually for the duration of each construction phase, and then at an interval determined by experience, the management of areas adjacent to the relevant construction area and designated within the Foreshore and Conservation Reserve Management Plan will be monitored and reported to appropriate agencies. This commitment will be fulfilled in consultation with the EPA (on advice from the Shire of Murray, PIMA and CALM, in the case of the Foreshore Reserve).	4
6.19	*Nutrient and Irrigation Plan Reporting* Annually for five years following the construction of the golf course, and thereafter every three years, the implementation of the Nutrient and Irrigation Management Plan (NIMP) will be reported to the EPA.	5

Table 6.1 (continued)

Environmental Management Recommendation Number	Environmental Management Recommendation	TPS Amendment Provision Number
6.20	*Phosphorus Leaching Monitoring and Modelling Implementation* Throughout the construction of the sewage treatment plant, annually for five years thereafter, and then at an interval to be determined by experience, monitoring of sewage treatment and treated effluent disposal facilities will be undertaken to confirm phosphorus storage performance in the soil profile. Follow-up phosphorus leaching modelling will be carried out to confirm that phosphorus objectives for the Peel-Harvey Estuary can be met for the foreseeable future. The monitoring and remodelling programme will be detailed in the NIMP, and will be carried out in consultation with the EPA upon advice from the WRC.	5
6.21	*Water Supply Monitoring and Management Implementation* For the duration of the water supply construction phase, annually for five years following completion of the last stage of construction and then at an interval determined by experience, the Water Supply Monitoring and Management Plan will be implemented in consultation with the EPA upon advice from the WRC.	9
6.22	*Waterbird Monitoring Plan Implementation* Annually for five years following the commencement of the Marina and Sailing Club development and then at an interval to be determined by experience, the Waterbird Monitoring Plan will be implemented in consultation with the EPA upon advice from CALM and PIMA.	11
6.23	*Robert Bay Wetland Management Plan Implementation* In the event that the proposed wetland system is constructed near Robert Bay, the Wetland Management Plan will be implemented in consultation with the EPA upon advice from PIMA.	13
6.24	*Marina and Entrance Channel Depth Monitoring Implementation* Annually for five years following the construction of the marina and thereafter at intervals determined by experience, the depths of the marina and entrance channel will be monitored to determine that there is adequate flushing and safe navigable depths, in consultation with the EPA on advice from DOT.	8

Table 6.1 (continued)

Environmental Management Recommendation Number	Environmental Management Recommendation	TPS Amendment Provision Number
6.25	*Water and Sediment Quality Monitoring Plan Implementation* Annually for five years following construction of the marina and thereafter at intervals determined by experience, the Water and Sediment Quality Monitoring Plan will be implemented for the marina in consultation with the EPA upon advice from PIMA.	8

Table 6.2
TPS Amendment 104 Special Provisions

(A)
Specified Land

Lots 75, 137, 138, 139, 293, 299, 322, 672, 727, 729, 738, 740, 1132, 1133 and 1145 Point Grey

(B)
Special Provisions Relating to (A)

1) SUBDIVISION AND DEVELOPMENT

(a) Subdivision and development shall generally be in accordance with an approved Outline Development Plan or any variations as approved by the Council and the Western Australian Planning Commission.

(b) All lots shall be provided with a reticulated water supply system with the exception of those lots larger than 4,000m2 in area.

(c) All lots shall be connected to a reticulated sewage system serviced by a centralised sewage treatment plant with the exception of those lots larger than 4,000m2 in area.

(d) On lots larger than 2,000m2 building envelopes are to be identified and sited at the subdivision stage.

(e) On lots larger than 2,000m2 no indigenous trees or other indigenous vegetation shall be destroyed or cleared except where the developer of the estate or landowner obtain the prior consent in writing of Council and where such

vegetation is dead or diseased, or where the clearing is required for the purpose of a firebreak, dwelling, outbuilding, fence, on-site effluent disposal system or driveway within the define system or driveway within the defined Building Envelope and for access to the Building Envelope from the road.

2) PERMITTED USES ("P")

(a) Notwithstanding the provisions of Clause 5.2.1 the following uses are classified "P" Uses within the Outline Development Plan:

- Golf course/Clubhouse
- Club Premises.

3) PERMITTED USES ("AA")

(a) Notwithstanding the provisions of Clause 5.2.1 the following Uses are classified as "AA" Uses within the Outline Development Plan:

- Chalet Park
- Bed & Breakfast Accommodation
- Hotel
- Hospital
- Education Establishment
- Marina

4) FORESHORE AND CONSERVATION RESERVE MANAGEMENT

(a) Prior to construction a Foreshore and Conservation Reserve Management Plan shall be prepared for the adjoining reserve areas, following consultation with the EPA, PIMA, CALM and the Shire of Murray. The Plan shall address off-site impacts to System 6 and existing conservation areas; the interface between these areas and development, the management of human pressures and hydrological impacts; and measures for the management of existing vegetation areas.

5) NUTRIENT AND IRRIGATION MANAGEMENT

(a) Prior to construction, a Nutrient and Irrigation Management Plan shall be prepared in consultation with the EPA, in order to limit phosphorus export from the site to the Estuary so as to comply with the phosphorus loading targets in the Environmental Protection (Peel-Harvey Estuarine System) Policy 1992. The preparation of the Plan may be undertaken as three independent studies dependent upon and relevant to the level of development proposed and will address:

(i) irrigation and nutrient management of the Golf Course and other landscaped areas;

(ii) management practices and nutrient-related objectives for the on-site treatment and disposal of sewage; and
(iii) ongoing monitoring and reporting of phosphorus concentrations and movements in the groundwater beneath the site.

6) BUSH FIRE MANAGEMENT

(a) The development of land within the Rural-Residential allotment areas shall be subject to a Bushfire Management Plan approved by Council and the Bushfires Board of Western Australia.

7) RURAL-RESIDENTIAL

The following provisions shall apply to the Rural-Residential ares where allotment areas are greater than 4,000m2.

(a) In order to conserve the landscape, trees and other indigenous vegetation shall not be felled or cleared without the prior written approval of the Council except where required for the erection of a dwelling, outbuildings, effluent disposal system, access ways, fences and firebreaks.

(b) Each dwelling shall be provided with a supply of potable water from either an underground bore or a rainwater storage tank with a capacity of not less than 92,000 litres being connected to a roof catchment with an area of not less than 120m2 in projected plan area. Access shall be permitted to domestic water supplies for emergency fire fighting purposes and all domestic water supply tanks to be fitted with a gate valve to enable fire brigade appliances to draw water. Tank fittings shall be positioned so as to leave 25% capacity of water in the tank.

All water tanks shall be located within the building envelope and where visible from outside of the lot upon which they are situated shall be painted and screened by vegetation to harmonise with the rural character of the locality to the satisfaction of the Council.

(c) Effluent disposal systems of a type that do not minimise the export of nutrients shall not be located closer than 100m to any water source and shall have a minimum 2m vertical clearance to the highest known water table or bedrock. Effluent disposal systems that are of a type that minimise nutrient export shall not be located closer than 30m to a water source.

(d) Any fence, other than a fence which may be required by Council to be erected around a swimming pool, shall comprise non-electrified stock-proof or ringlock fencing to a maximum height of 1.2m above the natural surface of the land, with posts being of split jarrah or treated pine.

(e) Notwithstanding the provisions of Clause 9.2.2 the keeping and rearing of stock shall not be permitted within the subdivision on any lot less than 4ha in area, except for domestic purposes and in such case shall not exceed one horse or one cow or two sheep. Stock may be permitted on allotments of larger than 4ha providing that this does not require nor result in removal of vegetation and that stock numbers are maintained at levels in accordance with the standards of good husbandry to the satisfaction of the Department of Agriculture.

(f) Water Supply Provisions:

(i) The subdivider shall make arrangements satisfactory to the Council for prospective purchasers to be advised that a reticulated water supply cannot be provided by the Water Corporation of Western Australia.

(ii) The land is subject to the provisions of the Water Corporation of Western Australia's By-laws applicable to underground water supply and pollution control. The subdivider shall inform all prospective purchasers in writing of the Water Corporation of Western Australia's requirements mentioned in (c) and (d) above.

(iii) A well licence must be obtained prior to construction of a well or bore to draw groundwater. Groundwater may be drawn from each of the lots to supplement household water supply and to supply water for irrigated development of an area to be determined by the Water Corporation of Western Australia.

(iv) Activities carried out on this land shall not contravene the Water Corporation of Western Australia's By-laws applicable to underground water pollution control.

(g) Where required strategic firebreaks shall be constructed by the subdivider to the specifications of the Bush Fire Board and Council.

8) MARINA MANAGEMENT

Prior to construction of the Marina, a Marina Management Plan shall be prepared in consultation with PIMA, DOT and the Shire of Murray. The Plan shall incorporate:

(i) Design standards to meet EPA objectives for water quality and beneficial use protection;

(ii) A Dredge Spoil Disposal Management Plan to include disposal of dewatering fluids and dredge spoil and construction of two offshore islands to create replacement habitat for water birds;

(iii) A Water and Sediment Quality Monitoring Plan; and

(iv) A maintenance and management agreement for the marina and entrance channel.

9) WATER SUPPLY MANAGEMENT

Prior to construction, a Water Supply Management and Monitoring Plan shall be prepared in consultation with the EPA on advice from the WRC. The Plan will address:

(i) groundwater monitoring, data analysis and reporting;
(ii) ongoing aquifer modelling to ensure that the growth and ultimate population of the development area is sustainable in terms of available water supply; and
(iii) the identification of appropriate contingency options for water supply.

10) LANDSCAPE MANAGEMENT

Prior to construction, a Landscape Plan shall be prepared for each stage of the development, in consultation with the EPA. The Plan will address:

(i) Methods proposed to supplement existing vegetation and increase fauna habitat, particularly in areas of degraded remnant vegetation, in accordance with landscaping requirements, habitat replacement priorities and Planting Guidelines published by the Pinjarra Community Catchment Centre; and
(ii) Planting of Tuart trees in strategic locations (focussing on the golf course) to enhance the site's landscape and increase the area of potential habitat for the Peregrine Falcon.

11) WATERBIRD MONITORING

Prior to construction, a Waterbird Monitoring Plan shall be prepared for those areas adjacent to important waterbird habitat in consultation with the EPA on advice from CALM and PIMA.

12) CONSTRUCTION MANAGEMENT

Prior to construction, a Construction Management Plan shall be prepared for each stage in consultation with the EPA on advice from the Shire of Murray. The Plan will address:

(i) The minimisation of clearing and vegetation disturbance;
(ii) The protection of foreshore buffers;
(iii) The control and monitoring of dust noise and smoke; and
(iv) The incorporation of environmental protection specifications in all construction-related contracts.

13) ROBERT BAY WETLANDS MANAGEMENT

Prior to construction of the Robert Bay Wetland, a Wetland Management Plan shall be prepared in consultation with the EPA on advice from PIMA, the Shire of

Murray and the Water Corporation. The Plan will address:

(i) maintenance of existing drainage functions of the drain;
(ii) minimisation of mosquito breeding areas;
(iii) maximisation of ecological and habitat functions of the wetland; and
(iv) ongoing monitoring of wetland water quality and ecological functions.

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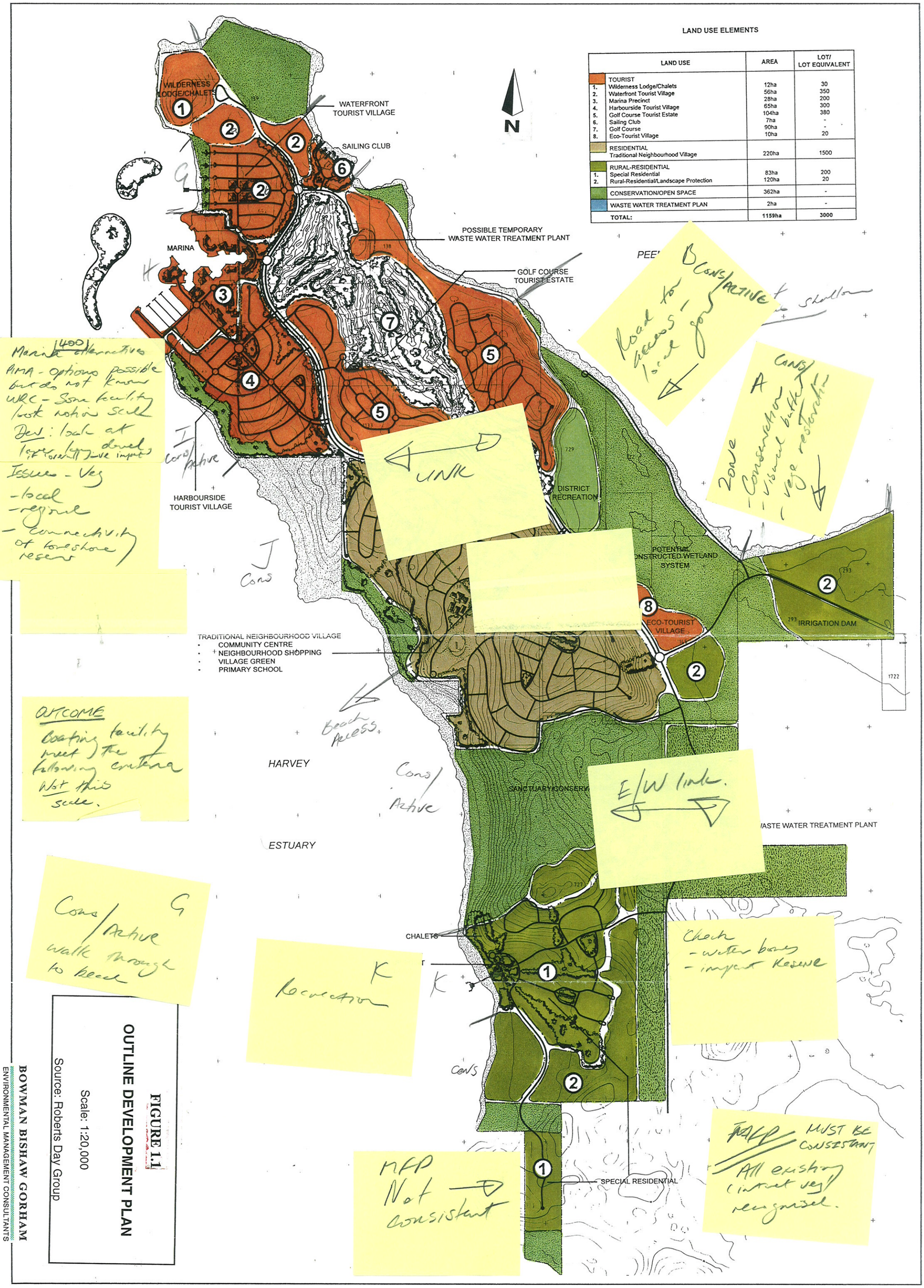
FIGURES



LAND USE ELEMENTS

LAND USE	AREA	LOT/ LOT EQUIVALENT
TOURIST		
1. Wilderness Lodge/Chalets	12ha	30
2. Waterfront Tourist Village	56ha	350
3. Marina Precinct	28ha	200
4. Harbourside Tourist Village	65ha	300
5. Golf Course Tourist Estate	104ha	380
6. Sailing Club	7ha	-
7. Golf Course	90ha	-
8. Eco-Tourist Village	10ha	20
RESIDENTIAL Traditional Neighbourhood Village	220ha	1500
RURAL-RESIDENTIAL		
1. Special Residential	83ha	200
2. Rural-Residential/Landscape Protection	120ha	20
CONSERVATION/OPEN SPACE	362ha	-
WASTE WATER TREATMENT PLAN	2ha	-
TOTAL:	1159ha	3000

FIGURE 1.1
OUTLINE DEVELOPMENT PLAN
Scale: 1:20,000
Source: Roberts Day Group

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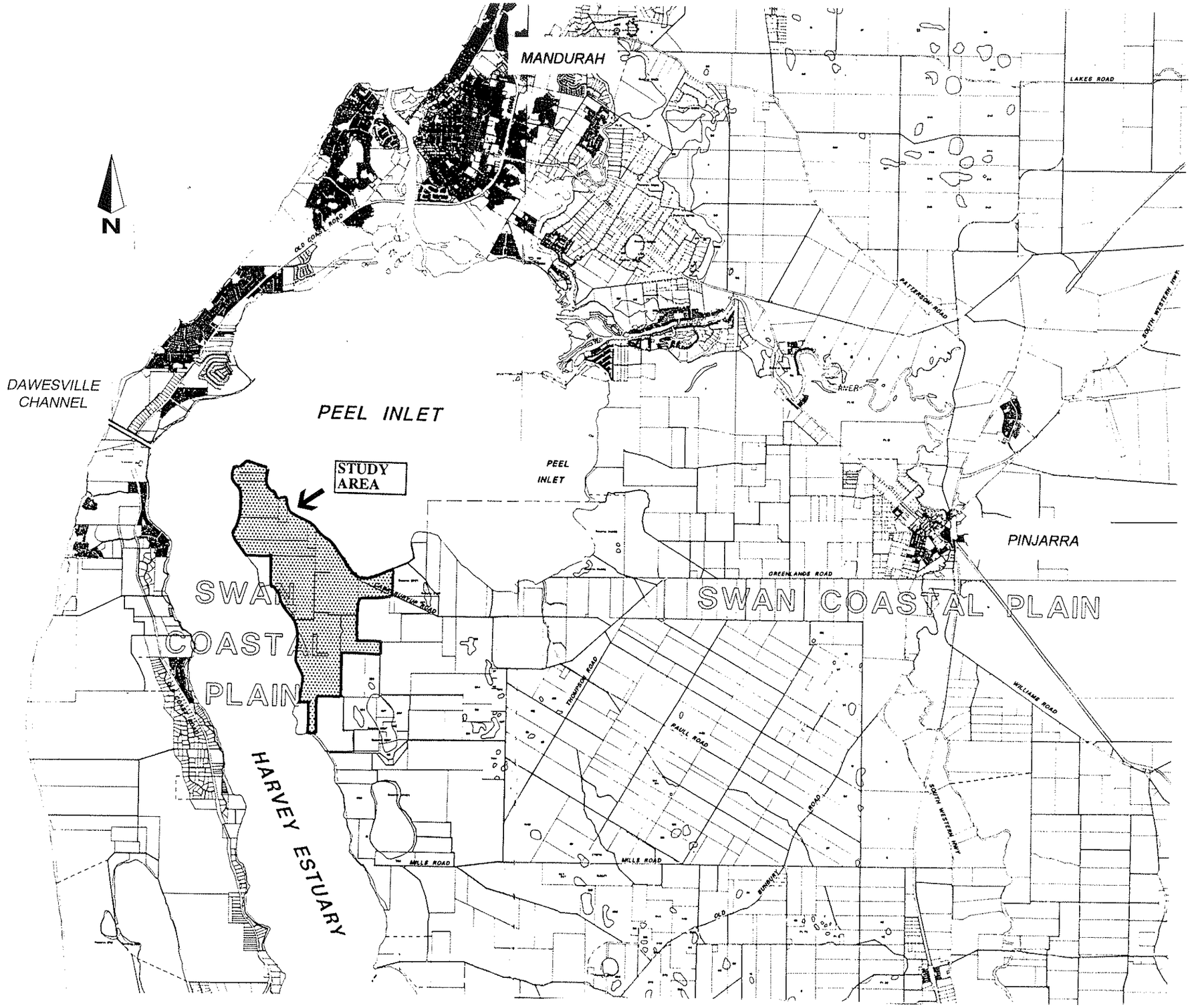

FIGURE 1.2

Site Location of Pt Grey

Scale: 1:115,000

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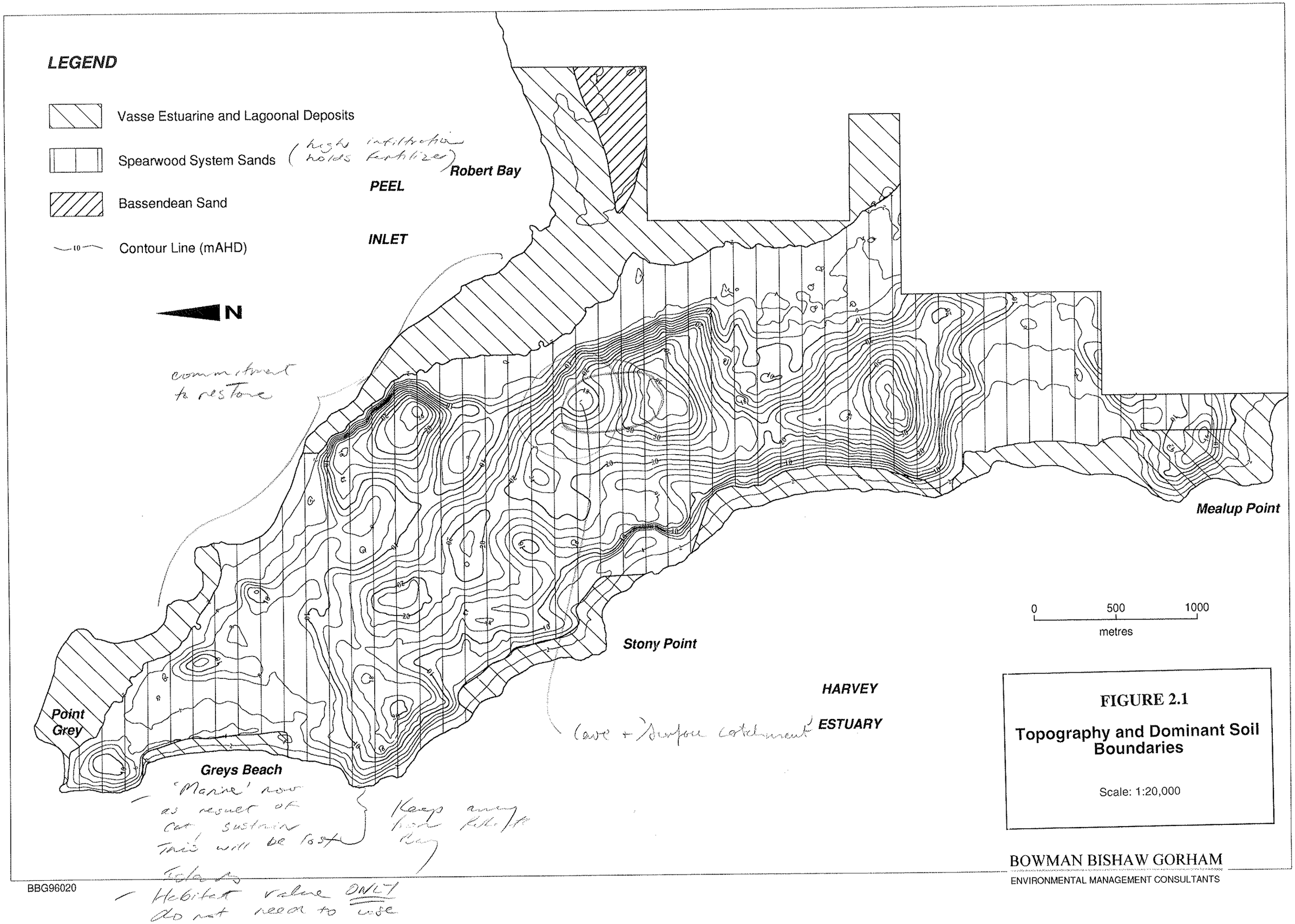

FIGURE 2.1

Topography and Dominant Soil Boundaries

Scale: 1:20,000

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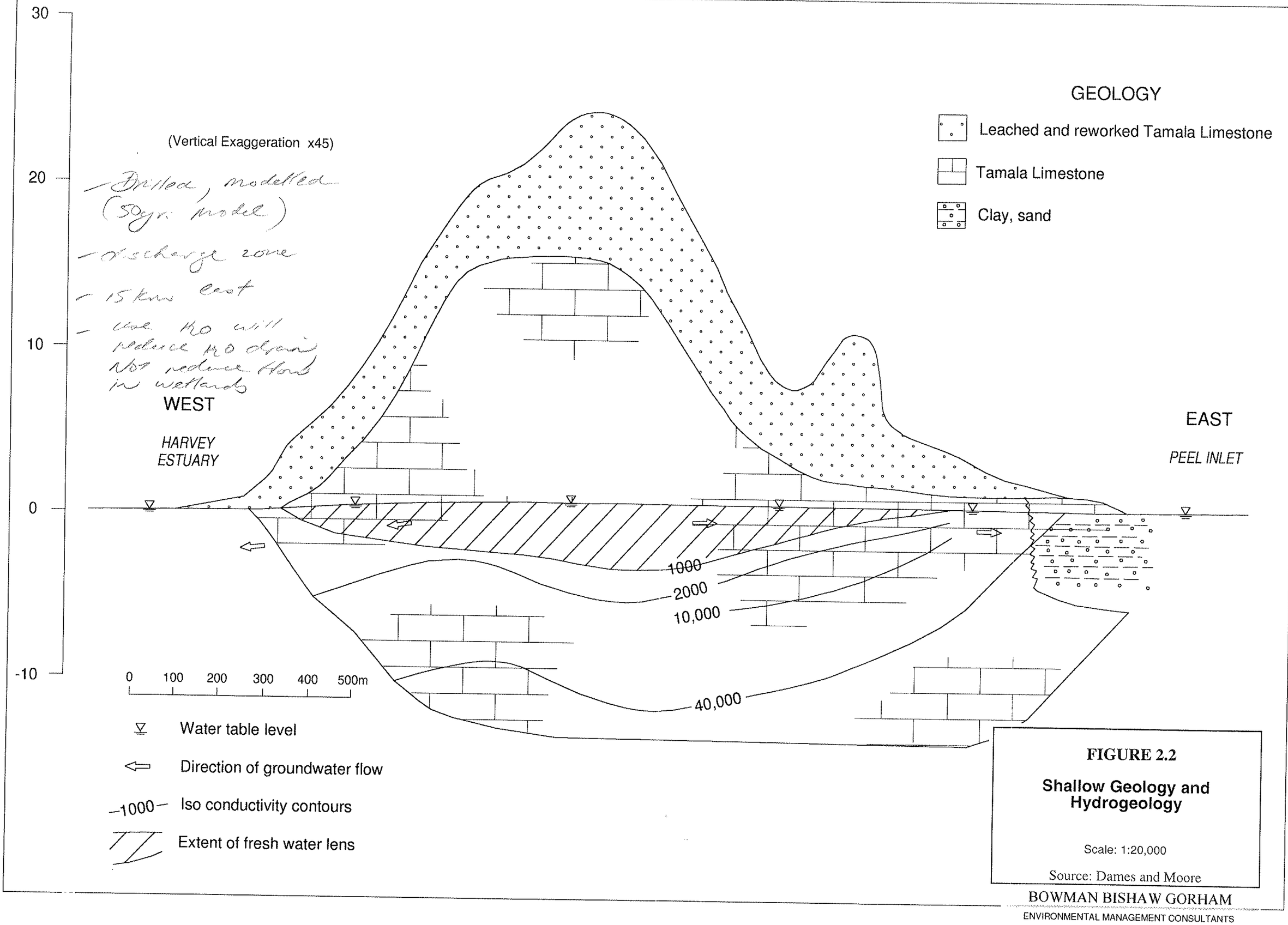

FIGURE 2.2

Shallow Geology and Hydrogeology

Scale: 1:20,000

Source: Dames and Moore

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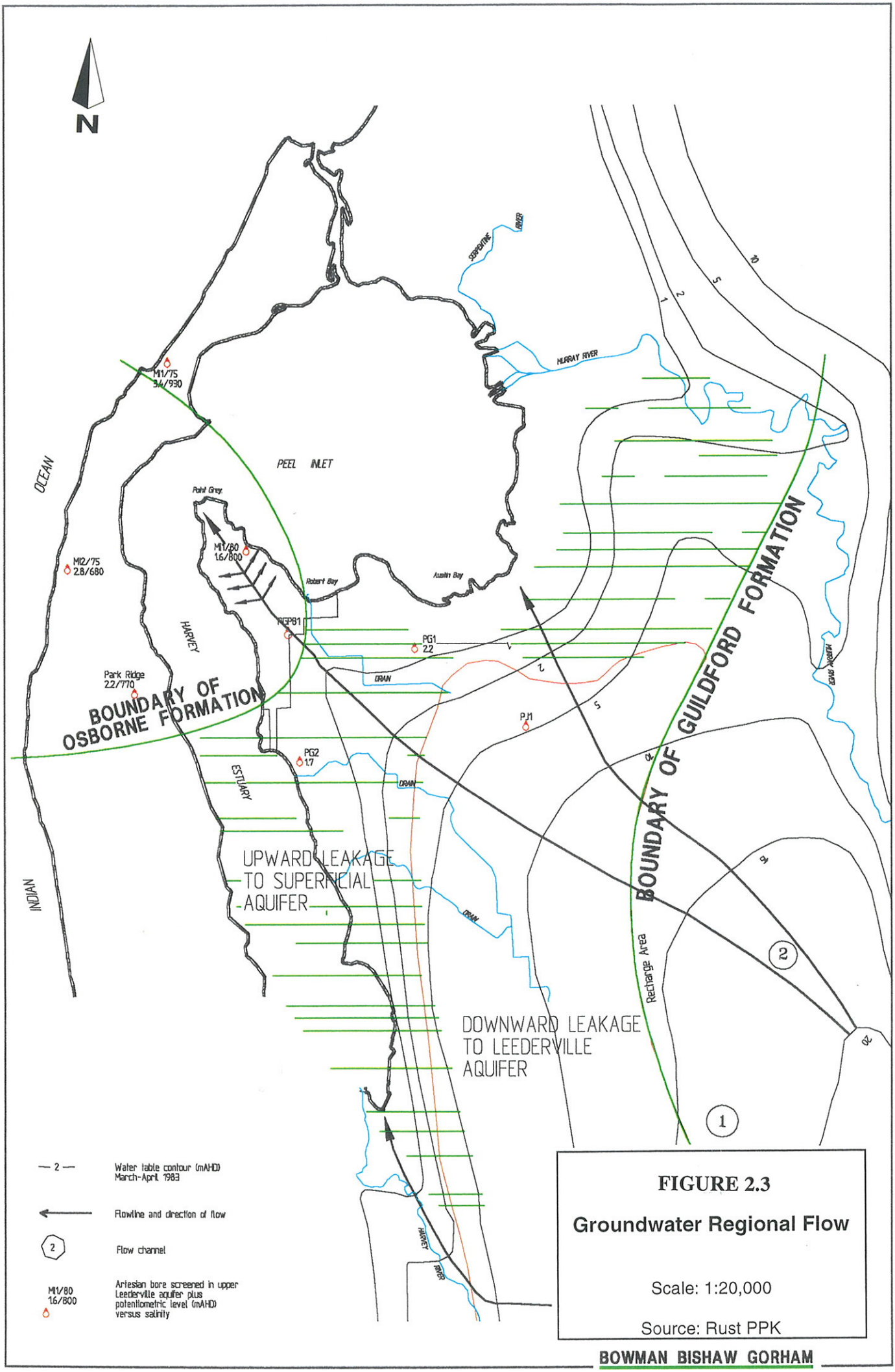

FIGURE 2.3

Groundwater Regional Flow

Scale: 1:20,000

Source: Rust PPK

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LEGEND

1	Good	Canopy and understorey intact or nearly so. Minimal or no weed invasion and little other disturbance evident.
1/2		Patches of condition 1 and 2
2	Fair	Canopy intact or nearly so, understorey altered with major presence of exotics, but still a diversity of native species.
2/3		Patches of condition 2 and 3
3	Poor	Canopy intact or with some clearing. No native understorey species present.
4	Depauperate	Either totally cleared or only isolated trees remaining. Pasture and other exotic species present.

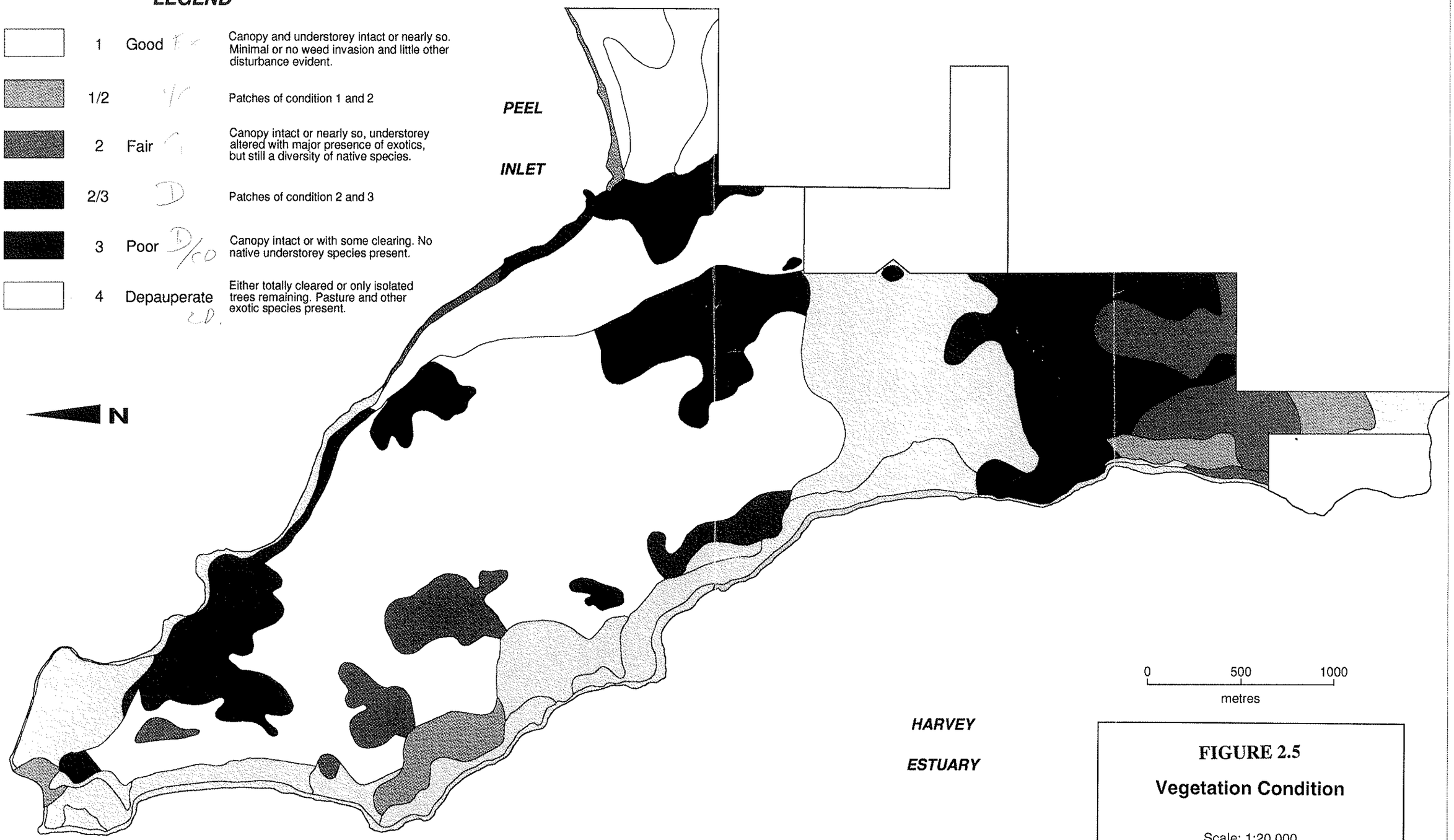

FIGURE 2.5

Vegetation Condition

Scale: 1:20,000

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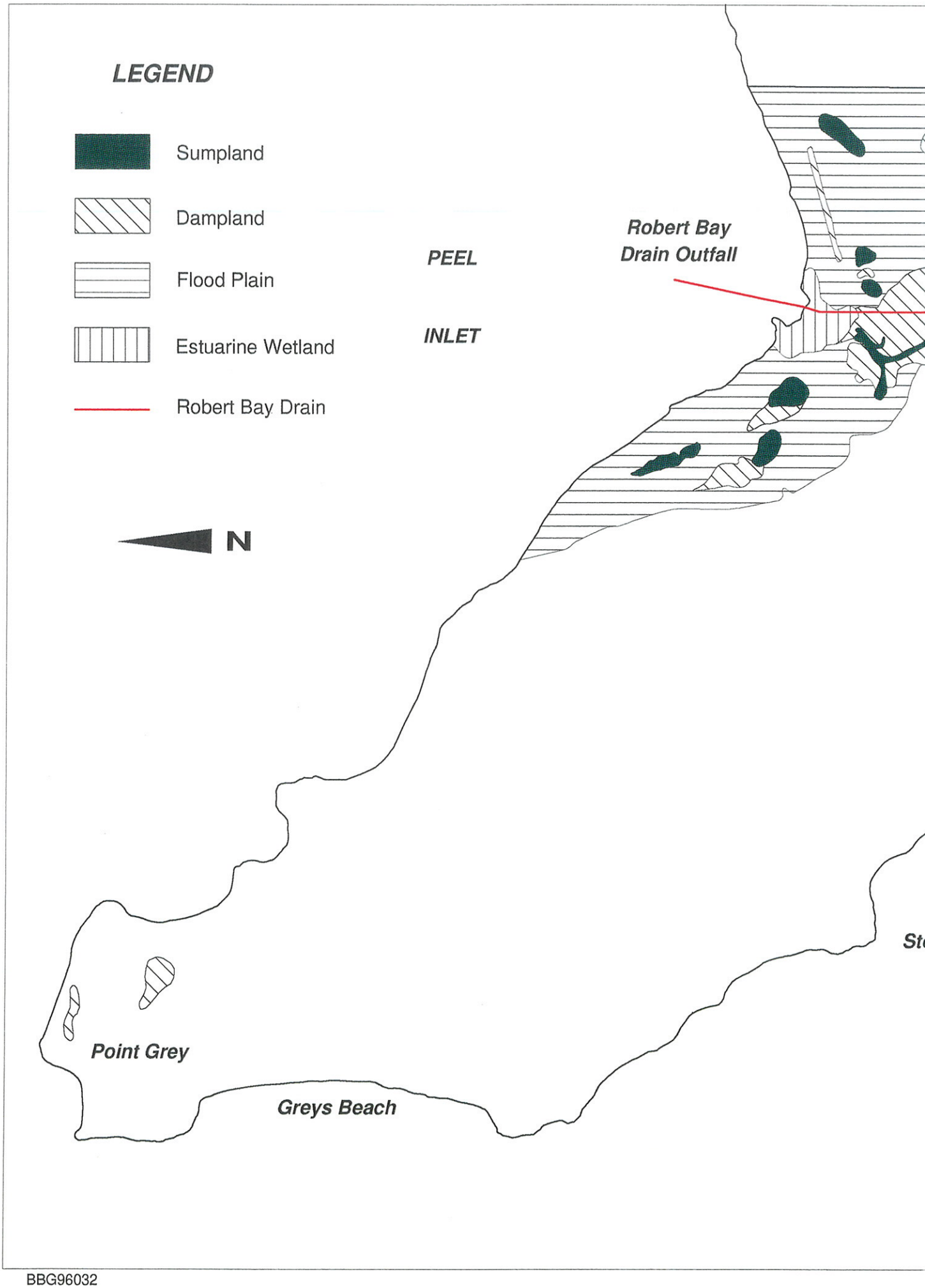
LEGEND
Sumpland
Dampland
Flood Plain
Estuarine Wetland
Robert Bay Drain
PEEL
INLET
Robert Bay
Drain Outfall
N
Point Grey
Greys Beach

BBG96032

N

Robert Bay

Robert Bay Drain Outfall

PEEL

INLET

Mealup Point

Stony Point

Point Grey

Greys Beach

HARVEY

ESTUARY

0 500 1000

metres

LEGEND

- Scattered patches of *Halophila ovalis*, occasional *Zostera* and *Ruppia* in some patches
- Dense *Halophila ovalis* – increasing in response to marine influence.
- Patches of *Ruppia megacarpa*, occasional rocks with macroalgae
- *Chaetomorpha* over anoxic mud
- Shallow, bare sediments

FIGURE 2.7

Seagrasses Surrounding the Pt Grey Peninsula

Scale: 1:20,000

BBG96023

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FIGURE 2.8

Samphire Marsh Distribution in the Peel-Harvey Area

Scale: 1:130,000

Source: MCComb *et. al.* 1995

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FIGURE 2.9

Existing Reserves and Foreshore Areas

Scale: 1:20,000

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FIGURE 3.1

Marina Village Tourist Resort

Scale: 1:20,000

Source: Peter Cala and Associates

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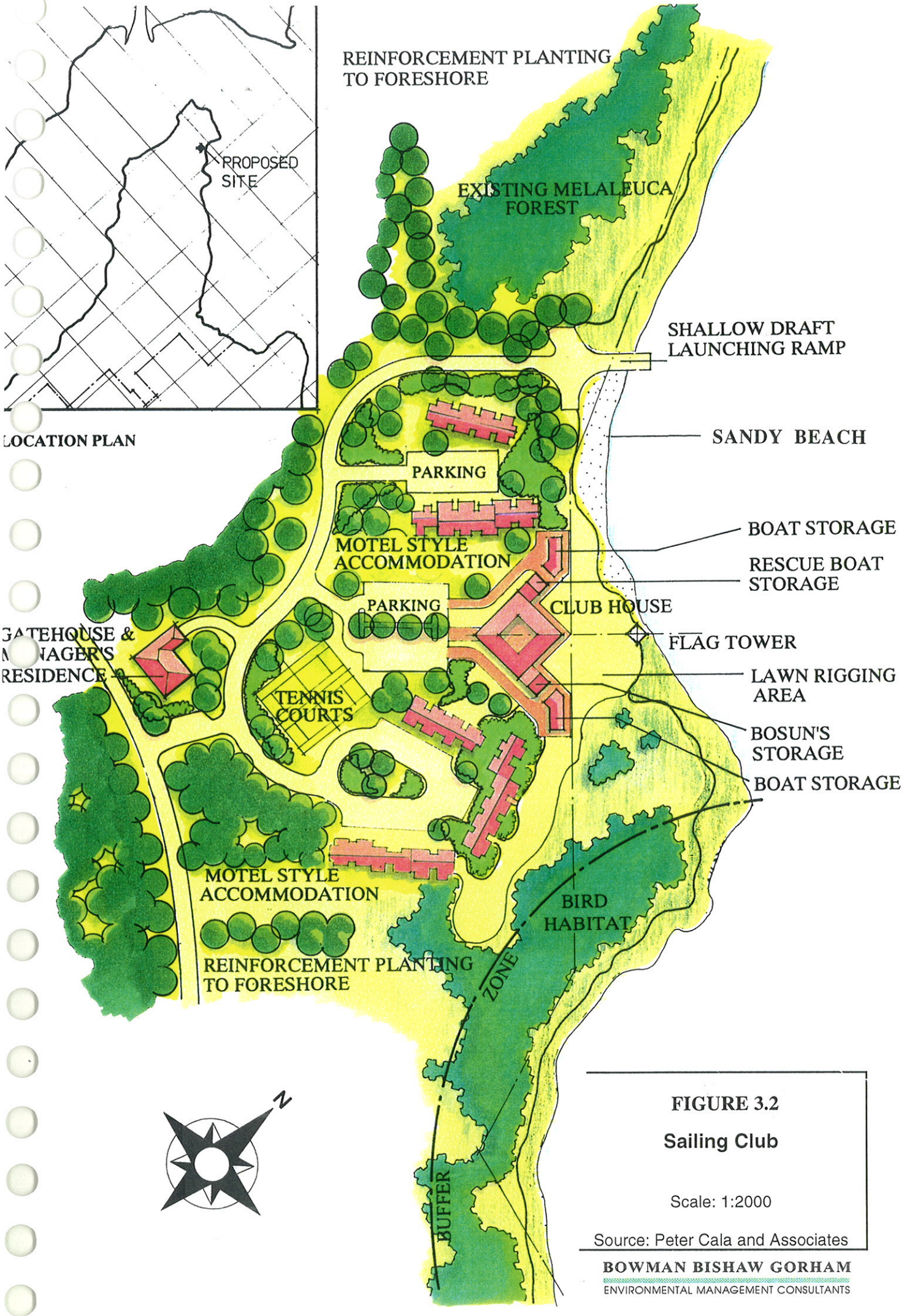

FIGURE 3.2

Sailing Club

Scale: 1:2000

Source: Peter Cala and Associates

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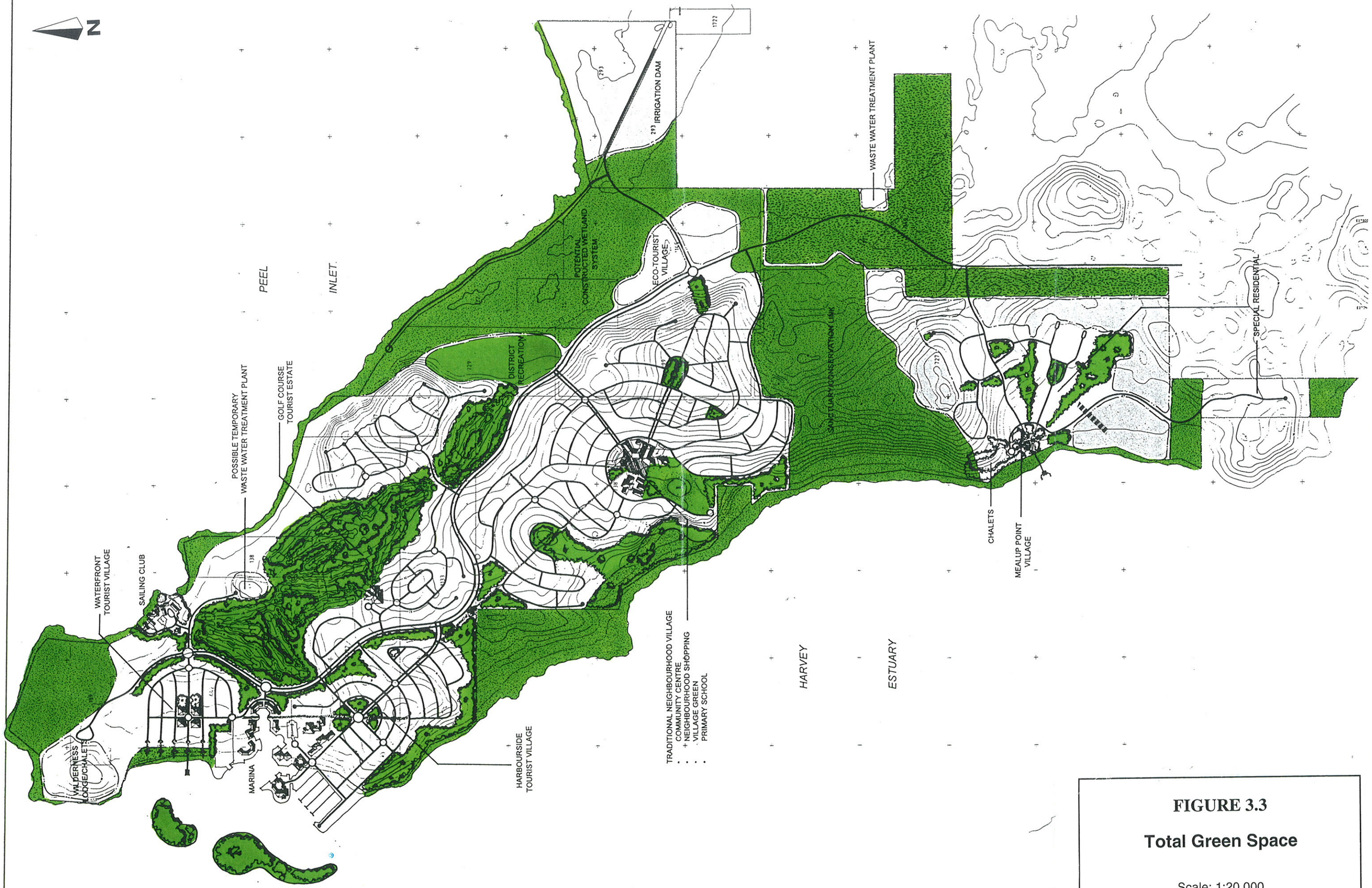

FIGURE 3.3

Total Green Space

Scale: 1:20,000

Source: Roberts Day Group

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FIGURE 3.4

Robert Bay Wetland

Scale: 1:2000

Source: Peter Cala and Associates

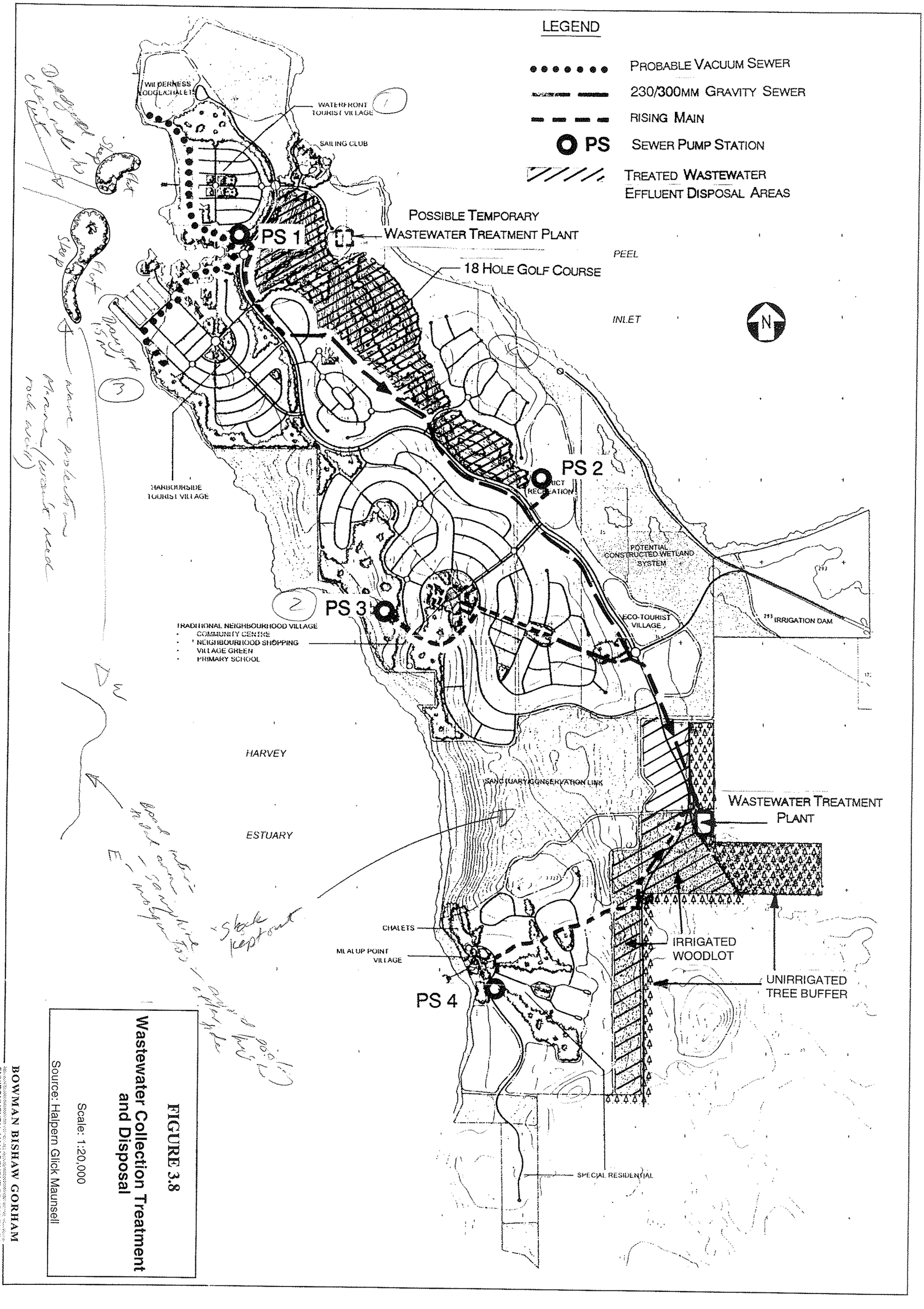

FIGURE 3.8

Wastewater Collection Treatment and Disposal

Scale: 1:20,000

Source: Halpern Glick Maunsell

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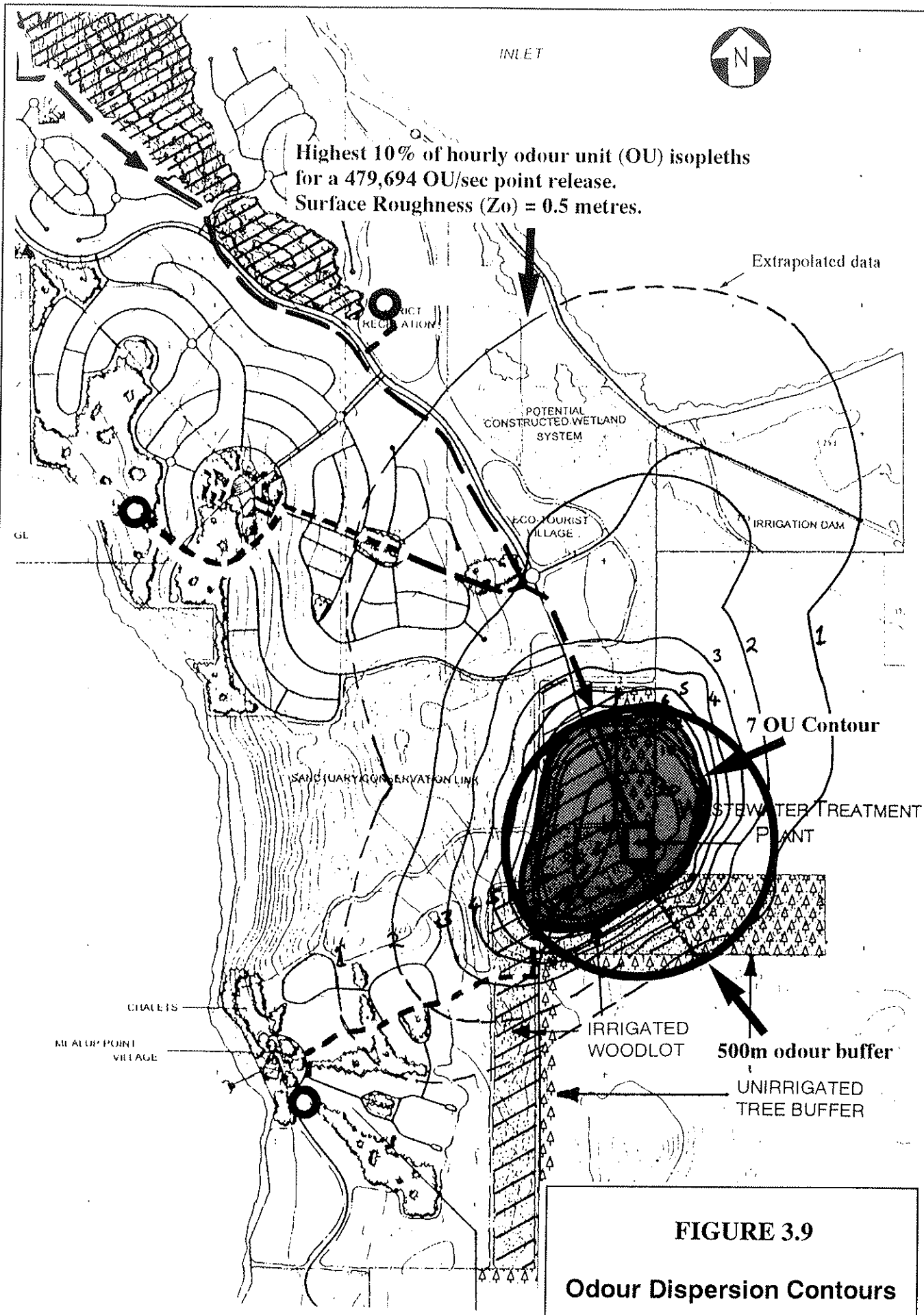

FIGURE 3.9

Odour Dispersion Contours

Scale: 1:20 000

Source: Halpern Glick Maunsell

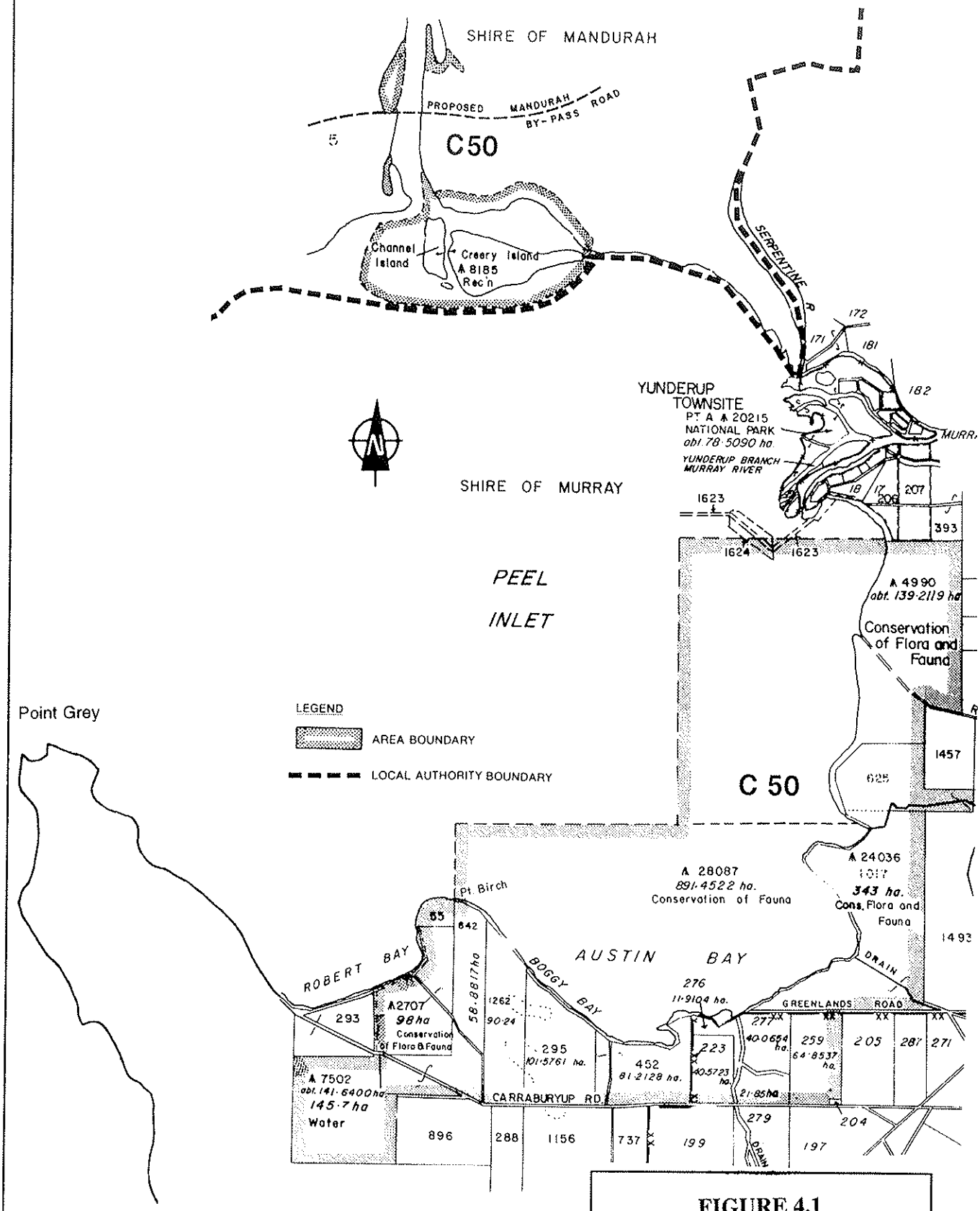

FIGURE 4.1

System Six Areas

Scale: 1:70,000

Source: Department of Conservation and Environment

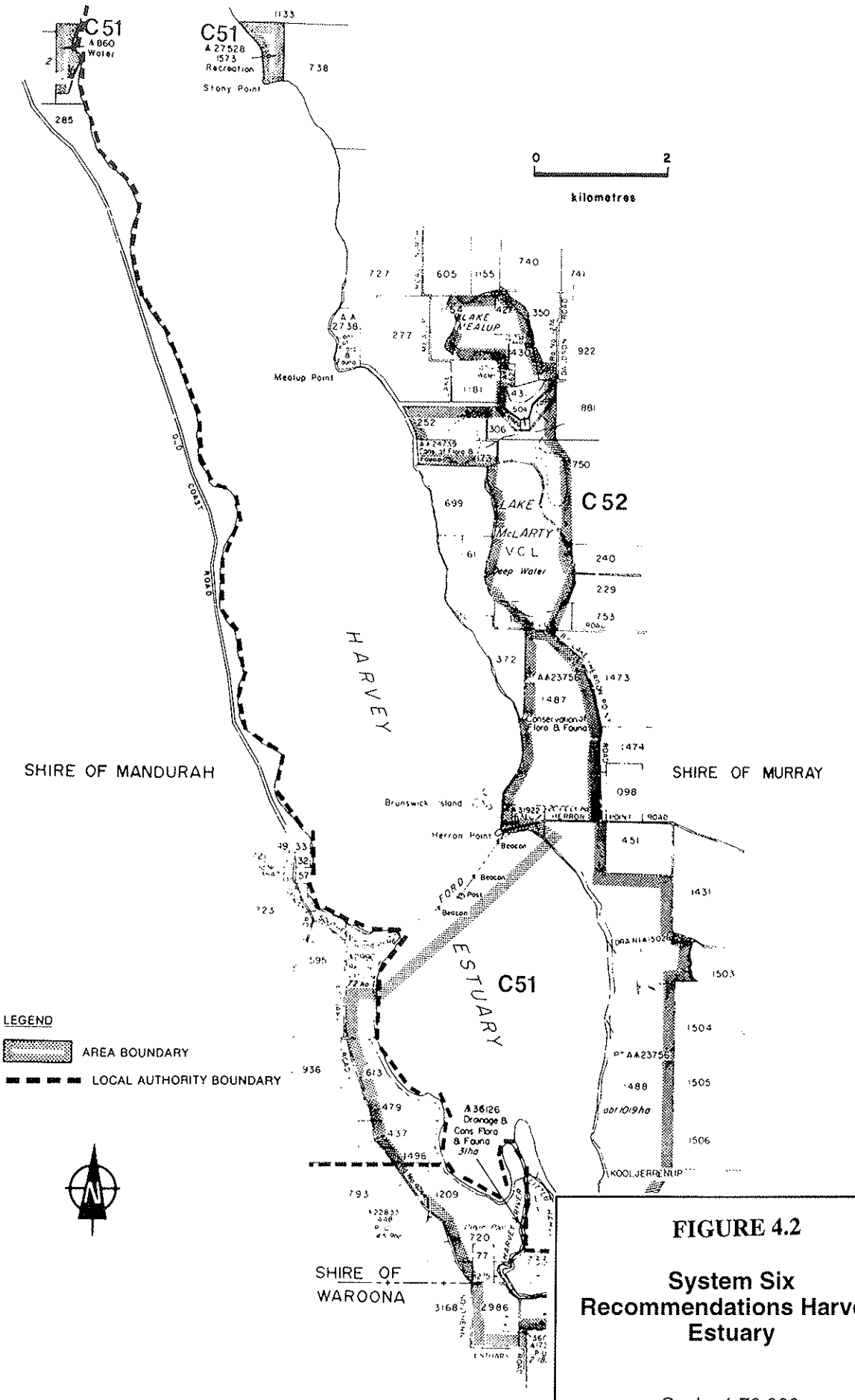

FIGURE 4.2

System Six Recommendations Harvey Estuary

Scale: 1:70,000

Source: Department of Conservation and Environment

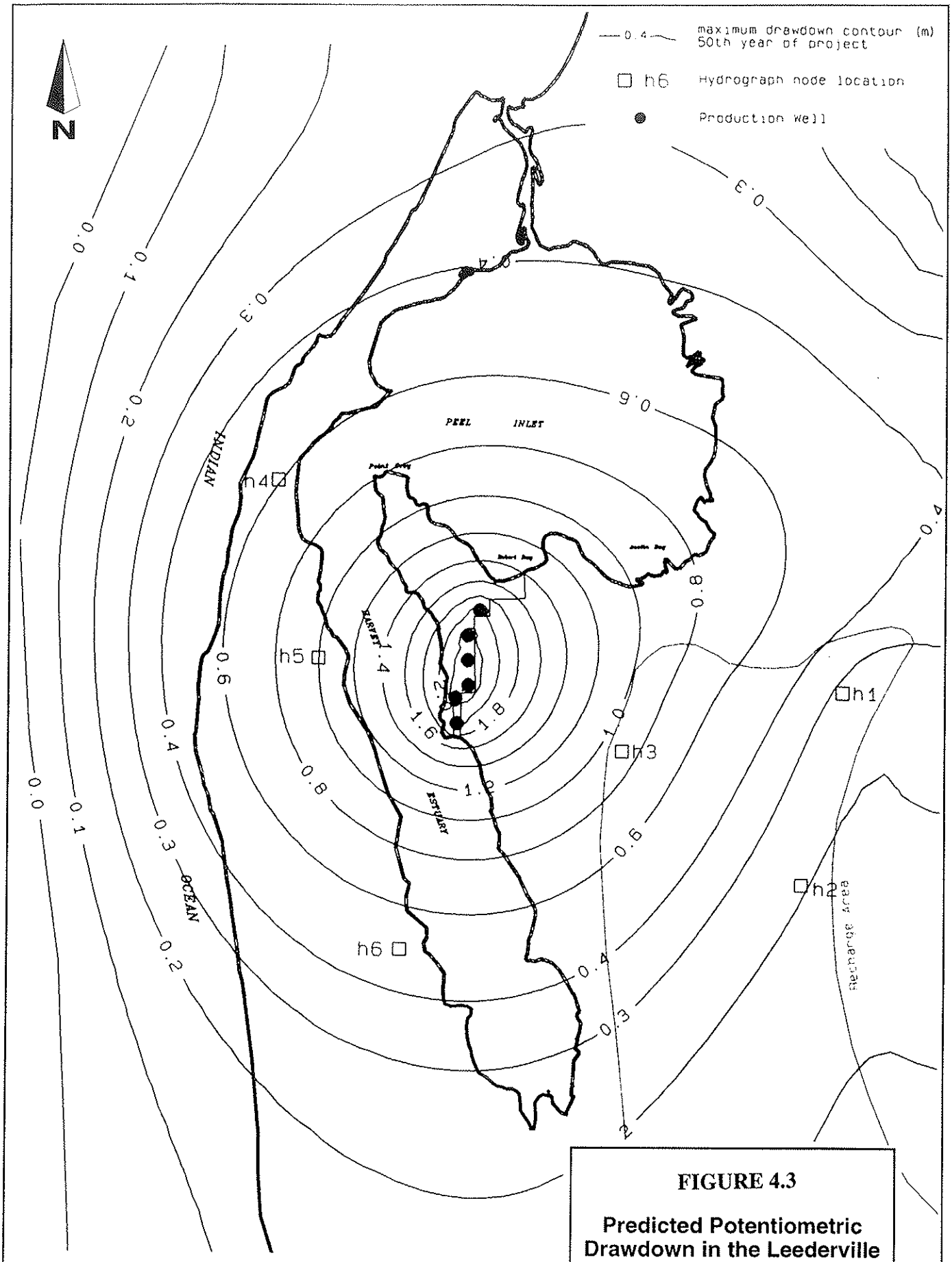

FIGURE 4.3

Predicted Potentiometric Drawdown in the Leederville Aquifer After 50 Years Pumping

Source: Department of Conservation and Environment

APPENDIX A

EPA Instructions

Attachment 1

1. Environmental factors relevant to the scheme

CONTENT		PRELIMINARY OBJECTIVE(S)
Preliminary environmental factors	**Site specific preliminary environmental factor(s)**	
BIO-PHYSICAL IMPACTS		
Terrestrial vegetation		
Vegetation	Reserves 2738 & 2707 and System 6 areas C51 & C52.	(a) Protect vegetation in the existing and proposed conservation estate from direct and indirect impacts; and (b) Maximise or increase the area of vegetative cover, consistent with landscape requirements and the Catchment Centre planting guidelines.
Declared Rare and Priority Flora		Protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act 1950.
Fauna	Waterbirds	Protect important waterbird habitat areas from disturbance consistent with the broad objectives of the Ramsar convention, and the Japan Australia and China Australia Migratory Bird Agreements.
Declared Rare Fauna		Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the Wildlife Conservation Act 1950.
Estuarine vegetation and fauna habitat		Avoid or minimise direct and indirect impacts on ecologically important areas and identify replacement/remediation strategies where ecologically important areas are likely to be impacted.
Estuarine water quality		Meet environmental quality objectives for the Peel Inlet-Harvey Estuary specified in the Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992 and the water quality guidelines specified in EPA Bulletin 711 for the protection of aquatic ecosystems.

Wetlands	Lakes protected by the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992, Wetlands of International Importance and important wetlands identified by the Australian Nature Conservation Agency, including the Peel-Harvey Estuary and Lake Meelup	(a) Maintain the integrity, functions and environmental values of wetlands. (b) Ensure an adequate buffer between the Peel-Harvey Estuary foreshore and the development, taking into account landscape, nutrients and protection of foreshore vegetation.
Groundwater quantity	Leederville aquifer	Maintain the quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected
POLLUTION		
Surface water quality	Peel-Harvey Estuary - general	Ensure compliance with the Environmental Protection (Peel Inlet-Harvey Estuary) Policy Approval Order 1992 and Statement of Planning Policy No 2 1992 *The Peel-Harvey Coastal Plain Catchment,* through the use of best practice particularly for stormwater and sewage effluent management.
Odours		Odours emanating from existing sources or proposed development should not adversely affect the welfare and amenity of nearby land users.
Noise & dust		Ensure that noise and dust levels generated from activities associated with the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements and acceptable standards.
Turbidity		Minimise construction impacts and the potential for ongoing turbidity problems by complying with relevant statutory requirements, Peel Inlet Management Authority policies, and sound design
SOCIAL SURROUNDINGS		

Aboriginal heritage		Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.
Mosquitoes		Control the breeding of mosquitoes without adversely affecting other flora and fauna.
Risk and hazards		Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DME's requirements in respect of public safety

2. Deferred environmental factors

None identified at this stage.

APPENDIX B

Climatic Records

nthly Data for KWINANA (MEDINA RESEARCH CENTRE)

e Number 009194 Latitude 32°13'18"S Longitude 115°48'22"E Elevation 14 metres Opened Mar 1983 Still Open

al Monthly Precipitation (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
83				10.1	34.7	238.2	115.6	137.1	112.8	12.8	51.4	29.4	
1984	0.3	4.2	16.4	46.2	226.9	203.8	87.0	145.8	110.2	41.4	93.2	18.8	994.2
985	0.0	0.0	17.8	60.6	85.2	153.7	180.0	155.8	48.3	35.5	36.6	2.8	776.3
86	1.0	100.8	22.6	3.2	149.6	147.6	239.2	150.0	45.6	24.6	25.6	3.0	912.8
1987	2.4	0.2	14.2	95.0	69.4	153.0	205.2	71.2	42.6	25.2	49.2	17.6	745.2
1988	0.4	1.2	21.4	60.2	147.2	187.4	173.0	87.2	76.6	37.8	48.0	5.2	845.6
89	17.0	32.8	1.4	55.2	148.4	83.6	191.0	102.8	73.8	108.0	7.8	5.6	827.4
990	31.2	10.8	58.2	104.8	88.2	74.2	155.5	98.2	59.4	51.6	13.8	3.2	749.1
1991	2.0	29.8	7.7	38.4	158.7	250.8	185.8	98.9	108.4	40.3	74.0	27.4	1022.2
92	0.8	246.5	41.8	13.2	75.7	164.8	90.4	170.7	54.5	13.4	66.6	10.0	948.4
993	2.1	21.8	18.8	10.6	123.3	96.4	139.8	102.9	97.4	33.6	10.0	2.6	659.3
1994	0.6	1.8	4.8	3.8	103.6	191.6	148.4	140.4	52.6	28.5	7.8	0.0	683.9
95	2.4	0.0	5.0	14.8	121.7	125.0	210.0	70.0	92.4	107.8	52.2	7.4	808.7
996	4.0	0.8	14.0	31.0	45.4	232.6	189.0	112.0	130.0	41.2			

mmary of Total Monthly Precipitation using available data between 1983 and 1996

Mean	4.9	34.7	18.8	39.1	112.7	164.5	165.0	117.4	78.9	43.0	41.2	10.2	831.1
Median	2.0	4.2	16.4	34.7	112.7	159.3	176.5	107.5	75.2	36.7	48.0	5.6	818.1
ghest	31.2	246.5	58.2	104.8	226.9	250.8	239.2	170.7	130.0	108.0	93.2	29.4	1022.2
Lowest	0.0	0.0	1.4	3.2	34.7	74.2	87.0	70.0	42.6	12.8	7.8	0.0	659.3
Number	13	13	13	14	14	14	14	14	14	14	13	13	12

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Contact us by phone on (09) 263 2222, by fax on (09) 263 2233, or by email on climate.wa@bom.gov.au

Monthly Data for KWINANA (MEDINA RESEARCH CENTRE)

Number 009194 Latitude 32°13'18"S Longitude 115°48'22"E Elevation 14 metres Opened Mar 1983 Still Open

Total Monthly Evaporation (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1983				110.7	70.4	50.9	48.0	66.3	91.4	149.1	198.0	211.6	
1984	264.9	250.8	164.7	121.0	62.1	51.2	47.7	65.0	104.4	145.5	170.6	192.4	1640.3
1985	239.4	245.1	186.9	113.7	74.9	45.0	47.5	61.6	92.1	147.0	188.5	211.2	1652.9
1986	281.4	176.0	155.1	103.3	60.1	48.8	50.4	51.9	78.6	129.1	192.8	233.7	1561.2
1987	247.8	232.5	179.4	99.4	60.3	49.4	49.4	67.0	102.1	143.8	171.6	213.5	1616.2
1988	234.3	261.9	194.3	109.6	65.2	43.8	51.9	62.3	84.7	115.5	187.3	224.1	1634.9
1989	226.1	192.2	204.9	103.8	60.6	42.8	41.4	62.2	77.8	121.0	208.9	222.3	1564.0
1990	235.7	202.1	165.1	106.5	61.0	45.0	55.0	74.6	87.8	131.6	180.5	230.3	1575.2
1991	271.2	215.4	186.6	118.3	69.4	50.2	48.0	76.9	85.2	132.7	143.4	236.4	1633.7
1992	284.1	192.2	162.7	126.8	68.6	71.0	58.4	74.2	85.4	134.5	186.6	248.5	1693.0
1993	265.9	226.7	190.8	114.0	80.7	55.6	61.9	70.8	104.8	137.9	188.9	284.5	1782.5
1994	285.0	242.9	215.8					87.0					
1996		274.2											

Summary of Total Monthly Evaporation using available data between 1983 and 1996

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Mean	257.8	226.0	182.4	111.6	66.7	50.3	50.9	68.3	90.4	135.2	183.4	228.0	1635.4
Median	264.9	229.6	186.6	110.7	65.2	49.4	49.4	66.7	87.8	134.5	187.3	224.1	1634.3
Highest	285.0	274.2	215.8	126.8	80.7	71.0	61.9	87.0	104.8	149.1	208.9	284.5	1782.5
Lowest	226.1	176.0	155.1	99.4	60.1	42.8	41.4	51.9	77.8	115.5	143.4	192.4	1561.2
Number	11	12	11	11	11	11	11	12	11	11	11	11	10

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APPENDIX C

Flora and Vegetation Survey

CONTENTS

1. INTRODUCTION

2. METHODS

3. RESULTS

3.1 Flora

3.2 Vegetation

3.2.1 Eucalypt/Banksia Woodland
3.2.2 Tuart Woodland
3.2.3 Spearwood Thickets
3.2.4 Beach Ridge Mosaic
3.2.5 Flooded Gum Woodland
3.2.6 Banksia Woodland
3.2.7 Shoreline Communities
3.2.8 Melaleuca Thickets
3.2.9 Acacia Thickets
3.2.10 Paperbark Swamps

4. DISCUSSION and RECOMMENDATIONS

5. REFERENCES

APPENDIX: CHECKLIST OF THE VASCULAR FLORA

FLORA AND VEGETATION SURVEY
POINT GREY - PROPOSED DEVELOPMENT SITE

1. INTRODUCTION

This report presents the results of a brief survey of the flora and vegetation on the proposed development site at Point Grey in the Shire of Murray.

Although all of the suitable woodland areas have been cleared/partially cleared for pasture in the past, the site has significant stands of remnant vegetation. The vegetation falls within the Spearwood and Bassendean vegetation systems as delimited by Beard (1979, 1981). Beard mapped the vegetation of the area as Tuart Woodland, which would certainly have been predominant on the site prior to clearing.

Previous work on the site (Dames and Moore, 1987) delimited and mapped ten vegetation types on the site. These ranged from Tuart and Jarrah/Banksia Woodland to Grass/Sedge Salt Flats.

2. METHODS

The site survey was undertaken over two days in April. The first visit in the company of Ninox Wildlife Consulting was essentially a familiarisation visit and to ascertain Fauna habitat types. The second day and more detailed survey encompassed all of the perimeter of the site and also several foot transects in selected remnants of the different vegetation types.

Note was taken of the dominant species present, and of the condition of the remnant vegetation. A record of associated species was made opportunistically, and where identification of a species could not be made in the field, a voucher specimen was taken for later identification / verification at the Western Australian Herbarium.

Prior to the site visits, reference was made to the Department of Conservation and Land Management's data base of Rare and Priority listed flora for the area. Particular attention was paid in the field to noting the presence of any of the species on the lists which would be visible or identifiable at the time of the survey.

3. RESULTS

3.1 Flora

A total of 110 taxa from 35 families of vascular flora were recorded during the survey. These are presented as a checklist in the Appendix. The families best represented in this opportunistic survey are the Myrtaceae with 17 species and the Proteaceae with 12 species. The Chenopodiaceae, Papilionaceae and Cyperaceae are also well represented.

Groups most likely to be under represented in the checklist because of the opportunistic nature and seasonal timing of the survey include some of the Monocotyledonous families (eg. Anthericaceae and Haemodoraceae), and possibly also the rush and sedge families (Cyperaceae

TABLE 1 (Continued)

TAXON	DISTRIBUTION
Priority Four - Rare Taxa *Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors*	
Conostylis pauciflora subsp. pauciflora	Sth of Mandurah, Spearwood sands nr. Estuary
Drosera occidentalis subsp. occidentalis #	Gingin-Pinjarra, winter wet peaty soils
Eucalyptus rudis subsp. cratyantha	Murray River flats, Pinjarra-Mandurah
Villarsia submersa (?)	Nearest south of Pinjarra, freshwater pools

and Restionaceae). Members of the Dicotyledonous genera Drosera, Isotoma, Lobelia, and Stylidium as well as several orchids and annual Asteraceae would be encountered on the site during a visit in Spring.

A summary of the Rare and Priority flora (eight species of Declared Rare / Threatened Flora and 13 taxa in the various Priority categories) which could possibly be present on the site given existing distribution records is given in Table 1. None of these species was encountered during the survey, or has been recorded on the site during previous surveys.

Habitat similar to that known to support the two species of Drakea is present on the site, but intensive surveying in Spring would be necessary to confirm their presence. Similarly, the Priority taxa *Jacksonia sericea, Dillwynia dillwyioides, Consostylis pauciflora* subsp. *pauciflora, Drosera occidentalis* subsp. *occidentalis* and *Villarsia submersa* could possibly be present

Weedy exotics were only recorded if they were present in remnant bushland (ie. not in the pastured areas). Sixteen taxa were identified which makes up just under 15% of the total in the checklist. Many weedy species are also annuals, and several more tuberous/bulbous plants as well as grasses and medic species would be identifiable in late Winter or Spring.

3.2 Vegetation

The vegetation on the site can be classified in broad terms into 10 units. These are based on physiognomy and species composition except for the composite units representing the shoreline communities, and the Beach ridge mosaic vegetation. The units are listed below with a brief description of the structure and dominant species. The units are listed in descending order (by approximation) of the size of intact, or nearly intact remnants remaining on the site. The vegetation types recognised have been mapped along with an indication of their condition in Figure 1.

In general the vegetation remnants that have not been cleared for improved pasture are mostly in a good to fair condition. Even where grazing has taken place, there is a diversity of understorey species still present. Some of the shoreline areas which are used for fishing and crabbing are

more disturbed, and would be described as fair to poor (see legend to Figure 1 for definitions of condition categories).

3.2.1 Eucalypt/Banksia Woodland (see Plate 1)

Distribution: A major remnant of this woodland type occurs across the centre and again right at the southern extension of the site.

Structure: This woodland type is generally fairly dense with a multi-layered canopy. The understorey is dense and diverse, consisting mostly of shrubs under a metre in height and a range of sedge and rush species

Main Species: The canopy is formed by a mixture of Jarrah (*Eucalyptus marginata*) and Marri (*Eucalyptus calophylla*), with Sheoak (*Allocasuarina fraseriana*) and various Banksias also present as a second stratum. Important shrubs in the understorey include *Conostephium pendulum*, *Conospermum stoechadis*, and *Hibbertia hypericoides*.

Condition and importance: The remnant of this woodland type on the site is of significance due to its fairly substantial size, shape and condition, which is excellent. Woodland/low forest with a similar canopy composition occurs to the south along the edge of the Harvey Estuary (much of it in the Kooljerrenup Nature Reserve). However, this area tends to be lower lying than on the survey site, and the understorey composition would show definite differences if a comparative survey was undertaken.

3.2.2 Tuart Woodland (see Plates 2 and 3)

+ Marri

Distribution: Prior to clearing, Tuart (*Eucalyptus gomphocephala*) Woodland would have been the principal vegetation type present, and remnants occur throughout the study site.

Structure: The Tuart Woodland generally has a fairly open canopy with mature trees well spaced. The understorey is low, and even when not grazed as it has been on the study site, tends to be more open in structure than in the adjacent Eucalypt/Banksia Woodland.

Main Species: Tuart is the dominant and sometimes the only species present in the canopy. However, in areas where there is limestone outcrop, Sheoak and Candle Banksia (*Banksia attenuata*) may become predominant. Important shrubs in the understorey include *Acacia pulchella, Hakea lissocarpha, Leucopogon pauciflorus*, and *Melaleuca acerosa*.

Condition and importance: Remnants of intact Tuart Woodland are rare locally, and not well represented on the east of the Peel-Harvey Estuary in general. None of the Tuart Woodland on the site is in a natural condition. The condition of the large remnant to the south of the Eucalypt/Banksia Woodland varies between fair, with a suite of native understorey species still present, to poor, where most of the understorey has been grazed out. All other areas which supported this woodland are under improved pasture, although mature Tuarts have been retained.

3.2.3 Spearwood Thickets (see Plate 4)

Distribution: These thickets occur quite extensively just inland of the Shoreline Communities along much of the western edge of the site.

Structure: This is a dense thicket of multistemmed shrubs (broombush type) to about four metres in height. At maturity there are very few understorey species present.

Main Species: Spearwood (*Kunzea ericifolia*) is the dominant species. Other species such as Sheoak, Candle Banksia, Swamp Banksia and *Acacia saligna* may occur as occasional individuals. In Spring orchids and other small herbaceous species may occur.

Condition and importance: This vegetation type on the site has mostly remained uncleared, and due to its impenetrable nature is generally little disturbed. Spearwood thickets of a similar structure and composition are found in comparable habitat southwards along the shores of the Harvey Estuary, and are not uncommon on the coastal plain from Perth southwards.

3.2.4 Beach ridge Mosaic (see Plate 5)

Distribution: Beach ridge Mosaic vegetation occurs on the northernmost part of the point, and also adjacent to the shoreline communities near the south-western end of the site.

Structure: This is a shrubland of varying density and height where the species distribution forms a pattern associated with the variations in topography caused by the old beach ridges.

Main Species: A diverse suite of shrubs, sedges and occasional low trees occurs. Important shrubs include *Jacksonia furcellata, Acacia saligna, Regelia ciliata* and also Spearwood. *Lyginia barbata*, several Lepidosperma species and *Carpobrotus edulis* are common low shrubs. *Banksia littoralis* occurs as an occasional low emergent.

Condition and importance: Except for areas close to access tracks to the water, at both the Point and the southern boundary of the site, this vegetation is in good condition and relatively weed free. This is a diverse community type, and quantitative survey would possibly result in the recognition of several different associations. Similar mixed shrublands occur sporadically along the eastern edge of the Harvey Estuary. However, occurrences are usually small in extent. More detailed surveys would be needed to determine both its extent regionally and variations in species composition

3.2.5 Flooded Gum Woodland (see Plate 6)

Distribution: Flooded Gum (*Eucalyptus rudis*) Woodland occurs on lower lying sites where fresh water is close to the surface. On the study site it is found just inland of the Shoreline Communities on the eastern side of the point, and on the sandy terraces and estuarine alluvium at the north-eastern end of the site.

Structure: This is an open woodland, both in terms of tree spacing and of density of canopy. Small thickets of one of the associated canopy species may also occur, and have been mapped as part of this vegetation type. The undertorey is low and dense.

Main Species: Flooded Gum is the dominant canopy species, although Swamp Banksia (*Banksia littoralis*) and Swamp Paperbark (*Melaleuca raphiophylla*) are also sometimes present. The understorey is mainly one of sedges and rushes and occasionally of samphires and other Chenopod shrubs including *Suada australis* and *Atriplex prostrata*.

Condition and importance: Flooded Gum Woodland is not uncommon regionally, as it occurs along all of the major rivers and on many of the flats around the Peel Inlet. However it is almost universally altered and in only a fair to poor condition. There are small areas on the site where it is in good condition, with a dense rush and samphire understorey. These should be retained if possible.

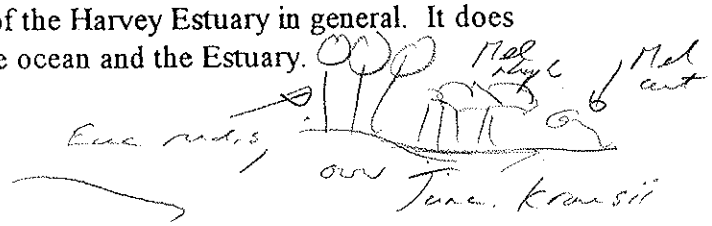
3.2.6 Banksia Woodland (see Plate 7)

Distribution: Banksia Woodland occurs on the crest and upper slopes of the rise at Point Grey, and also just to the north of the Eucalypt/Banksia Woodland about half way along the western boundary of the site.

Structure: This is a woodland/low woodland of varying density and with a fairly open understorey.

Main Species: Candle Banksia (*Banksia attenuata*) is the principal tree present, although several of the Eucalypts may occur occasionally as stunted trees. The understorey when mature as it is on the site is very open and relatively species poor. The main shrub species are *Acanthocarpos preissii, Macrozamia riedlei, Hibbertia hypericoides, Clematis microphylla* and several species of Leucopogon.

Condition and importance: Most of this vegetation type on the site is in good condition although rabbits were noticed here on the Point. There were some deaths on the slopes of the rise facing the Estuary and at its foot which should be investigated for dieback infection. Banksia Woodland is not common on the site, or along the eastern edge of the Harvey Estuary in general. It does occur more prolifically on limestone areas between the ocean and the Estuary.



3.2.7 Shoreline Communities (see Plates 8 and 9)

Distribution: These salt tolerant communities occur in a narrow band along the whole shoreline of the project with their development dependant on the local topography.

Structure: They consist of dense beds of rushes or low shrubs with occasional individuals or clumps of trees.

Main Species: *Juncus krausii* in dense beds is the most noticeable species. In places the rush beds are replaced by samphires and other Chenopod shrubs such as *Sarcocornia blackiana*.

Halosarcia pergranulata, Halosarcia indica subsp. *bidens, Halosarcia halocnemoides, Atriplex hypoleuca*, and *Suada australis*.

Condition and importance: For most of the length of the shoreline this community type is in good condition. There are stretches along Robert Bay which are used for fishing and crabbing where disturbance has led to the loss of some vegetation and the invasion of weedy species. These communities are ubiquitous along the edge of the Estuary and Inlet margins. They are important for shoreline stability and should be maintained wherever possible.

3.2.8 Melaleuca Thickets (see Plate 10)

Distribution: Remnants of these thickets are found on the seasonally wet flats and estuarine alluvium at the north-eastern end of the site, and also around the small swamp along the eastern fenceline.

Structure: In a natural state these thickets have an almost closed canopy to about four metres in height. There are few, if any, understorey species present.

Main Species: Three species form these thickets, with their presence probably dependant on the degree and timing of inundation. These are *Melaleuca viminea, M. uncinata* and *M. raphiophylla*

Condition and importance: Most of the thickets on the flats have been altered extensively with pasture and other weedy species forming a dense groundcover, or cleared completely. Similar thickets are not uncommon on flats around the eastern edge of the Peel inlet

3.2.9 Acacia Thickets (see Plate 11)

Distribution: Only one occurrence was noted on the site. This was at the south and eastern foot and lower slopes of the rise on Point Grey

Structure: These thickets are formed by closely spaced shrubs/small trees, and at maturity form a closed and dense canopy which may reach almost to ground level.

Main Species: *Acacia rostellifera* is the dominant, and sometimes the only species present.

Condition and importance: Rabbits were present in this vegetation type. Otherwise it appeared to be undisturbed. Similar thickets are not uncommon in the sub-coastal environment and around the Peel-Harvey Estuary.

3.2.10 Paperbark Swamps (see Plate 12)

Distribution: There are several basin swamps present on the Point and near the northern corner of the Eucalypt/Banksia Woodland which support a woodland of Paperbarks.

APPENDIX D

Vertebrate Fauna Assessment

REPORT

A VERTEBRATE FAUNA ASSESSMENT OF THE POINT GREY AREA

Prepared for: Bowman Bishaw Gorham

By: Ninox Wildlife Consulting

August 1996

TABLE OF CONTENTS

		Page
1.0	**INTRODUCTION**	1
	1.1 General Description	1
2.0	**METHODS**	1
3.0	**RESULTS AND DISCUSSION**	2
	3.1 Regional Significance	9
	3.2 Local Significance	10
	3.3 Rare Species	10
	3.4 Priority Species	14
	3.5 Significance of Fauna Habitats	15
	3.5.1 Project Area - Western Zone	15
	3.5.2 Project Area - Central Zone	17
	3.5.3 Project Area - Eastern Zone	18
REFERENCES		20

1.0 INTRODUCTION

In July 1987, a comprehensive Environmental Review and Management Programme was prepared for a proposed development on the Point Grey Peninsula (Dames and Moore 1987). This review discussed the area in the context of Peel Estuary and detailed information on fauna was provided, mainly concentrating on aquatic species. The following survey report updates this earlier information and also provides a review of terrestrial fauna habitats. The main purpose of this most recent survey was to provide an overview of the Project Area and its current conservation status.

1.1 General Description

Point Grey is a peninsula situated on the central eastern portion of the estuary and extends for approximately six kilometres in a north-westerly direction. Lake Mealup, an area rich in waterbirds, lies just south-east of the peninsula and is listed in the Register of the National Estate. Most of the coastal periphery of the Point Grey site has a relatively wide and undisturbed band of native vegetation (see Figure 1 and Flora and Vegetation report). Apart from Robert Bay in the extreme southern limits of the Project Area, the intertidal waterbird habitat surrounding the peninsula is fairly narrow compared to other locations on the estuary.

A large proportion of the Point Grey site is parkland cleared (Figure 1) and has been subject to long-term grazing by stock animals. The central portion of the peninsula, however, supports a large area of native vegetation in very good condition, and is a location which has retained much of the woodland understorey that has been lost elsewhere in the Project Area and on the adjacent coastal plain.

2.0 METHODS

The following report is based on a short but intensive survey in early April 1996. Two experienced field zoologists visited the area and spent a total of 20 personnel/hours assessing its current conservation status. The assessment was carried out in association with the project botanist and consisted of a series of vehicle and foot transects which covered all fauna habitats in the Project Area. An appraisal of vertebrate micro-habitat, habitat quality and critical fauna resources was conducted in order to facilitate an assessment of species not recorded during the site evaluation.

Supporting data for the Project Area and Peel Estuary as whole were drawn from a range of sources. These are referenced in text.

3.0 RESULTS AND DISCUSSION

Table 1 shows the fauna recorded during the field assessment. Because the survey took place in autumn a large number of species were not observed, primarily rare, nomadic or migratory birds or terrestrial species which would require a trapping survey to establish their presence. Table 1 also provides details on the bushbirds, mammals, frogs and reptiles which are expected to occur in the area. Table 2 lists the waterbirds known or expected to utilise the Project Area.

Table 1 ***Full listing of the bushbirds, mammals, frogs and reptiles which are expected to occur within the Project Area. Species recorded during the April 1996 survey are marked, as are Rare or CALM Priority List species.***

BIRD SPECIES	STATUS	RECORDED
DROMAIIDAE		
Emu		X
ACCIPITRIDAE		
Black-shouldered Kite		
Square-tailed Kite	CALM Priority List	
Whistling Kite		X
Brown Goshawk		
Collared Sparrowhawk		
Wedge-tailed Eagle		
Little Eagle		X
FALCONIDAE		
Peregrine Falcon	Rare List	
Australian Hobby		X
Brown Falcon		
Australian Kestrel		X
PHASIANIDAE		
Brown Quail		
TURNICIDAE		
Painted Button-quail		X
COLUMBIDAE		
Feral Pigeon		
Laughing Turtle-Dove		
Common Bronzewing		
Brush Bronzewing	CALM Priority List	
CACATUIDAE		
Red-tailed Black-Cockatoo	CALM Priority List	X

	STATUS	RECORDED
Baudin's Black-Cockatoo	Rare List	
Carnaby's Black-Cockatoo	Rare List	
Sulphur-crested Cockatoo	Introduced	X
LORIIDAE		
Purple-crowned Lorikeet		
POLYTELITIDAE		
Regent Parrot		X
PLATYCERCIDAE		
Red-capped Parrot		X
Western Rosella		
Port Lincoln Ringneck		X
Elegant Parrot		
CUCULIDAE		
Pallid Cuckoo		
Fan-tailed Cuckoo		
Horsfield's Bronze-Cuckoo		
Shining Bronze-Cuckoo		
STRIGIDAE		
Southern Boobook		
TYTONIDAE		
Barn Owl		
PODARGIDAE		
Tawny Frogmouth		
AEGOTHELIDAE		
Australian Owlet-nightjar		
ALCEDINIDAE		
Laughing Kookaburra	Introduced	
Sacred Kingfisher		
MEROPIDAE		
Rainbow Bee-eater		
HIRUNDINIDAE		
White-backed Swallow		
Welcome Swallow		X
Tree Martin		X
MOTACILLIDAE		
Richard's Pipit		
CAMPEPHAGIDAE		
Black-faced Cuckoo-shrike		X
MUSCICAPIDAE		
Scarlet Robin		
Western Yellow Robin		
Golden Whistler		X
Rufous Whistler		X
Grey Shrike-thrush		X
Restless Flycatcher		
Grey Fantail		X
Willie Wagtail		

	STATUS	RECORDED
MALURIDAE		
Splendid Fairy-wren		X
Southern Emu-wren		
ACANTHIZIDAE		
White-browed Scrubwren		X
Weebill		X
Western Gerygone		X
Inland Thornbill		X
Western Thornbill		
Yellow-rumped Thornbill		X
NEOSITTIDAE		
Varied Sittella		
MELIPHAGIDAE		
Red Wattlebird		X
Little Wattlebird		
Singing Honeyeater		
White-naped Honeyeater		
Brown Honeyeater		X
New Holland Honeyeater		
White-cheeked Honeyeater		
Tawny-crowned Honeyeater		
Western Spinebill		X
EPHTHIANURIDAE		
White-fronted Chat		
DICAEIDAE		
Mistletoebird		
PARDALOTIDAE		
Spotted Pardalote		
Striated Pardalote		X
ZOSTEROPIDAE		
Silvereye		X
GRALLINIDAE		
Australian Magpie-lark		X
ARTAMIDAE		
Black-faced Woodswallow		
Dusky Woodswallow		X
CRACTICIDAE		
Grey Butcherbird		X
Australian Magpie		X
Grey Currawong		
CORVIDAE		
Australian Raven		X
MAMMAL SPECIES		
TACHYGLOSSIDAE **Monotremes**		
Tachyglossus aculeatus Echidna		
DASYURIDAE **Native Carnivores**		
Phascogale tapoatafa Brush-tailed Phascogale	CALM Priority List	

		STATUS	RECORDED
Sminthopsis griseoventer	Grey-bellied Dunnart		
S. gilberti	Common Dunnart		
S. crassicaudata	Fat-tailed Dunnart		
PERAMELIDAE	**Bandicoots**		
Isoodon obesulus	Southern Brown Bandicoot	Rare List	
PHALANGERIDAE			
Trichosurus vulpecula	Common Brushtail Possum		
BURRAMYIDAE	**Pygmy Possums**		
Cercartetus concinnus	Western Pygmy-possum		
TARSIPEDIDAE			
Tarsipes rostratus	Honey-possum		
MACROPODIDAE	**Kangaroos**		
Macropus irma	Western Brush Wallaby	CALM Priority List	
M. fuliginosus	Western Grey Kangaroo		X
MOLOSSIDAE	**Mastiff-bats**		
Tadarida australis	White-striped Mastiff-bat		
Mormopterus planiceps	Little Mastiff-bat		
VESPERTILIONIDAE	**Bats**		
Nyctophilus major	Greater Long-eared Bat		
N. gouldi	Gould's Long-eared Bat		
N. geoffroyi	Lesser Long-eared Bat		
Chalinolobus gouldii	Gould's Wattled Bat		
Chalinolobus morio	Chocolate Wattled Bat		
Falsistrellus mackenziei	Great Pipistrelle		
Eptesicus regulus	Little Brown Bat		
MURIDAE	**Rodents**		
Hydromys chrysogaster	Water Rat	CALM Priority List	
Rattus rattus	Black Rat	Introduced	
Mus musculus	House Mouse	Introduced	
LEPORIDAE	**Rabbits/Hares**		
Oryctolagus cuniculus	Rabbit	Introduced	X
CANIDAE	**Carnivores**		
Vulpes vulpes	Fox	Introduced	X
FELIDAE	**Cats**		
Felis catus	Feral Cat	Introduced	
AMPHIBIAN/REPTILE SPECIES			
LEPTODACTYLIDAE	**Frogs**		
Crinia georgiana	Red-thighed Froglet		
C. glauerti	Glauert's Froglet		
C. insignifera	Sandplain Froglet		
Heleioporus eyrei	Moaning Frog		
H. psammophilus	Marbled Borrowing Frog		
Limnodynastes dorsalis	Western Banjo Frog		
Myobatrachus gouldii	Turtle Frog		
Pseudophryne guentheri	Guenther's Toadlet		
HYLIDAE	**Frogs**		
Litoria adelaidensis	Slender Tree Frog		

		STATUS	RECORDED
L. moorei	Western Green Tree Frog		
GEKKONIDAE	**Geckos**		
Phyllodactylus marmoratus	Marbled Gecko		
Underwoodisaurus milii	Barking Gecko		
PYGOPODIDAE	**Legless Lizards**		
Aprasia repens	South-western Sandplain Worm Lizard		
Delma fraseri	Fraser's Legless Lizard		
D. grayii	Gray's Legless Lizard		
Lialis burtonis	Burton's Snake-lizard		
Pygopus lepidopodus	Common Scaly-foot		
AGAMIDAE	**Dragon Lizards**		
Pogona m. minor	Western Bearded Dragon		
SCINCIDAE	**Skinks**		
Bassiana trilineata	South-western Cool Skink		
Cryptoblepharus plagiocephalus	Fence Skink		
Ctenotus fallens	West Coast Ctenotus		
C. impar	South-western Odd-striped Ctenotus		
C. lesueurii	Western Limestone Skink		
Egernia kingii	King's Skink		
E. napoleonis	South-western Crevice Egernia		
Hemiergis quadrilineata	Two-toed Earless Skink		
Lerista elegans	West Coast Four-toed Lerista		
L. lineata	Perth Lined Lerista	CALM Priority List	
L. praepedita	Western Worm Lerista		
Menetia greyii	Common Dwarf Skink		
Morethia lineoocellata	Western Pale-flecked Morethia		
M. obscura	Southern Pale-flecked Morethia		
Tiliqua occipitalis	Western Bluetongue		
T. r. rugosa	Bobtail		
VARANIDAE	**Monitors**		
Varanus gouldii	Gould's Monitor		
V. rosenbergi	Southern Heath Monitor		
TYPHLOPIDAE	**Blind Snakes**		
Ramphotyphlops australis	Southern Blind Snake		
BOIDAE	**Pythons**		
Morelia spilota imbricata	Southern Carpet Python	Rare List	
ELAPIDAE	**Elapid Snakes**		
Drysdalia coronata	Crowned Snake		
Neelaps bimaculatus	Black-naped Snake		
N. calonotus	Black-striped Snake		
Notechis scutatus occidentalis	Tiger Snake		
Pseudonaja a. affinis	Dugite		
Rhinoplocephalus gouldii	Gould's Hooded Snake		
R. nigriceps	Black-backed Snake		
Simoselaps bertholdi	Jan's Banded Snake		
S. semifasciatus	Southern Half-girdled Snake		
Vermicella calonotus	Black-striped Snake	CALM Priority List	

Table 2 *Full listing of waterbirds recorded on the Peel - Harvey Estuary and expected to occur in the vicinity of point Grey. Data have been drawn from the sources shown below*

KEY

SURVEY

CALM = Department of Conservation and Land Management surveys (unpubl.)

SWWB = South-West Waterbird Surveys (Jaensch *et al.* 1988)

MCRC = Mosquito Control Review Committee (Ninox wildlife Consulting 1990)

NINOX = Site assessment by Ninox Wildlife Consulting 1/4/96

X = Recorded

* = Recorded during MCRC study from other wetland sites adjacent to Peel Inlet e.g. Goegrup Lake

LISTING

JAMBA = Japan - Australia Treaty on Migratory and Endangered Birds

CAMBA = China - Australia Treaty on Migratory and Endangered Birds

PRIORITY = Department of Conservation and Land Management priority fauna list 1996

	LISTING		SURVEY			
BIRD SPECIES	**JAMBA CAMBA**	**CALM PRIORITY**	**CALM**	**SWWB**	**MCRC**	**NINOX**
PODICIPEDIDAE						
Great Crested Grebe			X		X	
Hoary-headed Grebe			X	X	X	
Australasian Grebe				X	X*	
PELECANIDAE						
Australian Pelican			X	X	X	X
ANHINGIDAE						
Darter			X	X	X	X
PHALACROCORACIDAE						
Great Cormorant			X	X	X	X
Pied Cormorant			X	X	X	X
Little Black Cormorant			X	X	X	X
Little Pied Cormorant			X	X	X	X
ARDEIDAE						
Pacific Heron				X		
White-faced Heron			X	X	X	X
Cattle Egret	Y			X		
Great Egret	Y		X	X	X	X
Little Egret			X	X	X	X
Eastern Reef Egret			X			
Rufous Night Heron				X	X*	
PLATALEIDAE						
Glossy Ibis	Y		X	X		
Sacred Ibis			X	X	X	X

BIRD SPECIES	JAMBA CAMBA	CALM PRIORITY	CALM	SWWB	MCRC	NINOX
Straw-necked Ibis			X	X	X*	
Royal Spoonbill			X	X	X	
Yellow-billed Spoonbill			X	X	X	
ANATIDAE						
Black Swan			X	X	X	X
Australian Shelduck			X	X	X	X
Pacific Black Duck			X	X	X	X
Mallard			X			
Grey Teal			X	X	X	X
Chestnut Teal			X	X	X*	
Australasian Shoveler			X	X	X*	
Pink-eared Duck			X	X	X	
Hardhead			X	X	X	X
Maned Duck				X	X	
Blue-billed Duck				X	X*	
Musk Duck			X	X	X	
PANDIONIDAE						
Osprey			X	X	X	
ACCIPITRIDAE						
Whistling Kite			X		X	X
White-bellied Sea-Eagle	Y			X		X
Marsh Harrier			X	X	X	
RALLIDAE						
Australian Crake					X*	
Spotless Crake					X	
Dusky Moorhen		Y			X*	
Purple Swamphen				X		
Eurasian Coot			X	X	X*	
HAEMATOPODIDAE						
Pied Oystercatcher					X	
CHARADRIIDAE						
Grey Plover	Y		X	X	X	
Lesser Golden Plover	Y		X			
Red-kneed Dotterel			X			
Hooded Plover		Y		X		
Large Sand Plover	Y		X	X		
Red-capped Plover			X	X	X	
Black-fronted Plover			X	X	X	
Inland Dotterel			X			
RECURVIROSTRIDAE						
Black-winged Stilt			X	X	X	X
Banded Stilt			X	X	X	
Red-necked Avocet			X	X	X	
SCOLOPACIDAE						
Ruddy Turnstone	Y		X	X	X	
Eastern Curlew	Y		X	X	X	

BIRD SPECIES	JAMBA CAMBA	CALM PRIORITY	CALM	SWWB	MCRC	NINOX
Whimbrel	Y		X	X	X	
Grey-tailed Tattler	Y		X	X	X	
Common Sandpiper	Y		X	X	X	
Greenshank	Y		X	X	X	
Marsh Sandpiper	Y		X	X	X	
Terek Sandpiper	Y				X	
Black-tailed Godwit	Y		X			
Bar-tailed Godwit	Y		X	X	X	
Red Knot	Y		X	X	X	
Great Knot	Y		X	X	X	
Sharp-tailed Sandpiper	Y		X	X	X	
Pectoral Sandpiper	Y		X	X		
Red-necked Stint	Y		X	X	X	
Long-toed Stint	Y	Y		X		
Curlew Sandpiper	Y		X	X	X	
Ruff	Y			X		
LARIDAE						
Silver Gull			X	X	X	X
Whiskered Tern			X	X	X	
White-winged Tern	Y			X		
Gull-billed Tern			X	X		
Caspian Tern	Y		X	X	X	X
Roseate Tern			X			
Fairy Tern		Y	X	X	X	
Crested Tern			X	X	X	X
SYLVIIDAE						
Little Grassbird			X	X	X	
EPHTHIANURIDAE						
White-fronted Chat			X		X	
GRALLINIDAE						
Australian Magpie-lark					X	X
Domestic Hybrid Duck					X*	
NUMBER OF SPECIES (84)	**27**	**4**	**65**	**67**	**65**	**22**

3.1 Regional Significance

The Project Area is situated on Peel Estuary which is recognised as an extremely important waterbird conservation area and has therefore been designated as a wetland of international significance. The estuary has also been proposed for listing under the Ramsar Convention. Peel Estuary normally supports in excess of 20,000 waterbirds, including 27 species cited in the Japan/Australia (JAMBA) and China/Australia (CAMBA) Migratory Birds Agreement. A total of 84 species of

waterbird and associated species have been recorded to date at Peel Estuary and its peripheral wetlands (Table 2). The importance of the inlet is also highlighted by the extremely large numbers of Banded Stilts which occur during low rainfall years and the frequent, large congregations of Black Swans, duck and cormorant species. Up to 100,000 individual waterbirds have been recorded during a single survey by the Department of Conservation and Land Management.

3.2 Local Significance

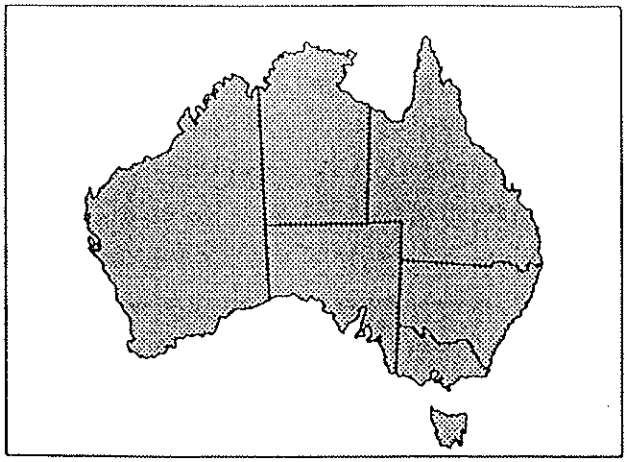
Practically every waterbird recorded to date at Peel Estuary is likely to occur in the littoral and intertidal zone surrounding the Project Area. However, because of the narrowness of this zone, numbers of most waterbird species will be comparatively low. The only exception to this are the large waterbird populations found in Robert Bay which is situated at the extreme south-eastern limits of the Project Area.

A total of 81 bushbirds, 21 native mammals, 5 introduced mammals, 10 frogs and 38 reptiles are expected to occur in the Project Area (Table 1). Many of these species have wide distributions extending well beyond the Coastal Plain and adjacent Darling Range, and are unlikely to be seriously affected by the Point Grey development, considering the amount of native vegetation which will be retained. Some, however, are categorised as rare under the Wildlife Conservation Act, while others are listed under the Calm Priority List. These are discussed separately below.

3.3 Rare Species

No rare animals were recorded during the field assessment. However, five species are expected to be present based on distribution patterns and records of the Western Australian Museum. In Western Australia, rare or endangered species are protected by Schedules 1 to 4 of the Wildlife Conservation Act (1996). Schedules 1 and 4 are relevant to this study. Schedule 1 species are described as "fauna that is rare or likely to become extinct." Schedule 4 species are "other specially protected fauna". Not all rare species are residents or equally susceptible to disturbance. Many are passage migrants, nomads, cryptic species or naturally uncommon predators at the higher trophic level of the food chain such as birds of prey typified by the Peregrine Falcon. Resident rare species known to occur in a given site generally have a much wider distribution than their localised records of occurrence suggest. In this document we have attempted to take a pragmatic and unbiased approach to the rare species that are predicted to occur in the habitats of the Project Area by specifically considering the above aspects. The shaded areas in the following diagrams show the current distributions of rare species.

Peregrine Falcon *Falco peregrinus*



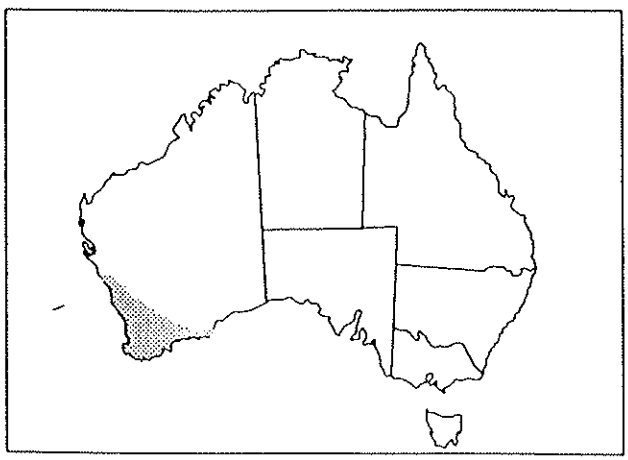
Status: Schedule 4. Resident.

Habitat: all vegetation types. This is a highly mobile bird with little apparent habitat specificity. While almost cosmopolitan in its distribution, Australia is a stronghold for this species (Blakers *et al.* 1984). Pesticide residue in food, which prevents successful breeding, is thought to be the main cause of decline throughout most of its worldwide range (Hoser 1991). The Peregrine Falcon is mainly a resident and could be expected to occur throughout the Project Area where its main prey will be waterbirds.

Probability of Occurrence: very high. In keeping with most large predators at the higher trophic levels of the foodchain, this species occurs in low numbers, contributing to its perceived rarity.

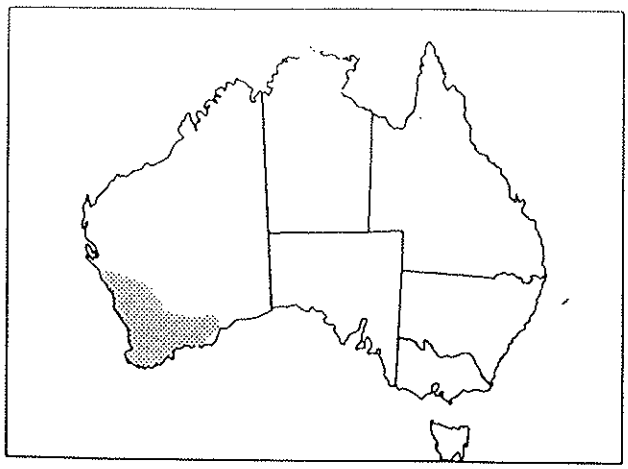
Project Impact: there is no apparent reason why the project should affect this bird.

Carnaby's Cockatoo *Calyptorhynchus funereus latirostris*



Status: Schedule 1. Nomadic.

Carpet Python *Morelia spilotus imbricatus*



Status: Schedule 4. Resident.

Habitat:rocky areas, heath.

Comments: this subspecies of Carpet Python occurs only in the south-west of Western Australia and is rarely encountered during fauna surveys. It shelters in hollow tree trunks and limbs, disused burrows, caves, rock crevices and beneath boulders and often occurs around human settlements. The major threats to its survival include habitat destruction and predation of young snakes by foxes and cats (Wilson and Knowles 1988).

Probability of Occurrence: high. Likely to occur in the small limestone cliffs of the Project Area.

Project Impact: this species should persist in the bushland areas set aside for conservation. However, increased traffic, dogs and cats will raise the mortality rate. This impact will be strictly local rather than regional.

3.4 Priority Species

The CALM Priority Fauna List contains species which have recently been removed from the list of rare fauna, that have a restricted distribution, are uncommon, declining in range and/or abundance, or for which there is insufficient information to make a reliable assessment of their status.

Four species of waterbirds on this list are likely to occur and are listed in Table 2. In addition to these, three bushbirds, three native mammals and two reptiles are also likely to be present (Table 1).

3.5 Significance of Fauna Habitats

The study area has been divided into a series of zones for ease of reference and to more accurately delineate locations of significance. These zones and the fauna habitats within them are discussed separately below with reference to the proposed development feature(s) planned for each. Comments on conservation measures are also included. Each location mentioned in text is marked on Figure 1.

3.5.1 Project Area - Western Zone

Terrestrial Fauna Habitats

1. Elevated Resort Site at Point Grey: the only distinguishing feature that sets this site apart from all other elevated locations in the Project Area is a narrow thicket of dense *Acacia rostellifera* in the wind shadow of its eastern edge (Location 1). There is a possibility that the declared rare Southern Brown Bandicoot may occur here. No typical diggings were seen and there are a range of seasonally damp, sedgy areas throughout the Project Area where this species may occur. Modification of this site is unlikely to have a major impact.

2. Marina Site - Principal Resort Area: no terrestrial habitats of particular significance occur here. All are adequately represented both locally and regionally. No fauna species are likely to be restricted to these sites. This habit type will be reserved and protected from by the Stony Point Recreation Reserve No. 27528, Reserve No. 11718, the Sanctuary/Conservation Area and the Point Mealup Nature Reserve.

3. All Sub-coastal Terrestrial Habitats to the South: see above. No development planned. Foreshore buffer zones are more than adequate and any waterbird breeding colonies or significant roosting sites will remain protected.

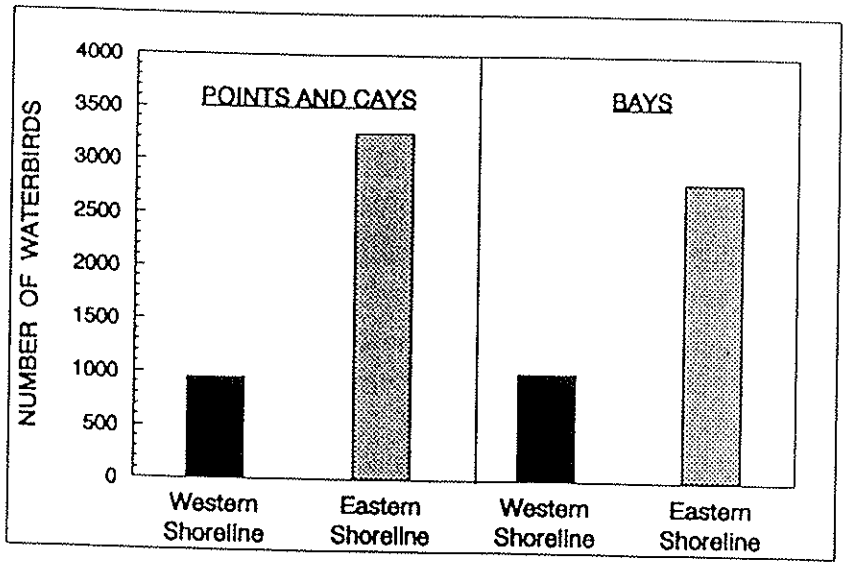
4. Other: some sections of this area support low limestone ridges with numerous small caves and deep fractures (Location 2). The rare Carpet Python is likely to use this geomorphological feature. These cliffs require special protection.

Waterbird Habitats - Western Littoral Area

Compared to the eastern shoreline, the intertidal zone is along this western edge is less extensive and waterbird activity reduced - particularly migratory shorebirds.

Data from the original environmental review (Dames and Moore 1987) has been graphed in Figure 2 to illustrate this.

Figure 2 ***Diagram comparing waterbird activity on the eastern and western shorelines of the study area (Constructed from waterbird records gathered during aerial surveys by the Department of Conservation and Land Management).***



1. Elevated Resort Site at Point Grey: there will be some disturbance to waterbirds at this site because of the proximity of the resort (Location 3).

2. Marina Site - Principal Resort Area: most waterbird activity at these sites consists of large numbers of cormorants and some pelicans roosting on exposed limestone rocks near the shoreline (Location 4). Some roosting in trees takes place. Migratory species are poorly represented. While disturbance to waterbirds can be expected through construction of a marina, the limestone rubble walls which are a feature of marinas will tend to compensate for habitat loss. Careful placement of dredge spoil could increase the area of the intertidal zone and make the site more attractive to migratory shorebirds.

3. All Waterbird Habitats to the South: This edge of the peninsula is much less affected by pastoral activity than the eastern side and is fenced for most of its length. A dense strip of mixed shrubland woodland limits access and minimises disturbance to birds.

3.5.2 Project Area - Central Zone

Terrestrial Fauna Habitats

1. Golf Course, Estate (15 ha), Clubhouse and Resort Accommodation: virtually all this area is parkland cleared (Location 5). However, a large number of mature trees remain. Most of these are Tuart but the north-western section of the golf course supports a mixture of these and very large Peppermints, apparently the only expression of the latter tree in the Project Area (Location 5). A large number of bushland birds utilise these trees and the Tuarts are important sites where Brushtail Possums, Cockatoos and parrots have access to deep hollows for nesting and refuge. Several species of ducks found on the inlet also use hollows for nesting. The rare Peregrine Falcon is also likely to nest in this habitat. As many of these mature trees as possible should be retained.

2. Estate (30 ha): the larger of the two golf course estates also supports mature Flooded Gums which are uncommon elsewhere in the Project Area (Location 6). These trees are also used by a range of birds and are particularly attractive to honeyeaters. As many of these mature trees as possible should be retained

3. Residential Villages (Precinct B - 80 ha, 160 ha: all comments made for the previous section apply here.

4. Bushland Block between Precinct B and Precinct A: in terms of terrestrial fauna, this portion of the Project Area represents a core conservation area for a large range of birds, native mammals and reptiles (Location 7). While some grazing has taken place within this area, the bushland is in very good condition and has retained much of the woodland understorey which has been lost elsewhere in the Project Area and the adjacent coastal plain. Serious consideration should be given to protecting and extending this area through rehabilitation and retaining it as a native wildlife preserve in perpetuity. This bushland is representative of a range of habitats which have been lost in sub-coastal Murray Shire.

5. Precinct A: as for paragraph 1 above.

3.5.3 Project Area - Eastern Zone

Terrestrial Fauna Habitats

1. Uncleared Bushland area east of Point Grey: this area is similar to other locations along the western edge of the Project Area. No transects were undertaken through here, but aerial photography appears to show two small seasonal wetlands within its confines (Location 8). This area will not be developed.

2. Marina Site: no terrestrial habitats of particular significance occur here. All are adequately represented both locally and regionally. No fauna species are likely to be restricted to these sites. This site differs from the western marina in that it is mainly parkland cleared and supports a range of mature trees such as Tuart, Flooded Gum and Marri. As before, as many of these as is possible should be retained. The loss of portions of this area is unlikely to affect terrestrial fauna locally or regionally.

3. Coastal strip south to Robert Bay: this area is not subject to development activity. The southernmost portion shows a fairly high level of degradation (Location 9).

Waterbird Habitats - Eastern Littoral Area

The main feature that requires stressing is that although waterbird activity is higher on this eastern edge, by far the major portion takes place at the extreme southern limits within Robert Bay (Location 10). Most trans-equatorial migratory waterbirds congregate in this bay. Concentrations of cormorants and pelicans occur at various points along this western edge, but mainly in association with limestone outcrops. This was evident during the recent survey with some 200 birds seen along the northern and central shoreline as opposed to close to 1000 in Robert Bay.

1. Uncleared Bushland area east of Point Grey: some waterbird activity has been recorded in the vicinity of the point and bay at this site (Dames and Moore 1987). This area will not be developed (Location 8).

2. Marina Site: most waterbird activity at this site consists of large numbers of cormorants and some pelicans roosting on exposed limestone rocks near the shoreline (Location 11). Some roosting in trees takes place. Trans-equatorial migratory species are poorly represented. While disturbance to waterbirds

can be expected through construction of a marina, the limestone rubble walls which are a feature of marinas will tend to compensate for habitat loss. Careful placement of dredge spoil could increase the area of the intertidal zone and make the site more attractive to migratory shorebirds.

3. Coastal strip south-east to northern Robert Bay: this area is not subject to development.

4. Lagoon/Island Sanctuary Incorporating Drainage, Water Treatment etc: while there is a fairly well-developed cover of various *Melaleuca* species in this area, the site shows a high level of degradation through clearing, stock damage, vehicle tracks and drainage channels (Location 12). The area apparently supports large concentrations of ducks and swans during winter and probably acts as a protected refuge during high winds on the inlet. The recent survey showed that in its present condition this site is of no value as a summer drought refuge. We strongly recommend that this area is converted to a Lagoon/Island Sanctuary to extend its value to waterbirds throughout the year. Using it as a nutrient sink will require careful management to avoid botulism toxicity and potential waterbird deaths.

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APPENDIX E

Phosphorus Export Model

1.0 INTRODUCTION

1.1 Objectives

Using soil science and accepted mathematical models in conjunction with data from previous studies a predictive integrated model is developed to assess the sites' phosphorus (P) retention capacity and hence the potential future export of P determined by the proposed landuses of the development to the adjoining waters of the Peel-Harvey.

The prediction of P export from the site is then compared to the allowable P export in the context of the long term protection of the water quality of the Peel-Harvey estuary (see relevant sections of main report)

The overall objective of this section of the report is therefore to analyse the capacity of the site to sustain the proposed development with regards to the future export of P.

1.2 Contents of the Report

A brief description of the contents of each major section of this report is as follows:

Section 2.0 Nutrient Export

Describes the P export mechanisms at the Point Grey peninsula.

Section 3.0 Phosphorus Transport Modelling

Provides a discussion and explanation of the current theories and chemical analyses regarding the retention of phosphorus. This section also discusses the results of the soil investigations and evaluates the parameters of the models that best describe the retention characteristics and groundwater recharge of the Point Grey site.

Section 4.0 Point Grey Model

This section discusses the integrated phosphorus transport model applied to the various proposed landuses under their prospective phosphorus application and groundwater recharge rates at full occupancy.

Section 5.0 Results

Provides a compilation of the results of the modelling exercise.

Section 6.0 Discussion and Conclusion

This section analyses the sensitivity of the proposed model and in this light evaluates the results and the conclusions which can be drawn from the modelling exercise.

2.0 NUTRIENT EXPORT

2.1 Point Grey Nutrient Export Mechanisms

At full occupancy P input to the site can be expected to occur at differing rates from the following proposed landuses:

- 18 hole Golf Course
- Residential areas
- Public open space
- Tourist/short stay accommodation
- Effluent irrigated disposal areas

Runoff from these landuses, in particular from residential and tourist nodes, will be managed through a series of compensation and infiltration basins to accomplish complete infiltration of the collected precipitation from impermeable surfaces such as roads, carparks and paved areas. Drainage from the site will therefore occur through recharge of the superficial aquifer and subsequent discharge to the adjacent Peel-Harvey estuary.

2.2 Conclusion

As the site will be engineered to accomplish complete infiltration of all the generated wastewaters, annual P export from the site will therefore be through the P content in the volume of annual groundwater recharge. The strategy to evaluate the site's P export rate under the proposed landuses is discussed in the following sections.

3.0 PHOSPHORUS TRANSPORT MODELLING

3.1 Introduction

The two most important parameters which determine the export rate of P from the proposed development are:

- The amount of P retained in the soil profile under the proposed landuses.
- Groundwater recharge from the site through evaluation of the irrigation needs associated with the proposed landuses in conjunction with historical rainfall data.

Through modelling both these parameters a prediction can be made regarding future concentrations of P in the groundwater recharge from the site which in turn discharges directly to the Peel-Harvey estuary.

The following sections provide an explanation of the technical background needed to evaluate the above parameters and discusses an integrated model.

3.2 Technical Background

Phosphorus Retention

The concentration and hence the mass of P in a soil solution is controlled by a number of processes including:

- Adsorption-desorption;
- Plant uptake;
- Immobilisation-decomposition;
- Precipitation, and;
- Leaching.

The removal of P from the soil solution is controlled by a combination of adsorption and precipitation. As it is difficult to differentiate between the two processes, it is generally referred to as sorption (Allen & Jeffery, 1990).

The uptake and release of P by soils is best described by sorption-desorption reactions . The relationship between the amount of P sorbed and the concentration of P in the soil solution (desorbed) at equilibrium is referred to as the P adsorption isotherm. A knowledge of the P sorption isotherm characterises a soil in terms of the soil's P sorption capacity.

The Freundlich isotherm is the relationship which best describes the P sorption-desorption characteristics of Western Australian sandy soils. The most widely used mathematical function used to describe this isotherm is the Barrow-Shaw equation (WAWA, 1992):

$$C_s = A \times C_m^{b1} \times T^{b2}$$

Where:
C_s = P sorbed to soil (mg/kg)
C_m = equilibrium concentration of P (mg/L)
$A, b1$ = coefficients determined from short term isotherm tests
$b2$ = long term adsorption coefficient (typically range: 0.1-0.35)

The Barrow-Shaw equation is valid only for virgin soil profiles which can be determined through analysis of the phosphorus retention index (PRI) and bicarbonate extractable phosphorus (Bic-P) of a profile at predetermined sampling depths.

A typical virgin profile will exhibit low (<2 mg/L) Bic-P results. In contrast, a soil which has a history of P application will have low or negative PRIs and high Bic-P results.

Large amounts of P are sorbed onto organic particulate matter typically contained in the top horizons of sandy soil profiles. McPharlin *et al* (1990) noted that up to 100% of applied P was retained in the top 100 cm of a Spearwood sand profile after five years of vegetable cropping. Total applied P on to these profiles ranged from 708-1266 kg/ha with annual application rates typically ranging from 130-350 kg/ha.

It is however not possible to predict or model the long term P sorption characteristics of top horizons using the Barrow-Shaw (or equivalent) equation as historical P application (natural or "artificial") has meant that these soils can no longer be classified as virgin. The amount of P sorbed can however be calculated from PRI and Bic-P results taken from samples of top soils that have historically been subjected to high P application rates (Jeffery, pers. comm.).

3.3 Soil Investigations

As the previous section highlights, a number of parameters and laboratory analyses are needed to evaluate soil P sorption, particularly in terms of historical P application and the effects this has on the short and long term P sorption characteristics. It was therefore necessary to conduct a comprehensive investigation of the soil profiles at the Point Grey site prior to the formulation of a suitable model to predict the discharge of P as a result of long term P application.

The soil investigation strategy consisted of the following elements:

1. *Initial Site Evaluation*

2. *Soil Profile Investigation*

3. *Sampling and Analytical Investigation*

Each element of the soil investigation strategy is discussed in the following section.

3.3.1 Initial Site Evaluation

Soil investigations were conductedto characterise the occurrence and extent of the dominant soil profiles and to gain a broad understanding of their P retention capabilities and history of P application.

During this phase of the investigation 9 test holes were excavated using a handauger. Fourteen soil samples were collected of representative horizons and analysed for PRI and Bic-P. The results of the analyses are shown in Table 1.

The soil samples in Table 1 are grouped in terms of colour and position in the horizon. PRIs of the Yellow Phase Spearwood Sand typically ranged from 10 ml/g at the surface increasing to 22 ml/g with depth. The Grey sand profile had low PRIs at the surface with one PRI of 40 ml/g at a depth of 1m (PS8-4). Most sites showed very low Bic-P levels with one site (PS6) showing evidence of P accumulation, with a Bic-P of 120 mg/L at the surface (PS6-1) and 10 mg/L deeper down (0.6m) the profile at PS6-2.

Table 2

Typical Yellow Phase Spearwood Sand Profile

Depth (mm)	Description
0-100	Dark Brown Organic Medium Sand
100-200	Light Brown Organic Medium/Fine Sand
200-500	Pale Yellow/Orange Fine Sand
500-3500	Yellow/Orange Fine Sand

Based on the analyses of these results, short term isotherm tests were performed on bulked samples of low Bic-P soils showing a similar range of PRI to obtain typical *A* and *b1* coefficients. Tables 3 and 4 show the results of the PRI/Bic-P and isotherm tests respectively. The average *b1* coefficient of 0.34 obtained from the three bulked samples is in close agreement with results from tests done on similar soils (Jeffery, pers. comm.).

Storage Capacity of Top Soils

To determine the P storage capacity of the Point Grey top soils, 2 samples were taken from the top 50 cm at 6 locations distributed throughout the site and analysed for Bic-P and PRI. These results were then used to calculate the percentage saturation and capacity for additional storageof each sample. The results of the tests and subsequent calculations are shown in Tables 5.

The storage capacity was calculated using the averages of Bic-P and degree of saturation to represent an average capacity for additional storage for the entire site.

3.4 Conclusions

The Yellow Phase Spearwood Sands of Point Grey are distributed over approximately 80% of the site in higher (>3m AHD) areas. Results of previous investigations (Dames & Moore, 1987) indicate soil depths of the Yellow Phase Spearwood Sands ranging from 7m in the centre of the site feathering out to 3-5m on the edges where and Alluvial Estuarine deposits become the dominant soil profile. This investigation largely confirms this soil sequence and depths of soil profiles.

The main conclusions that can be drawn from the soil analyses are as follows:

- Representative soil profiles of the Yellow Spearwood Sands indicate a fair P retention capacity with average PRI values of 3.8 ml/g at 50 cm below surface increasing to 25 ml/g at a depth of 3-4 m.
- Storage capacity in the topsoil horizons ranged from 68 to 420 kg/ha depending on previous application rates.

Table 3

Selected Soil Horizons

Results of PRI and Bic-P Analyses

	Horizons							
	B		C		D		E	
Depth (cm)	PRI (ml/g)	Bic-P (mg/l)	PRI (ml/g)	Bic-P (mg/l)	PRI (ml/g)	Bic-P (mg/l)	PRI (ml/g)	Bic-P (mg/l)
40-60	2.6	18	43	2	14	2	3.4	8
60-80	3.8	<2	11	<2	8.5	2	5.0	2
80-100	3.5	2	9.5	<2	3.4	<2	5.9	<2
100-120	3.6	<2	11	<2	5.0	<2	10	<2
120-140	4.0	<2	9.5	<2	4.8	<2	27	<2
140-160	4.0	<2	9.8	<2	4.5	<2	25	2
160-180	4.8	<2	9.4	<2	20	2	23	<2
180-200	5.1	2	9.4	<2	26	2	16	<2

Note:
detection limit for Bic-P analysis is 2 mg/L

Table 4

Barrow-Shaw Coefficients of Selected Soil Profiles

Bulked Samples	**Mean PRI** (ml/g)	***A*** **coefficient**	***b1*** **coefficient**
B[1]	3.8	14	0.46
C[2]	9.5	35	0.31
E[3]	25	67	0.25

Notes:
1. 80-160 cm
2. 120-200 cm
3. 120-180 cm

Table 5

Results of Top Soil Analyses

	Results and Calculations				
Sample ID	PRI (ml/g)	Bic-P (ppm)	Saturation (%)	Capacity (ppm)	Storage Capacity (kg/ha)
S1-1	4.2	36	80	9	68
S1-2	6.7	29	54	25	188
S2-1	6.5	26	50	13	98
S2-2	11	20	29	49	368
S3-1	8.4	19	35	35	263
S3-2	20	7	<20	56	420
S4-1	3.4	18	57	16	120
S4-2	2.8	11	46	13	98
S5-1	8.0	7	<20	56	420
S5-2	9.4	4	<20	36	270
S6-1	6.4	20	41	29	218
S6-2	3.4	8	32	17	128
Average:	7.5[1]	17[1]	38[1,2]	28[1]	221[1]

Notes:
1. Errors due to rounding off.
2. Average calculated assuming 0.5 of detection limit (<20)

4.0 POINT GREY MODEL

4.1 Phosphorus Retention Model

Logically, the scenario through which P will be retained on and leached through the soil profile is as follows:

- Storage in the top 20-50 cm of topsoil until the storage capacity is reached.
- Leaching of P from the topsoil horizon into the underlying horizons at concentrations determined by landuse application rates and rainfall data and irrigation needs.
- Sorption of P on to the underlying soil profile until saturated.
- Loss of P through groundwater recharge and subsequent discharge to the Peel-Harvey Estuary.

The elements of the model used to evaluate this scenario were as follows:

- Using the average P storage capacity value, calculation of the time taken for the top 50 cm of soil to become exhausted at the various application rates.
- Calculation of the storage of P in the underlying virgin soil profile using the Barrow-Shaw equation applied to the the soil profile with the lowest measured average *A* coefficient (Profile B, Table 4) and assuming soil saturation occurs when total sorption equals twice the A coefficient. The *b1* coefficient was set at 0.34 in accordance with the results of the analytical investigations. Based on literature values obtained from tests performed on similar soils, a value of 0.1 was adopted for the *b2* coefficient (Jeffery, pers. comm.).

Following P saturation of the soil profiles underlying each landuse area, the P content of the groundwater recharge, based on the modelled recharge rates, was calculated. Groundwater recharge is discussed in the following section.

Table 6

Application and Recharge Rates

Land Use	Irrigation Rate (mm/day)	Rainfall and Irrigation (mm/day)	Recharge Rate (mm/day)
Golf Course	3.5[1]	4.17	2.63
Public Open Space	1.8[1]	3.22	1.97
Residential/Golf Course Estate	1.8[1]	3.22	1.97
Tourist/Foreshore Village	1.8[1]	3.22	1.97
Rural Residential	2.0[1]	3.42	2.05
Effluent Disposal Area	2.4[2]	4.83	3.11
Conservation Areas	0	2.42	1.67

Notes:
1. Summer irrigation only
2. Continuous irrigation

Table 7

Phosphorus Application Rates

Landuse	Area (ha)	Percentage of Total Area (%)	Phosphorus Application Rate (kg/ha/annum)
Golf Course	90	7.7	20[1]
Residential/Golf Course Estate (7.1 houses/ha)	324	28	9[2]
Tourist andFacilities (4.8 houses/ha)	178	15	4[2]
Rural/Special Residential (1.0 house/ha)	203	17	4.0[2]
Effluent Disposal Area	65	4.3	13[3]
Conservation Areas	312	27	0

Notes:
1. Recommended maintenance application rate for golf course on similar soils (Bowman Bishaw Gorham, 1993)
2. Based on Gerritse *et al* (1991)
3. Based on 1 mg/l P and 200l/day/EP

5.0 RESULTS

5.1 Phosphorus Retention

Table 8 shows the results of the P modelling exercise. Exhaustion times of the P retention capacity in the top soil ranged from 11 to 55 years. Exhaustion timesof the underlying soil profile ranged from 160 to 420 years.

5.2 Phosphorus Discharge

The results of modelling determined that the soil profile underlying the effluent disposal area will become exhausted after 160 years. Given that P will move as a sharp front through the soil profile (WAWA, 1992), it is assumed that no P prior to exhaution (ie 160 years) will discharge from the site.

Table 8

Exhaustion Times

Landuse	**Phosphorus Application Rate** (kg/ha/annum)	**Storage Capacity (20-50 cm)** (years)	**Storage Capacity (50-700 cm)** (years)	**Total** (years)
Golf Course	20	11	200	211
Residential/Golf Course Estate	9	24	374	398
Tourist Facilities	4	55	365	420
Rural/Special Residential	5	44	310	354
Effluent Disposal Area	13	17	143	160

Note: An average soil depth of 5m was used for effluent disposal area

6.0 DISCUSSION AND CONCLUSIONS

6.1 Model Sensitivy

A crucial factor in determining the quality of a model is an evaluation of its' sensitivity to the input parameters. Through modelling extreme values of input parameters and evaluation of range of results obtained, a judgement can be made as to the sensitivity of the model to each respective parameter.

The parameters, the extreme upper and lower values chosen to evaluate the model sensitivity and the subsequent results are contained in Table 10.

The results and conclusions are summarised as follows:

Soil Depth

At the extreme input values of 3 and 9m, exhaustion times increased approximately threefold. In view of the fact that sorption is directly proportional to the mass and hence depth of soil, this variation was to be expected.

The extensive soil excavation programme undertaken to classify the soil profile at Point Grey, in conjunction with previously published data (Dames & Moore, 1987) determine quite conclusively that the profile extends from at least 4.5m to an average of 7m. Although the model is sensitive to the soil depth, the input value of 7m applied to the majority of landuses (see Table 8) can be considered valid.

A Coefficient

The input *A* coefficients values, ranging from 12 to 67mg/kg, represent the total range of values obtained as a result of the soil sampling and analytical investigation. The resultant 5 to 6-fold increase in exhaustion times shows direct proportionality of the Barrow-Shaw equation to this input parameter.

6.2 Conclusions

The P sorption characteristics of the Point Grey soils, based on a comprehensive soil survey and laboratory analyses, showed a capacity to retain applied P for a minimum of 160 years.

The input parameters used to model P retention either represented worst case scenarios or were based on results from scientific experiments on similar soils. Validation of the model confirmed the conservative values adopted for the parameters. In particular, the *A* coefficient value used was half the average of values obtained from the soil investigation and accepted literature values.

The model also assumed P application and irrigation rates at full occupancy which under the planned phasing of the development will will not be reached for a number of years.

In view of the above, soil P saturation of the Point Grey soils is most likely to occur well beyond the 160 years obtained as a result of the modelling exercise.