Metropolitan Desalination Proposal

Section 46 Review

Prepared for
Water Corporation
by Strategen

February 2004

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Strategen (formerly Welker Environmental Consultancy)
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February 2004

Disclaimer and Limitation

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Client: Water Corporation

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Draft Report	V4	TE	PW, DL, CW	email	18/12/03
Draft Report	V5	TE	PW, DL	email	7/1/04
Report for submission to EPA	V8b	TE	PW, DL	email	23/1/04
Final Report	Final	TE/DL	PW,DL		

INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. If you are able to, electronic submissions e-mailed to the EPA Service Unit project officer would be most welcome.

A proposal to develop a 30 GL/year Perth Desalination Plant at Kwinana Power Station, as a possible public water supply option, was granted environmental approval in May 2003. The Water Corporation proposes to upgrade the capacity of this plant, from the originally approved 30 GL/annum to 45 GL/annum. This will result in a 50% increase in both the originally approved use of seawater and in the originally approved discharge of concentrated seawater to Cockburn Sound. The proposed changes include options for combining intake seawater with cooling water discharged from Western Power's Kwinana power Station. The changes do not relate to the development of the plant at the East Rockingham site, which is an alternative site for the approved project (note that only one desalination plant can be built under the existing approval and under this proposal).

A Section 46 Review document has been prepared by the Corporation to examine the environmental effects associated with the proposed development, in accordance with Western Australian Government procedures. The Review describes the proposal, examines the likely environmental effects and the proposed environmental management procedures.

The Review document is available for a public review period of 4 weeks from 23 February 2004 closing on 23 March 2004.

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

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 by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in the EPA's report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group 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 Review 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 more environmentally acceptable.

When making comments on specific elements of the Review:

- 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 Review;
- if you discuss different sections of the Review, 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; and
- whether and the reason why you want your submission to be confidential.

Information in submissions will be deemed public information unless a request for confidentiality of the submission is made in writing and accepted by the EPA. As a result, a copy of each submission will be provided to the proponent but the identity of private individuals will remain confidential to the EPA.

The closing date for submissions is: 23 March 2004.

Submissions should ideally be emailed to
perthdesalplant@environment.wa.gov.au

OR addressed to:

Environmental Protection Authority
PO Box K822 OR Westralia Square, 141 St George's Terrace
PERTH WA 6842 PERTH WA 6000
Attention: Mr Sean McGunnigle

ACKNOWLEDGEMENTS

Technical data and interpretation by Mr Mark Bailey and Dr Karen Hillman of DAL Science and Engineering Pty Ltd.

Numerical modelling of Cockburn Sound supervised by Mr Murray Burling of Worley.

Preparation of s46 Review including revision and technical editing, by:

- Mr Tim Eckersley of Strategen;
- Mr Peter Walkemeyer on behalf of the Water Corporation; and
- Dr David Luketina and Dr Robert Humphries of the Water Corporation.

EXECUTIVE SUMMARY

Proponent

The Water Corporation remains the proponent for the amended proposal. The Water Corporation is responsible for the supply of drinking water and wastewater treatment services for the majority of Western Australia's population.

The Water Corporation contact for this proposal is:

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Background

The Perth Metropolitan Desalination Proposal was developed as an option by the Water Corporation to provide an additional supply of water (around 10% increase) to the State's Integrated Water Supply Scheme. The additional water can be used to meet normal growth in demand for water or as a drought recovery measure. The original proposal was assessed as an Environmental Protection Statement (EPS) by the Environmental Protection Authority, and approved with the issuance of Ministerial Statement No. 626 in May 2003.

The approved desalination proposal enabled the establishment of a 30 Gigalitre per annum (GL/a) reverse osmosis desalination plant either at the Kwinana Power Station (KPS) or in East Rockingham at the corner of Office and Patterson Roads. The East Rockingham plant also included a 20 MW gas fired power station. Note that only one desalination plant can be built under the existing approval and under this proposal.

Proposal changes

The approved desalination project is proposed to be amended by increasing the capacity of the plant to be located at the KPS from 30 to 45 GL/a and including the capability for a shared intake with KPS. No changes to the existing approval of a 30 GL/a desalination plant and associated power at the East Rockingham site are proposed. Further, the desalination process (reverse osmosis system) will be the same as that approved. The proposed changes are listed in Table 1 below and are submitted as a Section 46 (of the Environmental Protection Act) amendment to Ministerial Statement No. 626

Table 1: Changes to KPS site plant

	Kwinana Power Station site	
Characteristic	**Approved**	**Change**
Location	Kwinana Power Station	No change
Capacity	30 GL/a	45 GL/a
Power requirement	20 MW	25.6 MW average demand
Power Source	Western Power Grid	Kwinana Power Station
Clearing of vegetation required	Likely to be 2-3 ha of mostly completely degraded vegetation	No change
Seawater intake	220 ML/d (average)	300 ML/d (weekly average)
Seawater intake pipelines		

	Kwinana Power Station site	
Characteristic	**Approved**	**Change**
Location (indicative)	See Figure 1	No change for dedicated intake. Option for combined intake with Western Power facilities.
Length (indicative)	0.8 km	No change
Number	1	No change
Diameter	1400 mm	Negligible change (1500 mm)
Concentrated seawater discharge		
Volume	120 ML/day	180 ML/d (weekly average)
Salinity	65,000 mg/L	No change
Temperature	Less than 2^0C above ambient	No change if the dedicated intake is used. Use of KPS cooling water gives up to 13ºC above ambient (less than 0.3ºC after initial mixing)
Location of outlet	In 8m depth of water offshore from KPS	In 10m depth of water around 300 m offshore from KPS
Diffuser design	160 m long, risers at 10 m spacings at 60° from horizontal, riser ports 200 mm in diameter	Around 80 – 180 m long. Design to be based upon an average initial dilution of 45
Product water pipeline		
Location (indicative)	See Figure 1	No change
Capacity	>100 ML/day	>150 ML/day
Length (indicative)	10 km	No change
Number	1	No change
Diameter	900 mm	Negligible change (1000 mm)
Destination	Thompson Lake reservoir	No change

Community consultation

Key stakeholders identified and included in the consultation program during preparation of the EPS were again consulted during preparation of this section 46 review document. Major issues of concern remained as for the approved project and include effects on the water quality of Cockburn Sound, plant energy efficiency and emissions of greenhouse gases, and noise emissions. In addition, concern was raised over the fate of heavy metals and other contaminants that may be taken into the desalination plant. All areas of concern raised during consultation have been addressed by the mitigations proposed in this document, the original EPS, and in the Consultative Environmental Management Plan (CEMP) to be prepared to address and implement proponent commitments.

Management of environmental impacts

Of the seven significant environmental factors identified for the original proposal only the factor of Cockburn Sound marine habitat and biota is considered significant for the proposed changes (emissions of greenhouse gases due to the proposed changes have reduced from the approved project due to the purchase of all electricity from KPS following complete conversion of the station to natural gas).

Increasing the capacity of the desalination plant to be located at the KPS site will result in an increase in both plant intake and discharge. Daily plant intake will increase from the originally approved rate of 220 ML/day (actual 200) to 300 ML/day. Discharge of concentrated seawater from the desalination plant will increase from approximately 120 to 180 ML/day. Salinity of the plant discharge will remain at around 65,000 mg/L and temperature in the range of 1-2º above ambient unless KPS cooling water is used as intake to the plant. In either case, the discharge will form a dense plume that will flow downhill along the seabed and will reach the entrance to Stirling Channel approximately one day after release.

The EPA released the Revised Draft Environmental Protection (Cockburn Sound) Policy and the Revised Environmental Quality Criteria Reference Document (Cockburn Sound) in November 2002. These documents define a series of levels of protection and Environmental Quality Guidelines (EQGs) for each level of protection. Computer modelling of Cockburn Sound incorporating the desalination plant intake and discharge demonstrates that adequate dilution (average 45 fold) of the discharge will meet the EQGs for salinity and temperature. Dissolved oxygen levels in Cockburn Sound will not be less than those associated with the originally approved desalination proposal. Nitrogen loads entering Cockburn Sound will increase by an additional 6 t/a . This additional loading represents less than 0.4% of the total nitrogen load to Cockburn Sound and, as such, will not have a measurable effect and, in any case, will be mitigated by other Water Corporation activities. Further, no cumulative ecological effects and no impacts on the social values (fishing and aquaculture, recreation and aesthetics and industrial water supply) ascribed to Cockburn Sound are anticipated.

The proposal avoids any known Aboriginal heritage sites. However, the Aboriginal community will be consulted and approval will be sought under section 18 of the Aboriginal Heritage Act to conduct works in Cockburn Sound.

Consolidated proponent commitments

Environmental management commitments for the desalination plant and associated infrastructure are provided in Table 2.

Table 2: Environmental management commitments

No	Commitment	Objective	Action	Timing	Advice

1	Consultative Environmental Management Plan (CEMP)	To minimise environmental impacts from implementation of the proposal	Prepare a CEMP which addresses the following;
			• Water Quality Management Plan to include:
			  • procedures to mitigate potential impacts of construction of the discharge pipeline and intake;
			  • a monitoring program for TDS (salinity), temperature and DO (dissolved oxygen) of water surrounding the discharge site, a nearby reference site, and a site in the deeper waters of Cockburn Sound.
			  • A monitoring programme to ensure that the diffuser is performing to specifications and achieving the required level of average dilution.
			  • Monitoring of sediment habitat pre and post commissioning;
			  • a contingency plan that examines the risk of contamination and procedures to mitigate any unanticipated impacts; and
			• Flora and Fauna Management Plan to include:
			  • locating the plant and pipelines to minimise clearing and effects on conservation values;
			  • mitigating impacts on Priority Flora;
			  • Dieback management measures; and
			  • weed control measures.
			• Greenhouse gas management plan as part of the CEMP that will include:
			  • use of sources of renewable energy as far as is practicable;
			  • calculation of the greenhouse gas emissions associated with the proposal, as indicated in "Minimising Greenhouse Gas Emissions, Guidance for the Assessment of Environmental Factors, No 12" published the Environmental Protection Authority;
				Within four months following a decision to construct	DoE
					Key stakeholders
					(e.g. DoE Marine Branch for WQMP, CALM for flora and fauna, DoE Air Quality Manage-ment Branch for greenhouse gas, and DoE Noise Managemen t Branch for noise issues).

No	Commitment	Objective	Action	Timing	Advice
			• specific measures to minimise the greenhouse gas emissions associated with the proposal; • monitoring of greenhouse gas emissions; • estimation of the greenhouse gas efficiency of the proposal in comparison with the efficiencies of other comparable projects producing a similar product; and • an analysis of the extent to which the proposal meets the requirements of the National Strategy using a combination of: • "no regrets" measures, • "beyond no regrets" measures, • land use change or forestry offsets, and • international flexibility mechanisms. • Demonstration that Nitrogen Oxides emissions from a dedicated power plant at East Rockingham will comply with EPA Guidance 15 and the relevant NEPM. • Noise Management Plan that includes detailed modelling of noise emissions and cumulative affect of emissions. • Hazardous Materials Management Plan to minimise public risk from materials associated with the plant. • A contingency that includes an archaeological monitoring program in case Aboriginal heritage sites are discovered during construction. • A monitoring programme for Kwinana Power Station cooling water, if used as input water, will be conducted. Analysis shall be of sufficient accuracy and precision to enable comparison with appropriate standards and criteria for Cockburn Sound. • An annual inspection programme to check the physical integrity of the outlet pipe and diffuser.		
2	Ocean outlet for seawater return	Achieve compliance with Cockburn Sound EPP and associated criteria	Locate and design the ocean outlet diffuser system to ensure the discharge complies with the requirements of the Cockburn Sound Environmental Protection Policy and the Revised Environmental Quality Criteria Reference Document (Cockburn Sound). The design to be certified by an expert as soon as the optimised design of the diffuser is available.	Prior to construction	EPA
3	Seawater return	Address impact issues	Obtain an expert assessment of the likely stratification build up and any subsequent dissolved oxygen effects in the deeper area of Cockburn Sound.	Within 3 months of approval and prior to construction	
4	Eco-toxicity	Demonstrate that the discharge is environmentally safe	Whole Effluent Toxicity (WET) testing of the high salinity seawater discharge including added chemicals (anti-scalants and biocides) to be undertaken as soon as the chemicals to be used and their likely dosing rates are known to a reasonable level of certainty and 12 months after start up. Testing will follow ANZECC/ARMCANZ (2000) whole effluent toxicity protocols, at various concentration levels and the results will be reported to the DoE. The objective is to ensure that the discharge complies with the requirements of the Cockburn Sound Environmental Protection Policy and the Revised Environmental Quality Criteria Reference Document (Cockburn Sound).	As soon as is practicable before construction and 12 months after start up.	DoE
5	CEMP	Achieve objectives of Commitment 1	Implement CEMP	Before during and following construction	DoE CALM

No	Commitment	Objective	Action	Timing	Advice
6	Vegetation, Declared Rare and Priority Flora and Fauna Habitat	Protect vegetation, Declared Rare and Priority Flora and Fauna	Conduct a survey of product pipeline routes to determine final alignments to avoid areas identified by CALM or Department of Environmental Protection. Conduct detailed survey for Rare and Priority Flora, to contribute to the Flora and Fauna Management Plan.	Spring season before construction commences	CALM
7	Aboriginal heritage	Address heritage issues	Consult with regional and local Aboriginal organisations and conduct site inspections to determine issues	Before and during construction	
8	Aboriginal heritage	Address impact issues	Submit a section 18 application to develop into Cockburn Sound to the Aboriginal Cultural Materials Committee	Before construction	DIA
9	Nitrogen loading to Cockburn Sound	Address impact issues	Develop a strategic management plan to ensure that the net total nitrogen loads to Cockburn Sound associated with Water Corporation activities are reduced relative to baseline loadings in the long term. Baseline loadings will be those estimated for 2003 unless higher loadings are approved by the EPA. The strategic management plan will be developed in consultation with the Cockburn Sound Management Council and will be submitted to the EPA for approval.	Before construction	CSMC
10	Nitrogen loading to Cockburn Sound	Address impact issues	Nitrogen free alternatives will be used for process chemicals where appropriate and practicable.	During operation	

Consultative Environmental Management Plan

The Water Corporation will prepare the CEMP within four months following a decision to construct. The CEMP, which will include stakeholder input, will address in detail the commitments associated with this project and will cover management of water quality, flora and fauna, greenhouse gas, noise, Aboriginal heritage issues, monitoring and construction aspects of the proposal. A pilot plant of around 1 MLD capacity will need to be built and operated prior to the CEMP being finalised.

Conclusion

Overall, the upgrading of the capacity of the approved desalination plant from 30 to 45 GL/a will result in additional water for the State's Integrated Water Supply Scheme at substantially less cost per volume of potable water produced while essentially having no environmental effects beyond those in the previously approved proposal other than a small increase in nitrogen loads which will be mitigated by other Water Corporation activities.

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GLOSSARY/ABBREVIATIONS

Term	Meaning
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CALM	Department of Conservation and Land Management
CBH	Cooperative Bulk Handling
CEMP	Consultative Environmental Management Plan
CO_2-e	Carbon dioxide equivalent (greenhouse gas emissions taking into account greenhouse gases other than CO_2)
CSMC	Cockburn Sound Management Council
DBNPA	2,2-dibromo-3-nitilopropion amide (biocide)
DIA	Department of Indigenous Affairs
DO	Dissolved oxygen
DoE	Department of Environment (formerly the Department of Environmental Protection (DEP))
E2	High Ecological Protection Area (of Cockburn Sound)
E3	Moderate Ecological Protection Area (of Cockburn Sound)
E4	Low Ecological Protection Area (of Cockburn Sound)
end of pipe	Immediately prior to the discharge to the environment.
EPA	Environmental Protection Authority of Western Australia
EPP	Environmental Protection Policy
EPS	Environmental Protection Statement
EQG	Environmental Quality Guideline
EQO	Environmental Quality Objective
EQS	Environmental Quality Standard
FF	Floculation filtration
IWSS	Integrated Water Supply System
JAMBA/CAMBA	Japan/China Australia Migratory Bird Agreement
KPS	Kwinana Power Station
KWRP	Kwinana Water Reclamation Plant
LEPA	Low Ecological Protection Area
NEPM	National Environmental Protection Measure
NHMRC	National Health and Medical Research Council
PCWS	Perth Coastal Waters Study
PLOOM	Perth Long-term Ocean Outlet Monitoring
RO	Reverse Osmosis - hyperfiltration - removes particles down to 0.0001 µm diameter (atomic radius)
SBS	Safety Bay Sand
SDI	Silt Density Index
TBT	Tributyletin (antifoulant)
TDS	Total Dissolved Solids
TSS	Total Suspended Sediments
UF	Ultra-filtration
USEPA	The United States Environmental Protection Agency
WET	Whole Effluent Toxicity testing
WQMP	Water Quality Management Plan
WWTP	Waste water treatment plant

Units

a	Annum
d	Day
GL	Gigalitre or one thousand megalitres
ha	Hectare
L	Litre
m	Metre
mg	Milligram or one thousandth of a gram
ML	Megalitre or one million litres
mm	Millimeters or one thousands of a metre
MW	Megawatt or one million Watts
psu	Practical salinity unit (ratio of conductivity – typically 34-36 for seawater)
s	Second
t	Tonnes
µg	Microgram or one millionth of a gram

1. INTRODUCTION

1.1 BACKGROUND

A feasibility study and an environmental study were commenced in January 2002 to develop the Perth Metropolitan Desalination Proposal (WEC 2002) as an option to provide an additional 30 gigalitre per annum of water to the State's Integrated Water Supply Scheme (IWSS). The feasibility study was completed in July 2002. In August 2002 the Corporation decided to continue with the environmental approval work and process, but to otherwise defer work and expenditure on the project (other than the environmental approval work). The 30 gigalitre per annum desalination plant proposal has been assessed as an Environmental Protection Statement (EPS) by the Environmental Protection Authority, and approved in Ministerial Statement No. 626 dated May 2003.

The approved desalination proposal enabled the establishment of a 30 gigalitre per annum (GL/a) Reverse Osmosis (RO) plant either at the Kwinana Power Station (KPS) or in East Rockingham at the corner of Office and Patterson Roads. The East Rockingham site also includes approval to develop a 20 megawatt (MW) gas fired generating facility to provide electricity to meet the requirements of the desalination plant.

Following the approval in May 2003, the feasibility study was re-evaluated and a revised feasibility study completed by June 2003. During the feasibility study review the Corporation decided to evaluate the possibility of a 45 GL/a plant at the KPS site and a decision to adopt the 45 GL/a proposal was adopted in June 2003. Accordingly, the approved desalination project is proposed to be amended by increasing the capacity of the plant to be located at the KPS from 30 to 45 GL/a. No changes to the existing approval for a 30 GL/a RO plant and associated power at the East Rockingham site are proposed.

1.2 PROPONENT

The Water Corporation remains the proponent for the amended proposal. The Water Corporation is responsible for the supply of drinking water and wastewater treatment services for the majority of Western Australia's population.

1.3 PURPOSE AND STRUCTURE OF DOCUMENT

The purpose of this document is to describe the changes to the proposal, the impact these changes may have on the identified significant environmental factors, and management measures proposed to mitigate any adverse impacts. The proponent is seeking to change some of the conditions of Ministerial Statement 626 by amending the project key characteristics described in Schedule 1 to allow production from the desalination plant to be located at the KPS site to increase from 30 to 45 GL/a and to reflect project changes indicated in Table 1. The proponent is also seeking to amend Schedule 2 of Ministerial Statement 626 to update the environmental management commitments (as detailed in Table 14) as a result of proposed changes.

The original proposal, as approved in May 2003, contained a commitment to prepare a Consultative environmental Management Plan (CEMP) within four months following a decision to construct. The CEMP, which includes stakeholder input, is to address in detail the commitments associated with the approved project and to cover management of water quality, flora and fauna, greenhouse gas, noise, Aboriginal heritage issues, monitoring, and construction aspects of the approved proposal. Despite the original approval being in May 2003, the timing of a CEMP must remain the same, i.e. within four months of a decision to construct. This is because the issues in the CEMP cannot be properly addressed until the detailed design and pilot test work are completed. In turn, this detailed design and pilot test work, which is a sizeable part of the overall project, cannot commence until the State Government authorises the project to proceed (i.e. a decision to construct is made).

The decision to construct may be triggered by:

- the need to meet normal demand growth; or
- as an emergency measure due to drought or other problems that impact water supply.

Where possible, additional detail beyond that in the original EPS has been provided in this s46 Review to demonstrate that the upgrading of the approved desalination plant from 30 to 45 Gl/a is environmentally acceptable and will essentially have no environmental effects beyond those associated with the previously approved proposal.

1.3.1 Structure of Document

This document is structured as follows:

- **Introduction** describing the background to the proposal and changes to the current approved project and provides a **scoping of the significance of the impact of the proposed changes** on key environmental factors identified for the project.
- **Overview of the environment** providing a brief description of the terrestrial and marine environments that may be affected by the changes to the proposal.
- **Community consultation** providing a description of the consultation process and key issues raised during the community consultation from the original approved proposal and any additional issues raised by the scaling up of the desalination plant.
- **Assessment of changed environmental impacts** providing a review of key environmental factors affected by changes to the approved proposal.
- **Management of other environmental impacts** providing review of impacts and mitigation measures from the approved EPS.
- **Consultative Environmental Management Plan (CEMP)** overview**.**
- **Amendment of environmental conditions** for the updated proposal.

1.4 CHANGES TO APPROVED PROPOSAL

Proposal changes discussed in the sections below are for the option of locating the desalination plant at the KPS site only. No changes are proposed to the original proposal at the East Rockingham Site.

1.4.1 Plant production and power usage

The production of the desalination plant will be increased from 30 GL/a (82 ML/day) to 45 GL/a (123 ML/day) of potable water for supply to the IWSS and the average seawater intake will increase from around 220 (actual 200) to 300 ML/d, increasing the production of potable water from 82 to 123 ML/d. This production increase will require an increase in average electrical power demand to 25.6 MW and an increase in the discharge of concentrated seawater from an average of 120 to 180 ML/d.

1.4.2 Plant intake and discharge

The original proposal involved a dedicated intake and discharge for the desalination plant. The upgraded plant will have the potential to share intake facilities and to take used cooling water associated with Western Power's existing and planned power generating facilities at the KPS site.

The salinity of the discharge to Cockburn Sound from the desalination plant will remain at a maximum of about 65,000 mg/L (total dissolved solids) and 1-2° above ambient seawater temperature if a dedicated intake is used. If used Western Power cooling water is used in the plant then the temperature of the discharge may be up to 13°C above ambient seawater temperature but will increase by less than 0.3°C following initial dilution at the ocean diffuser.

1.4.3 Pipelines and diffuser

The diameters of intake and discharge pipelines may be required to increase marginally to cater for the increased production of the RO plant. However, any increase in pipeline diameter will only be in the order of 10% and will not require any additional disturbance of land, foreshore or seabed during construction.

The basic design of dedicated intake (including submersible pumps and onshore fine screening) and discharge (diffuser array) structures remain the same as for the approved proposal. The diffuser array will be designed based on an average initial 45 fold dilution of the discharge stream and may require an increase in the number of ports and/or a change in diffuser port diameter and spacings.

The dimensions and length of the product water pipeline remain unchanged. The route of the product water pipeline to Thompson Lake Reservoir will also remain the same (Figure 1).

1.4.4 Plant

The desalination plant and associated infrastructure will not change and will consist of the same components as the approved proposal including:

- seawater pump station;
- pre-treatment including flocculation and filters;
- lime silos;
- reverse osmosis membrane racks;
- chlorination, fluoridation, carbonation facility;
- product water pumping station;
- switch gear building;
- spare part store including mechanical and electrical workshop;
- gate house/administration; and
- car park and access roads.

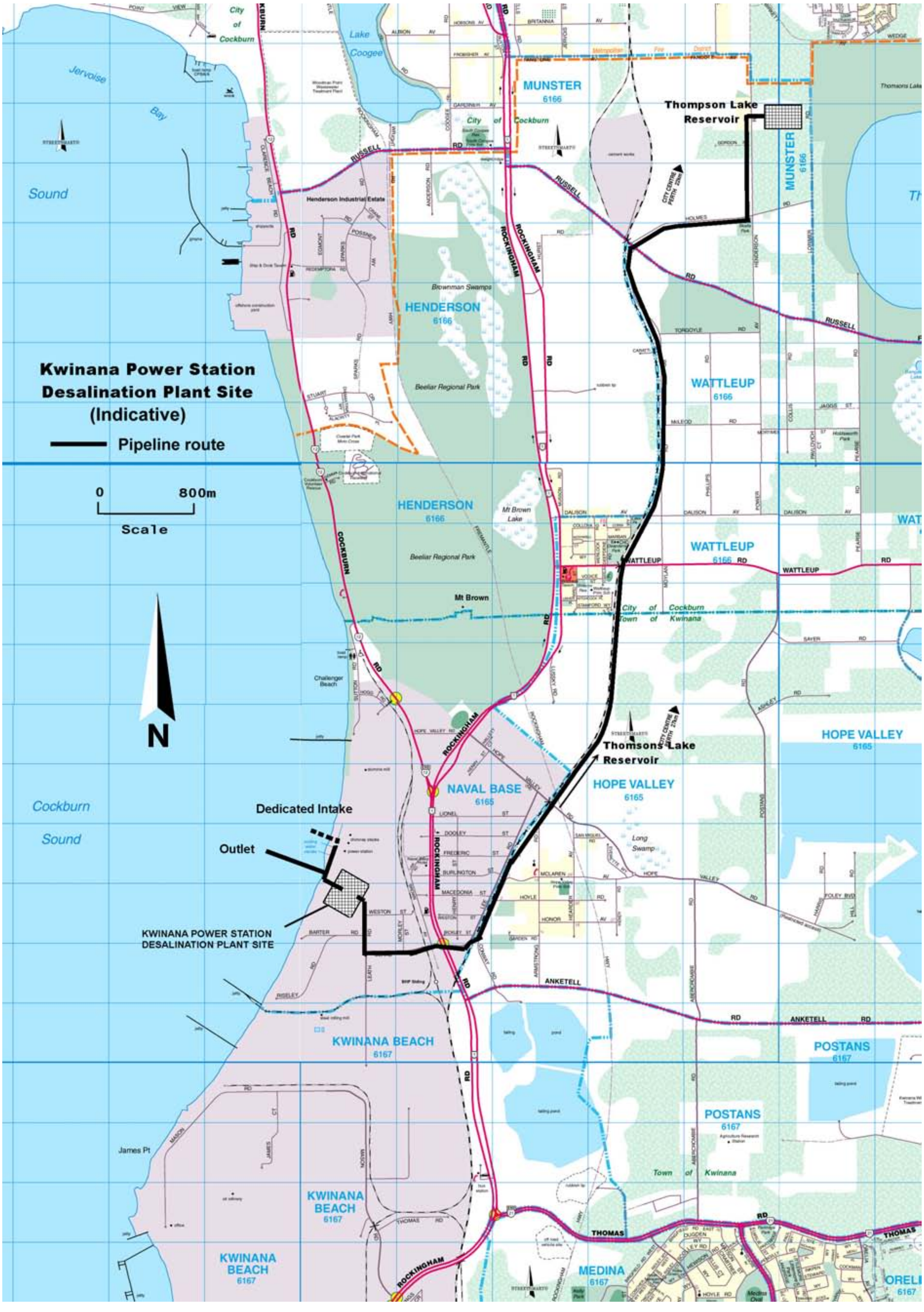


Figure 1 Desalination plant location and associated pipeline routes

1.4.5 Summary of changes proposed to KPS site plant

The changes to the approved desalination plant proposal at the KPS are described in Table 1 below.

Table 1: Changes to KPS site plant

	Kwinana Power Station site	
Characteristic	**Approved**	**Change**
Location	Kwinana Power Station	No change
Capacity	30 GL/a	45 GL/a
Power requirement	20 MW	25.6 MW average demand
Power Source	Western Power Grid	Kwinana Power Station
Clearing of vegetation required	Likely to be 2-3 ha of mostly completely degraded vegetation	No change
Seawater intake	220 ML/d (average)	300 ML/d (weekly average)
Seawater intake pipelines		
Location (indicative)	See Figure 1	No change for dedicated intake. Option for combined intake with Western Power facilities.
Length (indicative)	0.8 km	No change
Number	1	No change
Diameter	1400 mm	Negligible change (1500 mm)
Concentrated seawater discharge		
Volume	120 ML/day	180 ML/d (weekly average)
Salinity	65,000 mg/L	No change
Temperature	Less than 2ºC above ambient	No change if the dedicated intake is used. Use of KPS cooling water gives up to 13ºC above ambient (less than 0.3ºC after initial mixing)
Location of outlet	In 8m depth of water offshore from KPS	In 10m depth of water around 300 m offshore from KPS
Diffuser design	160 m long, risers at 10 m spacings at 60° from horizontal, riser ports 200 mm in diameter	Around 80 – 180 m long. Design to be based upon an average initial dilution of 45
Product water pipeline		
Location (indicative)	See Figure 1	No change
Capacity	>100 ML/day	>150 ML/day
Length (indicative)	10 km	No change
Number	1	No change
Diameter	900 mm	Negligible change (1000 mm)
Destination	Thompson Lake reservoir	No change

1.4.6 RO process and waste streams

The plant size and process configuration will change to accommodate the increased throughput of the plant. The desalination process (RO system) will be the same as the approved.

The RO process involves the pre-treatment of seawater and then pressurising it over a membrane so that freshwater is driven through and higher salinity seawater is left behind. This concentrated seawater is then discharged with backwash from pre-treatment and filter and membrane cleaning processes back to the sea. The product water from this process would be treated with lime as necessary to provide potable water in accordance with the requirements of the Australian Drinking Water Guidelines 1996 (NHMRC 1996).

A diagrammatic representation of desalination streams in the RO process is provided in Figure 2. Anticipated composition of the concentrated seawater (before discharge) is provided in Table 2 below.

The RO plant will consist of a series of RO-modules (see Figure 3) and it's capacity will be increased by increasing the number of RO modules.

The constituents of the discharge from the cleaning membranes and filters will not change but the volume will increase from 300 to 450 kL for each cleaning cycle.

Table 2: Typical composition of concentrated seawater from RO plant

Parameter	Seawater[1] (inflow)	RO seawater return	Backwash water[2]	Final discharge		Remarks
				Pre-dilution	Post-dilution[3]	
Flow[4] (ML/d)	300	153	14	~ 180	n/a	Constant design, no peaks expected, base load operation
Temperature (℃) (dedicated intake)	20-24	22-26	20-24	22-26	20-24	Pre-dilution discharge is 1 – 2 ℃ above ambient seawater temperature.
Temperature (℃) (KPS used cooling water)	27-36	29-38	27-36	29-38	20.3-24.3	KPS cooling water up to 13ºC above ambient. RO process raises temperature 1-2ºC.
pH	~ 8	~ 6 – 7	~ 6 – 7	~ 6 – 8	~ 8	Reduction in pH due to the dosing intake seawater by sulphuric acid.
TDS(salinity) (mg/ L)	35,900	63,537	35,900	61,195[5]	36,450	TDS concentration as result of RO process
TSS (mg/ L)	10	0.5	275	24	10.3	Increase in TSS due to $FeCl_3$ dosing. Solids in TSS comprise mainly $Fe(OH)_3$.
Iron (incl. In TSS) (mg/L)	1.38	0	55	5	1.5	Increase in iron concentration due to $FeCl_3$ dosing.
Chloride (mg/ L)	19,393	34,323	19,393	33,058	19,690	
Free chlorine (mg/L)	-	0	0	0	0	Neutralised
Sulphate (mg/L)	3,154	5,572	3,154	5,367	3,202	Slight increase in sulphate concentration due to dosing of H_2SO_4.
Boron (mg/ L)	4	5.9	4	6	4	Boron rejection of 71% in membranes is assumed

1 Average values for normal seawater
2 Based on continuous discharge of filter backwash water through a storage tank.
3 At the edge of the initial mixing or dilution zone based on average 45-fold dilution.
4 Flows are for a 45 GL/a plant.
5 Conservative values of 65,000 mg/L used for modelling.

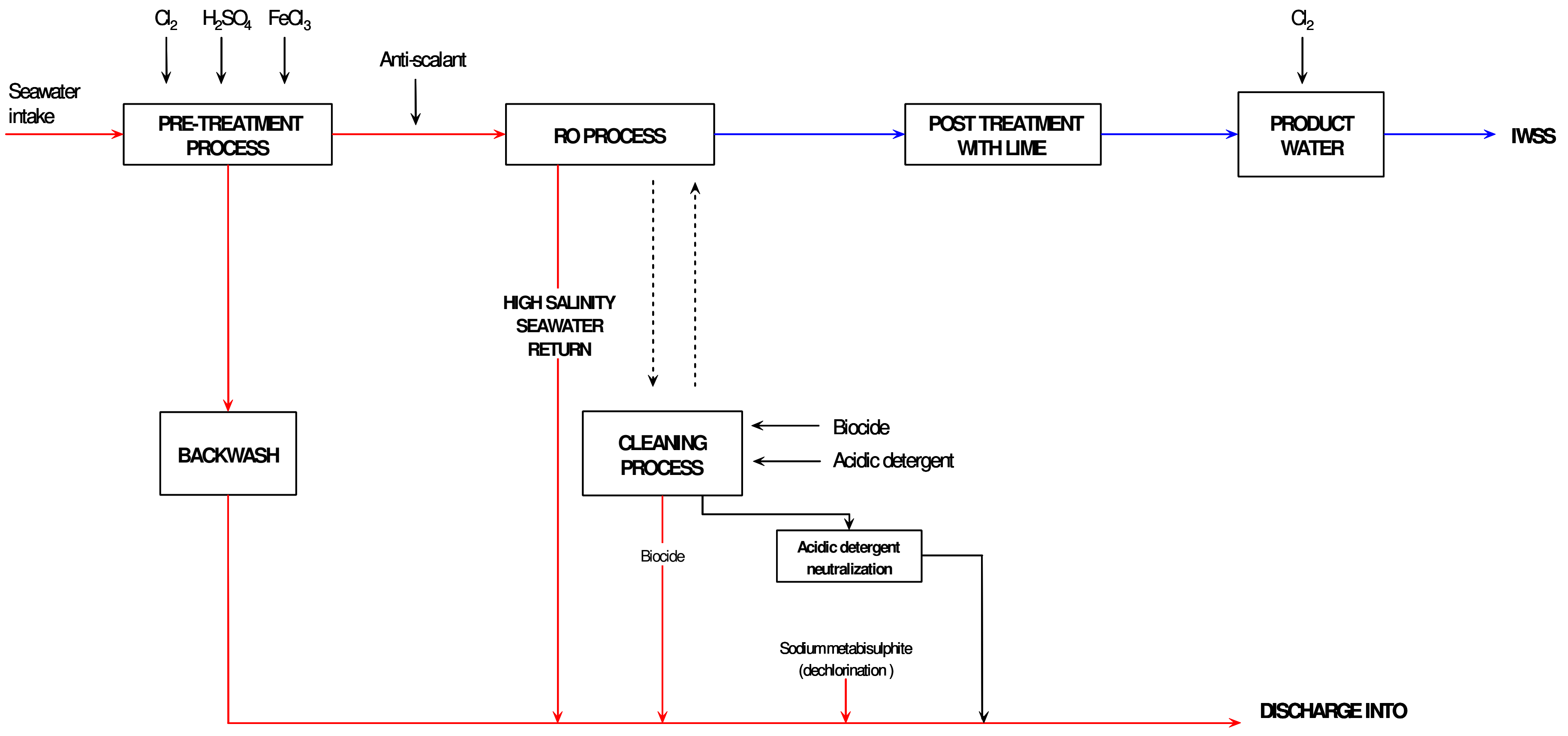


Figure 2: Streams in the typical desalination process

Source: Fichtner GmbH & Co

Figure 3: Rack with RO modules

1.4.7 Chlorination facility and chemical storage

The proposed chlorination system will be the same as for the approved project and will involve the use of liquefied chlorine from drums stored in a specially designed containment building. Should insufficient area be available to provide an adequate safety buffer an electrochlorination system will be used in lieu of liquefied chlorine.

The increased output from the RO plant will increase the consumption but not an extension of the types of chemical used. Chemicals that may be used at the site include:

- sulphuric acid – for pH adjustment of seawater;
- ferric chloride (liquid) –coagulant for seawater filters;
- biocide (active ingredient 2, 2 dibromo-3-nitrilopropionamide) – to prevent growth of microorganisms in the system;
- sulphamic acid – for cleaning of filtration and RO membranes;
- sodium bisulphite/sodium metabisulphite (solid) – for removal of oxidising agents and chloramides;
- fluorosilicic acid – for fluoridation of the product water;
- carbon dioxide (gas) – for pH adjustment of the product water;
- hydrated lime (powder) – for buffering of the product water to improve pH stability and
- chlorine (liquid) – for chlorination of product water depending on chlorination system[1].

[1] Should electrochlorination be used for water treatment liquid chlorine will not be required to be stored on site.

1.4.8 Construction and operation of main plant

The awarding of a contract is expected shortly after any Government decision to proceed with the project. Construction is anticipated to take approximately 18 – 24 months and may involve in excess of 500 construction personnel. Commercial operation of the plant could be expected to begin within two years of any decision to proceed. It is anticipated the plant will require at least 16 permanent operators.

1.4.9 Pilot Plant

Following a decision to construct, it will be necessary to conduct seawater pre-treatment pilot testing (using two pilot plants) as an integral element of the design process. The pilot testing provides essential baseline data on the suitability of various pre-treatment systems and will yield valuable data on chemicals and dosage rates. The pilot plants will provide information that will be useful in developing the CEMP. As such, the pilot plant will probably need to be operational before the CEMP is submitted.

Seawater pre-treatment pilot testing is expected to comprise the supply, installation, commissioning and operation, at a selected site, of a conventional flocculation filtration (FF) pilot plant, the compilation of the performance data and reporting to the Corporation. Note that conventional flocculation filtration and ultrafiltration (UF) will be compared, however, piloting priority will be given to flocculation filtration. Ultrafiltration will most likely be tested on a bench scale test unit only.

The flocculation filtration pilot plant will be operated at or near the finally selected site. One option is to locate the pilot plant on a self contained barge located offshore in the vicinity of the proposed intake structure. Alternatively, the FF pilot plant could be located on the selected site and temporary intake and discharge pipe-work (of relatively small diameter) installed. It is anticipated that the FF pilot plant would need to be run for a minimum of 2 months in winter and 2 months in summer or similar. The flow rates in the FF pilot plant are expected to be around 1 MLD – i.e. less than 1% of the flow rate in the desalination plant and, as such, not of environmental consequence.

Additional details on the filtration flocculation pilot plant and the ultrafiltration bench scale pilot are provided below.

Flocculation filtration pilot plant

It is anticipated that the flocculation filtration pilot plant will comprise components similar to those identified below:

a) three parallel trains of multimedia filtration each with a filter vessel diameter of 1000mm;
b) hardware to allow operation in gravity or pressure filter mode (maximum gravity head 3.5m);
c) hardware to allow air sparging or water only backwash;
d) hardware to allow reconfiguration to two filter vessels in series;
e) hardware to control flow through the filter vessels in pressure mode;
f) hardware to allow manual backwashing;
g) dosing systems to allow flocculant addition (multiple point), pH correction (multiple point), and hypochlorite dosing for each vessel;
h) an inline static mixer for each vessel;
i) a cartridge filter housing to allow polishing of a portion of the FF filtrate;
j) differential pressure indication across FF and cartridge housings;
k) turbidity indication after FF and cartridge housings;
l) pH indication and feedback to pH correction dosing;
m) flow indication at multiple points;
n) temperature indication; and

o) sample points at multiple locations to allow Silt Density Index (SDI) measurement.

The flocculation filtration unit will most likely be mounted on a skid, which will probably be purpose constructed and housed in a sea container for security and weatherproofing. The dosing systems, air sparge blower, instrumentation, flow control, feed and backwash pumps should all be located within the container. The test rig will most probably be powered by a portable generator set located adjacent to the container.

Operation of the pilot plant is anticipated to comprise:

a) routine checks and data logging;
b) topping up of chemicals and general maintenance;
c) reconfiguration and experimentation with dosing chemicals and pH; and
d) local sampling and instrument reading.

Analysis of data and reporting is anticipated to comprise:

a) methodology employed;
b) performance results, analysis and interpretation;
c) comment on suitability of the FF process with consideration of the expected feedwater variability, for seawater RO operation;
d) comment on impact of variability due to scale-up and ambient conditions; and
e) recommendations.

The seawater pre-treatment pilot testing study will probably provide a preliminary report, a final report and several information meetings.

Ultrafiltration bench scale pilot

The ultrafiltration bench scale testing program will most likely utilise existing UF test equipment at a laboratory in Perth.

The equipment will be selected to ensure that it allows different types of membrane to be installed and compared. The test program would focus on:

a) decline of flux over time; and
b) quality of filtrate and feed streams (SDI, turbidity, bacterial count, temperature, particle size distribution).

Analysis of Data and Reporting is expected to comprise:

a) performance results, analysis and interpretation;
b) comment on suitability of the UF process, with consideration of the expected feedwater variability, for seawater RO operation; and
c) recommendations.

1.5 UPDATED PROJECT KEY CHARACTERISTICS

Updated key characteristics of the desalination project, incorporating changes to the key characteristics of the proposal at the KPS site are shown in Section 8.

1.6 PRELIMINARY SCOPING OF IMPACT OF CHANGES

A preliminary scoping of impacts relevant to the proposed changes to the desalination plant at the KPS site is shown in Table 3. Of the seven significant environmental factors identified for the original proposal only the factor of Cockburn Sound marine habitat and biota is considered significant for the proposed changes.

Emissions of greenhouse gases due to the proposed changes have reduced from the approved project due to the purchase of all electricity from the KPS following its complete conversion to natural gas.

Table 3: Preliminary scoping of significant impacts identified in approved project

Factor	Aspect	Environmental Change	Detailed Assessment
Terrestrial flora and fauna	Clearing of vegetation for plant site	No change to approved proposal	No
	Clearing of vegetation for pipelines	No change to approved proposal	No
	Operation of plant	No change to approved proposal	No
Cockburn Sound marine habitat and biota	Discharge of concentrated seawater	Rate increasing to 180 ML/day	Yes – refer Section 4.1
	Intake of feed water	Rate increasing to 300 ML/day	Yes – refer Section 4.1
	Construction of intake and discharge infrastructure	No change for dedicated structures. Potential to use shared intake with Western Power.	Yes – refer Section 4.1
Greenhouse gas emissions	Emission of greenhouse gases	Emission of greenhouses gas reduced from a maximum of 180,000 to 85,000 tpa.	No – refer Section 4.2
Air quality	NO_X emissions	No changes directly related to the KPS site.	No
Noise	Vehicle movements and plant operation during construction	No change to approved proposal	No
	Operation of pumps and equipment	Increase in the number of RO modules not anticipated to increase noise emissions. No noise sensitive premises within heavy industrial area.	No
Aboriginal Heritage	Disturbance of land	No change to approved proposal	No
	Disturbance of seabed	No change to approved proposal	No
	Discharge of concentrated seawater	No change to approved proposal	No
Public safety and risk	Storage and handling of chemicals	No change to approved proposal	No

2. OVERVIEW OF EXISTING ENVIRONMENT

Detailed description of the existing environment is presented in the EPS for the original proposal at the KPS site (WEC 2002). A summary is reproduced below.

2.1 PHYSICAL CHARACTERISTICS OF TERRESTRIAL ENVIRONMENT

2.1.1 Geomorphology of all sites

The KPS site for the desalination plant is located on the Quindalup Dune System geomorphologic unit fringing the coastline of the Swan Coastal Plain in the southwest of Western Australia.

The Quindalup Dune system, which flanks the ocean, consists of wind blown lime and quartz beach sand forming dunes or ridges that are generally orientated parallel to the present coast, but which may also occupy blowouts within the Spearwood Dune System relic fore-dune plain. This dune system is of Holocene age.

2.1.2 Geology and soils

The surface geology of the KPS site is Safety Bay Sand (SBS), coinciding with the Quindalup Dune System, compromising of calcareous medium grained quartz sand with shell debris of shallow marine, coastal plain and aeolian (wind-transported) origin.

Coastal geology

Tamala Limestone is the underlying formation of the present coastline of Cockburn Sound. Woodman Point, at the northern end of the Sound, is further overlain by SBS, which thins southward to a narrow strip along the current shoreline of the Jervoise Bay Northern Harbour. Tamala Limestone outcrops at the coast from Russell Road to Naval Base, and then SBS reappears, extending from the industrial strip to Cape Peron. The coastal fringe extends along Warnbro Sound and Comet Bay South of Cockburn Sound and thins to a narrow strip just before Hawks Head in Mandurah. The extreme coastal fringe of the Safety Bay Sand is also known as the Becher Sand because of its marine rather than aeolian origins (DAL 2001).

2.1.3 Hydrology

The general hydrology of the KPS plant site is characterised by groundwater flow in a north west direction and is typically less than 1 m above AHD, with the general site elevation being 4 – 6 m above AHD.

Groundwater – coastal interface

The Safety Bay Sand and Tamala Limestone extend down to approximately 25 m below AHD. Groundwater in the SBS and Tamala Limestone aquifers flows from the Jandakot Mound, located about 9 – 11 km to the east and discharges into the nearshore marine environment.

Groundwater flow velocity through the underlying Tamala Limestone aquifer is highly variable ranging from about 200 – 2000 m/a, and is about an order of magnitude lower though the SBS aquifer (i.e. about 20 m/a). Near the coast, fresh groundwater overlies saline marine water that has moved into the lower section of the aquifer due to its greater density. As groundwater approaches the coast it is forced over this denser saline ‘wedge’, and follows the path of ‘least resistance’ to discharge into the shallow, nearshore zone (DAL 2001).

2.2 ECOLOGICAL OVERVIEW OF TERRESTRIAL ENVIRONMENT

2.2.1 Flora and Vegetation

The KPS site occurs in the Coastal Belt of the Drummond Botanical Subdistrict of the Southwest Botanical Province (Beard 1990). Various studies of vegetation have been undertaken to further classify the vegetation within this subdistrict.

The Quindalup vegetation complex is the main vegetation complex (as mapped by Heddle *et al*. 1980) along the eastern coastal fringe in the vicinity of the sites of Cockburn Sound. It is flanked by the Cottesloe Complex Central and South to the east associated with the Spearwood Dune System.

Vegetation associations within the Quindalup complex include herblands, sedgeland and acacia shrubland. Vegetation associations within the Cottesloe Complex Central and South include tuart, jarrah and marri woodlands and low, closed heath on the limestone outcrops.

The KPS site has been highly modified by removal of vegetation. The site is almost devoid of vegetation.

2.2.2 Fauna

The KPS site has been extensively modified and has very few fauna values in and surrounding the site.

2.3 OVERVIEW OF COCKBURN SOUND MARINE ENVIRONMENT

The Cockburn Sound area has the highest number of species of seagrass in Australia, with 13 of the 50 species existing worldwide found in Perth coastal waters. The densest stands of seagrass occur in shallow sheltered areas and consist of meadows of *Posidonia australis* and *P. sinuosa*. Cockburn Sound had extensive areas of these species before the massive seagrass die-off that occurred in the late 1960s and early 1970s, but large areas remain, particularly on the western edge of the Sound abutting Garden Island.

Cockburn Sound supports a wide range of fauna. Zooplankton in Cockburn Sound were found to be typical of temperate coastal regions from 1992 to 1994 and were about twice as abundant as zooplankton in Warnbro Sound, presumably in response to the greater food supply (phytoplankton).

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, and the Sound is a significant fisheries resource. Fisheries WA have provided information on the commercially/recreationally important species known to frequent various habitats in Cockburn Sound and these are listed in Section 2.3.8.

In addition, Cockburn Sound is of significant value to fauna because of its utilisation by dolphins, a large range of seabirds, protected migratory bids, and Little Penguins.

The main environmental features at the location of the marine intake and discharge areas at the KPS site are:

- substantial southward sediment transport occurring with build up of sediment around existing KPS intake and discharge structures;
- elevated nutrient levels;
- arsenic and tributyletin in sediment historically above national guidelines in some areas; and
- no seagrass cover.

2.3.1 Coastal processes

Wave climate

The wave climate of Cockburn Sound is characterised by low wave energy, with winter storms contributing the most significant wave energy. The wave climate is dominated by short period (<8 s) wind waves. Garden Island provides a considerable barrier to incident swell waves, and as little as 5% of the swell wave energy penetrates into southern Cockburn Sound (DEP 1996).

Beach stability

The beaches in this region are narrow and there is historical evidence to suggest that significant erosion can occur, causing loss of beaches.

Prior to 1953, the coastline near James Point was in a natural state, however, significant shoreline modifications have occurred since this time as a result of industrial growth at Kwinana. Shoreline progradation to the north of the BP cooling water intake jetty required construction of three breakwaters north of the cooling water intake in the mid 1970's.

Longshore sediment transport

Longshore sediment transport occurs due to the development of a longshore drift by obliquely incident waves. Along the Perth metropolitan coast the longshore transport direction is typically northwards, particularly in summer under the influence of swell and sea breeze generated waves (Masselink 1996). Occasional storms in winter result in southward longshore sediment transport. Along the eastern shore of Cockburn Sound, and particularly in the vicinity of James Point, it appears that combined effects of Garden Island and the causeway results in a net southward longshore sediment transport. The magnitude of southward sediment transport is low (1000-2000 m^3/a immediately to the north of James Point).

Significant sedimentation around the KPS intake and outlet infrastructure occurs due to the cooling water discharge canals forcing offshore movement of sand travelling alongshore. During conditions when northward transport is dominant (summer months) the sedimentation is to the north of the outlets and intakes and to the south of this infrastructure during the winter months.

2.3.2 Circulation and mixing in Cockburn Sound

Currents in Cockburn Sound are primarily a result of wind forcing (DEP 1996). The synoptic wind climate of Perth is controlled by the annual variation in the location of the mid-latitude anticyclonic belt. The influence of local-scale effects are also of considerable importance, in particular the diurnal sea breeze cycle which occurs during summer. During summer the winds are typically quite persistent and 50% of winds occur in the 5–9 m/s range. In winter, winds are more variable with occasional calms and strong storm winds, and 50% of winds have a velocity of 2–7 m/s. During summer the dominant wind direction is south to south-west, whereas in winter the dominant wind direction is westerly, though northerly winds frequently occur.

The tidal range in the vicinity of Cockburn Sound is between 0.1 and 0.9 m but is typically around 0.5 m and the tides are predominantly diurnal. Sea level is also influenced by the passage of anticyclonic pressure systems, storm surges and other long period forcings (DEP 1996).

Density effects are important in the main basin of Cockburn Sound (depth ca. 20 m) where lateral density differences can typically be up to 1 kg/m^3, and in the absence of strong vertical mixing (typically driven by winds), vertical density differences can be up to 0.5 kg/m^3 (DEP 1996).

In the vicinity of the KPS site, the net water movement is northward during summer in response to the prevailing south to south-westerly winds. Current velocities range up to 0.2 m/s under average conditions and are strongest offshore. During winter, and periods of calm the current velocities drop to below 0.1 m/s. The shallow inshore region is expected to have strong depth-averaged wind-driven flows, however, the increased influence of bottom friction would result in relatively rapid reduction in flows after the onset of calm conditions (Hearn 1991).

2.3.3 Water and sediment quality

Poor water quality and contaminated sediment due to industrial discharge has historically been a major environmental problem in Cockburn Sound, but with increasing improvements to industrial practice in the region, discharge of contaminants has decreased substantially.

The principal water quality issue in Cockburn Sound however, is nutrient enrichment, with the main source being contaminated groundwater input into the Sound.

2.3.4 Marine flora

The marine flora of Cockburn Sound includes seagrasses, seagrass epiphytes, macroalgae and phytoplankton. The distributions of seagrass, sand, reef and silt habitats were accurately mapped in 1999 (DAL *et al.* 2000) (Table 4).

Table 4 Areas of main habitat types in Cockburn Sound (DAL et al. 2000)

BENTHIC HABITAT	AREA (ha)	AREA (%)
Silt	6,940	60
Fine sand and silt	2	<1
Sand (including sparse seagrass)	3,725	32
Seagrass	750	7
Subtidal reef	68	<1

Seagrasses

Extensive seagrass cover has been recorded along the eastern margin of Garden Island, and along the western margin of the shallow eastern flats of Cockburn Sound. These seagrass meadows include the species *Posidonia australis* and *P. sinuosa*.

No seagrass cover has been recorded along the south-east margin of Cockburn Sound near the KPS.

2.3.5 Reefs

There are patches of reef along the eastern shore of the Sound between Challenger Beach and the Jervoise Bay northern harbour, and isolated hummocks on the eastern flats, mainly along the western fringe. The shoreline reefs carry mainly brown algae (kelps and *Sargassum*) while on the reefs further offshore red algae are more common. Green algae (*Ulva, Cladophora*) are also common, and some of the reefs have patches of coral, including the reef-building species *Flavites* (HGM 1997).

There are no exposed patches of pavement or low relief reef in waters adjacent to the KPS.

2.3.6 Phytoplankton

The species of phytoplankton present in Cockburn Sound were studied in 1978 by Chaney (1978), and by (Helleren & John 1995) between 1992 and 1994. There are over 300 species present in the Sound, the four main groups are diatoms (Bacillariophyta), dinoflagellates (Dinophyta), silicoflagellates (Chrysophyta) and blue-green algae (Cyanophyta).

2.3.7 Benthic invertebrate fauna

The benthic invertebrate fauna of the deep basin have been studied in 1978 (as part of the 1976–79 Cockburn Sound Environmental Study) and 1993 (as part of the Southern Metropolitan Coastal Water Study). The deep basins of Cockburn Sound, Warnbro Sound and Owen Anchorage contain fine organic-rich silts due to accumulation of detritus from surrounding areas (Wilson *et al.* 1978).

The 1993 survey of benthic invertebrates found that more species were present, and in greater numbers, in the northern half of the Sound compared to the southern half. More species were found in the northern half of the Sound in 1993 compared to 1978, yet the reverse was found for the southern half of the Sound. In 1993, the bivalve *Solemya*—which prefers low oxygen conditions—was also found in the southern half of the Sound.

Two acknowledged marine pests have also been found in the benthic fauna of Cockburn Sound: the European fan worm *Sabella* cf. *spallanzanii*, and the Asian date mussel *Musculista senhousia*.

2.3.8 Fish

Dybdahl (1979) estimated that there were about 130 species of fish and 14 large crustacean and mollusc species in Cockburn Sound. Fisheries WA[2] have provided the following list that indicates (but is not limited to) the commercially/recreationally important species known to frequent various habitats in the Sound:

- Open (deep) water. Snapper, pilchards, bonito (also dolphins, seals and penguins).
- Shallow water with sandy seabed. Whiting, juvenile King prawns, anchovies, blue sprat, and whitebait.
- Seagrass meadows. Leatherjackets, wrasse, crabs, herring.
- Jetties and groynes. Herring, yellow tail, scad, trevally, mussels.
- Earlier work by Pen (1977) also suggests that the deep basin is an important habitat for whiting, squid, cuttlefish, butterfish, sand skipjack, crabs and snapper.

Although there is little information on fish nursery areas within the Sound, the breeding success of the species listed above would be affected by adverse impacts on their feeding grounds. Fisheries WA advises that both feeding areas and nursery areas are important in affecting fish populations, and that the whole of Cockburn Sound is significant as a fish nursery/habitat.

2.3.9 Zooplankton

Zooplankton in Cockburn and Warnbro sounds were studied from 1992 to 1994 as part of the SMCWS, and were found to be typical of temperate coastal regions, apart from large blooms of radiolarians during late winter and early spring (DEP 1996). Zooplankton in Cockburn Sound from 1992 to 1994 were about twice as abundant as zooplankton in Warnbro Sound, presumably in response to the greater food supply (phytoplankton).

[2] Personal communication. Eve Bunbury, Fisheries WA, after discussions with Fisheries WA personnel.

2.3.10 Marine mammals, reptiles and seabirds

A population of bottlenose dolphins (*Tursiops sp.*) resides in Cockburn Sound, and has become a popular tourist attraction. About 180 dolphins use Cockburn Sound, and approximately a quarter of these are adult females with calves (Donaldson[3], unpublished data).

At least 12 species of seabirds are found in the Cockburn Sound/Warnbro Sound area, but as the eastern shores of Cockburn Sound are heavily developed, they are of far less importance as a nesting, feeding and roosting area than the Shoalwater Islands Marine Park and Garden Island. Numerous migratory birds utilise Cockburn Sound, some of which are listed under JAMBA/CAMBA.

Loggerhead, Leatherback and Green turtles sometimes stray as far south as Cockburn Sound but this is rare.

2.3.11 Social and Cultural

Cockburn Sound is an extremely popular area for social uses, which include:

- recreational fishing;
- water sports (swimming, boating, yachting, diving, windsurfing, skiing); and
- coastal recreational use (beach activities, use of boat ramps).

The waters immediately surrounding the KPS are in an industrial exclusion zone in which recreational use is prohibited (DAL 2001).

2.4 SOCIO-ECONOMIC ENVIRONMENT

2.4.1 Planning context

The zoning of the KPS site is suitable for the intended use (Table 5).

Table 5: Zoning Schemes for the KPS site

MRS Zoning	Other planning zoning	Existing land use/activity
Industrial	Industrial (Fremantle-Rockingham Industrial Area Regional Strategy) Preferred Land Use Strategy	Western Power – Power Station (Naval Base)

The KPS site is located in the Town of Kwinana with a population of approximately 20,000 and within the Kwinana Industrial Area which hosts various large and medium industries (Table 6).

Table 6: Local Government area covering the KPS site

Local Government	Approximate Population	Population centres close to site	Industries in municipality
Town of Kwinana	20,158	Anketell; Kwinana Beach, Leda, Naval Base	Refineries, LP gas storage, chemical works, nitrogen, fertiliser, power station, sand blasting/industrial painting, refractory, engineering, joinery, cement works, poultry farming, horticulture, extractive industries, mineral processing

[3] Rebecca Donaldson, Ph. D. researcher at the School of Biological Sciences, Murdoch University

2.4.2 Population and land uses

The land use immediately surrounding the KPS is industrial. Land uses surrounding Cockburn Sound area include urban areas, defence, industry, agriculture and conservation. Expansion in urban areas, defence and industrial land use are either planned or expected, while rural areas are being replaced by urban and industrial use. Coastal areas reserved for conservation include Woodman Point Regional Park, Beeliar Regional Park and Rockingham Lakes Regional Park, and their boundaries are unlikely to change in the near future.

2.4.3 Aboriginal heritage (land)

McDonald, Hales and Associates (2002) were commissioned to undertake a desktop study of the Aboriginal heritage values of areas potentially affected by the proposal. A summary of heritage findings for the KPS site is shown in Table 7.

Table 7: Aboriginal heritage findings for KPS site

Findings	Description
Aboriginal sites at KPS location	No previously recorded Aboriginal sites are located within or overlapping the site. No recorded sites along pipeline route.
Recorded sites in surrounding area	"Indian Ocean" site (ID 3776) - mythological site that encompasses Cockburn Sound.
Potential for archaeological findings	Low-moderate potential for surface material to be found.
Listed ethnographic sites	No previously recorded sites.

3. COMMUNITY CONSULTATION

Key stakeholders identified and included in the consultation program during preparation of the EPS were again consulted during preparation of this section 46 review document.

The same key issues of concern remained as for the approved project and include:

- water quality of Cockburn Sound as it may be affected by seawater discharge and construction activities;
- plant energy efficiency and emissions of greenhouse gases; and
- noise emissions.

In addition concern was raised over the fate of heavy metals and other contaminants that may be taken into or concentrated by the RO plant.

Management of all areas of concern raised during consultation has been addressed by mitigation proposed in this review document and in the CEMP.

A summary of issues raised during consultation sessions for the original EPS and proposed project upgrade and responses is given in Table 8.

Table 8: Issues raised during consultation

	Original EPS			Section 46 changes			
Key stakeholder	**Consultation**	**Key Issues**	**Responses**	**Consultation**	**Key Issues**	**Response**	**Outcome**
EPA Services Unit DoE	On-going liaison and briefings	Provision of permanent reference point for temperature & salinity measurements	To be established as part of ongoing seawater monitoring program	Briefing of proposal changes	Requirement for seawater return to meet Cockburn Sound discharge guideline values or demonstration of negligible biological impact due to discharge	Updated design and modelling undertaken to meet guideline values under the Cockburn Sound Draft EPP.	Modelling indicates guideline values will be met.
		Concern with seawater return discharge	Potential impact and mitigation addressed in EPS	Update on modelling of seawater return discharge	Compliance with discharge salinity guideline values.	As above. Addressed in Section 4.1	Modelling indicates salinity guideline will be met.
		Warnbro / Comet Bay-Whitebait considerations	Not an issue for Cockburn Sound		Appropriate real time water quality monitoring system.	Monitoring program addressed in Section 4.1.6 and water quality monitoring program to be included in CEMP.	Manual sampling to be undertaken sufficient to provide discharge model validation and to verify subsequent performance.
		Geo-technical parameters	To be assessed		Environmental management plan to include management during construction phase.	Construction aspects to be addressed in CEMP.	Construction aspects to be included in separate section of CEMP
					Reiteration of commitment of eco-toxicity test work during operation of plant.	Commitment to eco-toxicity test program maintained.	Testing to be initiated as soon as practicable after chemicals to be used are finalised.
					Adequate risk assessment or contingency planning for unscheduled events.	Inherent and residual risk assessment and contingency management actions included in CEMP.	Minimised risk of environmental harm due to unscheduled events.

	Original EPS			Section 46 changes			
Key stakeholder	**Consultation**	**Key Issues**	**Responses**	**Consultation**	**Key Issues**	**Response**	**Outcome**
Conservation Council of Western Australia	Briefings and discussions	Effects on coastal processes	Potential impact and mitigation addressed in EPS	Briefing and discussion	Potential intake of heavy metals to RO plant	Addressed in Section 4.1. Testing of KPS used cooling water required prior to use as RO plant feed water – see Section 4.1.	Modelling indicates minimal potential for short circuiting between Western Power and Desalination facilities, minimising risk of intake of heavy metals from dedicated plant intake. Use of KPS cooling water will only be considered following assessment of suitability.
		Site selection and consideration of alternatives	Many sites considered and selection process described in EPS		Effects of plant discharge on Cockburn Sound biota – both saline water and biocides and anti-scalants used in the plant	Addressed in Section 4.1. Chemicals chosen for low toxicity and rapid breakdown – see Section 4.1.	Modelling indicates discharge to meet conservative salinity and temperature criteria for Cockburn Sound. Impact of plant chemicals to be assessed by toxicity testing program when chemicals are finalised.
		Greenhouse gas emissions and efficiencies	Potential impact and mitigation addressed in EPS		Plant energy efficiency and use of renewable energy. Greenhouse gas emissions	Plant energy efficiency representative of current world standard – see Section 4.2. Greenhouse gas emissions lower than for existing approved desalination plant.	Commitment made to use of renewable energy if available – see Section 4.2. The Corporation will develop a greenhouse gas policy covering all of its activities.
		Use of power from renewable energy sources	Potential for use described in EPS.				

	Original EPS			Section 46 changes			
Key stakeholder	**Consultation**	**Key Issues**	**Responses**	**Consultation**	**Key Issues**	**Response**	**Outcome**
		Concerns about Port Kennedy and Woodman Point sites.	Potential impacts assessed during site selection, Port Kennedy and Woodman Point sites are not likely to be pursued.				
		Limit size of mixing zone	Small mixing zone required				
		Dispersion of discharge	Riser design and circulation ensures rapid dispersion.				
Cockburn Sound Management Council	Initial briefing to Chairman and WRC representatives Presentation to Council	Impact on water and sediment quality of Sound	Considered negligible, Potential impact and mitigation addressed in EPS.	Briefing of upgrade proposal at Council meeting. Council reiterated all issues raised during original EPS consultation with emphasis on meeting the Cockburn Sound EPP discharge guideline values	Impact on water and sediment quality of Sound	Addressed in Section 4.1.	Modelling indicates guideline values for salinity and temperature of discharge will be met. Commitment given to monitoring of sediment habitat before and after plant commissioning.
		Optimising mixing zone	Small mixing zone required		Optimising mixing zone	Addressed in Section 4.1.	No change to required mixing zone. Modelling indicates mixing occurring within existing Western Power LEPA.
		Conforming to EPA Bulletin 907	Bulletin has been used as guide for assessing significance of impact		Conforming to EPA Bulletin 907	Bulletin 907 and Revised Draft EPP used as assessment framework in review document.	Modelling of discharge has taken into account effect of existing projects in the vicinity.

	Original EPS			Section 46 changes			
Key stakeholder	**Consultation**	**Key Issues**	**Responses**	**Consultation**	**Key Issues**	**Response**	**Outcome**
		Impact on fisheries	Considered negligible, addressed in EPS		Impact on fisheries	No change from approved EPS.	Impact of Cockburn Sound fisheries considered to be negligible.
		Discharge of biocides and risk of toxic discharges	Impact and mitigation regarding biocides addressed. Low risk of toxic discharge.		Discharge of biocides and risk of toxic discharges	Low risk of toxicity associated with discharge. Management and mitigation addressed in Section 4.1.	Commitment made to eco-toxicity test program.
		Social aspects	High level of consultation during development of Consultative Environmental Management Plan (CEMP) will ensure social aspects are addressed.		Social aspects	No change from approved EPS.	Environmental management plan to be prepared in consultation with key stakeholders and will include social issues (in particular access to foreshore)
				Update on management of discharge of concentrated seawater	No further issues raised		
Kwinana Progress Association	Briefing and discussion on proposal	Locate the desalination plant in an agricultural area?	Associated costs and engineering factors preclude this option.	Briefing on updated proposal and management	Noise emissions from plant, in particular at East Rockingham site	Noise management for East Rockingham site addressed in original EPS. No change to proposal at this site.	Noise not considered a significant factor at the KPS site. Update of cumulative noise model required, in particular if East Rockingham site is to be developed.
		Effect of Global Olivine development on proposal	Not considered in detail due to uncertainty of development proceeding		Management of discharge to Cockburn Sound	Addressed in Section 4.1.	Modelling indicates conservative guideline values for salinity and temperature of discharge will be met.

	Original EPS			Section 46 changes			
Key stakeholder	**Consultation**	**Key Issues**	**Responses**	**Consultation**	**Key Issues**	**Response**	**Outcome**
		Dolphins, reef and fish breeding grounds in the vicinity of the KPS outfall	Low impact, addressed in EPS.		Potential recycling of heavy metals or other contaminants (TBT) into the RO plant and ending up in potable water or concentrated and discharged to Cockburn Sound	Heavy metal levels in sediment generally lower than sediment quality guidelines – addressed in original EPS. In the absence of sediment disturbance potential for intake to plant low.	Water quality monitoring program to include testing for suitability of KPS water if used as intake to the desalination plant.
		Effect on Barter Beach	Proposal will not affect use and amenity of beach.		Effect of proposed port on mixing of plant discharge	Not considered to preclude and not considered in detail due to uncertainly of port development proceeding	Modelling of discharge from plant has taken into account cumulative effects of existing projects.
		Impact on water quality of Sound	Considered negligible, potential impact and mitigation addressed in EPS.				
		Impact of Sound water quality on the operation of the plant	Considered by Water Corporation as important issue. Source protection plan required.				
		Consideration of discharge from Point Peron.	Determined to be unfeasible				
		Noise emissions	Manageable noise emissions, addressed in EPS..				
		Contamination of groundwater	Not considered key issue. Management of spills etc will be described in CEMP.				
		Effect of or on proposed harbour	Not considered to preclude or be affected by harbour development.				
Naragebup Environmental Centre	Briefing and discussion on proposal	Examination of re-use and recycling schemes	Water Corp investigating such projects. eg. Kwinana Industrial Water Re-use Scheme.	Briefing on updated proposal and management	Management of discharge to Cockburn Sound and diffuser design	Addressed in Section 4.1	Modelling indicates conservative guideline values for salinity and temperature of discharge will be met.

	Original EPS			Section 46 changes			
Key stakeholder	**Consultation**	**Key Issues**	**Responses**	**Consultation**	**Key Issues**	**Response**	**Outcome**
		Industrial use of scheme water	Re-use scheme, desalinated water potential alternative source to dam water.				
		Sourcing green power	Potential for use described in EPS.				
		Effect of desalination discharges	Considered low, potential impact and mitigation addressed in EPS.				
Recfish West	Briefing and discussion on proposal	Water Corp operations (i.e. water restrictions, policing of restrictions, allocations, education).	Practices under constant review. Use management addressed in EPS.	Briefing on updated proposal and management	Management of discharge to Cockburn Sound, in particular temperature change as it may affect fish	Addressed in Section 4.1	Modelling indicates conservative guideline values for temperature and salinity of discharge will be met.
		Dispersion of seawater return flow	Modelled by DAL (2002). Described in EPS.		Adequate consultation in development of CEMP	Addressed in section 6.	All stakeholders to be consulted in finalization of CEMP.
		Potential for riser to be fish attractor – public safety issues	Not significant environmental impact, will be addressed in CEMP.				
		Impact on mussel farming	Will not affect industry, addressed in EPS.				
		Heavy metal accumulation	Negligible because of only 60-80% increase in concentration in return flow and immediate dispersion affects on discharge				
		Risk of chemical release	Addressed in risk management section of EPS.				
		Impact on fisheries	Considered negligible, addressed in EPS.				
		Intake of seawater – public safety	Low velocity intake and provision of suitable screens will prevent accidents.				

	Original EPS			Section 46 changes			
Key stakeholder	**Consultation**	**Key Issues**	**Responses**	**Consultation**	**Key Issues**	**Response**	**Outcome**
Town of Kwinana	Briefing / feedback on areas of concern	Land zoning – appropriate use of land;	Zoning requirements adhered to.	Briefing on updated proposal and management	Land zoning/maximising potential use of land for heavy industry.		Plant footprint minimized.
		Maximising potential of land	Informal agreement with town officers that plant was suitable use of land		Impact of chemicals used in the plant on Cockburn Sound environment.	Addressed in Section 4.1.5	Commitment made for eco-toxicity test work and contingency actions included in CEMP.
		Risk management	Addressed in EPS.		Economic benefits of project - employment.	Demonstration of efficient desalination process. Potential employment opportunity addressed in Section 1.4.8.	n/a
		Cumulative emissions (Kwinana airshed)	Considered manageable		Cumulative noise emissions	Addressed in Section 5.	Operation of plant will be included in any update of the industrial area cumulative noise model.
		Cumulative noise	Not considered to add significantly to local noise environment, but to be further studied as part of CEMP.		Synergies with KWRP project	The KWRP project involves re-use of treated effluent by industry and disposal of industrial and treated wastewater far offshore to the Sepia Depression.	Limited opportunity for combining disposal streams.
		Impact on Cockburn Sound water quality and biota	Low impact, addressed in EPS.				
City of Rockingham	Briefing / feedback on areas of concern	Cumulative noise	Not considered to add significantly to local noise environment, but to be further studied as part of CEMP.	No changes proposed for East Rockingham site.			

	Original EPS			Section 46 changes			
Key stakeholder	**Consultation**	**Key Issues**	**Responses**	**Consultation**	**Key Issues**	**Response**	**Outcome**
		Visual amenity	Plant appearance not considered to detract from local urban industrial environment. Will be managed as part of CEMP,				
		Intake suction – effects on fisheries	Negligible effect on fisheries, potential for impact and mitigation addressed in EPS.				
		Sufficient consultation with relevant groups and MPs	Targeted consultation during EPS and wide ranging consultation during preparation of CEMP considered sufficient.				
City of Cockburn (issues mostly concerned possibility of Woodman Point WWTP site, and site is no longer being considered for placement of desalination plant)	Briefing / feedback on areas of concern	Consistency with planning/zoning	Use of Woodman Point site for desalination plant consistent with MRS and Cockburn Sound Town Planning Scheme 2 zoning.	Woodman Point site no longer part of the proposal.			
		Noise emissions	Manageable noise emissions, addressed in EPS.				
		Visual amenity	Plant appearance not considered to detract from local urban industrial environment. Will be managed as part of CEMP,				
		Effect on current buffer around Woodman Point WWTP	Woodman Point is not being considered for placement of desalination plant.				

	Original EPS			Section 46 changes			
Key stakeholder	**Consultation**	**Key Issues**	**Responses**	**Consultation**	**Key Issues**	**Response**	**Outcome**
		Plant and intake/outlet locations	Preliminary locations shown in EPS. Final location subject to geotechnical and marine survey.				
		Impact on local values, natural/aesthetic value of area, Lake Coogee environment	Woodman Point is not being considered for placement of desalination plant.				
Kwinana Industries Council	Briefing and discussion	Cumulative noise	Not considered to add significantly to local noise environment, but to be further studied as part of CEMP.	Briefing on updated proposal and management	Cumulative noise, in particular at the East Rockingham. Not considered to add significantly to cumulative noise impact at KPS site.	Noise impact of plant in heavy industrial area considered negligible.	Operation of plant will be included in any update of the industrial area cumulative noise model.
Western Power				Briefing on updated proposal and management	Results of discharge modelling.	Addressed in Section 4.1	Modelling indicates conservative guideline values for temperature and salinity of discharge will be met.
					Short circuiting affecting KPS intake	Addressed in Section 4.1	Short-circuiting between discharge and KPS intake unlikely.
					Elevated sediments during construction affecting KPS operation	Construction activities to be managed to occur over a two to three week period.	To be addressed in construction management plan of CEMP.

4. ASSESSMENT OF ENVIRONMENTAL IMPACTS ARISING FROM PROPOSAL CHANGES

The approved EPS identified the following key factors as those required to be addressed in detail to mitigate adverse impacts.

- terrestrial fauna and fauna at the proposed desalination plant sites at the KPS and East Rockingham, and along proposed pipeline routes;
- Cockburn Sound marine habitat and biota;
- greenhouse gas emissions from electricity generated for plant operation;
- air quality as it may be affected by emissions of nitrogen oxides from a potential gas fired power station at the East Rockingham site;
- noise emissions due to plant and potential power station operation;
- heritage values of the proposed plant sites, pipeline routes and of Cockburn Sound; and
- public safety and risk as it may be affected by the storage of chemicals required for plant operation.

A preliminary scoping of environmental consequence arising from potential impacts of changes to the proposal was undertaken (see section 1.6). From this scoping, the factor of Cockburn Sound marine habitat and biota was considered to require detailed review due to the proposed increase in plant capacity.

4.1 COCKBURN SOUND MARINE HABITAT AND BIOTA

4.1.1 Description of relevant changes

Increasing the capacity of the desalination plant to be located at the KPS site will result in an increase in both plant intake and discharge. Daily plant intake will increase from the approved average of 220 to around 300 ML/day. Discharge of concentrated seawater from the desalination plant will increase from approximately 120 to 180 ML/day. Salinity of the plant discharge will remain at approximately 65,000 mg/L and temperature in the range of 1-2° above ambient unless KPS cooling water is used as intake to the plant. If KPS cooling water is used the (pre-dilution) discharge temperature will be 13-14ºC above ambient but will be less than 0.3ºC above ambient after initial dilution.

4.1.2 EPA Objectives

The EPA's objectives that apply to management of the Cockburn Sound marine habitat and biota are:

- to ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and marine uses by meeting statutory requirements and acceptable standards; and
- to maintain the environmental values of the seabed and marine waters.

4.1.3 Assessment Framework or Policy

The Draft Environmental Protection Policy (DEPP) (EPA 2002a) and supporting Environmental Quality Criteria document (EPA 2002b) have been revised since the submission of the original EPS to the EPA, however, the assessment framework and policy for the Cockburn Sound marine habitat and biota remains largely the same as for the original EPS.

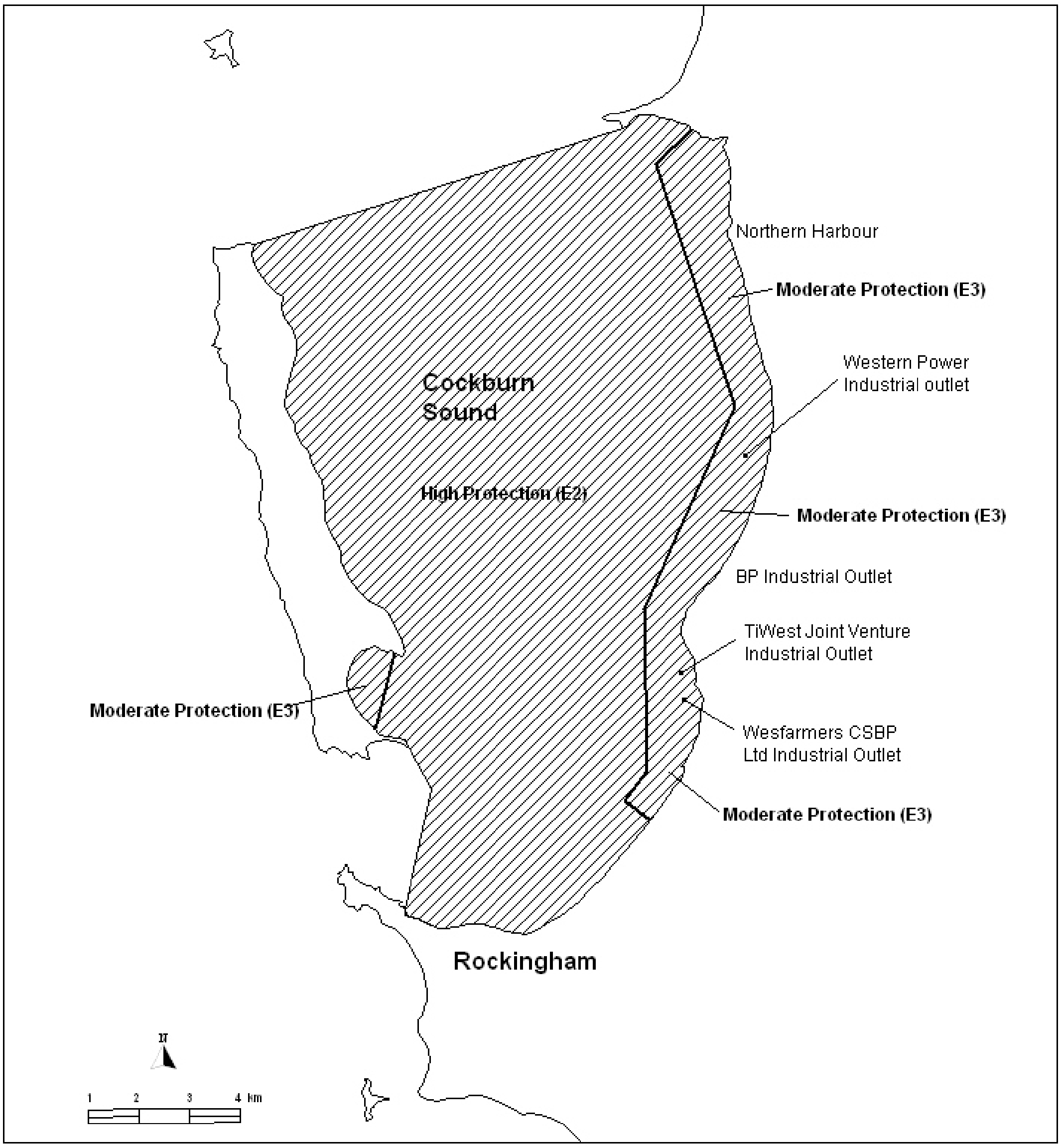
The EPA has identified a number of water quality and marine habitat issues in EPA Bulletin 907 (EPA 1998) and serves as a guide for considering cumulative impact issues in the marine environment of Cockburn Sound.

The Revised Draft Environmental Protection (Cockburn Sound) Policy (EPA 2002a) released in November 2002 defines a series of levels of protection in the waters of Cockburn Sound, including:

- a High Ecological Protection Area (E2);
- a Moderate Ecological Protection Area (E3); and
- Low Ecological Protection Areas (E4) to be located to the east of the boundary between the high and low protection areas (i.e. along the western shore of Cockburn Sound) and occupying not more than 5% of the total surface area of the moderate ecological protection area.

The boundary of the high and moderate ecological protection areas within Cockburn Sound is shown in Figure 4. Low Ecological protection areas associated with the KPS and BP refinery are shown in Figure 6 and Figure 7.

The supporting document released with the EPP is the Revised Environmental Quality Criteria Reference Document (Cockburn Sound) (EPA 2002b) which establishes environmental quality guidelines (EQG) and environmental quality standards (EQS) for the High and Moderate ecological protection areas. Guidelines relevant to the discharge of seawater from the desalination plant are shown in Table 9. The EPA guidelines are based on the framework established by the Australian and New Zealand Environment and Conservation Council (ANZECC) together with the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (ANZECC/ARMCANZ 2000). The guideline values established for Cockburn Sound are conservative. It is assumed that meeting the guideline values will not result in any adverse impact of environmental values of Cockburn Sound.



Source: Revised Draft Environmental Protection (Cockburn Sound) Policy (EPA 2002a)

Figure 4: Cockburn Sound protection areas

Table 9: Revised (draft) environmental quality guidelines for protection of marine ecosystems (EPA 2002b)

Indicator	Environmental Quality Guideline	
	High Protection	Moderate Protection
Dissolved oxygen	90% saturation	80% saturation
Temperature (°C)[1]		
Summer	±0.8	±1.6
Autumn	±1.9	±3.1
Winter	±0.5	±1.5
Spring	±1.2	±3.0
Salinity (psu)[1]	±0.8	±1.2

[1] In accordance with the EPP document, temperature and salinity guidelines are applied to waters 50 cm above the seabed and 50 cm below the sea surface.

4.1.4 Environmental aspects of Proposed Changes and Mitigation Measures

The main aspects of the proposal that may impact on the Cockburn Sound marine environment are:

- the discharge of concentrated seawater at a higher salinity and temperature than normal seawater;
- installation and operation of the dedicated seawater intake; and
- installation and operation of the diffuser and outlet pipeline

The consequences of this discharge and dedicated intake potentially include:

- an increase in the strength of vertical stratification in the vicinity of the diffuser, with the possibility of reduced vertical mixing and reduced levels of dissolved oxygen near the seabed;
- introduction of contaminants to the marine environment from the addition of anti-scalants and backwash from the RO system; and
- 'short-circuiting' between the warmer desalination discharge and the Western Power intake, thereby resulting in higher inflow and outflow temperatures from the Western Power discharges.

Proposed changes to the project that may affect the above aspects principally relate to increasing the rate of discharge of concentrated seawater to Cockburn Sound.

The Water Corporation has elected to construct an independent discharge via an offshore diffuser and an independent seawater intake structure while reserving the option to use KPS cooling water as part of the desalination feed and/or sharing the existing KPS cooling water intake.

This decision follows a range of feasibility investigations into shared infrastructure options with Western Power.

These studies found that adding the desalination plant discharge in with Western Power's cooling water from Western Power's approved Cockburn 2 diffuser may lead to a highly variable plume and associated difficulties in assessing impacts on Western Power's approved LEPA as well as governance and liability issues. The Western Power system has been designed for a buoyant (heated water), rather than a dense (concentrated) discharge. In addition, the relative location of the Western Power intakes (offshore and in deeper water) and the Cockburn 2 discharge point offered a high probability of short-circuiting (where warm discharge water is re-drawn into the Western Power cooling system, potentially causing operational and environmental problems if the water is recycled too many times). The construction of an independent discharge system for the desalination plant provides a more predictable discharge impact, removes governance and liability issues and reduces the likelihood of recirculation.

4.1.5 Environmental review of changes

EPA assessment of original proposal at KPS

The 30 GL/d proposal was assessed by the EPA and its report and recommendations are presented in Bulletin 1070 (EPA, 2002c), the EPA concluded…

> "*the factor of marine water quality and biota can be managed to meet the EPA's objectives to:*
>
> - *ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and marine uses by meeting statutory requirements and acceptable standards; and*
> - *maintain the environmental values of the seabed and marine waters.*

The proposed discharges will comply with the Cockburn Sound EPP. Marine water quality will be protected by ensuring that contaminants in the seawater discharge are minimised and that the rapid dilution at the outfall should mitigate the elevated salinity and temperature levels. Construction effects relating to the intake and outfall structures should be very limited in area and duration, and best practice design should avoid affects on biota."

The potential impacts of the changed proposal and mitigation and management of these impacts are discussed below.

Increased rate of discharge of concentrated seawater

Salinity criterion

Comparison of the environmental quality guidelines (see Table 9) with the proposed discharge characteristics shows that the salinity of the discharge is the constraining water quality component. The discharge salinity will be typically 75% above the background value (around 36 psu). This must be diluted so that the salinity at the edge of the mixing zone (E4/E3 boundary) is less than 3.4% above background to be acceptable. At the E3/E2 boundary, a little further offshore, the salinity elevation has to be less than 2.3% of the background value.

Dilution required to meet salinity guideline

A sub-sea diffuser was selected as the most appropriate option to dilute the discharge and meet the salinity guideline. The discharge will rapidly mix with entrained ambient water, and will settle towards the bottom as a negatively buoyant plume with an intermediate salinity and temperature (and therefore density) depending on the initial dilution. Given the generally quiescent conditions at the site subsequent environmental mixing will be slow in comparison. The result will be a plume of more dense water flowing downhill along the seabed.

Immediately offshore from the plant are the Calista and Stirling Channels that link the bathymetry with the basins for Alcoa and BHP's South and North Jetties. These regions are deeper than the surrounding areas by virtue of dredging, and therefore provide a preferential flow path for a dense bottom plume.

The initial dilution by the diffuser would have to achieve almost all of the mixing required to meet the E3 target guideline value of 0.8 psu (50 cm above the seabed) at the E3/E2 boundary given the lack of subsequent natural dilution and preferential flows along the seabed.

Based on the analytical results and as confirmed by the numerical modelling, an average initial dilution of 45 is required to ensure that the salinity elevation at the edge of the mixing zone is less than the 0.8 psu guideline value at the E2/E3 boundary.

A diffuser concept design was developed based on Roberts *et al*. (1997) who has shown that the most efficient diffuser design incorporates a discharge angle of 60^{o} from the horizontal, assuming that the plume does not intersect the surface and remains submerged under normal conditions.

The diffuser will be located on the seabed at approximately 10 m depth. The concept design limits the rise height of the discharge to 8–9 m to ensure that the discharge remains submerged. In order to achieve the design average dilution of 1:45 the following typical configuration would be required:

- 16 – 18 ports;
- 0.22 m nominal port diameter;
- around 1.1 m internal diameter pipe main pipe;

- port spacing 5 to 10 m (diffuser length 80–180 m); and
- diffuser approximately 300 m offshore.

The above design is indicative and will be refined during the detailed design process. Other aspects such as port orientation (eg uni-directional, alternating etc) will also be assessed in detail. Nevertheless, the above design demonstrates that an initial average dilution of 45 can be achieved with a practical engineering solution. The final design of the diffuser system will not be considered complete until it is certified by a diffuser system expert. The certification will specify that the ocean outlet diffuser system discharge complies with the requirements of the Cockburn Sound Environmental Protection Policy and the Revised Environmental Quality Criteria Reference Document (Cockburn Sound).

The discharge plume is expected to have the following characteristics in the initial mixing zone for the above conceptual design:

- a rise height of 8.5 m;
- a thickness at the edge of the mixing zone of 2.5 m; and
- 40 m laterally from the diffuser to the edge of the mixing zone in the absence of ambient cross-flow.

The presence of ambient currents will affect the size of the initial mixing zone by increasing the lateral excursion of the plume prior to it hitting the bottom. This excursion is expected to be approximately 5-10 m, and therefore a 100 m wide mixing zone centred on the axis of the diffuser array is typical. This is the same size mixing zone as was proposed for the previously approved project at the KPS site. For comparative purposes the model outputs showing discharge from the approved 30 GL/a plant are provided in Figure 9.

Modelling the discharge

Modelling was conducted under the same autumn and summer conditions used for the previously approved 30 GL/a plant. The Environmental Fluid Dynamics Code model developed for Cockburn Sound by James Point Pty Ltd together with Western Power and BP was also used to provide consistency with the past work. The details of the modelling approach are described in detail in the previous EPS.

Figure 5 below shows the relative model locations of the desalination plant intake and discharge, together with those of the KPS. The discharge has been modelled as a line source with an initial dilution spread over two model cells (an area of 100 by 100 m). As the model allows for the processes of medium to large scale recirculation, local short-circuiting and the impact of ambient flows, the reduction of the discharge salinity will vary somewhat in space and time. However, the median salinity will meet the high and medium protection guideline values.

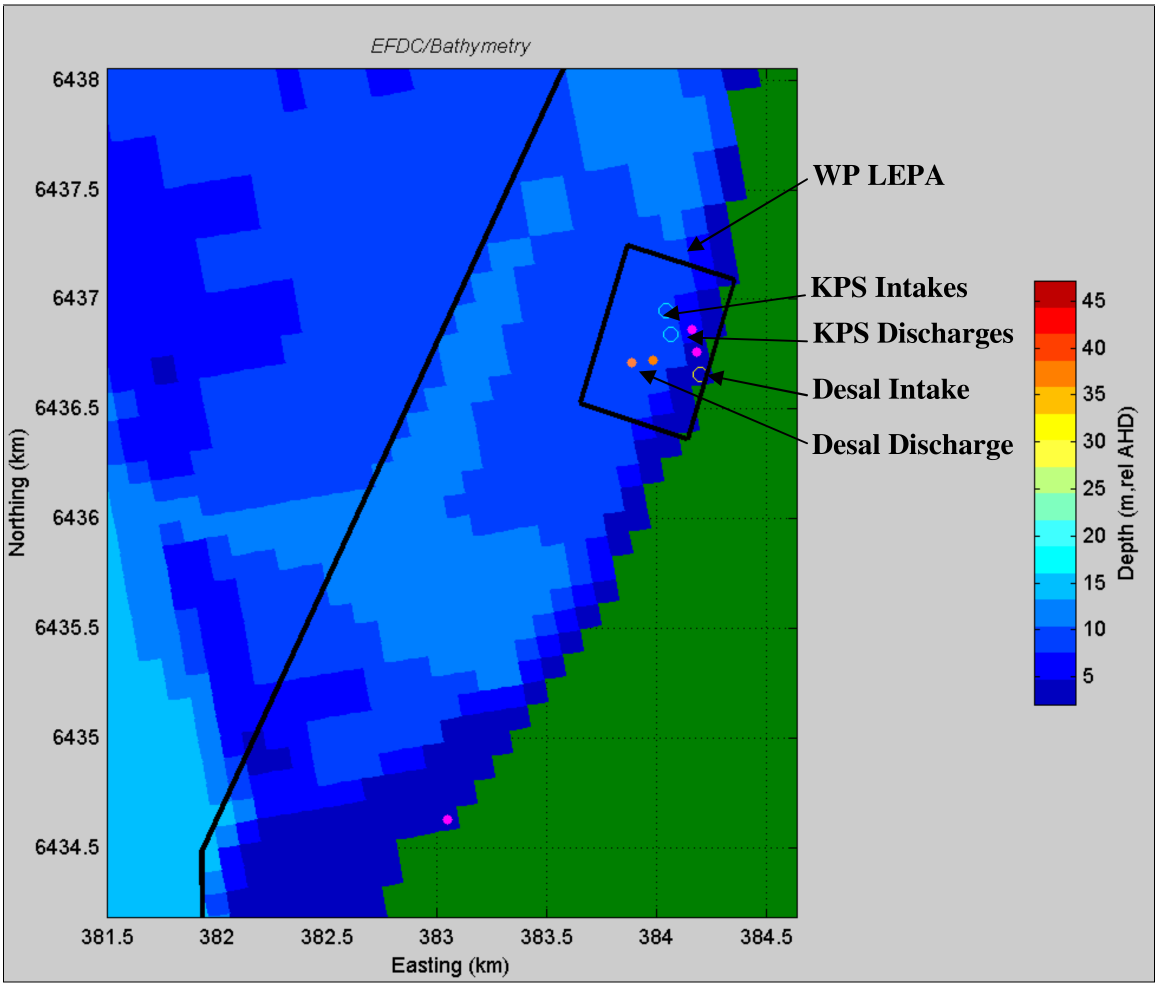


Figure 5 Locations of intakes and withdrawal points as modelled (LEPA = low ecological protection area).

Simulations for representative autumn and summer conditions were completed, with the results processed with reference to a base case. The base case had no discharges from existing industrial sources (with the exception of Western Power) or from the proposed desalination plant. As all other discharges are not significantly different from background salinity, the results for salinity will reflect the comparison between a wholly unaffected system and the proposed discharge.

Results are shown at a level of 0.5 m above the seabed in all locations, as per the EPA guidelines. Salinity represents the most constraining water quality parameter since temperature guideline values for all cases are met completely within the initial dilution zone (the worst case temperature increase at the edge of the intitial dilution zone will be less that 0.3ºC). Therefore the results are presented solely in terms of impacts on the near-seabed salinity.

The median salinity exceedence results for the autumn simulation are shown in Figure 6 below. The colours represent the median or 50th percentile value of the elevation of salinity above the background, or reference, value. The results show that the median salinity elevation will not exceed 1.2 psu outside the initial mixing zone under these conditions and the 0.8 psu guideline value will not be exceeded at the E3/E2 boundary.

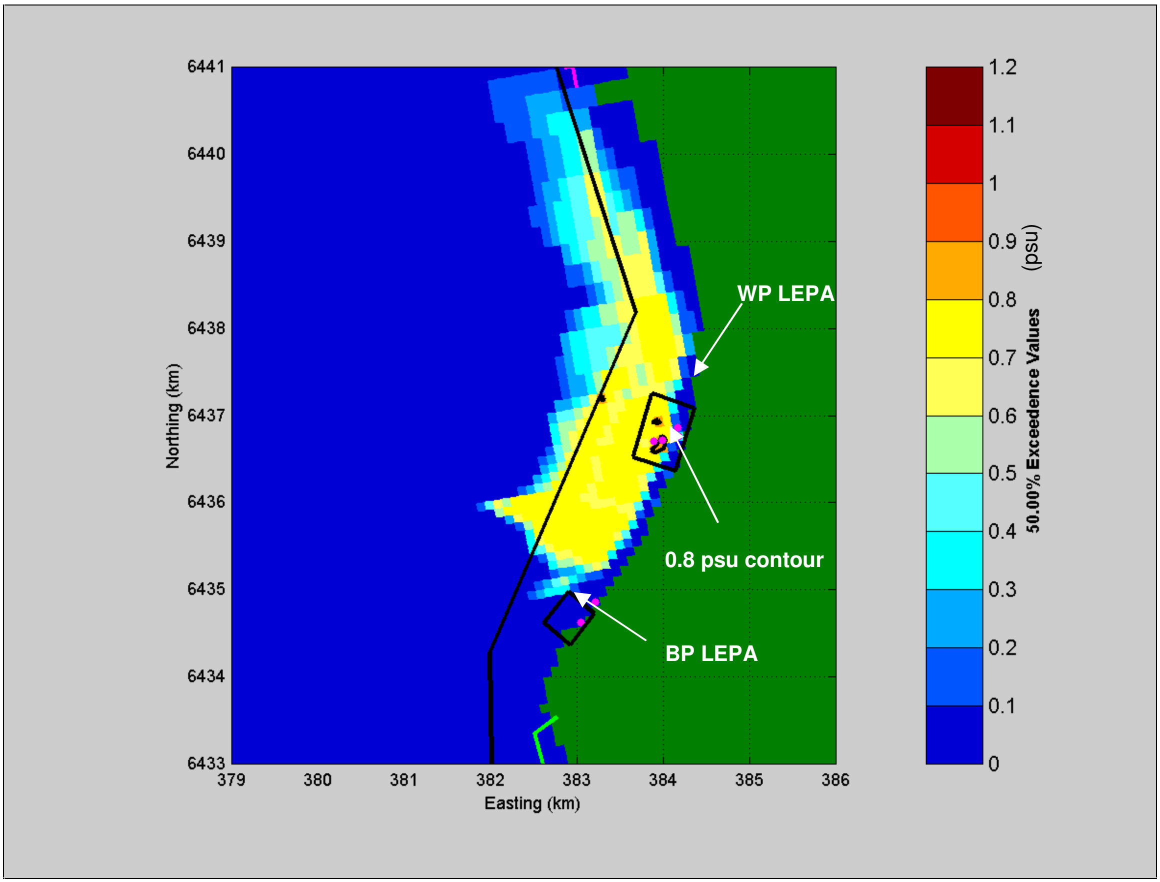


Figure 6 Autumn: Median (50% ile) Salinity Map 0.5m above the seabed

The summer result is shown in Figure 7, under these conditions, the more dynamic ambient environment during summer is predicted to result in stronger mixing and no exceedence of either the 1.2 of 0.8 psu guideline value, at the guideline median level.

Both Figure 6 and Figure 7 show that the discharge signal, particularly in the autumn simulation, occupies the region defined by the dredged channel and basins, flowing towards the entrance to Stirling Channel. This offers the discharge a preferred flow path leading to further dilution and dispersion over the sharp drop into the central portion of the Sound. This is also shown by the section taken offshore from the discharge site (Figure 8).

Figure 8 shows a section through Cockburn Sound along the diffuser alignment at a time of six days following the commencement of the discharge. The model initial mixing zone is clearly shown by the submerged light blue colour, which then travels along the bottom in a layer approximately 1–2 m thick, undergoing further dilution as it travels. The slight density differences force the discharge to follow the bathymetry 'downhill'.

The discharge travels away from the source along the bottom at a speed of approximately 0.03 to 0.05m/s, which is comparable with the ambient wind and tidal currents and allows the discharge to reach the entrance to Stirling Channel approximately one day following release. For this reason, the waters in the discharge are not expected to 'age' more than 1–2 days and therefore there will not be any additional effects on oxygen levels beyond those associated with the approved EPS.

The saline discharge water ultimately entering the deeper offshore area (around 20 m deep) of Cockburn Sound is relatively well oxygenated. For this reason, the oxygen levels in the deeper area are not expected to reduce as a result of the operation of the desalination plant. Nonetheless, the Corporation will confirm this by obtaining an expert opinion on the likely stratification build up and any subsequent dissolved oxygen effects in the deeper area of Cockburn Sound.

Only the 0.8 psu contour is visible in Figure 6 because of the high dilution attained in a small mixing zone. The mixing zones occur entirely within the existing LEPA designated for the KPS.

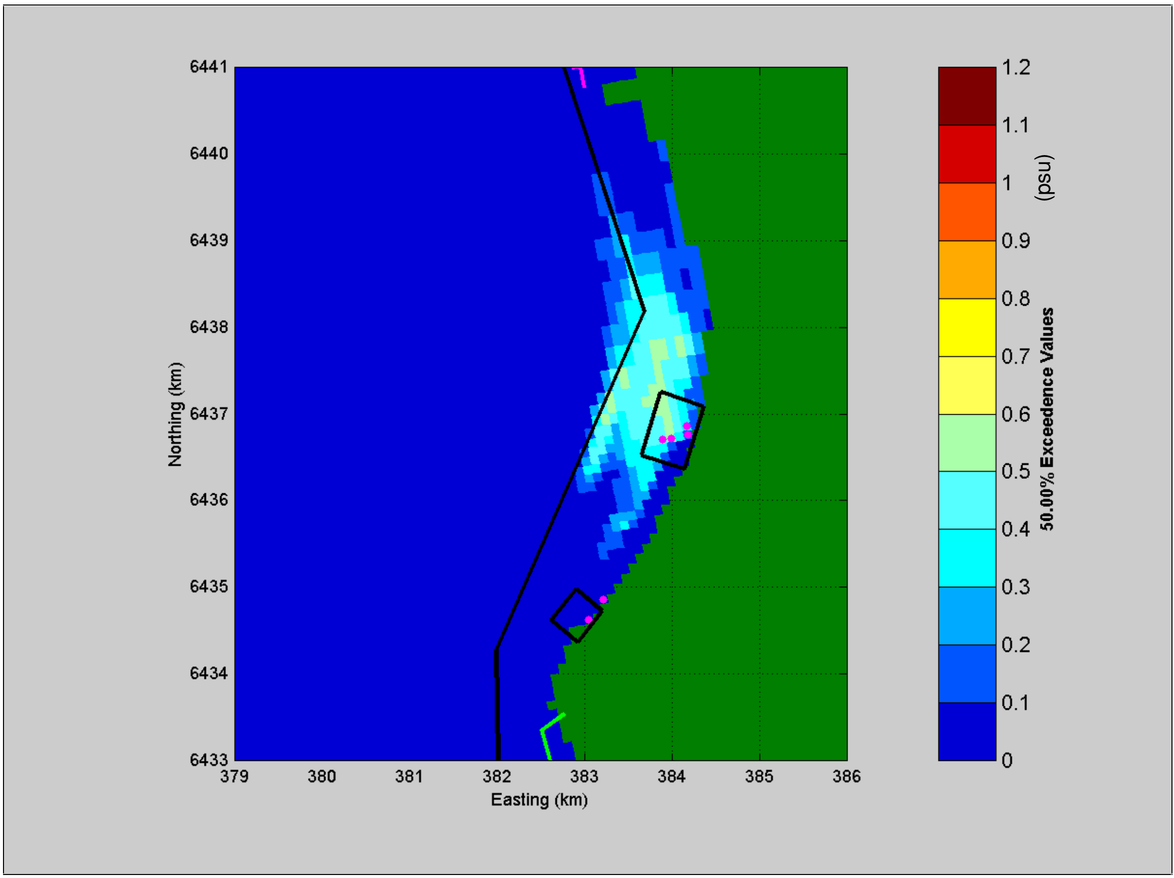


Figure 7 Summer: Median (50% ile) Salinity Map 0.5m above the seabed.

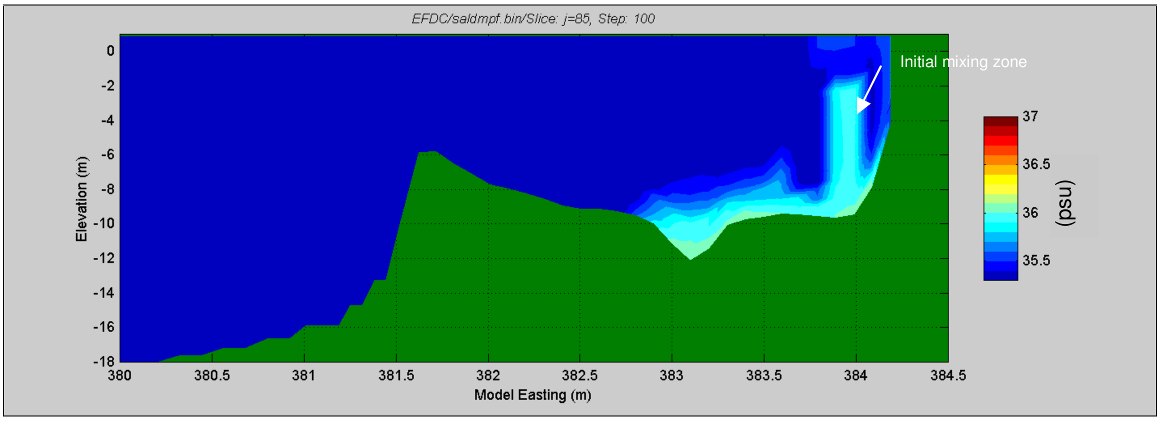


Figure 8 Autumn: Salinity cross-section through plume at diffuser site – 6 days after commencement of discharge.

For comparative purposes the model outputs showing the salinity associated with discharge from the approved 30 GL/a plant and the proposed upgraded 45 GL/a plant are shown in Figure 9.

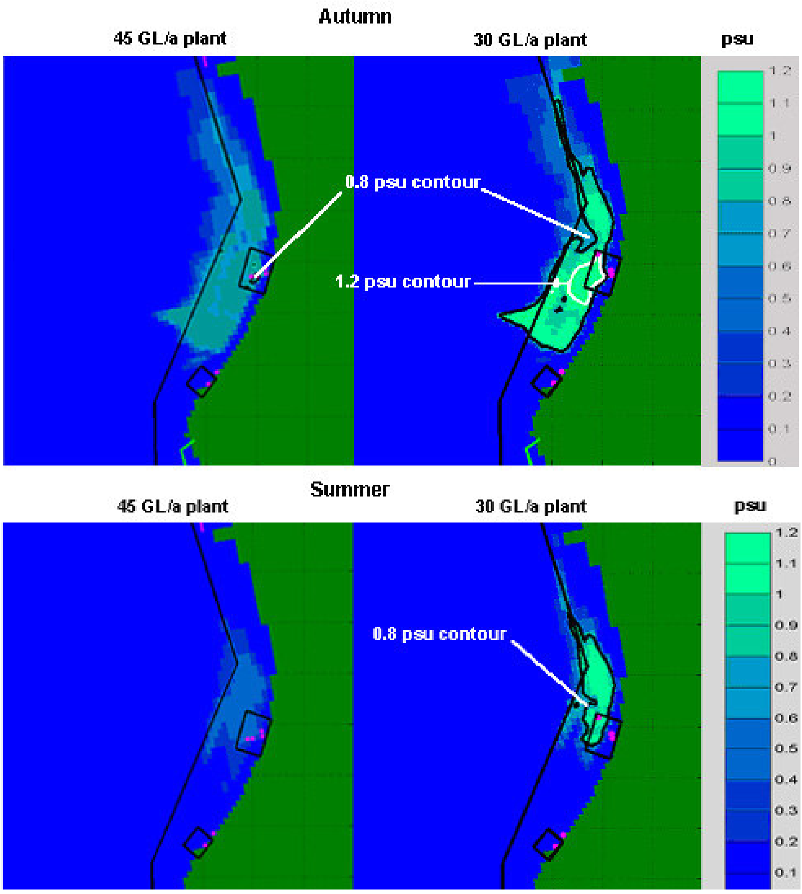


Figure 9: Comparison of discharge characteristics between proposed 45 GL/a and approved 30 GL/a desalination plants

It is clear from Figure 9 that the proposed 45 GL/a plant performs much better with respect to meeting the guideline values and has a much smaller "footprint". This is because of the greater dilution associated with the 45 GL/a plant proposal.

Potential interaction with Kwinana and Cockburn power stations

The proximity of the Kwinana and Cockburn Power Plants and desalination plant systems create a potential for short-circuiting. Short-circuiting is the process by which a wastewater discharge is redrawn into the intake, thus recirculating the water. This could potentially lead to the discharge of higher temperature (or salinity) water, a change in plume characteristics, concentration of contaminants and a reduction in operational efficiency. There are three potential local short-circuiting scenarios:

1. The redraw of the desalination plant discharge into the desalination plant intake.
2. The draw of the desalination plant discharge into the Western Power intake.
3. The draw of Western Power discharge into the desalination plant intake.

The first case may lead to a reduction in efficiency of the desalination plant, or the discharge of higher salinity water than normal. The second case would only cause concern should the temperature of the water at the Western Power intake be significantly different to background values. Of the above cases, the third is probably the least problematic, as the higher temperatures are likely to improve the operational efficiency of the desalination plant.

The results of modelling found that the salinity at each of the intake sites was relatively stable, with minor elevation of salinity above background at the intake locations, the values are within the range of natural variations. The lack of any overall increase shows that the system is stable and suggests that the probability of short-circuiting occurring is minimal. This is mostly because the saline discharge from the desalination plant is denser than background and will remain on the bed while the buoyant discharge from the KPS will remain at the surface. In addition, horizontal separation of intake and discharge point helps prevent local short circuiting.

During detailed design, engineering measures will be adopted in consultation with Western Power to ensure there are no adverse effects on the Western Power system, and a minimal chance of short-circuiting of the desalination system.

Discharge of chemicals used in the RO process

A number of chemicals may be required for efficient and effective operation of the desalination plant (also see Figure 2). These may include:

- intermittent chlorine dosing of the feedwater during pre-treatment to control marine growth;
- sulphuric acid added during pre-treatment to buffer the pH of the of the feedwater;
- ferric chloride and polyelectrolyte for pre-treatment of intake water;
- anti-scalant that may be continuously dosed to the reverse osmosis (RO) feed line;
- those required on an intermittent basis for cleaning of the filtration system (e.g. sodium hypochlorite) and RO membranes (e.g. biocide and acidic detergent);
- those required for preservation of membranes during RO unit shutdowns (e.g. bisulphite); and
- sodium metabisulphite (in the form of sodium bisulphate solution), which will be added to the discharge to neutralise any residual chlorine.

It is currently proposed to add the chemicals shown in Table 10 during pre-treatment or for conditioning the seawater prior to or during the process. The values given are estimated based on a conceptual design and are related to the 100 % active substance in the solution.

Table 10: Dosing rates

Substance	Type	Concentration	Consumption (t/a)
Sulfuric acid (H_2SO_4 100%)	continuous	10 mg/L$_{(seawater)}$	1,110
Ferric chloride ($FeCl_3$ 100%)	continuous	≤ 4 mg/L$_{(seawater)}$	≤ 440
Polyelectrolite (100%)	continuous	≤ 1 mg/L$_{(seawater)}$	≤ 110
Anti-scalant	continuous	≤ 1.5 mg/L$_{(product)}$	≤ 67
Sodium hypochlorite (NaOCl 100%)	intermittent, 0.5h/weekly	4 mg/L$_{(seawater)}$	1.3
Sodium bisulphite ($NaHSO_3$ 100 %)	intermittent, 0.5h/weekly	12 mg/L$_{(seawater)}$	3.9

It must be noted that actual chemical dosing regimes and quantities for the proposed plant will be the subject of detailed investigation and pilot testing carried out over a significant timeframe. There is considerable complexity in determining the ultimate chemicals and dosing rates for a large seawater RO plant. A paper presented at the European Conference on Desalination and the Environment: Water Shortage, Lemesos, Cyprus, on 28-31 May 2001 details the experience of the Dhekelia seawater desalination plant. The document can be found on the Internet at http://www.desline.com/articoli/4185.pdf.

Pre-treatment

Feedwater entering the RO process will be pre-treated. Pre-treatment includes filtration and may include the addition of chlorine, sulphuric acid, ferric chloride and polyelectrolyte.

Intermittent dosing of the feedwater with chlorine in the form of sodium hypochlorite (NaOCl) to control marine growth is necessary. This hydrolyses immediately to form sodium hydroxide (NaOH), and hypochlorite (OCL^{-3}) and hypobromite (OBr^-) ions (seawater contains around 65 mg/L bromide). As the RO membrane elements are very sensitive to chlorine, residual free chlorine in the feedwater will be removed prior to the RO system by dosing with sodium metabisulfite. When dissolved in water, sodium bisulfite ($NaHSO_3$) is formed from sodium metabisulfite ($Na_2S_2O_5$). Sodium bisulfite ($NaHSO_3$) then reduces the highly active hypochlorite (OCL^-) and hypobromite (OBr^-) ions that arise from chlorination producing chloride (Cl^-) and bromide (Br^-) ions and sodium bisulfate ($NaHSO_4$).

Sulphuric acid is added to the pre-treatment to buffer the pH of the RO system feedwater. The sulphuric acid will react with alkalis in the seawater (including any sodium hydroxide produced by chlorination) and be neutralised by this process. The resulting sulphate ions will be discharged in the reject stream from the RO system but represent a negligible addition (less than 1%) compared to naturally occurring sulphate ions.

Where flocculation filtration is applied for pretreatment (which is generally the case in large open intake seawater RO plants) backwash water from backwashing of the filters with filtered seawater is produced during cleaning operations. This backwash water comprises suspended solids originating from the seawater feed plus, if used, suspended iron from the ferric chloride flocculant dosing upstream of the filters.

The suspended solids and iron concentrations in the backwash water depends on the suspended solids and iron concentrations of the seawater, iron salt dosing rate and frequency of backwashing. Dissolved iron content in backwash water would be according to the iron solubility at the actual seawater pH. The dissolved solids in this backwash water are the same as those in the seawater feed to the pretreatment.

Mixing of the filter backwash water with the seawater RO concentrate (reject water) will result in plant discharge with suspended solids of up to approximately 24 mg/l and iron content up to approximately 5 mg Fe/l. The final concentrations of suspended solids and iron following initial dilution through the diffuser will be approximately 10.3 mg/L for suspended solids and 1.4 mg/L for iron at the edge of the mixing zone. As shown in Table 2, these post-dilution values are very close to seawater background values. Note that no US EPA quality criteria exist for iron as it is considered a non-priority pollutant (Lattemann & Höpner 2003). Further, the EU Water Directive does not consider iron to be of environmental significance (Chave 2001).

Due to dilution of the backwash water with the RO reject water, any discoloration of the discharge will be insignificant. The CEMP will provide detail on the management of this issue.

Polyelectrolyte (if used) will be dosed in the pre-treatment to enhance coagulation. Polyelectrolytes are organic substances with very high molecular masses that flocculate colloids. Polyelectrolytes are completely miscible in water and, therefore some of it will pass through the media filters into the RO modules. The remaining polyelectrolyte will be discharged with the backwash water. No toxic effects are expected from these organic substances. Polyelectrolytes of the type likely to be used consist of approximately 15% nitrogen and will result in up to 16.5 t/a of nitrogen being discharged.

Polyelectrolytes have the potential to have an adverse impact on the performance of the RO membranes (particularly the composite membrane polyamide spirals). As such, polyelectrolyte usage (as will all chemical usage) will be minimised as far as is possible.

Anti-scalant

Anti-scalant may also be added to the feedwater after pre-treatment and prior to it entering the RO process. Anti-scalants are commonly approved for RO systems around the world and are "comparable to naturally occurring humic materials in terms of chemical composition and fate" and are considered "comparatively safe for aquatic life" (Lattemann & Höpner 2003).

The main representatives of anti-scalants are organic, carboxylic-rich polymers which are characterised by COOH groups, such as polyacrylic acid and polymaleic acid. These additives are certified non-toxic and are biodegradable or breakdown. LC_{50} values are relatively high (generally exceeding 1000 mg/l), which indicates a low toxicity and is far above the typical dosage in desalination plants. The active ingredient in the anti-scalant currently proposed for use in the RO system is phosphinocarboxylic acid and does not contain heavy metals or designated hazardous substances. It has no potential to bioaccumulate, is neutralised by seawater alkalinity immediately and ultimately degrades to harmless natural by-products (carbon dioxide and phosphorus oxides). Available toxicity data for anti-scalants currently proposed for use in the desalination plant are shown in Table 11. Note that the toxicity data are for freshwater organisms, which are typically more sensitive than marine organisms. It is also noted that phosphinocarboxylic acid is certified by the United Kingdom Drinking Water Inspectorate for use in RO plants producing potable (i.e. drinking) water.

Table 11: Available toxicity data for the anti-scalant currently proposed*

Species test	LC50 (mg/L)
Rainbow trout	>1,000 (96 hour)
Zebra fish	>1,000 (96 hour)
Brown shrimp	>10,000 (96 hour)
Daphnia	>320 (24 hour)
Algal inhibition	>130 (72 hour)

*see http://www.wateradditives.com/Ext_28/webpdfs.nsf/ByName/Flocon+135/$file/F135GPI-WF.PDF

Typical dosing rates of anti-scalants are expected to be 1.5 mg/l or less to the feed water which will result in a concentration at the outlet of around 2.2 mg/l or less. The concentration following average initial dilution through the diffuser will be approximately 45 times less again with resulting anti-scalant concentrations being approximately 0.05 mg/L at the edge of the mixing zone, well below LC_{50} values for sensitive freshwater organisms shown in Table 11. Therefore there will be no discernible impact on the water quality and marine biota of Cockburn Sound due to the use of anti-scalant following discharge from a diffuser.

Lattemann & Höpner (2003) state: “it can be concluded that discharge levels of [anti-scalant from] desalination plants are far below concentrations that could have any significant toxic or chronic effects on marine organisms”. Nonetheless, the Water Corporation has committed to undertake eco-toxicological testing of the selected anti-scalant to verify the very low potential for the anti-scalant to have significant ecological impact.

Filtration (Pre-Treatment) Cleaning

Investigations of seawater quality have determined that backwashing with seawater should be adequate. Therefore, during normal operations of the plant, the filtration system will be backwashed with seawater only. Backwash water will be continuously discharged to Cockburn sound via a buffer tank.

In a scenario of heavy biological growth in the pre-treatment system, backwashing with a 12% w/w sodium hypochlorite solution may be carried out as an emergency measure. Neutralization of the sodium hypochlorite solution will be carried out and subsequent dilution on discharge will be such that it will be undetectable in the waters surrounding the outlet. The constituents of the solution are naturally found in the ocean and this additive is not considered to have any potential to cause any degradation of water quality or affect biota.

RO Membrane cleaning

It is anticipated that the chemically enhanced cleaning of each RO membrane (with acidic detergent) will occur about four times a year. The actual products used and the frequency of cleaning will be determined through pilot testing, operations monitoring and the warranty requirements of the membrane suppliers. Discharge from the cleaning operation will be to the discharge outlet through a storage tank.

Acidic detergents used for membrane cleaning are relatively weak and generally comprise a blend of organic acids, low foam surfactants and wetting agents. The active ingredient in the acidic detergent is likely to be either citric acid ($C_6H_8O_7$) or sulphamic acid (NH_2SO_3H). These are relatively benign compared to mineral acids (e.g. sulphuric acid and hydrochloric acid). A cleaning product based on citric acid is considered more likely due to the ferric chloride dosing in the pre-treatment, however a range of acidic detergents with different active ingredients are available to select from. Specific cleaning products to be used in the plant will be determined when membrane vendors are finalised following the detailed design phase.

Ammonium and/or nitrogen ions may result from usage of chemical cleaning solutions (e.g. based on ammoniated citric acid). For example, if a sulphamic acid solution is used for the cleaning operation, then following the cleaning operation and prior to discharge, the hydrogen component of the sulphamic acid solution is neutralised by the addition of sodium hydroxide. The sulphamic group (NH_2SO_3) then hydrolyses to ammonium bisulphate in the aquatic environment which then immediately dissociates into ammonium and sulphate ions, both of which are naturally abundant in seawater.

For the most likely cleaning process (i.e. with citric acid) it is estimated that cleaning of each membrane will be conducted 4 times a year and that a total of around 19 t/a of citric acid ($C_6H_8O_7$,100%) would be used. It is expected that that some 1.2 t/a of ammonium hydroxide (NH_4OH, 100%) may be dosed for pH adjustment. The ammonium will be gradually discharged via the storage tank to the discharge outlet resulting in a discharge concentration of around 0.3 mg/l may be expected. After further dilution at the end of the mixing zone the concentration would be as low as 0.007 mg/l. The total nitrogen load associated with this would be less than 0.4 t/a.

Control of Microbiological Growth

Microbiological growth impairs membrane efficiency and will be controlled using intermittent chlorination during pre-treatment. Analysis of the local seawater indicates that dosing with biocide in addition to intermittent chlorination will not be necessary for normal operations. However, the need for biocide will be determined during the commissioning and subsequent operations of the plant and, if required, it will be added to the RO system either during cleaning cycles, and/or at regular intervals, perhaps once per week for an hour for each membrane. The biocide product selected for use will be a non-oxidising, broad-spectrum (i.e. it kills bacteria, fungi, yeast, blue-green algae and true algae) fast-acting biocide. The product will be significantly diluted by the plant discharge and operation of the diffuser and will not contain any heavy metals and will decompose rapidly (in less than a day in normal circumstances) to harmless natural by-products in the aquatic environment. For example, a typical active ingredient in many biocides is 2,2-dibromo-3-nitrilopropion amide (DBNPA) which breaks down to carbon dioxide, ammonium and bromide.

Toxicology tests on DBNPA yield LC_{50}s from 0.5 to 14 mg/L for freshwater and estuarine organisms except for the Eastern Oyster which has an LC_{50} of 0.07 mg/L (US EPA 1994). Note that these LC_{50}s are all effectively associated with 24 hour tests due to the rapid degradation of DBPNA. Because DBNPA, if required, will only be dosed intermittently, the concentration at the edge of the initial mixing zone, following 45-fold average dilution, will only be around 0.0004 mg/L – well below the reported LC_{50}s.

Use of biocide, if required, will add less than 0.4 t/a of nitrogen to Cockburn Sound and is not expected to be detrimental to the water quality or have any effect on marine biota. The Water Corporation will however conduct its own eco-toxicity tests on any selected biocide to verify the very low potential for it to have significant ecological impact at the concentrations present in the discharge.

Membrane preservation

If plant operations are suspended for periods of time, bisulfite will be used for conservation of membranes. The detailed usage and management of preservation chemicals for the RO membranes has yet to be determined but these matters will be addressed in detail in the finalised CEMP.

Impact of chemicals on sediments

There is no potential for bioaccumulation of contaminants from the desalination discharge in nearby sediments due to neutralisation and the unstable and benign nature of the active ingredients of the chemicals being discharged. Deterioration in the quality of sediments in the vicinity of the outlet is not anticipated. However, the Water Corporation is committed to undertake pre and post commissioning surveys of sediment quality in the vicinity of the desalination discharge to confirm this.

Nitrogen loading

The EPA (EPA 2002a) has derived nutrient related environmental quality guidelines for Cockburn Sound [chlorophyll *a*, light attenuation coefficient (LAC), phytoplankton biomass and seagrass shoot density] to achieve:

- Protection of the remaining seagrass meadows in Cockburn Sound;
- Ensure a level of water quality that would enable seagrass meadows to re-establish along the eastern side of Cockburn Sound, including the Jervoise Shelf, to depths of up to 10 m; and
- Minimise the occurrence and extent of phytoplankton blooms in Cockburn Sound.

Estimated worst case nitrogen loads associated with this proposal are shown in Table 12. With regard to nutrients, nitrogen is the limiting nutrient in the ocean. It is clear from Table 12 that the dominant potential contributor of nitrogen under the worst case scenario is polyelectrolyte. It is possible that polyelectrolyte may not be needed. In any case, nitrogen free alternatives will be used for process chemicals where appropriate and practicable.

Table 12: Estimated worst case Nitrogen loads (t/a) to Cockburn Sound

Source	Approved (30 GL/a)	Proposed change
Polyelectrolyte	≤ 11	≤ 5.5
Biocide	0.22	0.11
Acid detergent	0.25	0.12
TOTAL	≤ 11.5	≤ 5.8

Table 12 shows that the proposed upgrading of the of the desalination plant from 30 Gl/a to 45 Gl/a will result in up to an additional 6 t/a of nitrogen entering Cockburn Sound. This additional loading represents around 2% of the total anthropogenic nitrogen load and 0.4% of the internal nitrogen load to Cockburn Sound and, as such, will not have a measurable effect (see CSMC 2001 for additional details).

The Water Corporation will develop a strategic management plan to ensure that the net total nitrogen loads to Cockburn Sound associated with its activities are reduced relative to baseline loadings in the long term. Baseline loadings will be those estimated for 2003 unless higher loadings are approved by the EPA. The strategic management plan will be developed in consultation with the Cockburn Sound Management Council and will be submitted to the EPA for approval.

Table 13 shows preliminary estimates of some possible reductions to the nitrogen loads (t/a) to Cockburn Sound related to Water Corporation activities with 2003 as the base year except that the Jervoise Bay Groundwater Recovery Scheme (JBGRS) is included because it is an ongoing actively managed activity. The upgraded desalination plant (45 GL/year) is also included. It is evident that there will be a significant net reduction in nitrogen loads entering Cockburn Sound around 2007-2010 and into the future. The majority of the nitrogen reduction is because of the Kwinana Water Reclamation Plant (KWRP) project which involves receipt and disposal of wastewater streams from many of the industries who presently discharge into Cockburn Sound. This wastewater will be disposed of via the Sepia Depression Ocean Outlet Landline to the Sepia Depression (this component of KWRP is currently subject to a Public Environmental Review).

Table 13 Preliminary estimates of some of the possible reductions to nitrogen loads (t/a) entering Cockburn Sound related to Water Corporation activities and the nitrogen load added by the desalination plant.

Action	2003	2007-2010 onwards
Jervoise Bay Groundwater Recovery Scheme*	0	-24
KWRP – redirection of industry waste discharge**	0	-70 to -140
Perth Metropolitan Desalination Plant (45 GL/year)***	0	28
TOTAL CHANGE in total nitrogen (t/a)	0	-66 to -136

* JBGRS shown as a post base year (2003) item due to its actively managed nature.
** Lower figure is based on estimates of likely discharges while the upper estimate is the permitted maximum discharge under existing licence conditions.
*** Estimated worst case nitrogen load.

Construction and operation of outlet and intake

Existing Environment

DAL Science and Engineering has previously undertaken surveys in this region on behalf of Western Power as part of the approval process for the Western Power Stage C diffuser. The benthic habitat in this region comprises of bare sediment, composed of coarse calcareous sands (refer Figure 10 and Figure 11).

A rapid drop-off to a depth of approximately 10 m occurs 120–150 m from shore. In field surveys, benthic invertebrates typical of temperate, soft sediment environments were observed (e.g. sand dollars and anemones). No seagrasses have been observed in the vicinity.

Seagrass meadows present on the Eastern Flats of Cockburn Sound were lost progressively from the region during the 1970s and 80s, most likely from increased nutrient loads causing blooms of phytoplankton and a concurrent increase in light attenuation. Previous benthic surveys on the Eastern Flats region of Cockburn Sound have recorded similar findings to those presented here (DAL *et al.* 1999, DAL 2001).

Construction Impacts

The concentrated seawater discharge pipe will cross the Barter Road Beach and extend approximately 300 m offshore ending in a diffuser 80–180 m. The outlet pipe will be around 1,100 mm internal diameter and will be buried for its entire length to ensure that it remains securely in place and also that it poses no intercepting effect on longshore sand transport or any navigation hazard.

The burial of the pipe will require removal of approximately 5,000–8,000 m^3 of sand and calcareous material to create a trench for the pipeline and diffuser. After the pipe is placed in the trench it will then be covered with crushed rock. As the amount of material is small and distributed over a lineal distance of approximately 300 m, it is intended to place the excavated sand on the seabed either side of the trench within a corridor of 10 m either side. The contractor will be required to ensure that the final elevation above the preconstruction seabed of material deposited either side of the trench is 0.75 m or less.

The seabed which will be disturbed by the trenching and disposal consists of bare sand and silt colonised by benthic invertebrates and algae. On completion of the works the habitat will consist of sand and rock which will be rapidly recolonised by the same assemblages. Construction is anticipated to occur over a two to three week period.

Geotechnical work will commence in the period leading up to the appointment of the contractor. However, based on recent experience with dredging and construction in the vicinity, the seabed is likely to consist of uncemented sands overlying calcarenite and possibly some limestone. It is highly likely that all material can be removed by mechanical means and there will not be a need for blasting.

Nevertheless, if the geotechnical survey indicates that hard material is present all practical construction options will be explored in an effort to remove the need for blasting. However, if this exploration of options finds that there are no practical construction alternatives to blasting, then management of blasting will be addressed in the final CEMP.

Similar construction methods are required for the both the discharge and intake pipelines. There is potential to share intake facilities with Western Power's existing or planned intake facilities, and thereby avoid the need for additional disturbance of the seabed.

Operational Impacts

For environmental, operational and human safety reasons, the entrance to the pipeline will need to be screened to prevent marine life and debris being drawn into the plant and to allow safe underwater inspection of the intake. The screen will be sized to ensure that the velocities at the screen do not exceed those associated with the original proposal.

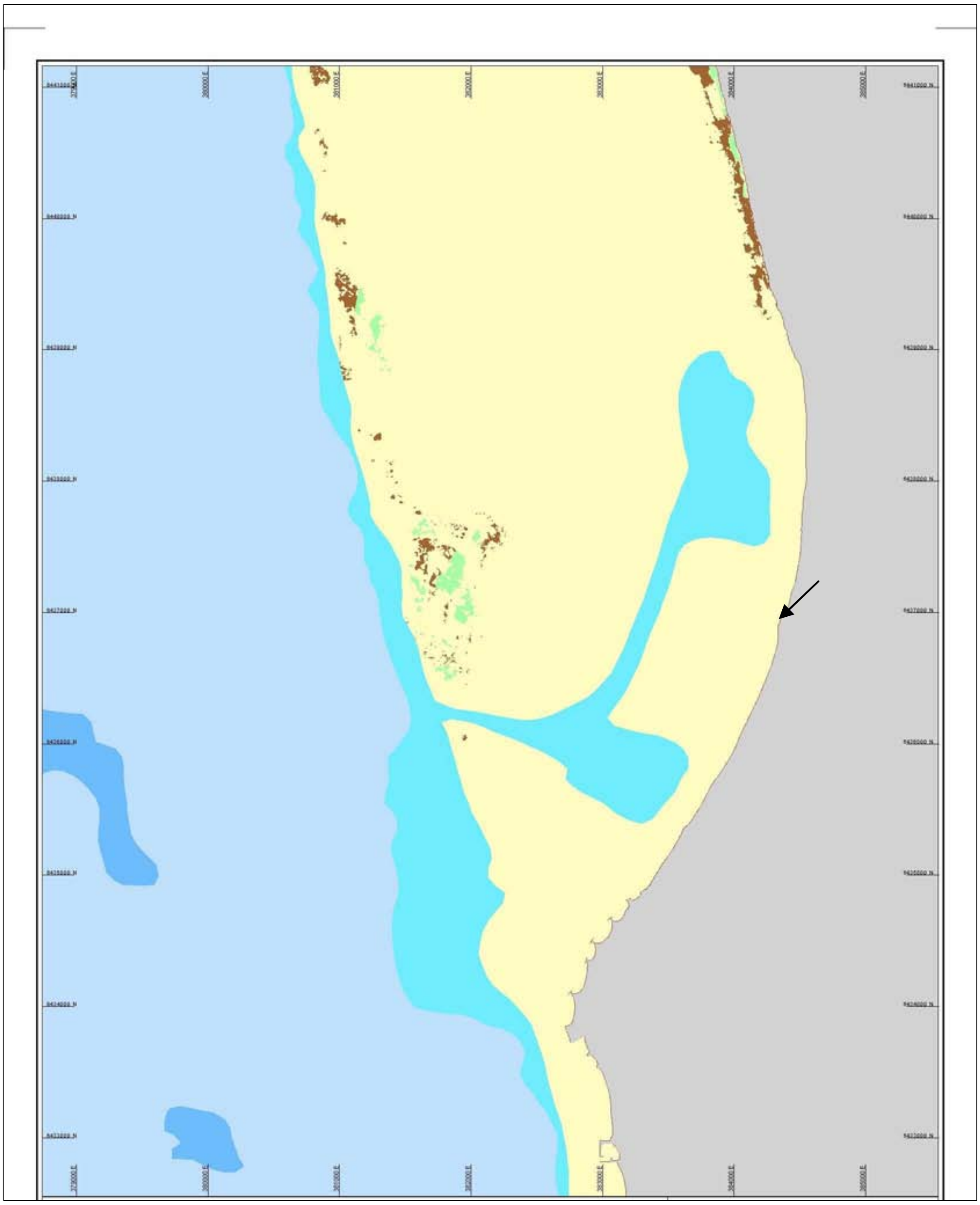


Figure 10 Benthic habitat in the vicinity of Western Power (yellow=sand, brown=reef, green =seagrass, blue=deeper than 10m)

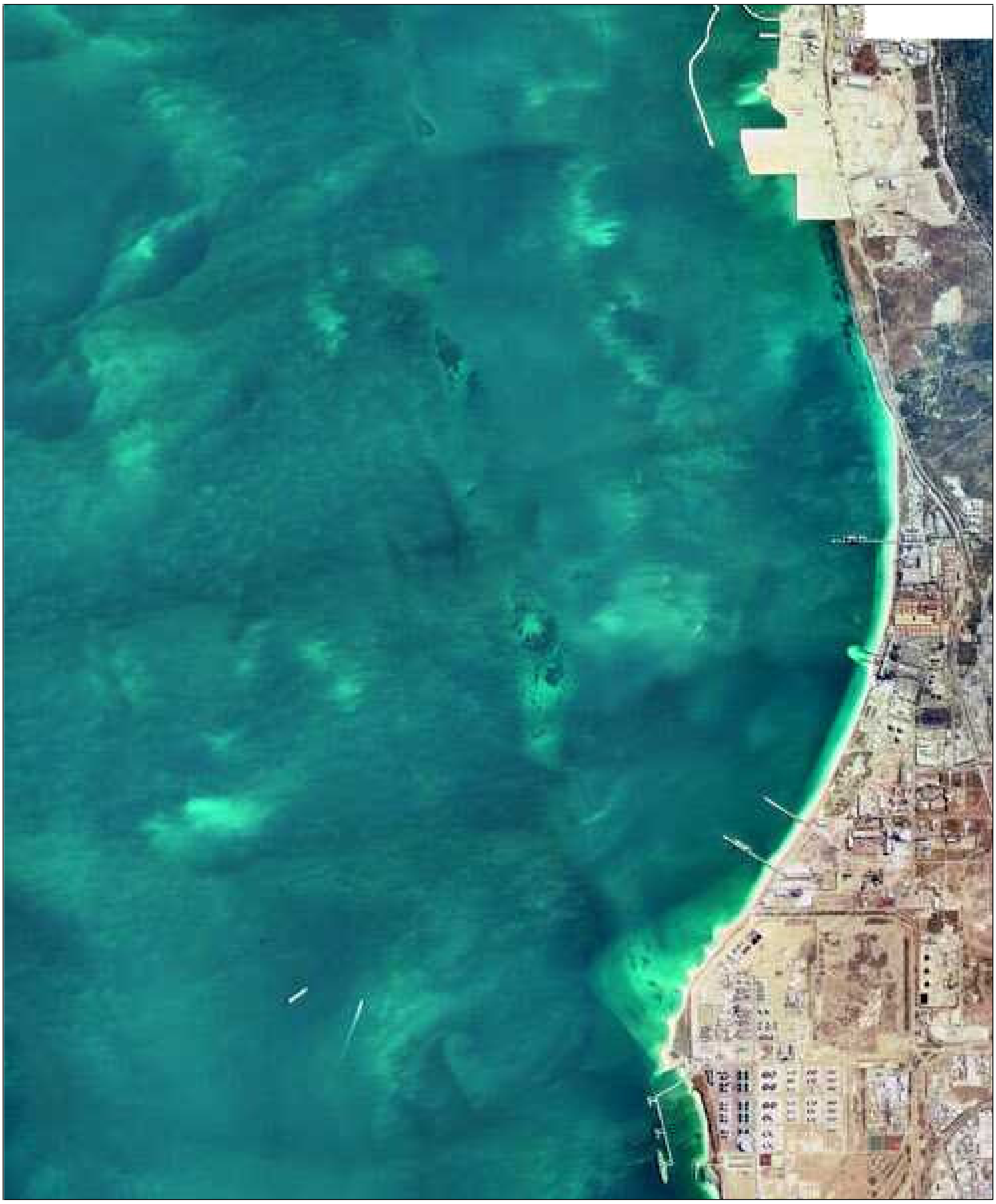


Figure 11 Aerial image of James Point and Western Power

4.1.6 Monitoring

The proponent has previously made the commitment to prepare a Water Quality Management Plan (WQMP), as part of the CEMP. The WQMP includes construction, operation and contingency plans.

A monitoring program will be prepared in consultation with the DoE to monitor the level of dilution and localised effects of the plant discharge through the diffuser array. The monitoring programme will be designed to be consistent with and compliment, as far as is practicable, the monitoring undertaken by the members of the Cockburn Sound Management Council.

The monitoring program will include:

- regular monitoring of the TDS (salinity), dissolved oxygen concentration and temperature of water surrounding the outlet, at a nearby reference site, and at a site in the deeper waters of Cockburn Sound;
- biological monitoring of sediments in the vicinity of the diffuser pre and post plant operation;
- testing of the Western Power discharge water prior to its use in the desalination plant to ensure it's suitability in the event that Western Power cooling water is used. Analysis shall be of sufficient accuracy and precision to enable comparison with appropriate standards and criteria for Cockburn Sound;
- field measurements of salinity to ensure that the diffuser is performing to specifications and achieving the required level of dilution;
- an annual inspection programme to check the physical integrity of the outlet pipe and diffuser; and
- Testing of the discharge for toxicity to marine life in accordance with ANZECC/ARMCANZ (2000) whole effluent toxicity protocols, at various concentration levels will be undertaken and the results reported to the DoE. This testing will be done as soon as is reasonably practicable (i.e. when the chemicals to be used and their likely dosing rates are known to a reasonable level of certainty). Testing will also be conducted 12 months after start up. The objective is to ensure that the discharge complies with the requirements of the Cockburn Sound Environmental Protection Policy and the Revised Environmental Equality Criteria Reference Document (Cockburn Sound).

4.1.7 Outcome

A mixing zone of 100 m in width around the seawater outlet would allow the EPA's salinity guideline value to be met at the edge of the mixing zone. As this mixing zone is already within the Western Power LEPA there will be no net change in the current cumulative sum of the LEPAs within Cockburn Sound. Salinity impacts will be monitored and reported to the DoE.

There will be no exceedence of the EPA's temperature guideline value. Temperature effects will be monitored and reported to the DoE.

Bottom dissolved oxygen levels will meet the EPA's guideline value. Effects on bottom dissolved oxygen levels will be monitored and reported to the DoE.

The Water Corporation will undertake investigations of the quality of Western Power's cooling water prior to using this water as source water for the desalination plant.

There is considered to be a very low risk of contamination arising from use of antiscalants in the desalination plant. The Water Corporation is committed to undertaking whole effluent toxicity testing of the desalination reject water in accordance with the protocols established by ANZECC/ARMCANZ (2000) and reporting the results to the DoE.

The final designs and installation procedures for the intake and outlet pipe and diffuser will be specified within the CEMP.

The seawater intake(s) will be screened to minimise risks to motile fauna and also to allow for safe operation of the facility.

There is considered to be a very low risk of short-circuiting and impacts on Western Power's operations. However, a salinity and temperature monitoring programme will be established and the results communicated to Western Power to confirm this assessment.

4.2 GREENHOUSE GAS EMISSIONS

4.2.1 Description of relevant changes

Greenhouse gas emissions due to the proposed changes do not require detailed assessment. Although energy requirements for the upgraded capacity plant are greater, greenhouse gas emissions are less than those for the approved 30 GL plant. Greenhouse gas emissions for the upgraded plant are estimated to be around 85,000 CO_2-equivalent tpa with an emission efficiency of 1.87 CO_2-e kg/kL.

For the original 30 GL/a plant, CO_2-e emissions were estimated to be 180,000 tpa for the KPS option based on sourcing 20 MW electricity from the state grid (EPA 2002c). However, since the preparation of the EPS for the original 30 GL/a Metropolitan Desalination Proposal environmental approval has been granted for Western Power to construct and operate a second 240 MW combined cycle gas turbine unit on the KPS site. The utilisation of a combined cycle plant will allow the discontinuation of coal firing at KPS in 2004, decreasing the emission factor for power sourced directly from gas fired generation facilities at the KPS from 1032 kg CO_2-e/MWh to 398 kg CO_2-e/MWh.

The following assumptions were made in the calculation of CO_2 emissions for the 45 GL/a plant consuming 25.6 MW:

- all electricity required for plant operation is sourced from KPS after its full conversion to gas firing;
- a greenhouse gas emissions factor for KPS electricity of 398 kg of CO_2/MWh (EPA 2003);
- all emissions from water pumping upstream of Thomson's Lake reservoir are included;
- methodology on estimation of CO_2-e emissions was sourced from Greenhouse Challenge – Factors and Methods Workbook, Version 3 (Australian Greenhouse Office 2003) and emission factors sources from EPA Bulletin 1086; and
- emissions of greenhouse gases, including those resulting from the emission of methane and nitrous oxide, are included in the greenhouse gas emission factor for KPS electricity.

4.2.2 Proponent commitments

Proponent commitments in relation to greenhouse gas emissions remain as for the previously approved 30 GL/a plant:

- Prepare a greenhouse management plan that will include:
    - use of sources of renewable energy as far as is practicable;
    - calculation of the greenhouse gas emissions associated with the proposal, as indicated in "Minimising Greenhouse Gas Emissions, Guidance for the Assessment of Environmental Factors, No 12" published the Environmental Protection Authority;
    - specific measures to minimise the greenhouse gas emissions associated with the proposal;
    - monitoring of greenhouse gas emissions;
    - estimation of the greenhouse gas efficiency of the proposal in comparison with the efficiencies of other comparable projects producing a similar product; and
    - an analysis of the extent to which the proposal meets the requirements of the National Strategy using a combination of:
        - "no regrets" measures,
        - "beyond no regrets" measures,

- land use change or forestry offsets, and
- international flexibility mechanisms.

5. MANAGEMENT OF OTHER ENVIRONMENTAL IMPACTS

Proposed changes to the desalination project are not considered to have any additional impact, or require further mitigation than has been proposed in the original EPS for the following environmental factors:

- terrestrial fauna and fauna at the proposed desalination plant site and along the proposed pipeline route;
- noise emissions due to plant operation;
- heritage values of the proposed plant site, pipeline route and Cockburn Sound; and
- public safety and risk as it may be affected by the storage of chemical required for plant operation.

In addition to the environmental factors above, a number of other factors were identified as being significant, but not considered key environmental factors requiring detailed assessment in the context of the environmental implications of the original EPS proposal. These were

- dust and traffic generated during construction of plant and infrastructure;
- visual appearance of plant and infrastructure – visual amenity; and
- recreational use of Cockburn Sound.

A summary of management of these factors is given in Appendix 1.

6. CONSULTATIVE ENVIRONMENTAL MANAGEMENT PLAN

A detailed Consultative Environmental Management Plan (CEMP) will be prepared in consultation with stakeholders and will address and implement the proponents commitments provided in the original EPS and this section 46 review document.

The CEMP is to comprise several component environmental management plans that address all environmental factors during construction and operational phases of the proposal. For each environmental factor, component environmental management plans will:

- define management objectives;
- describe management measures required to give effect to the environmental commitments and to achieve environmental objectives;
- provide a description of monitoring and key performance criteria for meeting environmental commitments and objectives;
- describe contingency measures to be implemented in the face of unexpected or unacceptable environmental impacts; and
- outline responsibilities and timing of implementation of described measures.

The CEMP will include an assessment of risk, audits of compliance with conditions and commitments and performance of environmental management plans and programs.

The CEMP is proposed to be reviewed on an annual basis by the Water Corporation to update management measures if monitoring and audit show this to be required.

6.1 PROPOSAL COMMITMENTS

A number of commitments relating to both the construction and operating phases of the project have been made by the Water Corporation. A summary of commitments, to be addressed in component environmental management plans is given in Table 14.

Table 14: Summary of proponent commitments

No	Commitment	Objective	Action	Timing	Advice
1	Consultative Environmental Management Plan (CEMP)	To minimise environmental impacts from implementation of the proposal	Prepare a CEMP which addresses the following; • Water Quality Management Plan to include: • procedures to mitigate potential impacts of construction of the discharge pipeline and intake; • a monitoring program for TDS (salinity), temperature and DO (dissolved oxygen) of water surrounding the discharge site, a nearby reference site, and a site in the deeper waters of Cockburn Sound. • A monitoring programme to ensure that the diffuser is performing to specifications and achieving the required level of dilution. • Monitoring of sediment habitat pre and post commissioning; • a contingency plan that examines the risk of contamination and procedures to mitigate any unanticipated impacts; and • Flora and Fauna Management Plan to include:	Within four months following a decision to construct	DoE Key stakeholders (e.g. DoE Marine Branch for WQMP, CALM for flora and fauna, DoE Air Quality Manage-ment Branch for greenhouse gas, and DoE Noise Managemen t Branch for noise

No	Commitment	Objective	Action	Timing	Advice
			• locating the plant and pipelines to minimise clearing and effects on conservation values; • mitigating impacts on Priority Flora; • Dieback management measures; and • weed control measures. • Greenhouse gas management plan as part of the CEMP that will include: • use of sources of renewable energy as far as is practicable; • calculation of the greenhouse gas emissions associated with the proposal, as indicated in "Minimising Greenhouse Gas Emissions, Guidance for the Assessment of Environmental Factors, No 12" published the Environmental Protection Authority; • specific measures to minimise the greenhouse gas emissions associated with the proposal; • monitoring of greenhouse gas emissions; • estimation of the greenhouse gas efficiency of the proposal in comparison with the efficiencies of other comparable projects producing a similar product; and • an analysis of the extent to which the proposal meets the requirements of the National Strategy using a combination of: • "no regrets" measures, • "beyond no regrets" measures, • land use change or forestry offsets, and • international flexibility mechanisms. • Demonstration that Nitrogen Oxides emissions from a dedicated power plant at East Rockingham will comply with EPA Guidance 15 and the relevant NEPM. • Noise Management Plan that includes detailed modelling of noise emissions and cumulative affect of emissions. • Hazardous Materials Management Plan to minimise public risk from materials associated with the plant. • A contingency that includes an archaeological monitoring program in case Aboriginal heritage sites are discovered during construction. • A monitoring programme for Kwinana Power Station cooling water, if used as input water, will be conducted. Analysis shall be of sufficient accuracy and precision to enable comparison with appropriate standards and criteria for Cockburn Sound. • An annual inspection programme to check the physical integrity of the outlet pipe and diffuser.		issues).
2	Ocean outlet for seawater return	Achieve compliance with Cockburn Sound EPP and associated criteria	Locate and design the ocean outlet diffuser system to ensure the discharge complies with the requirements of the Cockburn Sound Environmental Protection Policy and the Revised Environmental Quality Criteria Reference Document (Cockburn Sound). The design to be certified by an expert as soon as the optimised design of the diffuser is available.	Prior to construction	EPA
3	Seawater return	Address impact issues	Obtain an expert assessment of the likely stratification build up and any subsequent dissolved oxygen effects in the deeper area of Cockburn Sound.	Within 3 months of approval and prior to construction	
4	Eco-toxicity	Demonstrate that the	Whole Effluent Toxicity (WET) testing of the high salinity seawater discharge including added	As soon as is	DoE

No	Commitment	Objective	Action	Timing	Advice
		discharge is environmentally safe	chemicals (anti-scalants and biocides) to be undertaken as soon as the chemicals to be used and their likely dosing rates are known to a reasonable level of certainty and 12 months after start up. Testing will follow ANZECC/ARMCANZ (2000) whole effluent toxicity protocols, at various concentration levels and the results will be reported to the DoE. The objective is to ensure that the discharge complies with the requirements of the Cockburn Sound Environmental Protection Policy and the Revised Environmental Quality Criteria Reference Document (Cockburn Sound).	practicable before construction and 12 months after start up.	
5	CEMP	Achieve objectives of Commitment 1	Implement CEMP	Before during and following construction	DoE CALM
6	Vegetation, Declared Rare and Priority Flora and Fauna Habitat	Protect vegetation, Declared Rare and Priority Flora and Fauna	Conduct a survey of product pipeline routes to determine final alignments to avoid areas identified by CALM or Department of Environmental Protection. Conduct detailed survey for Rare and Priority Flora, to contribute to the Flora and Fauna Management Plan.	Spring season before construction commences	CALM
7	Aboriginal heritage	Address heritage issues	Consult with regional and local Aboriginal organisations and conduct site inspections to determine issues	Before and during construction	
8	Aboriginal heritage	Address impact issues	Submit a section 18 application to develop into Cockburn Sound to the Aboriginal Cultural Materials Committee	Before construction	DIA
9	Nitrogen loading to Cockburn Sound	Address impact issues	Develop a strategic management plan to ensure that the net total nitrogen loads to Cockburn Sound associated with Water Corporation activities are reduced relative to baseline loadings in the long term. Baseline loadings will be those estimated for 2003 unless higher loadings are approved by the EPA. The strategic management plan will be developed in consultation with the Cockburn Sound Management Council and will be submitted to the EPA for approval.	Before construction	CSMC
10	Nitrogen loading to Cockburn Sound	Address impact issues	Nitrogen free alternatives will be used for process chemicals where appropriate and practicable.	During operation	

7. CONCLUSIONS

Following are the conclusions that have been developed during the course of the investigations, study and preparation of this section 46 review document.

- Of the seven significant environmental factors identified for the original proposal only the factor of Cockburn Sound marine habitat and biota is considered significant for the proposed changes.
- Emissions of greenhouse gases due to the proposed changes have reduced from the approved 30 GL/a project because of the purchase of all electricity from KPS following its complete conversion to natural gas.
- Key stakeholders identified and included in the consultation program during preparation of the EPS were again consulted during preparation of this section 46 review document. Major issues of concern remained as for the approved project and include:
    - effects on the water quality of Cockburn Sound;
    - plant energy efficiency and emissions of greenhouse gases;
    - noise emissions; and
    - the fate of heavy metals and other contaminants that may be taken into the desalination plant.
- Management of all areas of concern raised during the consultation program will be addressed by mitigation proposed in this document, the original EPS, and in the Consultative Environmental Management Plan (CEMP).
- Computer modelling of Cockburn Sound incorporating the desalination plant intake and discharge demonstrates that the relevant Environmental Quality Guidelines for salinity and temperature are met by this proposal.
- Dissolved oxygen levels in Cockburn Sound will not be less than those associated with the originally approved desalination proposal.
- Nitrogen loads entering Cockburn Sound will increase by an additional 6 t/a and will not result in a measurable effect. In any case, the additional nitrogen load will be mitigated by other Water Corporation activities.
- There are no cumulative ecological effects on Cockburn Sound.
- There are no impacts on the social values (fishing and aquaculture, recreation and aesthetics and industrial water supply) ascribed to Cockburn Sound.
- The proposal avoids any known Aboriginal heritage sites. However, the Aboriginal community will be consulted and approval will be sought under section 18 of the Aboriginal Heritage Act to conduct works in Cockburn Sound.
- The Water Corporation will prepare the CEMP within four months following a decision to construct. The CEMP, which will consider stakeholder input, will address in detail the commitments associated with this project and will cover management of water quality, flora

and fauna, greenhouse gas, noise, and Aboriginal heritage issues. A pilot plant of around 1 MLD capacity will need to be built and operated prior to the CEMP being finalised.

- Overall, the upgrading of the capacity of the approved desalination plant from 30 to 45 GL/a will result in additional water for the State’s Integrated Water Supply Scheme at substantially less cost per volume of potable water produced while essentially having no environmental effects beyond those in the previously approved proposal.

8. AMENDMENT OF ENVIRONMENTAL CONDITIONS

The proponent is seeking to change conditions of Ministerial Statement 626 by amending project key characteristics and proponent commitments described in Schedules 1 and 2 of the Statement respectively. Proposed changes to the project key characteristics are provided in 8.1 below. The environmental commitments that are proposed by the proponent are provided in 8.2 below.

8.1 UPDATED SCHEDULE 1

The construction and operation of a seawater desalination plant at a site in the Kwinana/East Rockingham area, a pilot plant, and associated seawater intake and concentrated seawater discharge pipelines and product pipeline to Tamworth or Thompson Reservoir as specified in the key characteristics tables below (see tables 1 and 2).

The location of the plant and indicative product water pipeline alignments are shown in Figures 1 and 2 respectively (attached).

Table 1 Summary of key characteristics of the proposal

Characteristic	East Rockingham site	Kwinana Power Station site
Location	Cnr Office and Patterson roads	Kwinana Power Station
Capacity	30 GL/a	45 GL/a
Power requirement	20 MW	25.6 MW average demand
Power Source	Gas turbine/gas Engine or Western Power Grid	Kwinana Power Station
Clearing of vegetation required	2-3 ha degraded vegetation	Likely to be 2-3 ha of mostly completely degraded vegetation
Seawater intake	220 ML/d (average)	300 ML/d (weekly average)
Seawater intake pipelines		
Location (indicative)	See Figure 1	See Figure 2
Length (indicative)	3.1 km	0.8 km (potential to share with power station)
number	1	1
Diameter (indicative)	1400 mm	1500 mm
Concentrated seawater discharge		
volume	120 ML/day	180 ML/day (weekly average)
Salinity	65,000 mg/L	65,000 mg/L
Temperature	Less than 2^0C above ambient	No change if the dedicated intake is used. Use of KPS cooling water gives up to 13ºC above ambient (less than 0.3ºC after initial mixing)
Location of outlet	In 8m depth of water offshore from CBH Grains terminal	In 10m depth of water offshore from KPS site
Diffuser design	160m long, risers at 10 m spacings at 60° from horizontal, riser ports 200 mm in diameter	Around 80 – 180 m long. Design to be based upon an average initial dilution of 45
Product water pipeline		
Location (indicative)	See Figure 1	See Figure 2
Capacity	>100 ML/day	>150 ML/day
Length (indicative)	10 km	10 km
Number	1	1
Diameter (indicative)	900 mm	1000 mm
Destination	Tamworth Hill reservoir	Thompson Lake reservoir
Power station	20 MW gas turbine or gas engine power station	nil

Table 2 Key Proposal Characteristics – Power Station at East Rockingham Site

Characteristic	Gas turbine PS	Gas engine PS
Capacity	20 MW	20 MW
Fuel	Natural Gas	Natural gas
Cooling water	Seawater	Seawater
Plant	Two gas turbines	Five high efficiency reciprocating internal combustion engines
	One steam turbine	-
Air emissions		
Nitrogen oxides	4.56 g/s at 12.53% O_2	6.56 g/s at 10.6% O_2
Greenhouse gases (CO_2)	120,000 tonnes at normal operating load	80,000 tonnes at normal operating load
Vegetation clearing required	0.5 ha degraded vegetation	0.5 ha degraded vegetation

Figures (attached)

Figure 1 – Indicative location of desalination plant and pipeline infrastructure at the East Rockingham site
Figure 2 – Indicative location of desalination plant and pipeline infrastructure at the Kwinana Power Station site

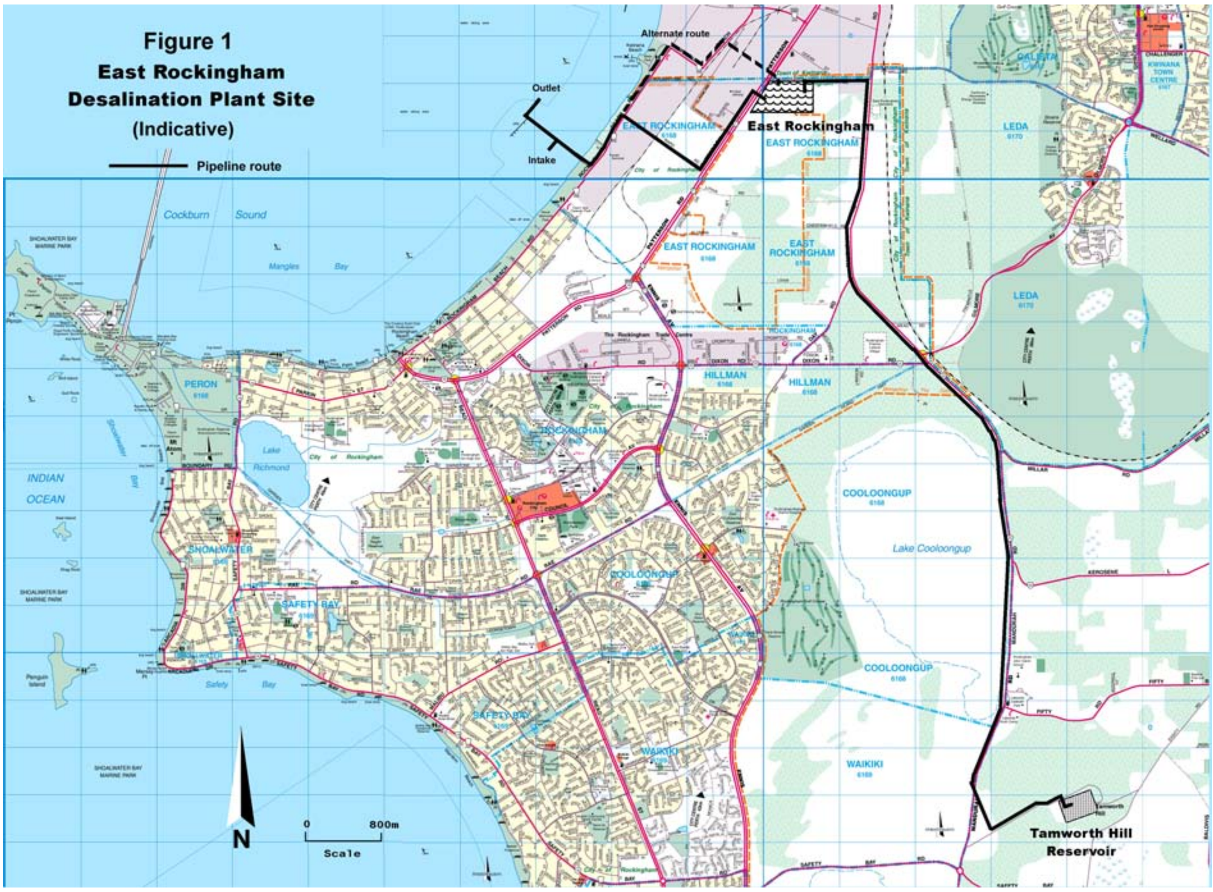


Figure 1: Indicative location of desalination plant and pipeline infrastructure at the East Rockingham site

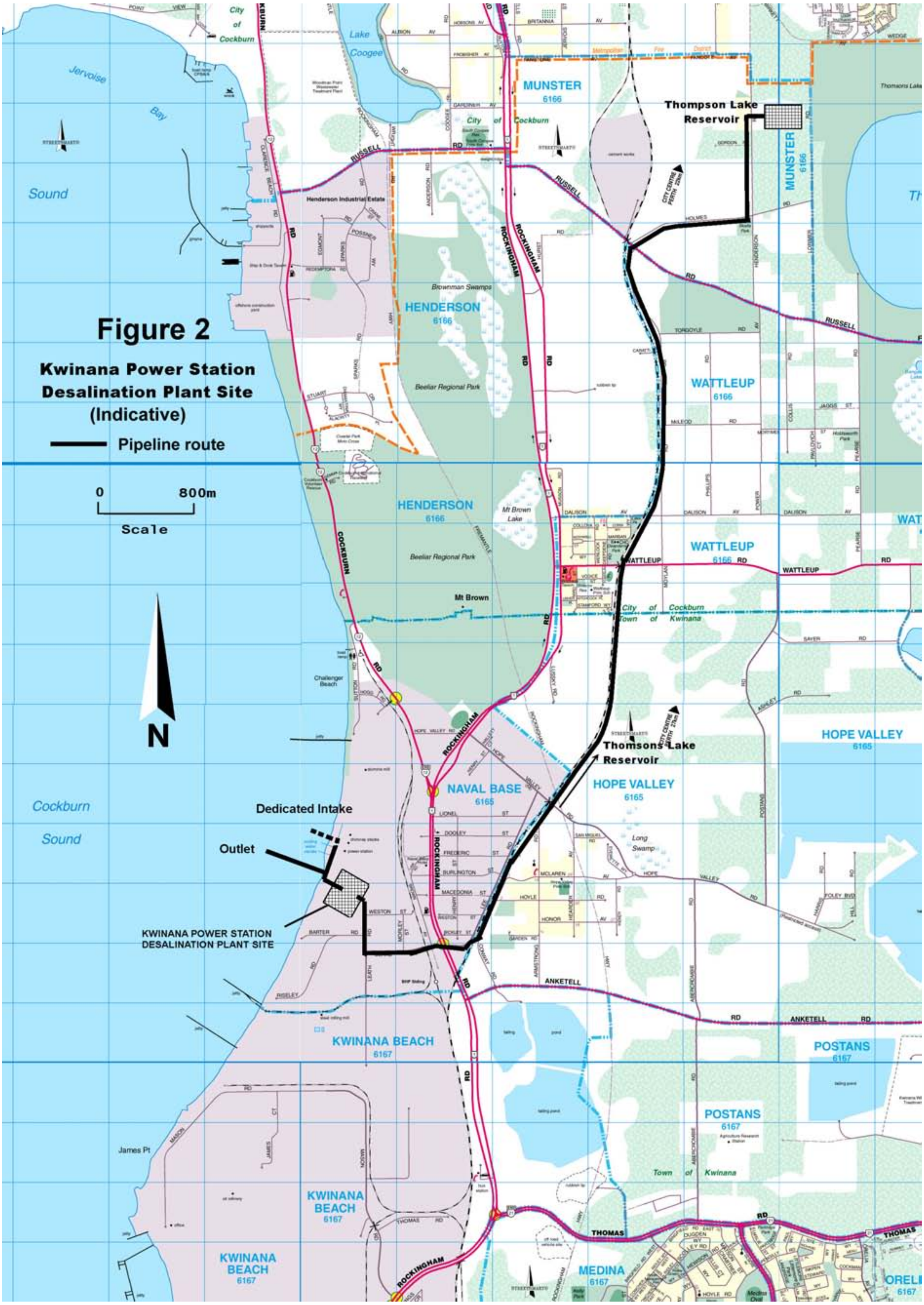


Figure 2: Indicative location of desalination plant and pipeline infrastructure at the Kwinana Power Station site.

8.2 UPDATED SCHEDULE 2

Proponent's Environmental Management Commitments – Perth Metropolitan Desalination Proposal

Note: The term "commitment" as used in this schedule includes the entire row of the table and its six separate parts as follows:

- a commitment number;
- a commitment topic;
- the objective of the commitment;
- the "action" to be undertaken by the proponent;
- the timing requirements of the commitment; and
- the body agency/agency to provide technical advice to the Department of Environmental Protection.

No	Commitment	Objective	Action	Timing	Advice

1	Consultative Environmental Management Plan (CEMP)	To minimise environmental impacts from implementation of the proposal	Prepare a CEMP which addresses the following;
			• Water Quality Management Plan to include:
			  • procedures to mitigate potential impacts of construction of the discharge pipeline and intake;
			  • a monitoring program for TDS (salinity), temperature and DO (dissolved oxygen) of water surrounding the discharge site, a nearby reference site, and a site in the deeper waters of Cockburn Sound.
			  • A monitoring programme to ensure that the diffuser is performing to specifications and achieving the required level of dilution.
			  • Monitoring of sediment habitat pre and post commissioning;
			  • a contingency plan that examines the risk of contamination and procedures to mitigate any unanticipated impacts; and
			• Flora and Fauna Management Plan to include:
			  • locating the plant and pipelines to minimise clearing and effects on conservation values;
			  • mitigating impacts on Priority Flora;
			  • Dieback management measures; and
			  • weed control measures.
			• Greenhouse gas management plan as part of the CEMP that will include:
			  • use of sources of renewable energy as far as is practicable;
			  • calculation of the greenhouse gas emissions associated with the proposal, as indicated in "Minimising Greenhouse Gas Emissions, Guidance for the Assessment of Environmental Factors, No 12" published the Environmental Protection Authority;
			  • specific measures to minimise the greenhouse gas emissions associated with the proposal;
			  • monitoring of greenhouse gas emissions;
			  • estimation of the greenhouse gas efficiency of the proposal in comparison with the efficiencies of other comparable projects producing a similar product; and
			  • an analysis of the extent to which the proposal meets the requirements of the National Strategy using a combination of:
			  • "no regrets" measures,
			  • "beyond no regrets" measures,
			  • land use change or forestry offsets, and
			  • international flexibility mechanisms.
			• Demonstration that Nitrogen Oxides emissions from a dedicated power plant at East Rockingham will comply with EPA Guidance 15 and the relevant NEPM.
			• Noise Management Plan that includes detailed modelling of noise emissions and cumulative affect of emissions.
			• Hazardous Materials Management Plan to minimise public risk from materials associated with the plant.
			• A contingency that includes an archaeological monitoring program in case Aboriginal heritage sites are discovered during construction.
			• A monitoring programme for Kwinana Power
				Within four months following a decision to construct	DoE
					Key stakeholders
					(e.g. DoE Marine Branch for WQMP, CALM for flora and fauna, DoE Air Quality Manage-ment Branch for greenhouse gas, and DoE Noise Managemen t Branch for noise issues).

No	Commitment	Objective	Action	Timing	Advice
			Station cooling water, if used as input water, will be conducted. Analysis shall be of sufficient accuracy and precision to enable comparison with appropriate standards and criteria for Cockburn Sound. • An annual inspection programme to check the physical integrity of the outlet pipe and diffuser.		
2	Ocean outlet for seawater return	Achieve compliance with Cockburn Sound EPP and associated criteria	Locate and design the ocean outlet diffuser system to ensure the discharge complies with the requirements of the Cockburn Sound Environmental Protection Policy and the Revised Environmental Quality Criteria Reference Document (Cockburn Sound). The design to be certified by an expert as soon as the optimised design of the diffuser is available.	Prior to construction	EPA
3	Seawater return	Address impact issues	Obtain an expert assessment of the likely stratification build up and any subsequent dissolved oxygen effects in the deeper area of Cockburn Sound.	Within 3 months of approval and prior to construction	
4	Eco-toxicity	Demonstrate that the discharge is environmentally safe	Whole Effluent Toxicity (WET) testing of the high salinity seawater discharge including added chemicals (anti-scalants and biocides) to be undertaken as soon as the chemicals to be used and their likely dosing rates are known to a reasonable level of certainty and 12 months after start up. Testing will follow ANZECC/ARMCANZ (2000) whole effluent toxicity protocols, at various concentration levels and the results will be reported to the DoE. The objective is to ensure that the discharge complies with the requirements of the Cockburn Sound Environmental Protection Policy and the Revised Environmental Quality Criteria Reference Document (Cockburn Sound).	As soon as is practicable before construction and 12 months after start up.	DoE
5	CEMP	Achieve objectives of Commitment 1	Implement CEMP	Before during and following construction	DoE CALM
6	Vegetation, Declared Rare and Priority Flora and Fauna Habitat	Protect vegetation, Declared Rare and Priority Flora and Fauna	Conduct a survey of product pipeline routes to determine final alignments to avoid areas identified by CALM or Department of Environmental Protection. Conduct detailed survey for Rare and Priority Flora, to contribute to the Flora and Fauna Management Plan.	Spring season before construction commences	CALM
7	Aboriginal heritage	Address heritage issues	Consult with regional and local Aboriginal organisations and conduct site inspections to determine issues	Before and during construction	
8	Aboriginal heritage	Address impact issues	Submit a section 18 application to develop into Cockburn Sound to the Aboriginal Cultural Materials Committee	Before construction	DIA
9	Nitrogen loading to Cockburn Sound	Address impact issues	Develop a strategic management plan to ensure that the net total nitrogen loads to Cockburn Sound associated with Water Corporation activities are reduced relative to baseline loadings in the long term. Baseline loadings will be those estimated for 2003 unless higher loadings are approved by the EPA. The strategic management plan will be developed in consultation with the Cockburn Sound Management Council and will be submitted to the EPA for approval.	Before construction	CSMC
10	Nitrogen loading to Cockburn Sound	Address impact issues	Nitrogen free alternatives will be used for process chemicals where appropriate and practicable.	During operation	

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Appendix 1

Management of environmental factors as proposed in the approved EPS

APPENDIX 1

MANAGEMENT OF ENVIRONMENTAL FACTORS AS PROPOSED IN THE APPROVED EPS

Factor	Description of factor	Environmental aspects	Management measures	Proponent commitments
Terrestrial flora and fauna	KPS site devoid of vegetation. Very little remnant bushland along or adjacent to product pipeline route.	▪ Clearing for plant construction and disturbance for pipeline construction. ▪ Operation of plant	Footprint of plant site may increase marginally but will remain within the 2-3 ha estimated clearing requirement and will not impact on any vegetation or fauna due to current status of the site. The product water pipeline is not proposed to be upsized. Potential impacts associated with pipeline construction will be managed as for the original proposal and includes: ▪ Aligning pipeline to sides of road with lowest vegetation values, both in aesthetic and ecological context. ▪ Conduct surveys for Rare and Priority Flora in the spring before construction. ▪ Conduct vegetation and fauna habitat surveys of product pipeline route to determine final alignment. ▪ Conduct dieback surveys along proposed pipeline route. ▪ Implementation of weed control measures during construction and rehabilitation. ▪ Rehabilitate pipeline easements immediately with species endemic to the area and any adjoining vegetation communities.	▪ Conduct vegetation and fauna habitat surveys of pipeline routes to determine final alignments. ▪ Conduct detailed surveys for Rare and Priority Flora during the spring before construction commences. ▪ Prepare Flora and Fauna Management plan as part of CEMP.
Noise	KPS site located well away from residential areas. No noise sensitive premises located in the vicinity of the KPS. The area potentially has increased environmental noise due to heavy industrial activity.	▪ Construction of plant and infrastructure. ▪ Operation of plant.	Increasing the number of modules in the desalination plant not anticipated to increase noise emissions. Management of noise emissions to remain as for original proposal and includes: ▪ Confining construction activities to day time only. ▪ Use of quietest available equipment. ▪ Construct screening walls around pumping equipment. ▪ Enclose facilities in acoustic enclosures.	▪ Prepare a noise management plan as part of the CEMP which would include modelling of noise emissions including examination of cumulative effect of noise emissions.

Factor	Description of factor	Environmental aspects	Management measures	Proponent commitments
Aboriginal heritage	Potential for dune systems to contain skeletal or other archaeological material. Cockburn Sound is a listed mythological site.	▪ Disturbance of land during construction ▪ Disturbance of seabed during construction of marine based infrastructure ▪ Discharge to Cockburn Sound.	No additional impact associated with change to proposal. Management to remain as for original proposal and includes: ▪ Consultation with Aboriginal community. ▪ Developing contingency plans in the event that archaeological material is located during construction.	▪ Consult with regional and local Aboriginal organisations and do site inspections to determine issues before construction. ▪ Submit a section 18 application to construct structures in Cockburn Sound to the Aboriginal Cultural Materials Committee. ▪ Prepare a contingency plan that includes an archaeological monitoring program in case aboriginal heritage sites are discovered during construction.
Public safety and risk	KPS site located within heavy industrial area.	▪ Storage and handling of potentially hazardous materials. ▪ Construction of plant and pipelines.	Increasing plant capacity may require storage of greater quantity of chemicals on site. No additional impact associated with change to proposal. Management to remain as for original proposal and include: ▪ Storage of chlorine, if required, in contained area with DoIR review of facility design. ▪ Other potentially hazardous materials to be stored outside in dedicated facilities with appropriate separation and in compliance with Dangerous Goods Regulations. ▪ Construction activities may pose a risk to public safety. The are is part of a designated industrial exclusion zone that runs from Challenge Beach to Kwinana Beach. Management will include measures to restrict public access to the land, foreshore and marine based construction area.	▪ Prepare a hazardous materials management plan as part of the CEMP. ▪ Construction management plan to be prepared as a component of the CEMP.

Factor	Description of factor	Environmental aspects	Management measures	Proponent commitments
Dust and traffic	KPS site located within heavy industrial area with high existing traffic volumes. Off-site dust levels of 1,000 $\mu g/m^3$ (15-minute average) prescribed in Kwinana EPP.	▪ Construction of plant and pipelines	Dust generation during construction expected to be minimal due to relatively small area to be disturbed. Management measures to remain as for original proposal and includes: ▪ Use of dust suppression measures such as watering during plant and pipeline construction. ▪ Minimise clearing to avoid large areas of exposed and potentially erosive sands. ▪ Rehabilitation of disturbed areas following construction. Traffic generated during construction anticipated to be insignificant compared with current traffic volume in area. If required, transport of equipment to be managed by: ▪ Transporting large equipment during periods of low traffic volume.	n/a
Visual appearance	KPS site located within heavy industrial area.	▪ Location of plant	Desalination facilities to be located in several site buildings. Given the location of the plant within developed industrial area the plant is not considered to have any adverse impact of visual amenity. Management to remain as for original proposal and includes: ▪ Buildings to have flat store or warehouse type roofs. ▪ Grounds surrounding plant to be landscaped and native vegetation established around buildings.	n/a
Recreational use of Cockburn Sound	Cockburn Sound is an important focus for recreational activities, both shore based and marine. Industrial exclusion zone exists between Kwinana and Challenger Beaches.	▪ Construction of plant and infrastructure. ▪ Discharge of concentrated seawater. ▪ Intake of seawater.	Facilities and operation not anticipated to have any impact on the recreational amenity, particularly when considering restricted public and boating access to the area. Management to remain as for original proposal and includes: ▪ Minimising working area for construction of any marine based infrastructure. ▪ Use of diffuser to discharge concentrated seawater.	n/a