REPORT AND RECOMMENDATIONS
by the
ENVIRONMENTAL PROTECTION AUTHORITY

WATERSIDE MANDURAH PROJECT

Department of Conservation & Environment
Perth, Western Australia

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REPORT AND RECOMMENDATIONS

BY THE

ENVIRONMENTAL PROTECTION AUTHORITY

WATERSIDE MANDURAH

ENVIRONMENTAL REVIEW AND MANAGEMENT PROGRAMME

Department of Conservation and Environment

Perth, Western Australia

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PREAMBLE

Environmental Review and Management Programmes for two canal projects, one from Parrys Esplanade Ltd for land on the west of the Inlet Channel (Halls Head Waterways project), the other from John Holland (Constructions) Pty Ltd for land east of the channel (Waterways Mandurah project), have been submitted for evaluation. Figure 1 shows the location of the two project sites, while Table 1 shows the characteristics of both projects.

The conservation values of the respective sites, flooding implications, consequences for groundwater resources and the possible impacts of the developments on the estuarine fishery are issues that have been considered in determining whether the projects are environmentally acceptable and could proceed. Also of fundamental importance is the quality of the source waters, the suitability of winds, tides and other phenomena to drive flushing mechanisms, and the geotechnical adequacy of in situ soils.

Table 2 summarises evaluation of these factors in relation to the canal proposals. In each case, the implications of development can be considered manageable, although detailed monitoring would be necessary to guide management efforts. In addition to these factors, because of differences in development concept and design detail, the projects raise many issues specific to the individual proposals which also require examination. Further, it has been necessary to examine the proposed developments in a regional context, particularly in terms of problems and expectations relating to the Peel-Harvey Estuary.

Management of the artificial waterways will be most important. However, as yet no manager for artificial waterways has been designated and neither has the means of funding management been determined. The Authority believes that a decision on management responsibility and funding should be made before any canal development is approved.

The Authority considers that management costs should be met by the beneficiaries of canal developments, the developers initially and the residents in the long term. However, canal developments will also cause demands for services in addition to those normally arising from new subdivisions. These demands will affect the Peel Inlet Management Authority, the Marine & Harbours Department, the Public Works Department and the Department of Fisheries and Wildlife, as well as the efforts already underway to overcome the environmental problems of the Peel-Harvey estuarine system. The Authority advises Government that, should approvals be granted for the canal developments, it would be necessary to acknowledge the validity of these demands.

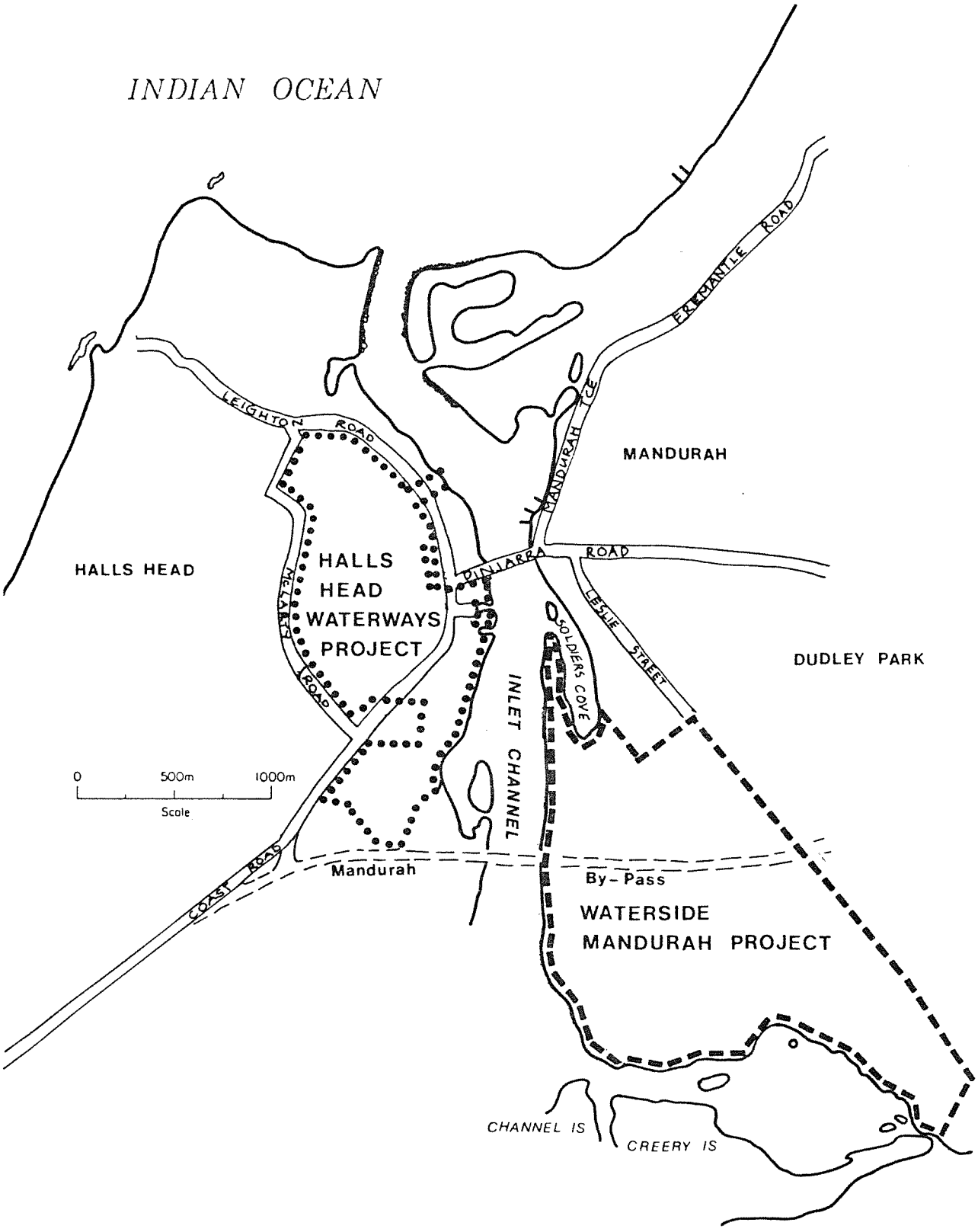

INDIAN OCEAN
LEIGHTON ROAD
FREMANTLE ROAD
MANDURAH TCE
MANDURAH
HALLS HEAD
HALLS HEAD WATERWAYS PROJECT
MELVA PARADE ROAD
DINJARRA ROAD
LESLIE STREET
SOLDIERS COVE
INLET CHANNEL
DUDLEY PARK
0 500m 1000m
Scale
COAST ROAD
Mandurah By-Pass
WATERSIDE MANDURAH PROJECT
CHANNEL IS
CREERY IS

Figure 1.

TABLE 1

ASPECTS OF THE WATERSIDE MANDURAH AND HALLS HEAD WATERWAYS CANAL PROJECTS AS IDENTIFIED IN THE ERMPS

FEATURE	PROJECT	
	WATERSIDE MANDURAH	HALLS HEAD WATERWAYS
Location	Pt Cockburn Sound Loc. 16 - (subdivided to three lots) east side of Inlet Channel	Pt Cockburn Sound Loc 16 - west side of Inlet Channel
Area (ha)	STAGE 1: 74; STAGE 2: 205; TOTAL: 279	129
Status of Land	Privately owned, subject to System 6, recomm., bisected by Mandurah by-pass	Privately owned, subject System 6 recomm., skirted by Mandurah by-pass
Proposed no. of lots	STAGE 1: 380; STAGE 2: 720; TOTAL: 1100 + commercial + med. density	Stages i-iv: 350; Stages v-x: 550 + tourist (150) Total 1050
Type of residence	Single residential + some medium density Potential for strata-titled islands	Fully developed units Strata-titled super-lots managed by corporate bodies
Construction/sale time	STAGE 1: 3-4 yr; STAGE 2: 6-8 yr; TOTAL: 9-12 yr	10 + yrs
Canals - area (ha) width (m) depth (m)	71.4 (25% of total area) 50 (stated): 28 (min. shown on concept plan 2.5	46 (36% of total area) 45 - 70 2.5
Total area of conservation + foreshore reserves (ha)	52 (18.6% of total area)	13.9 (10.8% of total area) (includes 1. 0 already provided)
Local open space	6%	10%
Area of reserves as per cent of dry land (ha)	25	16.7 (not including private open space related to units)
Lots with canal frontage (%)	65	98
Boats -		
Design vessel - length (m) draft (m)	10 2	10 1.5
Mooring	No permanent mooring, private ramps, jetty mooring 6m from wall & parallel to it Public boat ramp and parking area: marina proposed for Stage 2	End-on and side-on moorings; quayside mooring at shopping centre; no public launching or mooring
Est. no. of boats*	Approx. 900	Approx. 800

* Based on estimate of 80% ownership reported in Halls Head Waterways ERMP (Feilman Group, 1982).

TABLE 2
SUMMARY OF EVALUATION OF PRINCIPAL ISSUES

ISSUE	PROJECT	
	WATERSIDE MANDURAH	HALLS HEAD WATERWAYS
1. CONSERVATION	Extensive area of ecologically valuable saltmarsh/bird habitat adjacent to existing Channel and Creery Island reserves and subject of a System 6 recommendation.	Limited area of ecologically valuable saltmarsh/bird habitat subject of a System 6 recommendation.
Consequences of development	Some saltmarsh to be retained but a large area would be destroyed.	System 6 recommendation recognized by reservation.
Conflicts	Mosquitoes breed on saltmarsh and already cause a nuisance and, possibly, a health hazard.	
Conclusion	Limited conservation area as proposed, with vesting in WAWA, is acceptable.	Proposed conservation reserve acceptable with vesting in WAWA.
2. FLOOD RISE	Development site situated on flood plain and, therefore, is subject to periodic flooding.	Development site is beyond designated flood plain.
Consequences of development	Filling to above flood levels does not affect flood capacity providing adequate floodways are retained along the Inlet Channel. The canals would improve flood flows.	
Conclusions	Acceptable	Acceptable
3. GROUNDWATER RESOURCE	Superficial aquifer used by a number of existing residents notwithstanding availability of a reticulated water supply. Aquifer may already be subject to overuse.	
Consequences of development	Undesirable shift of saltwater/freshwater interface.	
Remedy	Curtain walling included in design. Advise against additional draw from superficial aquifer.	Curtain walling included in design. Advise against additional draw from superficial aquifer.
Conclusion	Manageable, subject to adequate monitoring programme	
4. COMMERCIAL FISHERY	Species important to commercial and amateur fishery migrate through the Inlet Channel.	
Consequences of development	Possible disturbance to migration when developments have only a single-opening and fish are trapped in "closed" canals.	
Conclusions	Monitor fish movements and develop through-channels if necessary.	
5. WATER QUALITY IN INLET CHANNEL	Generally suitable for beneficial uses defined by the Steering Committee on Canal Developments. Subject to periods of reduced quality during large-scale algal blooms in the estuarine system.	
Consequences of development for the source waters	Limited if project design minimizes input of pollutants of various kinds and maximizes water circulation. Plumes of organically coloured water may enter the Inlet Channel.	
Conclusions	Manageable, subject to some redesign, ongoing monitoring and maintenance.	Manageable, subject to ongoing monitoring and maintenance.
	Role of waterway manager of great importance	
6. FACTORS DETERMINING WATER MOVEMENTS IN CANALS	Diurnal and barometric tides and winds in the area are sufficient to drive flushing mechanisms and circulate water in the canals if engineering design is appropriate. Other phenomena such as density gradients would also contribute to water circulation.	
Suitability of design	Requires refinement of design, e.g. culverts may constrain circulation. Requires adequate monitoring and maintenance.	Acceptable subject to adequate monitoring and maintenance.
7. SOILS	Highly variable soils throughout - limited information provided.	Appear generally acceptable, but require further investigation.
Consequences for development	Variability of soils may cause engineering problems - disposal difficulties may arise if spoil is inadequate as fill material.	
Conclusions	Local variations in soil conditions can be further investigated in detailed engineering design.	Local variations in soil conditions can be further investigated in detailed engineering design.

CONCLUSIONS AND RECOMMENDATIONS

The Proponent has submitted a number of environmental reports in support of the Waterside Mandurah project over a period of several years. There has also been considerable liaison between the Proponent and officers of the Department of Conservation and Environment concerning the project and its documentation.

The Department prepared guidelines for the Proponent to follow in preparing an ERMP for the project and although the document submitted generally addressed the issues mentioned in the guidelines, it was essentially one of advocacy for the project rather than an objective statement of the existing environment and environmental implications of the development. The Environmental Protection Authority did, however, decide to assess the project as documented in the ERMP submitted.

In assessing the project, the Authority firstly considered the basic suitability of the project site for canal development and then considered the impact of the specific proposal. As the Waterside Mandurah project is one of the two major canal estates proposed for land adjoining the Inlet Channel to the Peel-Harvey Estuary, it has been necessary for the Authority to consider both the cumulative and specific effects of the proposals. Regional implications of the projects have also had to be assessed.

In evaluating the suitability of the project site for canal development, the Authority examined the basic environmental resources and characteristics of and influencing the site, these being conservation values, the groundwater system, the estuarine fishery, flooding, water quality in the Inlet Channel, water exchange mechanisms, and in situ soils. In assessing suitability, the Authority also noted that the Peel Inlet Management Plan identified land adjoining the Inlet Channel (including the project site) as being suitable for canal development subject to detailed environmental evaluation.

The Authority is of the opinion that the site could be considered generally suitable for canal development, provided that the specific project design was appropriate to the site and the environmental impact of development was minimised through appropriate ongoing management and monitoring programmes.

Assessment of site suitability has, in the Authority's opinion, emphasised the need for appropriate monitoring and management programmes and for the designation of an agency in which management responsibility for canal estates would be vested. The Authority concluded that the matter of a management agency needs to be resolved before land is rezoned to enable canal development and is of the opinion that the Peel Inlet Management Authority should be that agency.

Recommendation 1

Prior to the land being zoned for canal development the Peel Inlet Management Authority should be appointed as the manager for the artificial waterways.

Detailed evaluation of the Waterside Mandurah proposal indicated that many issues had not been satisfactorily resolved; most critically, the question of water quality and circulation within the canal system.

Nevertheless, the Authority has acknowledged that the outstanding issues could be adequately dealt with as matters of engineering, planning and design detail and, through implementation of appropriate monitoring, management and maintenance programmes.

Recommendation 2

The Authority concludes that the project can proceed subject to the following recommendations being accepted and implemented.

Recommendation 3

Prior to subdivision approval the Proponent should provide an undertaking that, if in the opinion of the waterways manager (PIMA) there is inadequate flushing of the estate and unacceptable water quality and there is a demonstrated need to bring forward the construction of the through canal, he will do so.

Recommendation 4

The Authority considers that the issues of flood discharge through the link under the by-pass and wall heights should be resolved during subsequent detailed planning.

Recommendation 5

The Proponent should be required to document options for disposal of spoil unsuitable for residential landfill.

Recommendation 6

A method of discharge of stormwaters acceptable to the waterways manager (PIMA) should be devised and an undertaking made to install, maintain and monitor such a system.

Recommendation 7

The Proponent should make a strong effort to promote the use of landscaping methods which will minimise the use of garden fertilizers and the need to water gardens. Further, the matter of minimising the inflow of surface run-off to the canals should be addressed as a matter of engineering detail and to the satisfaction of the waterways manager (PIMA).

Recommendation 8

Measures should be taken to protect vegetation on foreshore or conservation reserves where saline waters from excavation dewatering may cause damage.

Recommendation 9

Detailed planning for Stage 1 of the development should include provision of a boat waste water pump-out facility connected directly to the reticulated sewerage system.

Recommendation 10

Wall structures should be constructed to achieve at least the 30 year design life span advocated by the Steering Committee on Canal Developments.

Recommendation 11

The Proponent should provide the PWD with sufficient information for that Department to assess whether the form of wall structure proposed would achieve the 100 year life span.

Recommendation 12

The alignment and detailed design of the mouths of the connecting channels should be to the satisfaction of the PWD.

Recommendation 13

On completion of dredging of a connecting channel, a survey of the channel and the associated natural waterway should be carried out at the Proponent's expense and in accordance with PWD and PIMA requirements.

Recommendation 14

All maintenance and remedial works associated with the connecting channels during development of the canals project should be the responsibility of the Proponent.

Recommendation 15

Design of the structures linking the islands with the mainland and linking Stage 1 and Stage 2 should be reconsidered and a design providing optimum through-flow should be achieved to the satisfaction of the PWD and the waterways manager (PIMA).

Recommendation 16

The Proponent should comply with the canal width description given in the ERMP.

Recommendation 17

A programme of monitoring should include regular observation of fish movements. Redesign of the canal waterway to complete the through-loop into Stage 2 should be considered as a means of minimising disturbance of fish movements.

Recommendation 18

The groundwater monitoring programme should be designed and implemented by the Proponent to the satisfaction of officers of the Geological Survey of W.A. Depending on the results of monitoring the Proponent should be required to further investigate the grout curtain option and alternative forms of remedial action to combat excessive movement of the saltwater/freshwater interface within the shallow aquifer underlying the project site and adjoining areas.

Recommendation 19

The proposed floodways north of the proposed Mandurah by-pass bridge are adequate for the purpose and no change of level should be allowed unless the Public Works Department is satisfied that it would not materially alter the floodway. (See Fig 2).

The proposed foreshore reserve south of the proposed Mandurah by-pass should be regarded as a minimum requirement, with recognition that need for additional land may be identified in subsequent planning. (See Fig 2).

The foreshore reserves should be ceded to the Crown on or before the granting of subdivision approvals and a management programme acceptable to the waterways manager (PIMA) and the PWD be prepared and instituted by the Proponent as a condition of approval.

Recommendation 20

The Proponent and the waterways manager (PIMA) should resolve the question of public access to canals during the detailed planning phase.

Recommendation 21

The Proponent should surrender the southern buffer zone and the Soldiers Cove area as shown on Plan No 78/65/4 (Preliminary Development Concepts) to be reserved for the purpose of Conservation of Flora and Fauna. This land in total should be surrendered prior to the granting of subdivision approval for Stage 1 of the project.

The reserves for Conservation of Flora and Fauna should be vested in the Western Australian Wildlife Authority. Management of the areas should recognize that channel-widening options may be necessary in the future to improve the overall state of the Peel-Harvey estuarine system.

Recommendation 22

Vesting of the foreshore/floodway reserves should be as suggested by the Proponent with the added requirement that the management plan prepared for the reserve should be approved by the waterways manager (PIMA) and the PWD.

Recommendation 23

The Authority endorses the recommendation of the Steering Committee on Canal Developments that appropriate amendment should be made to the Town Planning and Development Act to allow for transfer, free of cost, of canal waterways to the Crown.

Recommendation 24

Matters relating to road networks should be resolved to the satisfaction of the Town Planning Department, Main Roads Department and the Shire of Mandurah. The Public Works Department must be satisfied that roads within floodways are not elevated above existing ground levels. Noise issues relating to roads should be resolved to the satisfaction of the Public Health Department.

Recommendation 25

Before construction commences the Proponent should discuss with the Shire of Mandurah the question of noise levels and hours of operation, and he should follow the 'Procedure for Assessing the Noise Effect of Proposed New Developments on Existing or Proposed Noise Sensitive Developments' as prepared for the Noise and Vibration Control Council[20].

Recommendation 26

The Proponent should liaise with the Commissioner for Soil Conservation on appropriate methods to minimise dust levels and stabilise soils during and after earthmoving operations.

Recommendation 27

The Proponent should include in the management programme, suitable provisions to protect the conservation areas, floodways and foreshore areas from any adverse effects during the development of the estate. Concurrence to this aspect of the plan should be obtained from the waterways manager (PIMA), PWD and WAWA.

Recommendation 28

Decisions concerning appointment of the waterways manager (PIMA) would need to consider the manner by which funds for management would be raised and the adequacy of resources available to the management agency to carry out its responsibilities.

Recommendation 29

The Proponent should develop a management plan which satisfies The Peel Inlet Management Authority.

Recommendation 30

The Proponent should reach an agreement with the waterways manager (PIMA) as to a time, or performance level at which the responsibility for all or parts of the project are handed over to the waterways manager. This agreement should be reached prior to subdivisional approval being issued.

Recommendation 31

The Proponent should develop a monitoring programme which satisfies The Peel Inlet Management Authority.

Recommendation 32

The Proponent should provide guarantees in a form acceptable to Government for remedial works which may be required as a result of failure of the project to achieve standards required by the waterways manager (PIMA).

TERMS AND ABBREVIATIONS USED IN THE TEXT

Authority	:	Unless otherwise qualified is the Environmental Protection Authority.
Connecting Channel) Canal or Canal Waterway)	:	As defined by the Steering Committee on Canal Developments.
ERMP	:	Environmental Review and Management Programme
Inlet Channel	:	Refers to the main channel linking the ocean with Peel Inlet.
Mandurah by-pass	:	The proposed second stage of the Mandurah by-pass road which, with the by-pass bridge, will complete a link between Mandurah Road and Old Coast Road.
Management Area	:	The area over and adjacent to a canal estate within which a designated body is responsible for maintenance, management and monitoring.
PIMA	:	Peel Inlet Management Authority.
Proponent	:	John Holland (Constructions) Pty Limited, proposer of the project and responsible for production of the ERMP.
PWD	:	Public Works Department.
WAWA	:	Western Australian Wildlife Authority.

1. INTRODUCTION

1.1 General Background

The Waterside Mandurah development is one of two residential canal estates* proposed for land adjacent to the Inlet Channel to the Peel-Harvey Estuary. In combination, the two projects would create in excess of 2 000 residential lots, the majority with a canal frontage, in an area generally regarded as having potential for canal development. The Waterside Mandurah site is in fact designated for canal development (subject, of course, to environmental studies) under the Peel Inlet Management Plan.[1] The site of the other development (the Halls Head Waterways project) is largely west of the Old Coast Road and is, therefore, beyond the scope of the Peel Inlet Management Plan. However, that portion of the project site between the Old Coast Road and the Inlet Channel is within an area designated for canal development (subject to environmental studies) under the plan.

The Peel-Harvey system has been, and will continue to be, strongly influenced by the activities of European man. These influences have altered the quantity and quality of water flowing to the estuary from the catchments, and the estuary's connection and interchange with the ocean. Residential canal estates would impose another impact on the system. The question must be asked whether the costs, in terms of loss of existing environmental values and demands for ongoing management, are acceptable.

In its evaluation of the Waterside Mandurah project, the Environmental Protection Authority has considered the following:

- Development of canal estates may have the potential to degrade existing environmental resources e.g. areas of conservation value, groundwater resources, landscape and fisheries.

- Poorly located or inadequately designed canal developments could exacerbate floods and cyclonic surges.

- Canal estates promote expectations of high environmental quality within the development with good water quality and general amenity, durable construction and low maintenance demands. Shortcomings in quality will create demands for remedies, usually on some segment of government.

- Occupants of canal estates will, no doubt, have expectations of access to high quality environments nearby. In this regard, the problems of the Peel and Harvey Estuaries are well known.

In the short term, risks of poor environmental conditions within the development must be borne by the developer as any obvious unsatisfactory environmental consequences will deter purchasers. It is therefore obviously in the developer's interest that quality is as high as possible.

* The other canal proposal is the Parrys Esplanade Limited Halls Head Waterways project. For documentation of this project see THE FEILMAN GROUP (1981) Halls Head Waterways Environmental Review And Management Programme. Parrys Esplanade Ltd. Perth. W.A.

On the other hand, long-term environmental effects within and adjacent to the development, leading to continuing high management costs, may take some time to manifest themselves and not become apparent until the developer's involvement would normally have ceased. The Authority, therefore, has had to consider whether the benefits of development of the canal estate outweigh the risks of high long-term management costs, and of reducing environmental quality.

1.2 Methods

The assessment process employed in evaluating the ERMP's for the Waterside Mandurah and Halls Head Waterways proposals has two steps. As a first step, the suitability of the project sites for canal development was examined by evaluating seven principal environmental factors, these being:

- conservation values;
- flood risk;
- impact on groundwater resources;
- the estuarine fishery;
- water quality in the Inlet Channel;
- forces available to circulate water in the canals; and
- the suitability of soils as substrates for development

In assessing the suitability of the project sites for canal development, it was also necessary to consider the proposals in the context of the Peel-Harvey estuarine system as a whole, particularly as the system is subject to massive pollution by agricultural fertilisers and as the success of remedial measures cannot be assured at this stage.

Because the two project sites are close together, and rely upon the same source water, treatment of the principal environmental factors is essentially similar for both projects.

The second step in the assessment process was to evaluate the suitability of the actual development proposals put forward. Attention was paid to planning and engineering mechanisms to be utilised to achieve as acceptable development within the limitations imposed by the prevailing environmental conditions. Because of fundamental design difficulties, assessment of the detailed acceptability of projects differs.

Notwithstanding the different forms of the two projects, assessment has revealed similar requirements for both in terms of on-going management and monitoring. Additionally, the allocation of responsibilities for monitoring and any remedial works revealed as necessary during the development phase are also similar. Accordingly, the Authority has adopted a similar approach to management, monitoring and contingency guarantees.

1.3 The Project

The Waterside Mandurah Project would be developed in two stages. Stage 1, north of the proposed alignment of the Mandurah by-pass road, would be a waterway with a single entrance to the Inlet

Channel and including 'islands' linked by culverts. Stage 2, for which planning is conceptual only, would be constructed south of the by-pass road, would be linked to Stage 1 via a culvert under the by-pass, and would have two further openings to the Inlet Channel.

Early project documentation by the Proponent, John Holland (Constructions) Pty Ltd, has been examined by various government agencies and the Proponent advised of a number of unsatisfactory features. In the course of this process the need for a more formal procedure for evaluating canal developments became apparent. The Steering Committee on Canal Developments was established and a moratorium imposed during its deliberations halted consideration of all canal estates. The Report of the Steering Committee was duly received and endorsed by Cabinet in August 1981[2]. This report established procedures in relation to planning and other statutory processes through which canal projects must pass. It set out certain definitions and conditions for canal estates and established the ERMP as the basis for all subsequent decisions relating to both environmental and planning matters.

1.4 The Projects in the Context of the Peel-Harvey Estuarine System

As the Hon. Minister for Conservation and the Environment has said, "the State Government has expended very substantial sums on research and possible solutions and remains firmly committed to reversing the deteriorating condition of the Peel-Harvey estuary"[3]. There is no doubt that a radical cure to the eutrophic condition can be achieved, but how soon and at what cost have still to be determined[3].

The Authority is well aware that short-term solutions are not available and it has, in the past, advised against developments that imply an expectation of high environmental quality in the vicinity of the Peel-Harvey Estuary while algal problems continue to degrade its amenity. The Department of Conservation and Environment has also consistently urged caution on proposed developments in the region which would rely on high environmental quality.

The proposed Waterside Mandurah and Halls Head Waterways canal estates would be partly buffered from the poor environmental quality of the estuary by the strong oceanic influences upon the waters of the Inlet Channel, influences which are largely dissipated by the physical characteristics of the estuaries. Nevertheless, approval of these developments would imply confidence in the early solution of eutrophication problems. This confidence imposes great responsibility upon the Proponents of development and the waterways manager. The Proponents must produce designs which have the least environmental impact and make the best use of the natural features and characteristics of the area. The Waterways manager must have expertise and resources to ensure the developments continue to function without detriment to the area as a whole.

2. THE EXISTING ENVIRONMENT

2.1 The Subject Land

The development is proposed for land on the eastern side of the Inlet Channel which will be bisected by stage two of the Mandurah by-pass road. The land is owned by the Proponent. Subdivision of the land into three lots, coinciding with Stage 1, Mandurah by-pass road and Stage 2, has been approved by the Town Planning Board.

The highest land, above the 2 metre contour, lies along the north-eastern boundary on the western margin of an area of shallow sands over limestone.[4] Immediately to the west of this high land is a narrow belt of beach ridges lying roughly between the 1 and 2 metre contours. It appears likely that seepage of fresh water from the unconfined aquifer in higher land to the east occurs along this narrow belt. This is suggested by the presence of coast saw sedge, a species characteristic of freshwater seepages on the margins of salt flats or salt lakes.

The greater part of the land, some 80%, lies below the 1 metre contour and represents Pleistocene Estuarine Lowlands. Le Provost, Semeniuk, and Chalmer[5] have illustrated the geomorphic processes which have operated to develop the landforms adjoining the Mandurah Inlet Channel. They show that the Holocene sequences comprise elongate shoals, representing accretional stages, separated by tidal channels. The shoals subsequently have provided nuclei for further sedimentary accretion. The vegetation sequence as the landforms developed was from saltmarsh to salt flat or to swamp sheoak/saltwater paperbark. Old shoals bearing swamp sheoak are clearly discernible on aerial photographs of the subject land.

2.2 Conservation

The saltmarsh area on the south and south-west of the subject land and bounded to the east and north by one such shoal, has been identified by the System Six Study Report as an area which, with Channel and Creery Islands, has considerable value for conservation of wading birds and other water birds. (Recommendation C 50)[6].

Shoals and islands at the southern end of the Inlet Channel have been identified as an Emergent Tidal Delta[5]. No other similar structure appears to be known in south-western Australia.

2.3 Floods

The greatest part of the land lies on flood plain and is undevelopable without substantial fill to raise buildings above flood height. As a means of development, a well designed canal estate would offer floodways not provided for in normal dryland development. This has been recognized in the Kinnaird Hill deRohan and Young Pty Ltd report[7] to the Peel Inlet Management Authority and PIMA's Management Plan[1].

The Public Works Department has commissioned the Centre for Water Research to evaluate flood data and the hydraulic efficiency of the Inlet Channel. Until this evaluation is completed the PWD will continue to specify minimum levels above which buildings should be placed to withstand a 100 year flood or major cyclonic event.

2.4 Groundwater

An aquifer in superficial deposits, mainly Tamala limestone, is utilized by residents of Dudley Park to the north-east of the subject land. This aquifer is recharged by direct infiltration of rainwater.

2.5 The Estuarine Fishery

The Peel-Harvey Estuary provides an important nursery area for commercial species of fish such as sea mullet, cobbler and King George whiting[6]. The system supports the largest commercial and amateur estuarine fishery in Western Australia and any damage to the fishery would be serious[8].

The Inlet Channel provides the only migratory route to the ocean for fish and crustacea entering or leaving the estuary. The Inlet Channel is of some importance as a fish habitat, particularly south of the Mandurah bridge. The area north of the bridge is highly modified and offers few areas in which aquatic fauna shelter and breed other than the rock walls at the channel mouth which provide a habitat mainly for marine fish. The shallow flats on the eastern side of the channel provide a limited feeding area. South of the Mandurah bridge, the area is more favourable as a habitat, providing sheltered areas such as Soldiers Cove and more extensive shallows which provide sheltered waters for overwintering marine fish and crabs[9].

2.6 Water Quality in the Inlet Channel

The problems facing the Peel-Harvey Estuary are outline in DCE Bulletin 118[3]. Relevant quotations follow :

"Until 1980 the algal nuisance affected mainly Peel Inlet; the weed accumulations were unpleasant and were costly to remove. However, the massive blooms of the blue-green alga Nodularia in the summers pf the 1980-81 and 81-82 are a new dimension in the condition of the estuary".

"It is not possible to predict the future of the estuary with any certainty, there are too many unknowns; the variability of rainfall, the use of agricultural fertilizers and the ability of coastal plain soils to store and release phosphorus. However ... its condition is not likely to improve until the amount of phosphorus available to plant life in the estuary is reduced".

"The Nodularia blooms will probably become more extensive and more prolonged and they will in turn fertilize greater quantities of green algae".

"If the blooms get worse there will be a further decline in fish populations and in professional and amateur catches. ... it is likely that blooms do create unfavourable conditions for crabs".

A considerable research effort is being put towards finding how the present high levels of plant nutrients in the estuary can be reduced, first to a point where there are no longer blooms of Nodularia and then to eliminate the harmful effects caused by filamentous green algae.

The problems outlined above are largely limited to the estuary as opposed to the Inlet Channel. Water quality in the Inlet Channel has been reasonably well documented from various studies. It carries marine water from the ocean to the Peel-Harvey Estuary on a flood tide, and estuarine water to the ocean on an ebb tide. The canal estate would draw its source water from the Inlet Channel.

PIMA has stated that it considers waters in the Inlet Channel would generally satisfy water quality requirements listed in the report of the Steering Committee on Canal Developments[10]. However, for periods during summer when a bloom of the blue-green algae Nodularia occurs in the estuary, water quality in the Inlet Channel is reduced in terms of turbidity, colour, dissolved oxygen and chlorophyl 'a' levels. This period of reduced quality will have an effect on water quality in the proposed canals.

2.7 Exchange Mechanisms

The ERMP has identified several driving forces which will exchange water between the canals and the Inlet Channel. These forces are winds, tidal variation, level variations along the Inlet Channel, long period water level variations and density currents.

Adequate data on these phenomena (with the exception of density differentials) are available to enable calculations to be made on anticipated exchange rates between the proposed canal estate and the Inlet Channel.

2.8 Soils

The Waterside Mandurah site comprises landform and soils of the Vasse association which can be described as poorly drained plain with variable undifferentiated estuarine and marine deposits[11]. The site is a tidal delta comprising a wedge of very fine to fine quartz-skeletal-fragment sand sediments of marine origins, built up where the Inlet Channel enters the Peel Harvey Estuary, and overlying the Pleistocene soils and interfingering with the more recent Holocene sands[12]. Drilling results reported by Treloar (1978)[13] indicate that the insitu sediments extend in parts to depths of 12 m below mean sea level.

3. DOCUMENTATION

3.1 Background

Early project documentation for the Waterside Mandurah project has been briefly outlined in Section 1.3. In August, 1981 the EPA decided that a document entitled Waterside Mandurah-Proposals for Waterfront Living : Environmental Review and Management Programme failed to assess the full environmental implications of the proposal and was inadequate as an ERMP. The document was accepted as a Notice of Intent but an Environmental Review and Management Programme was required to allow complete environmental assessment of the project. The Department of Conservation and Environment provided guidelines to be followed in preparation of the ERMP.

John Holland (Constructions) Pty Ltd submitted an Environmental Review and Management Programme to the Authority in April 1982.

3.2 Adequacy Of The ERMP

Like papers that preceded it, the document is one of advocacy for the project rather than an objective statement of the existing environment and environmental implications of the development. Nevertheless, it did address, in general terms, the issues identified in Department of Conservation and Environment guidelines. The Authority therefore decided that the document should be evaluated to enable a definitive decision on the project to be made. Accordingly, it was made available for public comment from 3 May to 23 July 1982. At the same time, comment was sought from government agencies and the Shire of Mandurah.

3.3 Submissions Received

. Public Submissions - nine submissions were received from private individuals, six of which were from local residents. Without exception, the local residents saw development of the canal estate as a good thing for Mandurah and a means of providing a desirable life style, providing any environmental concerns could be overcome. The Authority was given no direct evidence at this level of rumoured disapproval of canal development from local people. It is not clear whether the technical nature of the ERMP presents a barrier to comment from lay people, but it may be salient to note that only one of the submissions received from local residents made direct reference to the ERMP document.

  The remaining submissions from private individuals were received from people with technical expertise expressing concern at possible shortcomings in the treatment of some technical matters in the ERMP and identifying conservation values considered likely to be reduced by development of the subject land.

  Comments expressing strong opposition to the project were received from both local and non-local conservation groups and fishing interests. These submissions reflected a degree of technical expertise in addition to their commitment to the preservation of the natural environment.

On the basis of water quality research undertaken in connection with his project, the Proponent of a canal development in an adjoining municipal district challenged claims made in the ERMP regarding the effectiveness of hydraulic circulation and acceptability of water quality within the proposed Waterside Mandurah canal system. The contention underlying this submission was that circulation and water quality in the Waterside Mandurah development would be less satisfactory than in the other development and a technical report documenting research results was submitted in support of this contention. As this technical report has now been submitted in conjunction with a Notice of Intent for the other canal project, and as it documents research undertaken at a site where water exchange mechanisms and source water quality differ from the Waterside Mandurah site, the Authority does not consider it appropriate to discuss the report and its conclusions at this time. Nevertheless, questions raised in this submission regarding the adequacy of the Waterside Mandurah project in terms of circulation and water quality need to be addressed.

Comments on two other matters raised in public submissions are considered necessary at this stage. Firstly, as a corollory to comment on the ERMP, conservation groups requested an environmental study of the impact of the Mandurah by-pass road and bridge. This project has been planned for many years and its environmental implications have been considered. The Authority has received advice that when built, it will present less of a constriction to water flows during floods than does the existing bridge and its approaches. (The question of the by-pass route is discussed further at Section 4.3.7).

Secondly, recommendations were made that a physical model should be constructed to test the behaviour of the proposed canal system. The Authority has been advised that, because of the characteristics of the Peel-Harvey Estuary, particularly the small tidal range and the large surface area of the estuary relative to the width of the Inlet Channel, any model would have to be so large as to be prohibitively costly.

- Submissions from Government - submissions were received from ten government departments and instrumentalities, and the Shire of Mandurah.

3.4 Conclusions

A number of submissions received were strongly critical of the quality of the ERMP. Criticisms included incorrect attribution of sources and inaccurate citation of references, and superficial and inconsistent uses of information. These criticisms can be sustained at a number of levels. Material on vegetation is virtually a direct quotation of a general description from DCE Report No 9[8], indicating that the Proponent made little independent effort to gain an understanding of the specific features of the subject land. The section on the fauna demonstrates no effort to examine the acknowledged conservation values of the area as a water bird habitat, nor to identify to components of the saltmarsh environment significant to the species using it.

An incorrect statement is made about Department of Fisheries and Wildlife policy in relation to numbers of professional fishermen and unsubstantiated claims are made that increased amateur fishing will not be a limiting factor on the professional fishing industry.

Evaluation of certain sections of the ERMP was made difficult by the absence of raw data, and the failure to effectively analyse data that were included to substantiate claims made. For instance, data to support the assumptions on which estimates regarding wind traction were based are not presented and similarly, the contention that Nodularia would not tolerate salinity levels anticipated in the canals is unsupported. This contention was in fact challenged in one submission received and the organism is known to tolerate waters ranging from almost fresh to hypersaline.

In addition, certain implications of the proposed development have not been assessed. For instance, Appendix 8.1 (Stage 1 Hydraulic Analysis) contains a conclusion that the biological implications of the 15 to 25 day flushing time expected to result from wind traction should be assessed. This has not, however, been done.

4. ENVIRONMENTAL ASSESSMENT

As already mentioned, an assessment process employing two steps has been used. Initially, the suitability of the project site was examined on the basis of relevant environmental issues and secondly, the acceptability of the actual development that has been proposed in terms of engineering, planning and design detail was evaluated.

4.1 Identification of Issues

The Report of the Steering Committee on Canal Developments[2] defined the content of any document to be assessed by the EPA for canal projects, whether a Notice of Intent or an ERMP. Some of the issues to be addressed relate principally to environmental matters. Others, while clearly impinging on the environment, can be dealt with by planning and engineering means at later stages in the approval procedure, and by appropriate management initiatives, should a decision be made to proceed with the development.

Establishing whether or not the respective sites are suitable for canal development has necessitated examination of what are principally environmental factors. These factors have been more fully discussed elsewhere (Section 2 - THE EXISTING ENVIRONMENT) and can be summarised as:

- the conservation value of salt marsh areas on site;
- the role of the site in mitigating upstream flooding;
- the potential impact on groundwater resources;
- the potential impact on the estuarine fishery;
- the adequacy of source water quality;
- the adequacy of prevailing hydrological and meteorological influences to promote water circulation; and
- the geotechnical adequacy of in situ soils

The object in examining these matters has been to determine whether or not the anticipated consequences of canal development on the respective sites could be considered and manageable.

Once these decisions have been made, it is then necessary to establish at a more detailed level whether or not the actual development projects that have been put forward are acceptable. In assessing the possible acceptability of the respective projects, it has been necessary to consider a wide variety of matters which, although impinging upon what are in fact environmental issues, could be dealt with by planning, engineering and design means should the projects proceed.

The basic environmental factors that determine site suitability are similar for both the Waterside Mandurah and Halls Head Waterways projects and accordingly, there are certain common elements in the Authority's assessment. However, basic differences in the two development concepts mean that most matters relating to the suitability of the two proposals involve different considerations although again, there is some commonality.

4.2 Suitability Of The Land For Canal Development

4.2.1 Conservation Values

Unlike other areas proposed for development as canal estates in the Mandurah-Murray region, the Waterside Mandurah project site has some intrinsic conservation values:

- It represents more than 10% of the total area of saltmarsh in the Peel-Harvey system. Understanding of the function of saltmarshes in an estuarine ecosystem is limited and Hodgkin et al (1980)[8] have seen a need to increase knowledge of their role in shoreline stabilization, nutrient dynamics and bird life. The saltmarshes are known to provide feeding grounds for large numbers of wading birds and other water birds and are recognized in Recommendation C50 of the System 6 Study Report[6], reflecting advice of the Department of Fisheries and Wildlife.

- It presents a record of the geomorphological processes that have shaped the Mandurah Inlet Channel.

The physical features of the site that contribute to its conservation value also provide areas in which mosquitoes can breed. Parts of the site are in fact known breeding areas for saltmarsh mosquitoes and are subject to abatement programmes. Furthermore, the subject land is privately owned and it is, therefore, necessary to acknowledge the owner's developmental expectations and aspirations.

It is apparent that the site already experiences conflicting pressures and demands and that these are likely to increase with time. Evidently, acquisition would be the most effective means of preserving the site's conservation value. However, it is necessary to acknowledge the practical difficulties of such action and also, the fact that preservation of the total site has not been recommended in the System 6 Report.

The Authority has consistently endeavoured to achieve a balance between conservation and development and believes that such an approach could be beneficially pursued in this instance. Basically, the Authority considers that provided adequate areas could be set aside and managed towards conservation, the conservation values of the site need not be subjugated if canal development was to occur.

Accordingly, subject to this qualification, the conservation value of the project site would not be considered to constitute a reason for preventing canal development.

4.2.2 Groundwater Resources

Groundwater resources in the superficial aquifer underlying the project site and adjoining areas may already be over-exploited with freshwater supplies being jeopardised by abstraction rates exceeding the safe yield of the aquifer during the summer months.

The freshwater/saltwater interface within the unconfined aquifer is presently positioned generally beneath the central portions of the project site and the ERMP acknowledges (p 63) that canal construction will cause a shift in the interface towards the property's eastern boundary. As a result of this shift, the aquifer beneath much of the project site will become saline, thereby severely restricting the on-site availability of useable groundwater. Relocation of the freshwater/saltwater interface will further jeopardise groundwater resources being used in the Dudley Park locality immediately north-east of the project site.

In order to investigate the matter the Proponent installed five permanent groundwater monitoring bores on the boundary between the subject land and the currently developed Dudley Park subdivision. The object was to detect changes in the groundwater quality profile during the summer of 1981-82. A further ten private bores in the adjacent area of Dudley Park were tested for salinity levels. This information was obtained to provide a basis for comparison with groundwater quality following canal construction. The ERMP contends that immediate remedial action could be taken by the Proponent if a reduction in groundwater quality could be attributed to canal construction.

The Authority has been advised that the Proponent has presented a reasonably realistic assessment of the influence of canal development on the groundwater regime. The most marked changes in the salt water/fresh water interface would occur as a result of development of the Stage 1 waterway.

The Authority has further been advised that the project should only be approved if the consequences of saltwater intrusion beneath the western/south western edge of the existing Dudley Park subdivisions are acceptable.

Definition of 'acceptability' is difficult but basically, it amounts to making a decision about the relative worth of a groundwater resource that is being utilised by people who do have access to a reticulated water supply, and the perceived benefits to Mandurah of the canal development. The decision is, however, made more difficult because, if development proceeds, any subsequent deterioration in the quality of the resource could be the result of all or any of the following:

. installation of the canals;

. reduced recharge; and

. over-pumping of the aquifer

On the other hand, increased recharge during wet winters, and/or reduced evapotranspiration as a result of presently vegetated sections of Dudley Park being cleared to allow development, could over-ride the effects of canal installation.

The Authority concludes that an ongoing watch on groundwater quality fluctuations will be necessary if the development is to proceed. In addition, the possible need for remedial measured in the event of a major impact on the groundwater resource attributable to the canal project needs to be acknowledged. Provided acceptable

guarantees were provided in these regards, the Authority considers that the hydrogeological implications of the project would not represent a major impediment to use of the subject land for canal development.

4.2.3 The Estuarine Fishery

The importance of the commercial and amateur fisheries centred on the Peel-Harvey Estuary is such that developments on land adjacent to the estuarine system should not be allowed to have any significant adverse effects upon it. In assessing the acceptability of canal development along the Inlet Channel in relation to the estuarine fishery, the Authority has identified the following as being of importance:

- possible diminution of water quality in the Inlet Channel;
- impact of construction or maintenance dredging;
- interruption of fish movement patterns; and
- increases in boating activity or fishing pressures

From its examination of these issues, the Authority has concluded that the major concern is the possibility of interruption or alteration of fish migration between the ocean and the estuary. In its submission, the Department of Fisheries and Wildlife observed that single opening canals along the Inlet Channel could pose a threat in this regard, citing the possibility that juvenile mullet might congregate in the artifical waterways rather than completing their winter migration to the estuary. Possible interruption of fish migration was also a matter of concern to the Mandurah Professional Fishermen's Association.

Other factors which could affect fish migration patterns would be dredging activities or major reductions in water quality which could occur when the canal projects or stages of them are joined to the Inlet Canal.

The Authority believes that dredging or connection operations can be timed so that increased turbidity levels or reduced water quality will not cause significant alterations to fish migration.

In relation to other issues, the Authority notes that both the Department of Fisheries and Wildlife and the Mandurah Professional Fishermen's Association are concerned at the possible impact of development on the estuarine fishery. The effects of an increase in boating activity on the estuarine fishery also requires attention. It is difficult to assess how great an impact these factors may have on the estuarine fishery, particularly as it is the cumulative impact of all developments rather than the consequences of an individual project that requires consideration. However, it is considered that, with appropriate design, management and monitoring, canal developments along the Inlet Channel could be arranged so as to minimise possible impacts.

The Authority also notes that if canal estates are developed along the Inlet Channel, once a benthic community establishes in the canals, the resultant additional habitat could be seen as a beneficial consequence of development. This increased habitat could be of particular significance as embayments along the Inlet Channel are used as an overwintering area by several species of fish.

From its consideration of the possible impact canal development along the Inlet Channel may have on the estuarine fishery, the Authority concludes that with appropriate design, management and monitoring, such development could be regarded as acceptable.

4.2.4 Flood Impact

The ERMP states that a 1 in 100 year flood would cover 90% of the proposed development area in its present state. However, taking into account restrictions to flow at the Sticks Channel and training walls, plus the afflux at the traffic bridge, the effective contribution to the channel flow of the flood plain would be extremely small.

The PWD specifies minimum levels above which buildings should be placed to withstand a 1 in 100 year flood cyclonic event. In addition, the PWD has advised the Authority that it has commissioned preparation of a mathematical model of water flow characteristics of the Inlet Channel but that the model is unlikely to show the need to plan for higher flood levels than presently used by the Department. The Authority has also been advised by the PWD of the need to maintain adequate floodways along the Inlet Channel in the event of adjoining lands being developed.

The Authority therefore concludes that flood risk is not an impediment to development of the area as a canal estate, providing block heights exceed appropriate flood levels and adequate floodways are maintained along the Inlet Channel.

4.2.5 Water Quality In The Inlet Channel

The Inlet Channel connects the Peel-Harvey estuarine system to the ocean and its quality is influenced by the quality of those two water bodies.

Data available indicates that for most of the year, the water quality of the Inlet Channel is acceptable as source water for a canal estate. There are periods, however, when reduced water quality has been observed in the Inlet Channel and this could have a detrimental effect on water quality within the canals. These periods vary in duration but generally occur through the months of November, December and January.

Although this reduced water quality will have some effect on an ebb tide, waters of the Channel on a flood tide will be essentially marine.

The ultimate water quality within the canals will relate to source water quality, flushing times and nutrient input. These factors can only be assessed for a specific project.

Because of these periods of reduced source water quality, in the design of any project, flushing times should be reduced as much as possible and nutrient input to the canal should also be minimised.

As indicated at Section 2.6, PIMA has stated that it considers waters in the Inlet Channel would generally satisfy water quality requirements listed in the report of the Steering Committee on

Canal Developments[2]. The Authority therefore concludes that in terms of the beneficial uses of canal waters, the water quality in the Inlet Channel is adequate as source water, providing high flushing rates and low nutrient loading of the canal waters can be achieved in the design of the particular project.

4.2.6 Exchange Mechanisms

Waters of the Inlet Channel are considered acceptable as source water for canal developments provided high flushing rates are achieved in the artificial waterways. Accordingly, in evaluating the suitability of land adjoining the Inlet Channel for canal development, it is necessary to identify and quantify the factors available to exchange waters between canals and the Inlet Channel. To a large extent, exchange rates will be determined by the hydraulic characteristics of a particular development, but the mechanisms to cause exchange must exist, otherwise the site could not be considered suitable for canal development.

The following exchange mechanisms have been identified in the Inlet Channel/area:

- Winds - data indicate that coastal localities such as the Inlet Channel area, experience relatively windy conditions. An evaluation of recorded data from comparable sites shows that for 50% of the time, winds in the order of 4 metres per second could be expected. Calm periods (below 1.5 m/sec) occur mainly in the winter season and on average a calm of over 16 hours would occur only once a year.

- Tides - recordings at the Mandurah jetty for the period August 1977 to August 1978 indicate that for 98% of the time, the tidal range for the Inlet Channel could be considered to be from 0.5 m AHD to -0.4 m AHD[14]. Tidal variation in any one day was normally .2 m to .4 metres. A variation in tide levels along the Inlet Channel has been observed and it has been concluded that on this basis a tidal lag could be useful as an exchange force.

- Density Currents - stratification has been observed in the Inlet Channel associated with waters of different salinities. The difference in density of bottom and top waters of the channel could, on certain occasions significantly assist water exchange between the canal estate and the Inlet Channel. Although this phenomenon has been observed and recorded to a limited extent, it has not been adequately measured to accurately determine its extent or duration as an exchange mechanism.

The Authority considers that, with suitable design, these mechanisms could achieve adequate water exchange and flushing rates within canal systems adjacent to the Inlet Channel.

4.2.7 Soils

The ERMP contains test results from soils analyses carried out on samples from eight bores on the site. It is concluded (Appendix 8.4) that engineering interpretation of the results indicate that:

- such material would be adequate as an underlying base for residential land; and

- the majority of this material would be adequate as dredge spoil fill to the residential land.

Soils of marine and estuarine origins as characterize the Waterside Mandurah site are highly variable and quite possibly, the eight sampling points might not have identified significant localised variations. This is of particular relevance in the extensive samphire marsh area, which is presumably the most recently consolidated section of the emergent delta, where only three bore sites have been sampled.

In addition, the Authority's attention has also been drawn to the presence of material of poor load bearing capacity in the 0-2 m range, and, in one case, at depths greater than 3.8 m.

4.2.8 Site Suitability - Conclusions

Examination of the principal environmental factors influencing the suitability of the site for canal development reveals that the site could be considered generally suitable for such development providing the specific project design was appropriate to the site and the environmental impact of development was minimised through appropriate ongoing management and monitoring programmes.

Assuming that this soils analysis does confirm the acceptability of the site for canal development, the acceptability of the specific project cannot be ascertained until its likely impact has been assessed in detail. This further examination is carried out in Section 4.3.

The Authority has noted that if a canal estate is developed as proposed, it would require considerable and appropriate management, monitoring and perhaps remedial works. The issue of management is addressed in more detail in Section 5.

Recommendation 1

Prior to the land being zoned for canal development The Peel Inlet Management Authority (PIMA) should be appointed as the manager for the artificial waterways.

4.3 Suitability of the Proposal

More detailed examination of the actual development proposal that has been put forward is necessary to determine its suitability. A wide variety of matters, ranging from the critical issue of water quality and circulation in the canal system to the project's consequences for the social environment and the anticipated environmental impacts during construction, has had to be examined in this context.

Many of these matters were highlighted in submissions received and although they have clear environmental implications, it is generally considered that they could be adequately addressed by

engineering or planning means. Additionally, many of the matters either fall within the responsibility of existing agencies and the Proponent or would be most appropriately dealt with by, or to the satisfaction of, the yet to be designated waterways manager.

Accordingly, when the Authority reviewed these matters, it noted concerns drawn to its attention and recommended that appropriate measures be taken by the Proponent and the relevant agencies.

4.3.1 Environmental Engineering - Circulation And Water Quality

The most critical of the issues requiring more detailed examination in terms of establishing the acceptability of the development proposal is the quality of water to be expected within the canal network. It is also necessary to consider whether the development could cause a deterioration in the quality of waters in the Inlet Channel.

Water quality in the canal network will essentially be a function of the quality of the supplying waters and the capacity of the canal network to allow exchange with those waters. Because the development would be served by reticulated sewerage, input of sewage pollutants is not an issue. Pollutants may, however, arise from fertiliser enriched run-off from gardens and open space and stormwater discharge, or from spillages of fuels and oils.

Issues relating to drainage management are dealt with in Section 4.3.2. Difficulties are, however, likely in implementing safeguards to prevent fuel and oil spillages given that the development includes both public and private boat launching ramps. Public education programmes to reinforce the need for care in the handling of fuels and oils, and appropriate contingency plans to be implemented in the event of major spillages, appear the most satisfactory form of safeguard available and these matters are also discussed in Section 4.3.2.

Because it is not the only canal estate proposed for land adjoining the Inlet Channel, there is also a need to consider whether the combined effects of the proposed developments may reduce water quality in the Inlet Channel and the estuarine system.

Based on analysis of samples collected from the Inlet Channel in 1981-82, the ERMP concludes that water in the Inlet Channel is of suitable quality for swimming and recreational uses except for a period in early summer when a bloom of the blue-green algae Nodularia was moving out to sea. Episodes of low water quality associated with algal blooms during tidal flushing of the estuary in early summer have been recorded in the Inlet Channel for several years. Nodularia blooms occurred in the estuary in the summers of 1978-79, 80-81, and 81-82, and an extensive phytoplankton bloom commenced in October 1982. These events were recorded in the Inlet Channel for periods of approximately seven weeks. During these periods, waters are characterised by high turbidity and biological oxygen demand, green colouration and at times, an unpleasant odour.

Although the Authority has already acknowledged that, notwithstanding the periods of reduced water quality, the waters of the Inlet Channel are considered suitable for the beneficial uses discussed

in the Report of the Steering Committee on Canal Developments (see Section 4.2.5), it is necessary to emphasise that whatever quality of water occurs in the Inlet Channel will also occur (perhaps at an even lower level) in the canals. Should the proposal proceed, it will be necessary to carefully monitor the effect of these episodes to determine their impact on the canal estate to enable decisions to be made on subsequent stages.

The ERMP acknowledges the possibility of Nodularia entering the canal system as waters exchange with the Inlet Channel. However, it is contended that problems associated with the accumulation and blooms of algae in the canals are unlikely because high salinity levels in canal water would prevent the growth of Nodularia therein and as the canal system would flush regularly.

However, data to substantiate the contention that salinity levels in the canal system would prevent the growth of Nodularia have not been presented. This contention has in fact been challenged in one submission received and the organism is known to tolerate waters ranging from almost fresh to hypersaline. Further, although the Authority has acknowledged (at Section 4.2.6) that mechanisms adequate to promote flushing and circulation in canals developed on the Waterside Mandurah site do in fact exist, and while the ERMP contains considerable information concerning anticipated flushing times (particularly for the first stage of the project), advice received by the Authority expresses some doubts at the conclusions reached regarding the acceptability of development as proposed in this regard.

The validity of certain of the assumptions made by the Proponent in calculating water exchange characteristics has also been challenged. For instance, selection of a mean diurnal tidal range of 0.5 metres, when recordings at the Mandurah jetty indicate 0.2 metres to be a more realistic figure, has been criticised. This issue has been taken up with the Proponent who contends that even using the lesser value, diurnal tides would still promote flushing every 3 to 4 days in the Stage 1 canals.

Unsubstantiated data and assumptions are used in the analysis of flushing time expected to result from wind traction. The ERMP states that "Wind roses from the Bureau of Meteorology report consistent summer winds from the east in the morning and south-west in the afternoon in the ranges 3 to 5 m/s" (p 16 Appendix 8.1). Calculation of flushing time as a result of wind traction is based on a wind speed of 5 metres per second and this has been criticised as being optimistically high.

The only wind data presented in the ERMP are from an anemometer located at Robert Bay on the souther shores of Peel Inlet from October 1977 to February 1979. These data indicate a mean summer wind speed of less than the assumed 5 metres per second throughout the survey period and accordingly, criticism of the assumption appears quite reasonable. This issue has been taken up with the Proponent who contends, based on wind data recorded at the Fremantle Port Authority building, that the 5 metres per second wind speed is in fact a conservative value. The relevance of the Fremantle data to the Mandurah project site has not, however, been demonstrated.

The unexplained use of a value of 0.022 for the friction factor in flow calculations, as opposed to the value of 0.03 determined from study of the Inlet Channel, is another criticism levelled at the assumptions and data upon which conclusions regarding water quality and circulation are based. The experimentally determined 0.03 value would, the Authority has been advised, be more appropriate than the assumed value and would have the effect of increasing the calculated flushing times.

Several submissions received contain criticisms of the culverts to be included in the canal network. Although head losses through the culverts have been taken into account in calculating network flows within Stage 1 canals, advice received is that the culverts have other implications which have not been considered. The ERMP states (p 49) that culvert obverts will be 0.4 m above canal water level (the datum employed is not specified) to allow wind blown debris to pass through. Culvert dimensions are not provided but calculations are based on a pipe diameter of 2.1 m. Given the clearance to be allowed for debris movement and a canal depth of 2.5 m, culvert inverts would be 0.8 m above canal bed level.

Deficiencies in this arrangement that have been drawn to the Authority's attention are:

- the entry of surface water into and through the culverts will be restricted on occasions when obverts are below water levels in the canals - advice is that such will be a common occurrence due to tidal fluctuations;

- sediment and stratification traps will occur at culverts as a result of the 0.8 m difference between canal bed and culvert invert levels.

Bridges having a full opening down to the canal bed and an appropriate clearance between the underside of decking and high water level, rather than culverts, have been recommended in advice to the Authority.

Additionally, although flow calculations have been done for Stage 2 of the project, these pertain only to the main waterway. The implications of the second connection to the Inlet Channel to be included in the Stage 2 canal system, and of the culvert link beneath the by-pass route have not been assessed. The Authority has, however, been advised that the final layout adopted for the Stage 2 canal network will affect detention times of water in the overall estate and should, therefore, receive attention now rather than at some future time.

Doubts have also been expressed to the Authority concerning the validity of conclusions drawn from the monitoring of salinity levels in the Ormsby Terrace Lagoon. The analysis of data collected during the period from 3 November 1981 to 2 February 1982 that is reported in the ERMP (Appendix 8.1 pp 12-15) does not accommodate variations in the summer salinity regime caused by unusually heavy rains during January 1982. The Waterways Commission also sampled salinity levels in Ormsby Terrace Lagoon and in the central areas of Peel Inlet over a similar period. Based on analysis of the data collected, it was concluded that a more realistic flushing time for the Lagoon, taking into account the major exchange mechanisms of tidal variations, density straficiations and wind traction, would be 4 weeks. This is substantially longer than the 3-4 day exchange time estimated in the ERMP on the basis of density differences alone.

The Proponent contends that each of the three significant mixing mechanisms that occur (i.e. tides, density differences, and wind traction) would, individually, achieve satisfactory flushing of the proposed canal system and that the cumulative effect of these independent factors would be more favourable. Calculation of turnover based on the cumulative effect of these influences is not included in the ERMP and as already mentioned, the Proponent's conclusions concerning exchange times have been questioned. Therefore, the Proponent's estimate that average turnover time for the overall development would be less that 5 days cannot, in the Authority's opinion, be considered as having been substantiated.

Notwithstanding data contained in the ERMP and subsequently provided by the Proponent concerning water circulation and flushing within the proposed canal system, sufficient doubt has been expressed in submissions received for the Authority to conclude that caution should be exercised in assessing anticipated circulation and water quality characteristics for the artificial waterways. In essence, therefore, the Authority is responding to the advice it has received that:

- wind and tidal data presented in the ERMP have been interpreted to give an optimistic and over-simplified assessment of water exchange rates;

- suspended solids and nutrient loads will be deposited in the canal system when outflow from the rivers dominates the Inlet Channel waters;

- this nutrient enrichment could set the scene for summer phytoplankton blooms, particularly in poorly flushed areas adjacent to islands and culverts;

- if flushing characteristics in the canal network are similar to the Ormsby Terrace Lagoon, four weekly flushing could be expected;

- within this time frame, transient phytoplankton blooms within the canal network could be expected and could influence the quality of the Inlet Channel water;

- no attempt has been made to examine in detail water exchange mechanisms in Stage 2 of the development except in the designated main waterway;

- the final layout of the Stage 2 canal system would affect retention times of water in the totally developed estate;

- unsatisfactory aspects of the Stage 2 canal system, culvert design and the proposed third connection to the Inlet Channel in particular, indicate the likelihood of possible future problems;

- the implications of these unsatisfactory aspects for water circulation and flushing in the entire canal system should be determined now rather than at some future time.

Basically, the Authority's concern in relation to circulation and water quality within the Waterside Mandurah canal network is twofold. Firstly, based on advice received the Authority is concerned that the Stage 1 canal system may prove to be functionally inadequate. And secondly, again on the basis of advice received, the Authority is concerned that the implications of the Stage 2 network as proposed (particularly with inclusion of the culvert link under the by-pass route and the third opening to the Inlet Channel) for circulation and flushing in the total canal system, have not been adequately examined.

The Authority therefore concludes that, before the development can proceed, the Proponent should provide an undertaking to complete a through connection to the Inlet Channel unless the adequacy of a "closed" Stage 1 canal system can be conclusively demonstrated. As such a through connection is in fact an important element of the second stage canal network and in view of the concerns expressed in relation to aspects of the Stage 2 canal system, the Authority also concludes from its assessment of water quality and circulation data for the project that planning of the second stage waterways should be undertaken now rather than at some future time.

The acceptability of the proposed culvert links throughout the proposed development is further discussed at Section 4.3.2.

Notwithstanding the above the Authority is of the opinion that the project can proceed provided the recommendations which follow are agreed.

Recommendation 2

The Authority concludes that the project can proceed subject to the following recommendations being accepted and implemented.

Recommendation 3

Prior to subdivision approval the Proponent should provide an undertaking that, if in the opinion of the aterways manager (PIMA) there is inadequate flushing of the estate and unacceptable water quality and there is a demonstrated need to bring forward the construction of the through canal, he will do so.

4.3.2 Environmental Engineering - Other Issues

. Flood Impact - the Authority has concluded at Section 4.2.4 that development of the project site would not exacerbate the flood hazard provided adequate block levels were achieved and suitable floodways were retained along the Inlet Channel.

The Proponent has specified block heights for Stages 1, 2A and 2B stated to be sufficient to allow for 1 in 100 year floods and maximum cyclonic events. Such levels are consistent with PWD requirements and accordingly, the Authority concludes that the proposed development is acceptable in this regard.

The adequacy of floodways to be provided under the proposal is examined at Section 4.3.6. However, it is relevant to note that in assessing the impact of the development on flood flows, the ERMP states that Stage 1 has no calculable effect on the Peel-Harvey system. The complete system, (Stage 1 and

Stage 2 together) would increase flows by 5% in a minor flood and 6 - 7% in a 1 in 50 to 1 in 100 year flood. Provided the proposed floodways are in fact adequate, this beneficial possibility would enhance the acceptability of the project in terms of flood impact.

The Shire of Mandurah has questioned the effect of flood discharge on the canal beneath the Mandurah by-pass road. It is suggested that, in the event of a major flood, there could be excessive flood velocities through the canal under the by-pass. The construction and dimensions of the canal culvert have not been specified in the ERMP.

The Shire of Mandurah further submits that canal wall height of R.L. 0.6 m AHD is not sufficient to prevent overtopping under flood conditions and that a minimum wall height of R.L. 0.75 m AHD should be required so that residents do not engage in ad hoc wall heightening as this has caused problems in Queensland.

Recommendation 4

The Authority considers that the issues of flood discharge through the link under the by-pass and wall heights should be resolved during subsequent detailed planning.

The ERMP acknowledges the possibility that some dredge spoil may be unsuitable for residential landfill and that this will be placed in other areas (p 22). Criticism has been levelled at the lack of information regarding the anticipated quantities of spoil that would be unsuitable for residential landfill and where this would be deposited.

It is understood that dredge spoil found to be unsuitable for use as fill on residential lots will be used to fill open space areas, other than floodways, and could be disposed of on the Mandurah by-pass route. Disposal options being considered and the adequacy of spoil for the purposes envisaged should be documented. (Matters relating to the disposal of dredge spoil unsuitable for residential landfill, including the possibility of external disposal and the need for liaison with the relevant agencies, are further discussed at Section 4.3.8).

Recommendation 5

The Proponent should be required to document options for disposal of spoil unsuitable for residential landfill.

- Drainage Management - the Waterside Mandurah project will produce what is essentially an urban residential environment. Runoff from an urban catchment is an acknowledged source of pollutants,[15] [16] a fact which assumes particular significance because the development includes canals. In assessing the acceptability of the development, the Authority has had to consider the following aspects of drainage management:

Stormwater discharge - the ERMP states that stormwater would be collected from roads via a system of gulley traps and piped drains and discharged to the artificial waterways in various localities. It is intended that detailed design and construction of the drainage system would be to the satisfaction of the Mandurah Shire Council. The ERMP provides some information about the design of these structures (pp 47 - 48) and it is stated that they will trap not only sand and other debris which may enter the system but will also reduce the transfer of any oil slick from the road pavement.

While the Shire of Mandurah submitted that the concept of stormwater disposal is considered to be satisfactory, the Waterways Commission/Peel Inlet Management Authority identified unsatisfactory features and stated that stormwater discharge direct to the canals from the gully traps would not be acceptable. The Public Works Department has pointed out that the suitability of the proposals for stormwater drainage depends very largely on the maintenance which will be undertaken on the trapping system and that it will be necessary for the maintenance regime to be fully specified by the developer and fully accepted by the agency responsible for maintenance before the authority responsible for water quality can judge whether the scheme can be tolerated. It must be recalled that the effectiveness of water circulation within the canal network is also in doubt (Section 4.3.1) so that stormwater must be seen as a contributory factor to poor water quality if flushing proves to be inadequate.

Operation and maintenance of the drainage system should be monitored by the Proponent, with periodic reports being submitted to the relevant agencies.

Recommendation 6

A method of discharge of stormwaters acceptable to the waterway manager (PIMA) should be devised and an undertaking made to install, maintain and monitor such a system.

Surface runoff - while the system of gully traps and piped drains would receive surface drainage from roads and adjoining lands, typical cross sections of lots show that gardens and boat ramps slope at a maximum incline of 1 in 5 towards the canals. Thus, a certain amount of runoff would enter the waterways directly.

The ERMP makes no specific reference to the nutrient load such runoff could carry (e.g. from lawns and gardens) except to imply that urban development of the site would reduce the risk of nutrient input below that which would come from agricultural development of the area. Leaving aside the unreality of agricultural development of an area of seasonally inundated salt marsh, advice has been received that rates of fertilizer application to domestic lawns and gardens can be similar to those used for pasture maintenance in agriculture. Given the doubts about flushing times, the generally high nitrogen levels detected in the Ormsby Terrace Lagoon, and the fact that

phosphorus is the limiting factor to phytoplankton growth in the Peel-Harvey Estuary, flushes of garden fertilizer from summer rainstorms, or from runoff from garden watering, would be likely to promote algal blooms within the canals, particularly in pockets of water subject to stratification near culverts. Ultimate flushing from the canals could lead to some transitory deterioration of water quality in the Inlet Channel.

Recommendation 7

The Proponent should make a strong effort to promote the use of landscaping methods which will minimise the use of garden fertilisers and the need to water gardens. Further, the matter of minimising the inflow of surface runoff to the canals should be addressed as a matter of engineering detail and to the satisfaction of the waterway manager (PIMA).

Stormwater infiltration - in relation to another development, the Authority has received advice that disposal of stormwater by infiltration could contribute to rises in groundwater levels that could cause wet, boggy areas behind canal walls unless subsoil drainage was provided. Similar problems could be expected to occur at Waterside Mandurah and detailed design should take this into account.

- Fuel And Oil Spillages - the difficulty of implementing effective measures to safeguard against pollution from fuel and oil spillages has already been alluded to. Necessarily, all possible safeguards such as the bunding of any land based boat fuelling and servicing facility should be incorporated in detailed design. In addition, however, programmes to educate the users of both public and private boating facilities throughout the development concerning the need for care in the handling of fuels and oils should be implemented.

  The responsibility for development and implementation of such programmes should rest with the Proponent, although particulars of the actual programmes and their implementation would need to satisfy the relevant management agencies.

  In addition to the recommended education programmes, the Authority considers that there is a need to develop plans to combat major spillages of fuels and oils. Containment would appear the most satisfactory premise for such plans and again, the need for these plans to be acceptable to all agencies involved with management of the development is apparent. Although the need for fuel and oil spill contingency plans has been raised as a separate issue, the Authority believes that appropriate safeguards could be incorporated in the overall management plan developed for the estate. The Authority therefore only wishes to emphasise the need to include these contingencies in the overall management plan (see also Section 5.2).

- Sewage Disposal

  Reticulated service - the project is tenable only with provision of a reticulated sewerage system. The ERMP notes that preliminary discussion has already taken place with officers of the Public Works Department. The PWD

has submitted that the design and construction of the sewerage system and ancillary facilities should be in accordance with PWD requirements and at the Proponent's expense.

Because maintenance of water quality in the artificial waterways is critically important, the Authority considers that the sewerage system to be installed should contain inbuilt safeguards to prevent the input of sewage effluents to the waterways in the event of system failure.

The Authority has been advised that the laying of sewerage mains will necessitate a substantial amount of excavation dewatering.

Recommendation 8

Measures should be taken to protect vegetation on foreshore or conservation reserves where saline waters from excavation dewatering may cause damage.

The Authority notes that requirements for sewerage mains and other services may influence the design of culverts and/or bridges. Clearly, if the development proceeds, detailed design will need to accommodate the requirements of the servicing authorities in these regards.

Boat pumpout facilities - the design vessel adopted for the Waterside Mandurah project is a 10 m craft with a 2 m draft. Although it is contended (p 55 of the ERMP) that the great majority of craft using the waterways as a result of the development will be smaller than the design vessel, it is considered likely that the development will attract a number of substantial craft with on-board waste water systems.

Stage 1 of the project does not include any boat servicing facilities, the contention being that the existing Midstream Marina would provide sufficient services, including pump-out facilities for liquid wastes. The second stage of the project does incorporate a boat servicing facility, but this stage of the development is conceptual only at this time and details have not been provided.

The ERMP contains no assessment of the adequacy of the existing facility to accommodate boat servicing demands generated by the Waterside Mandurah and nearby Halls Head Waterways canal projects. The Authority is aware that doubts have been expressed concerning the capacity of existing boat servicing facilities to satisfy additional demands and accordingly, the Authority considers that the first stage of the Waterside Mandurah project should include some provision in this regard.

Recommendation 9

Detailed planning for Stage 1 of the development should include provision of a boat waste water pump-out facility connected directly to the reticulated sewerage system.

. Water Supply

The ERMP states that the development would be provided with reticulated scheme water and that it is anticipated that both the design and construction of the system would be carried out by the PWD. That Department has advised that connection to the Mandurah Regional Water Supply Scheme would require upgrading at cost to the Proponent. If construction of multi-storey buildings was anticipated note would need to be taken of standard Departmental design.

The ERMP states that a few selected areas of public open space would be permanently reticulated from a single deep bore to be installed. The PWD has advised that the Proponent should confirm that there would be no requirement for groundwater to be developed for parkland or landscape irrigation purposes.

Water supply and use of groundwater requires consultation with the Public Works Department as matters of planning detail.

. Canal Wall And Edge Treatment

Free standing walls - the Authority has been advised that free standing walls would be acceptable provided they were constructed of materials suitable to achieve the design life recommended by the Steering Committee on Canal Developments[2].

Recommendation 10

Wall structures should be constructed to achieve at least the 30 year design life span advocated by the Steering Committee on Canal Developments.

Connecting channel limestone walls - the ERMP proposes that the connecting channels to the Inlet Channel would have limestone walls to provide the 'optimum landscape effect and minimum maintenance' (p 48). The PWD has, however, advised the Authority that the information provided in the ERMP does not establish that the limestone walls would achieve the 100 year life span recommended by the Steering Committee on Canal Developments for structures bordering connecting channels[2].

Recommendation 11

The Proponent should provide the PWD with sufficient information for that Department to assess whether the form of wall structure proposed would achieve the 100 year life span.

Underwater bank slopes - the ERMP states that "underwater bank slopes of 1 in 4 have been found to be stable for submerged sands (R. Hattersley, 1974), and so this slope has been selected" (p 49).

The Authority has been advised that insufficient data has been provided to confirm that the slope will not erode and slump with time. Not all the natural material available at the site would be suited to the task of achieving a reliable 1:4 slope.

Appropriate specification and control documentation should be required in the final design submission to justify the expectation that underwater slopes will remain stable and that erosion of the banks will not contribute to damage of the free-standing walls.

Soft edge to the southern canal - the ERMP proposes that the canal adjoining the southern conservation buffer would have a soft edge, with some planting where necessary to improve stability. This soft-edge canal would have a flatter natural slope than other canals.

The Authority has been advised that the soft edge would be unlikely to withstand the wash from boats. The soft edge would also present easy beaching places for boats, allowing free access to the buffer zone which should have access limited if 'conservation' is to be its primary function.

The structure of the southernmost canal at the interface with the southern buffer zone should be such that long-term maintenance costs are minimal and access by boat from the canal is discouraged.

- Connecting Channels - advice received by the Authority indicates that, although major siltation and scouring is unlikely, without specific measures to minimise local turbulence, some scouring will occur at the confluence of the connecting channels and the Inlet Channel when the second stage of the overall project is developed. A particular need for such measures to be applied at the mouth of the Stage 1 connecting channel has been highlighted because of the substantial through-put of water.

The Authority has also been advised that the mouths of the second stage connecting channels will probably have to be substantially realigned to conform to stable flowlines as a safeguard against scouring. Clearly, the issue of turbulence and scouring at the confluence of the connecting channels and the Inlet Channel must receive further attention.

Recommendation 12

The alignment and detailed design of the mouths of the connecting channels should be to the satisfaction of the PWD.

The Authority has also been advised of the need for a survey of connecting channels and the associated natural waterways on completion of dredging, the object being to provide baseline data against which results from future monitoring could be compared. The Authority agrees that such a need exists and notes that the area to be surveyed as a basis for future monitoring will require careful consideration as connecting channels may have an effect on the Inlet Channel at points removed from their outfall. (See also Section 5.2 for expansion of the management area concept).

Recommendation 13

On completion of dredging of a connecting channel, a survey of the channel and the associated natural waterway should be carried out at the Proponent's expense and in accordance with PWD and PIMA requirements.

Maintenance of the connecting channels and any remedial works necessitated by construction of these channels are also matters upon which the Authority has received advice. It is contended in advice received that the Proponent should be responsible for undertaking such maintenance and remedial works as the connecting channels may necessitate. While the Authority agrees with this contention, the difficulty is in establishing an appropriate period during which the Proponent should bear this responsibility. Obviously, the Proponent must be responsible for all maintenance and remedial works while development is in progress and possibly, for a certain period following completion of the project.

Recommendation 14

All maintenance and remedial works associated with the connecting channels during development of the canals project should be the responsibility of the Proponent.

- Culverts - the ERMP proposes that links between islands and the mainland and between Stage 1 and Stage 2 would be provided by culverts. The design details of culverts were not provided in the ERMP beyond the statement that there would be a minimum clearance of 400 mm between the culvert soffit and the water surface. The calculations on culvert flow are based on 2.1 metre diameter concrete pipes flowing full.

  The Authority has been advised that, given these dimensions, the culverts would provide sediment and stratification traps within the canals which could provide foci for algal bloom development during some periods of the year. Bridges rather than the culvert links have also been recommended in advice received.

Recommendation 15

Design of the structures linking the islands with the mainland and linking Stage 1 and Stage 2 should be reconsidered and a design providing optimum through-flow should be achieved to the satisfaction of the PWD and the waterway manager (PIMA).

- Canal Widths - the ERMP states that the canals will incorporate 'wall-to-wall' water with a minimum width of 50 metres and wider expanses where canals come together. Calculations for canal flows were based on a 50 m width. However, plans provided with the document show that several minor canals are considerably narrower than 50 m.

Recommendation 16

The Proponent should comply with the canal width description given in the ERMP.

- Other Aspects Of Design - reference has been made in submissions received to other aspects of design such as building lines, design of boat ramps etc. The Authority believes that these matters could be addressed during the detailed planning stages by the Proponent, the Town Planning Department, the Shire of Mandurah and the waterway manager (PIMA).

- Staging - the ERMP states that the development north of the Mandurah by-pass would be the first stage and independent of subsequent stages. Stage 2 would lie south of the by-pass road and could be subdivided into two or more substages.

  The Authority believes, however, on advice received, that it may be necessary to construct the main road culvert and a link channel through the Stage 2 land before Stage 2 development is contemplated should there by problems in relation to the estuarine fishery and/or Stage 1 water quality (see Sections 4.2.3 and 4.3.1 respectively).

  Recommendation 17

  A programme of monitoring should include regular observation of fish movements. Redesign of the canal waterway to complete the through-loop into Stage 2 should be considered as a means of minimizing disturbance to fish movements.

4.3.3 Conservation

The ERMP states that development of the proposed canals and residential area will result in a completely modifed landform. Areas to be left in their natural state will be confined to land around Soldiers Cove in the north and a buffer, 150 - 200 m wide, on the southern margin of the subject land. No objective assessment is given of the values of these areas relative to the areas whose landform is to be completely altered but the ERMP states (p 72) that the samphire zone bordering the tidal area is the most significant area for water birds. In fact, a more significant section may be that subject to winter inundation and used as a winter feeding ground for duck, swans and some wading species. These winter-flooded sections lie outside the proposed conservation buffer (see Fig 2).

On the other hand, the area is a known breeding area for salt-marsh mosquitoes and subject to a programme of chemical control. Furthermore, the subject land is privately owned and the total area proposed to be set aside for various kinds of open space is 25% of the dryland area of the total development, a larger proportion than would normally be required as a condition of subdivision.

The Authority has already indicated that provided adequate areas could be set aside and managed towards conservation, the conservation values of the site need not be subjugated if canal development was to occur.

The proposed southern conservation buffer does not reflect the area recommended in the System 6 Study Report[6] for inclusion in a modified Flora and Fauna reserve over Channel and Creery Islands. Nevertheless, the Authority considers that areas to be set

aside as nature reserves around Soldiers Cove and on the southern margin of the subject land represent a reasonable recognition by the Proponent of the conservation values of the area, and that these areas could, given appropriate management, continue to fulfil some function as wildlife habitats. See 4.3.6.

In this regard, the Authority has been advised that land ceded as a condition of subdivision under Section 20A of the Town Planning and Development cannot be set aside for conservation purposes. (See Section 4.3.6 for discussion of vesting of the conservation areas).

The ERMP does not provide any detail of management initiatives to be applied within the conservation areas and accordingly, the overall acceptability of the development project from a conservation viewpoint cannot be ascertained.

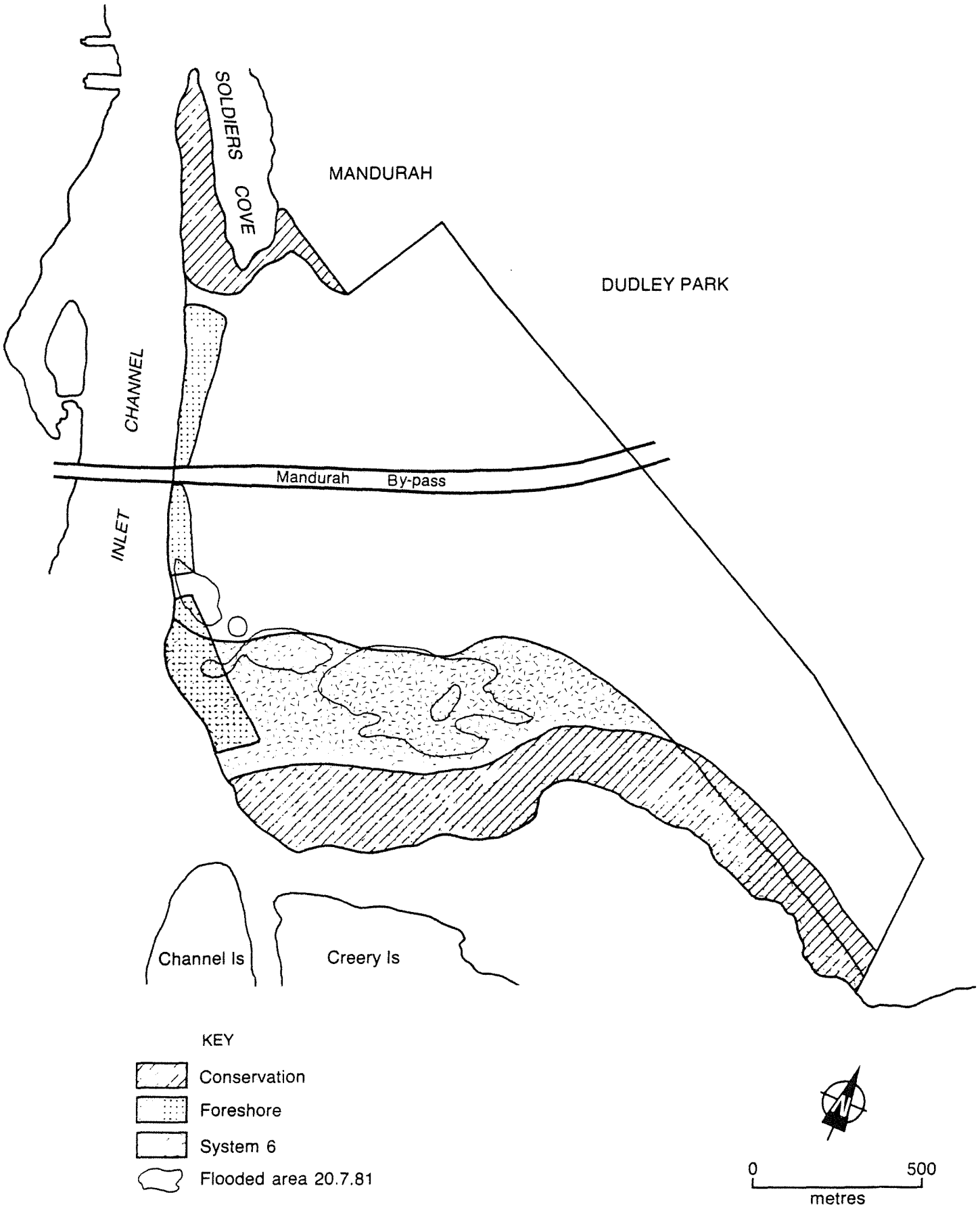
Before subdivision approval is granted, the Proponent should prepare management programmes for areas to be set aside for conservation. Necessarily, such programmes would need to satisfy the requirements of the agency in whom the conservation areas were vested and they would need to ensure that public access to these areas was limited to prevent disturbance of the fauna and degradation of the natural vegetation. These programmes would also have to address the mosquito problem associated with the seasonally and tidally inundated parts of the salt marshes to be retained in the conservation areas. Such areas are known breeding sites for saltwater mosquitoes (Aedes vigilax and Aedes camptorhynchus) and the Shire of Mandurah carries out a control programme[18]. Both species breed in salt to brackish water. They will bite fiercely day or night and will readily be dispersed towards settled areas by prevailing south-westerly winds.

By placing a human population even closer to the breeding sites, the proposed development could increase pressures for elimination of these areas. Inappropriate abatement techniques could downgrade the ecological values of the conservation areas. It is therefore important that abatement measures incorporated in the management programmes are compatible with the conservation orientation of these areas.

4.3.4 Groundwater Resources

Based on information contained in the ERMP, comments received, and additional data provided by the Proponent, the Authority is satisfied that the possible impact of the proposed development on the shallow aquifer underlying the project site and adjoining areas has been acceptably assessed.

Additional information is, however, necessary to enable definitive conclusions to be drawn regarding this impact and groundwater monitoring programmes will be necessary to provide the required information. The ERMP provides an undertaking by the Proponent to maintain a watch on groundwater quality fluctuations by means of its permanent monitoring bores indicates a balanced approach. The Authority has, however, been advised that the monitoring should be designed so that preliminary results obtained for the first 12 months of monitoring would provide definitive background data from which to assess future changes.



Compiled from aerial photography WA 1995 (C) 20/7/81

Figure 2 Waterside Mandurah Site Showing foreshore and conservation areas, as proposed, compared with the relevant portion of System 6 recommendation C50.

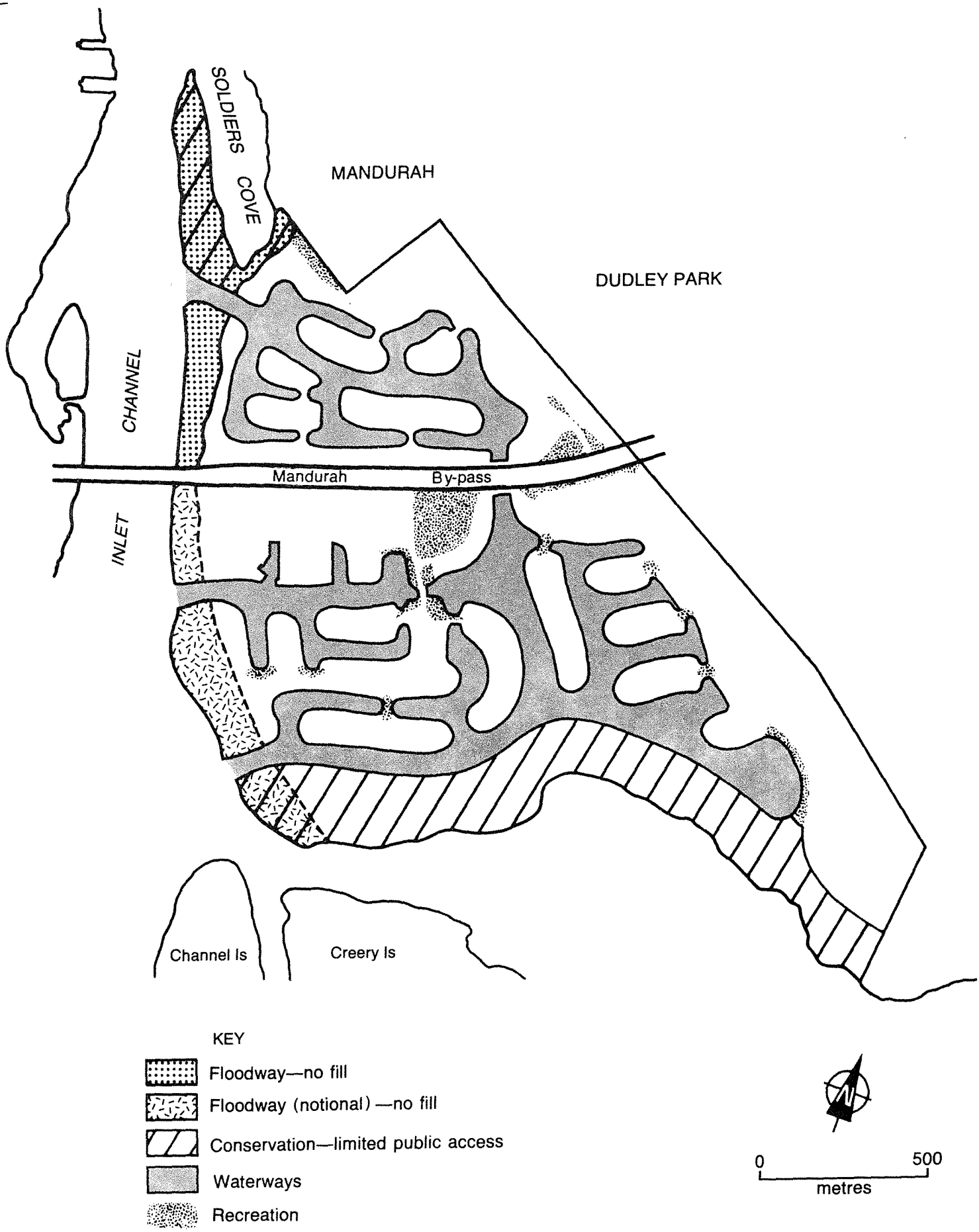


Figure 3 Distribution of reserves and open space.

Recommendation 18

The groundwater monitoring programme should be designed and implemented by the Proponent to the satisfaction of the Geological Survey of W.A. Depending on the results of monitoring the Proponent should be required to further investigate the grout curtain option and alternative forms of remedial action to combat excessive movement of the saltwater/freshwater interface within the shallow aquifer underlying the project site and adjoining areas.

Although the Proponent is confident that canal construction will not adversely affect groundwater resources being used by Dudley Park residents, installation of a grout curtain has been suggested as a means of preventing excessive movement of the saltwater/freshwater interface. Doubts have, however, been expressed concerning the practicability of installing a sufficiently extensive grout curtain to protect the shallow aquifer in Dudley Park from salt water intrusion. The Authority therefore considers that alternative forms of remedial action should be investigated by the Proponent.

Further, the Authority considers that the residents of Dudley Park should be informed that continuing supplies of groundwater cannot be guaranteed and that further draw on the aquifer is undesirable. Necessarily, residents of the canal estate should also be advised that bores within the development may not produce water suitable for lawns.

Residents of Dudley Park should be informed that further draw upon the groundwater resource is not advisable and that continuing supplies of groundwater cannot be guaranteed. The Proponent should liaise with the Shire of Mandurah regarding the manner by which residents are to be informed.

The Authority has also been advised that groundwater should not be used to reticulate open space within the development because of the limited supplies of irrigation-quality groundwater available in the locality. However, the ERMP envisages that some open space areas would be reticulated from a single deep bore. The Authority has already recommended that the Proponent should consult with the PWD concerning the use of groundwater resources within the development. The need for such consultation is reiterated.

4.3.5 The Estuarine Fishery

The ERMP states that the proposed canals will not have a detrimental effect on the present aquatic system of the Peel-Harvey Estuary. Dredge slurry will not be discharged into the Inlet Channel or in the vicinity of Channel and Creery Islands. The development of a series of waterways will create a new aquatic habitat in which animal movements will be similar to those in the Inlet Channel.

The ERMP further maintains that water stratification, resulting in deoxygenation of bottom water, would not occur because of the design of the canals. The waterway development would provide additional amateur fishing platforms and would thus potentially increase numbers of fish and crabs taken from this section of the estuary.

The Department of Fisheries and Wildlife has advised the Authority that, provided the predictions in the ERMP concerning frequency of water exchange, absence of water stratification and scouring effects, and the effectiveness of stormwater drains, are correct, the development in isolation should not pose problems of major concern to the Fisheries Section of the Department. However, the proposed waterway is only part of major development under consideration for the area. The combined effects of this development may have implications for water quality criteria for particular beneficial uses, the volume of litter and debris introduced to the estuarine system, increased fishing pressure and the effects of boating on turbidity, fish disturbance and hydrocarbon content.

Although the Authority considers that the Proponent has not produced conclusive evidence to support the contention that development as proposed would have no significant effect on the estuarine fishery, it has concluded (see Section 4.2.3) that with appropriate design, management and monitoring, the Waterside Mandurah project could be regarded as acceptable in terms of likely impact on the fishery.

Nevertheless, the Authority considers that the observation of fish movements should be included in the monitoring programme to be implemented and that the Proponent should provide a commitment to complete a through connection to the Inlet Channel as part of the Stage 1 development (as a means of minimising disturbance of fish movements) if monitoring reveals such a need. (See also Section 6.2.2 for further discussion concerning monitoring of the fishery).

Although the possible need for a through connection as part of the Stage 1 development has already been raised in the context of achieving satisfactory water cirulcation and quality (see Section 4.3.1 including Recommendation 3), the possible need for such a connection specifically in terms of limiting impact on the fishery should be acknowledged.

4.3.6 Open Space

Foreshores/Floodways - PWD requirements for floodways dictate that they should not be elevated above their present level. Advice received by the Authority is that the foreshore reserve adjacent to the Inlet Channel combined with the adjacent roadway under and north of the proposed Mandurah by-pass bridge, and the peninsula between Soldiers Cove and the Inlet Channel, constitute an adequate floodway for the more rare flood events provided these areas are not elevated above their present level by any development including road construction. The foreshore reserve south of the proposed bridge, while also generally adequate as a floodway provided it was not raised above its present level, should not be so precisely defined that it will inhibit options for change to the Inlet Channel if this is shown to be advisable as a means of helping to overcome water quality problems in the Peel-Harvey Estuary.

Recommendation 19

The proposed floodways north of the proposed Mandurah by-pass bridge are adequate for the purpose and no change of level should be allowed unless the Public Works Department is satisfied that it would not materially alter the floodway. (See Fig 2).

The proposed foreshore reserve south of the proposed Mandurah by-pass should be regarded as a minimum requirement, with recognition that need for additional land may be identified in subsequent planning. (See Fig 2).

The foreshore reserves should be ceded to the Crown on or before the granting of subdivision approvals and a management programme acceptable to the waterway manager (PIMA) and the PWD be prepared and instituted by the Proponent as a condition of approval.

Further, advice received from the Waterways Commission/ PIMA is that, despite constraints of no filling and other development, the foreshore reserve/floodway would be suitable for passive recreation and water-orientated uses if salt-tolerant grasses are planted and some minor beach nourishment is undertaken in areas degraded by use. However it is clear that the principal function of 'floodway' must be recognised. It is also clear that the 'floodways' are quite distinct from the normal 30 m foreshore reserve.

Open space for active recreation - despite the large proportion of the subject land proposed to be set aside for various forms of open space, the special demands for conservation areas and floodways would leave relatively small areas suitable for active recreation. This matter has been highlighted by the submission from the Town Planning Department which also noted that remaining open space areas were generally too small or of unsuitable shape for beneficial use. The difficulties of the Proponent in providing an equitable area of recreational open space were acknowledged.

The Proponent indicates a flexibility in its approach to this matter in a statement at p 76 of the ERMP: 'Active open space areas will be provided within and around the edges of the development for public use. This will be provided in amounts and localities satisfactory to the Local Authority'.

Access to canals - the Authority notes recommendation 3.4(b) of the Steering Committee on Canal Developments for some form of access at least every 300 m along each canal bank to provide a safety exit for canal users and facilitate maintenance and public access. The plans for Waterside Mandurah do not comply with this recommendation.

Recommendation 20

The Proponent and the waterway manager (PIMA) should resolve the question of public access to canals during the detailed planning phase.

. Vesting

Conservation areas - the ERMP states that the southern buffer zone and the area around Soldiers Cove should be set aside for Conservation and vested in WAWA.

Attention has been drawn elsewhere to the need to use special mechanisms to set land aside for "Conservation" (see Section 4.3.3).

The Department of Lands and Surveys has advised that two alternative courses of action are open:

(a) Reserve the land for "Recreation" with vesting in the Local Authority and conservation values being protected through an appropriate management plan to be prepared by the Proponent, in consultation with the Department of Conservation and Environment, the Department of Fisheries and Wildlife and the Shire of Mandurah. The Town Planning Board would need to agree to vary its policy on restrictions of use of the reserve if this action were taken.

(b) The Proponent would surrender portions of the subject land to the Crown on the undertaking that they be reserved for "Conservation of Flora and Fauna". The land could then be vested in an appropriate body.

The Authority favours the second option, with vesting in WAWA.

Recommendation 21

The Proponent should surrender the southern buffer zone and the Soldiers Cove area as shown on Plan No 78/65/4 (Preliminary Development Concepts) to be reserved for the purpose of Conservation of Flora and Fauna. This land in total should be surrendered prior to the granting of subdivision approval for Stage 1 of the project.

The reserves for Conservation of Flora and Fauna should be vested in the Western Australian Wildlife Authority. Management of the areas should recognize that channel-widening options may be necessary in the future to improve the overall state of the Peel-Harvey estuarine system.

Foreshores/Floodways - the ERMP states that Reserves for public use which include foreshore reserves will be vested in the Local Government Authority after agreement on a management plan approved by the waterway manager.

This is essentially consistent with recommendations of the Steering Committee on Canal Developments. The Steering Committee submitted that foreshore reserves adjoining the natural waterway affected by a canal development should not be included in the Public Open Space calculation for the development, basically because of the particular functions the foreshore reserve would have to fulfill. In essence, the foreshore reserve should:

- allow space for widening the effective channel of the natural waterway;

- include the usual Town Planning Board reserve;

- add extra 'no development' space to the usual Town Planning Board reserve, to allow for flood mitigation;

- allow a further area as a zone of limited development to make further allowance for flood migitation[2].

The Authority agrees with the Proponent's suggestion regarding vesting of the foreshore/floodway reserves but considers that appropriate management programmes should be instituted over these areas as a condition of subdivision approval (see Recommendation 19 in this Section).

Recommendation 22

Vesting of the foreshore/floodway reserves should be as suggested by the Proponent with the added requirement that the management plan prepared for the reserve should be approved by the waterway manager (PIMA) and the PWD.

Canals - the ERMP states that before the issue of titles to individual lots of the subdivision, the land under the waterways will be transferred to the Crown as a Class B reserve (p 83).

The Steering Committee on Canal Developments recommended Crown ownership of canal waterways. The Committee also advocated that Crown ownership should be achieved by transfer, free of cost, and that this action should, as far as possible, be an automatic process. The Committee recommended that the Town Planning and Development Act should be appropriately amended.

The Authority has been advised by the Department of Lands and Surveys that the Proponent's suggestion to transfer the waterways to the Crown as Class B reserves is not possible as the waterways would be subject to tidal influences and hence would not represent "Crown" lands in the context of the Land Act.

Recommendation 23

The Authority endorses the recommendation of the Steering Committee on Canal Developments that appropriate amendment should be made to the Town Planning and Development Act to allow for transfer, free of cost, of canal waterways to the Crown.

Other reserves - vesting of land ceded as a condition of subdivision for public recreation would ultimately be managed by the Local Authority and should, therefore, be vested in the normal way.

4.3.7 Social Environment

The development proposal and submissions received on the ERMP raise several matters pertaining to the social impact of the development.

. Road Network - the Waterside Mandurah project site is bisected by the alignment of the future Mandurah by-pass route. Clearly, the route imposes certain constraints upon the project by effectively determining the limits of Stage 1 and by shaping future road patterns.

The ERMP states that two entry points from the by-pass have been sought to facilitate the circulation of traffic throughout the project as a whole. The linking of Leslie Street through to the by-pass as a minor feeder to the town centre has been co-ordinated with the Mandurah Shire Council and rationalisation of roads between Stage 1 and the extension of Dudley Park is taking place. The road layout is designed to act as a buffer between the residential area and foreshore reserves along the main channel (p 45).

Two submissions received on the ERMP were critical of the by-pass route because of the environmental damage it would cause and evidently, the canal project was seen as confirming the alignment of this route.

The Authority is aware that a route by-passing Mandurah and premised on connection of the coastal routes north and south of the township has been envisaged since the mid-nineteen sixties. The Authority is also aware that since the mid-nineteen seventies, such a route has been accommodated in regional and local planning decisions, and that a conceptual alignment traversing the Waterside Mandurah site has been the basis on which the Main Roads Department has provided advice when approached for information concerning the by-pass route.

The Authority therefore considers it reasonable that the Waterside Mandurah development should accommodate the by-pass route and bridge across the Inlet Channel it necessitates. Accordingly, in its assessment of the project, the Authority has accepted the by-pass route and bridge as an integral part of the overall development proposal.

The Authority has received advice from several sources on issues related to roads. The Town Planning Department has recommended some changes to the road network in Stage 1 related to redistribution of open space and possible relocation of the public boat ramp. The Main Roads Department has advised that the request for an additional entry point for the Stage 2 development has been rejected but that liaison is taking place between MRD and the Proponent to resolve other matters affecting the Mandurah by-pass and bridge. The PWD has advised that roadways adjacent to the Inlet Channel under and north of the by-pass bridge form part of the floodway for the more rare flood events. As such, these roadways should not be elevated above the present ground level. This proviso would presumably also apply to roadways adjacent to the foreshore reserve south of the by-pass.

The ERMP has made no reference to effects on amenity likely to result from noise from traffic on the by-pass road and the Leslie Street feeder road. PIMA has pointed out that noise is readily transmitted across water so that the effects of noise from large traffic volumes may have significant impact on residents of the canal estate. The Public Health Department also pointed out that the Mandurah by-pass route could represent a source of noise pollution and that noise contours associated with the route should become an integral part of planning schemes guiding the development.

The Authority draws attention to these issues but considers that matters relating to road networks should be resolved during the detailed planning phase.

Recommendation 24

Matters relating to road networks should be resolved to the satisfaction of the Town Planning Department, Main Roads Department and the Shire of Mandurah. The Public Works Department must be satisfied that roads within floodways are not elevated above existing ground levels. Noise issues relating to roads should be resolved to the satisfaction of the Public Health Department.

- Housing Densities - the contention that the Waterside Mandurah development would create a low density residential environment has been criticised. However, given that allotments throughout would be similar in size to lots in adjoining residential areas, such criticism appears difficult to sustain. The Authority considers that the question of residential densities is essentially a planning matter that could be addressed by the planning process.

  Although it is primarily a single residential development, the proposal does include provision for some medium density development. The Authority is aware that inadequately controlled medium density development which has occurred in some canal projects in the Eastern States has been criticised because of its impact on visual amenity. Again, the Authority believes this to be a matter most appropriately dealt with via the planning process, but would highlight the need for careful attention in this regard.

- Landscape - the impact of inadequately controlled medium density development on landscape amenity within a canal estate has already been mentioned. However, a more fundamental concern that has been expressed is the possibility of diminished landscape amenity as a consequence of the Waterside Mandurah site being developed at all. Obviously, any form of closer development of the site, whether a canal or dryland subdivision, would comprehensively modify the site. While such modification may be viewed by some as detracting from landscape quality, the opposing opinion has been expressed in several submissions received on the ERMP. Quite clearly, the question of the effect of development on landscape amenity relates to personal perception and the Authority believes that this matter should be resolved at a local level.

- Boating Congestion - concern over this implication of the proposal was raised in several submissions. Suggestions were made that the ecological value of the Inlet Channel and other areas of the estuarine system could suffer from added boating traffic and that congestion would reduce recreational opportunities and enjoyment. The Authority believes that congestion of the estuarine system will increase regardless of this particular development and that there is little evidence available to show that a significant effect on the natural environment will occur through increased boating.

  The increased boating activity resulting from this proposal will impose additional workload upon PIMA and the Department of Marine and Harbours.

- Tourism - in its submission on the ERMP, the Department of Tourism indicated the importance of tourism to Mandurah's economy and emphasised the need for careful monitoring of the impact of essentially residential developments such as the Waterside Mandurah Project on the Peel-Harvey Inlet, upon which the district's tourist industry is based. Possible boating congestion on the Inlet was highlighted as a consequence of development that could have an unfavourable effect on the tourist industry.

- Noise - although possible noise intrusion from the Mandurah by-pass route has already been mentioned, the issue of noise within the development requires consideration in a more general context. Because of low attenuation rates over water, noise levels generated and propagated within the development are a feature of canal estates requiring careful attention.

  The Authority considers that boat noise and low sound attenuation rates are basic characteristics of canal development that, to a certain extent, have to be accepted by residents. In the case of the Waterside Mandurah project, the by-pass route in particular and, to a lesser degree, the Leslie Street link to central Mandurah, will represent additional noise sources with nuisance potential. Accordingly, the Authority has recommended elsewhere in this section that the matter of noise intrusion from roads within the development is a matter requiring resolution by the relevant planning agencies. (See Recommendation 24).

  The Authority also acknowledges that boats tend to be inherently noisy and that a degree of boat noise will have to be accepted.

- Odours - in its submission on the ERMP, the Public Health Department raised the matter of malodours caused by hydrogen sulphide from decomposing algae in parts of the estuarine system. Northern Coodanup, relatively close to the Waterside Mandurah site, is an acknowledged problem area[8], and subject to prevailing winds, there is a possibility that smells could encroach upon the site.

Research into algal problems in the Peel-Harvey Estuary is continuing and although various management scenarios to ameliorate the problem have been suggested[8], the Authority emphasises that short term solutions are not likely. Accordingly, the Authority considers that the possibility of malodours within the Waterside Mandurah site, and the fact that they may persist for a number of years, should be acknowledged by incoming residents.

It may be possible to modify methods of collecting and removing the algae so as to avoid the occurrence of noisome, decomposing masses. However, this is a matter on which the Proponent would have to liaise with PIMA.

4.3.8 Environmental Impacts During Development

Environmental impacts during the construction phase could arise from noise and other disturbance to existing communities, disturbance of wildlife, release of suspended sediments to the Inlet Channel, seepage of saline water from the dredge spoil, found to be unsuitable for use as fill, outside the development site this could also have detrimental effects.

The ERMP has stated that dredging will take place in a closed system so that there will be no discharge of turbid water to the Inlet Channel. Most of the water carrying the dredged material will flow back into the dredging pond but some will flow into the substrate. It also states that where natural vegetation is to be retained, small cut-off bunds may need to be constructed to contain the fill. The ERMP makes no reference to the other matters of concern identified above.

. Effects of Noise On Existing Communities - notes associated with construction of the canals and other earthmoving operations may have an adverse effect on adjacent residential areas, particularly if these operations were undertaken outside normal working hours. The ERMP makes no reference to this matter.

The Authority believes that discussions between the Proponent and the Shire of Mandurah (as local administrator of noise abatement regulations) should take place on this matter with particular reference to the hours of operation.

Recommendation 25

Before construction commences the Proponent should discuss with the Shire of Mandurah the question of noise levels and hours of operation, and he should follow the 'Procedure for Assessing the Noise Effect of Proposed New Developments on Existing or Proposed Noise Sensitive Developments' as prepared for the Noise and Vibration Control Council[20].

. Dust From Unstabilised Soils - it is possible that earthmoving activities and the creation of large areas of exposed sand could cause problems of increased dust levels and wind blown sand. These matters are generally easily managed and are not expected to be significant.

Recommendation 26

The Proponent should liaise with the Commissioner for Soil Conservation on appropriate methods to minimise dust levels and stabilise soils during and after earthmoving operations.

- Protection of Conservation Areas - during construction of the project or buildings, it is essential that conservation areas and foreshores are adequately protected. To achieve this protection, spoil or other materials should not be deposited on these areas, vehicles should be excluded, seepage from adjacent areas should be prevented and changes to ground water levels or quality should be avoided. Fencing of the conservation areas should be considered as a means of achieving some of these objectives.

Recommendation 27

The Proponent should include in the management programme, suitable provisions to protect the conservation areas, floodways and foreshore areas from any adverse effects during the development of the estate. Concurrence to this aspect of the plan should be obtained from the waterway manager (PIMA), PWD and WAWA.

- Release of Impounded Waters - the ERMP states (p 53) that all dredging will be done in a closed system so that there will be no discharge of turbid waters into the Inlet Channel.

  However, it is difficult to accept that initial flooding of the dredged waterway will not cause suspended sediment to enter the Inlet Channel and possibly influence fish movements. The Department of Fisheries and Wildlife has advised that it would be preferable to carry out initial flooding of the waterways at a time when high flow rates from the estuaries will ensure rapid dispersal of the sediment to the ocean.

  The Authority also notes that impounded waters may be organically stained and on release, may create a noticeable plume in the Inlet Channel. Again, the need for careful timing of the release of impounded waters is emphasised.

  In order to minimise the impact of releasing these waters into the Inlet Channel, the Authority believes that the time of release should be late autumn or early winter when natural turbidity levels in the Inlet Channel are high and the flow is predominantly towards the ocean.

  For reasons similar to those outlined above, care will also be necessary in effecting the link between the initial stage of the development and the subsequent stage/s.

- Disposal of Dredge Spoil - the ERMP envisages that dredge spoil from the canals will be deposited on areas requiring fill. It is also understood that the Proponent anticipates using spoil that is unsuitable for structural development to fill open space areas and possibly, to fill along the alignment of the by-pass route. However, as a thorough soils analysis has not been performed, the adequacy of spoil for the purposes mentioned has not been established, and there may be a need to dispose of unuseable spoil away from the project site.

External problems may arise from such an operation and accordingly, there is a need for the Proponent to document disposal options being considered should spoil unsuitable as on-site filling material be encountered. This has already been recommended (see Recommendation 5 at Section 4.3.2). Additionally, the Proponent should liaise with the Shire of Mandurah and other relevant agencies such as the Soil Conservation Commission concerning any plans to dispose of spoil externally.

4.3.9 Suitability Of The Proposal - Conclusion

Provided the recommended actions were implemented, the Authority considers that the development could proceed in an environmentally acceptable form.

5. MANAGEMENT

5.1 Management Structure

Long term management of the artificial waterways could be potentially costly and benefits accruing to the community at large would be minimal. In accordance with the finding of the Steering Committee on Canal Developments that management and maintenance funds should not be drawn from Government or local government agencies, it would be considered proper for costs to fall upon those gaining benefits from the canal estate, the Proponent initially and owners and occupants in the long-term. While the Authority endorses this philosophy, it does note that at present there is no statutory procedure by which this could be achieved.

Recommendation 28

Decisions concerning appointment of the waterway manager would need to consider the manner by which funds for management would be raised and the adequacy of resources available to the management agency to carry out its responsibilities.

5.2 Management Plan

The Authority believes a firmer commitment to management is required from the Proponent and considers that this should include preparation, prior to commencement of construction works, of a flexible management plan for the development. Necessarily, the plan should address the wide range of management issues arising from the development proposal, including such matters as monitoring and management of water quality, maintenance dredging, maintenance of walls and banks, erosion control, servicing and repair of navigation aids, and removal of rubbish and other pollutants from the waterways. The need for flexibility within the plan is stressed as the results from monitoring programmes may very well indicate that change to management initiatives is required.

Management and maintenance programmes for the project should include sections of the adjacent Inlet Channel on which the development would have an impact. This is especially important in terms of maintenance dredging. It is necessary, therefore, that an appropriate management area should be determined and agreed upon by all agencies involved as part of the overall management programme. Monitoring results may necessitate modification of the management area. Clearly, flexibility is again necessary.

Recommendation 29

The Proponent should develop a management plan which satisfies The Peel Inlet Management Authority.

The management area for the project should include sections of the adjacent Inlet Channel that in the opinion of PWD and PIMA may be affected by the existence of the project. The management area will need to be defined as the management plan/s developed.

Because of their implications for the Inlet Channel, connecting channels between the artificial and natural waterways are of particular significance in terms of management responsibility.

At Section 4.3.2 the Authority has recommended that the Proponent should be responsible for all maintenance and remedial works associated with the connecting channels both during construction of the development and for a specified period following completion of the project. The importance of the connecting channels is such that the period during which the Proponent should retain responsibility for maintenance and management may be longer than for other components of the development. Nevertheless, the underlying notion remains that responsibility should not be handed over until monitoring has conclusively established the adequacy of the connecting channels in terms of design, function and manageability. The Authority has not received any specific advice concerning the handing over of responsibility for the connecting channels in submissions on the Waterside Mandurah ERMP. However, in relation to the Halls Head Waterways project, the PWD has suggested that the Proponent should be responsible for the connecting channels for a period in the order of ten years.

Recommendation 30

The Proponent should reach an agreement with the waterway manager (PIMA), as to a time, or performance level at which the responsibility for all or parts of the project are handed over to the waterway manager. This agreement should be reached prior to subdivisional approval being issued.

The ERMP states that private landowners will be responsible for maintaining their waterway frontages (p 77) and acknowledges that the Proponent has a role to play in advising landowners concerning management of their properties in order to minimise impact on the waterways. The Authority endorses the Proponent's intention, but considers that the advisory role should be expanded. Recommendations have already been made on the need to caution incoming residents concerning the uncertain availability of a useable groundwater resource and the possibility of malodours from decomposing algae.

The Authority considers that the Proponent should liaise with the waterway manager (PIMA), the Local Authority and other relevant agencies on the type and extent of information to be provided to incoming residents and the techniques by which it could best be disseminated.

As the Waterside Mandurah project is a staged development, it will obviously be in the Proponent's interest to participate in monitoring and management programmes whilst the development is underway. The ERMP also acknowledges that "... Once the project is completed the developer must continue to monitor the result of his planning to ensure it meets the design standards and if not, to take corrective measures" (p 81). The question of how long the Proponent should be involved with monitoring and management following completion of the development is not, however, addressed.

The Authority believes that an essential part of the management programme is an agreement between the Proponent and the waterway manager on the 'hand over' of responsibility. At the time of handover, the estate should be shown to be functioning well and capable of meeting management costs. Management tasks and costs need to be clearly identified and quantified. This issue is essentially one to be resolved between the parties involved, but details of this aspect should be agreed upon before subdivisional approval is granted.

5.3 Management Implications For Government

The Waterside Mandurah and similar projects place additional demands on public agencies thereby generating needs for additional Government funding. Additional requirements would include:

- expertise, labour, administration and equipment for the waterway manager (PIMA);

- additional labour and equipment for the Department of Marine and Harbours to police the Navigable Waters Regulations;

- resources for the WA Wildlife Authority to provide for the proper management of the conservation areas being ceded to the State;

- any monitoring or evaluation of data on the impact of the project on fish migration into or habitation of the canal areas, groundwater deterioration etc.

In additional, the Authority notes that both the Waterside Mandurah and Halls Head Waterways projects have used a 10 metre design vessel and that the latter proposal in particular is designed for ocean going yachts. It is therefore probable that if the proposals are developed, increased demands will be made on Government to maintain a passage through the Mandurah Bar some 1.5 metres in depth. The financial implications of maintaining this depth in the passage through the bar would be considerable and Government should be fully aware of this.

The Authority draws the aforegoing to Government's attention.

6. MONITORING PROGRAMME

The ERMP refers to the groundwater and water quality monitoring programme being undertaken by the Proponent, and the need for the Proponent to continue monitoring on completion of the development is acknowledged. It also indicates that monitoring results would be used to assist in refining design as development progresses (p 79) and commits the Proponent to corrective action if monitoring reveals that design standards are not being achieved (p 81).

Evidently, the need for monitoring has been recognised by the Proponent, although assessment of the ERMP suggests that the range of monitoring needs arising from the proposed development may not have been fully appreciated. In terms of monitoring, the ERMP is also inadequate because details of monitoring proposals have not been provided and as it is not specific regarding the period during which monitoring would occur.

The Authority considers that specific monitoring programmes are necessary and should be developed prior to the granting of subdivision approvals for the project. These programmes should address the issues of interpretation of data collected, reporting and commitments to implement any changes to the project, staging, management and monitoring that may be revealed as necessary.

Recommendation 31

The Proponent should develop a monitoring programme which satisfies The Peel Inlet Management Authority.

7. CONTINGENCY GUARANTEES

The Authority has previously expressed the opinion that the beneficiaries of a canal estate should be responsible for maintenance after handover from the Proponent to the waterway manager. The Authority has also stated that the Proponent should be responsible for necessary remedial works until handover, and has recommended that the question of when handover should occur is a matter to be agreed upon by the Proponent and the waterway manager (PIMA) prior to subdivision approvals being issued. The underlying premise is that handover should not occur until the development is shown to be functionally adequate and capable of meeting management costs.

On a number of occasions, the Authority has also referred to the need for the Proponent to provide commitments to undertake such remedial works as become necessary prior to handover. The Authority considers that adequate guarantees should be provided by the Proponent to ensure that necessary corrective works are carried out during the period of its responsibility. The Authority does not wish to enter the debate as to what form the guarantees should take beyond stating that they would obviously need to be in a form acceptable to Government.

Recommendation 32

The Proponent should provide guarantees in a form acceptable to Government for remedial works which may be required as a result of failure of the project to achieve standards required by the waterways manager.

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9. PUBLIC AND GOVERNMENT SUBMISSIONS

Fourteen public and ten government submissions were received and the views given to the Authority considered in its analysis of the proposal.