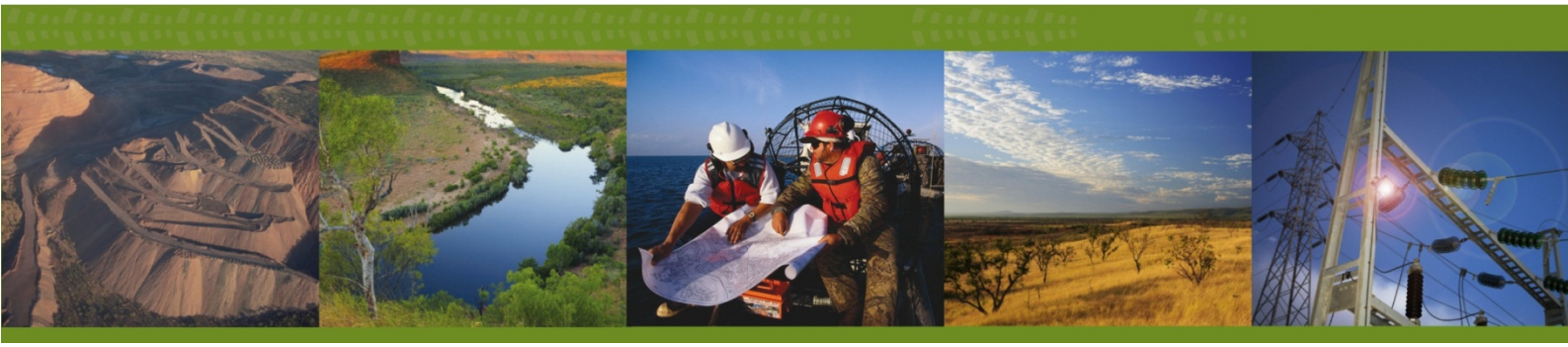

Mangles Bay Marina Based Tourist Precinct

Public Environmental Review

Prepared for
Cedar Woods Properties Ltd
by Strategen

February 2012

STRATEGEN
environmental consultants

Mangles Bay Marina Based Tourist Precinct

Public Environmental Review

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February 2012

Client: Cedar Woods Properties Ltd

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Preliminary Draft Report	A	Client review	TS/DN	Electronic / hard copy	30/9/2011
Preliminary Draft Report	B	Client review	AC/KT/DN	Electronic	7/10/11
Draft Report	0	EPA submission	DN/AC/KT/KO	Hardcopy	14/10/11
Final Draft Report	1	EPA submission	DN/KT/KO/ K Hillman	Electronic	27/01/12
Final Report	2	Public advertisement	Strategen/Cedar Woods	Hardcopy / Electronic	09/02/12

Filename: CED10088.01 Mangles Bay PER Rev 1 - 9 February 2012

Invitation to make a submission

Following referral of the Mangles Bay Marina Based Tourism Precinct to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) and the Western Australian Environmental Protection Authority (EPA), it was determined the proposal should be formally assessed. In making the determination, the Commonwealth and State Governments have agreed to a coordinated bilateral environmental assessment process. The Public Environmental Review (PER) is in accordance with the DSEWPaC and EPA requirements as set out in the Environmental Scoping Document. This PER document intends to satisfy the requirements of each jurisdiction under the formal environmental impact assessment process.

Accordingly, DSEWPaC and the EPA invites people to make a submission on this proposal. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental review documents. In releasing this document for public comment, DSEWPaC and the EPA advise that no decisions have been made to allow this proposal to be implemented.

Cedar Woods proposes to develop a tourist based marina development located in Mangles Bay, at the southern end of Cockburn Sound. In accordance with the *Environmental Protection Act 1986*, a PER has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 10 weeks from 13 February 2012, closing on 23 April 2012.

Comments from government agencies and from the public will assist DSEWPaC and the EPA to prepare an assessment report in which it will make recommendations to government.

Where to get copies of this document

Printed and CD copies of this document may be obtained from Cedar Woods Properties Limited, Ground Floor, 50 Colin Street, West Perth, 6005 ((08) 9480 1500) at a cost of $10, consistent with formal proponent advertisement. Electronic versions of the document, on CD, can be obtained at no cost.

The document/s may also be accessed through the proponent's website at *www.manglesbaymarina.com.au*.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received will be acknowledged and electronic submissions will be acknowledged electronically. The proponent will be required to provide adequate responses to points raised in submissions. In preparing its assessment report for the Ministers for the Environment, DSEWPaC and the EPA will consider the information in submissions, the proponent's responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the Freedom of Information Act 1992, and may be quoted in full or in part in each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the PER:

- clearly state your point of view
- indicate the source of your information or argument if this is applicable
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful
- refer each point to the appropriate section, chapter or recommendation in the PER
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name
- address
- date
- whether you want your submission to be confidential.

The closing date for submissions is: 23 April 2012

DSEWPaC and the EPA prefers submissions to be made by email to submissions@epa.wa.gov.au.

Alternatively submissions can be posted to: Chairman, Environmental Protection Authority, Locked Bag 33, CLOISTERS SQUARE WA 6850, Attention: Leanne Thompson; or delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth, Attention: Leanne Thompson.

If you have any questions on how to make a submission, please ring the EPA assessment officer, Leanne Thompson on 6467 5246.

Executive summary

Introduction

Western Australian Land Development Authority, LandCorp (Government Land Development Agency), has appointed Cedar Woods Properties Limited (Cedar Woods) as its private sector partner to progress this Proposal.

The Proponent, Cedar Woods proposes to develop a tourist based marina development located in Mangles Bay, at the southern end of Cockburn Sound. The Mangles Bay Marina Based Tourist Precinct (the Proposal) comprises a single entrance marina to accommodate up to 500 pens and moorings and a surrounding land development comprising tourism, accommodation, commercial, public open space (POS) and residential land uses.

This document is a Public Environmental Review (PER) for the Proposal and has been prepared in accordance with the Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2002 of the *Environmental Protection Act 1986* (EP Act).

Background

The Proposal (previously known as the Cape Peron Tourist Precinct Project) is a refinement of previous proposals that have been put forward since the early 1990s. Early project proposals were abandoned due to excessive costs, downturns in the real estate market or were rejected by the Environmental Protection Authority due to impacts on seagrass.

In response to community interest, the costs, benefits and constraints of Mangles Bay and other potential sites along the City of Rockingham coastline were reviewed. The review concluded that for a marina based development, when assessed against the project sustainability objectives, Mangles Bay presents the least constraints (not withstanding that the Mangles Bay site has some major environmental constraints) and the most opportunities when compared with other sections of the coastline in the City of Rockingham.

In 2006, a Strategic Environmental Review (SER) was prepared for the Proposal, for the consideration of the Environmental Protection Authority (EPA), to enable the EPA to give advice requested by the Minister for the Environment under section 16(e) of the *Environmental Protection Act 1986* (EP Act). The strategic assessment process enabled the EPA to examine (at the early stage in the Proposal development) the key environmental issues associated with the Proposal, including the provision of advice on potential key environmental items of the Proposal.

Under this strategic assessment process, in 2006, the EPA provided written and public advice to the Minister on the concept of an inland marina development at Mangles Bay. The EPA identified the following primary environmental issues:

- seagrass and water quality – direct loss through construction of the Proposal and indirect loss through changes in water quality, sand bypassing activities and coastal processes
- Lake Richmond – indirect impact on the lake and its key attributes (two threatened ecological communities [TECs]) through potential changes in hydrogeology thereby modifying the lake's water quality and water level and potentially threatening the TECs
- terrestrial vegetation – direct loss of vegetation and additional indirect loss through fragmentation, edge effects and changes in site hydrology.

Assessment process

The Proposal was referred to the EPA under section 38 of the EP Act on 25 August 2010. On 20 September 2010, the EPA set the level of assessment for the Proposal as a PER with a ten week public review period.

The Proposal was referred to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) on 21 September 2010 for consideration under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). On 27 October 2010, DSEWPaC advised that the action was considered to be a 'controlled action' under the EPBC Act (EPBC Reference: 2010/5659).

As the Proposal has been deemed a controlled action, it will be assessed through the Bilateral Agreement. The Bilateral Agreement between the Commonwealth of Australia and the State of Western Australia provides for the accreditation of the Western Australian environmental impact assessment process to ensure an integrated and coordinated approach for actions requiring approval under both the EPBC Act and the EP Act.

The Proponent submitted a preliminary Environmental Scoping Document (ESD) to the EPA on 11 October 2010, which detailed the potential environmental impacts, their significance and possible management response, proposed scope of work to obtain information for the PER, key legislation, stakeholder consultation program, proposal and assessment schedule, study team and peer review mechanisms. The final ESD was approved by the EPA on 16 June 2011.

The proposal

is for a tourist based marina development comprising a single entrance marina to accommodate up to 500 pens and moorings and a surrounding land development comprising tourism, accommodation, commercial, POS and residential land uses.

The development will also incorporate local aquatic clubs.

The Proposal comprises the following elements:

- marina
- boating access channel
- provision and maintenance of service infrastructure
- land development area
- rehabilitation of degraded areas of surrounding vegetation in proximity to the Proposal area and seagrass transplantation to offset vegetation losses.

The key characteristics of the Proposal are included in Table ES 1.

Table ES 1 Key proposal characteristics

Proposal detail	Characteristics
Main activities	Construction activities to include clearing, wet excavation of the marina and dredging of the access channel. Operational activities include marina operation and maintenance dredging
Proposal area	Proposal area up to 77 ha Total land development area up to 49 ha Total vegetation clearing up to 40 ha Total marine disturbance (below current high water mark) to 6 ha
Marina	Total water area of marina up to 12 ha Deepest depth in marina up to -4.0 mAHD, shallowest -2.7 mAHD Excavation for marina up to 800,000 m^3 (Volume of material below 0.0m AHD is 364,000m^3)
Channel construction	Total channel length up to 550 m Total channel navigable width up to 30 m, including batters the channel has a width of 55 m Total channel area up to 3.4 ha (includes the footprint of 1:5 batters) Total channel depth up to -4.0 mAHD Total channel dredging of up to 50 000 m3 of spoil Dredged spoil material will be piped to the Proposal area, where it will be settled, the water infiltrated and solid material treated and disposed of off-site
Reclamation	Total reclamation area up to 1.36 ha Total breakwater length up to 290 m Total breakwater width up to 40 m includes breakwater batters of 1:5 Total breakwater area up to 1.1 ha
Area west of Garden Island causeway	Improvement works potentially including an upgrade to the car park, boat ramp and jetty platforms
Seagrass loss	Total seagrass removal up to 5.36 ha (includes breakwaters, reclamation areas, channel and batters) Total indirect loss of seagrass up to 0.3 ha (due to halo effects around infrastructure of approximately 15 m). Total marine footprint up to 5.66 ha
Water Corporation asset (considered part of 'service corridor')	Length of pipeline up to 1.6 km Width of the service corridor up to 45 m (includes batters, provision for a dual road and Water Corporation infrastructure) Pump station area to be cleared up to 0.2 ha
Department of Defence	Provision of a dual-lane road as part of the service corridor to accommodate traffic to Garden Island
Outfall	Relocation of Mangles Bay stormwater ocean outfall pipe to Hymus Street

Stakeholder consultation

This Proposal has built formal advice and community and specialised stakeholder input. Much of this input was generated during the 2005 – 2006 consultation for the Cape Peron SER (Strategen 2006).

The Cedar Woods stakeholder engagement program for this Proposal commenced in April 2010 and will continue throughout the Local Structure Planning process. Key stakeholders were identified through previous consultation programs undertaken during the many iterations of this Proposal. Government agencies have also provided recommendations on stakeholders that should be included within the program, with these recommendations adopted by Cedar Woods. The Proponent also established a Marina Working Group and a Stakeholder Reference Group to provide ongoing input into the Proposal plan.

A summary of the key stakeholder consultation undertaken to date is included in Table ES 2.

Table ES 2 Summary of key stakeholder consultations undertaken for the Proposal

Stakeholder	Outcome of consultation
City of Rockingham	Preliminary comments regarding marina design. Advice provided to the strategy for obtaining planning approval.
Department of Planning	MRS amendment to be initiated subsequent to the s.38 environmental approval process.
Department of Sports and Recreation	Inclusion of passive recreation opportunities within the development, consultation with existing lessees.
Department of Transport	Preliminary comments regarding marina design and suggestions for marina management.
Office of the EPA	Confirmation of the assessment process for the proposal.
Mangles Bay Fishing Club	Inclusion of the club's comments regarding marina planning and club site facility.
Rockingham Offshore Fishing Club	Inclusion of the club's comments regarding marina planning and club site facility.
The Cruising Yacht Club of WA	Inclusion of the club's comments regarding marina planning and club site facility.
Blue Lagoon Mussels	Inclusion of the club's comments regarding marina planning and club site facility.
Rockingham Volunteer Sea Rescue Group	Inclusion of the club's comments regarding marina planning and club site facility.
Retired Service League Rockingham	Realignment of Memorial Drive to retain the RSL Hall.
Cockburn Sound Management Council	Preliminary comments on Proposal and advice on marine water quality within Cockburn Sound.
Department of Water	Inclusion of comments to evaluate the environmental impact to the environmental values within, and adjacent to, the Proposal area.
Conservation Commission of Western Australia	Confirmation of the Proposal area and environmental assessment process.
Department of Sustainability, Environment, Water, Population and Communities	Inclusion of comments into addressing Matters of NES within the environmental assessment of the Proposal.
Department of Defence	Provision for a dual-lane road within the service corridor to accommodate future traffic movement to HMAS Stirling.
Water Corporation	Provision within the service corridor to accommodate current and future infrastructure requirements.

Environmental impact assessment and management

Environmental factors and required technical investigations relevant to this Proposal were identified through the scoping process and are presented in this document along with additional environmental considerations identified during the detailed assessment process. The technical investigations supporting this assessment provide adequate and accurate information describing the receiving environment. This assessment demonstrates that the environmental impacts upon environmental factors resulting from the Proposal (including cumulative impact) have been minimised, are not significant and can be acceptably managed.

Residual impacts are proposed to be offset. Residual impacts relate to the environmental factors of seagrass, Conservation Areas and associated vegetation. An offset package will be negotiated with relevant Agencies during the review process.

The key environmental factors that have been addressed in the PER are:

1. Terrestrial environment:
    - groundwater
    - surface water
    - flora and vegetation
    - terrestrial fauna
    - conservation areas (included in terrestrial vegetation and flora chapter for the purposes of scoping).
2. Marine environment:
    - water quality
    - coastal processes
    - benthic primary producer habitat (BPPH)
    - marine fauna.
3. Matters of National Environmental Significance.
4. Social surrounds:
    - recreation and public access
    - Aboriginal and European heritage
    - visual amenity.
5. Other Environmental Factors:
    - traffic
    - contaminated sites and acid sulfate soils (ASS)
    - construction impacts of dust, noise and waste.

Groundwater

The Proposal is expected to result in the following outcomes in relation to groundwater:

1. The groundwater levels around the marina fingers equilibrate, with a greater area around the marina experiencing groundwater levels less than 0.1 mAHD than is currently the case.
2. An estimated reduction in groundwater levels at Lake Richmond of 0.032 m (3.2cm) during construction and 0.038 m (3.8cm) during operation.
3. The saltwater interface is modelled as being located along the southern and eastern edge of the marina. There is also some additional intrusion to the northeast of the marina. Groundwater salinities under Lake Richmond are not expected to change.
4. No estimated impact to groundwater quality at Lake Richmond during construction or operation.
5. Limited impacts to bore users in the Rotary Park area will be managed through the implementation of mitigation measures in line with the proposed Groundwater Quality Management Plan.

Surface water

The Proposal is expected to result in the following outcomes in relation to surface water:

1. The Proposal is likely to result in a decrease of water levels in Lake Richmond of 0.032 m (3.2cm) during construction and 0.038 m (3.8cm) during operation.
2. The change in the location of the saltwater interface within the groundwater will not impact upon Lake Richmond during construction or operation of the Proposal.
3. The moving of the Lake Richmond Outlet Drain will not impact upon water levels in the lake.
4. Stormwater from the Proposal will not directly enter the lake and hence there will be no change in surface water quantities or quality entering the lake as a result of the Proposal.
5. The increased population in the Lake Richmond area as a result of the Proposal is not expected to significantly impact upon the lake.
6. The estimated changes to water levels are within the tolerance range of the Thrombolite community and are therefore assessed as not representing a risk to their ongoing survival.
7. The Proposal is not expected to significantly impact upon the flora, vegetation and fauna that exist within or utilise Lake Richmond.
8. As the 50 m buffer will generally be retained intact and rehabilitation will occur, the impact of the proposal upon the integrity of the buffer of Lake Richmond is considered to be minimal.
9. The Proposal will not impact upon lake water quality, and hence will not result in an increase in the frequency of algal blooms in the lake.
10. The Proposal is not expected to have an impact on the function and ecology of Lake Richmond.

Terrestrial flora and vegetation

The Proposal is expected to result in the following outcomes in relation to flora and vegetation:

1. Development will result in the clearing of up to 40 ha of remnant vegetation which has suffered varying degrees of disturbance, including extensive weed invasion.
2. No DRF or Priority Flora will be affected by the Proposal.
3. The Proposal will not result in any vegetation complexes being cleared to less than 10% of the original extent.
4. The Proposal will clear 1.93 ha of TEC FCT 30a. It is proposed to retain and consolidate TEC FCT 30a into a more sustainable shape of a remnant of approximately 3.95 ha, where the boundary to area ratio is improved when compared to the current configuration of the remnant. This will comprise the retention of 1.12 ha of Very Good condition vegetation, rehabilitation of 1.61 ha that currently does not support FCT 30a and 1.22 ha of FCT 30a that has been identified as being in Good – Degraded condition.
5. The proposal would result in the clearing of 34ha of SCP 29b (P3 PEC) - *Acacia* shrublands on taller dunes.
6. The proposal would result in the clearing of 0.5ha of SCP 30b (P3 PEC) - Quindalup *Eucalyptus gomphocephala* and/or *Agonis flexuosa* woodlands.
7. A community objective for the Proposal is to provide a sum of up to $5 000 000 to enhance the balance of Cape Peron outside the Proposal area. The funding will be provided for a range of activities including rehabilitation and the acquisition of land with comparable or greater conservation value to secure the land for conservation.

Terrestrial fauna

The Proposal is expected to result in the following outcomes in relation to terrestrial fauna:

1. Loss of 38.28 ha of viable fauna habitat, of which 35.2 ha is coastal heathland, 0.9 ha is shoreline and 2.18 ha is woodland.
2. A reduction in potential Quenda habitat within the Proposal area due to clearing of coastal heathland.
3. An increase in availability of coastal heathland and woodland, and improvements to the condition of existing habitat outside the Proposal area.
4. A small reduction in numbers of Perth lined skink, jewelled ctenotus and carpet python.
5. Unlikely to have any impact on SRE terrestrial invertebrate fauna.
6. Reduction in area of available GSM habitat, and potential impact on local population; however the viability of existing population is doubtful independent of the Proposal.
7. No significant impact to migratory species as the Proposal area does not support important habitat for migratory species and the Proposal will not have a significant impact on Lake Richmond.
8. No direct or indirect impact to the black cockatoo (Carnaby's and Forest Red-tailed) habitat.

Overall, there are likely to be some local reductions in fauna populations within the Proposal boundary; but the Proposal is unlikely to significantly affect the regional diversity or abundance as the habitats are well distributed locally and regionally.

Conservation areas

The Proposal is expected to result in the following outcomes in relation to conservation areas:

Bush Forever Site 355 – Cape Peron

The Proposal is not expected to impact the regional significance of the Cape Peron Bush Forever Site 355. The Proposal will not significantly impact the diversity of flora and fauna, however, it will disturb areas of mapped Threatened Ecological Community SCP 30a and Priority Ecological Communities SCP 29b and 30b. The Proposal will also impact some of the heritage values of the area. The changes to the hydrological regime have been assessed as not impacting the vegetation that will be retained adjacent to the Proposal area. The offset measures of the Bush Forever Site 355 will also mitigate the localised impacts to this Bush Forever Site. The offset package is also designed to meet the requirements of Statement of Planning Policy (SPP) 2.8, which addresses the protection and management of regionally significant bushland.

Bush Forever Site 358 – Lake Richmond

The Proposal is not expected to impact on the regional significance of the Lake Richmond Bush Forever Site 358. The Proposal will not be significantly impact the TECs, fish species within the lake, the diversity of flora and fauna nor will it disturb the heritage values of the area. The changes to the hydrological regime are considered acceptable as the changes are within the seasonal variations experienced at Lake Richmond, with the key environmental values of the lake not being significantly affected.

Rockingham Lakes Regional Park

The Proposal area represents less than 1% of the Rockingham Lakes Regional Park (RLRP) which covers an area of 4270 ha (DEC 2010).

The Proponent is committed to providing an environmental offset ratio of approximately 1.5:1 to rehabilitate the balance area within Cape Peron, with an emphasis on improving and maintaining linkages and providing management measures to mitigate the increased visitation. Endorsement of the offset package would ensure the project rehabilitates 54 ha of the Cape to improve the biodiversity of the area, consistent with the objectives of the RLRP.

The area where rehabilitation/restoration effort should be focussed will be selected in consultation with the DEC and other stakeholders.

This program will be achieved in partnership with the Regional Park land managers and has the potential to create a large and easily measurable improvement in vegetation condition and ecological diversity in the Proposal area.

Shoalwater Islands Marine Park

The Proposal is located to the east of the Garden Island Causeway and therefore will not impact directly on the Shoalwater Islands Marine Park (SIMP).

Marine water quality

The Proposal is expected to result in the following outcomes in relation to marine water quality:

1. The Proposal dredging program will generate minor, highly localised, and short-term impacts on turbidity in Mangles Bay. Turbidity generated during construction is not expected to cause any long-term impacts on seagrasses.
2. No adverse effects expected due to contaminant release during dredging and disposal, as contaminant levels in the sediments to be dredged meet all relevant ecological and human health guidelines.
3. Chlorophyll levels in the marina will be about twice that of Mangles Bay, but there will be little effect on water quality in Mangles Bay and adjacent waters in Cockburn Sound and the SIMP due to the effects of dilution once the marina waters disperse into Mangles Bay.
4. A proportion of groundwater nutrients that presently fuel epiphyte growth on the extensive seagrass meadows of Mangles Bay will instead be taken up by phytoplankton growth in marina waters.
5. Modelling further predicts that flushing should be sufficient to prevent any gradual build-up of the concentrations of nutrients or other contaminants over time.
6. Mangles Bay presently meets phytoplankton biomass EQC for moderate protection. EQC for seagrass health for high ecological protection are met in the shallow waters of Mangles Bay, as are sediment quality EQC and recreational EQC (faecal bacteria). It is considered that the Proposal will not result in any significant decrease in the water quality of Mangles Bay, and that EQC for those environmental indicators that are presently met will continue to be met.

Coastal processes

The Proposal is expected to result in the following outcomes in relation to coastal processes:

1. Reorientation of beach profiles at Mangles Bay, with sediment deposition on either side of the marina breakwater.
2. Minor seagrass accumulation in the dredge channel and harbour.
3. Minimal impact to development and foreshore area by sea level rise and storm events.

Benthic primary producer habitat

The Proposal is expected to result in the following outcomes in relation to benthic primary producer habitat:

1. The loss of approximately 5.66 ha of seagrass loss.
2. Rehabilitation of 6 ha of seagrass in Cockburn Sound with the objective of achieving a no net loss outcome. The Proposal will also consult with DoT and DEC to rehabilitate the swing mooring scars adjacent to the Proposal area, an area estimated at 3 ha.

Marine fauna

The Proposal is expected to result in the following outcomes in relation to marine fauna:

1. The loss of marine habitat (5.66 ha) and unvegetated sediment (1.69 ha) may potentially cause a temporary reduction in fish stocks due to egg loss and/or larval mortality until the seagrass loss is offset by the proposed rehabilitation.
2. Increased recreational fishing pressure due to the Proposal will constitute only a small proportion of that predicted due to population increase.
3. The proposed development will result in a small increase (1%) in the number of vessels able to access Cockburn Sound and the SIMP in the next 10–15 years (within the context of predicted increases of boat ownership; see above) and as such, it will also increase the amount of human-dolphin interaction that occurs.
4. Expected and potential increase in boat strike of marine fauna, particularly Little Penguins and potential disturbance of Little Penguin colonies. During breeding season it is estimated that n the medium-term the Proposal will result in about 14 large vessels/day versus 11 large vessels/day from population-driven increases alone and 14 vessels/day with or without the Proposal in the long-term.

Matters of National Environmental Significance

The Proposal is expected to result in the following outcomes in relation to matters of National Environmental Significance:

1. Reduction in area of available GSM habitat, offset by an improvement in local, adjacent habitat.
2. No significant impact to migratory species as the Proposal area does not support important habitat for migratory species and the Proposal will not have a significant impact on Lake Richmond.
3. No direct or indirect impact to the black cockatoo (Carnaby's and Forest Red-tailed) habitat.
4. No significant impacts to marine migratory species.

Overall, there are likely to be some local reductions in fauna populations within the Proposal boundary; however, the Proposal is unlikely to significantly affect regional diversity or abundance as the habitats are well distributed locally and regionally.

Recreation and public access

Overall the Proposal will provide positive outcomes increasing the recreation and tourism values for the Mangles Bay area and the wider Rockingham Region. The Proposal will be developed in accordance with the City of Rockingham's Strategic Plan (CoR 2007) and the targets and visions of the RLRP Management Plan (DEC 2010a).

Once operational, the Proposal should not restrict recreational fishing and yachting activities within Mangles Bay. During construction there may be some temporary disruption of recreational fishing due to dredge movements, and the turbidity and noise associated with dredging (although these are expected to be minimal). There will also be some temporary disruption of other recreational activities (land-based and water-based) due to restricted site access, and some temporary effects on the amenity of the area due to noise and turbidity.

Aboriginal and European heritage

The Proposal is expected to result in the following outcomes in relation to Aboriginal and European heritage:

1. Affect two identified Aboriginal heritage sites (Rotary Park and Mooribirdup Ceremonial Grounds). Approval will be sought to disturb the Aboriginal heritage sites under section 18 of the AH Act.
2. In consultation with the local Aboriginal community, an appropriate 'interpretative display' will be established to recognise the Aboriginal heritage values of the area. The European heritage site, Turtle Factory will require removal as part of the proposed development. Opportunities to relocate the building will be investigated.

Visual amenity

Visual amenity of the coastline and surrounding views is an aesthetic value that may be compromised following the implementation of Proposal, though the view sheds are currently broken by the existing infrastructure, industry and residential housing. This impact may be managed through using landscape location, orientation, materiality and height.

Traffic

The increased traffic flow generated by the Proposal will not have significant negative impacts on local road traffic. A Traffic Management Plan, outlining actions to minimise impacts to safety and amenity will be developed prior to the commencement of construction phase of the Proposal.

Contaminated sites and acid sulphate soils

The Proposal is expected to result in the following outcomes in relation to contaminated sites and acid sulphate soils:

1. The risk from contaminated sites within the Proposal area is considered negligible; however, further investigations will be conducted in the three small locations identified in the PSI as being potentially contaminated.
2. Analysis of the proposed dredge spoil (i.e. sediment in Mangles Bay) did not identify any potential contaminants; however, stockpiled dredge spoil will tested for various contaminants (metals, TBT etc) in collaboration with advice from the contaminated sites branch of the DEC, to determine the most appropriate management and disposal strategy.
3. The Proposal has the very low potential to produce monosulfidic black ooze (MBO) within the proposed marina and offshore access channel due to the low to no presence of sulfidic soils and organic materials, together with the high buffering capacity of the soils present within the soil and marine sediments.

Environmental management framework

In addition to implementing the requirements of specific environmental conditions set by the EPA if the Proposal is approved, the Proponent will minimise environmental impacts through:

- maintaining an Environmental Management System (EMS)
- implementing the CEMP for the Proposal (Appendix 1)
- regularly reviewing the performance of the EMS, CEMP and developing environmental improvement plans for priorities identified in the reviews
- continually updating construction (including ASS and dewatering) management plans and measuring success
- training staff and contractors in environmental requirements and considerations of their work
- ensuring that stakeholder views are sought, respected and considered
- regularly reporting to stakeholders on performance.

The proposed management of the key issues associated with the Proposal has been documented in the CEMP in order to manage specific environmental aspects of the Proposal. Implementation of the Proposal in accordance with the CEMP will ensure that the Proposal meets all respective environmental obligations including internal objectives, legislation, regulations and conditions of approval relating to operation of the Proposal.

The CEMP is comprised of management sub-plans that describe the specific environmental objectives and targets for each environmental factor; the management measures to be applied to avoid and minimise the environmental impact of the Proposal; monitoring measures to measure the performance of management against the targets; and, contingency measures to mitigate unavoidable or accidental impact. The sub-plans are as follows:

- groundwater management plan
- surface water management plan
- dredge spoil and dredge maintenance management plan
- terrestrial biodiversity and habitat management plan
- marine biodiversity and habitat management plan
- graceful sun-moth management plan
- dust management plan
- noise and vibration management plan
- fire management plan
- cultural heritage management plan
- hydrocarbon management plan
- waste management plan
- contaminated sites and ASS management plan
- public access and beach management plan
- rehabilitation management plan
- community issues management plan
- visual amenity management plan
- road traffic management plan.

The EMP will be regularly reviewed and revised as appropriate.

Impact assessment summary

Table ES 3 provides a summary of the potential impacts, proposed management commitments and environmental outcomes for each of the environmental factors assessed.

Table ES 3 Executive Summary of the Impacts and Proposed Management Commitments

Management objectives	Relevant standards and guidance documents	Existing environment	Potential impacts	Management strategies/proponent commitments	Predicted outcomes
Groundwater					
To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.	• National Water Quality Management Strategy (ANZECC/ARMCANZ 2000) • Guidelines for Groundwater Protection in Australia (ANZECC/ARMCANZ 1995) • Guidelines on national water quality management - released by the Natural Resource Management Ministerial Council (NRMMC 2010) • Rights in Water and Irrigation Act 1914 • Rockingham – Stakehill Groundwater Management Plan (DoW 2008) • State Water Quality Management Strategy (Water and Rivers Commission 2001) • State Water Strategy (Government of Western Australia 2003) • Stormwater Management Manual (DoW 2004-2007) • Operational Policy 5.12 – Hydrogeological Reporting Associated with a Groundwater Well Licence • Operational Policy 1.02 Water Conservation/Efficiency Plans.	The key environmental value of groundwater in the area is in maintaining groundwater levels in Lake Richmond over the winter months. Groundwater in the area is used for irrigation of public open space and gardens. The superficial lithology in the Proposal area consists of two main superficial geological units (1) the Safety Bay Sand; and (2) the Tamala Limestone. The hydraulic conductivity (K) of the Safety Bay Sands is relatively high, with estimates ranging between 5 and 174 m/day (MWH 2011b). The hydraulic conductivity (K) of the Tamala Limestone is very high because of its' porous nature, with estimates ranging between 100 and 3000 m/day (MWH 2011b). Groundwater flow in the superficial aquifer in the Rockingham area is generally in a westerly direction, towards the Indian Ocean (Department of Environment 2004).	Changes to groundwater levels due to the presence of the marina allowing more interaction between local groundwater and the sea, resulting in: • lowering of water levels in nearby private garden bores • exposure of acid sulfate soils (if they exist) within the land development area. Saltwater intrusion caused by the inland movement of the saltwater-groundwater (fresh) interface due to the inland marina that may result in: • increasing salinity in local bores • salt entering the root zone of potentially salt sensitive native species.	Use of a wet construction method involving the use of excavators and dredges to construct the marina. Dewatering may not be required; however, if it is, it will be reduced in order to minimise groundwater drawdown. Limited dewatering may be required for the relocation of the SDOOL and construction of services such as sewers. This will be below the threshold required for a dewatering licence. Design modifications to reduce impacts to groundwater include reducing the length of the south eastern arm of the marina and reduction in depth of canals. The Proponent will develop a Groundwater Quality Management Plan to address potential changes in salinity on groundwater users, including measures to inform householders, investigating potential changes in locations for council irrigation bores and measures to mitigate impacts to affected households. This will be supported by a groundwater salinity monitoring program. A Local Water Management Strategy will be prepared to accompany the Local Structure Plan and will outline management measures for groundwater quality and quantity, and potable and non-potable water supplies (which would be initiated should these criteria be breached). Establishment of a contingency plan where domestic groundwater bore supply and quality be diminished. Using the construction methods advised by the Water Corporation, the construction of the SDOOL without the marina present resulted in a decrease in water levels at Lake Richmond of 0.24 m. With the marina being constructed at the same time, the decrease was 0.25 m. Thus cumulative impact of the two proposals on Lake Richmond is predominantly due to the construction of the SDOOL.	After mitigation measures as described, the proposal is expected to be able to: • result in a minimal reduction in groundwater levels at Lake Richmond of 0.032 m during construction and 0.038 m during operation • ensure no impact to groundwater quality at Lake Richmond during construction or operation • manage the limited impacts to bore users in the Rotary Park area through the implementation of mitigation measures in line with the proposed Groundwater Quality Management Plan. These impacts are considered to be acceptable as the key environmental values for groundwater surrounding the Proposal will not be significantly affected.
Surface water					
To maintain the integrity, ecological functions and environmental values of wetlands. To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected. To maintain biological diversity where that represents different plants, animals and micro-organisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.	• National Principles for the Provision of Water for Ecosystems (ANZECC/ARMCANZ 1996) • National Water Quality Management Strategy (ANZECC/ARMCANZ 2000) • State Water Quality Management Strategy 2001 (Waters and Rivers Commission 2001) • State Water Strategy (Government of Western Australia 2003) • Stormwater Management Manual (DoW 2004-2007) • Wetlands Conservation Policy for Western Australia (Government of Western Australia 1997) • Environmental Protection of Wetlands Preliminary Position Statement - Position Statement No. 4 (EPA 2004e) • Environmental Protection (Swan Coastal Plain Lakes) (EPA 1992) • Guideline for the Determination of Wetland Buffering Requirements (WAPC 2005b).	The soils of the Proposal area and surrounds are Safety Bay Sands, which are known for their high permeability (Gozzard 1983). Runoff is unlikely to occur, except perhaps during extreme events such as the 1 in 100 year rainfall event. Runoff from the Proposal area is not expected to enter Lake Richmond. Lake Richmond is a perennial, freshwater lake with an area of approximately 40 ha and a depth of approximately 14 m (MWH 2011a). The Lake Richmond Outlet Drain runs through the site, close to the southern and western boundaries of the Proposal area. Lake Richmond is a groundwater throughflow lake receiving groundwater from south and discharging water to the north towards Cockburn Sound (CALM 2003b). Water levels in the lake vary seasonally from between approximately 0.2 and 1.2 mAHD, with water levels generally peaking in spring and being lowest in summer/autumn, prior to the commencement of winter rainfall. Water quality in the lake is fresh, with values of between 400 mg/L and 1400 mg/L total dissolved salts (TDS) being recorded (MWH 2011a).	Construction and operation of the marina waterbody will lower regional groundwater levels which may lead to: • lowering of water levels in Lake Richmond • exposure of acid sulfate soils if they exist around Lake Richmond • saltwater intrusion caused by the inland movement of the saltwater-groundwater (fresh) interface due to the inland marina. Increased population as a result of development may increase indirect impacts on Lake Richmond through uncontrolled access, rubbish and domestic pets.	Minimising the amount of dewatering associated with the Proposal by adopting a wet construction method. Undertaking rehabilitation of areas not to be cleared within the Proposal area and within the Proposed Service Corridor. Installing best Management Practices that treat stormwater prior to infiltration or discharge in line with the Stormwater Management Manual (DoW 2004 - 2007). A Local Water Management Strategy will be submitted with the Local Structure Plan for the development outlining the details of the measures to be undertaken to manage stormwater quality and quantity within the Proposal area. Possible raising of the weir wall on the Lake Richmond Outlet Drain to decrease the amount of water leaving the lake as surface water each year. This measure will be considered in consultation with the City of Rockingham, Water Corporation, DEC, DOW and DSEWPaC.	The Proposal is likely to result in a decrease of water levels in Lake Richmond of 0.032 m during construction and 0.038 m during operation. This is not considered to significantly impact the lake ecology. The change in the location of the saltwater interface within the groundwater will not impact upon Lake Richmond during dewatering or following construction of the Proposal. The moving of the Lake Richmond Outlet Drain will not impact water levels in the lake. Stormwater from the proposal will not directly enter the lake and hence there will be no change in surface water quantities or quality entering the lake. The increased human population within the Lake Richmond area is not expected to significantly impact the lake. The Proposal is not expected to significantly impact upon the TECs present at Lake Richmond. As the 50 m buffer will generally be retained intact and rehabilitation will occur, the impact of the Proposal upon the integrity of the buffer of Lake Richmond is considered to be minimal. The Proposal will not impact upon lake water quality, and hence will not result in an increase in the frequency of algal blooms in the lake. The Proposal is not expected to have an impact on the function and ecology of Lake Richmond.

Terrestrial flora and vegetation					
To maintain the abundance, species diversity, geographic distribution and productivity of flora and fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvements in knowledge.	• EPA Position Statement No. 2 (EPA 2000a) • EPA Position Statement No. 3 (EPA 2002) • EPA Guidance Statement No. 33 (EPA 2008a) • EPA Guidance Statement No. 51 (EPA 2004b) • EPA Guidance Statement No. 10 (EPA 2006a) • *Wildlife Conservation Act 1950 (WA)* (WC Act) • *Environmental Protection Act 1986* (EP Act) • Conservation and Land Management Act 1984 (WA) • Bush Forever Policies, Principles and Processes • State Planning Policy 2.8 Bushland Policy for the Perth Metropolitan Region (WAPC 2005a) • *Environment Protection and Biodiversity Conservation Act 1999* (Australian Government) (EPBC Act).	Bennett (2005) recorded and described 25 different vegetation units as occurring in the Proposal area. Keating & Trudgen (1986) recorded 16 vegetation units, one of which was not recorded by Bennett (2005). Eight Floristic Community Types (FCTs) have been identified as occurring onsite (ENV 2010; Bennett 2005) and were mapped by ENV (2010). One TEC is located within the Proposal area and is in 'good' to 'degraded' condition. Two PECs occur within the Proposal area. Much of the Proposal area is located within the Bush Forever Site 355. Bush Forever Site 355 is 174.5 ha, of which approximately 107.1 ha is vegetated. A total of 54 vascular plant families, 112 genera and 132 taxa, of which 67 are endemic and 65 are weeds, were recorded by Bennett (2005) and/or ENV (2010). Four DRF and 15 Priority Flora species were identified from the DEC database as potentially occurring in the Cape Peron area (ENV 2010); however no Declared Rare Flora (DRF) or Priority Flora species were recorded during the Bennett (2005) or ENV (2010) survey.	• clearing of vegetation for the development will directly reduce the extent of vegetation communities with minimal disturbance expected to occur to threatened ecological communities (TECs) • creation of new saltwater interface as a result of the land based marina may affect saltwater/freshwater interface-dependent vegetation • increased human population as a result of development may increase indirect impacts on vegetation through uncontrolled access, rubbish and domestic pets • vehicle movements and earthworks have the potential to introduce and spread weed species • fragmentation of Bush Forever site 355 as a result of clearing for the development • dust generation due to earthworks and vehicle movements has the potential to smother vegetation • potential edge effects on surrounding vegetation from clearing and construction activities.	Clearing of vegetation will be minimised as far as practicable to allow construction and operation to be undertaken in a safe manner. Management strategies include a ground disturbance authorisation procedure, clear demarcation of areas approved for clearing and environmental awareness training to ensure all employees are aware of the requirement to minimise ground disturbance. Implementation of a rehabilitation program for the remnant vegetation of Cape Peron within the Bush Forever Protection Area including: • weed control program • planting and/or seeding disturbed areas with local provenance species where appropriate • consolidating and formalising walking tracks • fencing where required to protect vegetation • stabilisation of disturbed dune areas • establish a monitoring program to evaluate rehabilitation. Development of an offsets and rehabilitation package in consultation with DEC, OEPA, DoP and the City of Rockingham, to offset the vegetation loss and area excised from the RLRP and Bush Forever Site 355. The potential for the introduction of weeds will be managed through vehicle hygiene procedures for earth-moving equipment during the pre-construction and construction phases. Ongoing weed management will be undertaken through regular weed spraying programs. Dust will be managed through the use of water trucks or other dust suppression methods.	Development will result in the clearing of up to 40 ha of remnant vegetation which has been assessed as being of varying condition. FCT 30a near the corner of Memorial Drive and Safety Bay Road is 4.63 ha in area and is a an example of a TEC. The Proposal will clear 1.93 ha of TEC FCT 30a. It is proposed to retain and consolidate TEC FCT 30a into a more sustainable shape of a remnant of approximately 3.95 ha, where the boundary to area ratio is improved when compared to the current configuration of the remnant. This will comprise the retention of 1.12 ha of Very Good condition vegetation, rehabilitation of 1.61 ha that currently does not support FCT 30a and 1.22 ha of FCT 30a that has been identified as being in Good – Degraded condition. The consolidation of the area of FCT 30a will provide an area slightly less than the current mapped extent and an area of the occurrence which has a better area to boundary ratio. Confidence in the ability of the rehabilitation to improve the values of the remnant TEC occurrence is provided by the fact that the current occurrence of the TEC appears to have been an area of recolonisation / rehabilitation. The Proposal will not result in any vegetation complexes being cleared to less than 10% of the original extent. Approximately 48% of the pre-European extent Quindalup Vegetation Complex remains in the Metropolitan area. No DRF or Priority Flora will be affected by the Proposal. Changes in groundwater quality and levels are not anticipated to impact vegetation in the area The development will provide offsets in accordance with EPA Position Statement No 9.
Terrestrial fauna					
To maintain the abundance, diversity geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge. To maintain biological diversity that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.	• *Wildlife Conservation Act 1950 (WA)* (WC Act) • *Conservation and Land Management Act 1984* • *Environment Protection and Biodiversity Conservation Act 1999* (Australian Government) (EPBC Act) • EPA Position Statement No. 3 (EPA 2002) • EPA Guidance Statement No. 56 (EPA 2004c) • EPA Guidance Statement No. 20 (EPA 2009a).	Bamford (2005) identified 187 non-marine species that either may potentially occur or have previously been recorded in the surveyed area. Surveys within and in the vicinity of the Proposal area recorded 17% of the native mammals, 52% of the birds, 45% of the reptiles and 71% of the amphibians potentially occurring. Six species of migratory birds were found in the survey area, but no other conservation listed species (ENV 2011a). One reptile of conservation significance has been recorded in the Proposal Area (ENV 2011a). Two other reptiles of conservation significance may occur within the Proposal area. No Priority or EPBC-listed mammals or amphibians are recorded as occurring in the Proposal area (ENV 2011a). No conservation significant scorpions, millipedes or land snails were found in the Proposal Area. Four terrestrial fauna habitats were identified within the Survey Area: • shoreline habitat • coastal heath habitat • woodland habitat • wetland habitat (ENV 2011a).	• clearing of vegetation for the Proposal will directly disturb fauna habitat, fragment fauna linkages and may result in the loss of individual terrestrial fauna • vehicle movements and construction activities in the Proposal area may result in the loss or disturbance of individual terrestrial fauna • predation on terrestrial fauna species from introduced domestic pets from the land development • indirect impacts from increase in population degrading habitat quality over time thereby reducing habitat quality for terrestrial fauna • indirect impacts from increase in saltwater interface as a result of the land-based marina impacting groundwater-dependent vegetation.	Management measures to minimise the impact of construction and operation of the Proposal on fauna include: • not undertaking clearing outside authorised areas • relocating mammals, reptiles and amphibians prior to clearing where practicable • conducting clearing in stages to allow for the movement of any remaining fauna • limiting noise and vibration that may disturb fauna during construction • restricting the time and length excavated trenches are opened/exposed • preventing vehicle access outside authorised areas during construction, and limiting vehicle speeds inside the construction area • providing suitable areas as conservation offsets • rehabilitating habitat areas in the vicinity of the Proposal area.	The loss of 38.28 ha of habitat, of which 35.2 ha is coastal heathland, 0.01 ha is shoreline, and 2.18 ha is woodland. The Proposal will result in a small reduction in potential Quenda habitat within the Proposal area due to clearing of coastal heathland. Rehabilitation will increase the availability of coastal heathland woodland, and improve the condition of existing habitat outside the Proposal area. The Proposal will result in a small impact to numbers of Perth Lined Skink, Jewelled Ctenotus and Carpet Python. The Proposal is considered unlikely to have an impact on short range endemic or subterranean fauna. The Proposal will result in the clearing of 32.6 ha of GSM habitat; however, the Proposal is unlikely to significantly impact upon GSM population due to the existing habitat fragmentation. The Proposal is not expected to result in significant impact to migratory species as the Proposal area does not support important habitat for these species. The Proposal will result in a significant impact to potential black cockatoo habitat (if present), with 1 ha of roosting habitat proposed to be cleared.

Marine water quality					
To maintain the integrity, ecological functions and environmental values of the seabed and coast. To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land use by meeting statutory requirements and acceptable standards.	• State Environmental (Cockburn Sound) Policy 2005 (Cockburn Sound SEP) (Government of Western Australia 2005b) • Western Australian Planning Commission Policy Number DC1.8 (WAPC 1999) • National Health and Medical Research Council Guidelines (NHMRC 2008) • *Contaminated Sites Act 2003* (CS Act) • Department of Environment and Conservation Contaminated Sites Management Series (DEC 2010b) • National Assessment Guidelines for Dredging (NAGD; Commonwealth of Australia 2009) • SIMP Management Plan (DEC 2007).	Mangles Bay is sheltered by the Garden Island Causeway and Cape Peron, and is therefore relatively calm and poorly flushed by marine waters under most circumstances, but is exposed to storms from the north (Strategen 2006). **Nutrient enrichment** Chlorophyll-a levels in the shallows of Mangles Bay are generally higher than most other areas in Cockburn Sound, largely due to the reduction in flushing in Mangles Bay caused by the construction of the Garden Island Causeway. Baseline water quality surveys indicate chlorophyll-a levels in the shallows of Mangles Bay do not meet the phytoplankton biomass EQG or EQS set under the Cockburn Sound SEP for high ecological protection, or the EQG for moderate ecological protection (the EQS is met). Nutrient inputs into Mangles Bay come mainly from groundwater discharge and stormwater drainage, largely in organic forms available for plant growth. **Other contaminants** Studies for the Proposal have found low concentrations of metals in groundwater (MWH 2011a). Other contaminants sources include boat traffic and stormwater drainage (including faecal bacteria, metals, antifoulants, and fuels). Contaminant concentrations (metals, hydrocarbons, tributyltin) in sediments to be dredged for the Proposal access channel meet relevant guidelines (NAGD, and Cockburn Sound EQG), as do Mangles Bay sediments adjacent to the channel. Concentrations of ammonia in sediment elutriates also meet the toxicity guideline of the NAGD, and Cockburn Sound EQG for high ecological protection.	• changes to marine water quality (mainly turbidity) during construction may adversely affect marine ecology and function • outflow of marina waters into Mangles Bay may result in changes in turbidity, nutrients, and/or contaminants, which in turn may adversely affect marine ecology and function • changes in flushing of Mangles Bay may affect marine ecology and function • operational aspects with potential to impact on marine water quality include an increase in the number of boats in Mangles Bay and adjacent water, with the potential to release contaminants into the water.	• baseline and ongoing monitoring of water quality and seagrass health at agreed sites • agreed reporting requirements, management triggers for water quality and seagrass health, and required actions if management triggers are exceeded • post-construction monitoring of seagrass health. it is also proposed to include monitoring of water and sediments in the infiltration ponds used for temporary storage of dredged material, to confirm predictions that overall concentrations of contaminants (especially tributyltin) meet relevant EQG. Operational management plan will include: • fuel spill management plan • maintenance and management plan for marina facilities • codes of conduct for users of the marina • ongoing monitoring of water and sediment quality within the marina • monitoring of seagrass health • addition of sullage facilities. Best Management Practises for stormwater should ensure minimal Increases in stormwater runoff to Mangles Bay from the Proposal area. The realignment of the Lake Richmond drain will also redirect the single largest source of stormwater-borne contaminants into better flushed waters east of the Proposal.	The potential for contaminant release during dredging and disposal is considered very low, as contaminant concentrations in the sediments met NAGD screening levels (Commonwealth of Australia 2009). It is considered that the Proposal will not result in any significant decrease in the water quality of Mangles Bay, and that EQC for those environmental indicators that are presently met will continue to be met. Marina waters will also meet WAPC Policy No. DC1.8 guidelines for artificial waterways (WAPC 1999).
Coastal processes					
To maintain the integrity, ecological functions and environmental values of the seabed and coast.	• *Planning and Development Act 2005* • *Town Planning and Development Act 1928* • Statement of Planning Policy No. 2.6: State Coastal Planning Policy (SPP2.6) (WAPC 2006) • Sea Level Change in Western Australia – Application to Coastal Planning (DoT 2010).	The shallow sheltered waters of Cockburn Sound (and Mangles Bay) support extensive seagrass meadows and a wide range of marine fauna (Strategen 2010). Cockburn Sound is bound to the west by Garden Island and to the north by Parmelia Bank, resulting in the sound being relatively sheltered from swell energy. Limited swell does penetrate through from the northern entrance to the Sound. The local seas are dependent on wind conditions and basin dimensions. In the southern portion of Cockburn Sound, the locally generated seas have been found to come from the south or south west in summer, and from the west to northwest in winter. The coast where the Proposal is located, experiences diurnal microtidal conditions, with a maximum spring tidal range of 0.6 m. The beaches at Mangles Bay have been identified as low energy beaches. A number of shoreline structures have been constructed in the vicinity of the Proposal area since 1971, the most significant of which is the Garden Island Causeway. The coastline spanning the Proposal area is currently divided into distinct sub compartments by existing coastal structures.	• construction of the marina entrance breakwater and channel which may interrupt longshore sediment transport • construction of the breakwaters may result in the accumulation of seagrass wrack against the structure. In addition to consideration of the potential impacts of the Proposal on coastal processes, the effects of sea level rise and processes on coastal infrastructure need to be considered in the design of coastal structures.	Management, measures to protect the shore from erosion while ensuring that existing and planned recreation areas are not compromised include the installation of coastal defence structures, specifically: • two groynes located on either side of the marina breakwater entrance • buried sea wall adjacent to the development along the beaches within the Proposal area, exact location yet to be finalised • beach nourishment involving deposition of sediment along beaches at Mangles Bay to improve and protect social amenity and public access. The Proponent will undertake management and maintenance works until landscaping handover. The recommended coastal setback allowance calculation, as outlined in SPP 2.6 (WAPC 2003) is comprised of four distinct components, each of which have been addressed for the Proposal (JFA 2011). The calculated setback requirement for the Proposal also considered the management structures and beach nourishment activities which have been incorporated into the Proposal design.	• reorientation of beach profiles at Mangles Bay, with sediment deposition on either side of the marina breakwater • minor seagrass accumulation in the dredge channel and harbour • minimal impact to development and foreshore area by sea level rise and storm events.

Benthic primary producer habitats					
To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	• EPA Environmental Assessment Guideline No. 3 (EPA 2009b) • EPA Environmental Assessment Guideline No. 7 (EPA 2011) • Western Australian Government's Environmental Offsets Policy • EPA Position Statement No. 9 (EPA 2006c) • EPA Guidance Statement No. 19 (EPA 2008b) • State Environmental (Cockburn Sound) Policy 2005 (Government of Western Australia 2005b) • SIMP Management Plan 2007-2017 (DEC 2007).	Cockburn Sound has a history of poor water quality and large scale seagrass loss dating from the 1960s and 1970s. The shallow flats of Mangles Bay contain approximately 100 ha of seagrass. There has been an estimated 3 ha of seagrass loss within Mangles Bay due to mooring scars. Seagrass monitoring was undertaken in January 2010 at one reference site west of the Garden Island Causeway and one potential impact site east of the causeway in Mangles Bay. Shoot density counts were documented based on standard operating procedures established for Cockburn Sound. The median shoot density at the reference site met the 1 year shoot density EQS for high ecological protection but the potential impact site did not (Oceanica 2012) Seagrass monitoring in 2011 measured shoot density counts at four locations adjacent to the Proposal access channel. Three sites met the 1 year EQS for high ecological protection and one site did not, indicating considerable spatial variability in seagrass health (Oceanica 2012). Studies for the Proposal included seagrass transplant trials into mooring scars in Mangles Bay, where traditional moorings were replaced by seagrass-friendly designs. Results indicated regrowth of existing seagrass would achieve infilling of scars in about seven years, and a combination of transplanted seagrass and natural regrowth into the scars would reduce this time to around four to five years	The following aspects of the Proposal have the potential to affect BPPH values: • direct removal of seagrass to allow for the construction of the marina access channel and breakwaters • indirect impacts to seagrass meadows as altered patterns of sediment movement and water flow due to the breakwaters result in the erosion or smothering of seagrass, creating a 'halo' effect around breakwaters • indirect impacts to seagrass meadows as a result of alteration in water quality within Mangles Bay as a result of the creation of the marina.	The proposed dredging program has been designed to avoid or minimise impact on seagrass communities including: • dredging only between April and August when seagrasses are not actively growing • reduced period of dredging (3-4 months) • use of silt curtains to control turbidity release and dispersion. Seagrass health and water quality will be monitored during construction and contingency measures will be implemented, if necessary, to avoid impacts to seagrasses. Trained operators will be employed to operate machinery to ensure the loss of BPPH does not exceed the predicted footprint area. The number of swing moorings in the Mangles Bay area is proposed to be reduced, in turn reducing the damage to seagrass from these types of moorings. A CEMP will be prepared to identify the proposed breakwater and other construction methods and proposed management measures. After construction, seagrass will be monitored for two years through high resolution vertical digital imagery. The cessation of most boat launching activities across the beach adjacent to the Proposal area should reduce scouring damage to seagrass. The realignment of the Lake Richmond drain may also benefit seagrass. Any loss of seagrass will be offset by rehabilitation of at least an equal area of seagrass within Cockburn Sound. The proposed target for the total area of seagrass rehabilitation of 6 ha will exceed the total losses. A Seagrass Rehabilitation Plan will be developed identifying rehabilitation sites, species to be used, transplanting units and techniques, spacing of planting units and monitoring and management measures for transplanted seagrass. Development of an offsets and rehabilitation package for seagrass will be in consultation with OEPA, DEC and CSMC to offset the seagrass loss and area for replanting	The construction of the Proposal will potentially result in the loss of approximately 5.66 ha of direct and indirect seagrass loss. Approximately 1.7 ha of bare, unvegetated habitat (primarily mooring scars) will also be removed. No losses are expected due to turbidity generated during dredging, as this is expected to be minimal. The loss of seagrass will be offset by the rehabilitation of 6 ha of seagrass in Cockburn Sound, but this will probably target areas other than mooring scars. Transplant trials in mooring scars indicate that natural regrowth of existing seagrass should achieve infilling of scars in about seven years, once seagrass-friendly moorings are used (resulting in an estimated 3ha of seagrass). The Proposal is not expected to significantly impact on marine flora.
Marine fauna					
To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. To maintain the integrity, ecological functions and environmental values of the seabed and coast. To conserve WA's marine environment by managing and reducing the impacts of introduced marine species and by preventing further introduction and spread.	• *Wildlife Conservation Act 1950* • *Conservation and Land Management Act 1984* • *Environmental Protection and Biodiversity Conservation Act 1999* • State Environmental (Cockburn Sound) Policy 2005 (Government of Western Australia 2005b) • SIMP Management Plan 2007-2017 (DEC 2007) • *Fisheries Resources Management Act 1994*.	Mangles bay provides significant habitat for a high fish diversity and abundance, in comparison to the broader Cockburn Sound area, most likely due to its sheltered waters, extensive seagrass meadows close to shore and high availability of food. It is also an important nursery for fish species targeted by fishers and baitfish. Marine invertebrate surveys in Mangles Bay have identified polychaetes, nematodes, amphipods (small crustaceans) and juvenile decapods (e.g. crabs, prawns). The blue swimmer crab, *Portunus pelagicus*, octopus, southern calamari squid and mussels are fished commercially within Cockburn Sound. Common bottlenose and Indo-Pacific bottlenose dolphins occur and forage within Mangles Bay. Leatherback and green turtles are seen occasionally in Cockburn Sound, being visitors brought southwards from tropical waters by storms and/or the southward flowing Leeuwin Current. Loggerhead turtles are more commonly seen. Australian sea lions use the islands of the SIMP as haul-out sites (males only) during the non-breeding season, and are often seen in waters around Garden Island (including Cockburn Sound). A colony of little penguins is found on Garden Island. The southern right whale is often seen in Perth coastal waters and may occasionally enter Cockburn Sound. The humpback whale is likely to occur offshore of Garden Island but is unlikely to enter Cockburn Sound.	The following aspects of the Proposal may affect marine fauna: • temporary changes in water quality during construction (turbidity, nutrient-related water quality, contaminants) due to dredging and the discharge of return water • ongoing changes in water quality due to outflow of lesser water quality from the marina into Mangles Bay • direct and indirect loss of habitat due to construction of the access channel and breakwaters of the marina • increased risk of introduced marine species due to increased numbers of large recreational vessels berthing in the marina • increased human access causing littering • increased vessel numbers causing increased fishing pressure and the potential for boat strike • increased interactions between humans and marine fauna.	Management measures to reduce potential impact of habitat loss on marine fauna include: • improvement of habitat value of seagrass meadows in Mangles Bay • seagrass transplantation in other areas of Cockburn Sound • no removal of sea wrack • establishment and enforcement of no-wake zones in shallow surface waters • promoting/displaying information on ecological values and appropriate behaviour, sustainable fishing practices, wildlife regulations, boat speeds • providing a base for surveillance, monitoring and research in the marine environment • provision of fishing line discard bins and information signs • patrolling of marina to remove line and other entanglement sources and to support clean up measures • prohibiting fishing within the marina • implementing strict environmental management standards for the marina • encouraging recreational and charter boat owners to participate in penguin monitoring program • encourage and promote best practice measures for refuelling, cleaning vessels, oil spills, bilge water, detergents, stormwater runoff • collaboration with department of fisheries to prevent and respond to incidents of introduced marine pests, or significant amounts of fouling organisms or sediment.	Construction of the Proposal will likely result in: • minor temporary turbidity and noise associated with dredging, with minimal effect on marine fauna • direct loss of 5.66 ha of seagrass meadow and 1.69 ha of bare sediment and offset of 6 ha of seagrass in Cockburn Sound. Operation of the Proposal will likely result in: • increased shore based recreational activity and increased recreational vessels and fishing pressure, which will be offset through management measures described.

Matters of National Environmental Significance					
To provide for the protection of the environment, especially matters of NES, promote ecologically sustainable development through the conservation and ecological sustainable use of natural resources and control of international movement of wildlife, wildlife specimens and products made or derived from wildlife.	• *Environment Protection and Biodiversity Conservation Act 1999* (Australian Government) (EPBC Act). • Matters of National Environmental Significance: Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999 (DEWHA 2009) • Japan Australia Migratory Bird Agreement (JAMBA) • China Australia Migratory Bird Agreement (CAMBA) • Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) • Ramsar Convention.	Based on previous surveys, databases and literature searches of the Proposal area and surrounds, one endangered terrestrial species and 32 migratory bird species listed under the EPBC Act may occur in the Proposal area. A search using the EPBC Protected Matters Database search identified a number of matters of NES that may occur within the Proposal area as follows: • 3 wetlands of international significance • 2 TECs • 21 threatened species • 23 migratory species • 38 marine species • 13 whales and other cetaceans. *Synemon gratiosa* (GSM) is an endangered day flying moth endemic to the area between Beekeepers National Park (10 km North of Leeman) and Preston Beach (Bishop *et al.* 2010). Two EPBC listed TECs occur within close proximity to the Proposal area.	• vegetation clearing for the development will result in clearing of fauna habitat • construction of a inland marina may result in the inland migration of the saltwater interface and changes to water quality, which may potentially impact fauna habitat and threatened ecological communities • construction of the access channel and breakwater of the marina may result in the direct and indirect loss of marine habitat • increased boat movements and berths may potentially impact fauna habitat and individual fauna species by increasing the risk of introduced marine species, increasing fishing pressure and the increasing the potential for boat strike of marine fauna • increased recreational access may potentially impact fauna habitat through littering • edge effects may potentially impact habitat at Lake Richmond.	Implementation of a CEMP will include management of dredge spoil, dust, GSM and noise and vibration. Measures to minimise impacts to matters of NES include: • no clearing outside authorised areas • clearing in stages to allow for fauna movement • planting/seeding of disturbed areas with local provenance species where appropriate • limiting noise/vibration • limiting time and length excavated trenches are open • no vehicle access outside authorised areas and vehicle speed limits imposed • fencing to protect vegetation where required • monitoring to evaluate rehabilitation • offset plan • rehabilitation of areas in vicinity of Proposal area • landscape median strips of Memorial Drive and Safety Bay Rd • designing proposal in water sensitive manner • strategic weed control program.	The Proposal is expected to have minimal impacts on matters of NES, as follows: • reduction in area of available GSM habitat through clearing of 32.6 ha • the Proposal will not result in a significant impact to the potential black cockatoo (Carnaby's and Forest Red-Tailed) habitat (1 ha cleared) or the population of black cockatoo species that may potential occur • terrestrial migratory species – the Proposal is not expected to result in significant impacts to these species • marine migratory species – the Proposal is not expected to result in significant impacts to these species. Overall, there are likely to be some local reductions in fauna populations within the Proposal boundary; but the Proposal is unlikely to significantly affect the regional diversity or abundance as the habitats are well distributed locally and regionally. With management and offsets, it is considered that the Proposal can meet EPA objectives, as well as other applicable policy and guidelines objectives.
Aboriginal and European heritage					
To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	• Aboriginal Heritage Act 1972 • Native Title Act 1993 (Commonwealth) • EPA Guidance Statement No. 41, "Assessment of Aboriginal Heritage" (EPA 2004d) • Planning Policy 3.1.7 – Heritage Conservation and Development Policy.	Two 'Registered' sites are located within and/or adjacent to the Proposal area: • Lake Richmond (15974) • Rotary Park (3471). Two 'Other Heritage Places' are also included within the vicinity of the Proposal area: • Mooribirdup Ceremonial Ground (22888) • Lake Richmond (352). In April 2011, a detailed consultation program was undertaken to determine the significance of the sites located within / adjacent to the Proposal area. Sites / buildings of European heritage significance include: • Cape Peron Battery Complex • the Point Peron Recreation Camp buildings • the 'Turtle Factory' building.	As a result of the Proposal, one registered heritage site (Rotary Park) and one other heritage site (Mooribidup Ceremonial Grounds) will be affected through the following: • physical disturbance of the land surface during clearing and construction including removal of topsoil and overburden, and landform modification has the potential to disturb heritage sites and affect ethnographic values • presence of construction and operational personnel has the potential to disturb heritage sites, disrupt cultural association meetings and gatherings, and affect ethnographic values.	Where the Proposal may impact on any Aboriginal site, an application to disturb will be made under section 18 of the AH Act. Continue consultation and discussions with heritage site informants and the Native Title Claimants for the area throughout the planning, development and implementation stages of the Proposal. Install public art displays and signage to interpret and present the cultural and historical values held for the area, in close consultation with the Nyungar community. The Nyungar community will be given the opportunity to conduct appropriate proprietary rituals prior to ground disturbance associated with the sites mentioned above. Clearing is to be monitored by a qualified archaeologist and two Nyungar community members. Rehabilitation will be conducted utilising any indigenous seeds and plants are salvaged from the Proposal area. Employment opportunities for Nyungar people will be provided where possible throughout the construction phase of the Proposal. The Proponent will investigate the option for the former Sister Kate's Children's Home site to be leased to the Nyungar community. The site should also be registered with the DIA under the AH Act. Consideration will be given to relocating the Turtle Factory building; however, this may not be plausible given the building is constructed of asbestos material. The Proponent will consult with the relevant government heritage agencies, community groups and the City of Rockingham to determine the best outcome for this building.	The Proposal will potentially affect the cultural heritage values associated with the Cape Peron area, including two Aboriginal heritage sites (Rotary Park and Mooribirdup Ceremonial Grounds) and a European heritage site (the Turtle Factory). An appropriate 'interpretative site' will be established to recognise the Aboriginal heritage values of the area whilst providing for use by the local Aboriginal community as a meeting place. There are also other opportunities to recognise the Aboriginal connections with Cape Peron within the development (e.g. public art, information).

Recreation and public access impact assessment					
To ensure that existing and planned recreational uses are not compromised.	• Perth's Coastal Waters Position Paper (EPA 2000b) • Draft Perth Coastal Planning Strategy (DPI and WAPC 2008) • RLRP Management Plan (DEC 2010a) • City of Rockingham Strategic Plan 2006-2011 (CoR 2007).	The Mangles Bay foreshore comprises of sandy beaches backed by low sand dunes. A large proportion of this foreshore is presently occupied by the local yacht club, fishing club (with associated jetty and boat ramp) and chalet accommodation. The use of the land by these facilities currently restricts public access to these foreshore areas, although access along the beach is mostly unimpeded. The beach is not a popular swimming area, and beach-based recreation is more focussed on walking, and the launching of boats. Cape Peron is as a popular though neglected sightseeing destination, as well as providing for activities including fishing, walking, exercising dogs, diving, swimming, picnicking and windsurfing (DEC 2010a). Lake Richmond is an attractive expanse of water in an urban setting and is used for walking, bird watching and nature observation (DEC 2010a). Public facilities provided at Cape Peron include lookout points and an extensive walk trail.	• dredge movements may cause temporary disruption to yachting and recreational fishing activities • construction noise may affect recreational amenity • increased turbidity from dredging may affect local fish and crab behaviour and recreational swimming • direct removal of a small amount of beach due to the construction of the access channel and breakwaters to allow access to the marina • interruption of pedestrian traffic flow along the beach due to the access channel and breakwaters • increased traffic and use of both land and water based recreation areas • interruption of adjacent gazetted water-ski area and power craft area • construction of marina will reduce public access to the beach.	The proposed marina development is primarily a boating and tourist facility proposed to cope with the high demand for boating facilities in the City of Rockingham area. Within the Cape Peron and Lake Richmond area of the RLRP, it is proposed to: • improve recreational opportunities by providing hard walking and cycling paths without creating additional disturbance to the natural environment • formalise beach access points, provide parking and remove unnecessary paths to minimise dune erosion • recognise cultural heritage (Aboriginal and European) links with the area (e.g. providing interpretive signage at sites of significance and contributing to the maintenance of these sites) • contribute to research and educational opportunities through the provision of facilities within the marina and interpretative walk trails/signage The Proposal will provide new recreation facilities and funds to positively contribute to the management of the RLRP offset measure.	Overall the Proposal will provide positive outcomes increasing the recreation and tourism values for the Mangles Bay area and the wider Rockingham Region. The Proposal will be developed in accordance with the City of Rockingham's Strategic Plan (CoR 2007) and the RLRP Management Plan (DEC 2010a) targets and vision. Once operational, the Proposal will greatly enhance recreational fishing and yachting activities. There may be some temporary disruption of recreational fishing and yachting due to dredge movements, and effects on fishing movements due to turbidity and noise during construction. The Proposal will improve access to the beach, which is currently constrained by existing land uses.
Conservation areas					
To protect the environmental values of areas identified as having significant environmental attributes. To maintain the integrity, functions and environmental values. To maintain the integrity, ecological functions and environmental values of the seabed and coast.	• National Strategy for Ecologically Sustainable Development (Commonwealth of Australia 1992) • Australia's Biodiversity Conservation Strategy 2010-2030 (Natural Resource Management Ministerial Council 2010) • EPA Guidance Statement No. 10 (EPA 2006a) • Bushland Policy for the Perth Metropolitan Region, Statement of Planning Policy 2.8 (WAPC 2005a) • RLRP Management Plan (DEC 2010a) • SIMP Management Plan 2007–2017 (DEC 2007) • State Environmental (Cockburn Sound) Policy (SEP) (Government of Western Australia 2005b) • Japan Australia Migratory Bird Agreement (JAMBA) • China Australia Migratory Bird Agreement (CAMBA) • Republic of Korea Australia Migratory Bird Agreement (ROKAMBA).	All land within the Proposal area south of Point Peron Road is within Bush Forever Site 355 (Government of Western Australia 2000) and within the RLRP. The total area of Bush Forever Site 355 is 174.5 ha of which 106.1 ha is vegetated (Bennett 2005). The remaining 68.4 ha consists predominately of holiday cottages, the Water Corporation waste water treatment plant and recreational camps (Bennett 2005). The development will result in the clearing of approximately 40 ha of Bush Forever Site 355. The RLRP has significant conservation value owing to its geomorphic features, the presence of diverse wetland types, habitat, flora and fauna. The development will result in the clearing of approximately 37 ha within the RLRP or less than 1% of the total area of the RLRP, which covers an area of 4720 ha. The SIMP covers an area of approximately 6 658 ha and contains the chain of islands that run parallel to the coast between Cape Peron, Becher Point, the waters of Shoalwater Bay, Warnbro Sound and a part of Cockburn Sound off Cape Peron.	• decrease in the representation of regionally significant bushland in the Swan Coastal Plain portion of the Perth Metropolitan Region as a result of clearing and earthworks associated with the development • fragmentation of bushland as a result of clearing for the development which may disrupt recreational activities and the movement of terrestrial fauna • potential increase in recreational activity and opportunity to better manage recreation • potential loss of visual amenity associated with the natural coastal environment through the development; however, visual amenity may also be enhanced through rehabilitation measures.	An offset package has been formulated to compensate the impacts of the development. The package includes improving the quality of the surrounding Bush Forever Site and the RLRP, rather than buying land elsewhere. A Recreational Management Plan will be implemented with the primary aim of educating recreational users of the Mangles Bay and SIMP of the restrictions on use, to ensure that the conservation values of the SIMP are protected. Establishment of a Mangles Bay Heritage trail with informative signs and displays illustrating the heritage values of the area.	The Proposal is not expected to impact the regional significance of Cape Peron Bush Forever Site 355 or Lake Richmond Bush Forever Site 358, including TECs, fish species, flora and fauna and hydrological regimes of these sites. The proposed rehabilitation within Cape Peron is predicted to improve the biodiversity of the area, consistent with the objectives of the RLRP. The Proposal will not impact directly on the SIMP.

Visual amenity					
To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable. To maintain the integrity, ecological functions and environmental values of landscapes and landforms.	• EPA Guidance Statement No. 33 (EPA 2008a) • Visual Landscape Planning in Western Australia manual (WAPC 2007) • State Planning Policy No. 2 (WAPC 2003).	The vantage points of the proposed development were classified into three zones for assessment including: • zone 1 – perimeter • zone 2 – coastline • zone 3 – vantage points. Two primary vantage points were located, including Battery Hill within Cape Peron and the dunal ridge along Shoalwater Bay. The Proposal area will not be visible from John Point in Point Peron which is used frequently by the public.	• clearing vegetation will alter the appearance of the natural environment which may be visible from identified significant sites • physical attributes of significant infrastructure that may obstruct or change views of existing natural features considered aesthetically significant. The infrastructure may, in itself, be aesthetically displeasing.	Existing visual amenity values within, and surrounding the Proposal area will be maintained as far as practicable through the implementation of the following measures: • retaining vegetation associated with areas of public open space • the shore disturbance required for the Proposal is concentrated in the area of existing yacht club activity • aligning roads on existing contours where practicable • avoiding interruption of the natural ridgeline • contributing to rehabilitation and management works in adjacent RLRP • connecting the new development with the existing residential and commercial areas through pedestrian access ways • guiding building height and distribution to provide diversity, permeability and limit mass • developing design guidelines that specify architectural designs, colours and materials that blends well with the natural landscape and are visually sensitive to the area • developing a Local Structure Plan that maintains key view corridors • maintaining a landscape buffer around Proposal area that minimizes visual impact on the area • maintaining a landscape buffer along the coastline.	Visual amenity of the coastline and surrounding views is an aesthetic value that may be compromised following the implementation of Proposal, though the view sheds are currently broken by the existing infrastructure, industry and residential housing.
Road traffic					
To ensure that the increase in traffic resulting from the Proposal does not adversely impact on the amenity of social surroundings or increase the risk to local public safety.	Main Roads Western Australia (MRWA) Road Hierarchy Criteria (MRWA 2011) Western Australian Restricted Access Vehicles Network City of Rockingham Infrastructure Guidelines (City of Rockingham 2011)	The road network within and adjacent to the Proposal area consists of local access, local distributor and distributor roads that service the area. These existing roads provide access to Garden Island and direct access to residential, retail, commercial and recreational areas. Key roads connected to the Proposal area: • Point Peron Road • Naval access road • Memorial Drive • Lease Road • Boundary Road • Parkin Street • Rae Road • Safety Bay Road.	• public safety issues (e.g. road traffic and pedestrian safety) • reduction in amenity (e.g. increase in noise emissions from vehicles).	The increased volume of traffic created by both the construction and operation phases of the Proposal may potentially increase public safety issues and / or reduce amenity of the area (e.g. increased noise emissions). In order to mitigate these impacts the following management measures will be incorporated into the Local Structure Plan preparation and design phase: • design of roads according to the City of Rockingham standards • routing of construction traffic to avoid existing high volume and/or residential areas • upgrade of Memorial Drive (Section 21.5.2) to cater for increased demand, including the installation of appropriate intersection controls. A Traffic Management Plan, outlining actions to minimise impacts to safety and amenity will be developed prior to the commencement of construction phase of the Proposal.	It is not anticipated that the increased traffic flow generated by the Proposal will have significant negative impacts on local road traffic. The Proposal will generate increased traffic on the road network in the vicinity of Cape Peron, during both the construction and operation phases. Memorial Drive will be realigned and upgraded to improve traffic flow with multiple road connections to Mangles Bay and the marina. The service corridor will have provision for a dual road to accommodate increased traffic volumes to HMAS Stirling.
Contaminated sites and acid sulfate soils					
To ensure that emissions do not adversely affect environment values or the health, welfare, and amenity of people and land uses by meeting statutory requirements and acceptable standards. To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use and consistent with appropriate criteria.	• Contaminated Sites Act 2003 (WA) • Contaminated Sites Regulations 2006 • Environmental Protection Act (EP Act) • Contaminated Sites Management Series (developed by the DEC) • Acid Sulfate Soils Guideline Series (developed by the DEC) • Australian New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000) • National Ocean Disposal Guidelines for Dredged Material (Commonwealth of Australia 2002) • National Assessment Guidelines for Dredging (Commonwealth of Australia 2009).	A search of the ASS Swan Coastal Plain risk map (DEC 2003) indicated the site was within an area of "low to no risk of ASS occurring within 3 m of the natural soil surface. Results of geotechnical investigations suggest the majority of soil samples contain neutral to alkaline soils with a significant amount of acid neutralising capacity. Concentrations of metals within the sediments to be dredged did not exceed, EILs, HILs or EQGs), indicating that there was a low risk of adverse ecological effects due to dredging or disposal, and that the material was suitable for use on land. Concentrations of ammonia in elutriates of Mangles Bay sediments did not exceed the toxicity guideline of the NAGD or Cockburn Sound EQG for high ecological protection. The median TBT concentration at baseline sediment sampling sites also met the EQG.	• earthworks (excavation and dewatering) have the potential to disturb and expose contaminated soil, sediment and/or water if contamination exists on site • excavation onsite or along service infrastructure corridors has the potential to disturb ASS if they occur on the site • exposure of contaminated sediments during the dredging of the marina access channel.	Management measures will be implemented by the Proponent and include: • undertaking due diligence onshore ASS investigations as part of a dewatering management program • undertaking due diligence ASS monitoring of the access channel during the dredge program • undertaking due diligence ASS monitoring of the dredge spoil from construction of the access channel • stockpiled dredge spoil will be tested for contaminants (such as metals and TBT) on advice from DEC Contaminated Sites Branch • establish a monitoring program encompassing the marina and access channel sediments to monitor the potential for Monosulfidic black ooze formation. • conducting further investigations at three small localised locations of potential contamination, • maintaining an up to date contaminated sites inventory. Any areas of contaminated land within the Proposal area will be identified, remediated and managed by the Proponent for clearance by the DEC prior to the cessation of the construction period and the use of the potential contaminated land by the public and/or residents. The Proponent will maintain a contaminated sites register throughout the pre-construction and construction period at the Proposal area as required by the *Contaminated Sites Act 2003* (WA).	Contaminant levels in the sediment to be excavated are such that ecological values in the vicinity of the Proposal area will not be affected as no EILs or HILs are exceeded, no marine guidelines for sediment are exceeded. Elutriate testing of sediments in the breakwater footprints meet marine water quality guidelines. The risk of ASS (sediments and soil) for this Proposal is negligible and contaminated sites within the Proposal area are unlikely to cause any environmental impacts.

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1. Introduction

1.1 Proposal overview

1.1.1 Background

The proposed Mangles Bay Marina Based Tourist Precinct (the Proposal) is a refinement of previous proposals that have been put forward since the early 1990s. Early project proposals were abandoned due to high costs and downturns in the real estate market. In response to community interest, the costs, benefits and constraints of Mangles Bay and other potential sites along the City of Rockingham coastline were reviewed.

The review concluded that for a marina based development, when assessed against the project sustainability objectives, Mangles Bay presents the least constraints (not withstanding that the Mangles Bay site has some major environmental constraints) and most opportunities when compared with other sections of the coastline in the City of Rockingham (Strategen 2006).

This Proposal has been designed to address the physical, environmental and social opportunities and constraints that have been identified during the development and assessment of these previous proposals.

In 2006, a Strategic Environmental Review (SER) was prepared for the Mangles Bay Marina Based Tourist Precinct (previously known as the Cape Peron Tourist Precinct Project), for the consideration of the Environmental Protection Authority (EPA) to enable the EPA to give advice requested by the Minister for the Environment under section 16(e) of the *Environmental Protection Act 1986* (EP Act). The strategic assessment process enabled the EPA to examine (at the early stage in the Proposal development) the key environmental issues associated with the Proposal, including the provision of advice on potential fatal flaws of the Proposal.

Under this strategic assessment process, in 2006, the EPA provided written and public advice to the Minister on the concept of an inland marina development at Mangles Bay. The EPA identified the following primary environmental issues:

- seagrass and water quality – direct loss through construction of the Proposal and indirect loss through changes in water quality, sand bypassing activities and coastal processes
- Lake Richmond – indirect impact on the lake and its key attributes (two threatened ecological communities [TECs]) through potential changes in hydrogeology thereby modifying the lake's water quality and water level and potentially threatening the TECs
- terrestrial vegetation – direct loss of vegetation and additional indirect loss through fragmentation, edge effects and changes in site hydrology.

The Proposal was referred to the EPA under section 38 of the EP Act on 25 August 2010. The level of assessment for the Proposal was advertised on 20 September 2010 as a Public Environmental Review (PER) with a ten week public review period and a two week public review of the ESD.

This PER will describe the studies and investigations that have been conducted by the Proponent that are in addition to the existing information resources regarding the aforementioned environmental issues, as well as those identified through consultation and screening processes. The objective of the reviews and additional studies and investigations will be to ensure that the full environmental effects of the proposal are properly understood, thus guiding the development and timely implementation of optimal management controls and enabling a reliable and knowledge-based environmental impact assessment to be conducted.

1.1.2 Location

The Proposal is located within the Perth Metropolitan Area, on the Swan Coastal Plain approximately 40 km south southwest of Perth within the City of Rockingham, Western Australia (Figure 1). The proposed development is at the southern end of Cockburn Sound, immediately east of the Garden Island Causeway and bounded by Hymus Street/Safety Bay Road to the east (Figure 2).

1.1.3 Description

This Proposal is for a tourist based inland marina development comprising a single entry marina to accommodate up to 500 pens and moorings and a surrounding land development comprising tourism, accommodation, commercial, POS and residential land uses. The development will also incorporate local aquatic clubs.

The Proposal comprises the following elements:

- marina
- boating access channel
- provision and maintenance of service infrastructure
- land development area
- rehabilitation of degraded areas of vegetation in proximity to the Proposal area and seagrass transplantation to offset vegetation losses.

The Proposal will provide much needed protected boating facilities in Mangles Bay, enhance public access to Mangles Bay and create a vibrant tourist district that will attract visitors to the region and create employment opportunities for Rockingham and the surrounding area. The Proposal will also include rehabilitation of bushland in the Cape Peron region and provide additional passive recreation facilities such as walkways and information. The design objectives are included in Appendix 2.

A detailed description of the Proposal is outlined in Section 3, with Figure 6 and Figure 7 illustrating the indicative layout of marina, access channel, breakwaters and land development. The final layout of the Proposal, especially the marina, channel and breakwaters, is still subject to amendment on the basis of stakeholder consultation, environmental investigations and engineering investigations.

Source: Imagery supplied by Landgate (2010)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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environmental consultants

Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F001.dgn

Regional location of the Proposal

Figure No: 1

Source: Imagery supplied by Landgate (2010)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F002.dgn

Location of Proposal area

Figure No: **2**

1.2 The Proponent

The Western Australian Government endorsed the progression of the Proposal. Subsequently, the Western Australian Land Development Authority, LandCorp (State Government's Land Development Agency), appointed Cedar Woods Properties Limited (Cedar Woods) as its private sector partner to progress this Proposal. Cedar Woods is the Proponent for this Proposal. The nominated contact for the Proponent is:

Marcus Deshon
Development Manager
Cedar Woods Properties Limited
50 Colin Street
West Perth, WA 6005
PO Box 788 West Perth WA 6872
Email: Marcus.deshon@cedarwoods.com.au

1.3 Purpose and scope of this document

The purpose of this document is to present an environmental review of the Proposal, including a detailed description of the key components, environmental impacts and proposed environmental management measures for relevant environmental aspects identified by the ESD.

This PER includes:

- a description of the existing environment (Section 2)
- a detailed description of the Proposal (Section 3)
- a description of the stakeholder engagement and consultation process undertaken for the Proposal (Section 4)
- a factor-by-factor assessment of the environmental impact of the Proposal (Section 6 to Section 21)
- a description of key environmental management measures and controls (Section 22).

1.4 Rationale for Proposal

1.4.1 Requirement for marina development

The need for boating and marine facilities in the south of Cockburn Sound has been identified in several tourism and recreational studies of the area (LandCorp 1998).

Cockburn Sound is an important destination for boating, providing a large area of water for yachting and powerboat use. Its shoreline currently supports both yacht and power boat clubs. There are approximately 600 (legal and illegal) swing moorings in Mangles Bay, which provide little protection for vessels in winter storms that approach from the northwest. Damage to boats and moorings is regularly sustained during these storms, and provision of a marina would provide an alternate option for mooring these vessels. Swing moorings have also caused seagrass loss in Mangles Bay. Furthermore potentially contaminating activities such as re-fuelling, rubbish and sullage disposal are difficult to manage in this area.

In February 2010 the Port Rockingham Marina (approximately 5 km from the Proposal site) attained environmental approval. If this marina is built, it will provide pens for up to 500 boats. However, as the population increases, these additional marina facilities will not satisfy demand for boating facilities in the area. Rockingham is one of the fastest growing areas in the south west corridor and levels of disposable

income have increased with expanded employment opportunities and comparatively lower housing mortgage rates.

The population increase for the Cockburn, Kwinana and Rockingham areas between 1996 and 2011 is estimated at 138 800 to 216 530, an increase of 56%. The primary source of demand for moorings in the proposed Mangles Bay marina will be from the local Rockingham region and this demand will increase with population growth. The availability of pens will also allow current boat owners to upgrade beyond trailerable vessels. Boat owners from other areas of Metropolitan Perth will add to the demand as mooring space in existing metropolitan clubs and marinas reach capacity. Room for expansion of existing metropolitan facilities is limited, resulting in extended waiting periods for pens.

1.4.2 Social and economic benefits of the Proposal

Social benefits

The Proposal is expected to provide the following social benefits:

- provision of a range of public recreation and tourist facilities to enhance Cape Peron as a destination for local and international visitors
- improved public access to both Shoalwater Bay and Mangles Bay and pedestrian and cycle linkages between Rockingham Beach, Cape Peron and Shoalwater Bay
- provision of a secure marina area specifically designed for commercial and recreational boating and yachting clubs
- increased facilities for management and regulation of boating activity with associated improvements in public safety
- increased management presence, lighting and increased public use of Cape Peron will help discourage anti-social behaviour
- effective traffic management in the local area
- increase in housing supply and diversity
- provision of a site for a Marine Science Centre
- provision of low cost, family holiday accommodation for a wide cross section of the community.

Economic benefits

A detailed analysis of the economic impacts of the Proposal will be undertaken during the planning phase of the Proposal. It is envisaged that the construction and operation of the Proposal would generate significant economic revenue within Rockingham with flow-on effects for local industries.

The development is expected to include retail, tourist (including a hotel) and commercial businesses that will all create long-term employment opportunities within Rockingham. There will also be flow-on effects in employment opportunities.

The Proposal will comprise a major construction project and will also create employment for the duration of construction.

1.5 Environmental approvals

1.5.1 Western Australian Environmental Impact Assessment Process

The Proposal was referred to the EPA under section 38 of the EP Act on 25 August 2010. On 20 September 2010, the EPA set the level of assessment for the Proposal as a PER with a ten week public review period.

The Proponent submitted a preliminary ESD on 11 October 2010, which detailed the potential environmental impacts, their significance and possible management response, as well as outlining the proposed scope of work to obtain information for the PER, key legislation, stakeholder consultation program, proposal and assessment schedule, study team and peer review mechanisms. The final ESD was approved by the EPA on 16 June 2011.

The PER has been prepared in accordance with the Environmental Impact Assessment (Part IV Division 1) Administrative Procedures 2010 for environmental assessment prescribed under the EP Act. The purpose of the PER is to present an Environmental Impact Assessment of the key environmental aspects of the Proposal in accordance with the approved ESD (a table showing commitments made in the ESD, and how these have been addressed in the PER is included as Appendix 3). The Environmental Impact Assessment process is based on conformance with various relevant EPA Position Statements and Guidance Statements in order to determine the significance of the environmental effects of the Proposal

Following a ten week public review, the EPA will provide the Proponent with copies of any submissions received. The Proponent will be required to prepare a summary of the key issues and matters raised in the submissions and respond to these, to the satisfaction of the EPA.

The EPA will assess the PER document, submissions, Proponent response to submissions, and obtain advice from any other persons it considers appropriate and submit its assessment report to the Minister for the Environment.

The Minister will publish the EPA report as soon as the Minister is reasonably able to do so after receiving it. As provided for under section 100(1)(d) of the EP Act, any person may lodge an appeal to the Minister for the Environment against the findings or recommendations of the EPA assessment report within 14 days of the publication of the report. Subsequent to the determination of appeals (if any), the Minister will then decide whether or not the Proposal should be implemented and if so, under what conditions.

The procedure for a PER level of assessment is outlined in Figure 3.

1.5.2 Australian Government Environmental Impact Assessment Process

The Proposal was referred to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) on 21 September 2010 for consideration under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). On 27 October 2010, DSEWPaC advised that the action was considered to be a 'controlled action' under the EPBC Act (EPBC Reference: 2010/5659).

As the Proposal has been deemed a controlled action, it will be assessed through the Bilateral Agreement. The Bilateral Agreement between the Commonwealth of Australia and the State of Western Australia provides for the accreditation of the Western Australian environmental impact assessment process to ensure an integrated and coordinated approach for actions requiring approval under both the EPBC Act and the EP Act.

1.5.3 Other Environmental Approvals

Additional environmental-related approvals required are outlined in Table 1.

Table 1 Other environmental approvals required

Decision Making Authority	Approval Required	Legislation
Department of Water	26D License to construct wells for dewatering and injection 5C License to take water	*Rights in Water and Irrigation Act 1914*

1.6 Planning approvals

The proposed Precinct area is not currently zoned for residential development under the Metropolitan Region Scheme (MRS) or City of Rockingham's Town Planning Scheme (TPS) No. 2. As such, amendments to both the MRS and TPS and a Local Structure Plan (LSP) will be required prior to the commencement of development.

These processes allow for input from stakeholders and State and Local Government to ensure that the development meets social, economic and environmental needs. The MRS rezoning will be initiated following environmental approval of the Proposal. The LSP will require the preparation of an Environmental Review document and a Local Water Management Strategy (LWMS) to ensure that the Proposal adequately addresses environmental and water issues. The LWMS will provide details regarding water management in the Precinct and will be required to be approved by City of Rockingham and Department of Water (DoW) prior to the Proposal progressing.

After the rezoning and LSP have been approved, the land may then be developed and subdivided. At the subdivision stage, State and Local Government regulators may set conditions for subdivision that must be signed off by the regulators prior to the developer receiving Certificates of Title and being able to sell the lots. This includes environmental conditions, such as the preparation of a Construction Environmental Management Plan (CEMP) and Urban Water Management Plan.

The environmental and water management documents developed at the LSP and subdivision stage will comply with the commitments made in the PER and provide additional details regarding the implementation of these commitments.

1.7 Operational management framework

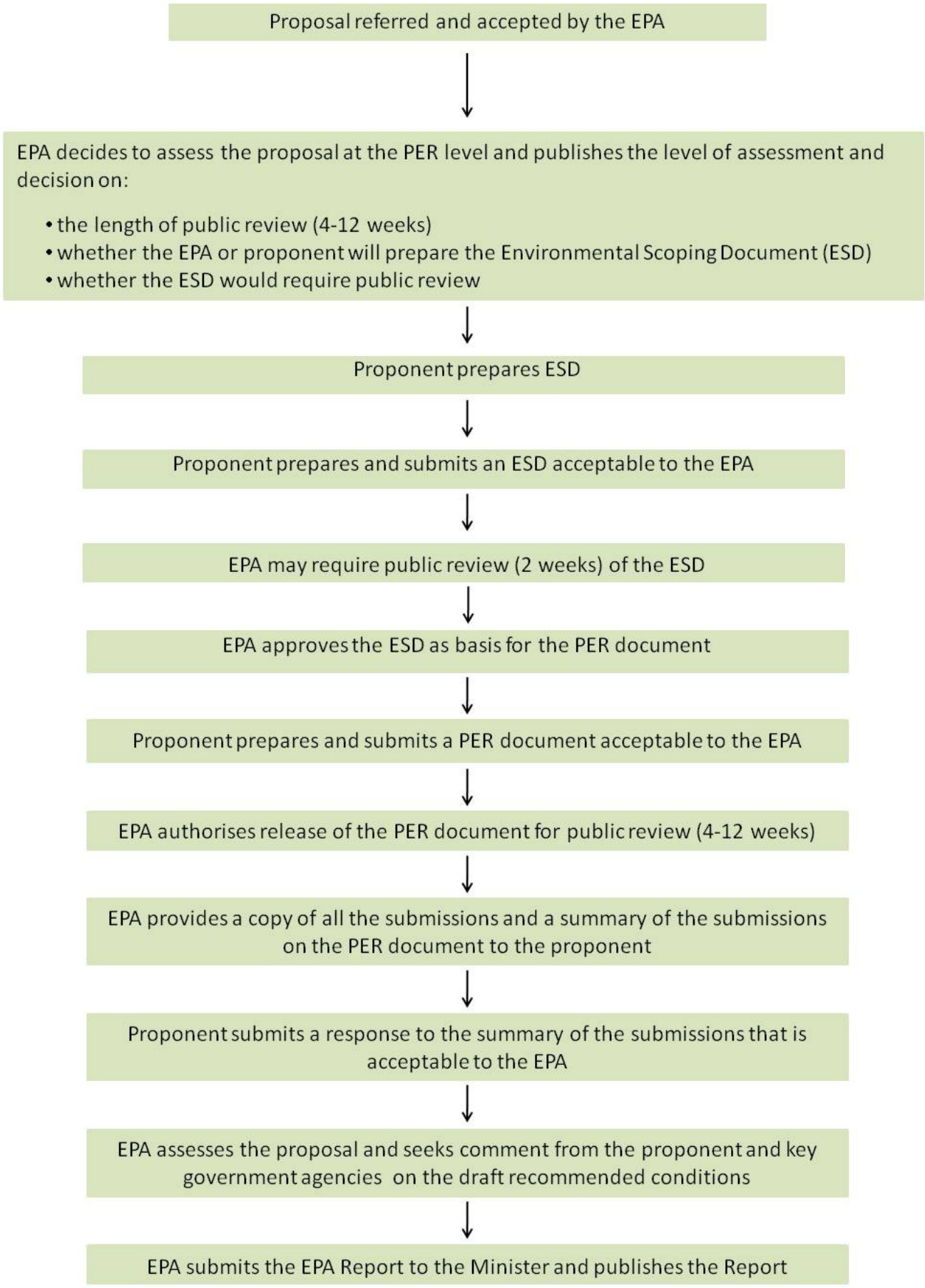
Policy No. DC 1.8 of Canal Estates and Other Artificial Waterways Developments require waterways to be transferred at no cost to the Department of Land Administration for subsequent vesting.

DC 1.8 stipulates the need for a Deed of Agreement to be finalised by Cedar Woods as the Proponent, prior to the City of Rockingham endorsing a Scheme Amendment for the proposal. It is not intended to pursue a scheme amendment until such time as the PER has been approved. Accordingly, preparation of a management agreement is considered premature until the environmental approval process has been completed. A draft Development Agreement will then be prepared as part of the future planning of the Proposal which will ultimately assist in determining the ongoing management and maintenance costs of the marina.

Pursuant to Clause 2.2.4, the Deed of Agreement is required to identify and provide the role and responsibility of the waterway manager to:

- monitor and manage the water quality and sediment to specified requirements
- construction, monitoring and maintenance of specific artificial waterways and channel (including entrance dredging, monitoring erosion or accretion associated with the development).

The maintenance period with which Cedar Woods, as the Proponent, will be responsible to undertake the maintenance works of the marina will also be included within the Deed.



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Mangles Bay Marina Based Tourist Precinct

Procedure for a PER level of assessment

FIGURE 3

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2. Overview of existing environment

2.1 Bio-physical setting

The region experiences a warm Mediterranean climate which is characterised by hot dry summers and mild wet winters. The nearest Bureau of Meteorology (BoM) weather station is located at Garden Island, approximately 5 km north of the Proposal area. The nearest long-term average weather station is located at Kwinana BP Refinery, approximately 8 km to the northwest of the Proposal area.

The Rockingham area experiences an average maximum summer temperature of 28.4°C and an average minimum winter temperature of 10.9°C. The average annual rainfall for the region is 748.9mm, with the majority of precipitation occurring in winter (BoM 2011).

Mangles Bay is at the southern end of Cockburn Sound and is part of the shoreline leading to the Garden Island Causeway and Point Peron. This area is known as Cape Peron.

2.1.1 Terrestrial environment

Geology

Cape Peron is a cuspate (sharp headland with adjacent smooth shoreline) foreland, formed where sand has been trapped and deposited in the lee of offshore islands, including Garden Island. Cape Peron was once an island that became connected to the mainland due to sand accumulation.

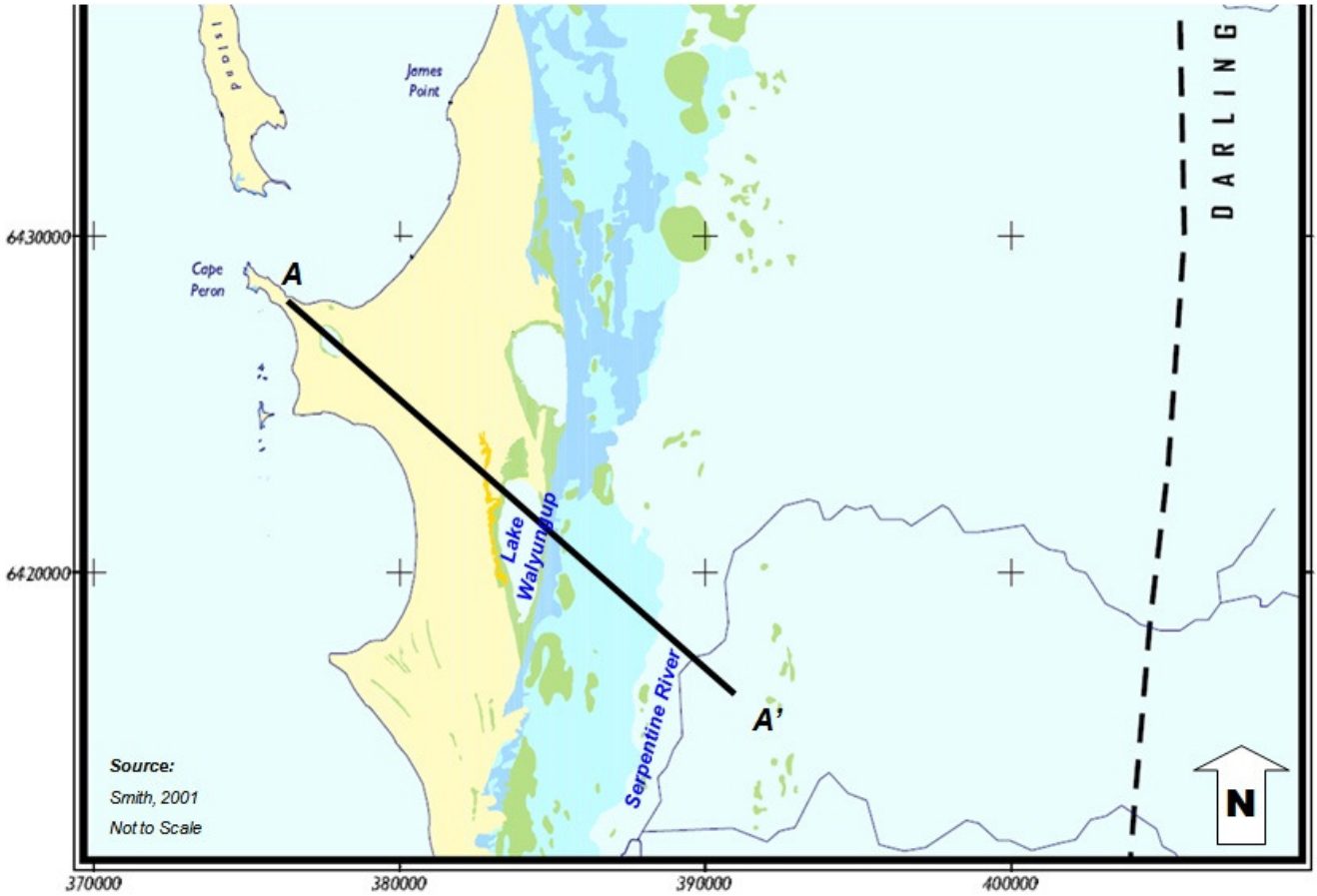
The site is underlain by approximately 30 m of superficial formations, comprising Safety Bay Sands and Tamala Limestone. These formations are in turn underlain by an approximately 100 m thick sequence of Rockingham Sand (WorleyParsons 2005).

The Safety Bay Sand formation which blankets the surface of the Cape Peron area overlies Tamala Limestone, which consists of cream, unlithified, calcareous fine-grained to medium-grained quartz sand and shell fragments.

The Tamala Limestone unit is a calcareous eolianite (rock formed by cementation of calcareous dune sands) that unconformably overlies the deeper Rockingham Sand formation. It contains various proportions of quartz sand, fine-grained to medium-grained shell fragments and minor clay lenses. The limestone typically exhibits secondary porosity in the form of numerous solution voids, channels and cavities. The average base elevation of the Tamala Limestone in the Proposal area is estimated to be 30 mAHD (metres Australian Height Datum) (Strategen 2006).

The Rockingham Sand formation occupies what is thought to be a palaeo-channel (erosional channel) incised into the bedrock Cretaceous sediments, which extends offshore from Rockingham to beneath the southern end of Garden Island. The unit mainly comprises slightly silty, medium-grained to coarse-grained sand of shallow marine origin. The maximum thickness of the Rockingham Sand is approximately 110 m at the southern end of Cockburn Sound in the Rockingham area.

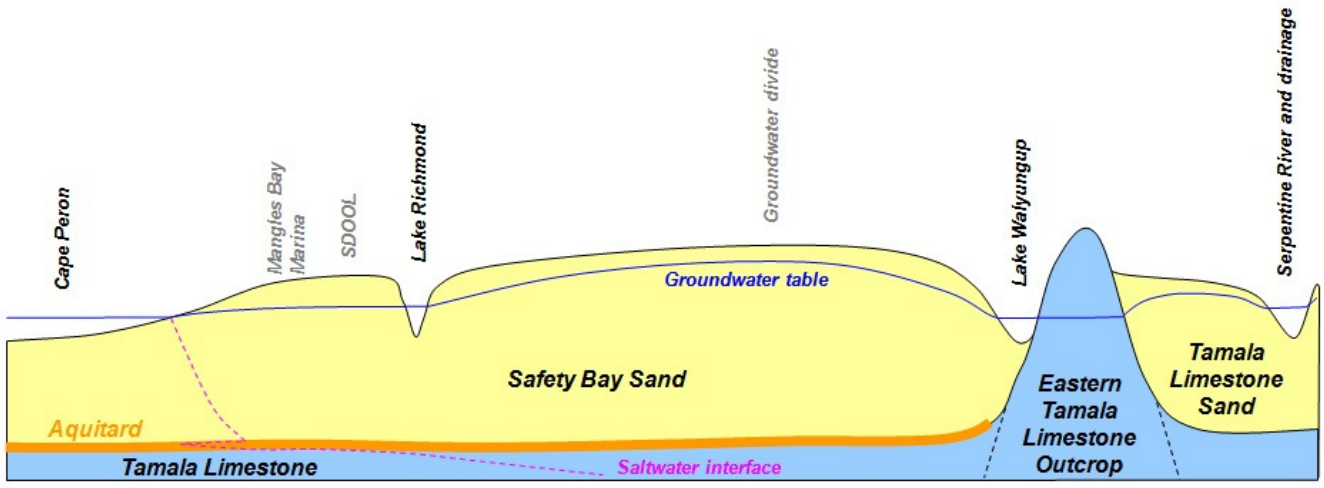
Geological units are shown on Figure 4.



Data Sources:
1:50,000 Environmental Geology Series (DOME)

LEGEND

Environmental Geology
- Safety Bay Sand
- Limestone (Safety Bay Sand)
- Tamala Limestone
- Sand (Tamala Limestone)
- Sand (alluvium)
- Swamp deposit



A A'

Note:
Based on Smith, 2001
Not to Scale

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Mangles Bay Marina Based Tourist Precinct

Regional hydrogeological of the Proposal area

Figure 4

Hydrogeology

Groundwater occurs in two main aquifer systems at the Cape Peron Proposal area:

- superficial aquifer: collectively made up of the Safety Bay Sands and Tamala Limestone
- underlying Rockingham aquifer: made up of the Rockingham Sand formation.

Groundwater in the superficial aquifer (top 30 m of profile) generally flows in a westerly direction. Being the surface aquifer, it is relatively shallow with flows tending to discharge to the near shore marine environment along the coastline.

The flow in the underlying Rockingham aquifer is generally in a westerly direction and discharges freshwater directly into the ocean below sea level. The aquifer extends to a depth of about -65mAHD, and the top 40 m contains groundwater of salinity less than 1000 mg/L (MWH 2011b).

The hydrogeology is described in further detail in Section 6.

Flora and fauna

The vegetation of the Proposal area consists mostly of coastal shrublands dominated by common species of Swan Coastal Plain areas over a series of low lying dunes between the rocky headland of Cape Peron and Lake Richmond (Keating & Trudgen 1986). There are no wetland vegetation communities within the Proposal area; Lake Richmond is to the south east of the Proposal area.

The site is mapped as containing the Quindalup Vegetation Complex: Coastal dune complex mainly consisting of two alliances – the standard foredune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata – Callitris preissii* and the closed scrub of *Acacia rostellifera* (ENV 2010).

The majority of the Proposal area is classified as coastal heath with a moderate value as fauna habitat. Other fauna habitat types in the Proposal area are woodland and shoreline habitats; also with a moderate value as fauna habitat (ENV 2011a).

Surveys conducted in and around the Proposal area recorded five amphibian, 19 reptilian, 66 avian and six mammalian species (including three introduced mammals) (ENV 2011a).

All land within the Proposal area south of Point Peron Road is within Bush Forever Site 355 (Government of Western Australia 2000) and within the RLRP.

Flora and fauna are described in further detail in Section 8 and 9 respectively.

Lake Richmond

The most significant surface water feature in the vicinity of the Proposal is Lake Richmond, located to the southeast of the Proposal area and separated from it by Safety Bay Road. Lake Richmond is a perennial freshwater lake occupying approximately 40 ha and is approximately 0.6 m above sea level (spill level of outlet drain) and up to 14.4 m deep (MWH 2011d). Currently, there are three main drains into Lake Richmond and one outlet that discharges to Mangles Bay (this drain traverses the Proposal area).

Lake Richmond is described in further detail in Section 6.1.

2.1.2 Marine environment

The Cape Peron headland extends westward into the Indian Ocean and defines the southern extent of Cockburn Sound. The Mangles Bay foreshore (within Cockburn Sound) forms most of the northern shoreline of the Cape while the Shoalwater Bay foreshore forms most of the southern shoreline of the Cape (Figure 2). The Cape Peron shoreline consists of sandy beaches and limestone rocky shores and headlands while the seabed comprises extensive sandy areas and limestone reefs.

The SIMP (Figure 2) comprises the chain of islands that run parallel to the coastline between Cape Peron and Becher Point (to the south). The SIMP borders Mangles Bay at the Garden Island causeway and contains the waters of Shoalwater Bay and Warnbro Sound. The islands are important for a diversity of wildlife, particularly the little penguin, other sea birds and the Australian sea-lion. The islands also make a significant contribution to the conservation value of Western Australia's islands estate.

Cockburn Sound is the most intensively used marine embayment in Western Australia. Historically, water quality at Mangles Bay has been of concern due to the effects of reduced flushing on nutrients loads, contamination from industrial uses, organic matter, and human health-related quality of the water, sediments and biota (EPA 2006b). With increasing improvements to industrial practice in the region, discharge of contaminants has decreased substantially. Subsequently, water quality has improved considerably since the 1970s but still remains the focus of current management attention.

Mangles Bay is sheltered by the Garden Island Causeway and Cape Peron, and is therefore relatively calm and poorly 'flushed' by marine waters under most circumstances. Natural patterns of sediment movement have been disrupted by the Causeway and the Cape Peron boat ramp, which has resulted in minor sediment accumulation and erosion along the Mangles Bay foreshore area adjoining the Proposal area. The waters in Mangles Bay within and adjacent to the Proposal area have been declared an Environmentally Sensitive Area, as per the Environmental Protection (Environmentally Sensitive Areas) Notice 2005 (Government of Western Australia 2005a). The shallow sheltered waters of Cockburn Sound (and Mangles Bay) support extensive seagrass meadows. Widespread loss of seagrass on the eastern margin of the Sound occurred during the 1970s; the loss attributed to shading caused by nutrient-stimulated growth of epiphytes (algae that grow on seagrass leaves) and phytoplankton (microscopic algae in the water).

The seagrass meadows in Mangles Bay show evidence of nutrient enrichment in the form of heavy epiphyte loads in summer while some areas of seagrass are partially exposed at low tide and experience desiccation and heat stress. The seagrass meadows are generally dense, but have patches of localised loss due to numerous mooring scars. Although the seagrass meadows in Mangles Bay are patchy due to the loss of habitat from mooring scars, the shallow, sheltered, slightly nutrient-enriched waters of Mangles Bay are recognised as an important fish nursery habitat.

Cockburn Sound supports a wide range of fauna and has significant fauna values because of its utilisation by dolphins, a large range of seabirds, protected migratory birds, and little penguins. The whole of Cockburn Sound is considered significant as a fish nursery/habitat. About 130 species of fish and 14 large crustacean and mollusc species are estimated to exist in Cockburn Sound. Accordingly, the Sound is a significant fisheries resource.

The marine biota of Cockburn Sound (and Mangles Bay) is further described in the following sections:

- marine water quality (Section 10)
- benthic primary producer habitats (BPPH) (Section 12)
- marine fauna (Section 13).

2.2 Socio-economic setting

2.2.1 City of Rockingham

The Proposal is located within the City of Rockingham, which has a population of greater than 100 000 residents. Historically, Rockingham was a seaside holiday town; however it is now one of fastest growing cities in Western Australia. Rockingham has undergone significant development, with increased industry, large residential developments (e.g. Port Kennedy and Secret Harbour) and redevelopment of the old Rockingham town centre foreshore and surrounds as well as the Rockingham City centre. Rockingham is also one of the most popular coastal destinations south of Perth.

The Royal Australian Navy has a strong presence in the area, with its base on Garden Island and a significant amount of residential requirement being filled in and around Rockingham.

Main industries and employment sectors in the City of Rockingham (NIEIR 2011) include:

- public administration and safety (including defence)
- retail trade (including food retail)
- construction
- education and training
- health care and social assistance
- accommodation and food services
- manufacturing
- transport, postal and warehousing.

2.2.2 Land tenure and zoning

The Proposal area south of Point Peron Road is vested in the Conservation Commission and is managed by Department of Environment and Conservation (DEC). The boating facilities are operating within a monthly leasehold arrangement vested with the Minister for Transport, Western Australia. The Water Corporation also hold an existing Crown Reserve within the Proposal. The details of land tenure are shown in Figure 5.

The area to the south of Point Peron Road is zoned 'Parks and Recreation' with the area to the north of Point Peron Road, along the Mangles Bay foreshore, being zoned 'Port Installations' under the MRS. There are other small areas within the Proposal area that are reserved for parking, drainage, special use (e.g. wastewater treatment plant) and a possible future road connection to the Garden Island Causeway.

2.2.3 Land use

The Proposal area and surrounds is the focus for the pursuit of many recreational activities, including:

- water-based activities: boating, swimming, snorkelling, fishing and crabbing
- land-based activities: walking, fishing and nature appreciation.

A large proportion of the Mangles Bay foreshore is currently occupied by the local yacht club, fishing club (with associated jetty and boat ramp) and chalet accommodation. The use of land by these facilities means that public access to the area is restricted.

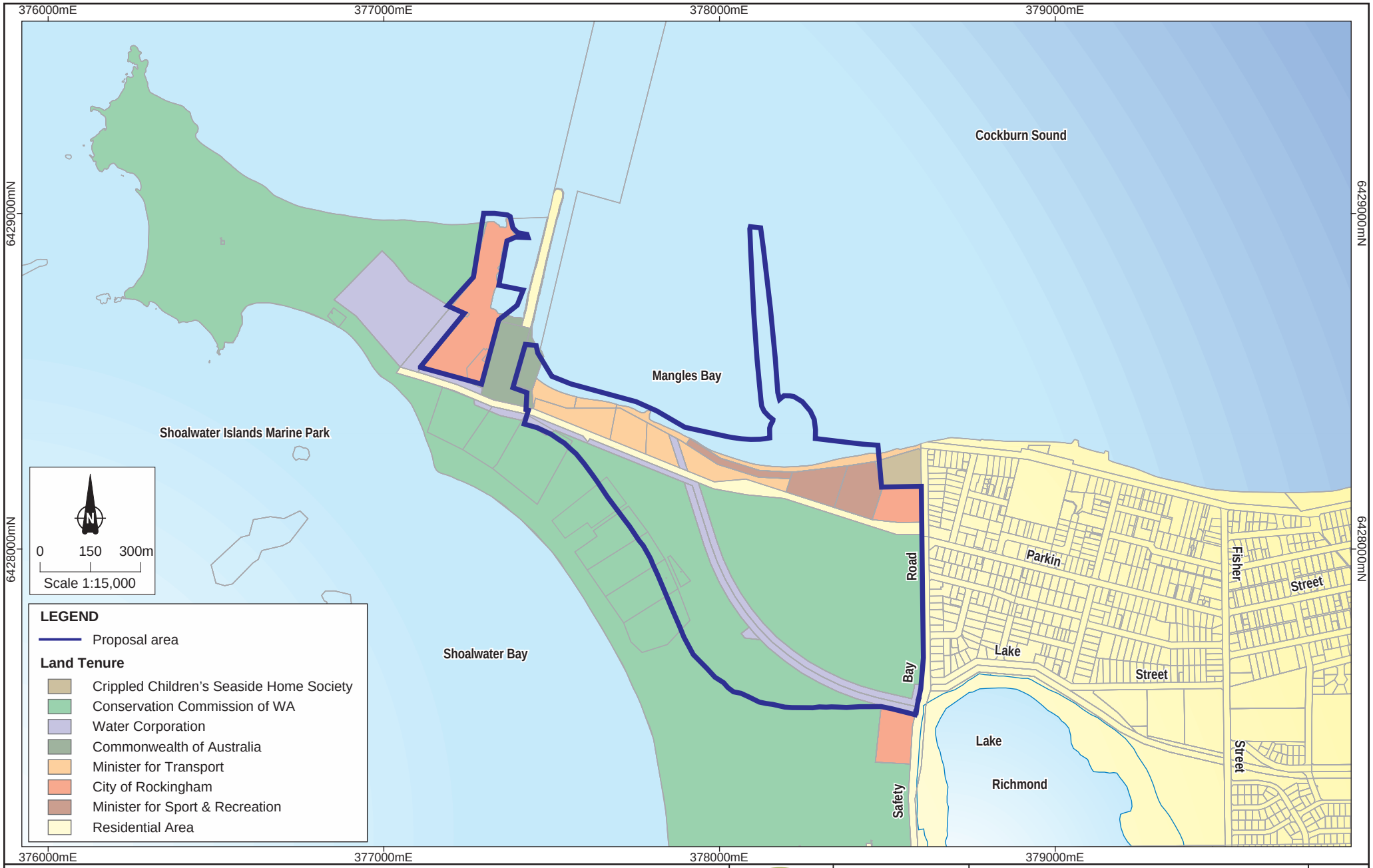
Other facilities within the Mangles Bay area include day-use car parks for accessing beaches and lookouts, and a public boat ramp directly to the west of the Garden Island Causeway. The City of Rockingham is currently undertaking minor upgrade works to the existing boat ramp facilities west of the Causeway. The development will look to build upon this infrastructure and improve facilities for the community.

Most of the Mangles Bay foreshore and some of the Shoalwater Bay foreshore are designated dog beaches. An area directly to the east of the Garden Island Causeway is designated a power water craft and water ski area. Visitor facilities on Cape Peron include 10 recreation camps, mainly located to the west of Memorial Drive along the Shoalwater Bay foreshore, which are managed by DEC and leased to private groups. DEC also manages one educational camp lease (leased by the Department of Education), which is located to the west of the Garden Island Causeway.

The Naragebup Rockingham Regional Environment Centre is located on the southwest corner of the Memorial Drive/Safety Bay Road intersection, opposite Lake Richmond. The centre is a community-run non-profit organisation that is actively involved in conservation activities in the Rockingham area and also provides a role in environmental education.

The Water Corporation Point Peron Wastewater Treatment Plant is located to the west of the Garden Island Causeway and the Water Corporation's infrastructure drain dissects the landscape from Lake Richmond to Mangles Bay.

Residential areas are located immediately to the east and south of the Proposal area.



Source:
Cadastral data supplied by Landgate
Tenure data supplied by MAPS
Coordinate System: MGA94 Zone 50
Date: 12/10/2011

NB: Potential errors may occur in some areas

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environmental consultants

Drawn:
CAD Resources

CAD Resources File No:
g1937_MB_PER_F003.dgn

Land tenure of the Proposal area

Figure No:
5

2.3 Key conservation values

2.3.1 Bush Forever

All land within the Proposal area south of Point Peron Road is within Bush Forever Site 355 (Government of Western Australia 2000). The purpose of Bush Forever is to provide protection for representative vegetation complexes and communities within the Perth Metropolitan Area. Lake Richmond, which is located to the south east of the Proposal area, is also identified as Bush Forever Site 358. Sections 8 (terrestrial flora and vegetation) and Section 17 (conservation areas) contain more detailed descriptions of Bush Forever Site 355 and Bush Forever Site 358.

2.3.2 Regional Park

In 1997 the State Government announced that Rockingham Lakes would be established as a regional park. Cape Peron and Lake Richmond are within the boundaries of the RLRP.

Regional parks are areas of regional open space that have been identified through planning processes as having regionally significant conservation, landscape and recreation values (CALM 2003a). The RLRP is one of eight regional parks in the Perth Metropolitan area.

The RLRP covers an area of 4270 ha, which consists of coastal areas, wetlands, remnant bushland areas, private leases and recreation areas. The RLRP is valued for its natural environment, recreation, cultural heritage, landscape, and research and education values. The *Rockingham Lakes Regional Park Proposed Final Management Plan* provides a broad direction for the protection and enhancement of these values (DEC 2010a).

Further details are provided in Section 17.

2.3.3 Shoalwater Islands Marine Park

The SIMP covers an area of approximately 6545 ha and comprises the waters of Shoalwater Bay, Warnbro Sound and a portion of Cockburn Sound off Cape Peron, approximately 400 m from the Proposal area.

The park is vested to the Marine Parks and Reserves Authority (MPRA), and managed by the DEC, apart from recreational fishing which is managed by the Department of Fisheries (DoF) in close cooperation with DEC. The Shoalwater Islands (i.e. the terrestrial portion) are managed under the 1992 Shoalwater Islands Management Plan.

The SIMP Management Plan 2007–2017 (the management plan) was formally approved by the Minister for the Environment in August 2007 (DEC 2007). The management plan sets out, among other things, a zoning scheme and a 'best practice' model for managing the identified ecological and social values of the SIMP. The zoning scheme proposes that the area to the north of Cape Peron (to the west of the Causeway) be within a 'General Use Zone'.

Shoalwater Bay (on the southern side of Cape Peron) is a recommended 'Special Purpose Zone' for wildlife conservation, and further south are two sanctuary zones (at Second Rock, and Becher Point). A 'Special Purpose Zone' for scientific reference is at Murray Reef.

Further details are provided in Section 17

2.3.4 Lake Richmond

Lake Richmond has national conservation significance due to the presence of TECs (thrombolites and sedgelands [in Holocene dune swales and Woodlands over sedgelands in Holocene dune swales]), and Bush Forever status (Bush Forever Site 358). Lake Richmond also has iconic value to the Rockingham Community. It is a perennial freshwater lake occupying approximately 40 ha and is approximately 0.6 m above sea level (spill level of outlet drain) and up to 14.4 m deep (MWH 2011d). The lake receives the majority of water from stormwater drains but is also connected to groundwater.

Lake Richmond was isolated from the sea when part of the marine portion of Cockburn Sound was in-filled during the last 4000 years (English *et al.* 2003). Cape Peron, to the northwest, was once an island that became connected to the mainland as sand accumulated on the leeward side. Lake Richmond was cut off from the marine environment by this process (CALM 2003b).

The lake is located outside, but in proximity to the Proposal area.

Further details are provided in the following sections:

- surface water impact assessment (Section 6.1)
- matters of national environmental significance (NES) impact assessment (Section 14)
- conservation areas impact assessment (Section 17).

3. Description of Proposal

3.1 Development overview and key characteristics of Proposal

3.1.1 History of the Proposal

The redevelopment of the Mangles Bay area has been the subject of a number of previous proposals since the 1970s that have included both sea-based and inland marina options. A water-based marina proposal in 1993 estimated a loss of about 30 ha of seagrass, this loss was considered unacceptable by the EPA, especially as seagrass rehabilitation was not a proven technique at the time. In 1998, another marina concept for the development of an inland marina in Mangles Bay was developed. The Proposal was never formally assessed but advice from the EPA indicated that the proposal would not be environmentally acceptable due to seagrass losses. Processes for seagrass rehabilitation were not considered reliable at the time. A summary of the proposal for a marina development at Mangles Bay, Rockingham, is provided below:

- 1971: The Fremantle Port Authority adopted a plan for the development of a container port in Mangles Bay.
- 1975: The MRS was amended to provide for the connection of the site to the regional road and rail network.
- 1982: A Cabinet Sub-Committee and Departmental Technical Committee were established to review the Mangles Bay site and compare it with other sites.
- 1984: The proposed container port facility for the area was rejected on the basis that Catherine Point and North Mole would be more suitable and cheaper alternative sites for a port.
- 1985: The John Holland Group put forward a proposal for a small marina built outwards from Mangles Bay, which was found to be environmentally acceptable. The proposal was never pursued due to the downturn in the real estate market.
- 1992: The Department of Marine and Harbours proposed a 500 pen marine-based marina built outwards from Mangles Bay, close to the Garden Island causeway. The proposal was formally assessed by the EPA at the level of a PER. The EPA identified the main environmental factor as the significant impact on the remaining seagrass in the Mangles Bay area and the ecological significance of preserving the small amount of seagrass that remained in Cockburn Sound. The EPA in its report and recommendations (Bulletin 693) recommended against the proposal primarily due to seagrass loss. At this time, seagrass rehabilitation was not considered feasible. The Minister for the Environment did not issue a Statement that the Proposal could be implemented and hence the proposal could not proceed. The Mangles Bay Steering Committee was established to consider potential options, taking into account the environmental issues associated with the area.
- 1998: Following a request by Cabinet in May 1997, the Mangles Bay Boat Harbour Steering Committee developed a concept plan for the development of an inland marina in Mangles Bay. The concept plan was never formally assessed. Most recent reports indicate the seagrass meadows are under similar pressures as in 1998, if not increased.

Seagrass in Mangles Bay continue to compare poorly with other sites in Cockburn Sound. The direct loss of seagrass therefore remains a primary issue for any proposal to develop the Mangles Bay Boat Harbour. The protection of Lake Richmond (recognised for its conservation value) and nutrient inflow and pollutants from the Lake Richmond drain on the waters of Mangles Bay are also of concern.

In 2005, concept plans were prepared for a marina development at the site following a comprehensive community consultation process. A SER on the proposal was undertaken by the EPA in 2006. The process undertaken was in accordance with section 16(e) of the EP Act. The purpose of reviewing the Proposal under section 16(e) of the EP Act was to identify key environmental issues associated with the proposal and to gather, at a strategic level, information on those environmental issues.

The SER was released for public comment on the 7 March 2006 for a four week period and received approximately 440 submissions. Following the public comment, and EPA review period, the EPA provided advice in October 2006 as Bulletin 1237 recommending major and minor environmental factors that should be evaluated in detail for any future proposal.

3.1.2 Key components of the Proposal

Land development area

The total land development area is estimated to be up to 77 ha (Figure 7). The land development area will encompass various land uses including: tourist-based commercial uses; an aquatic club area; short-term accommodation; POS; and residential uses. The distribution and density of residential land uses will be defined during the structure planning process of the Proposal. The development will however, comprise a variety of lot sizes and residential densities to provide a diverse mix of buildings.

It is intended that the marina will provide a focal point for the local community and a tourist destination. It is the Proponent's vision to provide the community with a gathering place from which locals and tourists will embark to explore the Cape and its surrounds. Memorial Drive, a local access road within the Proposal area that connects to Safety Bay Road will be realigned as part of the Proposal development. The road will be redesigned to meet current urban road standards and increased traffic volumes resulting from the Proposal.

Marina

The total water area of the single entrance marina is estimated to be up to 12 ha (Figure 7). The marina will be able to accommodate pens for up to 500 craft, ranging from 8 m to 25 m in length.

The marina will be constructed using wet excavation methods. Construction methods will include vinyl edge sheet piling, steel reinforcing and concrete anchors to provide support to canal walls and edges, which will provide structural integrity to allow for wet excavation.

Access channel

The Proposal includes a dredged access channel to allow large (up to 25 m) power and sail craft to access the marina. The channel will extend approximately 550 m north from the breakwaters at the entry of the marina, towards deeper waters in Cockburn Sound. The channel will be within Mangles Bay east of the Garden Island Causeway.

The channel will be dredged using a 'cutter suction dredge', with dredged material piped back to the mainland. The dredged material (spoil) will be placed in settlement and infiltration basins located within the Proposal area adjacent to the coast, where the seawater will infiltrate into the shallow groundwater system (which discharges to Mangles Bay) and solid material will be treated and disposed offsite, where necessary.

Key infrastructure

A Crown Reserve of the Water Corporation is located within the Proposal area (Figure 7). It is understood that the Water Corporation proposes to upgrade and duplicate the infrastructure within this reserve in the future. Through an agreement with Water Corporation, the Proponent proposes to realign the existing infrastructure within a service corridor along the southern Proposal boundary. The service corridor has been defined to accommodate the Sepia Depression Ocean Outlet Landline (SDOOL) and future Water Corporation service requirements including:

- realignment of the existing 1400 mm SDOOL 1
- realignment of the existing 2 x 450 mm Garden Island Wastewater Pressure Main
- realignment of the existing 450 mm Garden Island Water Reticulation
- duplication of the SDOOL, with the 1400 mm SDOOL 2
- future provision for the 1400 mm SDOOL 3
- future 1600 mm Brine Water Pipe.

The Water Corporation has indicated it seeks within the next 5 years to replace the existing SDOOL 1 and duplicate the service with the construction of SDOOL 2. SDOOL 3 and the Brine Water Pipe are provisional items for the Water Corporations strategic planning.

In consultation with the Water Corporation a conceptual design for the Service Corridor was developed indicating approximately 25 m of the 45 m width is required to accommodate existing and future infrastructure.

The realignment of the existing service infrastructure and the SDOOL duplication (SDOOL 2) requires approximately a 15 m width within the Service Corridor. A further 10 m width has been provided to accommodate the future infrastructure of the Water Corporation.

The requirement for SDOOL replacement and duplication is independent of the Proposal. The intersection between the two projects involves only the alignment of the infrastructure. Although the Water Corporation recognises that this Proposal will seek to realign the existing infrastructure, a separate proposal is also being progressed by Water Corporation to upgrade and duplicate the pipeline in the event where the Cedar Woods Proposal does not proceed. Only one of these proposals will be implemented.

An ocean outfall pipe carrying stormwater overflow from Lake Richmond to Mangles Bay (near the Mangles Bay Fishing Club jetty) is located within the Proposal area (Figure 2). The Proposal includes the relocation of this ocean outfall pipe to the end of Hymus Street with the pipeline infrastructure to be contained within the Safety Bay Road/Hymus Street road reserve.

The 45 m Service Corridor will also provide for a dual-lane road from Safety Bay Road to the Garden Island Causeway. The Department of Defence has forecasted traffic volumes that require that provision be made within the Service Corridor to accommodate a dual-lane road to Garden Island.

Area west of the Garden Island Causeway

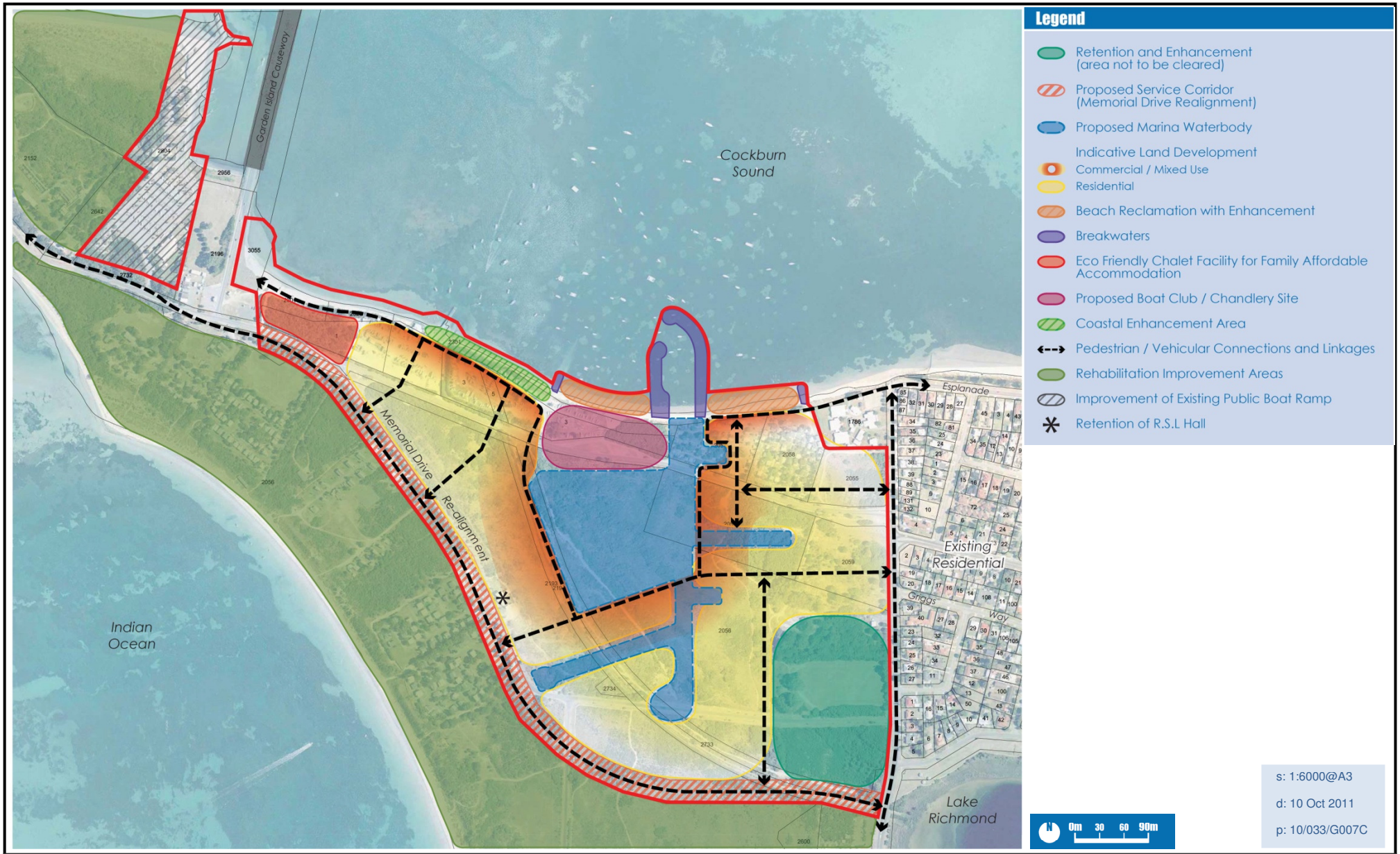
The Proposal boundary includes the existing car park and boat launching facility west of the Garden Island Causeway. Improvement works to the facility including an upgrade to the car park, boat ramp and jetty platforms will be considered as part of the Proposal. These improvement works will be limited to upgrading the amenity value of these facilities with works such as pile driving and dredging no longer proposed in this area.

Other elements of this Proposal

Other elements of this Proposal include:

- road improvements to cater for additional traffic
- improved beach access to the public
- remediation and enhancement works outside the proposed action including revegetation of degraded areas around Cape Peron, dune restoration, seagrass transplantation and improved walkways with educational signage with regard to the history and natural values of Cape Peron
- construction of a dual-use path along the length of the beachfront to the causeway
- affordable family holiday accommodation with beachfront access
- a site for the Boating Clubs, on a non-commercial leasehold basis, with marina frontage and beach access
- a seabed lease within the marina and adjoining the boating clubs site in which the clubs can build pens and lease them to members
- commercial pens to be provided in the public tourist area for commercial charter operators
- a tourism hub including restaurants, cafes and short-term serviced accommodation
- a site for a Marine Science Centre
- retention of the Returned and Services League (RSL) hall.

An indicative conceptual layout of the Proposal is outlined in Figure 6. This conceptual layout of the Proposal will be subject to the planning process should environmental approval of the Proposal be obtained.



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Mangles Bay Marina Based Tourist Precinct

Proposal conceptual layout (Source: TBB 2011)

FIGURE 6

strategen Oct-2011

3.1.3 Key Proposal characteristics

The key characteristics of the Proposal are included in Table 2.

Table 2 Key Proposal characteristics

Proposal detail	Characteristics
Main activities	Construction activities to include clearing, wet excavation of the marina and dredging of the access channel Operational activities include marina operation and maintenance dredging
Proposal area	Proposal area up to 77 ha Total land development area up to 49 ha Total vegetation clearing up to 40 ha Total marine disturbance (below current high water mark) to 6 ha
Marina	Total water area of marina up to 12 ha Deepest depth in marina up to -4.0 mAHD, shallowest -2.7 mAHD Excavation for marina up to 800 000 m^3
Channel construction	Total channel length up to 550 m Total channel navigable width up to 30 m (including batters the channel has a width of 55 m) Total channel area up to 3.4 ha (includes the footprint of 1:5 batters) Total channel depth up to -4.0 mAHD Total channel dredging of up to 50 000 m^3 of spoil Dredged spoil material will be piped to the Proposal area, where it will be settled, the water infiltrated and solid material treated and disposed of offsite
Reclamation	Total reclamation area up to 1.36 ha Total breakwater length up to 290 m Total breakwater width up to 40 m includes breakwater batters of 1:5 Total breakwater area up to 1.1 ha
Area west of Garden Island causeway	Improvement works potentially including an upgrade to the car park, boat ramp and jetty platforms
Seagrass loss	Total seagrass removal up to 5.36 ha (includes breakwaters, reclamation areas, channel and batters) Total indirect loss of seagrass up to 0.3 ha (due to halo effects around infrastructure of approximately 15 m) Total marine footprint up to 5.66 ha
Water Corporation asset (considered part of 'service corridor')	Length of pipeline up to 1.6 km Width of construction corridor up to 45 ha (includes batters and laydown areas) Pump station area to be cleared up to 0.2 ha
Department of Defence	Provision of a dual-lane road as part of the service corridor to accommodate traffic to Garden Island
Stormwater outfall	Relocation of Mangles Bay stormwater ocean outfall pipe to Hymus Street

Source:
Cadastral Data supplied by Landgate
Coordinate System: MGA94 Zone 50
Date: 10/1/2012
NB: Potential errors may occur in some areas

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Key characteristics of the Proposal

Figure No:
7

3.2 Exclusions from the Proposal

This Proposal only covers the environmental aspects of the proposed works and seeks approval for an environmental impact only. The Proponent will submit a separate application to the Western Australian Planning Commission (WAPC) and the City of Rockingham for regional and local scheme amendments.

3.3 Consideration of options/alternatives

The Proposals primary aim is to meet the high demand for boating facilities in the Rockingham area. Cockburn Sound is an important destination for boating, providing a large area of protected water for yachting and powerboat use. Rockingham is one of the fastest growing population centres in the southwest corridor. As a result, boat ownership and the demand for boating facilities are also rapidly increasing in the area.

Currently, boats unable to fit on trailers are confined to moorings in Mangles Bay, which provide little protection to vessels from winter storms that approach from the northwest. The existing swing moorings in Mangles Bay have also removed seagrass, resulting in mooring scars visible in Figure 2.

In 2005, a high level review of the costs, benefits and constraints of Mangles Bay and other potential sites along the City of Rockingham coastline was undertaken. The review concluded that Mangles Bay presented the least constraints and the most opportunities for a combined marina and land development, when compared with the other sections of the coastline in the City of Rockingham.

Alternative design concepts have been considered in consultation with the community during the 2005 and 2006 process and during the development of the current Proposal. All options involved an inland marina; however each differed with respect to layout and the extent of land footprint. An offshore marina option in Mangles Bay was considered unlikely to provide the project benefits of a mixed-use tourism precinct; would involve the loss of a substantial proportion of seagrass in Mangles Bay; and, would be unlikely to be found environmentally acceptable, even with rehabilitation of seagrass.

The details of the 2005/6 process and community and stakeholder involvement in developing the concept and project objectives are provided in Appendix 4 (as part of the SER).

The current Proposal being developed takes into account previous community and regulatory agency consultation and the EPA advice provided within Bulletin 1237 in October 2006. The configuration design of the marina and breakwaters has been thoroughly tested and scrutinised with detailed hydrogeological and hydrodynamic investigations and modelling undertaken for the development.

The development footprint has been reduced from the original design(s) presented in 1998 and 2006 to reduce the amount of native vegetation clearing; avoid disturbance to most of the TEC (Floristic Community Type [FCT] 30a: *Callitris preissii* forest and woodlands); to allow a greater buffer distance between the development and Lake Richmond; and, to reduce impacts on the SIMP.

3.4 Description of development process

Section 3.4.1 and Section 3.4.2 identify the types of infrastructure (marine and terrestrial) to be constructed as part of the Proposal. Once the project is established, the nominated structures (buildings, roads and fences) will be demolished and the nominated areas cleared as required for each stage of the development. Vegetative waste will be mulched and recycled for landscaping purposes on and offsite. Demolition and construction waste will be categorised, recycled where possible and transported offsite to landfill.

3.4.1 Marina and canal construction

Construction of the marina will be undertaken in stages over a seven to nine year period. The construction of the marina will be undertaken in wet conditions, such that no to very little dewatering required for the development of the inland marina. Construction methods will include vinyl edge sheet piling, steel reinforcing and concrete anchors to provide structural integrity to allow for wet excavation. Small amounts of localised dewatering will be required in wet excavation to allow concrete beams to form and cure.

The excavation of the inland marina will be undertaken, following the construction of canal edge walls. Long reach excavators will be used to gradually lower the earth material from between the vinyl sheet piled edges which would excavate down to the finished canal floor level. The material would be dry above groundwater level (approximately 0.0-0.5 mAHD) with all material excavated below this level to be wet.

The sand material excavated from below the water table will be placed in infiltration basins to allow for dissipation of the water. The material would then be double-handled and loaded onto trucks for either relocation on site, or exported to an appropriate facility offsite. In some instances where the required finished floor level of the marina cannot be achieved through long reach excavators, a dredge will be mobilised to complete final excavations in the wet, with no dewatering required to trim the base level of the marina and canal bodies.

The marina will be staged so that the canals in each stage are excavated as required. Consequently, temporary canal edge protection will be required along the existing batters which form the stage boundary. Filter fabric with rock material may be placed over temporary waterway edges, with a concrete revetment providing additional erosion protection if required, without the requirement for dewatering.

At the entrance of the marina between the rock breakwaters, excavation in wet conditions will proceed behind the existing beach, with an informal temporary bund resulting from the excavation. The marina body for Stage 1 will be excavated, separating the ocean from the internal water body until the 'bund' is removed as a final act of wet excavation on the completion of internal excavation for Stage 1.

Similarly, in future stages of the development, excavation may proceed behind stage boundaries, with a temporary edge protection forming a bund between stages, until the excavated water bodies are connected on removal of natural earth bunds.

The access channel will be constructed as part of the first stage of construction, along with a small section of the marina. Relocation of Water Corporation infrastructure will occur during Stage 1 and 2. Subsequent sections of the marina will be developed based on demand for land and boat pens. Marina construction may therefore be discontinuous, with periods of no construction occurring between marina construction stages. An indicative development schedule is outlined in Table 3 and Figure 8.

Table 3 Indicative development schedule of construction

Stage	Construction	Cumulative duration (months)
1	Wet excavation, sheet piling, temporary wall installation (shoreline, between Stage 1 and Stage 1.5 and between Stage 1 and Stage 2), and shoreline removal at end of Stage 1.	1 – 18
1.5	Wet excavation, sheet piling, temporary wall installation (between Stage 1 and Stage 4) and temporary wall (between Stage 1 and Stage 1.5), removal at end of Stage 1.5.	18 – 30
Break	No wet construction required.	31 – 37
2	Wet excavation, sheet piling and temporary wall removal (between Stage 1 and Stage 2) at end of Stage 2.	38 – 59
Break	No wet construction required.	60 – 66
3	No wet construction required.	67 – 79
Break	No wet construction required.	80 – 86
4	Wet excavation, sheet piling and temporary wall removal (between Stage 1 and Stage 4) at end of Stage 4.	68 – 101

In total, up to 800 000 cubic metres (m^3) of surplus material (which won't be used as fill on site) will be excavated during the construction of the marina and canals. The material will be good quality sand and will be recycled for use as fill at a number of project sites. This material will be transported offsite by road trucks in accordance with Traffic Management Plans to be submitted to, and approved by, the City of Rockingham.

3.4.2 Marina access channel construction

A boat entrance channel from Mangles Bay to the proposed inland marina and canals will be required to be in service coincidentally with the provision of mooring space in the marina. A dredging program is proposed for the access channel which will take place at the same time as the marina construction program.

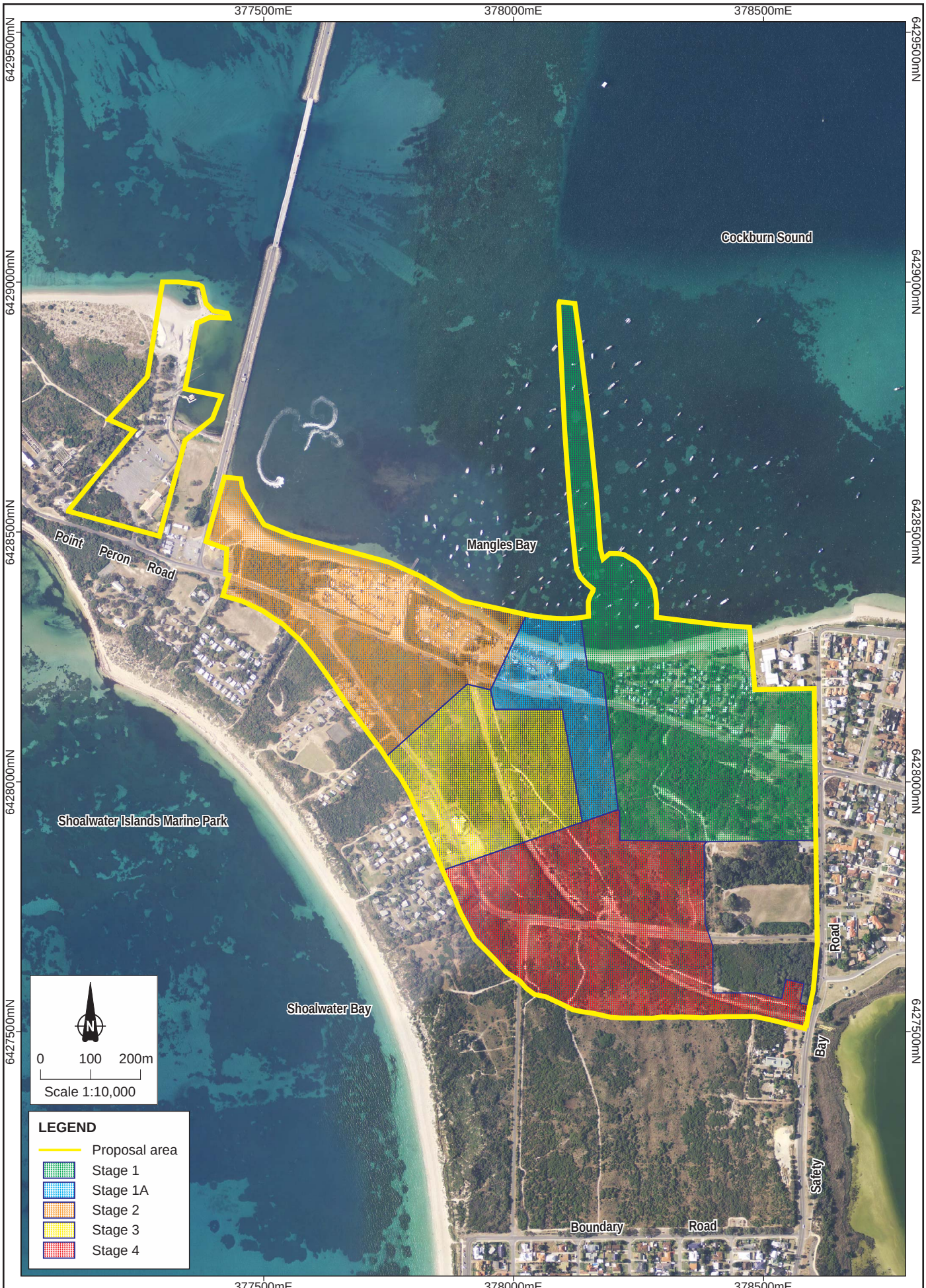
The channel will be 55 m wide (including batters), up to 550 m in length, up to -4.0 mAHD deep with stable batters in medium dense sand and will cover an area of up to 3.4 ha. Up to 50 000 m^3 of material will be dredged during the construction of the access channel. A small cutter suction dredge will be used which displaces the sand by cutter action whilst drawing it into the dredge pump before pumping the dredge slurry onshore via a pipeline. This method of dredging is commonplace in Western Australia, being used annually at a number of Marine Facilities.

At least two settlement basins will be constructed to receive the pumped dredge spoil to remove sediments from the excess water before it is released back to the environment. This will ensure that the turbidity of the sea water in the Mangles Bay area does not exceed set trigger levels due to the dredging program. The settlement basins will be located close to the coast to ensure maximum distance from Lake Richmond and nearby TECs; and this is shown in Figure 9. The solid spoil will be treated on site, and used as fill at other locations.

It is expected that the dredging works will be completed within a 12 – 15 week timeframe during the winter months of the bulk earthworks program.

3.4.3 Other infrastructure

Roads and service (electricity, water, sewerage, communication, gas) infrastructure will be constructed or installed during the marina construction period. Minor dewatering may be required for trenching to install some services.



Source:
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Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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Preliminary construction stages

Figure No:
8

Source: Imagery supplied by Landgate (2010)
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Indicative locations of settlement basins

Figure No:
9

4. Stakeholder Consultation

This Proposal has built on the outcomes of formal advice and inputs from the community and specialised stakeholders. Much of this input was generated during the 2005 – 2006 consultation for the Cape Peron SER (Strategen 2006).

In the development of the current Proposal, the Proponent has undertaken consultation with a number of government agencies, including the EPA, and has also commenced discussions with local fishing and boating clubs.

The following section summarises the consultation and outcomes to date, including consultation undertaken as part of the 2006 SER, due to its relevance to the current Proposal.

4.1 Stakeholder engagement process

4.1.1 Previous consultation

The consultation process for the development of a concept plan for a marina-based tourist precinct in 2005 and 2006 focussed on an active community engagement approach to developing concept options. A high level of interest was shown in the concept plan with more than 800 community members from a broad range of stakeholder groups participating in the process. The consultation process included public forums, establishment of a Stakeholder Reference Group (SRG), public advertising, project website, information hotline and various individual stakeholder meetings including Aboriginal representatives.

The outcomes of the stakeholder consultation process are summarised in the SER (Strategen 2006) (Appendix 4) and the Response to Submissions included as an appendix of Bulletin 1237.

Key agencies, non-government organisations and other stakeholder groups consulted at that time included:

- Royal Australian Navy and Corporate Support Infrastructure Group
- Environmental Protection Authority Services Unit
- Department of Environment
- Department of Conservation and Land Management
- Cockburn Sound Management Council (CSMC)
- Department for Planning and Infrastructure and the WA Planning Commission
- Public Transport Authority
- Main Roads WA
- Water Corporation
- City of Rockingham
- Naragebup Rockingham Regional Environment Centre
- Recreation camp leasees (e.g. Returned and Services League, Apex)
- Mangles Bay foreshore user groups (e.g. Mangles Bay Fishing Club)
- Aboriginal groups
- Local residents and interest groups
- Local business operators
- Local sport and recreation groups
- Boat owners and mooring owners
- Recreational beach users.

As described in Section 4.1.1, the Proponent has used the outcomes of the previous consultation to identify and help identify the relevant environmental factors for assessment in the PER.

4.1.2 Recent consultation

In September 2009, Premier Colin Barnett announced that the State Government would progress the marina project at Mangles Bay and commence the environmental impact assessment process. Once Cedar Woods was appointed as the Proponent for the Proposal, consultation commenced with the City of Rockingham and key government agencies including the Office of the Environmental Protection Authority (OEPA) and the Department of Planning. The Proponent also established a Marina Working Group and a SRG to provide ongoing input into the project plan.

In July 2010 the Mangles Bay Information Line was established to provide the public with an opportunity to ask questions and be informed about the development. In conjunction to the phone line, the Proposals objectives, deliverables and key documents were provided on the Cedar Woods website.

Furthermore local press advertorials and media statements have been used to communicate information and encourage further enquires to the dedicated information line.

A summary of the key stakeholder consultation undertaken to date for this is included in Table 4.

Table 4 Summary of key stakeholder consultation undertaken for this Proposal to date

Stakeholder	Outcome of consultation
City of Rockingham	Preliminary comments regarding marina design. Advice provided to the strategy for obtaining planning approval.
Department of Planning	MRS amendment to be initiated subsequent to the s.38 environmental approval process.
Department of Sports and Recreation	Inclusion of passive recreation opportunities within the development, consultation with existing lessees.
Department of Transport	Preliminary comments regarding marina design and suggestions for marina management.
Office of the EPA	Confirmation of the assessment process for the proposal.
Mangles Bay Fishing Club	Inclusion of the club's comments regarding marina planning and club site facility.
Rockingham Offshore Fishing Club	Inclusion of the club's comments regarding marina planning and club site facility.
The Cruising Yacht Club of WA	Inclusion of the club's comments regarding marina planning and club site facility.
Blue Lagoon Mussels	Inclusion of the club's comments regarding marina planning and club site facility.
Rockingham Volunteer Sea Rescue Group	Inclusion of the club's comments regarding marina planning and club site facility.
Retired Service League Rockingham	Realignment of Memorial Drive to retain the RSL Hall.
Cockburn Sound Management Council	Preliminary comments on Proposal and advice on marine water quality within Cockburn Sound.
Department of Water	Inclusion of comments to evaluate the environmental impact to the environmental values within, and adjacent to, the Proposal area.
Conservation Commission of Western Australia	Confirmation of the Proposal area and environmental assessment process.
Department of Sustainability, Environment, Water, Population and Communities	Inclusion of comments into addressing Matters of NES within the environmental assessment of the Proposal.
Department of Defence	Provision for a dual-lane road within the service corridor to accommodate future traffic movement to HMAS Stirling.
Water Corporation	Provision within the service corridor to accommodate current and future infrastructure requirements.

4.2 Stakeholder comments and proponent responses

The Cedar Woods stakeholder engagement program for this Proposal commenced in April 2010 and will continue throughout the Local Structure Planning process. Key stakeholders were identified through previous consultation programs undertaken during the many iterations of this Proposal. Government agencies have also provided recommendations on stakeholders that should be included within the program, with these recommendations adopted by Cedar Woods.

The program included three SRG meetings (including boating users, adjacent leaseholders and community groups) to provide input to prepare the marina design.

The consultation activities undertaken to date and the issues raised are summarised in Table 5.

Table 5 Summary of consultation undertaken to date and key topics raised regarding Proposal

Date	Stakeholder	Purpose	Topics Raised	Proponent Response
21 November 2010	Rockingham Fair patrons	To better inform the public of the Proposal.	• environmental impacts • consolidation of boating clubs • public boat ramp west of the Garden Causeway • traffic management • project partnering.	Environmental approvals to be undertaken in accordance with the statutory environmental assessment process. The public will have an opportunity to make a submission during the advertising of the Proponent's environmental impact assessment report. Proposal to upgrade the public car park facility and boat ramp West of the Garden Island Causeway. Proposal to provide a 3.5 ha site to the consolidated boating club with marina and ocean access. The Proposal is in partnership with LandCorp, the State's land development agency.
26 October 2010 24 November 2010	Stakeholder Reference Group	To provide design input to the master plan for the development.	• public access • potential impacts to SIMP • environmental Impacts to Lake Richmond, seagrass and vegetation • traffic impacts to HMAS Stirling • land uses and density of the Proposal • consolidation of boating clubs • impacts to existing leaseholders along Mangles Bay • realignment of the existing Water Corporation infrastructure • land use types within the Proposal area.	Provide a plan with improved public access to the Mangles Bay foreshore. Provide a pedestrian path along the length of the marina edge with connections to Mangles Bay. Environmental impacts to be assessed through the PER process, being assessed by the EPA. Proposal to undertake a traffic assessment to determine the service requirements for the Water Corporation and Department of Defence. Proposal to provide a 3.5ha site to the consolidated boating club with marina and ocean access. A family-affordable chalet facility to be provided along Mangles Bay. Land use types to be refined through the planning process.
9 December 2010 4 March 2011 25 March 2011 9 June 2011	Water Corporation	To determine an appropriate alignment and service corridor width to accommodate the existing and future infrastructure.	• existing infrastructure • future infrastructure provisions • environmental approval for the realigned service corridor.	A service corridor has been designed along the southern Proposal boundary to realign the existing, and to make provision for, the future Water Corporation infrastructure.
11 April 2011	Conservation Commission	To present the proposals and the environmental studies being undertaken to assess the environmental impact.	• reduce the number of swing moorings within Mangles Bay • impact to fauna • environmental offsets for development within RLRP and Bush Forever Site.	The Proposal seeks to reduce the number of swing moorings by providing boats with a safe protected anchorage. Fauna impacts from the development will be assessed in both local and regional context. An offset package has been prepared for consideration and comment from DEC.

Date	Stakeholder	Purpose	Topics Raised	Proponent Response
11 October 2010 19 October 2010 11 June 2011	Department of Environment and Conservation, Cockburn Sound Management Council	To inform DEC and representatives of CSMC of the Proposal and seek comments to the proposed environmental studies to be undertaken.	• require an understating of the environmental impacts of the Proposal • environmental offsets considered by the Proponent for the Proposal • environmental studies to be undertaken.	Additional environmental studies to be included within the ESD. Environmental impacts to be assessed within PER.
1 December 2010 28 January 2011 23 May 2011	Department of Environment and Conservation – Regional Parks	To familiarise DEC with the Proposal, the likely impacts to Bush Forever and RLRP.	• require an understating of the environmental impacts of the Proposal • environmental offsets considered by the Proponent for the Proposal.	Environmental offsets will be considered for the Proposal, with consultation with the relevant government agencies. Environmental aspects and mitigation strategies will be presented within the PER document. Relevant WAPC, DEC and EPA guidelines and statements will be considered and addressed when presenting the offsets package.
10 February 2011	Department of Water	To inform DoW of the proposal and seek comments prior to the commencement of the groundwater modelling.	• peer reviewer to be appointed for the conceptual and numerical modelling • climate change factors to be included within groundwater modelling • assessments required determining the impacts from dewatering during and post construction • monitoring data timeframes and parameters.	The conceptual and numerical groundwater model will be formulated in consultation with a peer reviewer. Environmental impacts to be assessed from the results on the modelling.
9 July 2010 1 October 2010 15 November 2010 2 December 2010 17 March 2011	City of Rockingham	To inform on the planning of the current marina footprint plan included within the ESD.	• environmental opportunities and constraints for the planning for the marina footprint design • the retention versus realignment of existing Water Corporation services • marina management following construction.	Structure planning will commence following the lodgement of the PER. The retention of the Water Corporation infrastructure on marina footprint plan will be unsuccessful in activating the marina edge. The management of the marina will be determined as part of the Project business case for funding.
14 October 2010 26 May 2011	Environmental Protection Authority	To inform EPA for finalising the ESD.	• need for consultation with the Water Corporation on the realignment of the existing services • Public Environmental Review (PER) to assess cumulative impacts between the Proposal and the Water Corporation SDOOL project • reduce the number of swing moorings within Mangles Bay.	The existing Proposal is a reduced environmental footprint from the 2006 concepts which were assessed under a SER. Environmental studies are being undertaken in accordance with the ESD. The PER will provide an assessment of the environmental impacts and how they are to be managed.
2 August 2010 9 November 2010 14 April 2011	Department of Transport	To inform the Department of Transport of the Proposal and marina design.	• marina design and boat capacity • management of the marina • swing moorings within Mangles Bay.	The marina is to accommodate up to 500 boats. Management of the marina to be determined during the planning. Swing moorings to be reduced on Proposal approval.

Date	Stakeholder	Purpose	Topics Raised	Proponent Response
27 October 2010	Department of Sustainability, Environment, Water, Populations and Communities	To familiarise the Department of SEWPaC with the existing environment, studies and management of the environmental disturbances.	• beneficial outcomes to the environment are to be considered for the Proposal • Proponent will need to demonstrate that no impacts will occur on listed marine species • offsets will need to be considered where relevant and developed in conjunction with the relevant government agencies • Proponent will need to demonstrate that there will be no hydrogeological interaction (no threat) between the marina and the Beecher Point Wetlands • Proponent will need to demonstrate the potential effects of the Proposal to thrombolites at Lake Richmond.	Environmental offsets will be considered within the Proposal with consultation with the relevant government agencies. Environmental aspects and mitigation strategies of the identified environmental impacts to the environment will be presented within the PER document.
15 February 2011	South West Aboriginal Land Council (SWALC)	To inform and determine a representative for the Aboriginal heritage consultations.	• compensation • reflecting Aboriginal values within the area.	Native Title is extinguished with no requirement to provide compensation. Consultation is being undertaken to determine the significance of the heritage values and what can be undertaken for the development to occur.
20 April 2011 21 April 2011 10 May 2011	Aboriginal Heritage consultations	To consult with Indigenous groups on the Proposal comprising representatives from the SWALC and site informants from Department of Indigenous Affairs. To formalise recommendations for inclusion into the ethnographic report.	• the site contains three Aboriginal heritage sites • the former Sister Kate's site on the South of Memorial drive and outside of the Proposal area is considered to be significant • the majority of the Indigenous groups supported the proposal subject to the recommendations being implemented.	The Proponent commits to adhere to the recommendations of the ethnographic report.
8 December 2010 21 September 2011	Technical Working Group (Office of EPA, City of Rockingham, Department of Transport, LandCorp, Cedar Woods, Cockburn Sound Management Council)	To inform the technical working group of the project objectives and commitments. Identify issues within environment, planning, engineering, management.	• project program. • environmental approval process • marina management • realignment of the Water Corporation infrastructure.	The project program has assumed timeframes contained within the draft Environmental Impact Assessment Guidelines. The Proposal will be assessed by the EPA as a PER. Management of the marina to be determined through the planning process. The realigned service corridor is required to accommodate the Water Corporation Infrastructure and a dual-lane road.

Date	Stakeholder	Purpose	Topics Raised	Proponent Response
16th August 2010 4th October 2010 30th November 2010 14th December 2010	Marina Working Group (Rockingham Sea Search and Rescue, Mangles Bay Fishing Club, The Cruising Yacht Club)	To provide input the consolidated club site facility.	• Site area and design for club facility. • Tenure. • Consolidation of the clubs. • Commercial viability.	Business case to be prepared to determine the operating viability of the consolidated club. Club site and improvements to be provided in accordance with the Proposal objectives.

4.3 Ongoing consultation

The Proponent is commencing a broader stakeholder engagement process with a SRG formed to include local user groups, community groups and adjacent leaseholders.

Following the ongoing consultation completed to date, it is important to continue this discourse with key stakeholders throughout, and beyond, the environmental approval process.

Ongoing communication and consultation with relevant Local, State and Federal Government representatives, business and industry leaders, local community groups, and existing Cape Peron users and tenants will continue in order to provide critical information to feed into the refinement of the Structure Plan and to identify communication issues that will need to be addressed during the process.

5. Framework for environmental impact assessment of Proposal

5.1 Identification of key factors and their significance

The key environmental factors were identified through the scoping process and an ESD was prepared in accordance with the Environmental Impact Assessment (Part IV Division I) Administrative Procedures 2010. The scoping process included:

- review of the outcomes of EPA Bulletin 1237 that was issued by the EPA in response to the s16(e) strategic environmental review process undertaken in 2005 and 2006
- stakeholder consultation for the SER and scoping process
- results of environmental investigations
- ESD assessment and approval by the EPA.

This process identified the key environmental factors listed in Section 5.2. These factors are addressed in detail in this PER in accordance with the requirements of the ESD.

The results of the stakeholder consultation process and EPA advice have provided a sound basis for the identification of the key environmental issues associated with this Proposal. Key environmental issues are considered to be: and are considered to be:

- loss of seagrass in Mangles Bay
- potential changes to water quality in Mangles Bay
- potential for indirect impacts on Lake Richmond from hydrological changes or increased use
- clearing of vegetation and fauna habitat within the predominantly cleared Metropolitan area
- the excision of the Proposal area from the RLRP and the Bush Forever Site 355
- continued and enhanced public access to Mangles Bay and Cape Peron.

5.2 Relevant factors

The environmental factors considered likely to be impacted by the Proposal are:

1. Terrestrial environment:
   - groundwater
   - surface water
   - flora and vegetation
   - terrestrial fauna
   - conservation areas (included in terrestrial vegetation and flora chapter for the purposes of scoping).
2. Marine environment:
   - water quality
   - coastal processes
   - benthic primary producer habitat (BPPH)
   - marine fauna.
3. Matters of National Environmental Significance.
4. Social surrounds:
   - recreation and public access
   - Aboriginal and European heritage.

5. Other Environmental Factors:
    - traffic
    - contaminated sites and acid sulfate soils (ASS)
    - construction impacts of dust, noise and waste.

5.3 Consistency with environmental principles

The Proposal has been developed with consideration of the principles of environmental protection (EPA 2004a). A summary of how the environmental principles have been incorporated into the Proposal is included in Table 6.

Table 6 Principles of environmental protection, as they apply to the Proposal

Principle	Applicability to this Proposal
1. The precautionary principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by – (a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) an assessment of the risk – weighted consequences of various options.	The Proposal is the culmination of a series of development options for a marina at Mangles Bay. The Proposal has been designed to avoid, as far as practicable, harm to the area's recognised environmental values, including Lake Richmond and Cockburn Sound/Mangles Bay. The potential effects to the environment have been studied rigorously, in order to ensure predictions of environmental outcomes are reliable. Mitigation measures have been developed from extensive consultation and review and will be finalised through the environmental impact assessment process.
2. The principle of intergenerational equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	The Proposal will improve the social amenity of the area by addressing an increasing need for safe boat anchorage and improving recreation assets. The Proposal will derive long-term environmental improvements to the area through mitigation measures, including the facility to relocate open moorings to the marina, rehabilitation of seagrass and terrestrial vegetation, while improving knowledge of the area's environment. The provision of facilities for passive recreation will ensure that the environment is protected from increased pressure from both the development and surrounding areas.
3. The principle of the conservation of biological diversity and ecological integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	The Proposal has been designed to maximise the separation distance to Lake Richmond. The Proposal will also minimise impacts to seagrass and terrestrial vegetation in the short-term while seeking to enhance conservation in the long-term. The Proposal involves loss of vegetation but the rehabilitation of the remainder of vegetation on Cape Peron is expected to enhance ecological integrity of this area. Additionally, the potential to offset the loss of conservation estate by a financial contribution toward land to be purchased is being considered in consultation with DEC.

Principle	Applicability to this Proposal
4. Principles relating to improved valuation, pricing and incentive mechanisms (1) Environmental factors should be included in the valuation of assets and services. (2) The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. (3) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. (4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.	Cost estimates of potential offsets have been incorporated into the cost estimates for the Proposal. Contribution will be made for management of adjacent environmental values in anticipation of increased utilisation and pressure on the area. The management of the marina, including water quality monitoring, marina regulation and maintenance of POS, will be funded by the development.
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Owing to its nature, the Proposal is expected to generate a minimal amount of waste. Any wastes will be managed consistent with the waste hierarchy.

5.4 Consistency with expectations of EPA for environmental impact assessment

Table 7 sets out the EPA expectations for environmental impact assessment of proposals, with a summary of how these matters are considered in this environmental impact assessment, together with a cross reference to the relevant sections.

Table 7 Statement of expectation for environmental impact assessment

Expectations	Consideration Given in Proposal	Relevant Sections in Document
a) Proponents will use best practicable measures and genuine evaluation of options or alternatives in siting, planning and designing their proposals to avoid, and where this is not possible, to minimise impacts on the environment.	Options and alternatives have been evaluated for each proposed marina design.	Section 3.3
b) The onus is with the proponents to describe the environmental impacts of their proposals, and to use their best endeavours to demonstrate that the unavoidable impacts are environmentally acceptable, taking into account cumulative impacts in the region.	Environmental impacts have been described for each factor under the relevant section. Instances of unavoidable impact have been studied and demonstrated to be environmentally acceptable. Cumulative impacts have been addressed for each factor.	Section 6, 6.1, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21
c) Proponents will use best practicable measures and mitigation to manage adverse environmental impacts.	Best practicable measures and mitigation have been evaluated for each factor under the relevant section. Mitigation measures for each factor outline how potential impacts will be mitigated through consideration of the EPA mitigation sequence: avoid, minimise, reduce, rectify and offset.	Section 6, 6.1, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21.

Expectations	Consideration Given in Proposal	Relevant Sections in Document
d) Proposals will meet relevant environmental objectives and standards.	The Proposal has been assessed against relevant environmental objectives and standards, and this assessment has been described in each factor section.	Section 6, 6.1, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21
e) In all EIA, there will be opportunities for effective stakeholder consultation, including engagement with the local community during the assessment of the proposal. Proponents should adequately engage in consultation with stakeholders who may be interested in, or affected by their proposals, early in the EIA process.	Stakeholder consultation has been undertaken and is described in the relevant section.	Section 4
f) Assessment will be based on sound science and documented information. It is essential that proponents allow adequate time and resources to carry out the necessary surveys and investigations as part of the EIA.	This PER has been written based on the results of extensive assessment of hydrology, vegetation, flora, fauna, contamination potential, marine environment, coastal processes, BPPH, heritage, and public access within the Proposal area and surrounds. Relevant documentation is included in appendices and the reference list.	Appendix 5 and References (Section 23)
g) Proponents will identify management measures for all key environmental factors during the assessment, to demonstrate whether the proposal can be implemented to meet the EPA's environmental objectives.	Environmental measures and controls have been described throughout the PER. An associated CEMP including management of: groundwater, surface water, dredge spoil, terrestrial biodiversity and habitat, marine biodiversity and habitat, GSM, dust, noise and vibration, fire, heritage, hydrocarbons, waste, contaminated sites and ASS, public access, rehabilitation, community issues, visual amenity, and road traffic has been included as an appendix to the PER.	Section 22, Appendix 1
h) In all EIA, performance standards will be established, communicated and agreed at the beginning of the EIA process, and these will be monitored, reviewed and reported against.	Performance standards are included as part of the management plan for the Proposal.	Appendix 1
i) Proponents will implement continuous improvement in environmental performance and will apply best practicable measures for environmental management in implementing their proposals.	Best practicable measures for environmental management will be implemented through the Proposal. Objectives, standards, actions, monitoring and contingencies to achieve successful management are included in the CEMP. The Proponent is also supporting research into seagrass rehabilitation and GSM conservation.	Section22, Appendix 1

6. Groundwater impact assessment

6.1 Relevant environmental objectives, policies, guidelines, standards and procedures

6.1.1 EPA objectives

The EPA applies the following objectives in assessing proposals that may affect groundwater:

To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.

To ensure that emissions do not adversely affect environmental values or the health, welfare or amenity of people and land uses by meeting statutory requirements and acceptable standards.

6.1.2 Legislation, policy and guidance

National legislation and policy

Water quality guidelines for the protection of marine and freshwater ecosystems have been released under the auspices of the National Water Quality Management Strategy (ANZECC/ARMCANZ 2000). The guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies, and are applied to five geographical regions across Australia and New Zealand. The National Water Quality Management Strategy is supported by the Guidelines for Groundwater Protection in Australia (ANZECC/ARMCANZ 1995), which outlines a framework for protecting groundwater in Australia. The Guidelines require the identification of beneficial uses for groundwater in aquifers, and a policy to manage these issues.

A series of guidelines on national water quality management has also been released by the Natural Resource Management Ministerial Council (NRMMC) and, in some cases, in collaboration with the National Health and Medical Research Council (NHMRC) and the Australian Health Ministers Conference. These guidelines address a range of issues including policies and processes for water quality management, water quality benchmarks, groundwater management, diffuse and point sources, guidelines for sewerage systems, effluent management and water recycling.

State legislation

The *Rights in Water and Irrigation Act 1914* (RiWI Act) makes provision for the regulation, management, use and protection of water resources, to provide for irrigation schemes, and for related purposes. The Proposal area is located within the RiWI Act proclaimed Rockingham Groundwater area, Warnbro Groundwater subarea.

Licences issued by the DoW under the RiWI Act are required for works associated with groundwater abstraction (including for dewatering purposes, if the volume exceeds the maximum volume and duration criteria) within the Rockingham Groundwater Area. Groundwater licences specify the maximum abstraction rate from aquifers and includes conditions for monitoring. Groundwater licenses may require the submission of supporting documentation outlining the local hydrogeology, operating strategies and management and water conservation measures in line with the DoW's Operational Policies.

Stormwater management, surface water discharges and potentially polluting activities are managed under an environmental licence issued under Part V of the EP Act. These activities are addressed in Section 7.

State Policy and water resources strategies

Rockingham – Stakehill Groundwater Management Plan

The Rockingham – Stakehill Groundwater Management Plan (DoW 2008) guides groundwater licence assessments and allocations within the Rockingham and Stakehill groundwater areas. The plan provides the objectives, policies, principles and strategies used to manage the groundwater resources of the plan area with the long-term objective to achieve sustainable use of the groundwater resources within the groundwater areas. Groundwater abstraction licences submitted to the DoW will be assessed in accordance with the groundwater objectives set in this plan.

State Water Strategy

The Government of Western Australia developed the State Water Strategy in 2003 with the objective of achieving a sustainable water future for all Western Australians by:

- improving water use efficiency in all sectors
- achieving significant advances in water reuse
- fostering innovation and research
- planning and development of a new source of water in a timely manner
- protecting the value of our water resources (Government of Western Australia 2003).

Stormwater Management Manual

The Stormwater Management Manual was developed by the Government of Western Australia to provide a consistent approach to stormwater management, while considering a variety of stormwater management options to be considered by land developments across Western Australia. The manual provides case studies and planning approaches for the consideration of stormwater management at the early planning stages of a land development, with an emphasis on source controls, regulation and education.

The Stormwater Management Manual provides the minimum best management practice to be applied for the management of stormwater to land developments. The manual focuses on the need to integrate a range of stormwater management measures, including urban design principles to be considered within the framework of 'Water Sensitive Urban Design' that maximise local retention, reuse of stormwater and management of 'non-point source' pollutants.

State Water Quality Management Strategy

The Government of Western Australia developed the State Water Quality Management Strategy in 2001 (Waters and Rivers Commission 2001) with the objective 'to achieve sustainable use of the Nation's water resources by protecting and enhancing their quality while maintaining economic and social development'.

The State Water Quality Management Strategy requires that a Water Conservation Plan be developed before a water allocation licence is issued or renewed. A water allocation license would be required for the Proposal if broad-scale dewatering is to occur or if groundwater is to be allocated for irrigation of POS. The Water Conservation Plan must outline water efficiency objectives and timeframes. Licence conditions require implementation of the Water Conservation Plan to an agreed schedule. This Water Conservation Plan is usually included within an 'Operating Strategy' which is prepared to support a water allocation application.

Operational policies

The DoW has prepared a range of 'operational policies' to assist proponents in the application of licences to take water and the associated reporting and management requirements associated with a water licence.

Two relevant operational policies, *Operational Policy 5.12 – Hydrogeological reporting associated with a groundwater well licence* and *Operational Policy 1.02 Water conservation/efficiency plans*, may be applicable to this Proposal.

Operational Policy 5.12 provides guidance to proponents on the hydrogeological assessment and groundwater monitoring reports required and the information they should contain when applying for a water licence. This information would form part of the water licence assessment that would be undertaken by the DoW prior to applying for a license to install a groundwater well for POS irrigation or dewatering.

Operational Policy 1.02 provides guidance on the preparation of conservation/efficiency plans to ensure the efficient use of a proponent's water entitlement. A water conservation/efficiency plan may be part of the hydrogeological assessment and groundwater monitoring report submitted as part of water licence application or a standalone document, which details the water conservation/efficiency measures considered and those to be implemented as part of the water entitlement.

The preparation of either or both of these reporting requirements, are listed as a licence condition, to ensure their implementation for the duration of the licence.

6.2 Findings of surveys and investigations

6.2.1 Existing groundwater use and values

The Guidelines for Protection of Groundwater Quality in Australia (ANZECC/ARMCANZ 1995) provide a framework to protect beneficial uses and values of groundwater throughout Australia. The key beneficial use of groundwater in the Proposal area is for the irrigation of POS and gardens. The key environmental values of groundwater in the area are:

- maintaining groundwater levels in Lake Richmond over the summer months, as discussed in Section 6.2.4
- providing a water source for vegetation, including the TECs FCT 30a *Callitris preissii* (or *Melaleuca lanceolata*) forest and woodlands and FCT 19 (Sedgelands in Holocene dune swales), as described in Section 8.2.1.

Groundwater in the area is used for irrigation of POS and gardens. Domestic bores for properties less than 2000 m^2 in area are not required to be licensed. As these bores are unlicensed, it is not possible to accurately determine the numbers in the area. Groundwater within the Rockingham area is mainly used for irrigation water for POS and recreational areas (DoW 2008). The Rockingham area has the greatest percentage of domestic garden bores in the Perth Metropolitan area (DoW 2008). A 1995 bore-ownership survey of 16 133 households indicated that 76% of properties in the Rockingham area had garden bores, compared with the average of 36% in the Perth region (DoW 2008).

Garden bores in the area are expected to be comparatively shallow, and would be expected to abstract water from the Safety Bay Sands. Groundwater in the Tamala Limestone in the area is mostly saline and is therefore unsuitable for beneficial uses such as irrigation and drinking water. Based on DoW guidance, groundwater with less than 1 000 mg/L total dissolved salts (TDS) is considered suitable for irrigation, with 1 000 to 2 000 mg/L being suitable for 'irrigation with caution' (Mayer *et al*. 2005).

Licenses are required for non-domestic bores that irrigate POS or private land. The DoW's WIN database includes 42 licenses within a 2 km radius of the Proposal area (ERM 2011). Licensees include the City of Rockingham (including a license for irrigation of Rotary Park approximately 300 m east of the proposal boundary), Rockingham Beach Primary School and various community groups in the Cape Peron area. Non-domestic bores that may be potentially impacted by the proposal are shown in Figure 10.

6.2.2 Regional geology and hydrogeology

The regional geology of the proposal area consists of layers of regolith deposited during the Late Tertiary and into the Quaternary. The superficial lithology in the Proposal area consists of two main superficial

geological units (1) the Safety Bay Sand; and (2) the Tamala Limestone. The Safety Bay Sand unconformably overlies the Tamala Limestone, which then overlies the Rockingham Sands.

The Safety Bay Sand consists primarily of shell fragments and variable amounts of white calcareous fine to medium-grained quartz sand with traces of fine-grained black, heavy minerals (Davidson 1995). The depth of Safety Bay Sand found in the investigation area was between 20 and 24 m, extending to approximately -20 mAHD (ERM 2011, Appendix 5). The hydraulic conductivity (K) of the Safety Bay Sands is relatively high, with estimates ranging between 5 and 174 m/day (MWH 2011b). A thin layer of clay (0.5 to 2 m thick) lies at the base of the Safety Bay Sands in the Proposal area and acts as an aquiclude, effectively limiting water movement between the Safety Bay Sands and the Tamala Limestone (ERM 2011). At Cape Peron, the Tamala Limestone is exposed above the water table.

The Tamala Limestone unconformably overlies the Rockingham Sand formation and has been described as a creamy-white to yellow or light grey limestone (Playford *et al.* 1976). The Tamala Limestone consists largely of coarse to medium grained shell fragments and variable amounts of fine to coarse-grained quartz and minor clayey lenses (Davidson 1995).

The limestone exhibits areas of secondary porosity due to cavities, channels and in some locations, karst structures. The Tamala Limestone extends to approximately -23 mAHD in the Proposal area (ERM 2011). The hydraulic conductivity (K) of the Tamala Limestone is very high because of its' porous nature, with estimates ranging between 100 and 3 000 m/day (MWH 2011b).

Groundwater flow in the superficial aquifer in the Rockingham area is generally in a westerly direction, towards the Indian Ocean with summer groundwater levels varying between 3 m AHD at Ennis Avenue to approximately 0 m AHD at the coast (Department of Environment 2004). The coastal strip of the superficial aquifer is generally characterised by relatively flat hydraulic gradients (1 in 1000 to 1 in 2000), due mainly to the hydraulic effects of the porous nature of the Tamala Limestone (Worley Parsons 2005).

6.2.3 Groundwater investigations

A groundwater investigation program was undertaken between March 2010 and August 2011 to support the development of the PER and groundwater modelling. Monitoring will continue until October 2011. The investigations were undertaken by MWH and included:

- drilling and construction of 16 monitoring bores at 14 locations throughout the Proposal area and geological logging, with one barometric datalogger to allow water level readings to be corrected for barometric pressure
- twelve months' collection of real time water level data in six bores using data loggers
- monthly water level and surveying of salinity to determine the presence and depth of any changes in salinity associated with saltwater wedges
- monthly collection of water samples from all bores for chemical analysis for general water chemistry, nutrients and heavy metals including:
    - general water chemistry (total dissolved solids [TDS], pH, electrical conductivity [EC[1]] cations, anions, Ca, Cl, Na, K, Mg, Fe, sulphate, nitrate, carbonate/bicarbonate)
    - eight standard metals (As, Cd, Cu, Cr, Hg, Pb, Ni and Zn)
    - nutrients (total nitrogen [TN], total kjeldahl nitrogen [TKN], nitrate, nitrite, TP and phosphate)
    - redox potential (E_h) (post February 2011)
    - monthly downhole monitoring of EC, pH, dissolved oxygen (DO) and temperature surveys at 1 m depth intervals.

The majority of bores were installed in March 2010 to between 8 and 30 m depth. The shallower bores, MB02, MB04, MB06, MB08, MB09S[2], MB13 and MB14S were installed within the Safety Bay Sands. The

[1] Electrical conductivity is used as a stand in measure for salinity (total dissolved salts) by hydrologists. In the Rockingham Area, an EC of 1 mS/cm is approximately equivalent to 600 mg/L total dissolved salts.

remainder of the bores intercepted both geological units. Three additional bores, MB14S, MB14D and PS1 were installed in February 2011 to assist in testing for hydraulic conductivity (pump testing).

Pump testing was also undertaken in the bores MB09S and the specially drilled production bore PB1 to determine aquifer properties for the model, including hydraulic conductivity and the interaction between the Tamala Limestone and Safety Bay Sand layers.

Groundwater monitoring locations are shown in Figure 10. Further details of the investigations can be found in Appendix 5.

It is noted that 2010 was a particularly dry year in the Rockingham area. Average rainfall for the Kwinana BP Refinery between 1955 and 2010 is 748.9 mm/yr (MWH 2011a). During the one year monitoring period, only 419.6 mm of rainfall was recorded. In the southwest of WA, 2010 had the lowest annual and winter rainfall on record (BoM 2011). Because of this, groundwater and surface water levels were lower than what would be expected in an average year. As an example, water levels in Lake Richmond varied between approximately -0.1 and 0.85 mAHD over the monitoring period, as compared to an average range of 0.2 to 1.2 mAHD (MWH 2011b).

Groundwater monitoring in the area is being continued by the Proponent.

Groundwater Reporting

Groundwater results were initially reported through MWH's *Cape Peron Groundwater Study* (2011a) (provided in Appendix 5). This report and additional work by ERM including downhole gamma logging and construction of additional bores was used to develop an understanding of the conceptual site hydrology, as presented in the *Mangles Bay Marina Groundwater Modelling: Revised Conceptual Site Model Report* (Conceptual Site Model) (ERM 2011, provided in Appendix 5). The PER reflects the understanding of the Proposal area hydrology presented in the Conceptual Site Model.

[2] Where multiple bores were installed at the same location, the letters 'S' and 'D' are added at the end to distinguish between them. 'S' refers to the shallower one and 'D' to the deeper one.

Source:
Imagery supplied by Landgate
Water Monitoring Sites supplied by ERM (2010)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011

NB: Potential errors may occur in some areas

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Groundwater monitoring locations

Figure No:
10

6.2.4 Local groundwater system

The groundwater monitoring program indicates there is little connection between the Safety Bay Sands and Tamala Limestone in the Cape Peron area due to the presence of a clayey aquiclude, which acts to limit the movement of water between the two layers (Figure 11). The Safety Bay Sands and the Tamala Limestone have therefore been considered to be two separate aquifers for the purpose of this investigation. This concept is supported by the head (pressure) difference between the two aquifers, with higher heads occurring in the Tamala Limestone than the Safety Bay Sand (ERM 2011) and gamma logging indicates the presence of a clay layer at the base of the Safety Bay Sands (MWH 2011c).

Neither the proposed marina nor Lake Richmond are deep enough to intercept the Tamala Limestone aquifer (Figure 11). As such, the proposal is not considered to impact upon the Tamala Limestone aquifer. Because of this, the focus of the PER has been on the Safety Bay Sands Aquifer.

Additional information regarding the local groundwater system can be found in Appendix 5.

Groundwater levels

Groundwater levels recorded manually during the study period varied between 0.05 and 0.95 mAHD (MWH 2011a). This is similar to the -0.1 and 0.85 mAHD water levels measured in Lake Richmond over the same period (MWH 2011a).

In the Safety Bay Sands, groundwater flow is generally in a northerly and westerly direction, towards the coast (ERM 2011). Groundwater in the Safety Bay Sands shows two different types of fluctuations, depending on the location of the bores. Groundwater in the Safety Bay Sands within approximately 500 m of the coast experiences tidal variations, with groundwater levels rising and falling with the tide (Figure 12). Further from the coast, groundwater levels respond directly to rainfall with groundwater levels peaking in August/September 2010 and at their lowest in April 2011, before the commencement of winter rains (Figure 13).

Groundwater levels in the Tamala Limestone Aquifer showed significant tidal variation throughout the groundwater monitoring area, supporting the concept that the Tamala Limestone and Safety Bay Sands are two separate aquifers (ERM 2011, Figure 14). This difference is because of the higher hydraulic conductivity (and hence lower resistance to water movement) in the Tamala Limestone as compared to the Safety Bay Sands. This allows tidal signals to move more easily through the limestone than the sand.

Groundwater flow directions and surface water interactions

The interaction between Lake Richmond and local groundwater varies over the year. Lake Richmond interacts with the groundwater and also receives surface water from an extensive catchment to the east of the lake (Section 7.2.2). The Lake Richmond Outlet Drain discharges water from the lake into Cockburn Sound when the water level exceeds the weir height of 0.58 mAHD. In an average year, the water level in the lake varies from less than 0.2 mAHD to 1.2 mAHD, with a mean water level of 0.74 mAHD (MWH 2011b).

In the winter months, the input of surface water causes lake water levels to rise and the water level in the lake rises. During this period, the lake acts as a recharge zone with surface water from the lake entering groundwater to the east and west of the lake (Figure 15). At this time of year, water levels within the proposal area vary from less than 0.2 mAHD to approximately 0.8 mAHD near Lake Richmond. Groundwater levels at the lake were modelled as approximately 1.1 mAHD.

As rainfall decreases during the spring months, the water level of the lake drops, the lake no longer acts as a recharge area, and groundwater flows into the lake in the south and east (discharging to the north) (Figure 16). At this time of year, water levels within the Proposal area vary from 0.2 mAHD to approximately 0.6 mAHD near Lake Richmond. Groundwater levels at the lake were modelled as approximately 0.74 mAHD.

The flow direction in the Safety Bay Sands changes during the drier parts of the year (late summer and autumn). Groundwater levels within the area modelled fall due to water use by vegetation and

groundwater users and also due to evaporation from Lake Richmond. The drop in water levels in Lake Richmond causes some groundwater to the north and east to flow towards the lake (Figure 17). At this time of year, water levels within the proposal area are between 0.2 and 0. mAHD. Groundwater levels at the lake were modelled as approximately 0.01 mAHD. This is a common pattern of lake behaviour on the Swan Coastal Plain (Townley *et al.* 1993).

Water Quality

Groundwater in the Safety Bay Sands in the study area generally has total dissolved salts (TDS) less than 1000 mg/L (Figure 18). Salinities greater than 2000 mg/L generally only occur within 200 m of the coast and at Cape Peron, which is bounded by seawater on both sides (Figure 18). Close to the coast, salinity increases with depth because saltwater is denser (and hence heavier) than freshwater, and thus sinks to the bottom of the aquifer. Because of this, the salinities of near-coast groundwater increase with depth in the Safety Bay Sands (Figure 19 at depths less than and including -20 mAHD). The exception is a zone of brackish groundwater with a salinity of 2000 to 3000 mg/L associated with Lake Richmond (Figure 18). Historically, Lake Richmond was a brackish water body (Passmore 1970), and this residual salinity in the groundwater is considered to be a remnant of the former state (ERM 2011).

Groundwater within the Tamala Limestone is generally saline (MWH 2011b) (refer to cross sections at -24 mAHD and below in Figure 19). The proposed marina and any associated dewatering will only occur in the Safety Bay Sands Aquifer, and will not intercept the Tamala Limestone. Therefore, this section of the report focuses on the properties of the Safety Bay Sands aquifer.

Within the Safety Bay Sands, all bores were slightly alkaline, with mean pH values between 7.3 and 8.2 (MWH 2011b). This is similar, but slightly less alkaline than the ranges of pH 7.6 to pH 9 recorded in Lake Richmond during the study period. Additional information regarding both aquifers and the bores can be found in Appendix 5.

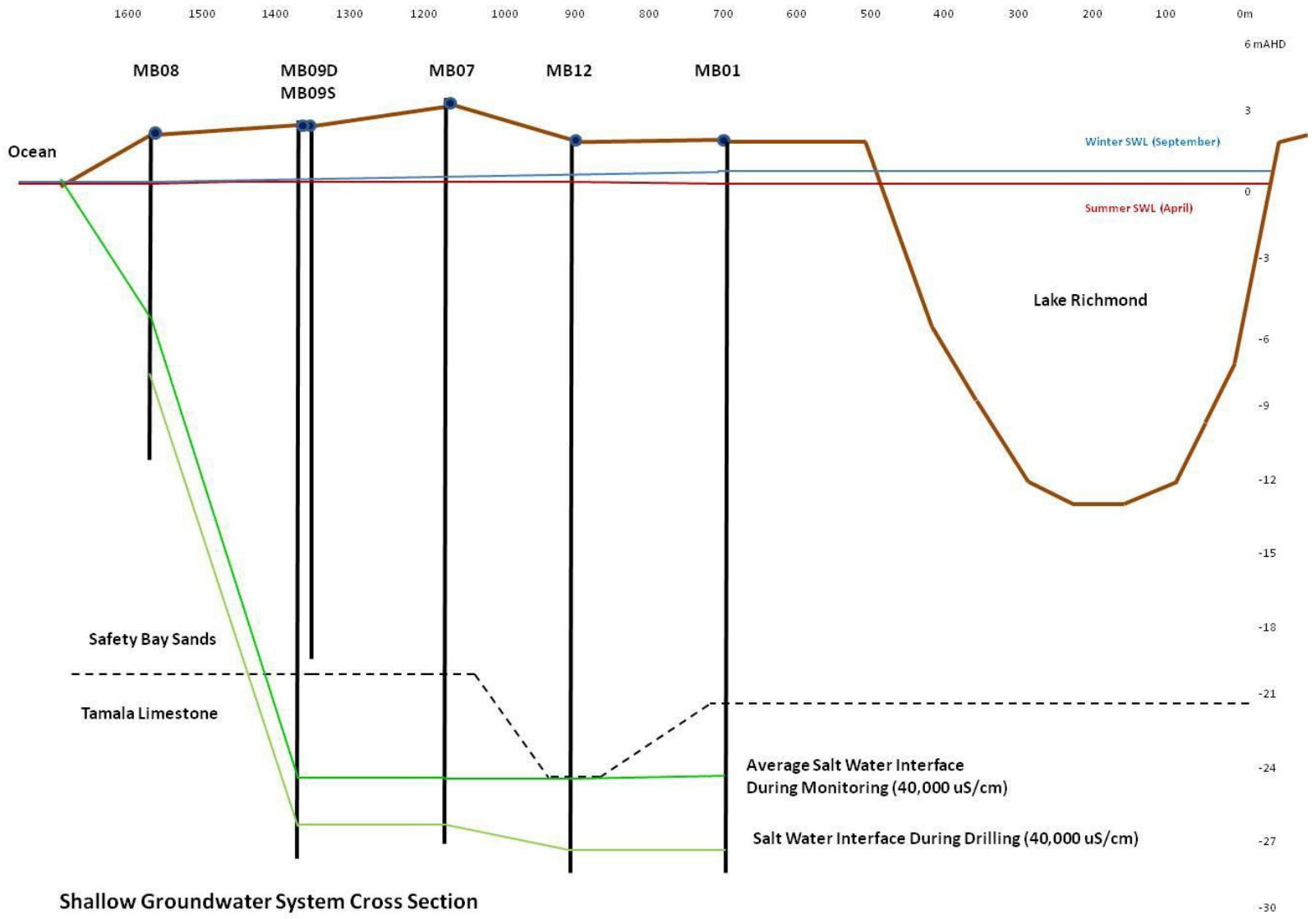
Nitrogen and phosphorus are important nutrients that influence biological growth in fresh and marine waters. TN and TP concentrations in the Safety Bay Sands bores were compared to water quality guidelines for the protection of marine and freshwater ecosystems released under the auspices of the National Water Quality Management Strategy (ANZECC/ARMCANZ 2000). Average TN and TP results for these bores were compared to the guidelines for slightly disturbed ecosystems in southwest Australia (ANZECC/ARMCANZ 2000). Values were also compared to the average and maximum concentrations observed in Lake Richmond (MWH 2011d).

Table 8 ANZECC/ARMCANZ 2000 guidelines for water quality in slightly disturbed ecosystems in south west Australia compared to water quality in study area

Item	Freshwater lake guideline (mg/L)	Wetland guideline (mg/L)	Marine, inshore guideline (mg/L)	Lake Richmond (average and maximum) (mg/L)	Range of average values for Safety Bay Sands bores (mg/L)
Total Phosphorus (TP)	0.01	0.06	0.02	0.02 0.03	0.038 – 0.18
Total Nitrogen (TN)	0.35	1.5	0.23	0.92 1.9	0.85 – 6

For TP, the average values for all seven bores were above the 0.01 and 0.02 mg/L guidelines set for freshwater lakes and inshore marine waters (Table 8). The average phosphorus concentrations at the three coastal bores, MNB02, MB06 and MB08, met the wetland water quality guidelines (Table 8). In terms of TN, none of the bores met the guidelines set for freshwater lakes and inshore marine waters (Table 8). The average TN concentration at bores MB04, MB06, MB08, and MB09S met the wetland guidelines (Table 8). Groundwater exhibited higher average phosphorus concentrations and generally higher average nitrogen concentrations than the lake (Table 8).

The values found in groundwater are similar to the average value of 0.24 mg/L TP and 2.64 mg/L TN for superficial bores in rural and vegetated areas in the nearby Murray catchment (DoW 2011).



Mangles Bay Marina Based Tourist Precinct

Hydrogeological cross section of the Proposal area

Figure 11

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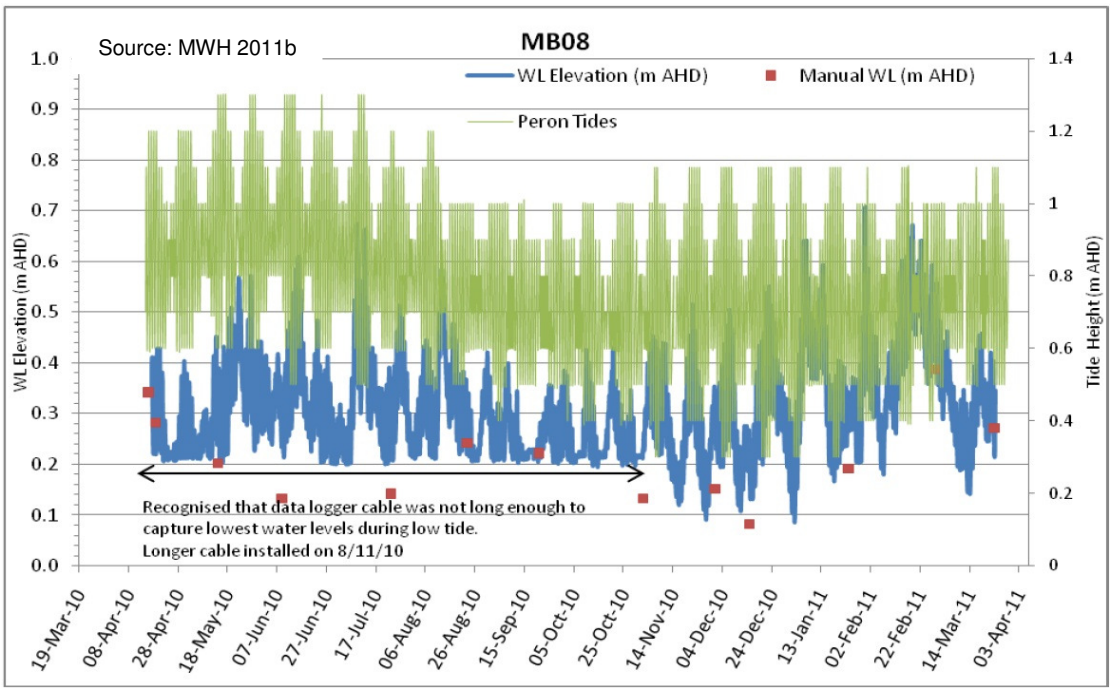

Figure 12 Groundwater levels in Safety Bay Sands aquifer, bore MB08 compared to tide levels

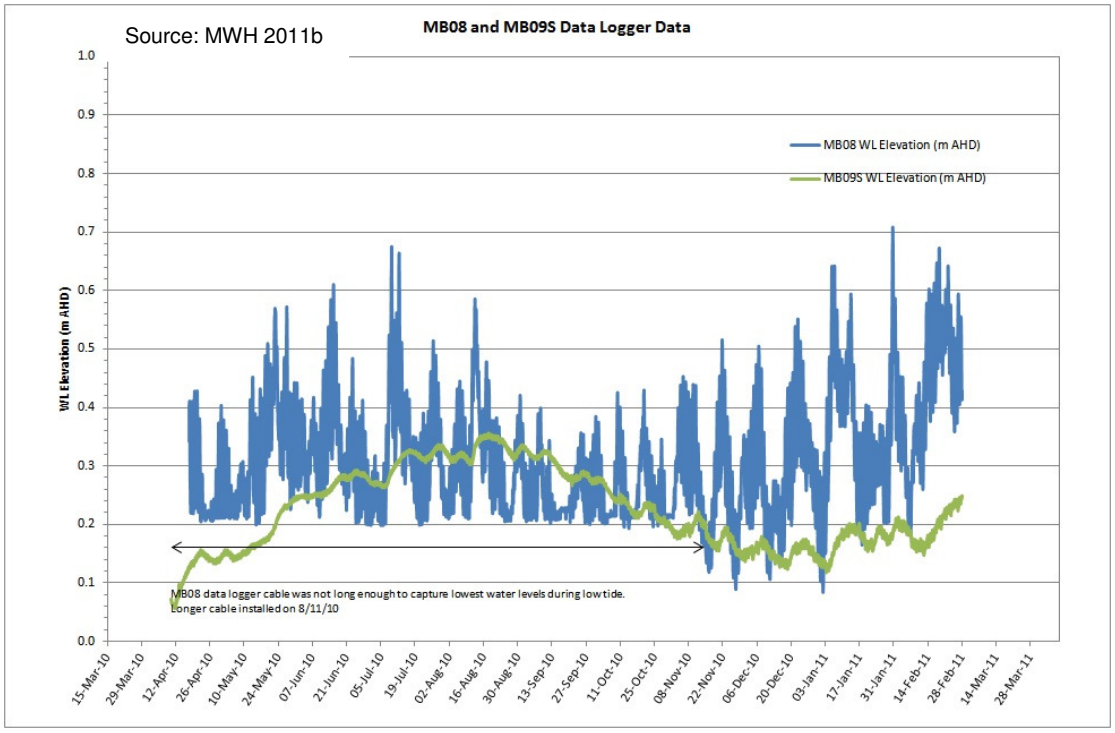

Figure 13 Groundwater levels in Safety Bay Sands aquifer, bore MB09S compared to rainfall

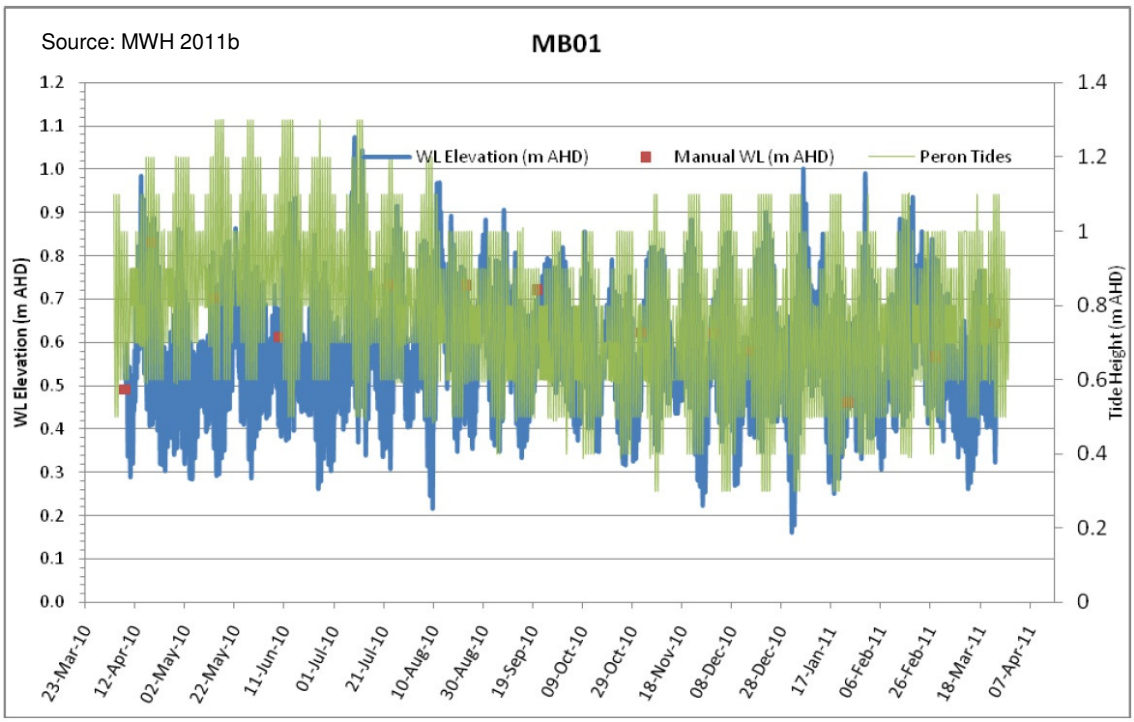

Figure 14 Groundwater levels in Tamala Limestone Aquifer bore MB01 compared to tide levels

Source: Cadastral data supplied by Landgate (2010)
Groundwater Contours supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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Modelled groundwater contours - existing high water levels

Figure No:
15

Source: Cadastral data supplied by Landgate (2010)
Groundwater Contours supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F054.dgn

Modelled groundwater contours - existing mean water levels

Figure No: **16**

Source: Cadastral data supplied by Landgate (2010)
Groundwater Contours supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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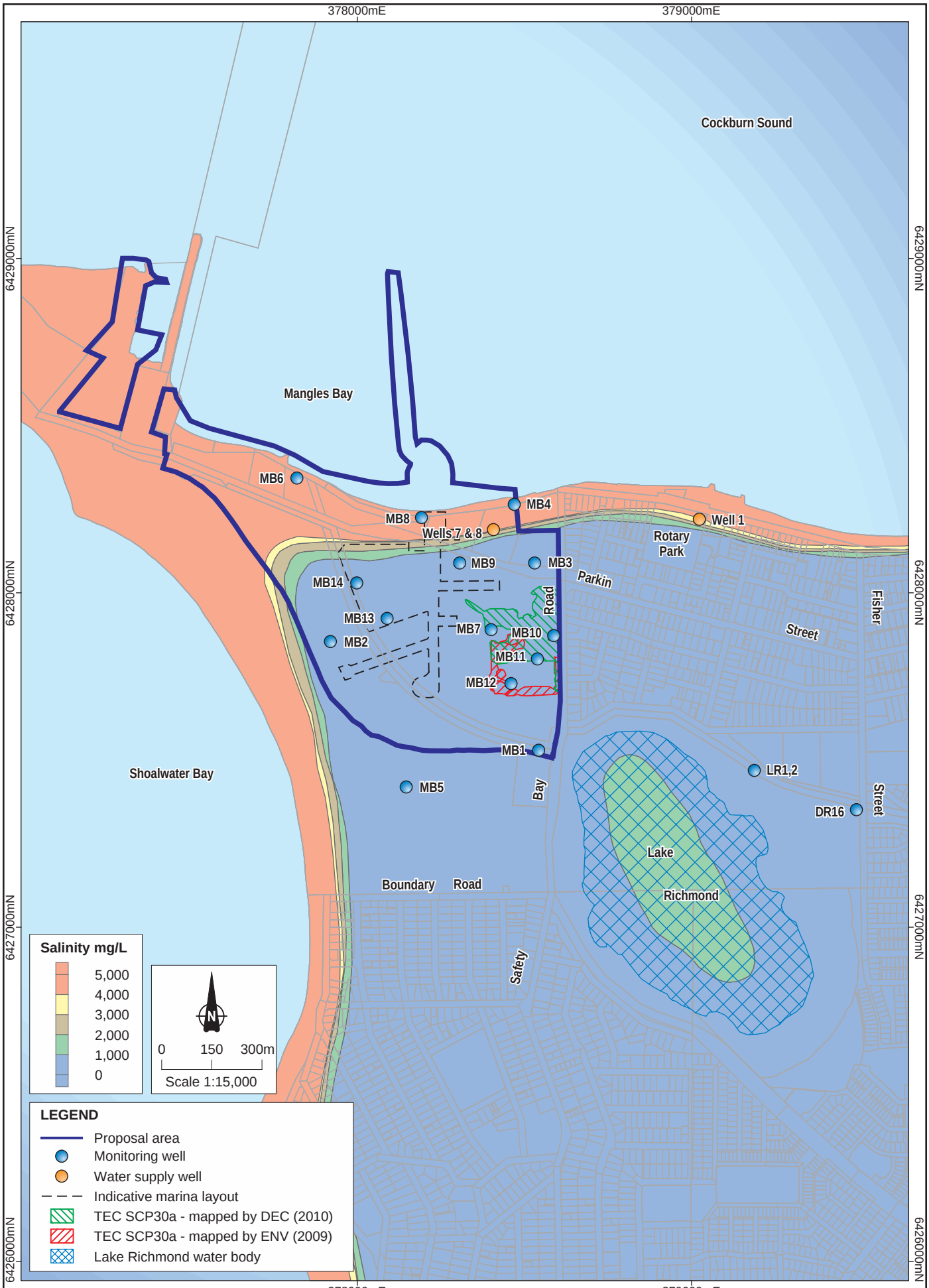
Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F040.dgn

Modelled groundwater contours - existing low water levels

Figure No: **17**



Source: Cadastral data supplied by Landgate (2010)
Modelled salinity supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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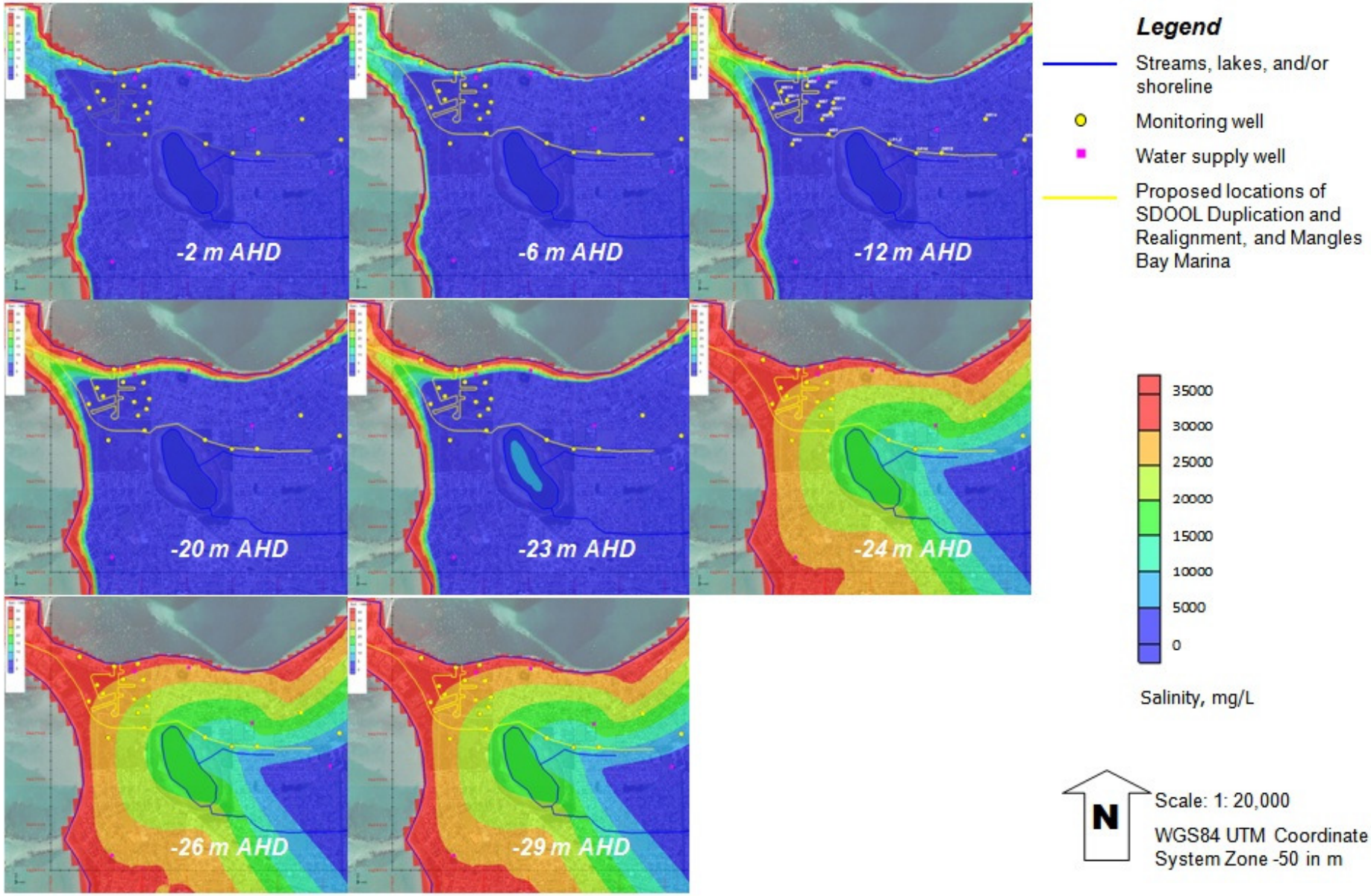
Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F036.dgn

Modelled salinity distribution under existing conditions at -12 m AHD

Figure No: **18**



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Mangles Bay Marina Based Tourist Precinct

Changes in modelled salinity distributions with depth under existing conditions

Figure 19

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Salinity at local bores

ERM (2011a) identified three main bores used for irrigation purposes in the modelled area: Wells 1, 7 and 8, as shown in Figure 18. The modelling indicates that the water quality at these bores may be fresh at shallower depths (Figure 19), but marginal for irrigation at -12 mAHD, with salinity between 1000 and 2000 mg/L (Figure 18). This estimated water quality in Wells 7 and 8 is consistent with the water quality measured in Rotary Park Lake, adjacent to the bores. Ecoscape (2009) recorded a salinity of 2220 to 2230 mg/L in this lake, above the 2000 mg/L guideline.

Hydraulic conductivity testing

Hydraulic conductivity testing of the Safety Bay Sands Aquifer was conducted by pump testing of the bores PB1 and MB09S. The aim of this was to assist in selecting a suitable hydraulic conductivity value for use in the model and investigate the interaction between the two aquifers. Test pumping was initially undertaken on the bore PB1, but the hydraulic conductivity provided was considered unrealistically low for a sandy aquifer (MWH 2011b).

Test pumping was then undertaken on the shallow monitoring bore (MB09S) to determine another value for hydraulic parameters for the Safety Bay Sands. Results from this second test suggested high hydraulic conductivity (K) values in the range of 40 to 75 m/d (MWH 2011b). Literature search values for hydraulic conductivity of the Safety Bay Sands are between 5 and 50 m/d: these values are at the high end of, or above, this range (ERM 2011). The model has been calibrated to a K value of 16 m/day.

6.2.5 Numerical groundwater modelling

The key driver in determining the extent of acceptable impacts is the likelihood of impacts if they are to occur to Lake Richmond as a result of the inland marina. To investigate the impacts of construction and operation of the marina, a model was developed.

The numerical model was developed for the Proposal by ERM. The model includes the groundwater/surface water interactions of Lake Richmond and has been calibrated to local groundwater and surface water data. The model was peer reviewed by Phil Wharton, a modeller with experience in the hydrology of the Rockingham area. A copy of the numerical groundwater model, including the peer reviewer's report, is provided in Appendix 4.

The model itself was based on the monitoring undertaken for this survey, with additional information from a number of sources including:

- DoW and Water Corporation regional Perth Metropolitan groundwater model Perth Regional Aquifer Modelling System (PRAMS) (Davidson and Yu 2006) to assess groundwater availability, rainfall recharge and aquifer yields
- PRAMS model development: hydrogeology and groundwater modelling (Davidson and Yu 2006)
- Hydrogeology and groundwater resources of the Perth region, Western Australia, Western Australia Geological Survey, Bulletin 142 (Davidson 1995)
- groundwater level and quality monitoring of the superficial aquifer and Rockingham Sand within the Warnbro groundwater subarea undertaken by the DoW from 1975 – 2010
- Rockingham – Stakehill Groundwater Management Plan for the allocation of groundwater for current and future users and to protect groundwater-dependent ecosystems (DoW 2008)
- water abstraction/groundwater licence information (available upon request from the DoW)
- groundwater monitoring and investigations undertaken by the Water Corporation in association with the SDOOL pipeline made available by the Corporation.

The numerical groundwater model developed addresses the impact of the Proposal in both the construction and operational phases. The methodology for development of the model included:

1. Developing a conceptual hydrogeological model of the area including the understanding of the geological and hydrogeological relationships of the various units in particular: the relationship of the Safety Bay Sands and the underlying Tamala Limestone units; interaction of Lake Richmond with the groundwater system; impact of tidal influence on the groundwater systems; the dynamics of the saltwater interface; groundwater recharge; and, potential impacts on the regional groundwater system.
2. Construction and calibration of a numerical groundwater model to the existing monitoring data collected as part of this proposal and from long-term regional data. The results and observations of the test pumping would also be utilised in the calibration of the groundwater model.
3. Undertaking simulations for the above construction scenarios to assess likely aerial extent of impacts, including cumulative impacts due to dewatering associated with the proposed duplication of the SDOOL.
4. The construction and calibration of a solute transport model to allow simulations of the potential changes in groundwater salinity that may to develop as a result of the marina increasing the connection between the groundwater and the ocean.

As described in Section 3.1.2, the Water Corporation is planning to undertake duplication of the SDOOL pipeline in the next five years. The Water Corporation has commenced discussions with regulatory agencies on this work, but has not yet formally referred the proposal to the EPA. As recommended by the EPA, modelling for the Mangles Bay Proposal has been undertaken in conjunction with the Water Corporation to ensure that the modelling is consistent with the modelling undertaken for the SDOOL, and that cumulative impacts of the two proposals can be considered. The same modellers have been used for both Proposals and the model utilised for the Mangles Bay Marina will be utilised for the SDOOL modelling.

6.3 Evaluation of options or alternatives to avoid or minimise impact

If construction occurs without dewatering, the main source of impact from the Proposal to the surrounding environment is expected to occur as a result of the hydrological changes due to the operation of the inland marina. This impact occurs because the marina allows greater interaction between groundwater and the sea. Because of this, the ocean water levels have a larger impact upon groundwater levels, such that groundwater levels around the marina may drop.

6.3.1 Construction method alternatives

The primary potential impact due to construction is the dewatering that may be associated with construction. Three construction method alternatives were considered for the construction of the inland marina, these were:

1. A dry construction method involving significant dewatering to ensure that the base of the marina or canal being constructed remains dry during construction. Under this scenario, dewatering would occur over a period of approximately five years. Additional information on the dry construction scenarios can be found in Appendix 5.
2. Construction of a reduced marina with only one canal using dry construction techniques. Under this scenario, dewatering would also occur over five years, but with a break of approximately twelve months in the middle.
3. A wet construction method involving the use of excavators and dredges to construct the marina with the use of no to very little dewatering, as described in Section 3.4.1.

The impact of these construction methods were investigated using a numerical groundwater model.

The construction of the marina results in a decrease in groundwater levels in area immediately surrounding the marina, as there is greater connection between the sea and groundwater in this area (Figure 21). The model indicated the following changes in water level at Lake Richmond during the construction of the marina and canals:

- maximum decrease of 0.42 m for dry construction
- maximum decrease of 0.19 m for dry construction of a marina with only one canal
- maximum decrease of 0.032 m for wet construction (ERM 2011, provided in Appendix 5).

Figure 22 shows a modelled time sequence of water levels in Lake Richmond during the wet construction scenario. Given the wet construction method showed a significantly lower impact on water levels in the lake (0.03 m as opposed to 0.42 m), it was considered to provide a better environmental outcome. Hence a wet construction method has been selected for this proposal.

In order to understand the cumulative impacts of the Water Corporation SDOOL construction and the Marina construction and operation, two scenarios were modelled for the SDOOL construction. The first scenario was developed based on assumed dewatering requirements and this scenario is included in the ERM Groundwater Model Report at Appendix 5. The second scenario represents a refinement of construction methodology.

A further scenario for the SDOOL construction relates to the revised alignment which would be required if the MBMBTP was implemented. With reference to Figure 7, the revised alignment departs the current alignment west of Lake Richmond to pursue an alignment along the southern boundary of the Proposal. This scenario has not been modelled as this section of the SDOOL will have little to no interaction with groundwater. This is described in SDOOL Scenario 3 below.

SDOOL Scenario 1 - Trenching associated with SDOOL duplication and relocation installation will require temporary dewatering to a depth of 1.84 to -1.56 m AHD. The locations and dewatering elevation were provided in the engineering drawings provided to ERM by TABEC. The proposed installation plan uses two separate working crews, each advancing the trenching continuously from east to west in 100 m segments, with each dewatering segment comprising a length of approximately 200 m (50 m in front and behind the 100 m trench), advancing at an approximate speed of 12.5 m/day. This scenario was used to model the potential cumulative impacts of SDOOL construction and is included in the ERM Groundwater Model Report at Appendix 5

SDOOL Scenario 2 - Trenching associated with the SDOOL installation will require temporary dewatering to a depth of 1.86 to -1.95 meters (m) Australian Height Datum (AHD), which is up to about 2 m below mean water level. The locations and dewatering elevations were given in the engineering drawings provided to ERM by the Water Corporation. The most recent proposed SDOOL installation plan involves advancing the trenching continuously from east to west, with the pipe to be installed in 100 m sections (advancing at an approximate speed of 25 m/day) and each dewatering segment comprising of a length of approximately 200 m (100 m trench plus 50 m behind and in front of the trench). This scenario has been modelled by the Water Corporation to support their application for approval for the SDOOL duplication. The modelling report is not available for inclusion in this report.

SDOOL Scenario 3 – Revised alignment. A concept design for the proposed realignment of the SDOOL pipeline was undertaken by GHD, which took into account and assessed the existing invert levels at each end of the section traversing the Mangles Bay project site. A requirement of the realigned concept design includes a connection to the existing invert levels outside of the project boundary.

The current SDOOL onsite includes a scour and air valve near the Safety Bay Road / Memorial Drive intersection to allow the pipe line to be elevated to an invert of 1.94m AHD. The current pipe then operates under gravity flow to the western boundary of the project where the existing invert is approximately 1.0mAHD as shown on the GHD sketches. The GHD concept design allows for the realigned route to provide a connection between these boundary points (eastern and western extent) and also considers minimum cover for adequate protection above the pipe which is provided.

It is understood the maximum groundwater exists at approximately 0.8m AHD and therefore the depth of construction of the proposed concept design, would require minimal to nil dewatering during construction.

It is expected that an invert within approximately 0.3m of ground water may experience wet ground and over excavation to allow for adequate bedding to be laid under the realigned pipe may be required during construction.

Based on the concept GHD plans, a significant dewatering program is not expected to cater for the construction of the SDOOL realignment.

Because a wet construction method was chosen for marina construction, and very little dewatering will occur, it was not necessary to model a 'best' and 'worst' case in terms of the impacts of dewatering for the Proposal. As such, only one scenario for groundwater changes has been provided, based on the proposed marina design.

6.3.2 Minimising operational impacts

The size of the marina affects operational impacts. A larger marina offers a greater area for interaction between groundwater and the sea, and thus larger impacts may be expected. The size of the marina did not appear to significantly change the long-term impact on the lake. A marina without any canals resulted in a drop in water levels in the lake of 1.8 cm during operation, while a marina with canals resulted in a drop of 3.8 cm (refer report provided in Appendix 5). A marina with canals was considered preferable to increase boat usage. Design steps undertaken to minimise the operational impact of the Proposal on groundwater include reducing the length of the south eastern canal of the marina to minimise impact to groundwater near TEC FCT30a (Figure 18). The reduction in the depth of the canals from an initially proposed -4 mAHD to varying from -4 mAHD at deepest depth with shallowest depth being -2.7mAHD may also reduce the impact of the marina on groundwater. Assessment of likely direct and indirect impacts

The use of wet construction methods will significantly reduce the impact of the proposal during construction, as outlined in Section 6.3.1. The long-term impacts of marina operation on water quality were determined by running the model, with the marina, for a period of 1000 years. If wet construction is used, the impact of construction of the marina on groundwater levels or quality is less than the long-term impacts (ERM 2011 provided in Appendix 5).

6.3.3 Impacts of marina construction using wet excavation on groundwater quality

Saltwater intrusion occurs when the interface between the saltwater and fresh groundwater moves inland. The construction of the marina will allow saltwater to move further inland through the marina. The salinisation in areas where groundwater was previously fresh may result in previously fresh bores becoming saline and changes in vegetation types to more salt-tolerant species. The potential for saltwater intrusion was modelled as part of the groundwater modelling (provided in Appendix 5).

A level of -12 m AHD is approximately half the depth of the Safety Bay Sands and is within the lower waters of Lake Richmond. This level is also considered to represent a reasonable depth for groundwater bores in the area.

Salinity impacts of construction are shown at -12 mAHD. A level of -12 m AHD is approximately half the depth of the Safety Bay Sands and is within the lower waters of Lake Richmond. This level is also considered to represent a reasonable depth for groundwater bores in the area. As groundwater salinity increases with depth, and there will not be extensive dewatering to move saltwater at shallow depths, the impacts at this level are considered to represent a 'worst case' for change in salinity at shallower depths. Groundwater to the south and east of the marina is not expected to be significantly affected. Modelling the excavation of the marina using wet construction methods did not significantly alter the salinity distribution in the area at -12 mAHD; only areas within 200 m of the coast would experience salinities greater than 2000 mg/L (Figure 23). The change in salinity during construction is very limited outside the Proposal area, with the saltwater wedge extending south by approximately 40 m at Safety Bay Road and east by approximately 20 m at Boundary Road (Figure 23). None the scenarios modelled resulted in a change in salinity of Lake Richmond.

6.3.4 Impacts of construction using wet excavation on groundwater bores

The changes in low water levels associated with construction are generally less than 0.4 m. This is a small impact, and within the level of seasonal variation of 0.9 m cited in Section 6.2.4. This level of change is small and is thus considered unlikely to cause domestic or other bores to become dry.

The council irrigation wells 1, 7 and 8 are expected to show an increase in salinity from greater than 1000 mg/L (which is marginal for irrigation) to greater than 2000 mg/L, the maximum level considered acceptable for irrigation.

The area impacted by increased groundwater salinity is generally not residential in nature and as such, household bores in the Rockingham – Shoalwater area are generally not expected to be impacted by changes in salinity (Figure 23). However, there is the potential that a few households between Well 7 and 8 and Rotary Park may experience increases in bore salinity (Figure 23). Water quality in this area appears to be already marginal for irrigation, and lot sizes are generally small, so it is unlikely that many of these households use bores for irrigation.

Prior to construction, the Proponent will develop a Groundwater Quality Management Plan to address impacts of potential changes in salinity on groundwater users, including measures to inform householders, investigating potential changes in location for council irrigation bores and measures to mitigate impacts upon affected households. This will be supported by a program of groundwater salinity monitoring.

6.3.5 Impacts of operation on groundwater levels

The long-term operational impact of the marina on groundwater levels is similar to the impact during construction (Figure 21, Figure 25). The groundwater levels around the marina fingers equilibrate, with a larger area around the marina experiencing groundwater levels less than 0.1 mAHD than is currently the case. Under a low water scenario, the 0.2 mAHD contour moves closer to the marina than occurred during construction, showing that a smaller area experiences groundwater levels less than this (Figure 24, Figure 25). Under a high (winter) water level scenario, the reduction in water levels in the vegetated area surrounding the Proposal during operation is less than 0.2 m (Figure 24). Under a low (summer) scenario, the impact is closer to 0.1 m (Figure 25). A long-term reduction in groundwater levels of 0.038 m is expected at Lake Richmond (ERM 2011).

The changes in low water levels associated with this proposal are generally less than 0.4 m. This is a small impact, and within the level of seasonal variation of 0.9 m cited in Section 6.2.4. This level of change is small and is thus considered unlikely to cause domestic or other bores to become dry.

6.3.6 Impacts of operation on groundwater salinity

The increased connection between seawater and groundwater in the area surrounding the marina may result in an increase in saltwater intrusion in the marina at a depth of -12 mAHD (Figure 26). The area experiencing salinities greater than 4000 mg/L extends further south and east, particularly between the marina and Cape Peron. The saltwater interface is modelled as sitting approximately along the southern and eastern edge of the marina. There is also some additional intrusion to the northeast of the marina. Salinities of groundwater under Lake Richmond are not expected to change (Figure 26).

A small portion of the DEC-mapped TEC FCT 30a will be affected by the increase in salinity. However, this area is proposed to be cleared as part of the Proposal (Figure 26) and as described in Section 8.2.1, for the purposes of this PER the ENV (2010) mapped extent of the TEC is utilised until further mapping is undertaken.

The irrigation wells 1, 7 and 8 are expected to show an increase in salinity to greater than 2000 mg/L, the maximum level considered acceptable for irrigation.

The area impacted by increased groundwater salinity in the long-term is generally not residential in nature and as such, household bores in the Rockingham – Shoalwater area are generally not expected to be impacted by changes in salinity (Figure 23). However, there is the potential that some households between the Proposal Area and Rotary Park may experience increases in bore salinity (Figure 23).

Householders and landowners in the affected areas will be notified of the issue and offered alternative water supplies for irrigation as outlined in Section 6.3.4.

Source: Cadastral data supplied by Landgate (2010)
Groundwater Contours supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F056.dgn

Modelled groundwater contours during construction - high water levels

Figure No: **20**

Source: Cadastral data supplied by Landgate (2010)
Groundwater Contours supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

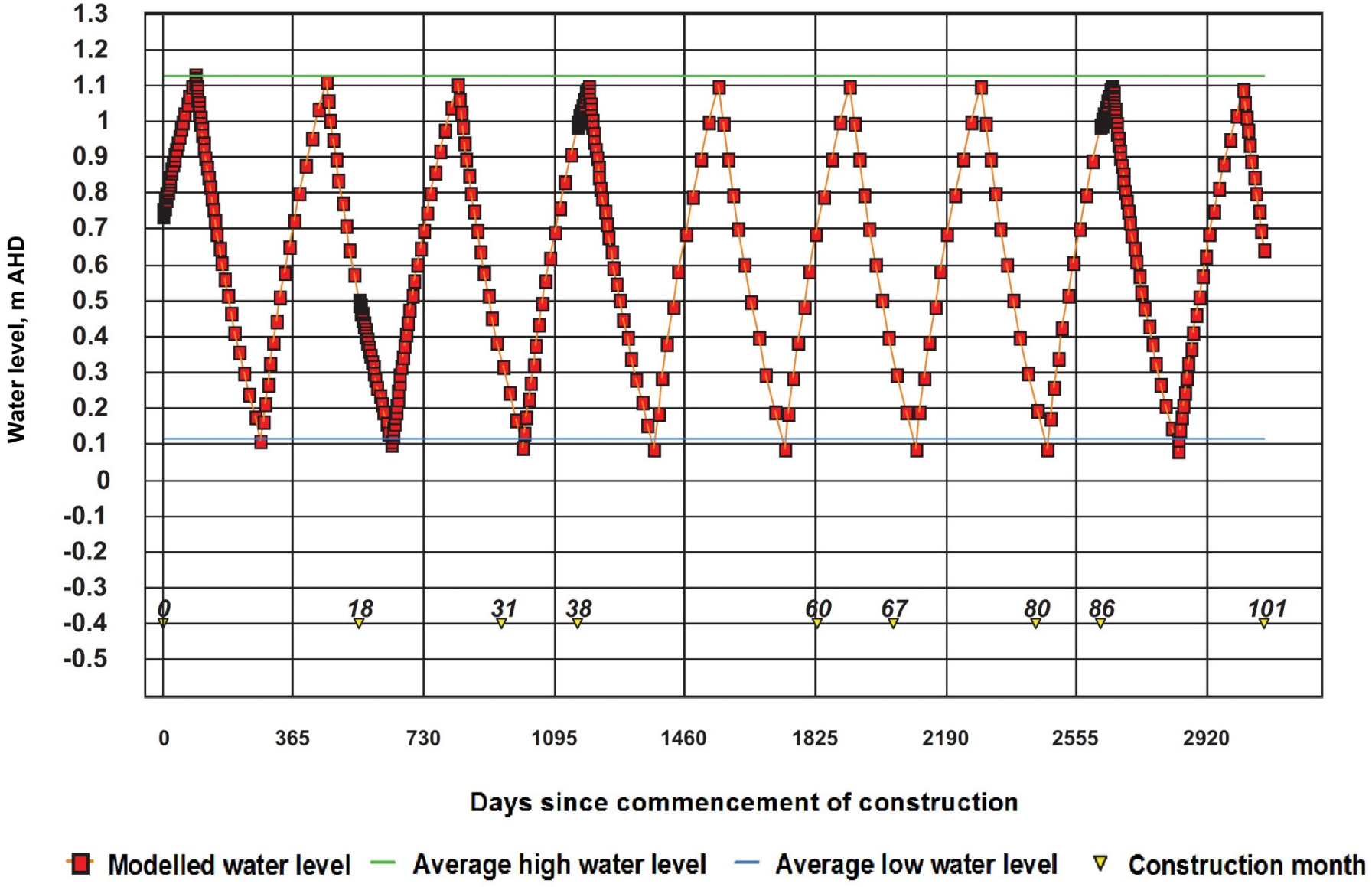
STRATEGEN
environmental consultants

Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F037.dgn

Modelled groundwater contours during construction - low water levels

Figure No: **21**



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Mangles Bay Marina Based Tourist Precinct

Modelled Lake Richmond Water Level during construction

Figure 22

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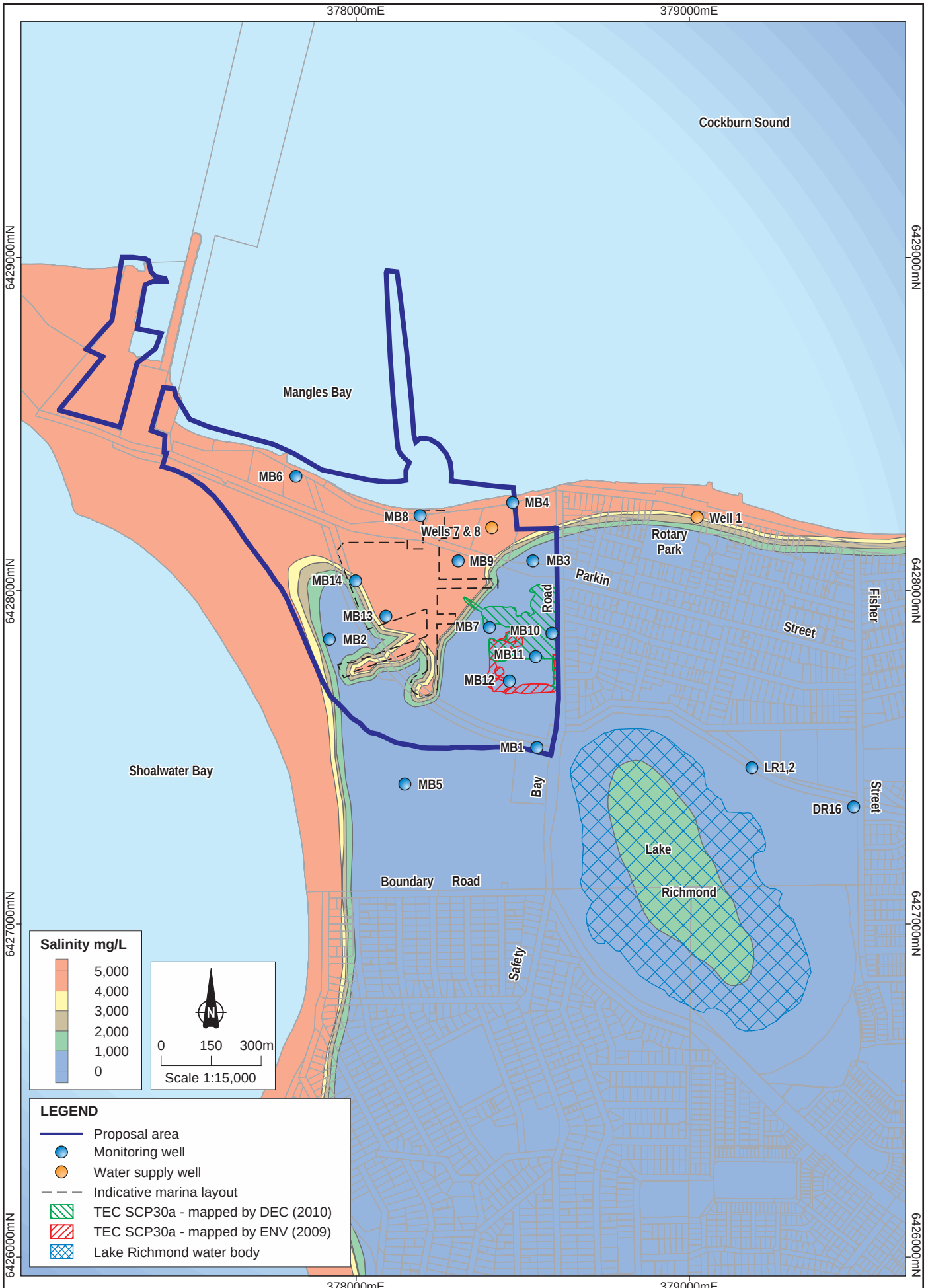

Source: Cadastral data supplied by Landgate (2010)
Modelled salinity supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

STRATEGEN
environmental consultants

Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F038.dgn

Modelled salinity distribution during construction at -12 m AHD

Figure No: **23**

Source: Cadastral data supplied by Landgate (2010)
Groundwater Contours supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

STRATEGEN
environmental consultants

Drawn:
CAD Resources

CAD Resources File No:
g1937_MB_PER_F058.dgn

Modelled groundwater contours post construction - high water levels

Figure No:
24

Source: Cadastral data supplied by Landgate (2010)
Groundwater Contours supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

STRATEGEN
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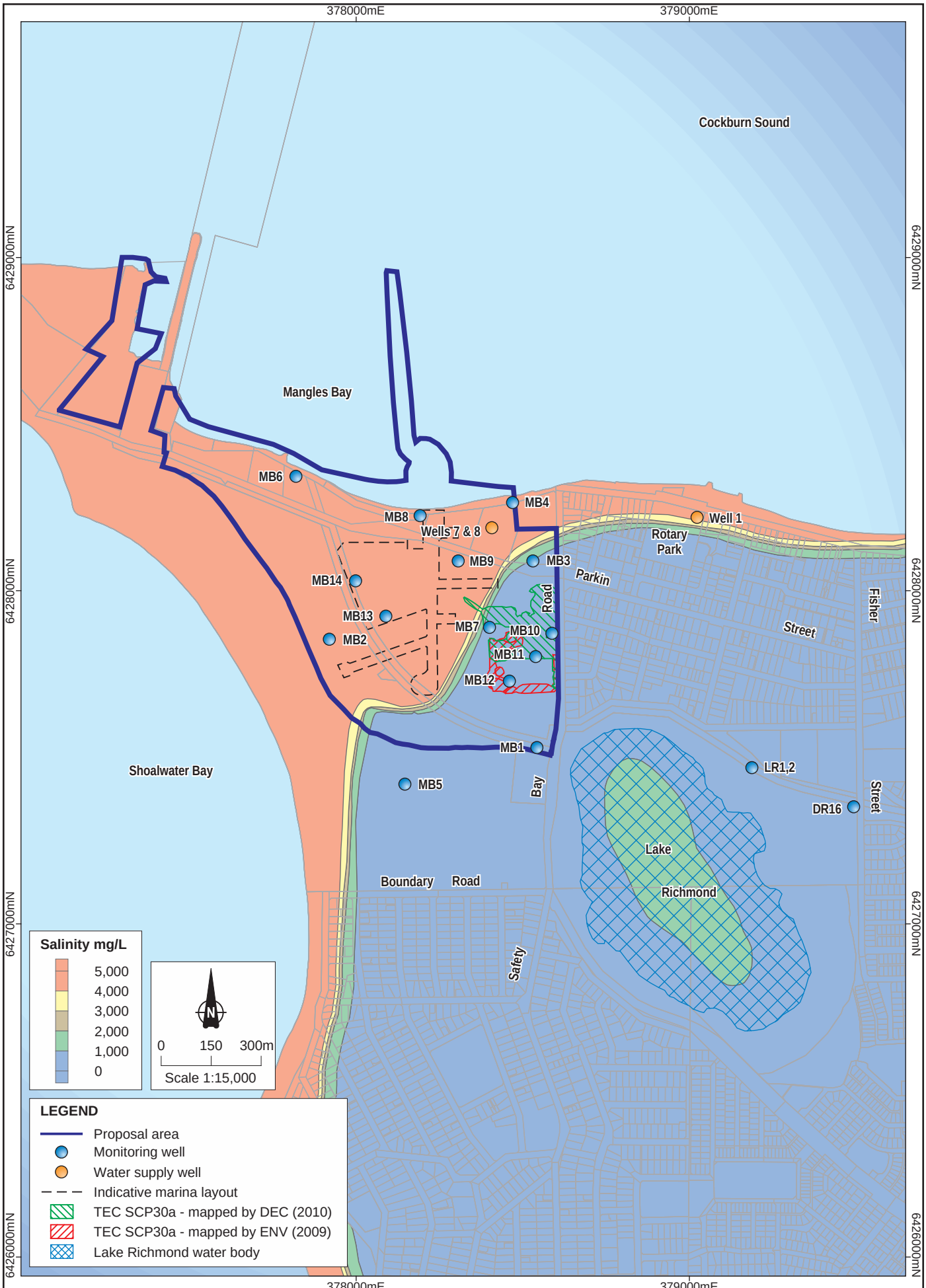
Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F041.dgn

Modelled groundwater contours post construction - low water levels

Figure No: **25**



Source: Cadastral data supplied by Landgate (2010)
Modelled salinity supplied by ERM (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

STRATEGEN
environmental consultants

Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F039.dgn

Modelled salinity distribution during operation at -12 m AHD

Figure No: **26**

6.3.7 Impacts on water quality factors other than salinity

The clearing of vegetation for urban or rural land uses can lead to an increase in nutrient and metal concentrations in groundwater due to fertiliser use and anthropogenic inputs such as road runoff. Urban nutrient inputs are generally higher in areas with large blocks, due to increased areas of garden that are fertilised (Water and Rivers Commission 2002). The Proposal will be designed with the intent of maintaining or reducing groundwater nutrient concentrations in line with *Better Urban Water Management* (BUWM) (WAPC and DPI 2008). In line with *BUWM:*

- a District Water Management Strategy (DWMS) will accompany the Metropolitan Region Scheme amendment and outline concepts for water quality management on the site
- LWMS will accompany the LSP to outline the measures being undertaken to manage water quality (WAPC and DPI 2008).

Both documents will be approved by the DoW and City of Rockingham as part of the approval process. Measures undertaken may include treatment of stormwater prior to infiltration, minimising fertiliser use in POS and providing householder education on fertiliser use.

The potential impacts of changes in the quality of groundwater that discharges to Mangles Bay is discussed in Section 10.

6.3.8 Public Open Space irrigation within the Proposal Area

The development proposes the construction of only limited new areas of POS along the Mangles Bay foreshore (Figure 6). This area will be predominantly sandy beach and hard surfaces that will not require irrigation. Limited irrigation may be required for establishment and maintenance of landscaped areas during the drier months. This water may be sourced from offsite groundwater. The irrigation requirements and how these will be managed will be investigated as part of the LWMS.

6.4 Assessment of likely direct and indirect impacts

The following aspects may potentially impact on groundwater values within the Proposal area:

- changes to groundwater levels due to the presence of the marina allowing more interaction between local groundwater and the sea, resulting in:
  - lowering of water levels in nearby private garden bores
  - exposure of ASS if they exist within the land development area
- saltwater intrusion caused by the inland movement of the saltwater-groundwater (fresh) interface due to the inland marina, that may result in:
  - increasing salinity in local bores
  - salt entering the root zone of potentially salt sensitive native species.

As the marina will be constructed predominantly without dewatering, the construction of the marina will not impact upon groundwater levels. Limited, temporary dewatering may be required for construction of services, such as sewerage and gas. Potential for and nature of any cumulative impacts

Should the marina construction coincide with the relocation and duplication of the SDOOL pipeline by Water Corporation, dewatering and construction activities for both proposals may occur simultaneously.

Three SDOOL scenarios were assessed with construction technique/alignment representing the biggest impact being modelled (Appendix 5).

Using the construction methods advised by the Water Corporation and GHD (Section 6.3.1), the construction of the SDOOL is assessed as having the following impacts to Lake Richmond:

Scenario 1 - Without the marina present resulted in a decrease in water levels at Lake Richmond of 0.24 m (Appendix 5). With the marina being constructed at the same time, the decrease was 0.25 m.

Scenario 2 - Low seasonal water levels in Lake Richmond during the SDOOL duplication construction dewatering without recharge will be reduced by 0.11 m and return to natural conditions within a year after construction; Low seasonal water levels in Lake Richmond during the SDOOL duplication construction with dewatering recharge to the construction trench will be reduced by 0.009 m and return to natural conditions within 6 months after construction

Scenario 3 – the construction of the SDOOL at the revised alignment has little to no interaction with the groundwater table and therefore dewatering is not required and the SDOOL construction does not contribute to any impacts on Lake Richmond.

The cumulative impact of the two proposals on Lake Richmond is predominantly due to the construction of the SDOOL. As modelled, the construction of the SDOOL is a relatively short-term proposal, with dewatering expected to occur for 160 days (ERM 2011, provided in Appendix 5). Determining the acceptability of the impacts of the SDOOL duplication, and how these may be managed or mitigated, are not within the scope of this PER, but are a matter to be discussed between the Water Corporation and the relevant regulatory authorities.

6.5 Management measures and performance standards

Management measures will be implemented to minimise the impacts on groundwater. These management measures are described below:

1. Marina constructed will involve a wet construction method involving the use of excavators and dredges to construct the marina with the use of no to very little dewatering.
2. Dewatering for the relocation of the SDOOL and service construction is expected to be below the threshold where a dewatering license is required. Should it be decided that this volume will be exceeded, a license application and Dewatering Management Plan will be submitted to the DoW.
3. Prior to construction, the Proponent will develop a Groundwater Quality Management Plan to address impacts of potential changes in salinity on groundwater users, including measures to inform householders, investigating potential changes in location for council irrigation bores and measures to mitigate impacts upon affected households. This will be supported by a program of groundwater salinity monitoring.
4. Bores surrounding the marina will be monitored quarterly for water levels and salinity during construction, and for three years following construction.
5. A District Water Management Strategy will be prepared to accompany the MRS.
6. A LWMS will be prepared to accompany the LSP and outline management measures for groundwater quality and quantity, and potable and non-potable water supplies.

It is considered that with the use of these management measures and performance standards, the development can effectively manage any impacts on water quality.

6.6 Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures

After mitigation measures as described above, the proposal is expected to be able to:

1. Result in a minimal reduction in groundwater levels at Lake Richmond of 0.032 m during construction and 0.038 m during operation.
2. Ensure no impact to groundwater quality at Lake Richmond during construction or operation.
3. Manage the limited impacts to bore users in the Rotary Park area through the implementation of mitigation measures in line with the proposed Groundwater Quality Management Plan.

These impacts are considered to be acceptable as the key environmental values for groundwater surrounding the Proposal will not be significantly affected.

Through the implementation of the management measures and performance standards outlined above, it is considered that the Proposal will meet the EPA guidelines for the management of water.

7. Surface water impact assessment

7.1 Relevant environmental objectives, policies, guidelines, standards and procedures

7.1.1 EPA objectives

The EPA applies the following objective in assessing proposals that may affect surface water:

To maintain the integrity, ecological functions and environmental values of wetlands

To maintain the quantity and quality of water (groundwater and surface water) so that existing and potential environmental values, including ecosystem maintenance, are protected.

To maintain biological diversity where that represents the different plants, animals and micro-organism, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.

7.1.2 Legislation, policy and guidance

National

In 1996, the Australian and New Zealand Environment and Conservation Council (ANZECC) together with the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) developed the National Principles for the Provision of Water for Ecosystems (ANZECC/ARMCANZ 1996). These national principles aim to improve the approach to water resource allocation and management and to incorporate the water requirements of the environment in the water allocation process. The overriding goal of the principles is to provide water for the environment to sustain and, where necessary, restore the ecological processes and biodiversity of water-dependent ecosystems.

A set of water quality guidelines for the protection of marine and freshwater ecosystems has also been released under the auspices of the National Water Quality Management Strategy (ANZECC/ARMCANZ 2000). The guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies, and are applied to five geographical regions across Australia and New Zealand.

A series of guidelines on national water quality management have also been released by the NRMMC and, in some cases, in collaboration with the NHMRC and the Australian Health Ministers Conference. These guidelines address a range of issues including policies and processes for water quality management, water quality benchmarks, groundwater management, diffuse and point sources, guidelines for sewerage systems, effluent management and water recycling.

State water quality management strategy

The Government of Western Australia developed the State Water Quality Management Strategy in 2001 (Waters and Rivers Commission 2001) to supplement the National Water Quality Management Strategy with the objective 'to achieve sustainable use of the Nation's water resources by protecting and enhancing their quality while maintaining economic and social development'.

State water strategy

The Government of Western Australia developed the State Water Strategy in 2003 with the objective of achieving a sustainable water future for all Western Australians by:

- improving water use efficiency in all sectors
- achieving significant advances in water reuse
- fostering innovation and research
- planning and development of new source of water in a timely manner
- protecting the value of our water resources.

Wetlands Conservation Policy for Western Australia

The *Wetlands Conservation Policy for Western Australia* was developed by the Western Australian Government in 1997. Its main aims include:

- to prevent the further loss or degradation of wetlands, and promote wetland conservation, restoration and creation
- to maintain, in viable wild populations, the species and genetic diversity of wetland-dependent flora and fauna
- to maintain the abundance of waterbird populations, particularly migratory species
- to increase community awareness and appreciation of wetlands, and the importance of good management of wetlands and their catchments.

Environmental Protection of Wetlands Preliminary Position Statement

The *Environmental Protection of Wetlands Preliminary Position Statement* (Position Statement No. 4) (EPA 2004e) was developed by the EPA in 2004 and requires that:

- environmental values and functions of wetlands will not be adversely affected
- biological diversity of wetland habitats will be protected, sustained, and, where possible, restored
- environmental quality of the wetland ecosystems will be protected through sound management in accordance with the concept of 'wise use', and ecologically sustainable development principles
- no net loss of wetland values and functions are to occur.

Environmental Protection (Swan Coastal Plain Lakes) Policy 1992

Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (EPP) prohibits degradation of any registered EPP lake without assessment by the EPA (EPA 1992). Lake Richmond is a registered lake under the EPP. The PER process is one EPA assessment tool for assessing impacts to an EPP lake.

Interim Recovery Plan No. 122: Thrombolite community of coastal freshwater lakes (Lake Richmond), interim recovery plan – 2003 – 2008

Interim Recovery Plans (IRPs) are developed within the framework outlined in Department of Conservation and Land Management Policy Statements Nos. 44 and 50 (CALM 2003b).

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

The Interim Recovery Plan (to operate until it is replaced) provides guidance on the Objectives, Criteria for Success and Criteria for Failure for the Thrombolite community within Lake Richmond.

Guideline for the Determination of Wetland Buffer Requirements

The WAPC has developed a *Guideline for the Determination of Wetland Buffer Requirements* to assist land owners, developers, planners and architects in identifying appropriate buffering between wetlands and existing or proposed land uses that will enhance or maintain the significant attributes and values of the wetland (WAPC 2005b).

The EPA promotes that the requirements of wetland conservation can extend beyond reserve or wetland boundaries and that maintaining native vegetation around wetlands has a beneficial effect on water quality and aesthetics and is essential for wetland fauna.

As a general guide, a wetland function area is defined by the outer boundary of the wetland vegetation or the geomorphologic boundary, whichever is the larger (WEC 2002). A buffer of 50 m between intensive land uses and Conservation Category Wetlands and Resource Enhancement Wetlands is recommended (WAPC 2005b).

Stormwater Management Manual

The Stormwater Management Manual (DoW 2004-2007) was developed by the Government of Western Australia to provide a consistent approach to stormwater management, while considering a variety of stormwater management options to be considered by land developments across Western Australia. The manual provides case studies and planning approaches for the consideration of stormwater management at the early planning stages of a land development, with an emphasis on source controls, regulation and education.

The Stormwater Management Manual provides the minimum best management practice to be applied for the management of stormwater to land developments. The manual focuses on the need to integrate a range of stormwater management measures, including urban design principles to be considered within the framework of 'Water Sensitive Urban Design' that maximise local retention, reuse of stormwater and management of 'non-point source' pollutants.

7.2 Findings of surveys and investigations

7.2.1 Surface water hydrology of the Proposal area

The topography of the Proposal area varies between 0 and 8 mAHD (Figure 27). The site is higher in the south and west, due to the occurrence of a series of small rises that run in an approximate northeast to southwest direction. The Lake Richmond Outlet Drain runs through the site, along Memorial Drive (Figure 28).

The soils of the Proposal area and surrounds are Safety Bay Sands, which are known for their high permeability (Gozzard 1983). Because of this, rain falling in the area will infiltrate during storm events. Runoff is unlikely to occur, except perhaps during extreme events such as the 1 in 100 year rainfall event. Because of this and the general slope of the Proposal area towards the coast rather than Lake Richmond, and the presence of the Lake Richmond outlet drain on the site (Figure 28) runoff from the Proposal area would not currently enter the lake.

7.2.2 Lake Richmond

Lake Richmond is a perennial, freshwater lake occupying an area of approximately 49 ha and a depth of approximately 14 m (MWH 2011a), making it one of the deepest lakes in the Metropolitan area. The lake is thought to have been part of the Cockburn Sound and was isolated from the sea when part of the marine portion of Cockburn Sound was in-filled during the last 4000 years (CALM 2003b).

The interaction between Lake Richmond and groundwater changes over the year. During late winter and spring, the surface water levels in the lake rise faster than groundwater levels, and the lake discharges water to the north and west. During the summer and early autumn, the water level in the lake drops faster

than groundwater, and the lake receives water from groundwater on all sides. Between these times, groundwater flows through the lake, entering on the south and east and discharging to the north and west. Further information regarding this can be found in Section 6.2.4.

The lake also receives stormwater runoff from urban areas via three drains in the southern part of the lake (Figure 28) (MWH 2011a). It is estimated that approximately 1 GL/yr (1000 ML/yr) of stormwater enters the lake (MWH 2011b). There are no natural streams or creeks entering or leaving the lake. The outlet drain was constructed in 1968 (CALM 2003b) with inlet drains being constructed as the catchment became urbanised between this time and 2005.

The Lake Richmond Outlet Drain discharges water from the lake into Cockburn Sound when the water level exceeds the weir height of 0.58 mAHD. The weir also prevents seawater entering the lake during storm events, when sea levels rise.

Water levels in Lake Richmond have been monitored since 1946 and regular monitoring by DoW has occurred since 1978 (Figure 29). Water levels in the lake vary seasonally from between approximately 0.2 and 1.2 mAHD, with water levels generally peaking in spring and being lowest in summer/autumn, prior to the commencement of winter rainfall (MWH 2011a). Based on these levels, approximately 24.4 ha of the lake bed is considered to be seasonally inundated (i.e. inundated at the average high water level but not the average low water level (Table 9). Low water levels may vary by more than 0.3 m between years (Figure 29). High water levels are similarly variable between years (Figure 29).

Table 9 Lake Richmond average water levels and area inundated

Water level	Low	Mean	High	Annual variation
Average water level	0.2 mAHD	0.74 mAHD	1.2 mAHD	1 m
Area inundated (ha)	31.0	48.9	55.4	24.4

This change in water levels leads to the seasonal exposure of a significant area around the perimeter of the lake. Examples of this extrapolated from historical aerial photos show the historical extent of the lake waterbody, including high and low water levels as shown in Figure 30. In the higher water levels recorded, the thrombolites and some vegetation would be covered by water (Figure 30). At the low water levels, a portion of the area containing thrombolites would be covered in water.

Water quality in the lake is fresh, with values of between 400 mg/L and 1400 mg/L TDS being recorded (MWH 2011a). Prior to the construction of the drains, brackish salinity levels of 2000 mg/L to 3500 mg/L were recorded (Passmore 1970; CALM 2003b). The pH is slightly alkaline, and has varied between 8.3 and 9.3 (CALM 2003b).

Algal blooms have been previously recorded in the lake, including in 2002 and 2003 (Rose *et al.* 2004). One bloom sampled in September 2002 showed high levels of potentially toxic blue-green algae (*Microcystis* spp) (Naragebup 2003). Algal blooms are driven by elevated levels of the nutrients phosphorus and nitrogen (Hemond & Fechner-Levy 2000). No information was available on algal blooms in the lake since 2004.

The City of Rockingham is currently undertaking a Water Quality Study and developing an Integrated Catchment Management Plan for Lake Richmond.

Source:
Topographic data supplied by Landgate (2011)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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CAD Resources File No:
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Proposal area topography

Figure No:
27

Source:
Aerial Photography supplied by Landgate (2010)
Coordinate System: MGA94 Zone 50
Date: 10/1/2012
NB: Potential errors may occur in some areas

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CAD Resources File No:
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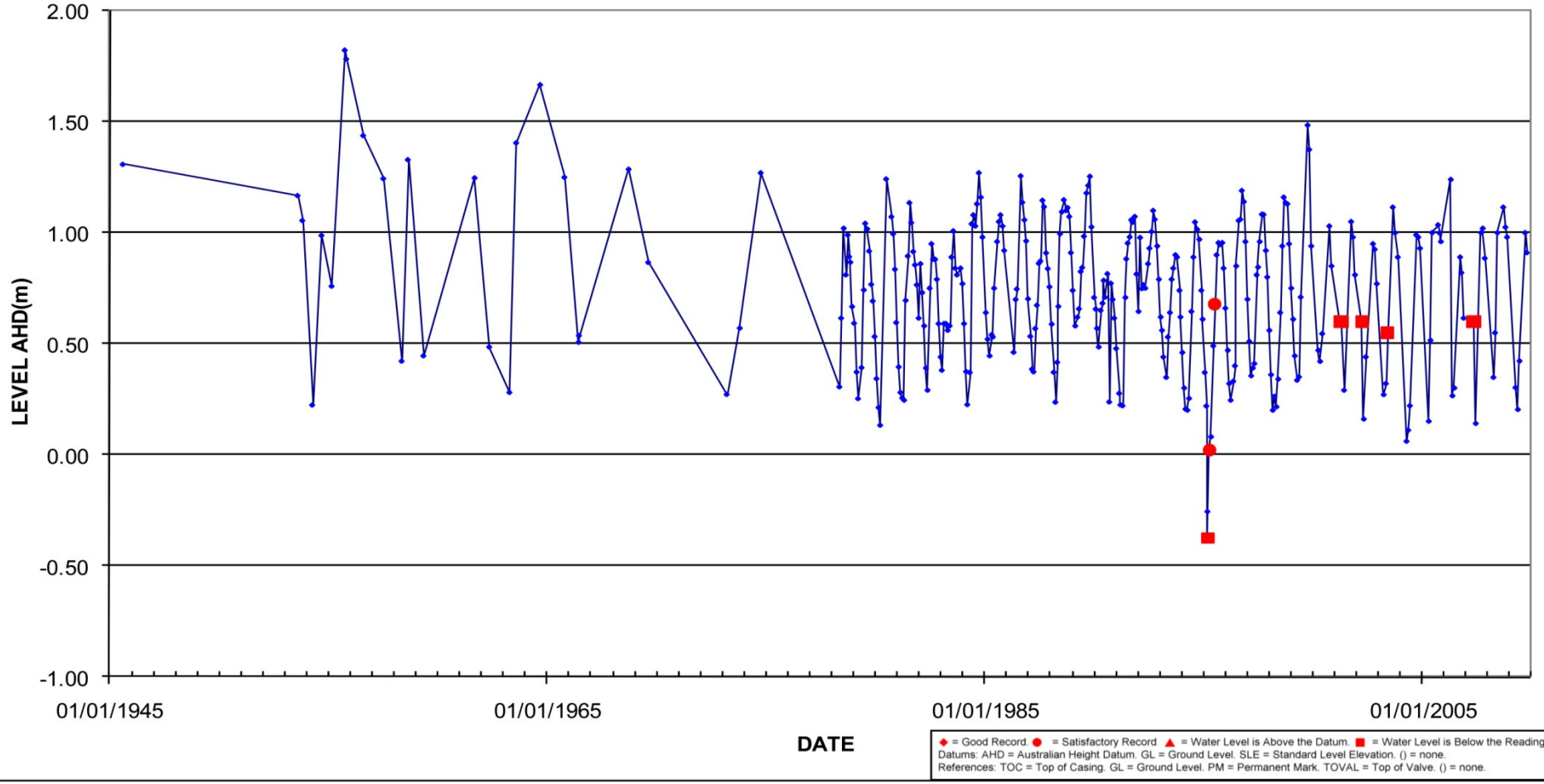
Surface water features and stormwater drainage

Figure No:
28

Government of Western Australia
Department of Water

6142501 LAKES AND WETLANDS LAKE RICHMOND

Easting = 378808.00 Northing = 6427609.00 Zone = 50 PM = 2.84mAHD WIN SITE ID = 13662



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Mangles Bay Marina Based Tourist Precinct

Lake Richmond historical surface water levels graph

Figure 29

strategen
Oct-2011

Source:
Aerial photography supplied by Landgate (2010)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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CAD Resources File No:
g1937_MB_PER_F030.dgn

Lake Richmond historical surface water levels and extent of waterbody

Figure No:
30

Hydrology and Water Quality Monitoring Program

Lake Richmond has been monitored by MWH since January 2010, and monitoring is planned to continue until October 2011. This report includes monitoring results up to, and including, March 2011. The surface water investigations undertaken to date (MWH 2011b, provided in Appendix 5) include:

- depth transects of the lake
- lake water level monitoring using a datalogger
- monthly water quality monitoring at two sites; each sample is analysed for standard water quality (pH, EC, TDS, Na, K, Ca, Mg, Fe, Cl, SO_4, NO_3, HCO_3 and CO_3), TSS, DO, TN, TP, nitrite, RFP (subsequent anions), eight standard metals (As, Cd, Cu, Cr, Hg, Pb, Ni, Zn), hydrocarbons (TRH $C_6 – C_{36}$), turbidity (NTU) and colour
- monthly stratification monitoring at three sites in the lake with EC, pH, DO and temperature recorded at 1 metre depth intervals.

Monitoring locations are shown in Figure 32. Additional detail regarding the monitoring program and results can be found in Appendix 5.

Bathymetry and depth transects

Depth transects of Lake Richmond were undertaken by MWH in January 2010 (MWH 2011a). An additional detailed survey of the lake fringe bathymetry was undertaken by Strategen in August 2011 (Figure 30). Cross sections of Lake Richmond are provided in Figure 38, Figure 39, Figure 40 and Figure 41.

The lake has a comparatively flat, shallow edge between approximately 0 and 1.5 mAHD (Figure 30). Beyond this, a steep descent (generally greater than 1 in 6) occurs to a depth of -10 to -14 mAHD (MWH 2011a). The base in the middle of the lake appears to be relatively flat. Based on an average water level variation between 0.2 and 1.2 mAHD, the area of inundation in the lake would be expected to vary from between 31 ha and 55 ha over an average year.

Water levels

Water levels in the lake varied between approximately -0.1 and 0.85 mAHD over the monitoring period (MWH 2011a) (Figure 33). Water levels peaked in September 2010 following winter rains, and were at their lowest in March 2011 (Figure 33). Water levels were above the 0.58 mAHD level that allows water to flow out of the lake via the Outlet Drain between July and November 2011 (Figure 33). A July to November flow period was also recorded in 2002 (Naragebup 2003). The long-term average water level in the lake is 0.74 m (MWH 2011d) (Figure 29).

Water quality

Water quality was monitored monthly at two locations within the lake, and on one occasion at the stormwater outlet over the period January 2010 to March 2011 (Figure 32). The lake was generally alkaline, with pH varying between 7.6 and 9, which can be expected given the high concentrations of calcium carbonate (lime) in the local soils (MWH 2011a). The water was slightly brackish, with salinity between 520 and 660 mg/L (MWH 2011d).

Table 10 ANZECC/ARMCANZ (2000) guidelines for water quality in slightly disturbed ecosystems in south west Australia

Item	Freshwater lake guideline (mg/L)	Wetland guideline (mg/L)	Lake Richmond (average and maximum) (mg/L)
Total Phosphorus (TP)	0.01	0.06	0.02 0.03
Total Nitrogen (TN)	0.35	1.5	0.92 1.9

Nitrogen and phosphorus are important environmental chemicals, in that they provide nutrients for biological growth. However, elevated nitrogen and phosphorus concentrations can result in algal blooms, such as the *Microcystis* blooms that have occurred in the lake (Ecoscape 2008). Water quality in the lake exceeded the ANZECC/ARMCANZ (2000) guidelines for TN and TP in freshwater lakes in slightly disturbed ecosystems in south west Australia (Table 10). This is consistent with the results of Naragebup (2003), which noted that nitrogen and phosphorus levels in the lake exceeded the ANZECC guidelines with respect to nitrogen and phosphorus. This is not surprising given the urban nature of the surrounding areas and volumes of urban stormwater entering the lake. Nitrogen and phosphorus in the lake are likely to come from stormwater and groundwater from urbanised areas, due to the use of fertilisers on gardens and POS.

Stratification monitoring

Stratification monitoring was undertaken at three locations within the lake to determine whether the chemical and physical properties of the lake varied with depth (Figure 32) (MWH 2011d). This is an important parameter for deep lakes, such as Lake Richmond, where physical and chemical properties may vary significantly with depth. These changes may represent a lake interacting with saline water or represent changes in physical processes with depth that may impact on the behaviour of the lake. Properties may vary over the year due to changes in air temperature; solar radiation; degree of mixing due to wind; and, groundwater salinity following rainfall. All three locations showed similar results. Results for Site 2 are discussed under this heading. Results for all sites are provided in Appendix 5.

Lake Richmond appears to be a comparatively well mixed lake, with pH, temperature and EC remaining relatively stable above -10 mAHD, except during the summer months (MWH 2011d). Temperature in the lake varied between approximately 14 and 28°C, with deeper waters being a few degrees cooler than shallower waters in summer (Figure 34). There is a slight decrease of pH from approximately 9 to 7(Figure 35) and an increase in EC from 0.9 mS/cm (approximately 550 mg/L TDS) to 1.4 mS/cm (approximately 840 mg/L TDS) (Figure 36) with depth. While salinity at the bottom of the lake is slightly brackish, it is well below the salinity of seawater at approximately 35 000 mg/L.

Between January and April, a layer of more saline, alkaline and less oxygenated water occurs in the lower four metres of the lake. This appears to disappear in autumn, possibly due to increased wind mixing or freshwater inputs.

Functional Ecology

Thrombolites

The Thrombolite TEC is an association of microorganisms that aggregate in rock-like formations, formed by the deposition of calcium carbonate during growth and metabolic activity within the community micro-environment (Figure 31) (Moore 1991). The area of thrombolite habitat is not well defined. No formal mapping of the thrombolites has occurred (English V [DEC] 2011, pers. comm. 26 September).

Thrombolite structures at Lake Richmond occur from perhaps 0 mAHD to within the vegetated fringe of the lake (CALM 2003b). Old stranded thrombolites (no longer living) have been reportedly identified immediately to the east of Lake Richmond (CALM 2003b). It is therefore difficult to establish the veracity of the area covered by the active community or the ecological water requirements of the thrombolites. It is inferred that at least seasonal inundation and seasonal drying is required for thrombolites to persevere.

An unconfirmed observation made by a member of the public indicates that the Thrombolites have also established near the weir in the Lake Richmond Outlet Drain, since this was constructed in 1968. Whilst this is unsubstantiated (due to water levels being too high during the writing of this PER) (this potentially indicates that the community is capable of colonising new areas over time.

The survival and growth of the community is considered to be dependent upon light and a continuing supply of fresh water which is rich in calcium and bicarbonate/carbonate (ESSS 2007). Groundwater in the area contains these chemical components as a result of the dissolution of the shell fragments commonly found in the Safety Bay Sands (Davidson 1995). The thrombolites at Lake Richmond appear to

be adapted to fresh or brackish water, and would be unlikely to survive major increases in salinity (ESSS 2007).

Sedgelands in Holocene dune swales

The Sedgelands TEC occurs in linear damplands and occasionally sumplands between Holocene dunes. The TEC is not limited to Lake Richmond, occurring at eight locations in the Rockingham Becher Plain area and at two other locations in the South West, with a total estimated area of 130 ha (CALM 2002). Approximately 11 ha of this TEC occurs in a band around the edge of Lake Richmond (CALM 2002). This band extends to the edge of Safety Bay Road.

Hydrological regime is considered to be the primary non-biological factor that influences the characteristics of this TEC (CALM 2002). Depth, timing and duration of flooding and length of the dry period affect vegetation composition and distribution (CALM 2002). Sedgelands in damplands and sumplands of the Holocene dune swales have relatively specific water regime requirements to maintain current biology, but are tolerant of seasonal and longer-term variations that reflect natural climatic patterns. Maintenance of water level and quality is considered critical for this TEC (CALM 2002).

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Thrombolites at Lake Richmond

FIGURE 31

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Oct-2011

Fauna

Aquatic vertebrates in Lake Richmond were surveyed by Rose (1998) and Rose *et al.* (2004). The 2004 survey found that the native *Pseudogobius olorum* (Swan River goby) was the most common species (Rose *et al.* 2004). The feral *Gambusia holbrooki* (mosquito fish) was also recorded in large numbers, and one native *Mugil cephalus* (sea mullet) was also caught (Rose *et al.* 2004). Feral *Carassius auratus* (goldfish) were also considered likely to be present in the lake.

Rose *et al.* (2004) also noted the presence of numerous introduced *Cherax destructor* (yabbies) in the lake, which "were observed coming out of holes that they had presumably constructed, within the thrombolites".

Five species of amphibians have also been observed in the area (ENV 2011a).

The minimal impacts modelled to occur to water levels in Lake Richmond, are not sufficient to impact these species.

Additional information regarding fauna in the Lake Richmond area can be found in Section 9.2.2.

Conservation Status and Buffers

Lake Richmond is listed as an EPP lake and as a Conservation Category wetland in the Geomorphic Wetlands of the Swan Coastal Plain dataset. Conservation Category wetlands are considered to support a high level of ecological attributes and functions. Lake Richmond is not listed under the Directory of Important Wetlands in Australia (Commonwealth) or List of Wetlands of International Importance of the Ramsar Convention (Commonwealth).

7.2.3 Rotary Park Lake

A small, artificial lake called Rotary Park Lake is located approximately 300 m east of the eastern boundary of the Proposal (Figure 1). The lake is a permanent water body maintained by City of Rockingham and has aesthetic value but little environmental value. The lake also has a drainage function (Ecoscape 2009). Ecoscape (2009) recorded a brackish salinity of 2220 to 2230 mg/L in this lake.

Rotary Park Lake is not listed as an EPP lake. It is not included in the Geomorphic Wetlands of the Swan Coastal Plain dataset.

Because of the limited size, limited environmental value of the lake and the limited potential for the Proposal to impact the lake, it was not monitored as part of this Proposal.

Source: Aerial Photography supplied by Landgate (2010)
Water monitoring data supplied by MWH (2010)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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CAD Resources File No: g1937_MB_PER_F024.dgn

Surface water monitoring locations and transects

Figure No: **32**

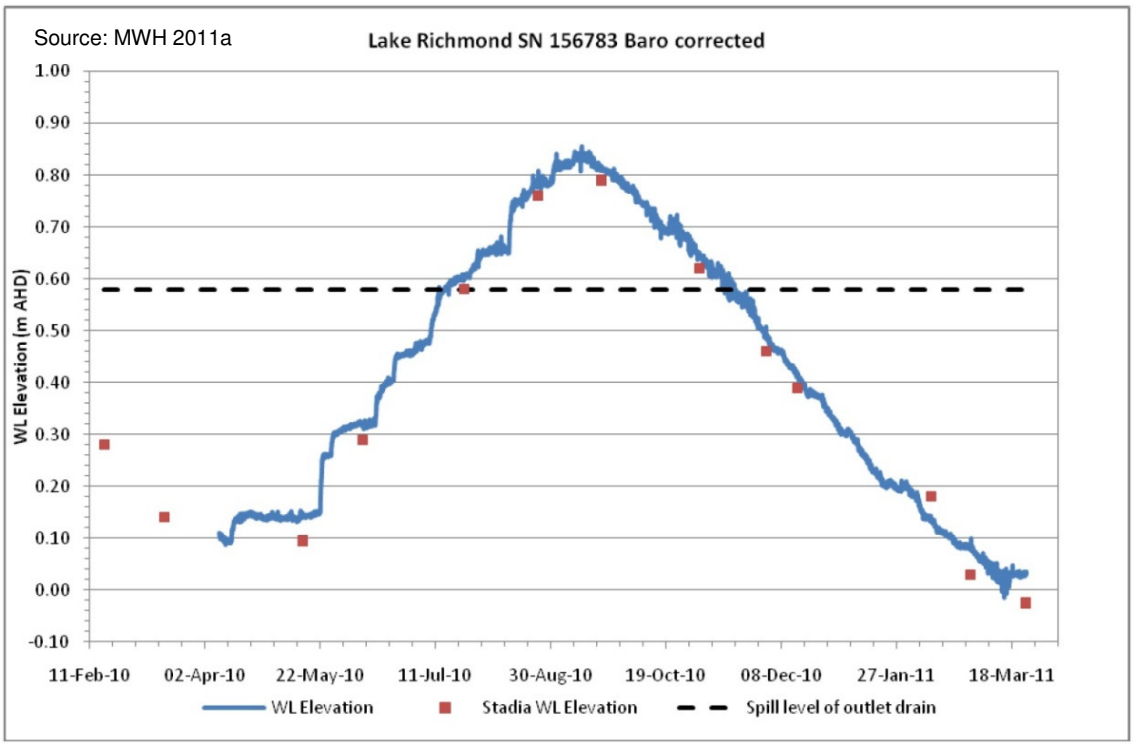


Figure 33 Lake Richmond surface water levels during monitoring

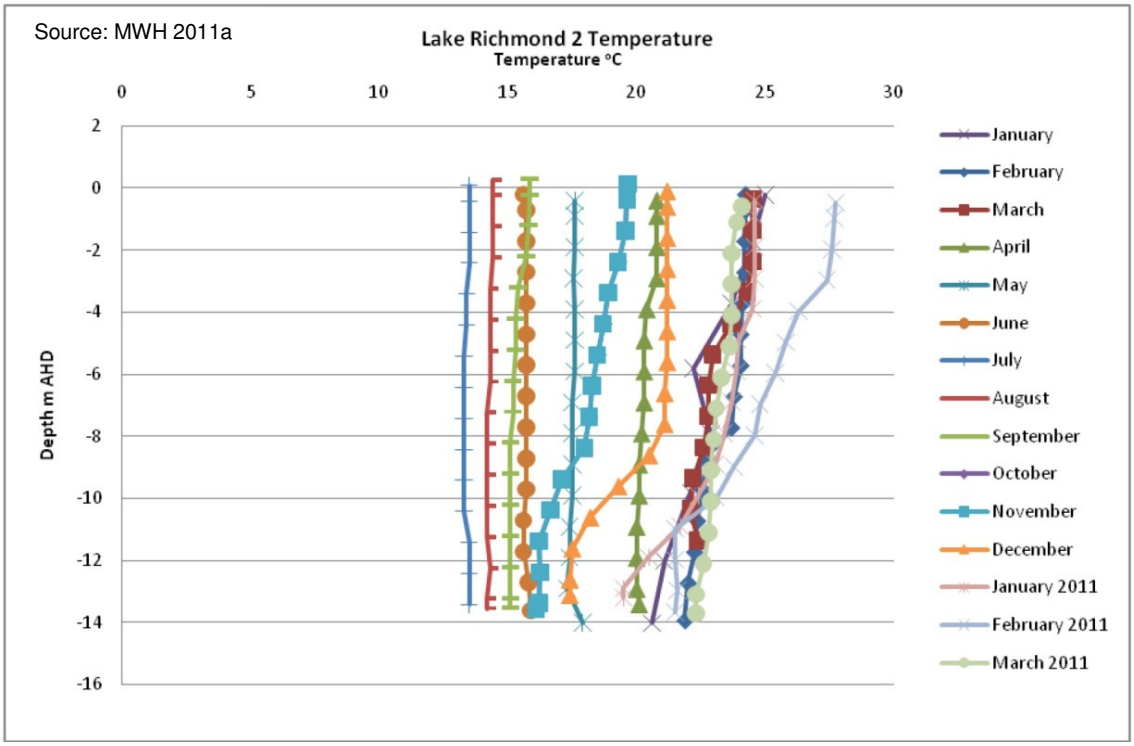


Figure 34 Lake Richmond temperature profiles during monitoring (Site 2)

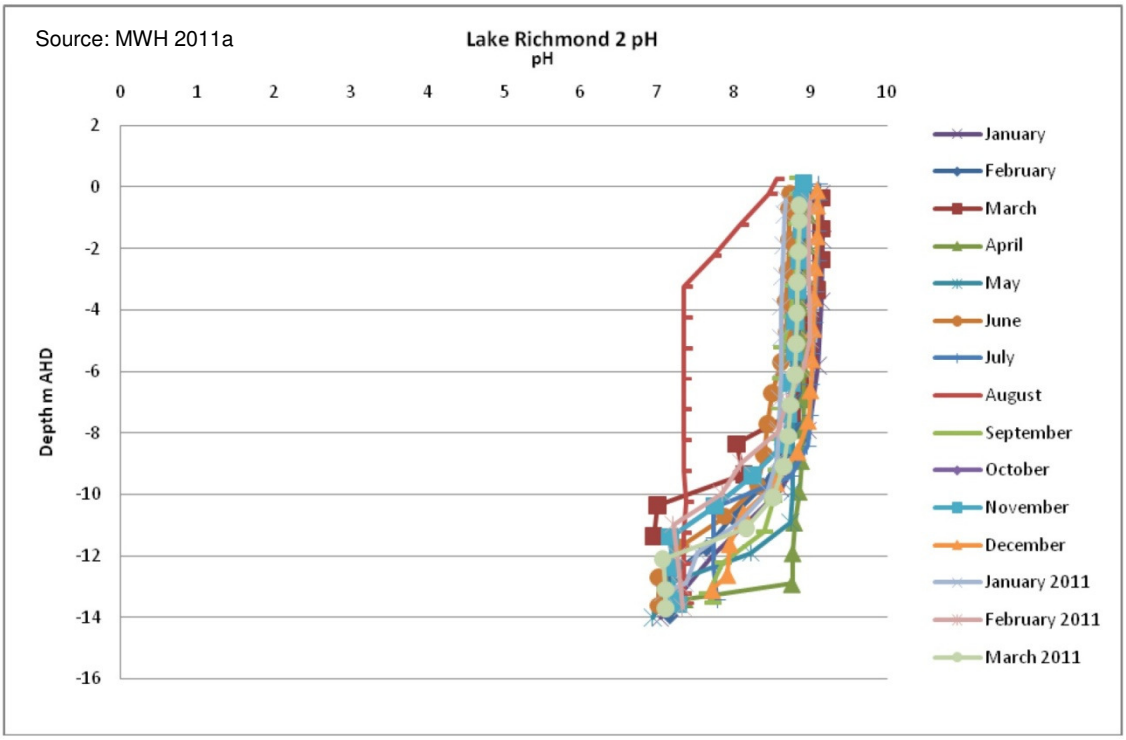


Figure 35 Lake Richmond pH profiles during monitoring (Site 2)

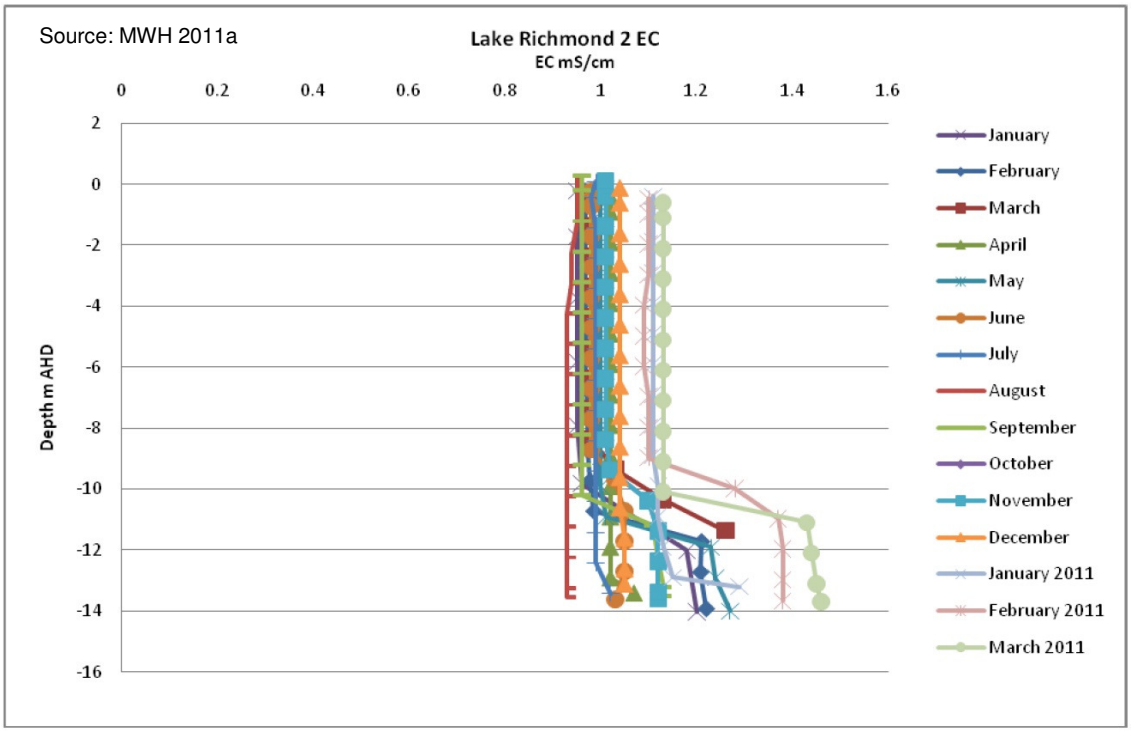
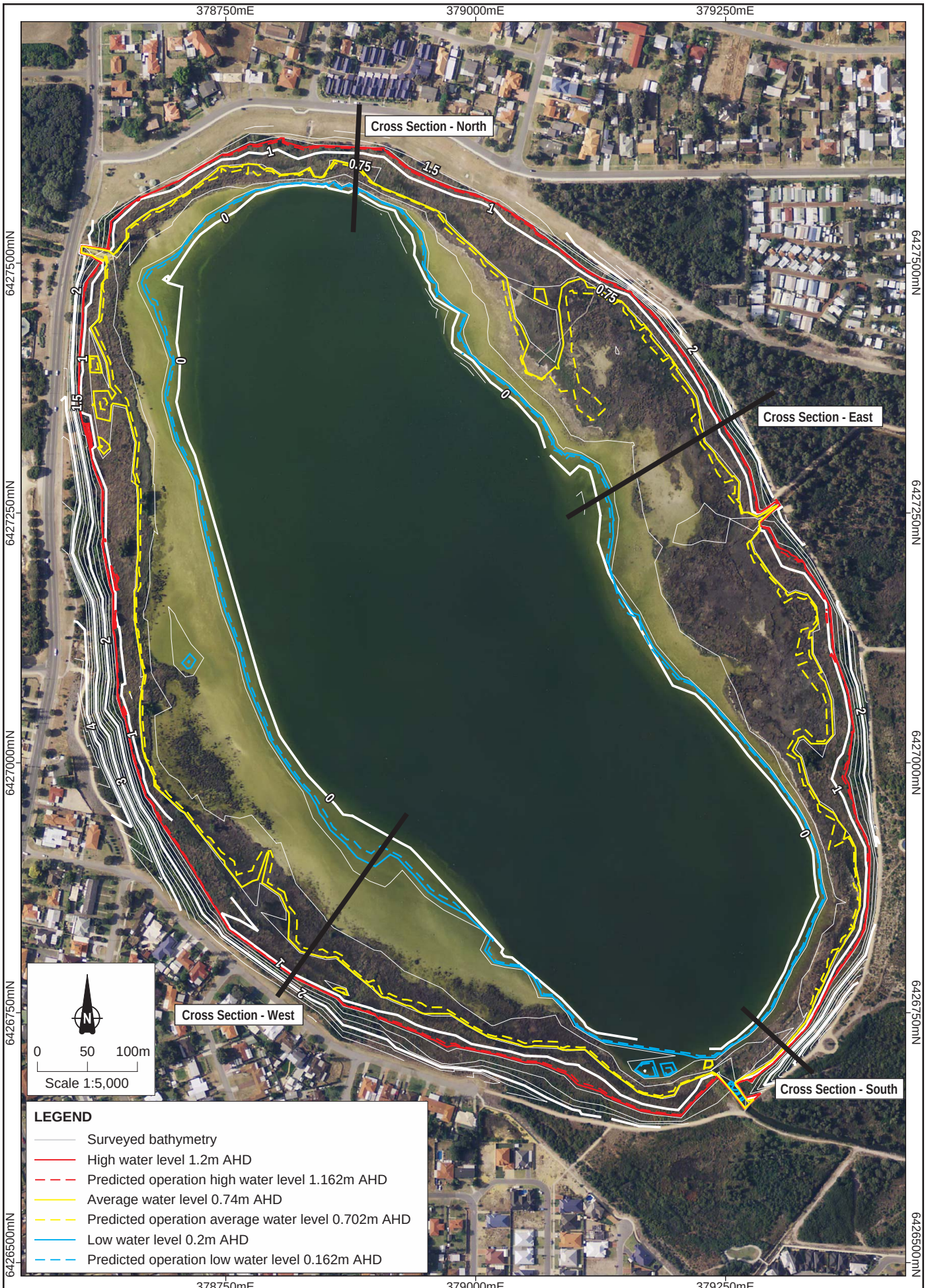


Figure 36 Lake Richmond electrical conductivity profiles during monitoring (Site 2)



Source:
Aerial photography supplied by Landgate (2010)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011
NB: Potential errors may occur in some areas

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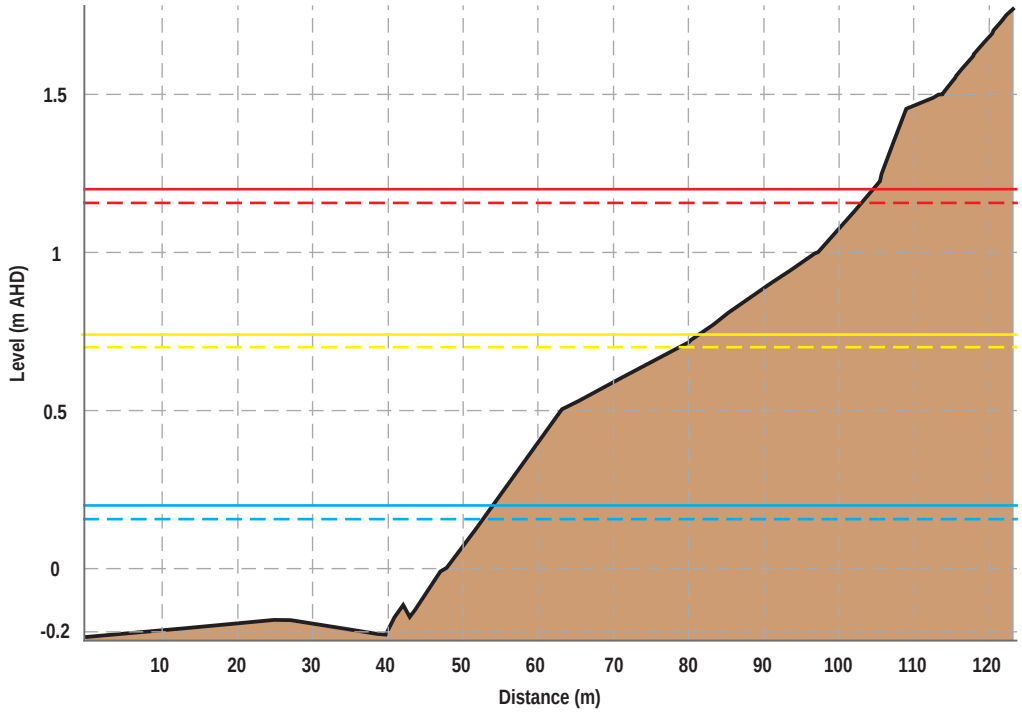
Predicted operational impact on Lake Richmond water levels

Figure No:
37



0 40m

Horizontal Scale 1:1,000

0 1m

Vertical Scale 1:40,000

LEGEND

- Surveyed bathymetry
- High water level 1.2m AHD
- Predicted operation high water level 1.162m AHD
- Average water level 0.74m AHD
- Predicted operation average water level 0.702m AHD
- Low water level 0.2m AHD
- Predicted operation low water level 0.162m AHD

Source:
Bathymetry supplied by ST Spatial
Date: 12/10/2011
NB: Potential errors may occur in some areas

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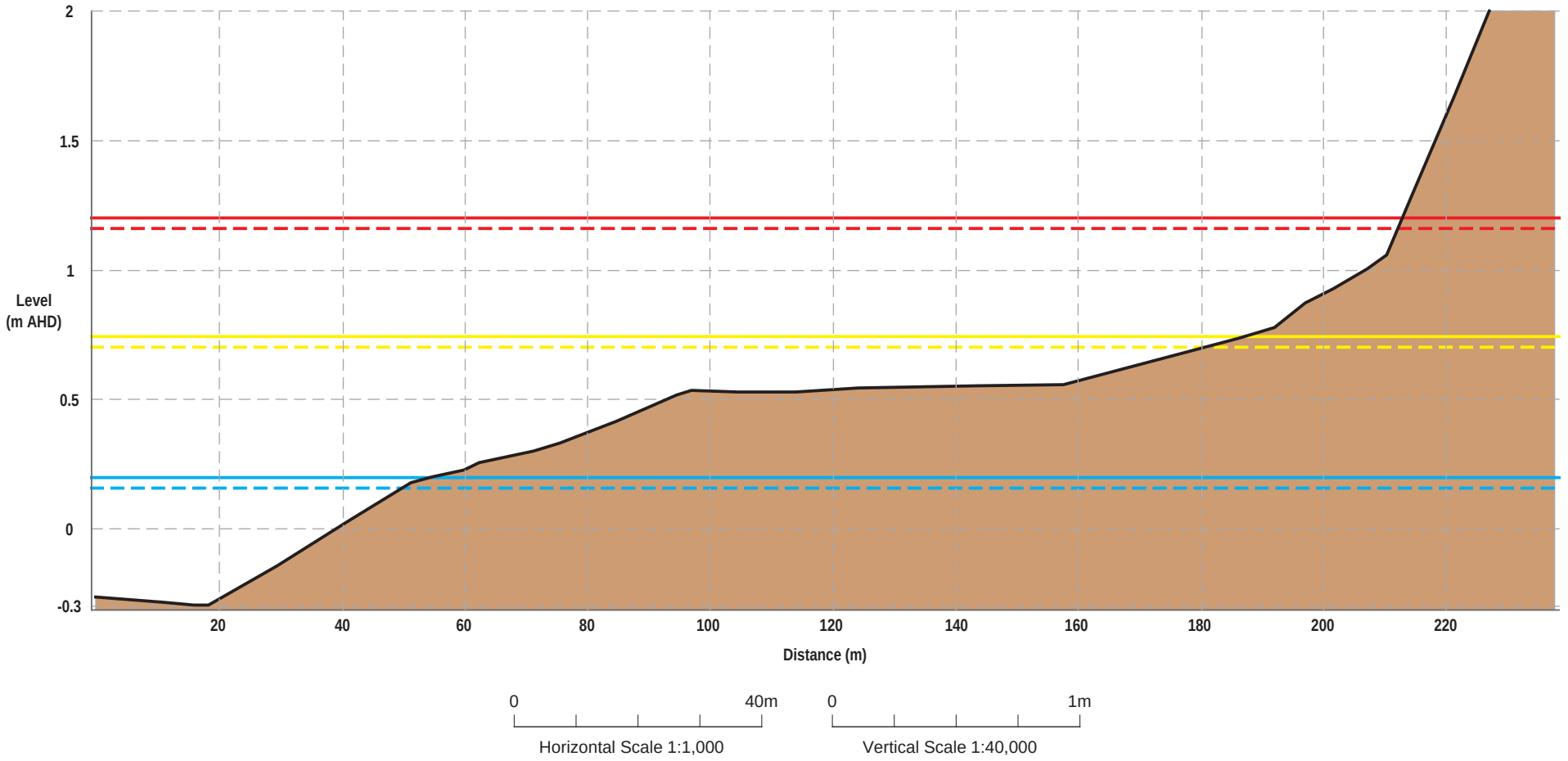
CAD Resources

CAD Resources File No:
g1937_MB_PER_F048.dgn

Lake Richmond cross section north

Figure No:
38



LEGEND

- Surveyed bathymetry
- High water level 1.2m AHD
- Predicted operation high water level 1.162m AHD
- Average water level 0.74m AHD
- Predicted operation average water level 0.702m AHD
- Low water level 0.2m AHD
- Predicted operation low water level 0.162m AHD

Source:
Bathymetry supplied by ST Spatial
Date: 12/10/2011
NB: Potential errors may occur in some areas

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CAD Resources File No:
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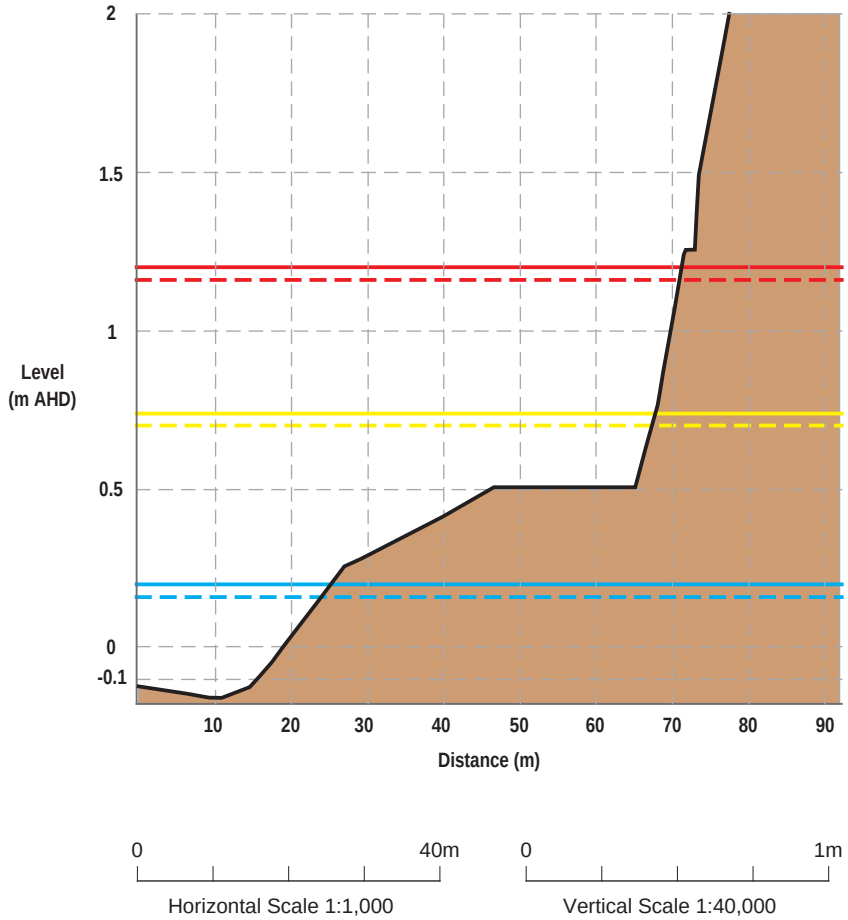
Lake Richmond cross section east

Figure No:
39



LEGEND

- Surveyed bathymetry
- High water level 1.2m AHD
- Predicted operation high water level 1.162m AHD
- Average water level 0.74m AHD
- Predicted operation average water level 0.702m AHD
- Low water level 0.2m AHD
- Predicted operation low water level 0.162m AHD

Source:
Bathymetry supplied by ST Spatial
Date: 12/10/2011
NB: Potential errors may occur in some areas

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CAD Resources File No:
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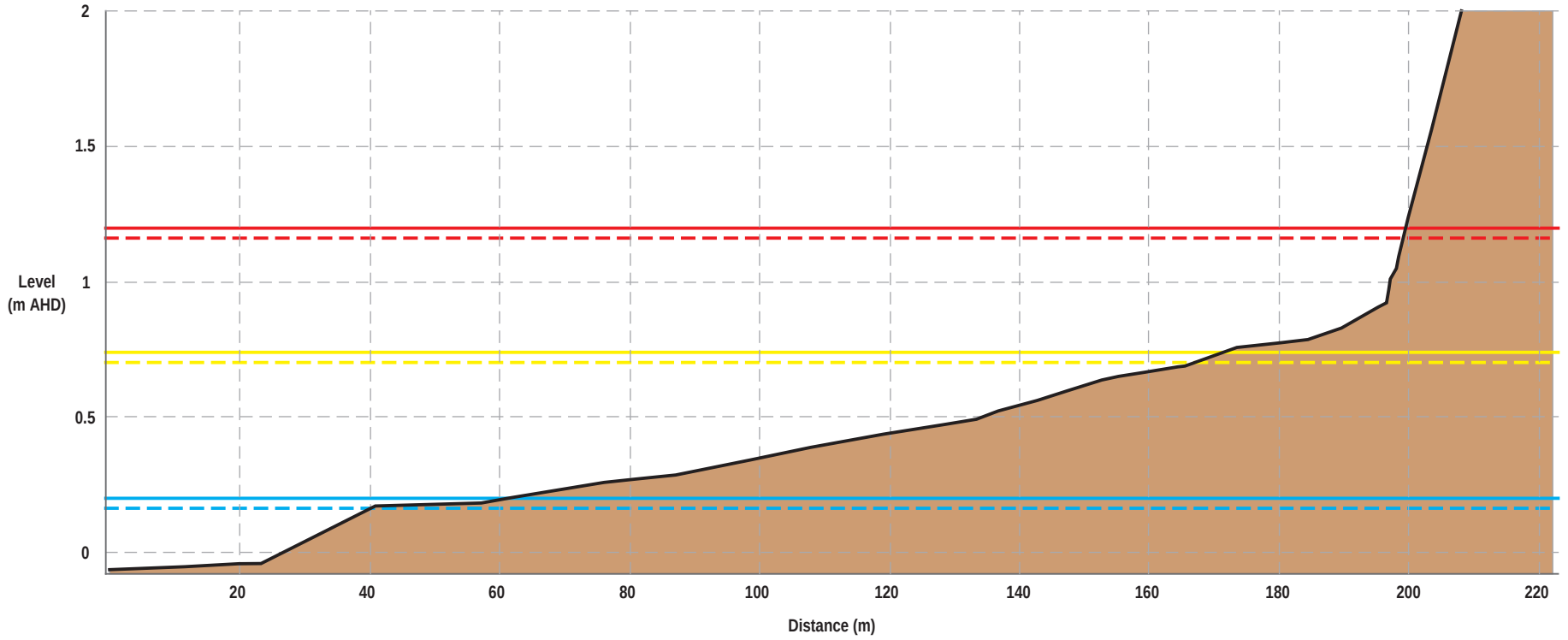
Lake Richmond cross section south

Figure No:
40



0 40m

Horizontal Scale 1:1,000

0 1m

Vertical Scale 1:40,000

LEGEND

- Surveyed bathymetry
- High water level 1.2m AHD
- Predicted operation high water level 1.162m AHD
- Average water level 0.74m AHD
- Predicted operation average water level 0.702m AHD
- Low water level 0.2m AHD
- Predicted operation low water level 0.162m AHD

Source:
Bathymetry supplied by ST Spatial
Date: 12/10/2011
NB: Potential errors may occur in some areas

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CAD Resources File No:
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Lake Richmond cross section west

Figure No:
41

7.3 Evaluation of options or alternatives to avoid or minimise impact

The most effective way of minimising the long-term impact of the Proposal on surface water is to minimise the impact of construction by utilising a wet construction method, which avoids the need for dewatering during construction, as described in Section 6.3.1.

Stormwater from the Proposal area will not enter Lake Richmond, but will be treated and infiltrated onsite or discharged to the ocean. The Proposal will be connected to reticulated sewerage in line with Department of Health requirements.

7.4 Assessment of likely direct and indirect impacts

The main environmental value of surface water in the Mangles Bay area is supporting the ecology and aesthetics of Lake Richmond. The following aspects of the Proposal may potentially impact on the values of Lake Richmond:

- the construction and operation of the marina waterbody will lower regional groundwater levels drawdown which may lead to:
  - lowering of water levels in Lake Richmond
  - exposure of ASS if they exist around Lake Richmond
- saltwater intrusion caused by the inland movement of the saltwater-groundwater (fresh) interface due to the inland marina
- impacts to water quality, other than salinity
- increased population as a result of development may increase indirect impacts on Lake Richmond through uncontrolled access, rubbish and domestic pets
- impacts to Lake Richmond functional ecology
- impacts to Rotary Park Lake. .

Issues associated with ASS are discussed in Section 20. Potential impacts of stormwater runoff from the development into the marine environment are discussed in Section 10.

The edge of the lake includes two TECs that are protected under the EPBC Act. These are “Sedgelands in Holocene dune swales of the southern Swan Coastal Plain” and “Thrombolite (microbial) community of coastal freshwater lakes of the Swan Coastal Plain (Lake Richmond)”. Changes in surface water levels and quality in Lake Richmond may impact upon these communities.

7.4.1 Impact to Lake Richmond groundwater and surface water levels

The development will result in a slight decrease in groundwater levels at Lake Richmond of 0.032 m (3.2 cm) during construction and 0.038 m (3.8 cm) during operation (Section 6.3.5). Assuming that a change in groundwater levels leads to an equivalent change in lake water levels (a worst-case scenario), this would result in a decrease in lake levels of 0.032 m (3.2 cm) during construction and 0.038 m (3.8 cm) during operation. As the Proposal potential construction impacts are smaller and shorter-term than the operational impacts, the following section focuses on the operational impacts.

The annual variation in lake water level is approximately 1 m, and thus this change is less than 4% of the annual variation in lake water levels. The 0.038 m (3.8 cm) change is significantly less than the inter-annual variation in high and low water levels of 0.3 m discussed in Section 7.2.2. Thus the impacts on lake water levels are comparatively small (Table 11). The change in areas inundated in low, mean and high scenarios is similarly small, with 1.3 ha of additional area exposed due to the drop in water level at mean water level and 0.3 ha no longer experiencing inundation at a high water level (Table 11). These changes account for less than 6% of the area seasonally inundated (Table 11).

Table 11 Operational impact on Lake Richmond water levels and area inundated

Water level	Low	Mean	High
Current average water level	0.2 mAHD	0.74 mAHD	1.2 mAHD
Average water level with operational impacts (mAHD)	0.162 mAHD	0.702 mAHD	1.162 mAHD
Area currently inundated (ha)	31.0	48.9	55.4
Predicted area of inundation with operational impacts (ha)	30.5	47.6	55.2
Decrease in area inundated (ha)	0.5	1.3	0.27
Decrease as a percentage of the area seasonally inundated	1.6%	2.66%	0.48%

A series of cross sections were developed to show the impact of these changes on the lengths of shoreline exposed on the north, east, south and west sides of the lake (Figure 38 to Figure 41). The locations of the cross sections are shown on Figure 37. In each location and water level change, the maximum difference in terms of length of shoreline exposed is less than 5 m in summer (dry) (Figure 38 to Figure 41), with the difference in shoreline exposed being less than 2 m on average.

7.4.2 Impact to saltwater interface

Groundwater modelling of the Proposal shows no change in groundwater salinity at Lake Richmond as a result of the Proposal (Section 6.3.6). Within the Safety Bay Sand Aquifer, the saltwater interface will not approach within 500 m of the lake (Section 6.3.6). Hence the saltwater interface will not enter the lake, and thus the salinity of the lake is not considered to be impacted by the Proposal.

7.4.3 Impacts to water quality other than salinity

Surface water present in the lake is a mixture of groundwater and stormwater. The local groundwater is high in the calcium and carbonate/bicarbonate considered necessary for thrombolite growth, because of the high levels of calcium carbonate in the Safety Bay Sands. The movement of groundwater through the soils results in the dissolution of small amounts of calcium carbonate. This dissolution of this carbonate/bicarbonate material causes the lake to be slightly alkaline (pH 7.6 to 9). The proposal retains the current groundwater flow patterns and hence this dissolution of calcium carbonate The Proposal is therefore not expected to alter the pH of the lake.

Stormwater from urban areas may contain herbicides, pesticides and fertilisers. To manage the potential impacts of these pollutants, the DoW requires that stormwater is treated prior to infiltration or discharge through the use of mechanisms such as swales and gross pollutant traps (DoW 2004 – 2007). These measures will be used in the Proposal area to minimise the amount of these pollutants leaving the site.

Stormwater from the Proposal area will not enter Lake Richmond. In small rainfall events (less than the 1 in 1 year event) stormwater from roads will be infiltrated within the Proposal area through the use of Best Management Practices (BMPs) such as soakwells, swales and/or underground infiltration cells in a manner consistent with Water Sensitive Urban Design and the Stormwater management manual (DoW 2004 - 2007). These BMPs act as treatment mechanisms as well as infiltration measures. Rainfall events less than the 1 in 1 year event constitute 99% of the volume of rainfall (DoW 2004 - 2007). The infiltrated stormwater will recharge the groundwater table. A small portion of the infiltrated stormwater may enter the lake via groundwater flow, under circumstances of summer rainfall and a portion of the infiltration is positioned to south of the Proposal area, but the predominant flow direction for groundwater will remain towards Mangles Bay (Section 6).

Rainfall on future residential lots will be managed through the use of soakwells and/or rainwater tanks in smaller rainfall events with the potential for overflow to the road drainage system in larger events.

Treated stormwater will be infiltrated in smaller events. Options for stormwater management in larger events are subject to investigation. In larger events, stormwater may be discharged into Mangles Bay through the marina, as currently occurs at Port Bouvard and Mandurah Ocean Marina. Alternatively, water may be discharged into the realigned Lake Richmond Outlet Drain into Mangles Bay. Stormwater drainage will be treated prior to discharge. Drainage from the Proposal area will not enter Lade Richmond

or existing native vegetation. A combination of these options may also be used. The design will be outlined in the LWMS that will accompany the LSP, as required by *Better Urban Water Management* (WAPC and DPI 2008). Detailed design will be provided in the Urban Water Management Plans that will accompany subdivision plans.

Wastewater will be collected through a reticulated (piped) sewerage system, connected to the Water Corporation sewerage system.

Stormwater from an urban development can contain higher levels of nutrients and contaminants such as hydrocarbons and heavy metals than surface water or groundwater from bushland areas (DoW 2004-2007). Vegetated detention areas and gross pollutant traps will be used to treat stormwater prior to reduce nutrient and contaminant concentrations, prior to infiltration or discharge. The Proponent is also proposing to undertake rehabilitation around the lake, which will assist in improving water quality.

Because of the use of water treatment structures and infiltration to treat stormwater and limited impacts of increased population, stormwater from the Proposal is not expected to impact upon non-salinity water quality at Lake Richmond, including nutrient levels. The Proposal is therefore not expected to cause increased frequency of algal blooms or other water quality problems at the lake.

7.4.4 Moving of the Lake Richmond Outlet Drain

The current alignment of the Lake Richmond Outlet Drain is located within the Proposal area (Figure 28). The open drain will therefore need to be moved as part of the Proposal (Figure 28). The drain will be realigned as a piped drain along Hymus Street.

It is considered that the moving of the Lake Richmond Outlet Drain associated with the Proposal will not significantly impact on water levels in the lake. Any changes to the Outlet Drain will be undertaken in a manner that minimises the impact to any thrombolites present around the weir.

The need to move the Outlet drain provides a degree of complexity due to the presence and proposed duplication of the Water Corporation's SDOOL. The intersection of the outlet drain and the SDOOL will require further engineering design with both operating at a similar topographical level. This detail will be managed during the town planning phase of the project; however, it provides a potential mitigation option for Lake Richmond whereby the height of the weir could be raised, thus providing an increase in the maximum height of water in the lake.

7.4.5 Impacts on Lake Richmond due to increased population

The Lake Richmond portion of the RLRP is currently impacted by human activities, including pedestrian and dog access to Lake Richmond (DEC 2010a). These activities can impact upon water quality in the lake through rubbish disposal and unauthorised access to the lake.

The Proposal will result in an increased human population in the area, which is likely to result in increased pedestrian and pet movements in the RLRP. However, the change in population is not considered significant when compared to the broader increase in population in the area. The estimated increase in population due to the Proposal is 1500 to 2000 persons. This is relatively small compared to the estimated increase in the population of the City of Rockingham from 106 000 in 2011 to 165 000 in 2031 (CoR 2011).

The residents of the Proposal area are more likely to access the Lake Richmond area than those who live further away. However, the residents of the Proposal area are less likely to have dogs than other residents, as the lot sizes will be significantly smaller (mostly townhouses and apartments) than the existing lots in the area, which are predominantly free standing houses on larger lots. While the population will increase, the associated impact of people and their pets visiting the lake is likely to be small, due to the large area available for recreation at Cape Peron.

It is therefore considered that the increase in population associated with the Proposal will not significantly impact on water quality in the lake.

7.4.6 Impacts to Lake Richmond functional ecology

The impacts to water levels in Lake Richmond associated with the Proposal are considered unlikely to impact upon ecological water requirements for the TEC FCT 19 Sedgelands in Holocene Dune Swales on the Swan Coastal Plain (Section 8.4). The impact is comparatively small in terms of reduction in water levels (0.038 m) and is therefore considered highly unlikely to alter species composition by drawing water below the rooting level of local plants. This drop is also within the 0.3 m inter-annual variation in low water levels observed in the lake.

The *Interim Recovery Plan No. 122: Thrombolite community of coastal freshwater lakes (Lake Richmond), interim recovery plan – 2003 – 2008* (CALM 2003b) lists the following criteria for success and failure.

Criteria for success:

- maintenance of water quality and levels in Lake Richmond
- maintenance of the vigour and extent of the microbial community including maintenance of the composition of the microbial species
- an increase in the area of this community or its catchment area under conservation management.

Criteria for failure:

- significant and sustained detrimental changes to water quality or levels in Lake Richmond
- significant decline in area as measured by physical damage or loss of thrombolite structures
- decline in health as measured by a major shift in composition of the microbial community.

The TEC thrombolite community is assessed as not being impacted by the predicted changes to water level, which, whilst sustained, is not significant in terms of the current variability of the lake. Low water levels are experienced at Lake Richmond during the summer months (March to April) (CALM 2003b) where little to no recharge of the lake occurs from direct rainfall or stormwater runoff into Lake Richmond. As shown in Figure 38 to Figure 41 the largest impact from the change in water levels (0.038 m) in terms of shoreline exposure will be experienced during the drier months (March to April). Whilst the full extent of the thrombolite community is unknown, visible thrombolites are already exposed during these months and therefore a minor increase in additional exposure of shoreline is unlikely to impact the community.

As the groundwater flow direction is not expected to change as a result of the Proposal, groundwater will still flow through soils high in calcium and carbonate/bicarbonate which is considered necessary for thrombolite growth. The dissolution of this carbonate/bicarbonate material is what causes the lake to be slightly alkaline (pH 7.6 to 9). The Proposal is therefore not expected to alter the pH of the lake. The salinity of the lake is also not expected to change. The water quality experienced by the Sedgelands and Thrombolite TECs is therefore not expected to be impacted.

It is therefore considered that the Proposal will not impact upon the factors considered important for continued survival of thrombolites.

Impacts to wetland fauna species, including migratory birds, are discussed in Section 9.5 (Fauna) and Section 15.4 (Matters of NES).

7.4.7 Impacts to Rotary Park Lake

The Proposal is considered unlikely to result in changes in groundwater levels at Rotary Park Lake (Figure 17 and Figure 25). The park is currently on the edge of the groundwater saline intrusion zone, however the groundwater salinity (and hence lake water salinity) in the park may increase (Section 6.3). This may alter the species present in the park. This is not considered to be a significant impact as the lake is artificial and does not have significant environmental values.

7.5 Potential for and nature of any cumulative impacts

Cumulative impacts of the Proposal being constructed and operating at the same time as Water Corporation's SDOOL duplication project are discussed in Section 6.3.1. Modelling indicates that any cumulative impact would be largely due to the SDOOL duplication and that mitigation of these impacts would therefore be the responsibility of that project.

It is noted that there are no other known projects that may negatively impact upon water levels and quality in the area.

7.6 Management measures and performance standards

7.6.1 Proposed mitigation measures

Management measures will be undertaken to minimise the impact of the Proposal on Surface Water. These management measures will include:

- minimising the amount of dewatering associated with the Proposal
- undertaking rehabilitation within the Proposal area and within the proposed service corridor
- utilising best management practices to treat stormwater prior to infiltration or discharge in line with the Stormwater Management Manual (DoW 2004-2007).

A LWMS will be submitted with the LSP for the development outlining the details of the measures to be undertaken to manage stormwater water quality and quantity in the development.

A CEMP addressing the protection of the environmental values of Lake Richmond can be found in Appendix 5.

7.6.2 Possible mitigation through raising of weir

The height of the weir wall on the Lake Richmond Outlet Drain is currently 0.58 mAHD. The weir controls the outflow of water from the lake as surface water. Water currently overtops the weir for approximately four to eight months per year, depending on rainfall. Increasing the weir height and decreasing the width of the weir would decrease the amount of water leaving the lake as surface water each year.

While the primary source of water lost to the lake is considered to be groundwater, reducing surface water outflows may partially offset the decrease in water levels associated with the Proposal. Increasing the weir height would increase water levels during the winter period when water levels may be above the top of the weir. However, once the water level falls below 0.58 mAHD, the change would not have an effect. The effectiveness of the changes to the weir would need to be modelled through the use of combined surface water – groundwater modelling to confirm the effectiveness of such a mitigation option.

Any changes to the weir would need to be discussed and approved by the City of Rockingham, Water Corporation, DEC, DoW and DSEWPaC. As such, the potential raising of the weir should be considered as a possible mitigation option, depending on the views of these agencies.

7.6.3 Lake Richmond buffer management

The edge of the wetland vegetation at Lake Richmond can be considered to be the edge of the wetland boundary. The western side of the lake, corresponds with the edge of Safety Bay Road and is due to the presence of the road and cleared areas to the western side of the road. To the north of the lake, the wetland area is bounded by a grassed area and then Lake Street and residential development. The residential development and cleared areas are within 50 m of the edge of the wetland area. A 50 m buffer from the edge of the wetland vegetation can be considered to be the acceptable standard for a Conservation Category Wetland (WAPC 2005b).

The only non-conservation land use proposed within 50 m of the wetland area is the proposed service corridor. Where clearing is not necessary for access purposes, this area is planned to be rehabilitated following service construction, pending Water Corporation approvals for the SDOOL duplication. A section of the existing Water Corporation service easement at Lake Richmond is vegetated and was rehabilitated following works on the SDOOL in 2005/6.

As the 50 m buffer will generally be retained intact and rehabilitation will occur, the impact of the proposal upon the integrity of the buffer of Lake Richmond is considered to be minimal.

7.7 Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures

The Proposal is expected to result in the following outcomes in relation to surface water:

1. The Proposal is likely to result in a decrease of water levels in Lake Richmond of 0.032 m during construction and 0.038 m during operation. This decrease is not considered to significantly impact the ecology of the lake.
2. The change in the location of the saltwater interface within the groundwater will not impact upon Lake Richmond during construction or operation of the Proposal.
3. The moving of the Lake Richmond Outlet Drain will not impact upon water levels in the lake.
4. Stormwater from the Proposal will not directly enter the lake and hence there will be no change in surface water quantities or quality entering the lake, or the current hydraulic performance of the lake, as a result of the Proposal.
5. The increased population in the Lake Richmond area as a result of the Proposal is not expected to significantly impact upon the lake.
6. The Proposal is not expected to significantly impact upon the TECs present at Lake Richmond.
7. As the 50 m buffer will generally be retained intact and rehabilitation will occur, the impact of the proposal upon the integrity of the buffer of Lake Richmond is considered to be minimal.
8. The Proposal will not impact upon lake water quality, and hence will not result in an increase in the frequency of algal blooms in the lake.
9. The Proposal is not expected to have an impact on the function and ecology of Lake Richmond.

These impacts are considered to be acceptable as the key environmental values of Lake Richmond will not be significantly affected by the Proposal.

8. Terrestrial flora and vegetation impact assessment

8.1 Relevant environmental objectives, policies, guidelines, standards and procedures

8.1.1 EPA objectives

The EPA applies the following objective in its assessment of proposals that may affect vegetation and flora:

To maintain the abundance, species diversity, geographic distribution and productivity of flora and fauna at species and ecosystems levels through the avoidance or management of adverse impacts and improvements in knowledge.

EPA Position Statement No. 2

EPA Position Statement No. 2 (EPA 2000a) provides an overview of the EPA position on the clearing of native vegetation in Western Australia. Principles and related objectives and actions have been adopted from national strategies in the development of this Position Statement. In assessing a proposal, the EPA will take into account the following principles when considering impacts on vegetation:

- comparison of proposal scenarios, or options, to evaluate protection of biodiversity at the species and ecosystems levels, and demonstration that all reasonable steps have been taken to avoid disturbing native vegetation
- no known species of plant or animal is caused to become extinct as a consequence of the proposal and the risks to threatened species are considered to be acceptable
- no association or community of Indigenous plants or animals ceases to exist as a result of the proposal
- there is a comprehensive, adequate and secure representation of scarce or endangered habitats within and/or in areas biologically comparable to the Proposal area protected in secure reserves
- if the proposal is large (in the order of 10–100 ha or more, depending on where in the State) the Proposal area itself should include a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity are secure and protected
- the onsite and offsite impacts of the proposal are identified and the proponent demonstrates that these impacts can be managed.

EPA Position Statement No. 3

EPA Position Statement No. 3 (EPA 2002) discusses the principles the EPA would apply when assessing proposals that may have an effect on biodiversity values in Western Australia. The outcomes sought by this Position Statement are intended to:

- promote and encourage all proponents and their consultants to focus their attention on the significance of biodiversity and, therefore the need to develop and implement best practice in terrestrial biological surveys
- enable greater certainty for proponents in the environmental impact assessment process by defining the principles the EPA will use when assessing proposals that may have an effect on biodiversity values.

EPA Guidance Statement No. 33

EPA Guidance Statement No. 33 (EPA 2008) provides guidance on assessing vegetation where it is considered significant for a range of reasons including:

- scarcity
- unusual species
- novel combination of species
- a role as a refuge
- a role as a key habitat for threatened species, or large populations representing a significant proportion of the local or regional total population of a species
- being representative of the range of a unit
- a restricted distribution.

TECs, as listed by DEC and under the EPBC Act, are of high significance.

In addition, DEC maintains a list of Priority Ecological Communities (PECs) which identifies those communities that need further investigation before possible nomination for TEC status. PECs are considered to be of a Regional to State level of significance (ENV 2010).

EPA Guidance Statement No. 51

EPA Guidance Statement No. 51 (EPA 2004b) provides guidance on standards and protocols for terrestrial flora and vegetation surveys, particularly those undertaken for the environmental impact assessment of proposals.

EPA Guidance Statement No. 10

EPA Guidance Statement No. 10 (EPA 2006a) provides guidance on the level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 Region.

8.1.2 Legislation, policy and guidance

State protection

In a legislative context, the preservation and conservation of flora and ecological communities is covered primarily by the following Western Australian legislation:

- *Wildlife Conservation Act 1950 (WA) (WC Act)*
- *Environmental Protection Act 1986 (WA)*
- *Conservation and Land Management Act 1984 (WA).*

The WC Act protects all native flora in Western Australia. Flora considered to be rare are gazetted as Declared Rare Flora (DRF) under section 23F of the WC Act. Under the WC Act it is illegal to remove or damage DRF without approval. DRF are specifically scheduled for protection under the WC Act and are species that have been adequately searched for, and are deemed to be either rare, in danger of extinction, or otherwise in need of special protection.

Priority species are those listed by DEC as potentially threatened but for which there is insufficient evidence to properly evaluate their conservation significance. They range from Priority one to Priority four species, and are as follows:

- Priority One: Poorly Known Taxa. Taxa, which are known from one or a few (generally <5) populations, which are under threat
- Priority Two: Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat
- Priority Three: Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat
- Priority Four: Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Note that of the above classifications, only DRF has statutory standing. The Priority flora classifications are employed by the DEC to manage and classify their database of species considered potentially to be at risk, but these categories have no legislative status for protection in addition to the native vegetation clearing legislation.

Bush Forever Policies, Principles and Processes

Bush Forever relates to the areas identified through the Bush Plan process undertaken by the Government of Western Australia to ensure that bushland, an important aspect of the urban environment, is given proper recognition and consideration in the development of Western Australia's cites, particularly Perth. The policy objectives of Bush Forever are to:

- meet the needs and aspirations of the community of Western Australia for the appropriate protection and management of bushland of regional significance in the Swan Coastal Plain portion of the Perth Metropolitan Region
- establish a conservation system that is (as far as achievable) comprehensive, adequate and representative of the ecological communities in the region
- achieve the protection of Bush Forever Sites through a collective and shared responsibility on the part of government, landowners and the community
- secure partnerships between landowners, government and the community in conservation management through government and community advice, assistance with incentives
- establish a range of measures that will enable the recommendations of Bush Forever for the protection of regionally significant bushland to be implemented by 2010
- bring a greater certainty to the processes of land use planning and environmental approvals by the early identification and protection of areas of regionally significant bushland.

Bush Forever is concerned with the protection of regionally significant bushland and associated wetlands. The Proposal area intersects with Bush Forever Site 355 and is adjacent to Bush Forever Site 358. Regionally significant bushland is defined with areas that represent:

- a range of ecological communities
- areas with high diversity
- areas containing rare or threatened communities or species
- areas that maintain ecological systems or natural processes
- areas that provide scientific or evolutionary importance
- areas containing conservation category wetlands, including fringing vegetation and associated upland vegetation.

State Planning Policy 2.8 Bushland Policy for the Perth Metropolitan Region

State Planning Policy 2.8 (SPP 2.8) applies the *Town Planning Act 2005* in relation to Bush Forever within the Perth Metropolitan area (WAPC 2005a). SPP 2.8 provides the policy measures for the planning, assessment and decision making criteria and processes relating to development of bushland areas in the Perth Metropolitan region. SPP 2.8 states that proposals or decision making should:

- recognise regional significant bushland protection and its management as a primary purpose and a fundamental planning consideration
- ensure that all reasonable steps have been taken to avoid, minimise or offset any likely adverse impacts
- adopt or incorporate the impact assessment process stipulated in SPP 2.8 where there is likely to be an unavoidable adverse impact on regionally significant bushland within a Bush Forever area
- recognise that Bush Forever area boundaries and the regionally significant bushland therein, have been defined using the best available information but may be subject to further analysis
- encourage, support and require, consistent with the policy, bushland management plans and the management of regionally significant bushland for conservation purposes
- support coordinated bushland management advice and assistance through the DEC, in conjunction with other relevant government and non-government agencies.

Australian Government protection

In a legislative context, the preservation and conservation of flora and ecological communities is covered by the following Commonwealth legislation:

- *Environment Protection and Biodiversity Conservation Act 1999* (Australian Government) (EPBC Act). Species and vegetation communities are protected as Matters of NES if they are listed under Schedule 1 of the EPBC Act.

8.2 Findings of surveys and investigations

The Proposal area has been subject to a number of flora and vegetation surveys undertaken to map the vegetation communities and flora species present and identify any vegetation communities and flora species of conservation significance. Key flora and vegetation surveys of the Proposal area include:

- Keating & Trudgen 1986: A Flora and Vegetation Survey of the Point Peron – Lake Richmond Area
- Bennett 2005: Flora and Vegetation, Point Peron, Western Australia
- ENV 2010: Flora and Vegetation Survey of the Mangles Bay Area, Cape Peron, Rockingham
- AECOM 2011: Assessment of TEC 30a, Corner of Memorial Avenue and Safety Bay Road, Rockingham.

The extent of flora and vegetation surveys of Cape Peron, including the Proposal area, is shown in Figure 42.

Keating and Trudgen 1986, Flora and Vegetation Survey

The historical flora and vegetation survey of the Cape Peron – Lake Richmond area was conducted on behalf of the WA State Planning Commission. The aims of the survey were:

- to identify and list as many flora species present in the study area as possible
- to document any populations of rare or geographically restricted species encountered
- to produce a 1:5000 scale vegetation map of the study area with accompanying descriptions of each of the vegetation type and their distributions.

This report is provided in Appendix 5 for further reference.

Bennett 2005, Flora and Vegetation Survey

Bennett Environmental Consulting Pty Ltd (Bennett) 2005 undertook a detailed Level 2 flora and vegetation survey of the Proposal area and surrounds. The level of survey required was determined in accordance with EPA Guidance Statement No. 51 (EPA 2004b) based on the potential impacts of the Proposal and the likely flora and vegetation to be present within the Proposal area. The objective of the survey was to record and map the vegetation units and vegetation condition within and outside the Proposal area and record the location of DRF and Priority Flora. The survey was undertaken in June 2005 after the annual species had commenced germination but many species were still too small for positive identification, and therefore a spring survey was recommended for completion of a more comprehensive species list.

This report is provided in Appendix 5 for further reference.

ENV 2010, Flora and Vegetation Survey

The ENV (2010) Flora and Vegetation Survey consisted of a desktop assessment and spring field survey. The objective of the survey was to undertake a targeted spring flora and vegetation survey for TECs and DRF and Priority Flora.

This report is provided in Appendix 5 for further reference.

AECOM 2011: Assessment of TEC 30a

Previous assessment by various consultants and the Department of Environment and Conservation (DEC) have resulted in conflicting results as to the extent of TEC 30a, leading to the need for this verification study. In early November 2011 AECOM Australia Pty Ltd (AECOM 2011) undertake the verification.

This report is provided in Appendix 5.

8.2.1 Vegetation within the Proposal area

Vegetation Units

Cape Peron is within the Drummond Botanical Subdistrict of the Darling Botanical District of the South western Botanical Province as defined by Beard (1981). Beard (1981) mapped Cape Peron as scrub heath, mixed shrubs and heathland, mainly Proteaceous and Myrtaceous.

All vegetation of Cape Peron is representative of the Quindalup Complex, as described by Heddle *et al.* (1980), of which approximately 48% of its pre-European extent in the Metropolitan area remains. Approximately 5.2% of the pre-European extent is within reserves that meet the International Union for Conservation of Nature (IUCN) criteria. The complex is described as a coastal dune complex consisting mainly of two alliances – the strand and foredune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata-Callitris preissii* and the closed scrub of *A. rostellifera*.

Bennett (2005) recorded and described 25 different vegetation units as occurring in the Proposal area (Table 12 and Figure 43). Detailed descriptions of these vegetation units are provided in Appendix 5. Keating & Trudgen (1986) recorded 16 vegetation units, one of which was not recorded by Bennett (2005); *Olearia axillaris* shrubland. Keating & Trudgen (1986) did not record any of the taller units recorded by Bennett (2005), vegetation units 19, 21 – 24, nor a completely degraded unit, vegetation unit 25. ENV (2010) did not record any vegetation units.

Table 12 Vegetation unit descriptions mapped at Cape Peron (Bennett 2005)

Vegetation unit	Description	Total area mapped
Shoreline		
1	Open Low Heath of *Frankenia pauciflora* and scattered *Sarcocornia blackiana*.	1.2
2	Very Open Herbland of **Cakile maritima* occasionally associated with *Carpobrotus virescens* and *Tetragonia decumbens*.	0.3
3	Open Low Heath of *Tetragonia decumbens* and *Frankenia pauciflora* over grass weeds.	0.7
4	Grassland of *Spinifex hirsutus* over a Low Shrubland of *Tetragonia decumbens*.	0.4
Fore dune		
5	Very Open to Open Grassland of *Spinifex longifolius* and Open Low Heath of **Pelargonium capitatum*.	3.8
6	Open Low Heath of *Olearia axillaris* and **Pelargonium capitatum* over an Open Grassland.	10.5
7	Open Low Heath of *Scaevola crassifolia* and *Olearia axillaris* over Grassland of introduced species.	3.3
8	Open Shrubland of *Olearia axillaris* and *Acacia rostellifera* over a Low Shrubland of *Rhagodia baccata* and a Sedgeland of *Lepidosperma gladiatum*.	1.1
9	Open Heath of *Acacia rostellifera* over Sedgeland of *Lepidosperma gladiatum* over Grassland.	
10	Tall Open Shrubland of *Acacia rostellifera* over an Open Heath of mixed species dominated by *Spyridium globulosum* and *Alyxia buxifolia*.	0.2
11	Closed Tall Scrub of *Acacia rostellifera* over a Low Shrubland dominated by *Olearia axillaris* and Rhagodia baccata over a Herbland/Grassland of weeds.	5.2
Stable dune		
12	Low Shrubland of **Pelargonium capitatum* and Herbland of *Acanthocarpus preissii* over a Grassland/Herbland of introduced species.	17.1
13	Closed Tall Scrub to Open Heath of *Acacia rostellifera* over an Open Low Heath of mixed species or a Closed Grassland of introduced species.	39.3
13/16		4.9
14	Closed Heath of *Acacia rostellifera* and *Alyxia buxifolia* over an Open Herbland/Grassland of introduced species.	0.8
15	Closed Tall Scrub of *Acacia rostellifera* over Open Shrubland of *Rhagodia baccata* and a Very Open Grassland of introduced species.	8.2
16	Closed Tall Scrub of *Acacia rostellifera* and *Olearia axillaris* over an Open Sedgeland of *Lomandra maritima*.	41.6
17	Closed Low Heath of *Melaleuca huegelii* var. *huegelii* and *Templetonia retusa* over a Grassland/Herbland of weeds.	0.2
18	Closed Heath of *Pittosporum ligustrifolium* with *Acacia rostellifera* and *Scaevola nitida* over an Open Sedgeland of *Lepidosperma gladiatum*.	0.7
19	Shrubland of *Melaleuca huegelii* var. *huegelii* and *Melaleuca lanceolata* over Herbland of *Senecio pinnatifolius* and Grassland of introduced species.	0.7
20	Closed Tall Scrub of *Melaleuca huegelii* var. *huegelii* over Low Shrubland of *Rhagodia baccata* and *Scaevola nitida*.	0.4
21	Low Open Forest of *Eucalyptus gomphocephala* over Shrubland of *Acacia rostellifera* over Herbland/Grassland of introduced species.	1.7
22	Closed Forest of *Melaleuca lanceolata* and *Callitris preissii* over mulch.	0.08
23	Closed Forest of *Agonis flexuosa* var. *flexuosa* over Sedgeland of *Lepidosperma gladiatum*.	0.5
24	Open Forest of *Eucalyptus gomphocephala* over Low Open Forest of *Agonis flexuosa* var. *flexuosa*, *Callitris preissii* and *Melaleuca lanceolata* over a Herbland of introduced species.	1.5
Degraded area		
25	Closed Grassland of **Hyparrhenia hirta* over Herbland of **Oxalis pes-caprae*.	0.6

Abbreviations: subsp. = subspecies, var. = variety, * = introduced species/weed, ? = thought to be the correct species name. sp. = species – used where the genus but not the species is known

Source: Aerial photography supplied by Landgate (2010)
FCT mapping supplied by ENV (2010)
Vegetation mapping supplied by BEC (2005)
Bush Forever Sites supplied by Department of Planning
Coordinate System: MGA94 Zone 50 ; Date: 10/1/2012
NB: Potential errors may occur in some areas

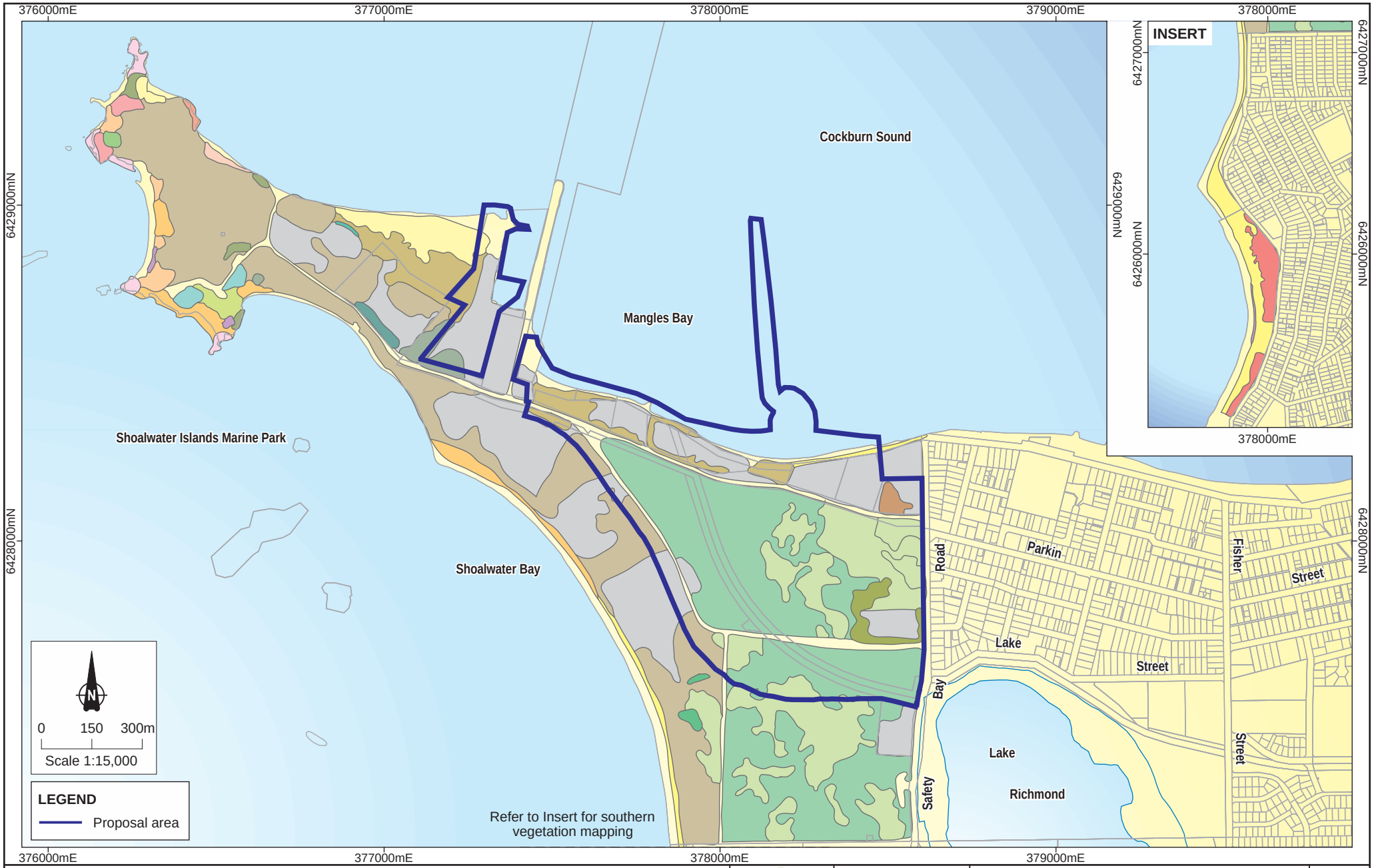
STRATEGEN
environmental consultants

Drawn:
CAD Resources

CAD Resources File No:
g1937_MB_PER_F029.dgn

Extent of flora and vegetation surveys across Cape Peron

Figure No:
42



Source:
Cadastral data supplied by Landgate
Vegetation Mapping supplied by Bennett Environmental Consulting (2005)
Coordinate System: MGA94 Zone 50
Date: 12/10/2011

NB: Potential errors may occur in some areas

STRATEGEN environmental consultants

Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F020.dgn

Vegetation units mapped at Cape Peron (Bennett 2005)

Figure No: **43**

Shoreline

VU1 Open Low Heath of *Frankenia pauciflora* and scattered *Sarcocornia blackiana* in reddish yellow sand in depression in limestone outcrops

VU2 Very Open Herbland of *Cakle maritima occasionally associated with *Carpobrotus virescens* and **Tetragonia decumbens* in cream sand

VU3 Open Low Heath of **Tetrgonia decumbens* and *Frankenia pauciflora* over grass weeds in brown sand with limestone outcropping

VU4 Grassland of *Spinifex jirsutus* over a Low Shrubland of **Tetragonia decumbens* in cream sand

Foredune

VU5 Very Open to Open Gassland of *Spinifex longifolius* and Open Low Heath of **Pelargonium capitatum* in creamy yellow sand

VU6 Open Low Heath of *Olearia axillaris* and **Pelargonium capitatum* over an Open Grassland of introduced species in cream sand

VU7 Open Low Heath of *Scaevola crassifolia* and *Olearia axillaris* over Grassland of introduced species in yellow sand

VU8 Open Shrubland of *Olearia axillaris* and *Acacia rostellifera* over Low Shrubland of *Rhagodia baccata* and a Sedgeland of *Lepidosperma gladiatum* in yellow sand

VU9 Open Heath of *Acacia rostellifera* over Sedgeland of *Lepidosperma gladiatum* over Grassland of weeds in brown sand

VU10 Tall Open Shrubland of *Acacia rostellifera* over an Open Heath of mixed species dominated by *Spyridium globulosum* and *Alyxia buxoflia* in yellow sand above a limestone knoll

VU11 Closed Tall Shrub of *Acacia rostellifera* over a Low Shrubland dominated by *Olearia axillaris* and *Rhagodia baccata* over a Herbland/Grassland of weeds in dark brown sand over yellow sand

Stable Dune

VU12 Low Shrubland of **Pelargonium capitatum* and Herbland of *Acanthocarpus preissii* over a Grassland/Herbland of introduced species

VU13 Closed Tall Scrub to Open Heath of *Acacia rostellifera* over an Open Low Heath of mixed species or a Closed Grassland of introduced species

VU14 Closed Heath of *Acacia rostellifera* and *Alyxia buxifolia* over an Open Herbland/Grassland of introduced species in yellow brown sand

VU15 Closed tall Scrub of *Acacia rostellifera* over Open Shrubland of *Rhagodia baccata* and a Very open Grassland of introduced species in cream sand

VU16 Closed Tall Scrub of *Acacia rostellifera* and *Olearia axillaris* over an Open Sedgeland of *Lomandra maritima* in yellow sand

VU17 Closed Low Heath of *Melaleuca huegelii* var. *huegelii* and *Templetonia retusa* over a Grassland/Herbland of weeds in brown sand

VU18 Closed Heath of *Pittosporum ligustrifolium* with *Acacia rostellifera* and *Scaaevola nitida* over an Open Sedgeland of *Lepidosperma gladiatum* in brown sand

VU19 Shrubland of *Melaleuca huegelii* var. *huegelii* and *Melaleuca lanceolata* over Herbland of *Senecio pinnatifolius* and Grassland of introduced species in yellow sand

VU20 Closed Tall Scrub of *Melaleuca huegelii* var. *huegelii* over Low Shrubland of *Rhagodia baccata* and *Scaevola nitida* in pale yellow sand

VU21 Low Open Forest of *Eucalyptus gomphocephala* over Shrubland of *Acacia rostellifera* over Herbland/Grassland of introduced species in yellow brown sand

VU22 Close

VU1-d Forest of *Melaleuca lanceolata* and *Callitris preissii* over mulch in yellow sand

VU23 Closed Forest of *Agonis flexuosa* var. *flexuosa* over Sedgeland of *Lepidosperma gladiatum* in grey sand

VU24 Open Forest of *Eucalyptus gomphocephala* over Low Open Forest of *Agonis flexuosa* var. *flexuosa*, *Callitris preissii* and *Melaleuca lanceolata* over a Herbaldn of introduced species in grey sand

Degraded

VU25 Closed Grassland of **Hyparrhena hirta* over Herbland of **Oxalis pes-caprae* in grey sand

DEV Developed Area

Source:
Vegetation Supplied by Bennett Environmental Consulting
Date: 12/10/2011

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g1937_MB_PER_F020_Leg.dgn

Vegetation units mapped at Cape Peron (Bennett 2005) Legend

Figure No:
43

Floristic community types

Eight FCTs have been identified as occurring onsite (Bennett 2005 and ENV 2010) and were mapped by ENV (2010) (Figure 44). Bennett (2005) inferred the FCTs for each vegetation unit (Table 13) using Gibson *et al*. (1994). A PATN numerical analysis[3] was also undertaken by EA Griffin and Associates (EA 2005) to confirm the inferences for the vegetation units that occurred within the proposed development area (Table 13). The PATN analysis was limited in its application due to the relatively small number of flora species recorded from the study quadrats on Cape Peron (due to the mostly 'degraded' condition of the vegetation).

The AECOM survey of TEC 30a has been used to further refine the areas of floristic community types present within the Proposal area.

Table 13 Floristic community types for vegetation units mapped

Floristic community type	Inferred vegetation units mapped by Bennett (2005)	PATN confirmation	Total Area Mapped at Cape Peron	Area within Proposal area
FCT 16 Highly saline seasonal wetlands	1, 3	-	1.85	0.00
FCT 29a Coastal shrublands on shallow sands	2, 8, 9, 10, 11, 12, 15	Vegetation Unit 12: probably 29b, but may be 29a Vegetation Unit 15: possibly 29b or 30b or 30c	27.03	10.72
FCT 29b *Acacia* shrublands on taller dunes	13, 14, 16, 17, 18, 20	Vegetation Unit 16: probably 29b	87.05	33.75
FCT S13 Northern *Olearia axillaris* – *Scaevola crassifolia* shrublands	6, 7	-	4.96	0.44
FCT S14 *Spinifex longifolius* grasslands and low shrublands	4, 5	-	4.31	0.17
FCT 30a *Callitris preissii (*or *Melaleuca lanceolata*) forest and woodlands	19?, 22, 24	Vegetation Unit 24: Probably FCT 30a (TEC)	2.41	4.27**
FCT 30b Quindalup *Eucalyptus gomphocephala* and/or *Agonis flexuosa* woodlands	21, 23	-	2.32	0.56
FCT S15 Weed group	25	-		

* area refers to mapped occurrence within the Proposal area, not area to be cleared

[3] PATN is a software package that extracts and displays patterns in complex data. PATN generates estimates of association (resemblance, affinity, distance) between any set of objects described by a suite of variables or attributes. PATN then classifies the objects into groups (Blatant Fabrications 2004).

Conservation significance

Threatened Ecological Community – FCT30a

FCT 30a *Callitris preissii (*or *Melaleuca lanceolata*) forest and woodlands is listed as a TEC by the DEC within the 'Vulnerable'[4] conservation category. It is not listed by the Australian Government (ENV 2010). There are three occurrences of FCT 30a in the survey area extent as mapped by ENV but only one in the Proposal area (Figure 45). The TEC located within the Proposal area is near the corner of Memorial Drive and Safety Bay Road. The TEC was recorded by Bennett (2005) and ENV (2010), in an area occupying approximately 1.57ha.

Subsequent to the ENV 2010 survey, the DEC undertook an assessment of the area mapped by ENV as FCT 30a. The DEC mapped area of FCT 30a covers a greater area than the occurrence mapped by either Bennett 2005 or ENV 2010 (Figure 45), both of which map the TEC community and surrounding vegetation communities not mapped as the TEC, very similarly

Based on the variability between the DEC mapping and previous mapping of the TEC, AECOM were commissioned by Cedar Woods to undertake a verification survey of TEC 30a. The presence of the TEC, FCT 30a was confirmed at the site during the field assessment conducted by AECOM on 4 November 2011. The AECOM mapped extent of TEC 30a and the condition of the vegetation within this extent is shown in Figure 46. Data collected from two permanent monitoring quadrats at the site also supports this result Appendix 5. Based on DEC advice, spatial mapping of the extent of the TEC focused on the presence of *Callitris preissii* and the results of this mapping are presented in Figure 45. The extent of mapping of the TEC vegetation type is more widespread than previously mapped by Bennett (2005) and ENV (2010). The results align most closely with mapping conducted by DEC (2010) at the site. Some locations that were previously mapped as TEC 30a vegetation type may have since been cleared or disturbed, including a location to the west of the parkland that supports only *Acacia rostellifera* and weeds, including Japanese Pepper (**Schinus molle*) (Appendix 5). However, an area of *Callitris preissii* close to Memorial Drive near the corner of Safety Bay Road has recently been slashed, rendering the condition here to be poorer (Figure 46).

The mapping of vegetation condition within the mapped extent of the TEC vegetation type would be a useful tool for determining the sustainability and conservation potential of specific areas within the site. DEC's advice is that the true TEC is confirmed where *Callitris preissii* occurs in moderately good condition vegetation (Jill Pryde, *pers.comm.* 2011). Moderately good or better condition vegetation could be interpreted to be equivalent to "Good" condition or better, in accordance with the Keighery (1994) scale. In this regard, only about 65% of the site (2.8 hectares of a total of 4.3 hectares of the mapped TEC) would be considered to meet the criteria and be confirmed as the true TEC 30a. The areas of the TEC in better condition ("Good" or better, Figure 2), are considered to have the highest conservation potential. Keating and Trudgen (1986) mapped the vegetation of the area in question as cleared and supporting a vegetation community coded ArAb (*Acacia rostellifera* and *Alyria buxifolia*, Open – Closed Heath) (Figure 47). This vegetation community, mapped by Keating and Trudgen (1986) contained none of the dominant species identified in 2005 by Bennett, nor none of the dominant species associated with TEC FCT 30a.

The Bennett 2005 and ENV 2010 reports were developed following adherence to the methodological practices prescribed by EPA Guidance Statement No. 51, including the establishment of quadrats in identified vegetation community types. Advice from the DEC indicates that the Bennett 2005 results may have been impacted by a recent fire, however, no observations of fire impacts to the vegetation are present in the Bennett 2005 report. ENV (2010) utilised the vegetation community mapping and quadrat areas established by Bennett (2005). This has resulted in no quadrat data being available from Bennett (2005) or ENV (2010) specific to the area of discrepancy between the mapping of these reports and the DEC mapped occurrence of TEC FCT 30a. The Bennett report is explicit in describing the methodology employed both in the selection of vegetation community types for quadrat establishment and effort outside of the established quadrats "The area outside of the quadrat was also surveyed to record additional (opportunistic) species for the vegetation unit".

[4] 'Vulnerable' conservation category for TECs: An ecological community that is declining or has declined in distribution and/or condition and whose ultimate security has not been secured OR still widespread but will become increasingly endangered in the near future if threatening processes continue or begin to operate.

With reference to Figure 48, the vegetation of the area mapped by the DEC as FCT 30a has changed over the past 60 years as a result of anthropogenic activities. The earliest aerial photograph available (1953), appears to support low, dunal heath type vegetation. The appearance of taller vegetation typology is coincident with the establishment of the recreational oval. Consistent with the Keating and Trudgen (1986) report, the northern part of the subject area has been historically cleared and supported accommodation.

The previous flora and vegetation surveys, historical aerial photographs and Bennett (2005) observations of rehabilitation effort in the area (or portion of) mapped by DEC as FCT 30a, indicates that the extent of the vegetation community observed by DEC may be recent and a result of either natural recruitment or rehabilitation works (or both).

The history of the establishment of the mapped occurrence of TEC FCT 30a suggests that the community type is responsive to rehabilitation / colonisation.

The other two occurrences of FCT 30a at Cape Peron as mapped by ENV (2010) are located outside the Proposal area. The first is located on the boundary of Rockingham Beach Primary School, approximately 1.3 km to the southeast of the Proposal area and was mapped as being in 'good' condition; however there is no native understorey present and since the Bennett 2005 survey which identified the site, all the *Callitris preissii* have died (ENV 2010). This vegetation community is not a viable representation of FCT 30a and does not represent the TEC as it has likely been subject to recent degrading factors. The second occurrence is located at the base of the western-most car park, approximately 1 km from the Proposal area. This site is surrounded by dunal vegetation and is a viable representation of the TEC (Figure 44).

No other vegetation units occurring on Cape Peron or in the Proposal area are listed or probable TECs.

Priority Ecological Community

Two of the FCTs are listed as PECs by the DEC (ENV 2010). Reservation and conservation status of these FCTs was described by Gibson *et al*. (1994):

- FCT 29b (Priority 3): poorly reserved and susceptible (a community of concern due to evidence that it can be modified or destroyed by human activities, or would be vulnerable to new threatening processes)
- FCT 30b (Priority 3): well reserved and susceptible.

FCT 29b (Priority 3) is described across the majority of Cape Peron and is well represented inside and outside the Proposal area (Table 13). FCT 30b (Priority 3) occurrences are in 'good' condition (ENV 2010) with 24% of the area of FCT 30b mapped at Cape Peron, located within the Proposal area.

Vegetation condition

The vegetation condition[5] of Cape Peron mapped by ENV (2010) varies between 'very good' and 'completely degraded' (excluding development areas). Figure 49 highlights that the majority of the vegetation mapped at Cape Peron is in 'good' condition, while Table 14 indicates the condition of the uncleared vegetation within the Proposal area.

[5] Vegetation condition rating (Department of Environmental Protection 2000):
Pristine = Pristine or nearly so, no obvious signs of disturbance.
Excellent = Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very good = Vegetation structure altered, obvious signs of disturbance.
Good = Vegetation structure significantly altered by very obvious signs of multiple disturbances; retains basic vegetation structure or ability to regenerate it.
Degraded = Basic vegetation structure severely impacted by disturbance; scope for regeneration but not to a state approaching good condition without intensive management.
Completely degraded = The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

Figure 46 shows the condition of TEC FCT 30a as mapped by AECOM (2011).

The high variability of the condition is reflected by the fragmentation of the area by different infrastructure, roads, tracks, weeds and rubbish. The volume of people that use the area everyday has contributed to the degradation of the vegetation both directly through trampling and spread of weeds and indirectly through the need for additional infrastructure such as roads and amenities (ENV 2010).

The Proposal area, which in the 1986 survey was regarded as 'degraded' (Keating & Trudgen 1986), is recovering. Basic vegetation units are developing and several species were recorded in the area that were not recorded elsewhere (e.g. *Calothamnus quadrifidus*) (Strategen 2006). It is anticipated that with time, the vegetation will continue to recover and develop into a dense shrubland.

Several areas associated with development were 'degraded' or 'completely degraded'. The 'completely degraded' sites were those where there are holiday homes and other infrastructure.

Table 14 Area and proportion of each vegetation condition type in the Proposal area

Vegetation condition	Area mapped at Cape Peron (ha)	Area mapped in Proposal area (ha)	Proportion of area mapped in Proposal area (%)
Very good	25.70	18.08	70.4%
Very good to Good	8.45	0.02	0.2%
Good	70.16	20.18	28.8%
Good to Degraded	4.77	1.55	32.6%
Degraded to Completely Degraded	10.18	2.51	24.6%
Completely Degraded	8.07	5.32	66.0%

Bush Forever

Much of the Proposal area is located within the Bush Forever Site 355 (Figure 42). Bush Forever Site 355 is 174.5 ha in area of which approximately 107.1 ha is vegetated (Figure 42).

Bush Forever (Government of Western Australia 2000) states a detailed survey was undertaken of the site by Keating and Trudgen in 1986, which resulted in 60% of the flora taxa being sampled with no significant species being found. The site meets six specific coastal reserve criteria, which include:

- Quindalup Dune types: youngest, older and beach ridge plain
- continuing natural processes: 174.5 ha (107.1 ha of bushland) of Quindalup Dunes extending to 3.1 km inland from the point
- shoreline: soft (sandy) and Hard (rock)
- linkage: contains Quindalup/Spearwood Dunes (Tamala Limestone) interface; roads and developments fragment site
- vegetation: typical Quindalup/Spearwood units
- habitats: significant reptile species.

The Cape Peron site features rocky headlands displaying excellent exposures of the aeolian phase of Tamala Limestone, connected to the mainland by a series of Holocene beach-sand and dune-sand ridges of the Safety Bay Sands (Government of Western Australia 2000). The Cape Peron site is recognised as forming a linkage with Bush Forever Site 358, *Lake Richmond* (29 ha total area; approximately 27 ha vegetated), which is to the east; Safety Bay Road separates the two areas. The Cape Peron site is also part of Greenways[6] 1, 93 and 97 (Tingay & Associates 1998).

[6] The term 'greenways' is a generic term that has been used to describe ecological linkages in the landscape that connect natural areas, preferably with continuous corridors of native vegetation, in ways that allow both fauna and flora to move between these areas to access resources and suitable habitat for survival and reproduction. A study of Perth's greenways by Tingay and Associates (1998) identified proposed greenway corridors linking the Park internally and to external areas.

Source:
Cadastral data supplied by Landgate
FCT Mapping supplied by ENV
Coordinate System: MGA94 Zone 50
Date: 12/10/2011

NB: Potential errors may occur in some areas

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Drawn:
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CAD Resources File No:
g1937_MB_PER_F005.dgn

Floristic Community Type (FCT) mapping across Cape Peron (ENV 2010)

Figure No:
44

Source: Imagery supplied by Landgate (2010)
TEC mapping supplied by BEC (2005), ENV (2008), DEC (2010), Aecom (2011)
Coordinate System: MGA94 Zone 50
Date: 8/2/2012
NB: Potential errors may occur in some areas

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g1937_MB_PER_F044.dgn

Mapped extent of TEC SCP30a

Figure No:
45

Source:
Cadastral data supplied by Landgate
TEC Mapping Supplied by Aecom (2011)
Vegetation Conditoin Mapping supplied by Aecom
Coordinate System: MGA94 Zone 50

Date: 8/2/2012
NB: Potential errors may occur in some areas

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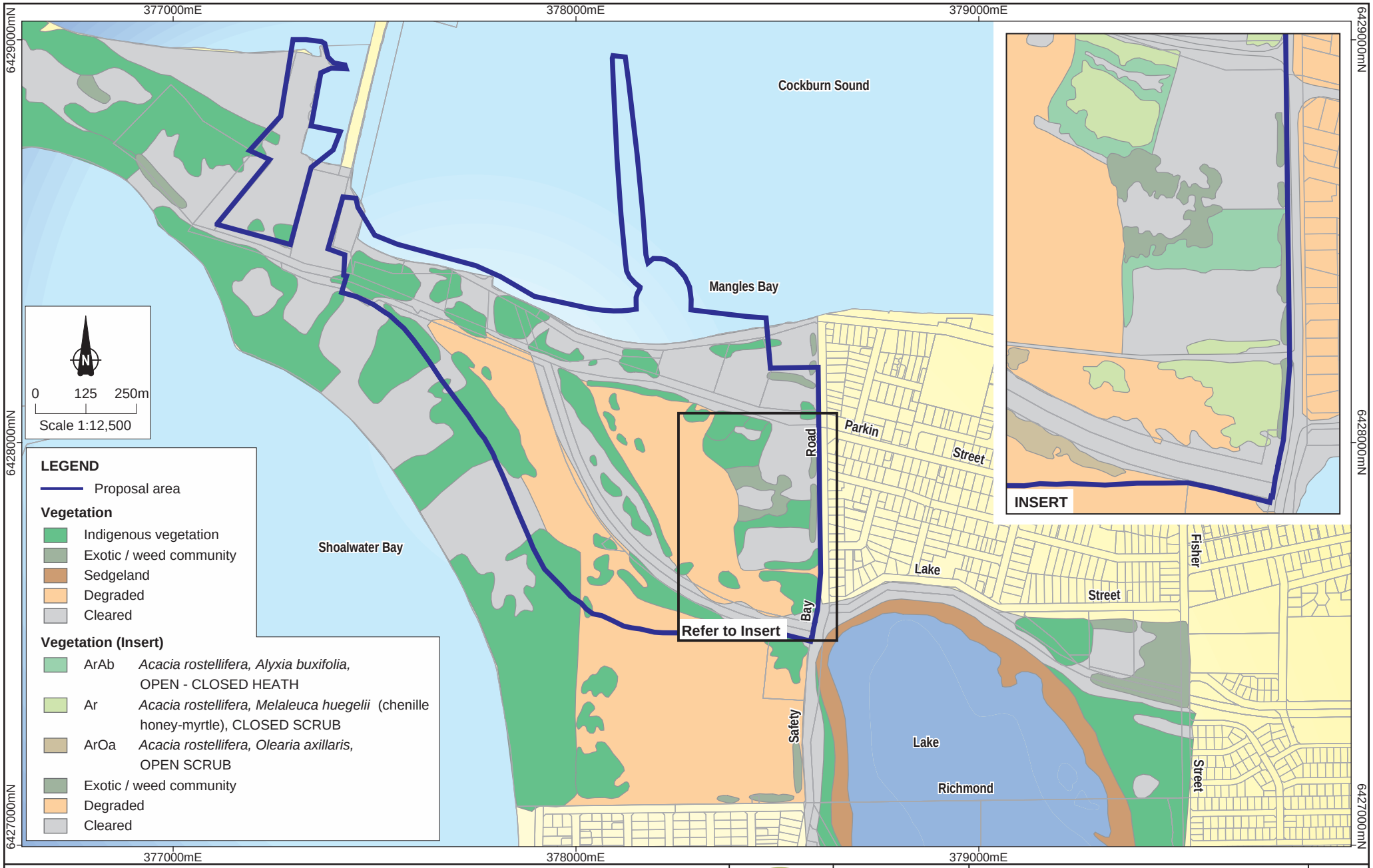
g1937_MB_PER_F061.dgn

TEC extent and condition (mapped by Aecom)

Figure No:
46



Source:
Cadastral data supplied by Landgate
Vegetation Mapping supplied by Keating and Trudgen 1986
Coordinate System: MGA94 Zone 50
Date: 8/2/2012

NB: Potential errors may occur in some areas

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Drawn:
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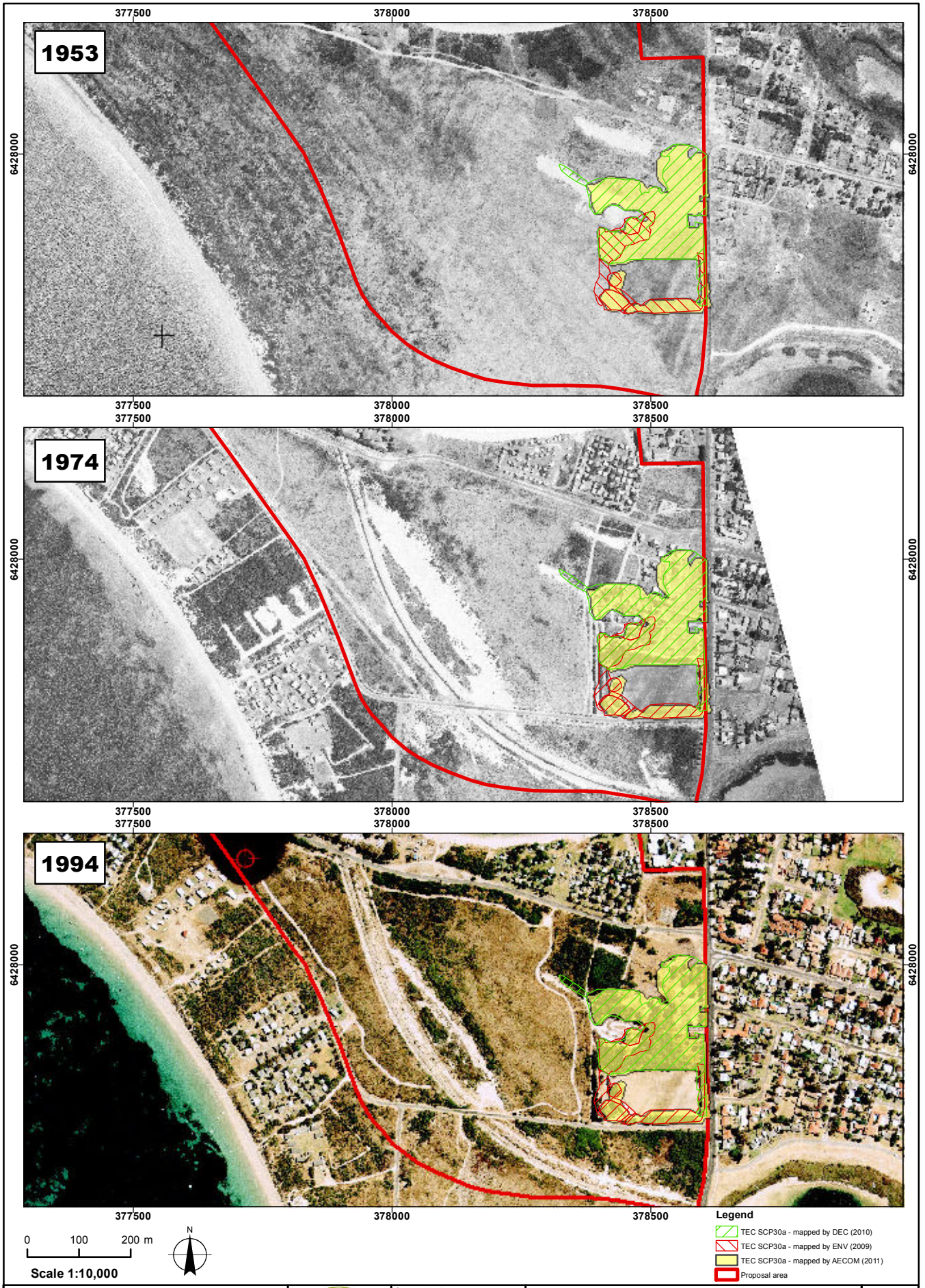
CAD Resources File No:
g1937_MB_PER_F052.dgn

Keating and Trudgen vegetation mapping

Figure No:
47



Source: Imagery supplied by Landgate (2010)
Coordinate System: MGA94 Zone 50
Date: 08/02/2012
NB: Potential errors may occur in some areas

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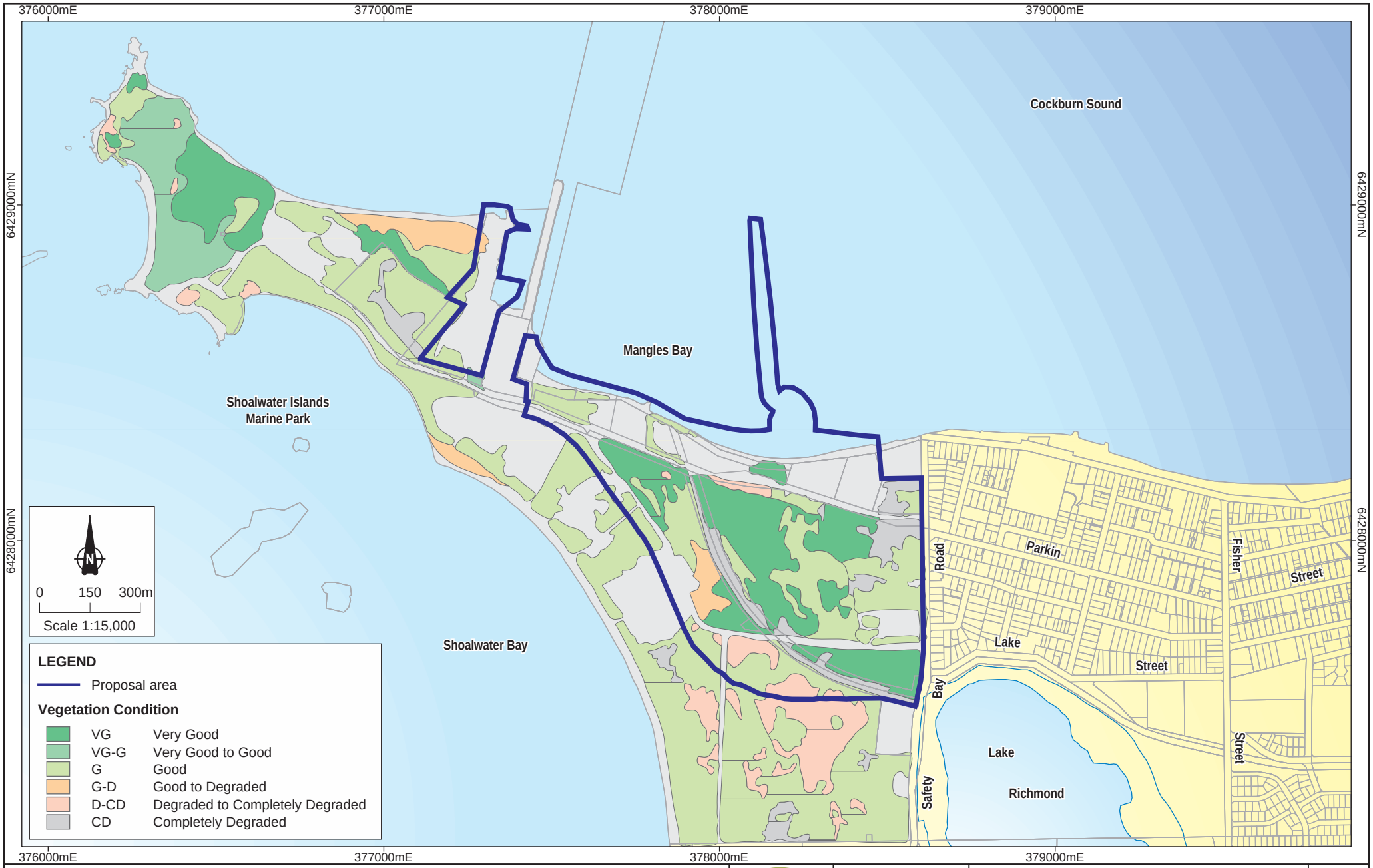
Compiled: atomeo

File: Figure 48 Historical Imagery.mxd

Historical imagery

Figure No: 48



Source:
Cadastral data supplied by Landgate
Vegetation Condition mapping supplied by ENV
Coordinate System: MGA94 Zone 50
Date: 8/2/2012

NB: Potential errors may occur in some areas

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Drawn:
CAD Resources

CAD Resources File No:
g1937_MB_PER_F006.dgn

Vegetation Condition mapping of Cape Peron

Figure No:
49

8.2.2 Vegetation adjacent to the Proposal

Bush Forever Site 358 *Lake Richmond* is located adjacent to the Proposal area and within the RLRP (Figure 118).

The Bush Forever site is located on the Quindalup Vegetation Complex consisting of uplands, shrublands and wetland units. The lake is bordered by flats devoid of permanent vegetation surrounded by sedges at the base of surrounding coastal dunes. The sedgeland is several metres wide and is underlain by peaty soil. The area is dominated by *Baumea juncea*, *Scirpus validus* and clumps of bulrush *Typha orientalis* (ENV 2011a). The vegetation community surrounding Lake Richmond and within Bush Forever Site 358 is FCT 19 Sedgelands in Holocene dune swales of the southern Swan Coastal Plain which is identified as a TEC by the WA DEC and is listed under the EPBC Act.

Sedgelands in Holocene dune swales

The Sedgelands TEC occurs in linear damplands and occasionally sumplands between Holocene dunes. The TEC is not limited to Lake Richmond, but occurs at eight locations in the Rockingham Becher Plain area and at two other locations in the South West, with a total estimated area of 130 ha (CALM 2002). Approximately 11 ha of this TEC occurs in a band around the edge of Lake Richmond (CALM 2002). This band extends to the edge of Safety Bay Road.

Hydrological regime is considered to be the primary non-biological factor that influences the characteristics of this TEC (CALM 2002). Depth, timing and duration of flooding and length of the dry period all affect vegetation composition and distribution (CALM 2002). Sedgelands in damplands and sumplands of the Holocene dune swales have relatively specific water regime requirements to maintain current biology, but are tolerant of seasonal and longer-term variations that reflect natural climatic patterns. Maintenance of water level and quality is considered critical for this TEC (CALM 2002).

8.2.3 Flora within the Proposal area

A total of 54 vascular plant families, 112 genera and 132 taxa, of which 67 are endemic and 65 are weeds were recorded by Bennett (2005) and/or ENV (2010). The dominant families were Poaceae (grass family), Asteraceae (daisy family), Myrtaceae (myrtle family) and Papilionaceae (pea family). An outline of the species observed and recorded during each survey is provided in Appendix 5.

Declared Rare and Priority flora

Four DRF and 15 Priority Flora species were identified from the DEC database as potentially occurring in the Cape Peron area (ENV 2010); however no DRF or Priority Flora species were recorded during the Bennett (2005) or ENV (2010) survey (Figure 50).

One species, *Dodonaea hackettiana* (Priority 4), has been previously recorded from the vicinity of Cape Peron outside the Proposal area. Considering the species was not found in the location that it was previously known to occur, nor the rest of the Cape Peron survey area by the two intensive surveys undertaken (Bennett 2005 and ENV 2010), it can be assumed that it was misidentified or the individuals have subsequently died.

The potential for the Proposal area to contain DRF or Priority Flora is considered to be low. The area has been surveyed intensively (traversed on foot) during spring at peak flowering time and no DRF or Priority flora were identified.

Six flora species considered by Bush Forever (Government of Western Australia 2000) to be of significance for the Quindalup dune system in the Perth Metropolitan area were recorded during the Bennett (2005) and/or ENV (2010) survey (Table 15).

Table 15 Significant species identified by Bush Forever recorded at Cape Peron

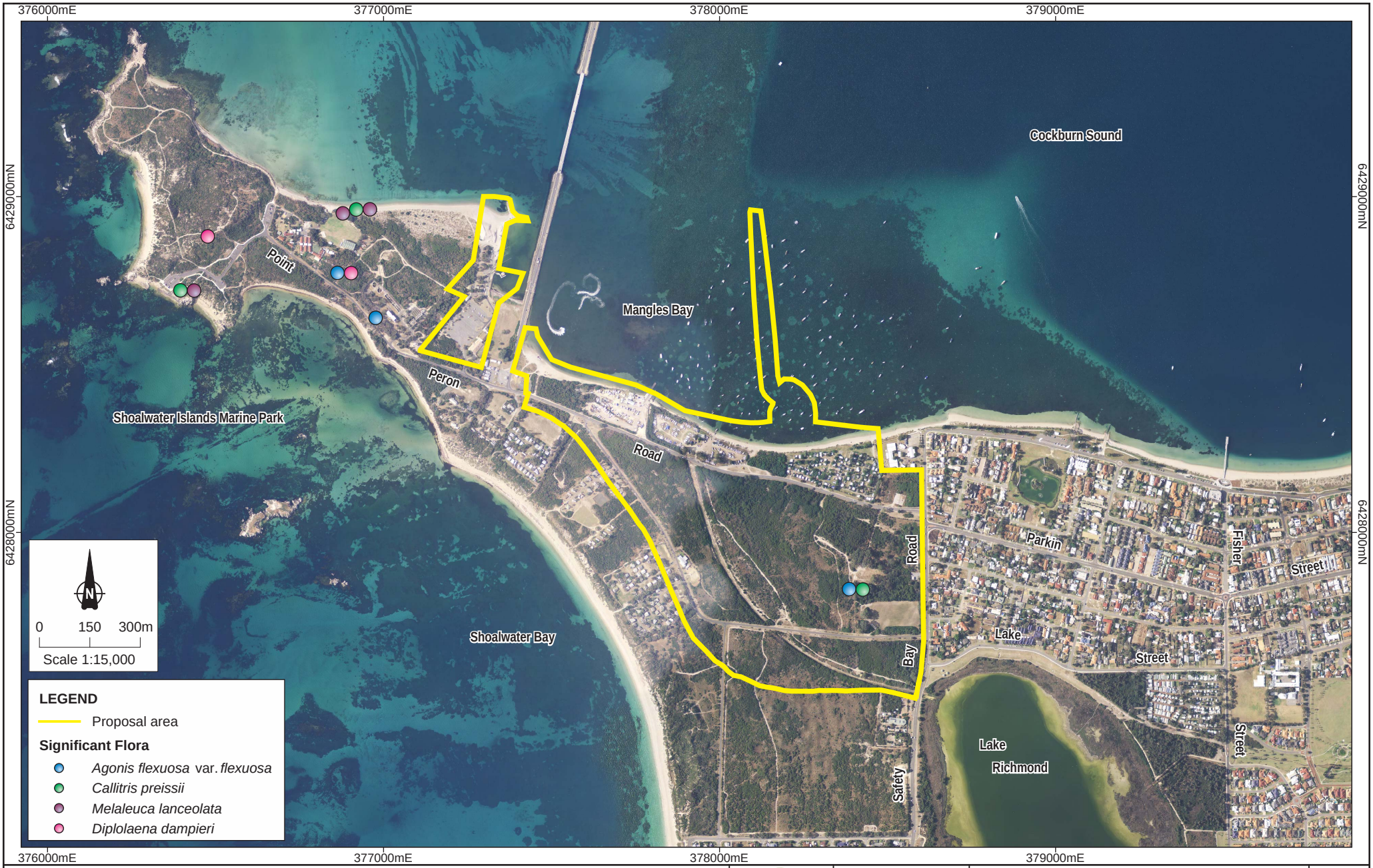
Species	Significance category	Floristic Community Type (FCT)
Agonis flexuosa var. *flexuosa*	At northern extension of known range Significant population	FCT 30b
Allocasuarina lehmanniana	Significant population	FCT 29a
Callitris preissii	Significant population Endemic to Swan Coastal Plain in Perth Metropolitan area	FCT 30a
Diplolaena dampieri	At northern extension of known range Significant population	FCT 29a
Hibbertia cuneiformis	At northern extension of known range Significant population	FCT 29a
Melaleuca lanceolata	Disjunct population (geographically or ecologically isolated from other populations of the same species) Significant population	FCT 30a

Flora potentially sensitive to groundwater changes

Of the species recorded during surveys, nine have been identified as being potentially susceptible to changes in groundwater levels and three as being susceptible to changes in groundwater quality (ENV 2010).

Table 16 Flora species potentially sensitive to groundwater level and quality changes

Susceptible to changes in groundwater levels	Susceptible to changes in groundwater quality
Spinifex hirsutus	*Callitris preissii*
Spinifex longifolius	*Desmocladus flexuosus*
Ficinia nodosa	*Leucopogon parviflorus*
Lepidosperma gladiatum	
Lepidosperma sp. Coastal Dune (R. J. Cranfield 9963)	
Agonis flexuosa	
Eucalyptus gomphocephala	
Melaleuca lanceolata	
Frankenia pauciflora	



Source:
Imagery supplied by Landgate
Significant Flora data supplied by ENV (2010)
Coordinate System: MGA94 Zone 50
Date: 8/2/2012

NB: Potential errors may occur in some areas

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CAD Resources File No:
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Flora species of conservation significance

Figure No:
50

Introduced flora

A total of 65 weed species (49% of the total number of taxa) were recorded by Bennett (2005) and/or ENV (2010) surveys. Weed species are listed in respective reports (provided in Appendix 5), all of which have been determined as weeds by CALM (1999). In addition, four cultivated species and a group of unidentifiable grasses were recorded.

The weeds present are generally typical for urban sites but some weed species recorded had been planted as part of rehabilitation, mainly within lease areas. Cultivated species planted for ornamental purposes were not recorded by the survey.

Nine of the weed species were rated by CALM (1999) as 'High'[7] including:

- *Asparagus asparagoides* (bridal creeper)
- *Bromus diandrus (*great brome)
- *Ehrharta calycina* (perennial veldt grass)
- *Eragrostis curvula* (African love grass)
- *Eurphorbia terracina* (Geraldton carnation weed)
- *Hyparrhenia hirta (*tambookie grass)
- *Lagurus ovatus* (Hare's tail grass)
- *Pelargonium capitatum* (rose pelargonium)
- *Romulea rosea* (guildford grass).

One Declared Plant species, **Asparagus asparagoides*, listed by the *Agriculture and Related Resources Protection Act 1976* was found in the study area (ENV 2010). This species is listed as Priority 1 for the whole State.

Species widespread throughout the area include *Euphorbia terracina*, (Geraldton carnation weed, 'High'), *Pelargonium capitatum* (rose pelargonium, 'High'), *Lagurus ovatus* (Hare's tail grass, 'High') and *Lolium rigidum* (wimmera ryegrass, 'Moderate'). Another common weed species in the area was *Trachyandra divaricata* (onion weed), which is rated as 'Mild'[8]. This species is known to be aggressive in interdunal beach heathland (Hussey *et al*. 1997).

8.3 Evaluation of options or alternatives to avoid or minimise impact

The TEC, FCT30a *Callitris preissii* community has been identified near the corner of Memorial Drive and Safety Bay Road. The Proposal will clear 1.93 ha of TEC FCT 30a. The Proposal was designed to minimise direct and indirect impacts on the TEC FCT 30a. These include:

- the length of one of the eastern arms was shortened to reduce the potential for hydrological impacts on the vegetation community
- it is proposed to retain and consolidate TEC FCT 30a into a more sustainable shape of a remnant of approximately 3.95 ha, where the boundary to area ratio is improved when compared to the current configuration of the remnant. This will comprise the retention of 1.12 ha of Very Good condition vegetation, rehabilitation of 1.61 ha that currently does not support FCT 30a and 1.22 ha of FCT 30a that has been identified as being in Good – Degraded condition.

[7] Ratings based on three criteria; invasiveness, distribution and environmental impacts. 'High' rating indicates weed is prioritised for control and/or research.

[8] 'Mild' rating indicates monitoring of the weed and control where appropriate.

8.4 Assessment of likely direct and indirect impacts

The Proposal will result in the clearing of a total area of up to 40 ha. The majority of the Proposal area is within both the RLRP and Bush Forever Site 355. Bush Forever Site 358, incorporating Lake Richmond and its surrounding vegetation, is adjacent to the south eastern corner of the Proposal area. In addition to the physical removal of native vegetation, there is the potential for secondary impacts to vegetation health arising from changes in the groundwater hydrology to be considered in the assessment. Both of these effects may reduce the values of the RLRP without appropriate management.

The following aspects of the Proposal may affect flora and vegetation values:

- clearing of vegetation for the development will directly reduce the extent of vegetation communities with minimal disturbance expected to occur to TECs
- dewatering to lower groundwater levels to allow for the excavation of the marina may affect groundwater-dependent vegetation
- creation of new saltwater interface as a result of the land based marina may affect saltwater/freshwater interface dependent vegetation
- increased population as a result of development may increase indirect impacts on vegetation through uncontrolled access, rubbish and domestic pets
- vehicle movements and earthworks have the potential to introduce and spread weed species
- fragmentation of Bush Forever Site 355 as a result of clearing for the development
- dust generation due to earthworks and vehicle movements has the potential to smother vegetation
- potential edge effects to surrounding vegetation from clearing and construction activities.

8.4.1 Vegetation clearing

Clearing requirements for the Proposal will result in the clearing up to 40 ha excluding areas that are already 'completely degraded' and development areas already cleared, such as the caravan park and fishing club (Figure 51). The remnant vegetation of the Proposal area (excluding already developed areas) was generally assessed to be in 'good' or 'very good' vegetation condition comprising 61% of the Proposal area. There are small areas of 'degraded' and 'completely degraded' vegetation in the Proposal area due to public access, clearing for infrastructure, road and track edges (Bennett 2005). The edges of these tracks were typically in poorer condition than the vegetation further away. The vegetation along the drain that bisects the area blended with the surrounding vegetation and in some sections included weedy areas, but mostly was in 'good' vegetation condition.

Clearing of vegetation will directly reduce the extent of vegetation communities; however, all of the vegetation complexes impacted by clearing are well represented at Cape Peron outside the Proposal area and clearing required for the Proposal would not result in any vegetation complexes being cleared to less than 10% of the original extent (Table 13). Five FCTs in the Proposal area will be directly impacted by clearing including:

- FCT S14: *Spinifex longifolius* grasslands and low shrublands
- FCT 29a: Coastal shrublands on shallow sands
- FCT 29b: Acacia shrublands on taller dunes (P3 PEC)
- FCT 30a: *Callitris preissii* (or *Melaleuca lanceolata*) forest and woodlands (TEC)
- FCT 30b: Quindalup *Eucalyptus gomphocephala* and/or *Agonis flexuosa* woodlands (P3 PEC).

The TEC located within the Proposal area near the corner of Memorial Drive and Safety Bay Road is in 'very good' to 'degraded' condition (Figure 46). The area is surrounded by native vegetation and there are many informal tracks that dissect the area and rubbish has been dumped adjacent to the site. These degrading influences will need to be controlled if the vegetation community is to be conserved.

The TEC (FCT 30a) is approximately 4.3 ha in total size. The Proposal will clear 1.93 ha of TEC FCT 30a ranging from very good to degraded to good condition. It is proposed to retain and consolidate TEC FCT 30a into a more sustainable shape of a remnant of approximately 3.95 ha, where the boundary to area ratio is improved when compared to the current configuration of the remnant. This will comprise the retention of 1.12 ha of Very Good condition vegetation, rehabilitation of 1.61 ha that currently does not support FCT 30a and 1.22 ha of FCT 30a that has been identified as being in Good – Degraded condition. Management measures, such as demarcating Environmental Exclusion Areas, will be implemented to protect and manage the TEC from additional clearing and potential community activities such as motorcycling and illegal rubbish dumping (discussed in 'Indirect disturbance and spread of weeds' sub-section below). The P3 PECs will remain well represented outside the Proposal area and where possible, these communities within the Proposal Area will be retained as part of the development.

Based on flora and vegetation surveys conducted to date, no DRFs or Priority Flora will be directly impacted by clearing.

Clearing for the development may result in the potential fragmentation of Bush Forever site 355 and this impact is discussed in Section 17. The Proposal proposes to impact upon 40 ha of native vegetation within Bush Forever site 355 and 37 ha within the RLRP. The area represents less than 1% of the RLRP which covers an area of 4270 ha (RLRP Management Plan, DEC 2010a).

The development will provide offsets that involve support for the management, protection and rehabilitation of vegetation in the Cape Peron area of RLRP thereby enhancing the biodiversity including botanical values in those sections of Regional Park and improving the ecological linkage between Lake Richmond and Cape Peron. A further offset is proposed through securing a parcel of land that is currently not protected, with similar or greater conservation value. The rehabilitation and possible land acquisition offsets will be determined (in consultation with the DEC and OPEA) in accordance with the EPA Position Statement No. 9 on Environmental Offsets.

8.4.2 Groundwater levels and quality changes

The lowering of the water table and change in groundwater quality by creation of a new saltwater interface is likely due to the dewatering activities required for the excavation and construction of the marina may potentially impact upon vegetation health and condition.

Groundwater levels recorded manually during the study period varied between 0.05 and 0.95 mAHD (MWH 2011a). Under a high (winter) water level scenario, the reduction in water levels in the vegetated area surrounding the Proposal during operation is less than 0.2 m (Section 6.3.5). Under a low (summer) scenario, the impact is closer to 0.1 m (Section 6.3.5). This drawdown may indirectly impact flora species identified in Table 16 such as *Eucalyptus gomphocephala* (tuart) or *Agonis flexuosa*. However, the magnitude of this groundwater level change is not considered to be significant in the context of seasonal variation in groundwater levels of 0.3 to 0.7 m and is within the known range of all vegetation species and communities.

The hydrological requirements of TEC 19 are well documented. Extracted from Interim Recovery Plan No. 110 Sedgelands in Holocene Dune Swales 2002 – 2007 (CALM 2002), the hydrological requirements of this TEC are described as follows "*Both long-term regional data (up to 24 years of records) and short-term site specific data at Port Kennedy indicate that the seasonal watertable fluctuation in the swale wetlands is low, generally less than 0.5 m. Although maximum watertable levels range from 0.4 m to 1.9 m below ground, some of the wetlands (sumplands) contain very limited areas of surface water during the winter months."* As the development will result in a change in groundwater levels of 0.038 m at Lake Richmond, where the community is located, it is considered that the community will not be impacted by changes in groundwater levels.

Groundwater in the Safety Bay Sands in the study area generally has a total dissolved salts (TDS) of less than 1 000 mg/L, except in areas within 200 m of the coast (Section 6).

With reference to Figure 52, the impact on water quality, by way of saline intrusion is limited and is not expected to impact any of the mapped TECs, except a small portion of the DEC mapped TEC FCT 30 which is proposed to be cleared. There may be some change in water quality under areas of community

SCP 29a and SCP 29b to the south of the site (Figure 52). These communities also occur in areas where the salinity is currently greater than 1 000 mg/L at Cape Peron and Shoalwater Bay (Figure 52). It is therefore considered that this change in salinity will not impact upon this community.

8.4.3 Indirect disturbance and spread of weeds

The proposed marina development will most likely result in an increased residential population of the area and increase in tourism activity leading to an increased public usage of the Cape Peron area. Increased vehicle movements during construction and post-construction of the proposed marina development may result in uncontrolled and unmanaged access to vegetated areas which can lead to:

- introduction and/or spread of weeds
- illegal rubbish dumping
- direct disturbance of vegetation and flora (e.g. from trampling and erosion of existing sandy tracks).

Currently there is evidence of bushland degradation, some of which is due to uncontrolled access at Cape Peron owing to the network of sandy tracks through vegetated areas and the associated invasion of weeds along track edges and degradation of vegetation adjacent to the tracks. Improving visitor access facilities as part of the Proposal will improve the protection of native vegetation through the provision of hard paths, increased management presence in the area and the removal and rehabilitation of unnecessary paths. Therefore, increased visitor access to the area is not expected to result in the impacts listed above.

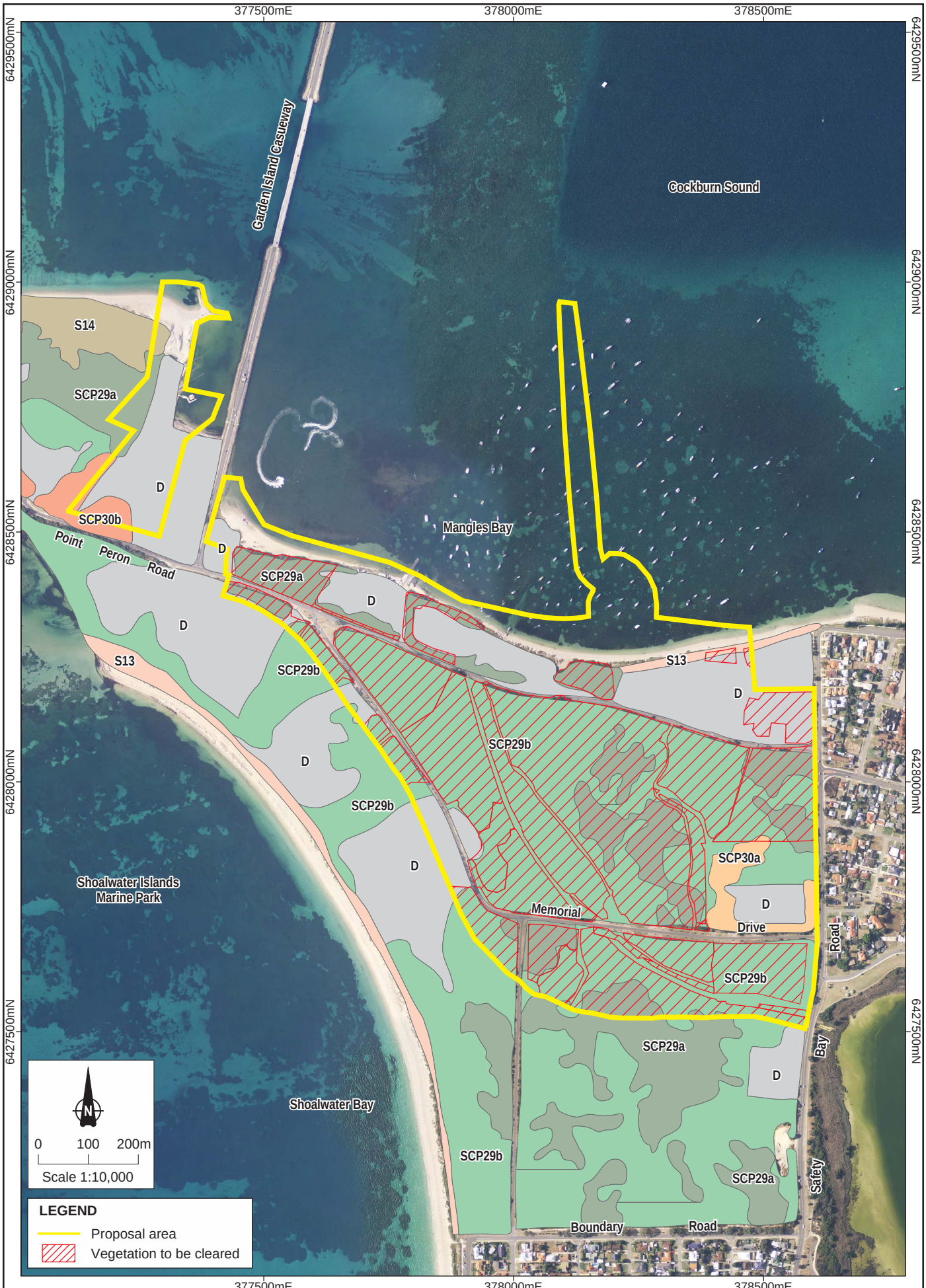
8.4.4 Dust Generation

Earthworks during construction will generate dust which may have direct physical effects on plants such as blockage and damage to stomata, shading, abrasion of leaf surface or cuticle and cumulative effects (e.g. drought stress on already stressed species). Dust also has the potential to adversely affect the health of construction workers and nearby residents.

Dust will be managed throughout the clearing and construction phase of development in accordance with DEC (2011a) publication " A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities" through the use of water trucks or other suitable dust suppression methods. Areas left exposed following development will be rehabilitated or sealed where appropriate, to reduce the risk of dust generation.

8.4.5 Potential edge effects

There is the potential for edge effects to occur to the vegetation surrounding the Proposal area, including the TEC FCT 30a surrounding the small grassed area on the corner of Memorial Drive and Safety Bay Road and the remnant vegetation adjacent in the RLRP (also Bush Forever Site 355). Degrading influences such as general construction activities during the construction phase of the Proposal, recreational walking, littering and domestic pets may potentially affect these areas. These potential edge effects would only be minor and would be subject to proposed management strategies which include rehabilitation and management effort within the TEC FCT 30a and RLRP.



Source: Imagery supplied by Landgate (2010)
FCT Mapping supplied by ENV (2010)
Coordinate System: MGA94 Zone 50
Date: 8/2/2012
NB: Potential errors may occur in some areas

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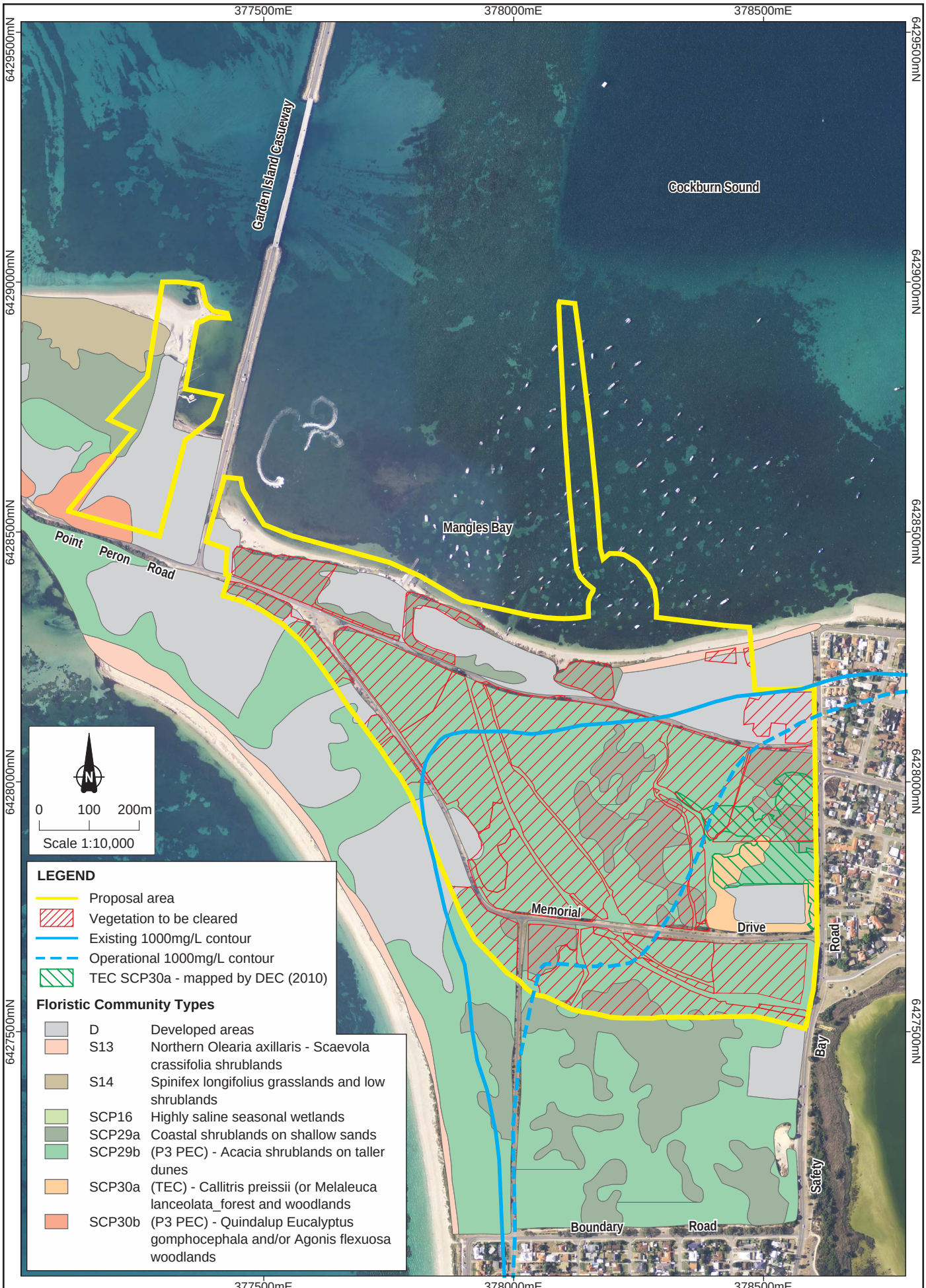
Drawn: CAD Resources

CAD Resources File No: g1937_MB_PER_F028.dgn

Vegetation communities to be cleared as a result of the Proposal

Figure No: **51**



Source: Imagery supplied by Landgate (2010)
FCT Mapping supplied by ENV (2010)
Coordinate System: MGA94 Zone 50
Date: 2/8/2012
NB: Potential errors may occur in some areas

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Drawn:
CAD Resources

CAD Resources File No:
g1937_MB_PER_F060.dgn

Salinity level changes and surrounding vegetation

Figure No:
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