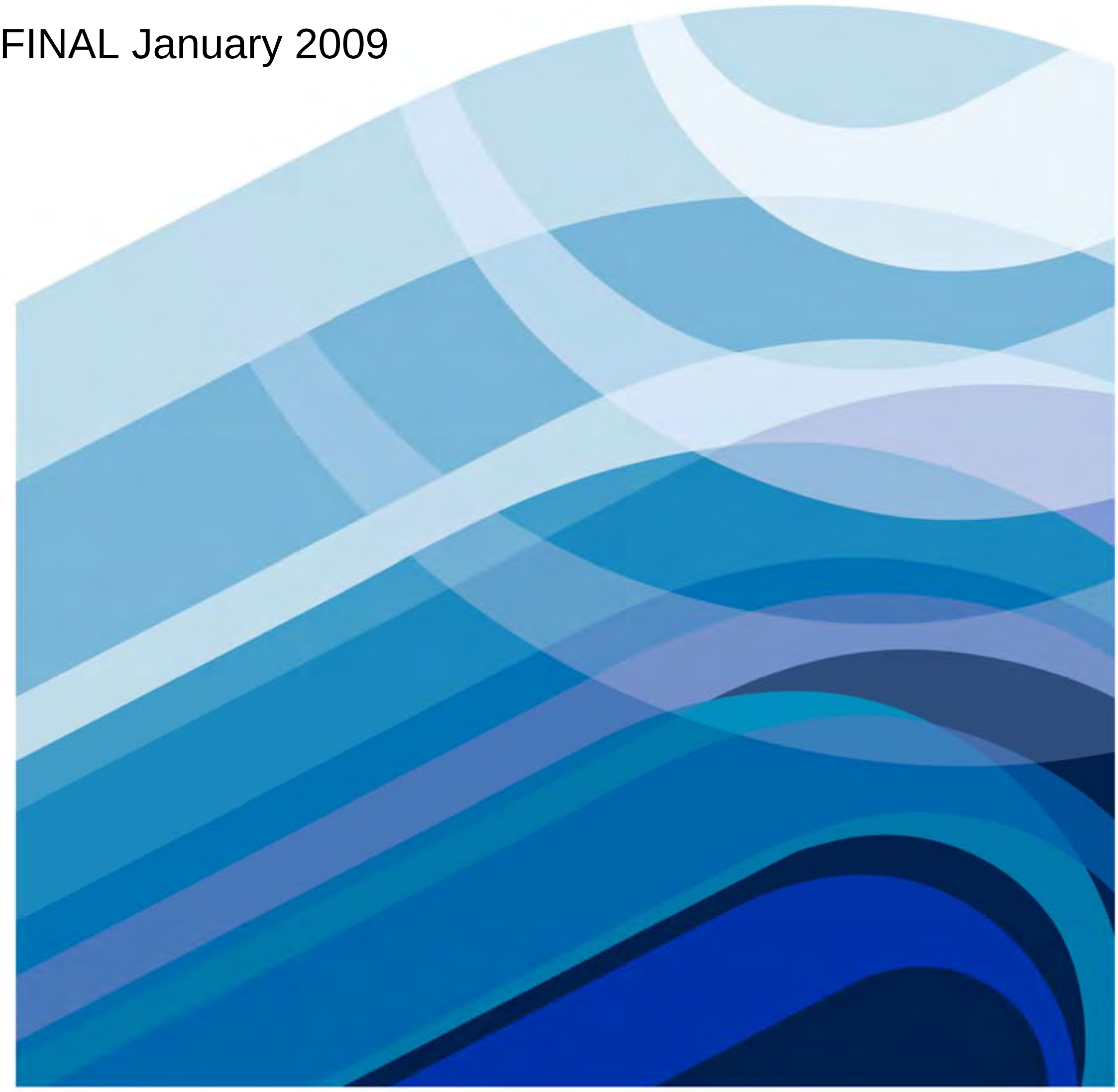
Southern Seawater Desalination Project

Operational Environmental Management Framework

FINAL January 2009



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1.0 Overview

1.1 Project Outline

The Water Corporation is a public utility of the State Government of Western Australia responsible for public water supply in accordance with the *Water Corporation Act 1995* (WA) and associated legislation. The Water Corporation's Southern Seawater Desalination Project (SSDP) is considered critical infrastructure for public water supply to the Integrated Water Supply Scheme (IWSS) by the Government of Western Australia.

The Southern Seawater Desalination Project involves the construction and operation of:

- A reverse osmosis seawater desalination plant to produce Up to 100 GL/y, located at Lots 32 and 33 and Part Lot 8 on Taranto Road in the Shire of Harvey (approximately 140km south of Perth). The plant will include:
    - up to four submerged seawater intake pipelines extending up to 600m offshore;
    - a seawater pump station;
    - storage facilities for chemicals;
    - dual media filters (including backwash tanks) and drying beds;
    - a reverse osmosis building;
    - potabilisation and storage facilities for associated process chemicals;
    - drinking water storage tank(s) and pump station(s);
    - up to four seawater brine outlets with diffusers extending up to 1100m offshore; and
    - site amenity buildings for purposes including administration, plant operations control, laboratory, workshop and general storage.
- 100ML water storage facility (in up to 4 storage tanks) with up to 5ML sump located north-east of the town settlement in the Shire of Harvey.
- Approximately 30km of 1400mm diameter cement-lined steel pipeline to connect the plant to the storage facility, and the storage facility to the existing Stirling Trunk Main of the Integrated Water Supply System (IWSS).

The Southern Seawater Desalination Project will be developed in stages. The initial construction and operation for a plant with the production capacity of 50 GL/y and with one water storage tank up to 32 ML capacity. All terrestrial and marine pipelines will be constructed for 100 GL/y capacity at the initial stage of construction including all earthworks. The capacity of the plant and water storage facility will be increased as water supply demand increases.

A map identifying showing the location of the plant, and associated infrastructure is shown in **Figure 1.1**.

The Southern Seawater Desalination Project will produce drinking quality water from seawater abstracted via the inlet pipe. The desalination process allows for the recovery of approximately 42% of the volume of the seawater as drinking water with the remaining water being discharged as a waste brine solution. This brine will be approximately twice as saline as the feed water (i.e. seawater).

The intake pipelines will extend from the shore up to 600m offshore and the outlet pipelines up to 1100m offshore. The outlet pipe discharge system will include multi-port diffuser(s) which will facilitate mixing in the Low Ecological Protection Area (LEPA) surrounding the outlet diffuser(s) (see Figure 1.2). The multi-port outfall is designed to reduce the salinity increase to 1 ppt or less above ambient conditions at the boundary of the LEPA. The LEPA is surrounded by a High Ecological Protection Area (HEPA). LEPAs and HEPAs are defined in the State Environmental (Cockburn Sound) Policy 2005 (Government of Western Australia, 2005).

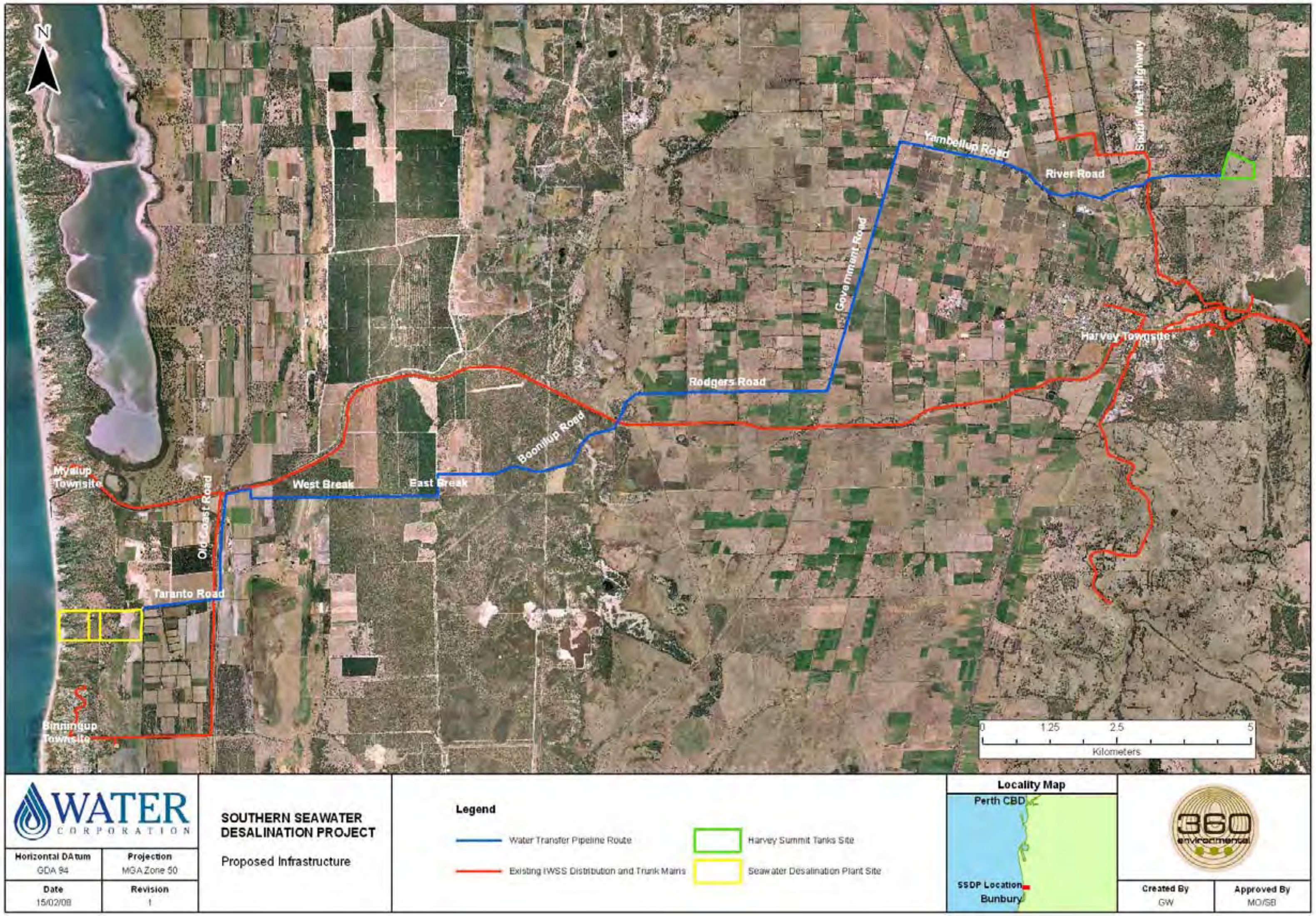

Figure 1.1 Overview map showing project infrastructure

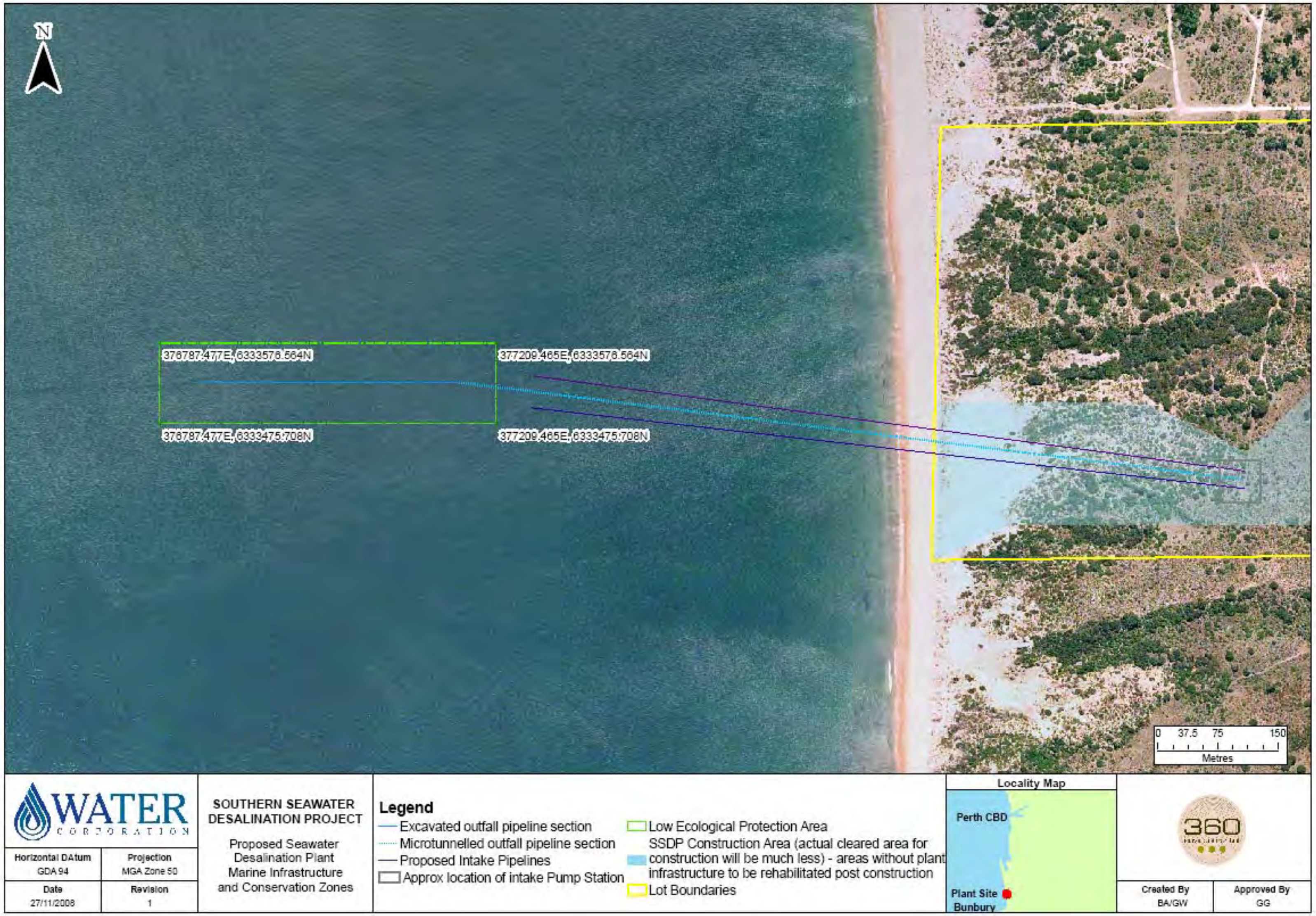

Figure 1.2 Schematic of the outlet and the Low Ecological Protection Area (LEPA) surrounding the diffuser(s)

1.2 Purpose of this OEMF

This Operation Environmental Management Framework (OEMF) contains the following management plans:

1. Whole Effluent Toxicity Testing Management (Section 4.0)
2. Diffuser Performance Monitoring (Section 5.0).
3. Discharge Water Quality Monitoring (Section 6.0).
4. Benthic Habitat Monitoring (Section 7.0)
5. Chemical and Dangerous Goods Management Plan (Section 8.0).
6. Waste Management Plan (Section 9.0).

These plans outline the actions that will be implemented to minimise any potential impacts on the environment associated with the operation of the Southern Seawater Desalination Plant. It is a primary objective that all environmental impacts during operation are avoided or minimised as far as practicable.

It is the purpose of this OEMF to:

1. meet statutory environmental requirements for the project;
2. identify actions to manage impacts on the environment that may occur as a result of operational activities; and
3. demonstrate transparency and accountability to community and government by identifying environmental management actions and making this OEMF publicly available.

1.2.1 Environmental Requirements of OEMF

This OEMF focuses on the management actions to be implemented during operation by operational staff. Supporting information is available upon request, or is contained in the Environmental Impact Assessment (Public Environmental Review) document available at www.watercorporation.com.au.

This OEMF will be further developed with the assistance of the relevant stakeholders for each component of the management plan. Stakeholders will be consulted during the Environmental Impact Assessment (Public Environmental Review) so that they have the opportunity to provide input into the project's environmental management actions.

1.3 Specifications

The materials and methodology stated in this plan are correct as of the publication date. The following changes to materials and methodologies will not invalidate this plan:

1. Changes to materials that do not result in additional or different environmental impacts.
2. Minor changes to methodologies that do not lessen environmental monitoring and/or additional or result in different environmental impact.

Changes to the materials or methodology that may result in reduced monitoring and/or cause a significant environmental impact will be referred to the relevant advisory agencies prior to implementation of the change.

This plan should be read in conjunction with the applicable Ministerial Conditions and other regulatory approvals (e.g. Works Approval, Licence).

1.4 Implementation of Contingency Actions

The OEMF outlines a number of contingency actions that may be used in the event that the management actions proposed do not achieve the purpose stated in each management plan.

1.5 OEMF Training

All staff involved in the operation of the SSDP Plant will receive training on relevant management plans within this OEMF. The names of the people trained on this OEMF will be recorded in an

OEMF Training Log along with the date and the specific plans for which that training was conducted.

1.6 Environment Policy

This OEMF is consistent with the Water Corporation's Environmental Policy (see Appendix 1). The policy can be found at the Water Corporation's website www.watercorporation.com.au.

1.7 Infrastructure Operation

This OEMF addresses matters related to operation. A separate Construction Environmental Management Framework (CEMF) contains management plans relating to construction.

1.8 Amendments arising from Public Environmental Review

This document may be amended following assessment of the Public Environmental Review. This document (as amended) will be made publicly available on the Water Corporation's website prior to operation.

2.0 Definitions

The terms used in this OEMF have the following meanings:

Brine or Brine Stream means the seawater concentrate from the reverse osmosis treatment process

Bund means an embankment of earth or a wall constructed of brick, stone or concrete to form the perimeter of a compound that will prevent lateral movement of the material contained within the embankment or wall.

CTD is the abbreviation for a conductivity/ temperature/ depth profiler.

Desalination Effluent means the effluent that is being discharged via the outlet pipeline and diffuser(s). Typically the desalination effluent will consist of the brine stream or a combination of the brine stream and injected seawater (the seawater being injected to increase dilution) plus any chemicals used in the treatment process.

EC10 is an estimate of the concentration causing an observable adverse effect on 10% of the population of a test organism.

EC50 is an estimate of the concentration that causes an observable adverse effect on 50% of the population of a test organism; Germination-concentration that results in 50% germination of zoospores; Larval development- concentration that results in 50% of larva deformed; Reproduction-concentration that results in 50% less fecundity when compared to controls.

High Ecological Protection Area is defined in the State Environmental (Cockburn Sound) Policy 2005 (Government of Western Australia, 2005) as an area afforded high protection in which small changes are allowed to the quality of water, sediment or biota (i.e. small changes in contaminant concentrations with no resultant detectable changes beyond natural variation in the diversity of species and biological communities, ecosystem processes and abundance/biomass of marine life).

IC10 is an acronym for "Inhibition Concentration 10%", which is the concentration required to inhibit 10% of a parameter such as growth or luminescence in a test organism.

IC50 is an acronym for "Inhibition Concentration 50%", which is the concentration required to inhibit 50% of a parameter such as growth or luminescence in a test organism. Typically a reduction in a biological response when compared with controls (e.g. Growth: Concentration that results in 50% less growth when compared to controls);

Limit of Reporting – the lowest concentration of an analyte that can be determined with an acceptable precision and accuracy.

LOEC - Lowest Observed Effect Concentration Function of concentration tested

Low Ecological Protection Area is defined in the State Environmental (Cockburn Sound) Policy 2005 (Government of Western Australia, 2005) as an area in which large changes are allowed to the quality of water, sediment or biota (i.e. large changes in contaminant concentrations that could cause large changes beyond natural variation in the natural diversity of species and biological communities, rates of ecosystem processes and abundance/biomass of marine life, but which do not result in bioaccumulation/biomagnification in near-by high ecological protection areas).

NOEC - No Observed Effect Concentration

Plant site means the site of the seawater desalination plant including Lots 32 & 33 Taranto Road Binningup, Part Lot 8 (to the southern boundary of Lots 32 and 33) Taranto Road Binningup, and includes the seawater pipelines located on part of Reserve 29628 (to the southern boundary of Lots 32 and 33) and the Indian Ocean (to the southern and northern boundaries of Lots 32 and 33) to a nominal distance of 1100m out to sea.

Pollution means the direct or indirect alteration of the environment to its detriment or degradation, to the detriment of an environmental value, or is of a prescribed kind from an emission (as defined by the *Environmental Protection Act 1986* (WA)).

Pycnocline is a region where decreasing temperature and salinity with depth results in corresponding increases in density.

3.0 Abbreviations

The following abbreviations used in this OEMF have the following meanings:

Terms

ANZECC	Australia and New Zealand Environment and Conservation Council
APHA	American Public Health Association
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASTM	American Society for Testing and Materials
AQIS	Australian Quarantine and Inspection Service
OEMF	Operational Environmental Management Framework
DAF	Department of Agriculture and Food (WA)
DEC	Department of Environment and Conservation (WA)
DEWHA	Department of Environment, Water, Heritage and the Arts (Commonwealth)
DIA	Department of Indigenous Affairs (WA)
DoCEP	Department of Consumer and Employment Protection (WA)
DoF	Department of Fisheries (WA)
DoH	Department of Health (WA)
DoW	Department of Water (WA)
DPI	Department for Planning and Infrastructure (WA)
FESA	Fire and Emergency Services Authority (WA)
FPC	Forest Products Commission (WA)
HEPA	High ecological protection area
IWSS	Integrated Water Supply Scheme
LEPA	Low ecological protection area
LOR	Limit of Reporting
MRWA	Main Roads Western Australia
MSDS	Materials Safety Data Sheet
NATA	National Association of Testing Authorities
OC	Organochlorine
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
WAPC	Western Australian Planning Commission
WET	Whole effluent toxicity

Measurement

cm	Centimetre
dB	Decibels of noise
GL/y	Gigalitres per year
ha	Hectare
kg	Kilograms
kg/ha	Kilograms per hectare
km	Kilometre
m	Metre
m^2	Square metre
mg/kg	Milligrams per kilogram
mg/L	Milligrams per litre
ML	Megalitre
ML/y	Megalitres per year
^oC	Temperature in degrees Celsius
ppt	Parts per thousand
psu	Practical salinity units (equivalent to ppt for practical purposes)

4.0 Whole Effluent Toxicity Testing Management

4.1 Context

A whole effluent toxicity (WET) testing methodology was developed for the Perth Seawater Desalination Plant to compare the discharge with the specifications in the Cockburn Sound Environmental Protection Policy (Government of Western Australia, 2005) and the supporting Manual of Standard Operating Procedures for monitoring against the Cockburn Sound Environmental Quality Criteria (2003-2004) (EPA, 2005). This methodology has been adopted (with some minor modifications based on accumulated learning from the testing of the Perth Seawater Desalination Plant desalination effluent) for the Southern Seawater Desalination Project.

The use of living test organisms (i.e. WET testing) is a reliable way to measure the potential biological impacts of the brine discharge on the surrounding environment. Indigenous organisms are chosen to maximise the relevance of the test results for the system under consideration.

4.2 Purpose

The purpose of this WET testing is to compare the discharge from the desalination plant with the ecosystem protection target at its boundary with the low ecological protection area (LEPA) surrounding the ocean outlet diffuser(s). WET testing methodology is based on the principles in USEPA (2003a, 2003b), APHA (1989) and ASTM (1998) protocols. Testing will be conducted at a NATA accredited laboratory in accordance with ANZECC/ARMCANZ (2000) whole effluent toxicity protocols.

4.3 Performance Indicators

1. Design/actual dilution compared to dilution determined using EC10 (the concentration that causes an effect on 10% of the population) and IC10 (inhibition concentration 10%) values obtained from each WET test.

4.4 Management Actions

4.4.1 Sampling Design

1. WET testing of the desalination plant discharge will occur twice[1] during operation using a sample obtained:
    a. Within three (3) months of establishment of a brine discharge, and
    b. Twelve (12) months after establishment of a brine discharge.
2. The following tests will comprise the WET testing:
    a. 15 minute Microtox test using the marine bacteria *Vibrio fischeri*;
    b. 48 hour macroalgal germination test using the marine brown kelp *Ecklonia radiata*;
    c. 48 hour mussel larval development test using the marine blue mussel *Mytilis edulis;*
    d. 72 hour algal growth test using the unicellular marine alga *Isochrysis galbana;*
    e. 24 Day copepod reproduction test using the estuarine copepod *Gladioferens imparipes;* and
    f. 7 day larval fish growth test using the marine fish pink snapper *Pagrus auratus.*
3. Testing will follow the WET methodology (section 4.5).
4. Reports will be submitted to the DEC for the WET tests conducted as per 1(a) and 1(b). These reports will contain:
    a. Explanation of methodology and approach.
    b. Presentation and discussion of results for the tests 2(a) to 2(f).

c. A discussion of any instances where WET testing indicates that the design dilution of the discharge at the boundary of the LEPA 80% species protection target and the HEPA 95% species protection target [2].

4.4.2 Microtox Test

5. The 15 minute Microtox test will be used as a range finding test to ensure that the concentrations selected for the chronic bioassays will bracket the EC50. The 15 minute acute toxicity test using the growth of the luminescent marine bacteria *Vibrio fischeri* will be based on the method listed in the Microtox Manual: A Toxicity Testing Handbook, Microbics, 1992[3].

4.4.3 Microalgae[4]

6. The 72 hour sub-chronic toxicity test using the growth of the marine alga *Isochrysis galbana* will be based on the method described by Stauber *et al.* (1994).
7. Tests will be performed in a temperature controlled laboratory using untreated microplates, which will be rinsed with dilution water prior to testing.
8. A filtered seawater control will be tested concurrently. A number of concentrations will be tested with four replicates each. The concentrations will be based on the results of the Microtox *Vibrio fischeri* test.
9. After 72 hours, the growth of the algae will be measured, and growth for each replicate will be calculated and compared with the control growth to obtain a percentage decrease in growth. The IC50 and IC10 will be determined using a probit analysis with the appropriate statistical program.

4.4.4 Macroalgae

10. A 48 hour sub-chronic toxicity test using the germination of the marine macroalga *Ecklonia radiata* will be undertaken based on the method described by Burridge *et al.* (1999).
11. Zoospores will be collected from adult specimens. The *E. radiata* specimens will be collected from sites that are unlikely to be affected by contamination.
12. Various concentrations of the water sample will be tested with three replicates each. The concentrations will be based on the results of the Microtox *Vibrio fischeri* test[5].
13. After 48 hours, the numbers of germinated gametes will be measured by counting a total of 40 of germinated and non-germinated gametes using a microscope. The EC50 and EC10 will be determined by using a probit analysis with the appropriate statistical program.

4.4.5 Copepods[6]

14. A modified 21-28 day acute toxicity test using the reproduction of the Swan River copepod *Gladioferens imparipes* will be undertaken based on the method described by the US EPA (2003a) Daphnid, Survival and Reproduction Test Method 1002.0.
15. Six concentrations will be tested based upon the results obtained from the Microtox *Vibrio fischeri* toxicity testing. Exposure to these concentrations will be for 24 hours. After this time, the Copepods will be placed in diluent water.
16. At day 15, after maturation, male and female copepods will be placed in the same well. Water changes and feeding will continue as previously.
17. Every second day the number of neonates produced by the female will be counted and recorded. These results will be used to calculate the EC50.
18. The concentration of sample resulting in a 50% decrease in the numbers of neonates produced compared with the control copepod (26 day EC50) will be determined using a probit analysis with the appropriate statistical program.

4.4.6 Mussels[7]

19. The 48 hour sub-chronic toxicity test using the larval development of the marine mollusc *Mytilis edulis* will be based on ASTM E724-98 (1998).
20. Collected male and female specimens will be induced to spawn using temperature shocks, and sperm and eggs will collected then added together to fertilise the eggs. Specimens will be collected from sites that that are unlikely to be affected by contamination.

21. The discharge will be tested at various concentrations (obtained from Microtox *Vibrio fischeri* testing) with three replicates each.

22. After 48 hours, the numbers of abnormal larvae will be measured by counting the number of normal and abnormal larvae using a microscope. The EC50 and EC10 will be determined by using a probit analysis with an appropriate statistical program.

4.4.7 Larval Fish[8]

23. The seven day sub-chronic toxicity test using growth of the larval pink snapper *Pagrus auratus* will be undertaken based on methods described by the USEPA (2003b) Test Method 1004.0 Sheepshead Minnow Larval Survival and Growth Test.

24. Various concentrations of collected water will be tested (based on the results obtained from the Microtox *Vibrio fischeri* toxicity tests) with three replicates.

25. Newly hatched larvae will be randomly allocated to each treatment.

26. Larvae will be monitored once per day at each water change and any mortality will be observed and recorded. The concentration of sample resulting in a 10% and 50% decrease in growth will be compared with the control fish to determine IC50 and IC10 values. The IC50 and IC10 will be determined by using a probit analysis with the appropriate statistical program.

4.5 Methodology

Grab samples downstream of all waste streams that enter the discharge pipe will be collected at the outlet during stable operation. Diluent will be collected from a site approximately 2km to the south of the diffuser(s) in the same water depth as the diffuser(s) (10-12m depth)[9]. The exact location will be recorded in accurate geographic coordinates. In the laboratory, test samples will be analysed for pH, salinity and temperature immediately prior to testing. The sample will be filtered (e.g. 0.45 microns) to remove all macroinvertebrates, microalgae and the majority of the bacteria that may confound toxicity test results.

Ecotoxicity testing will occur as soon as practicable after water sampling, and filtered seawater samples will be maintained at the appropriate temperature for each test throughout the testing period. Each toxicity test will use up to fifty dilutions of the seawater concentrate to represent the design dilution (within the LEPA) of the desalination effluent at high discharge rates.

Data (as shown in Table 4.1) will be placed in the BurrliOZ (Campbell et al., 2000) software to calculate a value designed to protect 95% (the target protection value for the HEPA) of the species from effects due to toxicants discharged from the proposed desalination plant with 50% confidence levels.

Table 4.1 Details of WET tests including the testing duration and applicable performance indicator

Test	Duration	Effect Concentration
Microalgae	72 hour	IC10
Macroalgae	48 hour	EC10
Copepod[6]	28 day test with 24 hour exposure	EC10=EC50/5
Mussel	48 hour	EC10
Larval Fish	7 day	IC10

The BurrliOZ software is designed to estimate the protecting concentrations of chemicals (and associated dilutions) such that a given percentage of species will not be affected. The estimations of the protecting concentrations will be computed by fitting the Burr III distribution to the toxicity data generated by the WET testing.

4.6 Additional Information

[1]Monitoring frequency

This monitoring frequency is considered sufficient because WET testing of the existing reverse osmosis Perth Seawater Desalination Plant (PSDP) (Geotechnical Services, 2008), shows that specifications in the Cockburn Sound Environmental Protection Policy (Government of Western Australia, 2005) and the supporting Manual of Standard Operating Procedures for monitoring against the Cockburn Sound Environmental Quality Criteria (2003-2004) (EPA, 2005) are met with a considerable margin of safety (the Southern Seawater Desalination Project plant will be similar in design to the PSDP). Further, Water Consultants International (2006), as part of a worldwide review of reverse osmosis desalination plants stated "detailed and quantified studies of the impact of desalination discharges on marine life surrounding Caribbean coral islands provides strong evidence of little or no impact, even when using unsophisticated discharge design".

[2]Trigger Criteria

A High Protection Zone (HEPA) is adjacent to the Low Ecological Protection Area (LEPA) surrounding the diffuser(s) discharging the desalination effluent. The Manual of Standard Operating Procedures – For Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (2003-2004) (EPA, 2005) states that for a High Protection Zone (HEPA):

If five species have been assessed and the statistical distribution method used, the dilution of the effluent (as % effluent) … should be protective of at least 95% of species

This means that the dilution at the LEPA/HEPA boundary should be higher than that which results in a measurable effect on 5% of species. In terms of concentrations, the concentration of brine at the LEPA/HEPA boundary should be lower than that which results in a measurable effect on 5% of species.

[3]Microtox Test

The marine bacteria *Vibrio fischeri* is a ubiquitous bacteria found in marine ecosystems throughout the world. *V. fischeri* displays a high sensitivity to a broad range of chemicals and is used throughout the world for determining toxicity of water, soil and sediment samples.

[4]Microtox Test

Unicellular algae form the base of the food chain in the marine system. These algae are primary producers in the marine system and provide food for larval, juvenile and adult crustaceans and molluscs. The microalgal species *Isochrysis galbana* was selected as the microalgal species to assess the toxicity of the discharge. This species was selected because it is widely distributed in Australian waters and the availability of temperate and tropical strains make it particularly suitable for site specific toxicity testing (Stauber *et al.* 1994). This species has been commonly used in toxicity tests throughout Australia for the past 15 years, and therefore, a large amount of information on this species is available.

[5]Macroalgae

The marine macroalga *Ecklonia radiata* provides both food and habitat for a range of other organisms in near-shore coastal areas. *E. radiata* is common along the temperate Western Australian coast (Wernberg et al. 2004). Therefore, *E. radiata* was selected as a suitable test organism for assessing the environmental impacts of the discharge. Toxicity tests using *E. radiata* have been performed on marine discharges throughout temperate Australia (e.g., Bidwell et al 1998, Burridge et al. 1999).

[6]Copepods

Copepods are a major part of the marine food chain as they represent a first order consumer, and they, in turn, provide food for larval fish and crustaceans. The Swan River copepod *Gladioferens imparipes* was selected to represent the copepod species in Cockburn Sound for the Perth Seawater Desalination Plant. Further, toxicity testing has been performed on this species for the last 10 years (Evans et al 2000).

Despite the theoretical suitability of the copepod *Gladioferens imparipes* for WET testing, data from WET testing of copepod reproduction using *Gladioferens imparipes* for the Perth Seawater Desalination Plant desalination effluent discharge shows that it is not possible to obtain consistent EC10 results (Geotechnical Services, 2008). However, reliable EC50 values can be obtained. For this reason, Warne (2008) recommended replacing the EC10 with the EC50 divided by 5.

Warne (2008) points out that the standard copepod test is an acute test while the other tests are sub-chronic and that acute and chronic toxicity test results should not be combined when using species sensitivity distribution methods. For this reason the standard copepod test has been modified, as was done for the Perth Seawater Desalination Plant (PSDP) tests (Geotechnical Services 2008), by reducing the time that the copepods are exposed to the desalination effluent to 24 hours. This is also closer to the duration that free drifting organisms such as copepods would be exposed to the desalination effluent (CWR, 2007c). Because of the energetic environment offshore of Binningup and subsequent high levels of dilution (KBR, 2008b), this exposure time is likely to be shorter than for the PSDP.

Consideration was given to substituting the copepod WET tests with the prawn *Penaeus monodon*. However, this prawn test is an acute test and would lead to acute and chronic toxicity test results being combined – contrary to the recommendations of Warne (2008). For this reason, the modified copepod test will be used.

[7]Mussels
The blue mussel, *Mytilis edulis*, is a first order consumer, filtering bacteria, microalgae and other small particles from the water column. *M. edulis* is found in temperate waters throughout the world, and in Western Australia it is found south of Geraldton. *M. edulis* has been used in toxicity tests throughout the world since 1980.

[8]Larval Fish
The pink snapper, *Pagrus auratus*, is a temperate marine fish commonly found associated with reefs. *P. auratus* is commonly found along the Western Australian coast where juveniles find appropriate habitat and food within seagrass beds.

[9]Site for Diluent

Modelling (KBR, 2008b) shows that the desalination effluent will be fully mixed within 2km of the discharge point and will therefore have little effect at this distance. Further, currents flow to the north the majority of the time, thus reducing the likelihood that the sample site to the south will be affected by the desalination effluent discharge. Finally, sites to the north can be affected by discharge from the Harvey Diversion Drain, so a southern site is preferred.

4.7 Contingency Actions

If the design dilution, which is a conservative estimate of the actual dilution (CWR, 2007b), is not protective of 95% of species i.e. the design dilution is less than the target dilution) then an additional set of tests will be undertaken. If these additional tests show that the design dilution is not protective of 95% of species, contingency actions could include:

1. Measuring the actual dilution at the LEPA/HEPA boundary using the methodology of CWR (2007b) and then comparing that dilution to the target dilution (actual dilution is likely to be higher than the design dilution).

2. Seeking the establishment of a Moderate Ecological Protection Area between the LEPA and the HEPA.

3. Identifying the chemicals contributing to the toxic effects and reducing the usage of those chemicals or substituting them.

4. Review operational procedures. For example, seawater injection could be increased at low flow rates to increase dilution.

5. Review the diffuser(s) design and modify the diffuser(s).

DEC will be advised if contingency actions are being investigated and the outcomes of those investigations.

4.8 Relevant Legislation

1. *Environmental Protection Act 1986* (WA).

5.0 Diffuser Performance Monitoring

5.1 Context

Water quality profile monitoring of the desalination discharge will be conducted to provide quantification of desalination effluent dilution at the boundary of the low ecological protection area (LEPA). The program's monitoring activities consist of profile sampling of salinity, temperature and dissolved oxygen at selected monitoring points. Salinity profiles will be used to calculate the increase in salinity and the dilution of the desalination effluent discharge. The dilution will be applied to the toxicant concentration data obtained from implementing the Discharge Water Quality Monitoring Plan to estimate toxicant concentration at the LEPA boundary. The estimated toxicant concentration will be compared with the ANZECC/ARMCANZ (2000) guidelines at the boundary of the LEPA and the high ecological protection area (HEPA).

Three types of monitoring locations have been chosen for the water quality profile monitoring:

1. *LEPA boundary*, 50m from the diffuser(s)
2. *Near LEPA*, 500m from the diffuser(s), directly north or south of the monitoring sites on the LEPA boundary.
3. *Reference*, 1250m from the diffuser(s)[1], directly north or south of the monitoring sites on LEPA boundary.

5.2 Purpose

The purpose of the water quality profile monitoring is to determine that the salinity increase at the boundary of the LEPA meets salinity criteria.

5.3 Performance Indicators

1. Salinity increase based on comparing the salinity at the LEPA boundary with the background salinity. The salinity increase is not to exceed 1 ppt more than 95% of the time and is not to exceed 1.3 ppt.

5.4 Management Actions

5.4.1 Water Quality Sampling Design

1. Two replicate vertical profiles measuring salinity, temperature and dissolved oxygen will be conducted at the following monitoring stations:
   a. 50m north of the mid-point of the diffuser(s)
   b. 50m south of the mid-point of the diffuser(s)
   c. 500m north of the mid-point of the diffuser(s)
   d. 500m south of the mid-point of the diffuser(s)
   e. 1250m north of the mid-point of the diffuser(s)
   f. 1250m south of the mid-point of the diffuser(s)
2. The data will be collected as prescribed in the 'Methodology' section below.
3. Testing will be conducted every two months to capture seasonal and operational variation with the first post-commissioning monitoring conducted after establishment of brine discharge. Monitoring will be conducted over a 12 month period with the first and final tests no closer together than 10 months.
4. The accuracy of the instruments will be sufficient to meet the Limit of Reporting (LOR) as per Table 5.1.
5. All instruments will be maintained and calibrated according to the manufacturers' specifications.

Table 5.1 Required Limit of Reporting

Parameter	LOR
Dissolved oxygen (DO)	± 0.1 $mg.L^{-1}$
Salinity	± 0.05 ppt
Temperature	± 0.1°C

5.4.2 Diffuser Inspection

6. The diffuser(s) and outlet pipeline will be visually inspected on a regular basis. Inspection methods may include divers, towed cameras/video or remotely operated vehicles. The frequency of inspection will be in accordance with the Ministerial Conditions/Commitments.

5.4.3 Reporting

7. A report will be submitted to the DEC within three months of the final sampling. The report will include calculations of the salinity increase and desalination effluent dilution at the boundary of the LEPA and at the stations 500m from the diffuser(s).

8. CTD (salinity is a function of Conductivity, Temperature and Depth) profile data will also be included in the report. The salinity increase will be compared to salinity requirements in the Ministerial Conditions.

5.5 Methodology

Salinity data collected at the sampling sites at the edge of the LEPA will be used to determine seawater salinity (temperature corrected) measured at no closer than 0.5m increments (with at least 30 seconds of data at each sampling depth) in the bottom 5m of the water column[2]. Pycnocline affect attributable to the diffuser(s) discharge will be identified and only those depths below the pycnocline averaged to assess diffuser(s) performance. However, if a pycnocline cannot be clearly identified, it shall be defined in accordance with the method of Roberts and Toms (1987) (also see Roberts *et al.* 1997).

At each station wind speed, wind direction, current speed and current direction will be estimated or measured manually for the period of 24 hrs before the time of measuring the seawater salinity. The background seawater salinity will be as measured by the on-line seawater intake meter in the desalination plant, averaged over the time of the diffuser monitoring sampling. This will then be used to calculate the background salinity of the seawater. Should the on-line instrument not be functioning at the time of sampling, an alternative calibrated instrument may be used. Failing this, the depth average salinity from the reference sites may be used to determine the background salinity ($S_{S)}$ of the seawater.

The seawater discharge will be as measured by the on-line wastewater outlet meter (from which salinity will be calculated) or a substitute instrument, averaged over the time of the diffuser monitoring sampling.

The increase in salinity (ΔS) at the monitoring sites on the LEPA boundary will be calculated as:

$$\Delta S = S_M - S_S$$

while the dilution or dilution factor at the monitoring sites on the LEPA boundary will be calculated using the following formula:

$$\text{Dilution Factor} = D = (S_B - S_S) / \Delta S$$

where:

S_B = salinity of the desalination effluent discharge
S_M = salinity at the monitoring station
S_S = background salinity of the seawater (at the inlet).

5.6 Additional Information

[1]Monitoring Sites

The reference sites coincide with sites used in the project's baseline water quality monitoring.

[2]Alternate salinity measurement method

If it is impractical to obtain measurements at 0.5 m increments in the vertical (for example, due to large waves moving the deploying vessel and instruments large distances vertically), then 5 vertical profiles obtained from a constantly descending instrument may be averaged to provide a representative profile.

5.7 Contingency Actions

If the diffuser inspection as per Section 5.4.2 shows the diffuser(s) and/or outlet pipe requires maintenance, then that maintenance will be scheduled and implemented.

Contingency actions will be triggered if the salinity increase at the edge of the LEPA (ΔS) is greater than 1ppt for more than 5% of the time or if ΔS exceeds 1.3ppt. Contingency actions may include the following:

1. The diffuser(s) will be inspected.
2. If the diffuser(s) needs maintenance, then that maintenance will be implemented and the salinity monitoring will be repeated.
3. Review operational procedures. For example, seawater injection could be increased at low flow rates to increase dilution.
4. Implement additional testing as per the Whole Effluent Toxicity Management Plan to determine if the higher levels of salinity are having an unacceptable ecological impact.
5. Review the diffuser design and modify the diffuser(s).

5.8 Related Plans

Discharge Water Quality Monitoring
Benthic Habitat Monitoring

5.9 Relevant Legislation

1. *Environmental Protection Act 1986* (WA).

6.0 Discharge Water Quality Monitoring

6.1 Context

The desalination effluent discharge stream will be monitored continuously for some parameters and at selected intervals for other parameters to provide information on operations, toxicants (metals), process additive chemicals and nutrient loading.

In general, substances that are in the intake seawater will be approximately doubled in concentration before being discharged in the brine stream. Dilutions of 25 to 50 within the Low Ecological Protection Area (LEPA) would result in these substances increasing in concentration by around 4% to 2% respectively compared to background seawater concentrations. Additional dilution beyond the LEPA will reduce this increase in concentration even further. Hence, it is only if a substance is added during the treatment process, as opposed to being present in the seawater intake stream, that there is the potential for any environmental impact.

Unlike thermal desalination plants, reverse osmosis desalination plants do not result in concentrations of metals increasing measurably beyond the approximate doubling discussed above. However, given the potential toxicity of some metals, monitoring of the desalination effluent stream for metals will be carried out as a safeguard.

Some of the additive chemicals used in pre-treatment processes can contain nitrogen. In turn, nitrogen can stimulate the growth of algae. For this reason, nitrogen and some of its compounds will be monitored and an annual nitrogen load estimated.

6.2 Purpose

The purpose of the discharge water quality monitoring is to quantify:

1. Flow volumes, flow rates and salinity of the discharge
2. Nutrient (nitrogen and phosphorus) load being discharged
3. The concentration of toxicants (metals) in the discharge
4. The concentration of process additive chemicals in the discharge.

6.3 Performance Indicators

1. Measurements are undertaken and reported
2. Detection of any toxicants (metals) added during the treatment process.

6.4 Management Actions

6.4.1 Operational Monitoring

1. Operational monitoring of the desalination plant will provide data for direct or indirect determinations of:
    a. Daily total volume and daily average flow rate of the desalination effluent discharged to marine waters.
    b. Daily total volume and daily average flow of the brine component of the desalination effluent discharged to marine waters.
    c. Daily average salinity of the inlet seawater and the desalination effluent discharged to marine waters.

6.4.2 Sampling Design for Desalination Effluent and Inlet Stream Sampling

1. Testing will be conducted twice a year with the first post-commissioning monitoring conducted within three months of establishment of brine discharge. Monitoring will continue for two years (four testing periods) after commissioning.
2. Three replicate grab samples will be taken of the seawater desalination effluent stream (i.e. downstream of where waste streams enter the discharge pipe) and of the inlet stream.
3. Samples will be analysed at a NATA accredited laboratory; to the detection limits where practicable, shown in Table 6.1, Table 6.2 and Table 6.3.
4. Sampling techniques will be consistent with those recommended in ANZECC/ARMCANZ (2000) and EPA (2005) including safe handing and sampling procedures[1].
5. All instruments will be calibrated and maintained according to manufacturers' specifications.

6.4.3 Data Analysis for Desalination Effluent and Inlet Stream Sampling

6. The net additional annual nitrogen load to marine waters due to the operation of the desalination plant will be calculated for the forms of nitrogen listed in Table 6.1.
7. The increase in concentration for each toxicant in Table 6.2 will be calculated as a concentration ratio (the ratio of desalination effluent concentration divided by inlet concentration).

6.4.4 Reporting

8. Results of the sampling will be reported annually and will include:
   a. Data as required by section 6.4.1 of this management plan
   b. Data as required by section 6.4.3 of this management plan for the duration of the desalination effluent and inlet stream sampling
   c. Any concentration ratio above 2 will be noted and discussed.

6.5 Additional Information

[1] Sampling Information

Water samples will be collected in accordance with Standard procedures consistent with AS. 5667. Analyte concentration will be measured to at least half the trigger level concentrations. The general approach to the sampling method will be pursuant to ANZECC/ARMCANZ (2000b). All samples will be appropriately labelled and tracked, and chain-of-custody documentation will be appropriately stored and maintained.

Sampling Compounds

The following list specifies the compounds (toxicants and nutrients) that will be measured during water quality sampling from the seawater concentrate discharge. The specific analysis for process chemicals will be determined prior to sampling of the desalination effluent stream.

Table 6.1 Water Quality Monitoring Parameters – General Water Quality and Nutrients

Analyte	Unit	LOR
Alkalinity (mg $CaCO_3$/L)	mg $CaCO_3.L^{-1}$	1
Total dissolved solids, TDS (mg/L)	$mg.L^{-1}$	5
Ammonium	µg $N.L^{-1}$	3
Nitrite and Nitrate	µg $N.L^{-1}$	2
Total Nitrogen	µg $N.L^{-1}$	50
Ortho-phosphorus	µg $P.L^{-1}$	2
Total Phosphorus	µg $P.L^{-1}$	5

Table 6.2 Water Quality Monitoring Parameters - Toxicants

Analyte	Unit	LOR
Filterable, Al	$mg.L^{-1}$	0.01
Total Al	$mg.L^{-1}$	0.01
Arsenic, As	$mg.L^{-1}$	0.002
Boron, B	$mg.L^{-1}$	0.003
Cadmium, Cd	$mg.L^{-1}$	0.002
Chromium, Cr[1]	$mg.L^{-1}$	0.001
Copper, Cu	$mg.L^{-1}$	0.001
Lead, Pb	$mg.L^{-1}$	0.002
Filterable Manganese, Mn	$mg.L^{-1}$	0.0002
Total Manganese, Mn	$mg.L^{-1}$	0.0002
Mercury, Hg	$mg.L^{-1}$	0.0005
Molybdenum, Mo	$mg.L^{-1}$	0.0005
Nickel, Ni	$mg.L^{-1}$	0.004
Selenium, Se	$mg.L^{-1}$	0.002
Silver, Ag	$mg.L^{-1}$	0.001
Vanadium, V	$mg.L^{-1}$	0.001
Zinc, Zn	$mg.L^{-1}$	0.002

Table 6.3 Water Quality Monitoring Parameters – Process Additive Chemicals

Analyte	Unit	LOR
Coagulating agent	$mg.L^{-1}$	TBD
Antiscalant	$mg.L^{-1}$	TBD
Filterable Iron, Fe	$mg.L^{-1}$	0.003
Total Fe	$mg.L^{-1}$	0.003

TBD = To BeDetermined

6.6 Contingency Actions

Contingency actions may include the following:

1. If the annual nitrogen load exceeds an allowed load then:
    a. The use of alternative process chemicals with a lower nitrogen content will be explored
    b. Chlorophyll-a data will be collected in the surrounding marine waters to determine the extent of any algal stimulation associated with nitrogen in the desalination effluent

c. Based on the algal stimulation in marine an increase in the allowed nitrogen load could be sought.

2. If a concentration ratio exceeds 2 for a toxicant then:

    a. Whole effluent toxicity testing may be conducted on the desalination effluent as per the Whole Effluent Toxicity Testing Management Plan.

    b. Additional samples may be analysed to determine the bio-available fraction.

    c. The estimated concentration (C) of the toxicant at the boundary of the Low Ecological Protection Area will be compared with ANZECC/AARMCANZ (2000) guideline trigger values for Low, Medium and High Ecological Protection Areas. The concentration (C) will be determined using:

$$C = (C_B + DC_S) / (1 + D)$$

where:

C_B = concentration of the toxicant in the desalination effluent discharge

C_S = concentration of the toxicant in the seawater (at the inlet)

D = the dilution in the LEPA (this can be obtained from implementing the Diffuser Performance Monitoring Plan or from theoretical or empirical relationships – also see Centre for Water Research, 2007).

6.7 Related Plans

Diffuser Performance Monitoring

6.8 Relevant Legislation

1. *Environmental Protection Act 1986*
2. *Occupational Safety and Health Act 1984*

7.0 Benthic Habitat Monitoring

7.1 Context

The marine benthic habitats in the vicinity of the Southern Seawater Desalination Plant were characterised using towed underwater video taken in December 2007 (UWA, 2008d). Habitats comprised (i) no biota (i.e. free of obvious fauna in video footage), (ii) vegetation and sessile invertebrates, (iii) sessile invertebrates and (iv) vegetation.

The area mapped was described by UWA (2008) as highly energetic (by natural wave energy), with large areas of reef pavement devoid of biota and where biota occurred they occupied a small proportion of the total reef surface. Megaripples and sediment sheets were observed midshore suggesting that sediment was highly mobile. The mosaic of seaweeds and benthic invertebrates was most developed on reefs 300-500m offshore with areas further inshore exhibiting an extensive pavement bare of invertebrates and seaweed due to the pavement being frequently covered and scoured by shifting sands.

Marine macroflora (including seaweeds and seagrasses) species occur at a distance from approximately 500m offshore to greater than 2500m offshore from the Seawater Desalination Plant site. More specifically, seagrass beds are more than 1200m from the shore along the pipe alignment. The seawater intake and outlet pipelines will be located along an alignment that generally contains bare sand and shell material. From 500m or so offshore the outlet pipelines and diffuser(s) are within a few hundreds of metres of marine flora and/or fauna.

Construction works may impact on the marine flora in close proximity to those works (Oceanica, 2008). The application of this Plan in relation to construction impacts is specified in the Seawater Pipeline Management Plan which is within the Construction Environmental Management Framework.

A worldwide review did not find any significant impacts on surrounding flora and fauna associated with the discharge of highly diluted brine from reverse osmosis desalination plants (Water Consultants International, 2006).

7.2 Purpose

The purpose of the Benthic Habitat Monitoring is to assess whether the construction and operation of the Southern Seawater Desalination Project may affect offshore benthic flora and fauna.

7.3 Performance Indicators

Performance will be demonstrated by:

1. Mean depth range that seagrass and sessile macroinvertebrates are found[1].

7.4 Management Actions

7.4.1 Prior to and Soon After Construction

1. The timing requirements are specified in the Seawater Pipeline Management Plan which is within the Construction Environmental Management Framework.

7.4.2 During Operation

2. Benthic habitat monitoring will be conducted between 18 and 30 months of brine discharge based on the methodology[2]. A report will be provided to the DEC within 6 months of the completion of the monitoring.

7.4.3 Method and Data Analysis

3. GIS referenced video footage from monitoring transects will be analysed using the same methodology as UWA (2008).
4. The transects will be the same as those used by UWA (2008) (see Figure 7.1) or a modification to provide greater detail in the vicinity of the outlet pipeline and diffuser(s).
5. All appropriate safety precautions for working in the field including collection and handling of samples, boat handling and diving (where applicable) will be followed by all sampling personnel.
6. Seagrass cover will be compared with previous surveys.
7. Sessile macroinvertebrate cover will be compared with previous surveys.

7.5 Additional Information

[1] Performance Indicators

EPA (2005) outlines two different approaches for monitoring seagrass. The first relates to seagrass shoot density while the second relates to the depth range that seagrass are found over.

The offshore environment in the vicinity of the desalination discharge and construction area is extremely dynamic (for this reason, the only seagrass species present - *Posidonia angustifolia* and *Posidonia coriacea* - are pioneer species). As such, there may be considerable changes in seagrass shoot density and presence/absence at any specific location from one year to the next. Broader mapping of seagrass which shows the depth range that seagrasses are found is considered to be more reliable. The same logic is applied to sessile macroinvertebrates.

[2] Timing of Surveys

The waters offshore of the desalination plant are turbid near the seabed for much of the year. This, means that the survey can only be conducted within a few months of the year is the highest possible quality video footage can be obtained.

[2] Habitat Transects and Categories

The baseline survey conducted by UWA (2008) consisted of a grided towed video design of the target area. This grid consisted of towed video transects every 500 m, equating to 10 transects running north-south and east-west as shown in Figure 7.1.

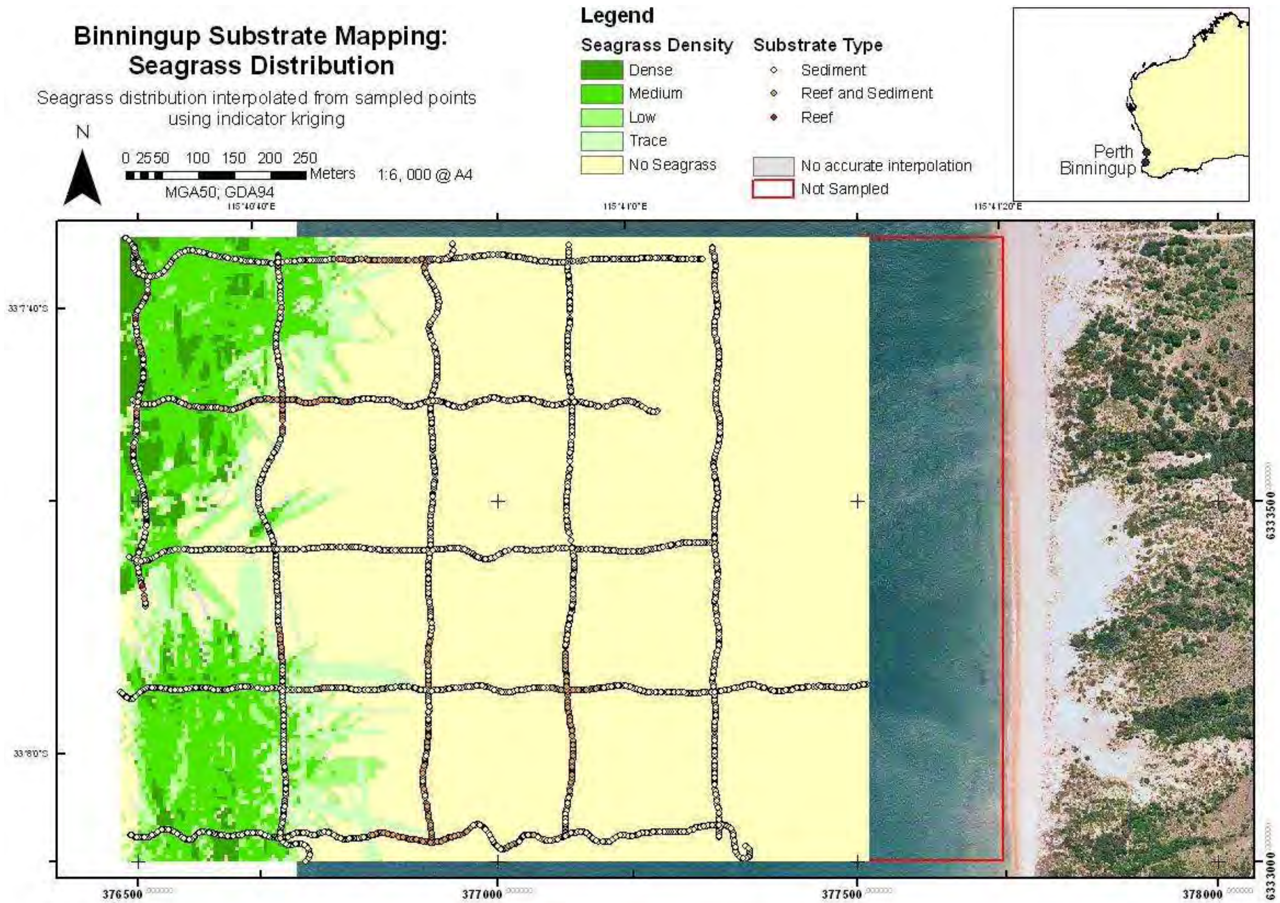

Figure 7.1 Location of transects used by UWA (2008d) and location of seagrass

Resulting underwater towed video imagery was observed and the following categories shown in Table 7.1 used to describe the habitat.

Table 7.1 Categories describing benthic communities for video interpretation.

Substrate	Macroalgae	Seagrass	Sessile invertebrates
Hard (reef/rock)	Undifferentiated	Undifferentiated	Undifferentiated
Can't discern	Mixed brown algae	*Amphibolis*	Sponges
Fractured/Fissured/Broken	Mixed red algae	*Zostera/ Heterozostera*	Ascidians
Unbroken	Mixed green algae	*Halophila*	Bryozoa
Cobbles	*Ecklonia*	*Posidonia*	Hydroids
Boulders/small outcrops	*Sargassum*	*Thalassodendron*	Soft corals, gorgonians
Soft (sediment)	*Caulerpa*		Hydroids
Can't discern	*Scytothalia*		Hard corals
Coarse gravel	Epiphytes		Sea whips
Fine gravel	*Codium*		*Tethya*
Sand			Black coral
Fine sand (silt/clay)			*Pyura*

7.6 Contingency Actions

Contingency actions will be largely dependent on the circumstances that result in changes and loss of seagrass and sessile macroinvertebrate cover. For example, loss of seagrass and/or sessile macroinvertebrates in the vicinity of the discharge area may be the result of winter storms and other inclement weather. Contingency actions in response to significant loss or change in seagrass and sessile macroinvertebrate cover may include:

1. investigation of the cause of seagrass or sessile macroinvertebrate changes

2. investigation of and/or collection of additional water quality monitoring data in order to determine if there are any correlations between the water quality data and the changes

3. re-examination of whole effluent toxicity analysis data and/or conducting additional whole effluent toxicity testing as per the Whole Effluent Toxicity Testing Management Plan to determine if toxicity effects may be responsible. If toxicity effects are present, the contingency actions in the Whole Effluent Toxicity Testing Management Plan may be implemented

4. implementing additional macrobenthic monitoring.

7.7 Related Plans

Whole Effluent Toxicity Testing Management
Discharge Water Quality Monitoring

7.8 Relevant Legislation

1. *Environmental Protection Act 1986*
2. *Wildlife Conservation Act 1950*
3. *Wildlife Conservation Regulations 1970*
4. *Occupational Safety and Health Act 1984*

8.0 Chemical and Dangerous Goods Management Plan

8.1 Context

A number of chemicals are used during the seawater desalination process and subsequent potibilisation process, including:

- Sulphuric acid
- Ferric sulphate
- Coagulating agent
- Antiscalant
- Calcium carbonate
- Carbon dioxide
- Chlorine
- Fluorosilicic acid
- Sodium hypochlorite
- Sodium bisulphite

These chemicals will be managed by Department of Consumer and Employment Protection (WA) (DoCEP) under the *Dangerous Goods Safety Act (2004).*

8.2 Purpose

The purpose of the chemical management plan is to ensure safe management of transport, storage and use of chemicals at the plant site to prevent any safety or environmental incidents.

8.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed key management actions.

8.4 Management Actions

8.4.1 Prior to Operation

1. All chemicals will be stored in areas designed to applicable Australian Standards and regulatory requirements.

8.4.2 Chemical Storage

2. All licenses required by the Chief Inspector of the DoCEP under the *Dangerous Goods Safety Act (2004)* will be obtained prior to any storage or use of any dangerous goods.

3. Liquid dangerous goods will be stored in a bunded area capable of containing 110% of the volume. For packaged liquid dangerous goods (goods in a number of smaller containers), the goods shall be stored in a covered bunded area capable of containing 110% of the volume of the largest container.

4. Where practicable, dangerous goods will be stored in minimum quantities to minimise the environmental impact if spillage occurs.

5. Incompatible dangerous goods will be segregated.

8.4.3 Record Keeping

6. Material Safety Data Sheets (MSDS) will be maintained for each dangerous good stored on site. The MSDS will be located outside of the compound in which the material is stored. The compound will be placarded in accordance with the DoCEP's *Guidance Note for Placarding*.

7. Deliveries of dangerous goods will only be accepted if they are accompanied by the relevant MSDS, or, if there is an existing and current MSDS for that dangerous good already held on the site.

8. A Dangerous Goods Log(s) will be maintained for all dangerous goods held on the site. The Log(s) will be stored in a secure location at the site entrance or in the main office. The Log(s) will identify the:

a. date on which the goods were received.
b. location(s) at which the goods are stored.
c. volume/quantity stored at each location.
d. date and volume/quantity removed whenever goods are removed from storage.
e. name of the person(s) receiving/removing goods to/from storage on each occasion.

A site plan that identifies the storage location of each dangerous good will accompany the Log.

8.4.4 Safety

9. Measures will be put in place to prevent unauthorised access to dangerous goods.
10. As standard practice, ignition sources (e.g. welding equipment, cigarettes, lighters) will be prohibited within any compound storing dangerous goods.

8.4.5 Training

11. All relevant operations staff will be trained on identification, storage and handling procedures for dangerous goods. Staff will also be trained on response procedures (including use of Spill Response Kits) for accidents and incidents and emergencies involving dangerous goods.

8.4.6 Accidents, Incidents and Emergencies

12. A Spill Response Kit will be installed and maintained for the clean-up and containment of spills to land or water. Each spill kit will contain as a minimum:
    a. universal absorbent pads or pillows or blankets.
    b. labelled plastic contaminated waste bags.
    c. safety gloves.

    Contaminated material from a spill will be disposed of in accordance with the Waste Management Plan.
13. The Chief Inspector of DoCEP will be notified of any accident involving dangerous goods.
14. FESA will be notified of any incident involving dangerous goods that has had, or has the potential to, have a significant impact on the environment or human safety.
15. DEC will be notified of any incident involving dangerous goods that has had, or has the potential to, have a significant impact on the environment.

8.5 Contingency Actions

No contingency actions are proposed**.**

8.6 Related Plans

Waste Management Plan

8.7 Relevant Legislation

1. *Environmental Protection Act 1986*
2. *Dangerous Goods Safety Act (2004)*
3. *Dangerous Goods (Transport) Act 1998*
4. *Occupational Safety and Health Act 1984*

9.0 Waste Management Plan

9.1 Context

Operational works will produce a range of liquid and solid wastes. These wastes include:

- site office paper, packaging and domestic wastes
- thickened sludge from media filter backwash
- desalination effluent discharge.

Inappropriate waste disposal has the potential to contaminate soil, surface water or groundwater and affect visual amenity.

Management of the desalination effluent is addressed in the Whole Effluent Toxicity Testing Management (section 4.0), Diffuser Performance Monitoring (section 5.0), Discharge Water Quality Monitoring(section 6.0) and Benthic Habitat Monitoring (section 7.0) plans.

9.2 Purpose

The purpose of the Waste Management Plan is to outline management actions to:

1. reuse waste materials where possible;
2. recycle wastes where practicable; and
3. dispose of waste streams in an acceptable manner.

9.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

9.4 Management Actions

9.4.1 General Office Waste

1. Separately marked waste bins will be provided for:

CATEGORY	DISPOSAL
General wastes.	Dispose on-site in a covered bin to prevent attraction of vermin. Bulk disposal offsite to landfill.
Recyclables (generally glass, paper and plastics).	Bulk dispose offsite to the nearest recycling facility. May be disposed of to landfill if a facility does not exist within 50km of the site[1].

9.4.2 Thickened Sludge from Media Filter Backwash

2. If alternative uses cannot be found for the thickened sludge, it will be disposed of to an appropriate Class III landfill pursuant to the Landfill Waste Classification and Waste Definition (DoE, 2005).
3. The composition of the thickened sludge will be tested prior to disposal to ensure that it meets Class III criteria.

9.5 Additional Information

[1] Waste Bins

General wastes and recyclables may be mixed (i.e. one bin used) if they are subsequently separated at a recycling facility.

9.6 Contingency Actions

The following actions will be undertaken if wastes are not appropriately disposed:

1. investigate the cause
2. alter management actions, if required.

9.7 Related Plans

Chemical and Dangerous Goods Management Plan

9.8 Relevant Legislation

1. *Environmental Protection Act 1986*
2. *Dangerous Goods Safety Act (2004) 1961*
3. *Dangerous Goods (Transport) Act 1998*
4. *Occupational Safety and Health Act 1984*
5. *Waste Avoidance and Resource Recovery Act 2007*

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Legislation referred to in the OEMF can be accessed via the State Law Publisher website at *http://www.slp.wa.gov.au.*

Appendix 1 – Water Corporation Environmental Policy

Introduction

The Water Corporation provides essential water, wastewater and drainage services to the people of Western Australia. We take water from the environment and return drainage water and treated wastewater and its by-products back into the environment.

In doing this, we aim to provide sustainable, safe and reliable water services to customers and the community.

This policy applies to the Statewide operations of the Water Corporation, which includes all activities, services and products provided by the Corporation to its customers, in accordance with its operating licence.

All employees, and where practicable, 'second parties' (Water Corporation agents, alliance participants, contractors and suppliers) will comply with and support implementation of this policy.

Commitment

The Corporation is committed to:

- playing a leading role in the sustainable future of Western Australia's water resources;
- compliance with applicable environmental legal requirements and with other environmental requirements to which the Corporation subscribes;
- preventing pollution and minimising the adverse effects of our activities; and
- excellence and continual improvement in environmental performance, including conserving natural resources and ecological systems and enhancing them where practicable.

How

Our commitments will be met by:

- providing appropriate services, resources and infrastructure to meet our stated objectives;
- identifying, assessing and managing our environmental risks;
- developing and implementing environmental improvement programmes with measurable targets;
- regularly reviewing and auditing our environmental systems and performance;
- developing and maintaining appropriate incident response plans and minimising the adverse environmental consequences of any accidents; and
- promoting efficient use of resources and minimisation of waste.

Our Environmental Management System provides the framework for developing, implementing, monitoring and reviewing our environmental objectives, targets and actions.

PCY230 Environmental Policy
31 October 2007
CDMS#: 375822

Peter D Moore
Chief Operating Officer

FOI 190429
Document 2k

Revegetation Management Plan

SOUTHERN SEAWATER ALLIANCE

Revegetation Management Plan

Document No	:	Supporting Reports and Plans. Attachment f
Revision	:	R00
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1. INTRODUCTION AND BACKGROUND

The Southern Seawater Desalination Plant Project consists of a Design-Build-Operate-Maintain (DBOM) facility for the supply of 50 GL/year of drinking water into the Water Corporation's Integrated Water Supply (IWSS). The initial net drinking water production capacity of 50 GL/a would be provided by means of a Seawater Reverse Osmosis (SWRO) plant. The plant would be designed, constructed and commissioned with flexibility for expansion to 100 GL per year.

The project would comprise mainly the following systems:

- seawater extraction system, seawater intake and brine return
- SWRO plant with pre-treatment and potabilisation system
- drinking water storage and drinking water pumping station
- pipeline between seawater intake and SWRO plant
- drinking water pipeline
- Sustainability control systems (including ecological, social and environmental).

This revegetation management plan has been developed based on previous environmental studies conducted for the Project Area. In addition, the revegetation management plan has taken into consideration documents including the Public Environmental Review (PER) and Construction Environmental Management Framework (CEMP) prepared by the Water Corporation which described the environmental status of the site and outlined actions to be taken to minimise environmental impacts arising during construction works.

In preparing this management plan, a desktop study of flora and vegetation of the region was conducted followed by a field trip to the site to ground truth the plant species list, mapping of vegetation associations and vegetation condition. Following the field trip, additional species were added to the plant species list and delineation of offset areas was finalised

This revegetation management plan is part of the Sustainability Management System (SMS) prepared for the project which provides a structured approach to embedding sustainability assessment, actions and review during the three stages of the project. The SMS aims to ensure the three aspects of sustainability, ie environmental, social and economic, are considered equally, early and in an integrated approach.

2. PROJECT AREA

The selected location for the Southern Seawater Desalination Plant is near the Water Corporation's existing Wastewater Treatment Plant along Taranto Road north of Binningup. The Project Area consists of Lot 32, Lot 33 and Part Lot 8. The majority of the plant would be constructed in a disused quarry on the eastern edge of the Project Area, with a seawater extraction and drinking water pump station about 400 m east of the ocean and a pipeline corridor connecting the two. An 8 m high berm would be constructed along the eastern and southern area of SWRO plant site to shield the site from neighbours.

The Water Corporation has proposed to offset areas cleared for construction of the plant by revegetating designated degraded or partially degraded remnant vegetation in the Project Area. In the PER, Water Corporation proposed to revegetate 10 ha of remnant vegetation chosen from areas to the north, south and west of the SWRO plant site. Areas proposed by SSWA to fulfil the 10 ha offset requirements are as follows (see Appendix 1):

- Tuart - Agonis woodland to the north of the plant site: degraded offset area

- Banksia - Agonis woodland to the north of the plant site: degraded offset area
- Coastal dunes to the north west of the plant site: good condition offset area
- Coastal shrubland to the north west of the plant site: good condition offset area.

If additional degraded areas are to be revegetated as part of an offset package agreed to by the Water Corporation, the following options are suggested (see Appendix 2):

- Option 1. Banksia - Agonis woodland to the north of the plant site: degraded offset area, with a total area of 2.18 ha
- Option 2. coastal shrubland to the west of the plant site: good condition offset area ,with a total area of 2.21 ha.

The target area of 12.6 ha for the offset areas included in the Environmental Response to the public consultation can be achieved with any of these optional areas. However, the revegetation of any of these additional offset areas has not been included in this Revegetation Management Plan.

Two drawings showing the different revegetation areas have been developed: These include the offset areas, the berm and the areas disturbed during the construction works.

DRAWING NUMBER	DRAWING TITLE
JK43-096-100.4	Revegetation Areas and Site Map
JK43-096-100.5	Revegetation Areas, Site map and Offset Options

Moreover, a final drawing with the combination of landscape and revegetation actions has been developed to show the final appearance of the site and his surroundings:

DRAWING NUMBER	DRAWING TITLE
JK43-096-100.6	Revegetation and Landscape

These drawings can be consulted in the general folder for drawings.

3. OBJECTIVES

The objectives of this Revegetation Management Plan are as follows:

- to manage clearing to generate topsoil and vegetation for use in revegetation
- to revegetate the area disturbed by construction to as close to their condition prior to construction as practicable
- to revegetate 10 ha of disturbed remnant vegetation as part of the offset package

- to vegetate a 8 m high berm to minimise impacts on viewscapes into the site
- to use locally occurring native plant species utilising only plant material collected within 50 km of the project area to ensure local genetic variances are used in revegetation
- to minimise impacts on pre-existing native vegetation and landforms of significance;
- to prevent the spread of weeds and disease such as dieback
- to ensure that weed species cover in the revegetated areas is similar to or less than in surrounding good condition areas.

It should be noted that in addition to revegetation of areas disturbed by construction, areas within and outside the SWRO plant site would be landscaped with a mixture of locally native and other plants. Landscaping is not covered in this document.

4. CLEARING

4.1 FENCING

As soon as possible following contract award, a stock fence would be installed at the boundary of the Project Area or the existing stock fence would be repaired and any stock in the project area would be removed. In addition, a stock fence would be installed at the boundary of the area required to be cleared for the Seawater Desalination Plant to fence off the native vegetation that would be retained. The fencing would aim to prevent unauthorised vehicle access and to discourage human and stock traffic between the native vegetation and the construction areas in order to prevent further degradation of the existing vegetation by stock or motor vehicles, while still permitting fauna movement through the native vegetation and the construction areas.

The stock fence would be a 5 strand wire fence strained with posts with strand heights at 250mm, 500mm, 750mm, 1000mm and 1250mm above ground level. The fencing would be installed from the inside of the area to be cleared or from the outside of vegetation to be retained. Where vegetation in areas where vegetation is to be retained is required to be cleared to construct the fence, the clearing corridor would be a maximum of 2 m wide.

4.2 FLORA AND FAUNA

Prior to clearing, the site would be re-surveyed for the presence of Declared Rare and Priority Flora (as per the Wildlife Conservation (Rare Flora) Notice 2008) and for the presence of Critically Endangered, Endangered and Vulnerable flora (as per the Environment Protection and Biodiversity Conservation Act 1999 (C'th)). If Declared Rare Flora are identified within the construction area a Licence to take Declared Rare Flora would be applied for, in accordance with the Wildlife Conservation Act 1950 (WA) and the Wildlife Conservation Regulations 1970 (WA).

Prior to clearing, the site would be re-surveyed for the presence of specially protected fauna (as per the Wildlife Conservation (Specially Protected Fauna) Notice 2008) and for the presence of potential habitat trees. If specially protected fauna are identified within the construction area, a Licence to take specially protected fauna would be applied for in accordance with the Wildlife Conservation Act 1950 (WA) and the Wildlife Conservation Regulations 1970 (WA). Potential habitat trees would be marked and if possible, would be retained.

4.3 VEGETATION

Clearing of native vegetation would only commence once permission is obtained. Clearing would be limited to those areas identified for clearing as shown in the *Revegetation Areas and Offset Options* drawing. In addition, as part of the revegetation of degraded offset areas, the topsoil in areas dominated by weeds would be removed by scalping without removing native species (see Section 5). Before clearing commences, a *Phytophthora cinnamomi* dieback survey would be undertaken as described in the Construction Environmental Management Plan. If dieback is present, vehicle and soil movement would be undertaken under dry conditions to minimise the potential for movement of dieback infected or vehicles would be between areas of different dieback status.

Trees would be felled and cut into useable lengths of timber so that as much useable timber as possible can be recovered from both the trunk and limbs. Felled timber would be stockpiled in millable lengths in separate piles up to 3 m high according to species (i.e. Tuart, Peppermint, Banksia, others) at an approved location within the site in such a manner that the timber can be readily inspected and removed. Stockpiles would be located so that no native vegetation outside cleared areas is damaged.

The timber would be offered to sawmillers or others who would use the timber for the manufacture of furniture, floor boards, parquetry, rafters or fence posts etc. Sawmillers would select suitable logs from the stockpile and, after drying and sawmilling, would offer them to potential users such as furniture makers, carpenters and craftspeople.

Timber not collected by commercial sawmillers would be made available to local residents and others. Some of the remaining timber would be moved to un-impacted parts of the site to be used as habitat.

Hollow branches would be retained and either placed on the ground in revegetated areas for use by native animals, or parts would be used for the construction of bird nesting boxes. Artificial bird nesting boxes of various sizes with hollow branches used as entrances would be constructed to replace any nesting hollows removed during clearing and would be secured to remaining Tuart trees near the SWRO plant at least 3 m above ground.

All other tree trunks would retained and stockpiled to a height of 3 m.

Vegetation crowns, branches, stumps, roots and other vegetation that has been cleared would be separately stockpiled to a height of no more than 5 m above ground. Machines used for stockpiling operations would be fitted with root rakes or similar equipment and operated in a manner such that as little topsoil as possible is removed and stockpiled with the cleared vegetation.

Vegetation unsuitable for use in revegetation such as weeds would be disposed of offsite at an approved green waste tip site. No timber or vegetation would be burnt on the site.

The site would be surveyed at the completion of clearing works to determine and record the area of native vegetation cleared.

5. TOPSOIL

Before topsoil is stripped, a topsoil evaluation/quality assessment would be conducted to classify topsoil into the following categories.

- Topsoil which is relatively free of weeds or weed seeds and likely to contain numerous native seeds would be classified as good quality and not require any treatment or management before use in revegetation

- Topsoil which contains some weeds or weed seeds but also contains native seed would be classified as medium quality and would require weed control for use in revegetation

- Topsoil which contains large numbers of weeds and/or weed seeds and very few or no native seed would be classified as unusable and would not be used in revegetation.

The site would be delineated to mark the area of topsoil of different classification and different vegetation associations, as well as any areas where dieback has been identified, in order to keep topsoil of different vegetation, weed and dieback status separate.

Wherever possible, good and medium quality topsoil would be stripped in dry conditions during November-March. The topsoil would be stripped in two passes. The first pass would remove the top 50-100 mm of soil which contains nearly all of the native seeds. The second pass would remove 200 mm of subsoil. The two passes would be kept separate and would be stockpiled in windrows no more than 1.2 m high adjoining or as close to their area of origin as possible with signs or markers indicating the origin and classification of the topsoil. The windrows would be covered with tarpaulins or the topsoil would be stored in portable shelters to keep the topsoil dry until it is re-spread during revegetation.

Following the completion of construction or removal of weedy topsoil, and once the excavations have been backfilled, the stockpiled subsoil would be returned to form a non organic substrate for the topsoil. The areas would then be contoured and the topsoil would then be re-spread at a thickness of 25-100 mm. Only topsoil from the same vegetation association and dieback status would be spread over the area to be revegetated. The areas would then be lightly ripped to remove any compaction.

Unusable topsoil from either construction areas or degraded offset areas dominated by weeds would be completely removed by scalping the top 50-100 mm of soil. This weedy topsoil would be placed at the top of the berm proposed to be constructed along the eastern and southern boundary of the Project Area and covered with 300-500 mm of clean fill or clean topsoil, to avoid the regeneration of weeds in revegetation areas.

Construction areas or offset areas from which the weedy topsoil was removed would either be covered with excess good quality topsoil from similar vegetation associations, or would be revegetated directly into the subsoil.

6. MULCH

Tree trunks unsuitable for timber, branches, stumps, roots and other vegetation felled on the site would be chipped for spreading over areas to be revegetated. Vegetation would be chipped rather the used directly as brushing because of the need to broadcast seed and irrigate the revegetation areas, which would be difficult and unsafe to access if branches and other irregular vegetation was spread.

Vegetation would be chipped to an average size of 50-80 mm with no individual pieces greater than 150 mm. Chipped vegetation would be stockpiled in windrows no more than 1.5 m high adjoining or as close to their area of origin as possible with signs or markers indicating the origin and classification of the chipped material.

Following the completion of construction and topsoil placement, the chipped vegetation would be re-spread over the areas to be revegetated to a thickness of 10-20 mm to maximise the likelihood of seed in the topsoil or broadcast germinating and not being smothered by too thick a mulch application. If chipped vegetation is re-spread over the areas to be revegetated to a thickness greater than 10-20 mm, it would be incorporated into the topsoil through rotary hoeing. Chipped vegetation spread over those areas from which the weedy topsoil was scalped would be incorporated into surface layer of soil through rotary hoeing. Only chipped vegetation from the same vegetation association would be spread over the area to be revegetated.

If there is inadequate chipped vegetation to cover all the areas to be revegetated, priority for spreading chipped vegetation would be given to those areas from which the weedy topsoil was scalped or subsoil used as the top soil layer.

7. WEED MANAGEMENT

7.1 INTRODUCTION

A large portion of the Project Area, including areas that would be affected by construction as well as offset areas, are infested with weeds. Not controlling the weeds or allowing uncontrolled movement or importation of soil would result in proliferation, introduction or spread of weeds which may result in the loss of vegetation, especially in revegetated areas. Although most of the weeds are grassy weeds, several highly invasive weeds, including Marram Grass (*Ammophila arenaria*) and Dune Onion Weed (*Trachyandra divaricata*) have been recorded on the site along the foredunes and in cleared areas respectively. Some Declared Noxious Weeds (Arum Lily and Bridal Creeper) have also been recorded from the Project Area.

Weed management needs to occur at appropriate times to ensure that weeds are controlled or eliminated prior to and following revegetation.

7.2 STRATEGY

Most of the land in the Project Area would not be affected by construction activities or would not be revegetated following construction or as part of the offsets. It is not proposed to remove or control weeds in areas not subject to revegetation activities.

The strategy that would be adopted for weed management in areas that would be revegetated would be a combination of the following:

- removing and controlling weeds in all areas being revegetated or landscaped with native vegetation
- completely removing topsoil heavily infested with weeds from the construction area and degraded offset areas and either burying it under fill in areas of construction, or mixing it with green waste and composting it before re-spreading it as topsoil
- not using topsoil infested with weed seeds in revegetation without some pre-treatment
- using a combination of manual and chemical weed removal techniques in offset areas prior to revegetation
- controlling weeds in stockpiled topsoil by spraying with appropriate selective herbicides
- controlling weeds following revegetation by regular spraying with appropriate herbicides
- taking care that native plants are not destroyed by weed removal when controlling weeds in revegetation areas
- using a herbicide approved for use in wetland areas and with minimum impacts on wetland fauna if chemical weed control near wetland areas is needed.

7.3 WEED REMOVAL

7.3.1 Construction areas

The topsoil in the construction area between the eastern edge of the Project Area and the access road through the middle of the Project Area is generally very weedy. Very weedy topsoil would be completely removed by scalping to a depth of 50-100 mm and would be placed at the top of the berm proposed to be constructed along the eastern and southern boundary of the Project Area and covered with 300-500 mm of clean fill or clean topsoil. Medium quality topsoil would be stripped and used in revegetation.

At the end of construction, and following spreading of subsoil, good or medium quality topsoil and chipped vegetation as described in Sections 5 and 6, the area would be left to rest until the commencement of the following winter. As soon as germination of weeds is observed after the first winter rains, a glyphosate based herbicide would be applied to all areas. A follow-up application of a glyphosate based herbicide would be applied just prior to commencing revegetation by direct seeding and seedling planting.

7.3.2 Degraded offset areas

The topsoil in the offset areas between the eastern edge of the Project Area and the access road through the middle of the Project Area is very weedy. The majority of the topsoil would be completely removed by scalping to a depth of 50-100 mm and this topsoil would be placed at the top of the berm proposed to be constructed along the eastern and southern boundary of the Project Area and covered with 300-500 mm of clean fill or clean topsoil.

The area around native vegetation from which weedy topsoil could not be removed without damaging the native vegetation would be carefully treated with a herbicide to avoid killing the native vegetation. Any remaining infestations of *Trachyandra divaricata* would be spot sprayed with chlorosulfuron when the plants are actively growing.

Following spreading of any excess topsoil and chipped vegetation as described in Sections 5 and 6, the area would be left to rest until the commencement of the following winter. As soon as germination of weeds is observed after the first winter rains, an appropriate herbicide such as Fusillade or Targa (for grassy weeds), chlorosulfuron (for *Trachyandra*) and glyphosate for other weeds would be applied to all areas. A follow-up application of herbicide would be applied just prior to commencing revegetation by direct seeding and seedling planting.

7.3.3 Good condition offset areas

The offset areas along the coast range from relatively good quality secondary dune vegetation with bare patches to foredunes with Marram Grass and other weeds.

Weed control within the bare patches would consist of spot spraying with an appropriate herbicide such as Fusillade or Targa (for grassy weeds), chlorosulfuron (for Trachyandra) or for other weeds. Herbicides would be applied just prior to revegetation by direct seeding and seedling planting.

To remove Marram Grass and other weeds such as Euphorbias and *Cakile maritima* on the foredunes, either glyphosate or a selective herbicide such as Fusillade,Targa, Ally®, Brushoff®, or Metosulfuram would be applied just prior to revegetation by seedling planting.

7.3.4 Berm

The berm would be constructed from fill with a layer of weedy topsoil covered by weed free subsoil. Following spreading of subsoil, any good quality excess topsoil and chipped vegetation would be spread over the surface. The area would be left to rest until the commencement of the following winter. As soon as germination of weeds is observed after the first winter rains, a glyphosate based herbicide would be applied to all areas. A follow-up application of a glyphosate based herbicide would be applied just prior to commencing revegetation by direct seeding and seedling planting.

7.4 APPLICATION OF HERBICIDE

Herbicide would be applied when the plants are growing, before flowering and before the seed heads develop. Most plants have their greatest growth and flower just before or during spring.

The herbicide would be applied using a vehicle-based sprayer such as 4WD Mule fitted with a 300 litre boom spray where a large, totally degraded area can be sprayed with a non-selective herbicide. For the majority of spot spraying, a 4WD ute with spray units with 150 metre hoses and lance hand pieces would be used. In inaccessible or very sensitive locations where a relatively small number of weeds or individual weeds need to be treated, a knapsack sprayer with a small spray head or wick would be used.

Herbicide would be applied in still, dry, conditions when no rain is predicted within 12 hours. Work would be undertaken in such a manner that no spray drift occurs and that native species growing in the vicinity are not affected either by spray, accidental application or trampling.

After spraying, the ground would be left for a minimum of two weeks before preparation of the planting areas commences.

Application would be undertaken by trained personnel in accordance with manufacturer's instructions. Appropriate safety requirements, including appropriate clothing and spray shield, would be employed.

7.5 ON-GOING WEED CONTROL

Weeds would invade the treated and re-vegetated area, so weed control would continue following planting. However, the revegetated areas are intended to be minimal maintenance and self-sustaining, so on-going weed management would be minimal and consist of the following activities:

- Inspection
- Herbicide application.

Weed management would be undertaken in revegetated areas whenever the completion criteria for weeds are not met, and would continue for a minimum of two years following the cessation of planting, including any replacement planting.

Weed management would consist of selective herbicide application one to three times per year in areas where weeds have become re-established. Herbicide application would be timed to coincide with the active growing season of the weeds to be controlled.

8. REVEGETATION

The Alliance has aggregated the various vegetation associations found in the Project Area into the following five nominal Floristic Community Types (FCT) types based on the PATN analysis undertaken by 360 Environmental:

- FCT 24: Northern Spearwood shrublands and woodlands/Banksia - Agonis woodlands
- FCT 29a: Coastal shrublands on shallow sands
- FCT 30b (Tuart dominated): Quindalup *Eucalyptus gomphocephala* or *Agonis flexuosa* woodlands
- FCT 30b (Peppermint dominated): Quindalup *Eucalyptus gomphocephala* or *Agonis flexuosa* woodlands
- FCT S13: Northern *Olearia axillaris-Scaevola crassifolia* shrublands.

To the 92 native species listed in the Flora List published in the Public Environmental Review as being present in the Project Area, the Alliance has added a further 3 species that have also been found in the Project Area.

Revegetation would be undertaken to re-create vegetation in areas disturbed by construction and in offset areas to match these FCTs to as close to their natural condition or condition prior to disturbance as practicable. All material used in revegetation would be collected within 50 km of the project area to ensure local genetic variances are used in revegetation.

The total area of the Project Area that would be revegetated would be as follows:

- Construction area: 5.2 ha
- Berm: 12.7 ha
- Offset areas: 10.5 ha
- Landscape amenity plantings inside security fencing: 7.2 ha
- Landscape amenity plantings outside security fencing: 7.7 ha.

The optional areas that could be revegetated to reach the 12.6 ha offset target would be as follows:

- Optional Offset area 1: 2.18 ha
- Optional Offset area 2: 2.21 ha.

Revegetation would rely on the following strategies:

- Spreading of thin layers of good quality topsoil
- Direct seeding
- Planting of seedlings propagated from seed, cuttings, runners or tissue culture.

The collection, storage and spreading of topsoil has been discussed in Section 5. Direct seeding and planting of seedlings are covered in the next sections.

9. DIRECT SEEDING

9.1 GENERAL

The Water Corporation is undertaking the collection and pre-treatment of seed which will be obtained from within 50 km of the project area. The Water Corporation has indicated that seed collectors shall collect the seed found during flora and vegetation surveys for the project and listed in the Flora List published in the Public Environmental Review. The Water Corporation has not specified which of these species or how much seed of each of these species would be used for revegetation of the SWRO Plant as distinct from the pipeline route. However, the Water Corporation has indicated that 5 kg/ha of seed would be used in direct seeding. Consequently, for the purposes of this Management Plan and the design of the revegetation program, the Alliance has presumed that the Water Corporation would collect and pre-treat adequate seed to be able to broadcast a total of 5 kg/ha of the type and quantity for each of the Floristic Community Types (FCT) types present in the Project Area as listed in Appendix 3. This seed would be used both for direct seeding and for propagation of seedlings.

9.2 DIRECT SEEDING AREAS

The Alliance would broadcast seed of the specified seed mix for each of the Floristic Community Types (FCT) specified in Appendix 1 as follows, as shown in Appendix 2:

- FCT 24: rehabilitation area, offset area degraded
- FCT 29a: rehabilitation area
- FCT 30b (Tuart dominated): rehabilitation area, offset area degraded, berm
- FCT 30b (Peppermint dominated): rehabilitation area, offset area degraded
- S13: foredune.

Areas nominated for direct seeding would be delineated by the use of stakes or site features or other means so that the areas are clearly marked prior to the start of operations. Prior to broadcasting seed, the surface of the soil would be lightly harrowed or scarified to remove any compaction.

9.3 DIRECT SEEDING TECHNIQUE

Seed would be broadcast uniformly within the marked areas in overlapping passes using manual equipment (not by hand) to allow for complete seed coverage of the pre-prepared area. The Water Corporation has indicated that 5 kg/ha of seed shall be used in revegetation. The Alliance believes that so much seed is not required to achieve acceptable results if appropriate timing, good ground preparation and direct seeding techniques are used but has based this Management Plan and the estimated cost of implementing this plan on this requirement.

Seed would be mixed with a bulking agent such as Vermiculite, clean sand or sawdust in a ratio of 2 parts bulking agent to 1 part seed. A slow release fertiliser having a low phosphorus content (such as Osmocote® PLUS Native Gardens (ratio nitrogen 17: phosphorus 1.6: potassium 8.7)) would be applied at a nominal rate of 200kg/ha (by total weight, or at a rate as directed by the manufacturer) at the time of seeding.

Seed would be covered by very light harrowing, scarifying, bagging, dragging or light raking of the seeded area as soon as practical and within the same day of seeding.

9.4 TIMING

The seed would be broadcast in the offset areas shown in Appendix 1 in May-July 2010 following the first winter rains.

The seed would be broadcast in the rehabilitation areas disturbed by construction and over the berm shown in Appendix 1 in May-July 2011 following the first winter rains.

Direct seeding would be undertaken in these areas before planting of seedlings.

10. PLANT PROPAGATION

The Alliance would obtain living plants of the species, size and number specified for each of the Floristic Community Types (FCT) listed in Appendix 3. The plant species would be propagated from seed, cuttings, runners or tissue culture using pre-treated seed and any other plant material collected by the Water Corporation to meet the provenance requirements of the project.

Seedlings would be obtained from nurseries accredited under the Nursery Industry Accreditation Scheme of Australia. Seedlings would be grown in potting mix meeting the requirements of AS 3743 Potting Mixes and supplied in industry-approved containers.

Seedlings would be propagated and grown in 30 mm square x 70 mm deep tubes (unless otherwise determined by the nature or size of the plants required). All seedlings would be hardened off by growing in open areas receiving sun for around 75% of the day and gradually reducing watering and fertiliser to prepare them for planting out.

Some species such as *Carpobrutus virescens* would be supplied as bare runners rather than as seedlings.

Seedlings would be a minimum of 100 mm high except those to be planted in coastal frontal dunal areas which would be a minimum of 500 mm high.

11. PLANTING SEEDLINGS

11.1 PLANTING AREAS

The seedlings and runners for each of the Floristic Community Types (FCT) listed in Attachment 1 would be planted in the locations shown in the *Revegetation Areas* drawing as follows:

- FCT 24: rehabilitation area, offset area degraded
- FCT 29a: rehabilitation area, offset area good condition (infill planting to 10% of area)
- FCT 30b (Tuart dominated): rehabilitation area, offset area degraded, berm
- FCT 30b (Peppermint dominated): rehabilitation area, offset area degraded, offset area good condition (infill planting to 10% of area)
- FCT S13: offset area good condition.

Individual seedlings would be set out within the planting area in accordance with the following spacings:

- Trees and overstorey: 4 m
- Understorey/shrubs: 2 m
- Groundcover: 1 m

11.2 PLANTING OUT

Planting would be undertaken by hand or by using a mechanical planter. Planting would not occur in unsuitable weather conditions such as extreme heat.

Unless otherwise specified or unless a mechanical planter such as a Potti Putki is used, the planting hole would be excavated vertically to accommodate the root ball of the plant, such that the top of the plant root ball finishes below the existing ground surface and creates a watering saucer suitable for the size of the plant. If necessary the base of the hole would be broken up to a minimum depth of 100 mm and the sides of the planting hole loosened.

In primary dunal areas, especially blowouts, the planting hole would be excavated to a depth of approximately 300 mm, depending upon the height of the seedling or length of the runner to be planted, leaving only the top 25-33% of the seedling or runner exposed once planted.

Prior to any planting into mulch or mulch-modified topsoil, the planting hole would be prepared by first moving clear the mulch to allow for the planting hole to be excavated and space provided for the excavated soil.

Prior to planting the seedling, any tangled roots would be loosened and good soil to plant contact made. Prior to placing the seedling in the planting hole, an appropriate quantity (as recommended by the manufacturer) of a water retention and nutrient-containing medium such as Terracottum would be deposited in the bottom of the hole.

Individual plants would be placed in the centre of the planting hole and set plumb. The backfill would be firmed progressively after placing to eliminate air pockets and minimize settlement. After firming and settlement, the top of the root ball would be covered with soil and sit below the finished lowest level of the surrounding watering saucer shaped during planting. The outside lip of the watering saucer would be approximately three times the diameter of the plant container and capable of holding a sufficient volume of water necessary for any follow-up watering for the plant container size.

A granular, low phosphorus, slow release fertiliser suitable for native plants would be applied to each plant in accordance with good horticultural practice.

Plant guards at least 500 mm high would be installed around plants which are prone to being eaten by rabbits or kangaroos.

11.3 TIMING

Seedlings would be planted in the offset areas shown in Appendix 1 in June-July 2010 following the first winter rains once soil moisture is optimal.

Seedlings would be planted in the rehabilitation areas and over the berm shown in Appendix 1 in June-July 2011 following the first winter rains once soil moisture is optimal.

Planting would be undertaken in these areas after direct seeding.

12. WATERING

An irrigation system would be installed to water areas which are proposed to be seeded and where tubestock would be planted The irrigation system would consist of a layout of a four 100 m long main feeder lines per ha with branch lines every 4 m. Mini sprinklers with an effective watering radius of 2 m would be installed every 4 m on the branch feeder lines. Water would be fed through the main line from temporary watering tanks stationed at the 4 main revegetation areas using low pressure pumps. The water tanks would be replenished on a regular basis by water tanker deliveries.

The revegetation areas would watered once per week for a period of 4 weeks following seeding and planting, which is proposed to occur in May-July. Should seeding and planting occur in the summer period (December to March), these areas would be watered twice a week for those months. In any event, this irrigation setup could remain in place for several years after planting and used to water the revegetation areas at any time, particularly during dry periods, if deemed necessary based on monitoring of rehabilitation success.

13. MANAGEMENT AND MONITORING

13.1 GENERAL

Following direct seeding and planting, the condition and development of the plants would be monitored at least half-yearly. One permanent 1 m x 5 m quadrat and one permanent 20 m x 20 m quadrat would be established per hectare of planted area. In addition, one permanent photo reference point would be established in each of the four revegetation areas before revegetation work starts. Photo records would be captured prior to construction and annually over 5 years to qualitatively assess density and diversity.

Activities would be carried out as necessary for a period of five years to establish and promote the growth of all plant materials and maintain all works in good order and functional condition.

The activities to be undertaken would include but not be limited to the following:

- repairs and replacement of damaged or failed areas of seeding to meet the completion criteria
- replacement of plants that have died to meet the completion criteria.

13.2 COMPLETION CRITERIA

Final completion criteria would be developed in conjunction with the Department of Environment and Conservation. The proposed completion criteria discussed in the following sections have been used for the purposes of this management plan and to develop the estimated cost of implementing this plan.

The proposed completion criteria for tubestock are specified in Table 1. The monitoring to determine whether these completion criteria are achieved would be undertaken in the autumn of each year following planting using the 20 m x 20 m quadrat per hectare of planted area.

Table 1. Tubestock completion criteria

Year after planting	1	2	3	4	5

Acceptable survival (%)	95	90	85	80	75

Where survival of tubestock does not meet the completion criteria specified in Table 1, additional tubestock would be planted to replace dead plants so as to meet the completion criteria specified in Table 1.

The proposed completion criteria for direct seeded areas are specified in Table 2. The monitoring to determine whether these completion criteria are achieved would be undertaken in the autumn of each year following direct seeding using the 1 m x 5 m quadrat per hectare of planted area. The criteria include both plants germinated from seed as well as planted seedlings.

Table 2. Direct seeded areas completion criteria

Year after planting		1	2	3	5
Plant density (plants/m^2) (minimum)	Quadrat	10	10	9	8
Plant diversity (% of original number of species in Vegetation Association) (minimum)	Quadrat	20	25	35	30
Plant diversity (% of original number of species in Project Area) (minimum)	Overall	20	25	30	35
Plant coverage (% area visual ground cover) (minimum)	Quadrat	5	10	25	50
Weeds (number of species) (maximum)	Overall	3	3	3	3
Weed coverage (% area visual ground cover) (maximum)	Quadrat	2	2	2	2

Where areas of direct seeding do not meet the completion criteria specified in Table 2, tubestock would be planted so as to meet the completion criteria specified in Table 2.

14. REVEGETATION OUTSIDE PLANT SITE

In order to have enough space to develop the laydown area, including the batching service, an especific out side area will be transformed to build up these facilities. It is necessary to develop this area out side of the lots marked by the Water Corporation as construction area, because of the total area required to this action will be approximately 5 hectares.

There are some options in terms of availability to develop this service, all of them very close to the construction area. Obviously, these areas will be selected taking into consideration the sustainability issues, i.e. social impact (in terms of noise, night light and dust impact), economic cost and environmental impact (conservation category of each area, important nature values in close proximity).

The actions to undertake in order to minimize the impacts in this area will be all of the actions included in the CEMP. Additionally, a visual and/or noise screen will be construct if it is required.

In addition, the actions to develop to restore the area to the original condition, i.e. to allow the land use that is currently developed, will be the next:

- Top soil managing (cutting, lay down, conservation)

- After construction use, topography restoring.
- Respreading topsoil
- Final seeding and planting of the species that were growing there before construction stage.
- Monitoring of erosion and revegetation.

During the second construction phase, has been planed use the same location to develop the lay down area, with the same procedure to restore it.

15. ACKNOWLEDGEMENTS

This revegetation management plan was prepared with valuable inputs from the following sources:

- Botanic Gardens and Parks Authority
- Southern Gateway Alliance
- Tranen
- Challenger TAFE
- Landcare Services.

Attachment 1 – Species and quantities of seed to be utilised and plants to be propagated

		Offset area-good condition							
	Species	Seeds (g)				Tubestock			
Seed/Tube stock/Vegetative	Species	Total	S13	29a	30b-Af	Total	S13	29a	30b-Af
S	Acacia cochlearis	45.4	0 0	45.4	0.0	0	0	0	0
S	Acacia cyclops	2772 8	0 0	0.0	2772.8	0	0	0	0
S	Acacia lasiocarpa var. lasiocarpa	230 3	0 0	24.9	205.4	0	0	0	0
S	Acacia saligna	1071 9	0 0	115.8	956.1	0	0	0	0
S	Acacia truncata	52 2	0 0	52.2	0.0	0	0	0	0
S	Acanthocarpus preissii	6831 5	4334 3	186.6	2310.6	0	0	0	0
S	Agonis flexuosa var. flexuosa	81.7	0 0	0.0	81.7	0	0	0	0
T	Alyxia buxifolia	155 2	52 0	1.0	102.2	621	208	4	409
T	Anthocercis ilicifolia	2 0	0 0	0.0	2.0	409	0	0	409
S	Asteridea pulverulenta	1 0	0 0	1.0	0.0	0	0	0	0
S	Austrodanthonia occidentalis	25.1	0 0	25.1	0.0	0	0	0	0
S	Austrostipa campylachne	25.1	0 0	25.1	0.0	0	0	0	0
S	Austrostipa flavescens	102.7	0 0	25.1	77.6	0	0	0	0
T	Banksia attenuata	0 0	0 0	0.0	0.0	0	0	0	0
T	Carex preissii	4.1	0 0	0.0	4.1	409	0	0	409
V	Carpobrotus virescens	54 0	52 0	2.0	0.0	2161	2080	81	0
T	Cassytha racemosa forma racemosa	0.4	0 0	0.4	0.0	4	0	4	0
T	Clematis linearifolia	20.4	0 0	0.0	20.4	409	0	0	409
S	Conostylis aculeata subsp. aculeata	1026.4	936 2	12.5	77.6	0	0	0	0
S	Conostylis aculeata subsp. preissii	0 0	0 0	0.0	0.0	0	0	0	0
S	Daucus glochidiatus	44 9	0 0	4.0	40.9	0	0	0	0
T	Dianella revoluta var. divaricata	0 0	0 0	0.0	0.0	0	0	0	0
S	Dichopogon capillipes	0 0	0 0	0.0	0.0	0	0	0	0
T	Diplolaena dampieri	26 8	0 0	0.5	26.3	521	0	10	511
S	Elymus scaber	2 0	0 0	2.0	0.0	0	0	0	0
S	Eucalyptus gomphocephala	0 0	0 0	0.0	0.0	0	0	0	0
T	Exocarpos sparteus	0 2	0 0	0.2	0.0	4	0	4	0
T	Ficinia nodosa	23.1	23.1	0.0	0.0	2080	2080	0	0
T	Geranium retrorsum	106 2	0 0	4.0	102.2	1062	0	40	1022
S	Hakea prostrata	71.7	0 0	71.7	0.0	0	0	0	0
S	Hardenbergia comptoniana	1252.4	0 0	143.3	1109.1	0	0	0	0
T	Hemiandra pungens	11 2	0 0	1.0	10.2	449	0	40	409
T	Hibbertia cuneiformis	24 2	9 3	0.4	14.6	679	260	10	409
T	Hibbertia racemosa	0.4	0 0	0.4	0.0	10	0	10	0
S	Jacksonia furcellata	1730 2	1387 0	55.7	287.5	0	0	0	0
S	Kennedia prostrata	0 0	0 0	0.0	0.0	0	0	0	0
S	Lagenophora huegelii	34.7	0 0	0.0	34.7	0	0	0	0
T	Lepidosperma gladiatum	10 0	0 0	10.0	0.0	10	0	10	0
T	Lepidosperma pubisquameum	16 2	11 6	0.1	4.5	1459	1040	10	409
T	Lepidosperma squamatum	0.1	0 0	0.1	0.0	10	0	10	0
T	Leucopogon parviflorus	4 0	0 0	4.0	0.0	40	0	40	0
T	Logania vaginalis	1 0	0 0	0.0	1.0	409	0	0	409
T	Lomandra maritima	1 0	0 0	1.0	0.0	40	0	40	0
S	Microlaena stipoides var. stipoides	10 2	0 0	0.0	10.2	0	0	0	0
S	Millotia myosotidifolia	1 0	0 0	1.0	0.0	0	0	0	0
T	Myoporum insulare	6 8	0 0	0.0	6.8	41	0	0	41
S	Olearia axillaris	706 6	520.1	13.9	172.5	0	0	0	0
S	Ozothamnus cordatus	6 3	0 0	6.3	0.0	0	0	0	0
S	Phyllanthus calycinus	116 3	0 0	2.8	113.5	0	0	0	0
S	Poa drummondiana	1 0	0 0	1.0	0.0	0	0	0	0
S	Poa poiformis	0 5	0 0	0.5	0.0	0	0	0	0
S	Poa porphyroclados	37 2	26 0	1.0	10.2	0	0	0	0
S	Podotheca angustifolia	1 0	0 0	1.0	0.0	0	0	0	0
S	Rhagodia baccata subsp. baccata	3212.7	2837 0	22.8	352.9	0	0	0	0
S	Rhodanthe citrina	4 0	0 0	4.0	0.0	0	0	0	0
T	Santalum acuminatum	1593 0	0 0	60.7	1532.3	53	0	2	51
T	Scaevola crassifolia	53 8	28 9	2.2	22.7	969	520	40	409
T	Schoenus grandiflorus	52 3	52 0	0.3	0.0	2091	2080	10	0
S	Senecio pinnatifolius var. latilobus	570 8	468.1	25.1	77.6	0	0	0	0
V	Spinifex hirsutus	17.4	17 3	0.1	0.0	2091	2080	10	0
V	Spinifex longifolius	104 0	104 0	0.0	0.0	4161	4161	0	0
S	Spyridium globulosum	52.1	13 0	4.5	34.7	0	0	0	0
S	Templetonia retusa	420.1	0 0	0.0	420.1	0	0	0	0
T	Tetraria octandra	0 0	0 0	0.0	0.0	0	0	0	0
T	Thomasia cognata	1 0	0 0	1.0	0.0	40	0	40	0
T	Thysanotus arenarius	0 2	0 0	0.2	0.0	10	0	10	0
T	Thysanotus manglesianus	0 2	0 0	0.2	0.0	10	0	10	0
T	Thysanotus multiflorus	0 2	0 0	0.2	0.0	10	0	10	0
S	Trachymene coerulea subsp. coerulea	35 8	0 0	35.8	0.0	0	0	0	0
S	Trachymene pilosa	22.4	0 0	22.4	0.0	0	0	0	0
T	Tricoryne elatior	0 0	0 0	0.0	0.0	0	0	0	0
T	Wurmbea monantha	0.4	0 0	0.4	0.0	40	0	40	0
S	Zygophyllum fruticulosum	25 3	0 0	25.3	0.0	0	0	0	0
	Total (g)	22915 5	10871 9	1048.4	10995.2	20302	14511	489	5302
	Total (kg)	22 9	10 9	1.0	11.0	20302	14511	489	5302
	Area(ha)	4 3	2.1	0.2	2.0	4 3	2.1	0.2	2.0
	Seed application rate	5 3	5 2	5.2	5.4	4721	6975	2447	2595

		Offset area-degraded									
	Species	Seeds (g)					Tubestock				
Seed/Tube stock/Vegetative	Species	Total	24	30b-Af	30b-Eg	29a	Total	24	30b-Af	30b-Eg	29a
S	Acacia cochlearis	49.6	0 0	0.0	0.0	49.6	0	0	0	0	0
S	Acacia cyclops	3823.5	0 0	3410.3	413.3	0.0	0	0	0	0	0
S	Acacia lasiocarpa var. lasiocarpa	350.9	40 5	252.6	30.6	27.2	0	0	0	0	0
S	Acacia saligna	1444.9	0 0	1176.0	142.5	126.5	0	0	0	0	0
S	Acacia truncata	57.1	0 0	0.0	0.0	57.1	0	0	0	0	0
S	Acanthocarpus preissii	8081.2	1821.4	2841.9	3214.2	203.8	0	0	0	0	0
S	Agonis flexuosa var. flexuosa	125.9	10.7	100.5	14.7	0.0	0	0	0	0	0
T	Alyxia buxifolia	226.2	53 5	125.6	45.9	1.1	905	214	503	184	4
T	Anthocercis ilicifolia	2.9	0 0	2.5	0.4	0.0	576	0	503	73	0
S	Asteridea pulverulenta	1.1	0 0	0.0	0.0	1.1	0	0	0	0	0
S	Austrodanthonia occidentalis	27.4	0 0	0.0	0.0	27.4	0	0	0	0	0
S	Austrostipa campylachne	27.4	0 0	0.0	0.0	27.4	0	0	0	0	0
S	Austrostipa flavescens	169.2	0 0	95.5	46.3	27.4	0	0	0	0	0
T	Banksia attenuata	1639.2	1639 2	0.0	0.0	0.0	321	321	0	0	0
T	Carex preissii	10.1	2.1	5.0	2.9	0.0	1010	214	503	294	0
V	Carpobrotus virescens	2.2	0 0	0.0	0.0	2.2	0	0	0	0	0
T	Cassytha racemosa forma racemosa	0.4	0 0	0.0	0.0	0.4	4	0	0	0	4
T	Clematis linearifolia	25.1	0 0	25.1	0.0	0.0	503	0	503	0	0
S	Conostylis aculeata subsp. aculeata	155.5	0 0	95.5	46.3	13.7	0	0	0	0	0
S	Conostylis aculeata subsp. preissii	15.3	15 3	0.0	0.0	0.0	0	0	0	0	0
S	Daucus glochidiatus	98.8	0 0	50.3	44.1	4.4	0	0	0	0	0
T	Dianella revoluta var. divaricata	13.4	13.4	0.0	0.0	0.0	214	214	0	0	0
S	Dichopogon capillipes	21.9	21 9	0.0	0.0	0.0	0	0	0	0	0
T	Diplolaena dampieri	38.6	0 0	32.4	5.7	0.6	749	0	628	110	11
S	Elymus scaber	2.2	0 0	0.0	0.0	2.2	0	0	0	0	0
S	Eucalyptus gomphocephala	1322.4	0 0	0.0	1322.4	0.0	0	0	0	0	0
T	Exocarpos sparteus	0.2	0 0	0.0	0.0	0.2	4	0	0	0	4
T	Ficinia nodosa	0.0	0 0	0.0	0.0	0.0	0	0	0	0	0
T	Geranium retrorsum	227.6	53 5	125.6	44.1	4.4	2276	535	1256	441	44
S	Hakea prostrata	78.2	0 0	0.0	0.0	78.2	0	0	0	0	0
S	Hardenbergia comptoniana	2291.1	109 3	1364.1	661.2	156.5	0	0	0	0	0
T	Hemiandra pungens	13.7	0 0	12.6	0.0	1.1	547	0	503	0	44
T	Hibbertia cuneiformis	27.8	2 9	17.9	6.6	0.4	778	80	503	184	11
T	Hibbertia racemosa	0.4	0 0	0.0	0.0	0.4	11	0	0	0	11
S	Jacksonia furcellata	700.2	0 0	353.7	285.7	60.9	0	0	0	0	0
S	Kennedia prostrata	1020.0	1020 0	0.0	0.0	0.0	0	0	0	0	0
S	Lagenophora huegelii	49.5	6 8	42.6	0.0	0.0	0	0	0	0	0
T	Lepidosperma gladiatum	133.3	0 0	0.0	122.4	10.9	746	0	0	735	11
T	Lepidosperma pubisquameum	9.3	2.4	5.6	1.2	0.1	838	214	503	110	11
T	Lepidosperma squamatum	0.1	0 0	0.0	0.0	0.1	11	0	0	0	11
T	Leucopogon parviflorus	4.4	0 0	0.0	0.0	4.4	44	0	0	0	44
T	Logania vaginalis	1.3	0 0	1.3	0.0	0.0	503	0	503	0	0
T	Lomandra maritima	9.2	5 3	0.0	2.8	1.1	368	214	0	110	44
S	Microlaena stipoides var. stipoides	12.6	0 0	12.6	0.0	0.0	0	0	0	0	0
S	Millotia myosotidifolia	1.1	0 0	0.0	0.0	1.1	0	0	0	0	0
T	Myoporum insulare	14.3	0 0	8.4	5.9	0.0	80	0	50	29	0
S	Olearia axillaris	432.8	34 0	212.2	171.4	15.2	0	0	0	0	0
S	Ozothamnus cordatus	6.8	0 0	0.0	0.0	6.8	0	0	0	0	0
S	Phyllanthus calycinus	232.7	59.4	139.6	30.6	3.1	0	0	0	0	0
S	Poa drummondiana	1.1	0 0	0.0	0.0	1.1	0	0	0	0	0
S	Poa poiformis	0.6	0 0	0.0	0.0	0.6	0	0	0	0	0
S	Poa porphyroclados	24.7	0 0	12.6	11.0	1.1	0	0	0	0	0
S	Podotheca angustifolia	1.1	0 0	0.0	0.0	1.1	0	0	0	0	0
S	Rhagodia baccata subsp. baccata	832.2	92.7	434.0	280.5	24.9	0	0	0	0	0
S	Rhodanthe citrina	4.4	0 0	0.0	0.0	4.4	0	0	0	0	0
T	Santalum acuminatum	2391.7	0 0	1884.6	440.8	66.3	80	0	63	15	2
T	Scaevola crassifolia	36.5	0 0	27.9	6.1	2.5	657	0	503	110	44
T	Schoenus grandiflorus	5.6	5 3	0.0	0.0	0.3	225	214	0	0	11
S	Senecio pinnatifolius var. latilobus	138.2	15 3	95.5	0.0	27.4	0	0	0	0	0
V	Spinifex hirsutus	0.1	0 0	0.0	0.0	0.1	11	0	0	0	11
V	Spinifex longifolius	0.0	0 0	0.0	0.0	0.0	0	0	0	0	0
S	Spyridium globulosum	153.8	51 2	42.6	55.1	4.9	0	0	0	0	0
S	Templetonia retusa	1098.3	331 2	516.7	250.5	0.0	0	0	0	0	0
T	Tetraria octandra	5.3	5 3	0.0	0.0	0.0	214	214	0	0	0
T	Thomasia cognata	1.1	0 0	0.0	0.0	1.1	44	0	0	0	44
T	Thysanotus arenarius	0.2	0 0	0.0	0.0	0.2	11	0	0	0	11
T	Thysanotus manglesianus	0.2	0 0	0.0	0.0	0.2	11	0	0	0	11
T	Thysanotus multiflorus	3.8	3 6	0.0	0.0	0.2	225	214	0	0	11
S	Trachymene coerulea subsp. coerulea	39.1	0 0	0.0	0.0	39.1	0	0	0	0	0
S	Trachymene pilosa	38.1	13.7	0.0	0.0	24.5	0	0	0	0	0
T	Tricoryne elatior	7.1	7.1	0.0	0.0	0.0	214	214	0	0	0
T	Wurmbea monantha	0.4	0 0	0.0	0.0	0.4	44	0	0	0	44
S	Zygophyllum fruticulosum	27.6	0 0	0.0	0.0	27.6	0	0	0	0	0
	Total (g)	27810.1	5437 0	13523.2	7705.1	1144.7	12224	2862	6521	2395	446
	Total (kg)	27.8	5.4	13.5	7.7	1.1	12224	2862	6521	2395	446
	Area(ha)	5.3	1.1	2.5	1.5	0.2	5 3	1.1	2.5	1.5	0 2
	Seed application rate	5.3	5.1	5.4	5.2	5.2	2318	2675	2595	1630	2020

		Rehab area									
	Species	Seeds (g)					Tubestock				
Seed/Tube stock/Vegetative	Species	Total	24	30b-Eg	30b-Af	29a	Total	24	30b-Eg	30b-Af	29a
S	Acacia cochlearis	1835.3	0 0	0.0	0.0	1835.3	0	0	0	0	0
S	Acacia cyclops	1977.6	0 0	745.3	1232.3	0.0	0	0	0	0	0
S	Acacia lasiocarpa var. lasiocarpa	1188.4	35 8	55.2	91.3	1006.0	0	0	0	0	0
S	Acacia saligna	5365.1	0 0	257.0	424.9	4683.2	0	0	0	0	0
S	Acacia truncata	2112.6	0 0	0.0	0.0	2112.6	0	0	0	0	0
S	Acanthocarpus preissii	15981.7	1612 9	5796.7	1027.0	7545.1	0	0	0	0	0
S	Agonis flexuosa var. flexuosa	72.3	9 5	26.5	36.3	0.0	0	0	0	0	0
T	Alyxia buxifolia	216.5	47.4	82.8	45.4	40.9	866	189	331	182	164
T	Anthocercis ilicifolia	1.6	0 0	0.7	0.9	0.0	314	0	132	182	0
S	Asteridea pulverulenta	40.9	0 0	0.0	0.0	40.9	0	0	0	0	0
S	Austrodanthonia occidentalis	1014.1	0 0	0.0	0.0	1014.1	0	0	0	0	0
S	Austrostipa campylachne	1014.1	0 0	0.0	0.0	1014.1	0	0	0	0	0
S	Austrostipa flavescens	1132.0	0 0	83.5	34.5	1014.1	0	0	0	0	0
T	Banksia attenuata	1451.6	1451 6	0.0	0.0	0.0	284	284	0	0	0
T	Carex preissii	9.0	1 9	5.3	1.8	0.0	901	189	530	182	0
V	Carpobrotus virescens	81.8	0 0	0.0	0.0	81.8	0	0	0	0	0
T	Cassytha racemosa forma racemosa	16.4	0 0	0.0	0.0	16.4	164	0	0	0	164
T	Clematis linearifolia	9.1	0 0	0.0	9.1	0.0	182	0	0	182	0
S	Conostylis aculeata subsp. aculeata	625.0	0 0	83.5	34.5	507.0	0	0	0	0	0
S	Conostylis aculeata subsp. preissii	13.5	13 5	0.0	0.0	0.0	0	0	0	0	0
S	Daucus glochidiatus	261.2	0 0	79.5	18.2	163.6	0	0	0	0	0
T	Dianella revoluta var. divaricata	11.8	11 8	0.0	0.0	0.0	189	189	0	0	0
S	Dichopogon capillipes	19.4	19.4	0.0	0.0	0.0	0	0	0	0	0
T	Diplolaena dampieri	43.0	0 0	10.2	11.7	21.1	835	0	199	227	409
S	Elymus scaber	81.8	0 0	0.0	0.0	81.8	0	0	0	0	0
S	Eucalyptus gomphocephala	2384.9	0 0	2384.9	0.0	0.0	0	0	0	0	0
T	Exocarpos sparteus	9.1	0 0	0.0	0.0	9.1	164	0	0	0	164
T	Ficinia nodosa	0.0	0 0	0.0	0.0	0.0	0	0	0	0	0
T	Geranium retrorsum	335.8	47.4	79.5	45.4	163.6	3358	474	795	454	1636
S	Hakea prostrata	2897.3	0 0	0.0	0.0	2897.3	0	0	0	0	0
S	Hardenbergia comptoniana	7576.8	96 8	1192.5	492.9	5794.7	0	0	0	0	0
T	Hemiandra pungens	45.4	0 0	0.0	4.5	40.9	1817	0	0	182	1636
T	Hibbertia cuneiformis	35.5	2 5	11.8	6.5	14.6	993	71	331	182	409
T	Hibbertia racemosa	14.6	0 0	0.0	0.0	14.6	409	0	0	0	409
S	Jacksonia furcellata	2896.5	0 0	515.3	127.8	2253.5	0	0	0	0	0
S	Kennedia prostrata	903.2	903 2	0.0	0.0	0.0	0	0	0	0	0
S	Lagenophora huegelii	21.5	6 0	0.0	15.4	0.0	0	0	0	0	0
T	Lepidosperma gladiatum	623.2	0 0	220.8	0.0	402.4	1734	0	1325	0	409
T	Lepidosperma pubisquameum	10.9	2.1	2.2	2.0	4.5	979	189	199	182	409
T	Lepidosperma squamatum	4.5	0 0	0.0	0.0	4.5	409	0	0	0	409
T	Leucopogon parviflorus	163.6	0 0	0.0	0.0	163.6	1636	0	0	0	1636
T	Logania vaginalis	0.5	0 0	0.0	0.5	0.0	182	0	0	182	0
T	Lomandra maritima	50.6	4.7	5.0	0.0	40.9	2024	189	199	0	1636
S	Microlaena stipoides var. stipoides	4.5	0 0	0.0	4.5	0.0	0	0	0	0	0
S	Millotia myosotidifolia	40.9	0 0	0.0	0.0	40.9	0	0	0	0	0
T	Myoporum insulare	13.6	0 0	10.6	3.0	0.0	71	0	53	18	0
S	Olearia axillaris	979.3	30.1	309.2	76.7	563.4	0	0	0	0	0
S	Ozothamnus cordatus	253.5	0 0	0.0	0.0	253.5	0	0	0	0	0
S	Phyllanthus calycinus	271.9	52 6	55.2	50.4	113.6	0	0	0	0	0
S	Poa drummondiana	40.9	0 0	0.0	0.0	40.9	0	0	0	0	0
S	Poa poiformis	20.4	0 0	0.0	0.0	20.4	0	0	0	0	0
S	Poa porphyroclados	65.3	0 0	19.9	4.5	40.9	0	0	0	0	0
S	Podotheca angustifolia	40.9	0 0	0.0	0.0	40.9	0	0	0	0	0
S	Rhagodia baccata subsp. baccata	1666.7	82.1	505.9	156.8	921.9	0	0	0	0	0
S	Rhodanthe citrina	163.6	0 0	0.0	0.0	163.6	0	0	0	0	0
T	Santalum acuminatum	3929.4	0 0	795.0	681.0	2453.4	131	0	26	23	82
T	Scaevola crassifolia	112.0	0 0	11.0	10.1	90.9	2016	0	199	182	1636
T	Schoenus grandiflorus	15.0	4.7	0.0	0.0	10.2	598	189	0	0	409
S	Senecio pinnatifolius var. latilobus	1062.1	13 5	0.0	34.5	1014.1	0	0	0	0	0
V	Spinifex hirsutus	3.4	0 0	0.0	0.0	3.4	409	0	0	0	409
V	Spinifex longifolius	0.0	0 0	0.0	0.0	0.0	0	0	0	0	0
S	Spyridium globulosum	341.2	45.4	99.4	15.4	181.1	0	0	0	0	0
S	Templetonia retusa	931.7	293 3	451.7	186.7	0.0	0	0	0	0	0
T	Tetraria octandra	4.7	4.7	0.0	0.0	0.0	189	189	0	0	0
T	Thomasia cognata	40.9	0 0	0.0	0.0	40.9	1636	0	0	0	1636
T	Thysanotus arenarius	6.8	0 0	0.0	0.0	6.8	409	0	0	0	409
T	Thysanotus manglesianus	6.8	0 0	0.0	0.0	6.8	409	0	0	0	409
T	Thysanotus multiflorus	10.0	3 2	0.0	0.0	6.8	598	189	0	0	409
S	Trachymene coerulea subsp. coerulea	1448.7	0 0	0.0	0.0	1448.7	0	0	0	0	0
S	Trachymene pilosa	917.5	12.1	0.0	0.0	905.4	0	0	0	0	0
T	Tricoryne elatior	6.3	6 3	0.0	0.0	0.0	189	189	0	0	0
T	Wurmbea monantha	16.4	0 0	0.0	0.0	16.4	1636	0	0	0	1636
S	Zygophyllum fruticulosum	1022.2	0 0	0.0	0.0	1022.2	0	0	0	0	0
	Total (g)	65986.4	4814 6	13896.0	4886.8	42389.0	25730	2534	4319	2356	16519
	Total (kg)	66.0	4 8	13.9	4.9	42.4	25730	2534	4319	2356	16519
	Area(ha)	12.7	0 9	2.6	0.9	8.2	12.7	0.9	2.6	0.9	8 2
	Seed application rate	5.2	5.1	5.2	5.4	5.2	2029	2675	1630	2595	2020

		Berm			
	Species	Seeds (g)		Tubestock	
Seed/Tube stock/Vegetative	Species	Total	30b-Eg	Total	30b-Eg
S	Acacia cochlearis	0.0	0 0	0	0
S	Acacia cyclops	1258.4	1258.4	0	0
S	Acacia lasiocarpa var. lasiocarpa	93.2	93 2	0	0
S	Acacia saligna	433.9	433 9	0	0
S	Acacia truncata	0.0	0 0	0	0
S	Acanthocarpus preissii	9787.9	9787 9	0	0
S	Agonis flexuosa var. flexuosa	44.7	44.7	0	0
T	Alyxia buxifolia	139.8	139 8	559	559
T	Anthocercis ilicifolia	1.1	1.1	224	224
S	Asteridea pulverulenta	0.0	0 0	0	0
S	Austrodanthonia occidentalis	0.0	0 0	0	0
S	Austrostipa campylachne	0.0	0 0	0	0
S	Austrostipa flavescens	140.9	140 9	0	0
T	Banksia attenuata	0.0	0 0	0	0
T	Carex preissii	8.9	8 9	895	895
V	Carpobrotus virescens	0.0	0 0	0	0
T	Cassytha racemosa forma racemosa	0.0	0 0	0	0
T	Clematis linearifolia	0.0	0 0	0	0
S	Conostylis aculeata subsp. aculeata	140.9	140 9	0	0
S	Conostylis aculeata subsp. preissii	0.0	0 0	0	0
S	Daucus glochidiatus	134.2	134 2	0	0
T	Dianella revoluta var. divaricata	0.0	0 0	0	0
S	Dichopogon capillipes	0.0	0 0	0	0
T	Diplolaena dampieri	17.3	17 3	336	336
S	Elymus scaber	0.0	0 0	0	0
S	Eucalyptus gomphocephala	4027.0	4027 0	0	0
T	Exocarpos sparteus	0.0	0 0	0	0
T	Ficinia nodosa	0.0	0 0	0	0
T	Geranium retrorsum	134.2	134 2	1342	1342
S	Hakea prostrata	0.0	0 0	0	0
S	Hardenbergia comptoniana	2013.5	2013 5	0	0
T	Hemiandra pungens	0.0	0 0	0	0
T	Hibbertia cuneiformis	20.0	20 0	559	559
T	Hibbertia racemosa	0.0	0 0	0	0
S	Jacksonia furcellata	870.0	870 0	0	0
S	Kennedia prostrata	0.0	0 0	0	0
S	Lagenophora huegelii	0.0	0 0	0	0
T	Lepidosperma gladiatum	372.9	372 9	2237	2237
T	Lepidosperma pubisquameum	3.7	3.7	336	336
T	Lepidosperma squamatum	0.0	0 0	0	0
T	Leucopogon parviflorus	0.0	0 0	0	0
T	Logania vaginalis	0.0	0 0	0	0
T	Lomandra maritima	8.4	8.4	336	336
S	Microlaena stipoides var. stipoides	0.0	0 0	0	0
S	Millotia myosotidifolia	0.0	0 0	0	0
T	Myoporum insulare	17.9	17 9	89	89
S	Olearia axillaris	522.0	522 0	0	0
S	Ozothamnus cordatus	0.0	0 0	0	0
S	Phyllanthus calycinus	93.2	93 2	0	0
S	Poa drummondiana	0.0	0 0	0	0
S	Poa poiformis	0.0	0 0	0	0
S	Poa porphyroclados	33.6	33 6	0	0
S	Podotheca angustifolia	0.0	0 0	0	0
S	Rhagodia baccata subsp. baccata	854.2	854 2	0	0
S	Rhodanthe citrina	0.0	0 0	0	0
T	Santalum acuminatum	1342.3	1342 3	45	45
T	Scaevola crassifolia	18.6	18 6	336	336
T	Schoenus grandiflorus	0.0	0 0	0	0
S	Senecio pinnatifolius var. latilobus	0.0	0 0	0	0
V	Spinifex hirsutus	0.0	0 0	0	0
V	Spinifex hirsutus	0.0	0 0	0	0
S	Spyridium globulosum	167.8	167 8	0	0
S	Templetonia retusa	762.7	762.7	0	0
T	Tetraria octandra	0.0	0 0	0	0
T	Thomasia cognata	0.0	0 0	0	0
T	Thysanotus arenarius	0.0	0 0	0	0
T	Thysanotus manglesianus	0.0	0 0	0	0
T	Thysanotus multiflorus	0.0	0 0	0	0
S	Trachymene coerulea subsp. coerulea	0.0	0 0	0	0
S	Trachymene pilosa	0.0	0 0	0	0
T	Tricoryne elatior	0.0	0 0	0	0
T	Wurmbea monantha	0.0	0 0	0	0
S	Zygophyllum fruticulosum	0.0	0 0	0	0
	Total (g)	23463.6	23463 6	7293	7293
	Total (kg)	23.5	23 5	7293.4	7293.4
	Area(ha)	4.5	4 5	4.5	4.5
	Seed application rate	5.2	5 2	1630	1630

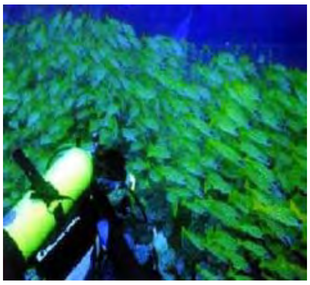
	Species	Total Seeds (g)		Total Tubestock	
Seed/Tube stock/Vegetative	Species	Total (g)	Total (kg)	Total No.	No of plants minimum 500mm stem
S	Acacia cochlearis	1930 3	1.9		
S	Acacia cyclops	9832.4	9.8		
S	Acacia lasiocarpa var. lasiocarpa	1862.7	1.9		
S	Acacia saligna	8315 9	8.3		
S	Acacia truncata	2221 9	2.2		
S	Acanthocarpus preissii	40682 3	40.7		
S	Agonis flexuosa var. flexuosa	324.7	0.3		
T	Alyxia buxifolia	737 6	0.7	2951	208
T	Anthocercis ilicifolia	7 6	0.0	1522	
S	Asteridea pulverulenta	43 0	0.0		
S	Austrodanthonia occidentalis	1066 5	1.1		
S	Austrostipa campylachne	1066 5	1.1		
S	Austrostipa flavescens	1544 9	1.5		
T	Banksia attenuata	3090 8	3.1	605	
T	Carex preissii	32.1	0.0	3215	
V	Carpobrotus virescens	138 0	0.1	2161	2080
T	Cassytha racemosa forma racemosa	17 2	0.0	172	
T	Clematis linearifolia	54 6	0.1	1093	
S	Conostylis aculeata subsp. aculeata	1947 8	1.9		
S	Conostylis aculeata subsp. preissii	28 8	0.0		
S	Daucus glochidiatus	539.1	0.5		
T	Dianella revoluta var. divaricata	25 2	0.0	403	
S	Dichopogon capillipes	41 2	0.0		
T	Diplolaena dampieri	125 8	0.1	2441	
S	Elymus scaber	86 0	0.1		
S	Eucalyptus gomphocephala	7734 3	7.7		
T	Exocarpos sparteus	9 6	0.0	172	
T	Ficinia nodosa	23.1	0.0	2080	2080
T	Geranium retrorsum	803 9	0.8	8039	
S	Hakea prostrata	3047 2	3.0		
S	Hardenbergia comptoniana	13133 8	13.1		
T	Hemiandra pungens	70 3	0.1	2813	
T	Hibbertia cuneiformis	107.4	0.1	3008	260
T	Hibbertia racemosa	15.4	0.0	430	
S	Jacksonia furcellata	6197 0	6.2		
S	Kennedia prostrata	1923 2	1.9		
S	Lagenophora huegelii	105 6	0.1		
T	Lepidosperma gladiatum	1139.4	1.1	4727	
T	Lepidosperma pubisquameum	40.1	0.0	3611	1040
T	Lepidosperma squamatum	4 8	0.0	430	
T	Leucopogon parviflorus	172 0	0.2	1720	
T	Logania vaginalis	2.7	0.0	1093	
T	Lomandra maritima	69 2	0.1	2768	
S	Microlaena stipoides var. stipoides	27 3	0.0		
S	Millotia myosotidifolia	43 0	0.0		
T	Myoporum insulare	52 6	0.1	281	
S	Olearia axillaris	2640.7	2.6		
S	Ozothamnus cordatus	266 6	0.3		
S	Phyllanthus calycinus	714.1	0.7		
S	Poa drummondiana	43 0	0.0		
S	Poa poiformis	21 5	0.0		
S	Poa porphyroclados	160 8	0.2		
S	Podotheca angustifolia	43 0	0.0		
S	Rhagodia baccata subsp. baccata	6565 8	6.6		
S	Rhodanthe citrina	172 0	0.2		
T	Santalum acuminatum	9256.4	9.3	309	
T	Scaevola crassifolia	221 0	0.2	3978	520
T	Schoenus grandiflorus	72 8	0.1	2914	2080
S	Senecio pinnatifolius var. latilobus	1771.1	1.8		
V	Spinifex hirsutus	20 9	0.0	2511	2080
V	Spinifex longifolius	104 0	0.1	4161	4161
S	Spyridium globulosum	715 0	0.7		
S	Templetonia retusa	3212 8	3.2		
T	Tetraria octandra	10.1	0.0	403	
T	Thomasia cognata	43 0	0.0	1720	
T	Thysanotus arenarius	7 2	0.0	430	
T	Thysanotus manglesianus	7 2	0.0	430	
T	Thysanotus multiflorus	13 9	0.0	834	
S	Trachymene coerulea subsp. coerulea	1523 6	1.5		
S	Trachymene pilosa	978 0	1.0		
T	Tricoryne elatior	13.4	0.0	403	
T	Wurmbea monantha	17 2	0.0	1720	
S	Zygophyllum fruticulosum	1075.1	1.1		
	Total (g)	140175 6	140.2	65549	14511
	Total (kg)	140 2			
	Area(ha)	26 8		26.8	
	Application rate/ha	5 2		2450	

REPORT

Review of Literature on Sound in the Ocean and Effects of Noise and Blast on Marine Fauna







Prepared for
Western Australian Water Corporation

URS Project No.: 42906896-1892 : R1340

8 July 2008

URS

R E P O R T

Review of Literature on Sound in the Ocean and Effects of Noise and Blast on Marine Fauna

Prepared for

Western Australian Water Corporation

8 July 2008

Job No.: 42906896-1892
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1. INTRODUCTION

1.1 BACKGROUND

The Western Australian Water Corporation (WAWC) is proposing to develop a desalinisation plant at Binningup, Western Australia as part of the Southern Seawater Desalinisation Project (SSDP).

In accordance with Commonwealth and Western Australian environmental approvals requirements, the WAWC has undertaken a range of environmental studies and assessments in support of the SSDP proposal. These are summarised in the *Southern Seawater Desalination Project: Environmental Impact Assessment Public Environmental Review* (PER) (WAWC 2008).

The construction and operation of the SSDP will generate in-water noise, which has the potential to lead to adverse impacts upon marine fauna in the vicinity of the development site.

Potential sources of noise during construction include dredging activities, pile driving (e.g. during construction of the temporary jetty and the laying of the pipe), rock armour dumping, sand/sludge dumping and general vessel traffic. If explosives are used during construction of the pipeline then this too will be a source of noise as well as impulse. Potential noise sources during operations include the movement of water through the outfall as well as vessel traffic associated with periodic maintenance and inspection.

All of these activities may disturb marine fauna to varying degrees. As a result, it was deemed pertinent to undertake a review of literature focusing on the effects of noise and blast on marine fauna and assess potential impacts associated with this project.

1.2 OBJECTIVES AND SCOPE

This report provides information on important marine fauna in relation to noise generating activities and examines the potential risk associated with noise generated from activities attendant to this project. The report provides a literature review on sound in the ocean and the effects of noise on marine fauna, where the following topics are discussed:

- the characteristics of ambient noise;
- natural sources of noise in the ocean;
- anthropogenic sources of noise in the ocean;
- noise effects on marine fauna; and
- likely effects of noise from the construction and operation of the SSDP upon marine fauna of interest.

This review focuses principally on the known and potential physiological responses of fauna to noise in the offshore marine environment, with emphasis given to the area around Binningup. Although this review is not exhaustive, it does illustrate and place into a risk context the range of impacts that might be anticipated as a result of noise from this project.

The review's weighting towards cetaceans is a reflection of the relatively high research intensity afforded to this group of animals. Less is known about the effects of exposure to sounds on other marine fauna such as pinnipeds, turtles and sharks. In cases where data are available, they are often so few that one must be cautious in attempting to extrapolate between species, even for identical stimuli. Moreover, one must also be cautious with any attempts to extrapolate results between stimuli because the characteristics of sources (e.g., ship noise, pile driving) differ significantly from one another.

A description of the abundance and distribution of marine fauna in the area of the project is presented in the SSDP PER (WAWC 2008).

2. PROPOSED ACTIVITY IN RELATION TO UNDERWATER ACOUSTIC IMPACTS

2.1 NOISE GENERATING ACTIVITIES

The project to construct the SSDP, in particular the intake and outfall pipelines and a temporary jetty as well as associated activities, will result in a temporary increase in noise levels and a change in the characteristics of ambient background noise during construction. Operation of the SSDP may also generate noise from the flow of water in the pipelines, as well as periodic vessel activity undertaken for maintenance and inspection purposes. These alterations could conceivably affect transitory and resident marine fauna within the project area.

Activities associated with this project which will generate noise are:

i. dredging
ii. pile driving
iii. explosive blasting
iii. rock armour dumping and sand/sludge dumping
iv. general shipping/vessel traffic
v. pipeline laying and operation.

The key marine components of the SSDP are the seawater intakes and the brine outlets. The inlets will comprise up to three individual pipelines of up to 3 m diameter, extending 400 m to 600 m offshore. The brine discharge outlet pipelines, including diffuser, will comprise up to four pipes of up to 3 m diameter, extending no more than 1100 m offshore. The diffuser will have a total length of up to 450 m and will be located between 600 m and 1100 m offshore. The pipelines will be trenched and emerge from the seabed once beyond the 6 m depth contour and will extend into water no more than around 8 m deep.

At present there is no information available on actual noise levels likely to be generated from this project, or the frequency and duration of specific noise generating activities or the time of year these activities are likely to occur. The only information available is that the construction of the marine components of the project is likely to take up to 18 months and will mostly be undertaken in daylight hours only.

2.2 MARINE FAUNA OF INTEREST

Given their iconic and charismatic status, as well as their general level of protection under both Commonwealth and WA legislation, the marine fauna of particular interest in relation to underwater noise and the SSDP are cetaceans (i.e. whales and dolphins), Australian sea lions, marine turtles and sharks.

As denoted by WAWC (2008) and the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA), the principal marine species of interest in the context of acoustic noise effects are:

- humpback whale (*Megaptera novaeangliae*)
- southern right whale (*Eubalaena australis*)
- blue whale (*Balaenoptera musculus*)
- Bryde’s whale (*Balaenoptera edeni*)
- pygmy right whale (*Caperea marginata*)

- killer whale (or orca) (*Orcinus orca*)
- bottlenose dolphin (*Tursiops sp.*)
- Australian sea lion (*Neophoca cinerea*)
- grey nurse shark (*Carcharias taurus*)
- great white (or white pointer) shark (*Carcharodon carcharias*)
- whale shark (*Rhincodon typus*)
- leatherback turtle (*Dermochelys coriacea*)
- loggerhead turtle (*Caretta caretta*)

2.2.1 Cetaceans

Humpback whales migrate through WA’s south west coastal waters. The species is mainly encountered within the area between the coast and the 200 m bathymetric contour. The northward migration is concentrated from June to August and southward from September to November. The southern migration usually occurs closer to the coast. A feature of the southern migration is the passage of cow/calf pairs, particularly in the latter stages. Humpbacks do not feed during the migration period and their presence in the waters around Binningup would normally be associated with migratory transit.

While most southern right whales venture no further north than WA’s south coast, a small number migrate through the region around Binningup from around mid-May to late September. This number may be expected to increase over time as the population recovers from the decimation of earlier commercial whaling. This species is often encountered close to the coast in sheltered embayments, where whales may come to give birth and/or nurse their young. Based upon incidents with the closely related northern right whale, this species is considered especially vulnerable to ship strikes.

Blue whales prefer deeper waters of at least 500 m. From early November to mid-May both pygmy blue whale (*Balaenoptera musculus brevicauda*) and the true blue whale (*Balaenoptera musculus intermedia*) are known to congregate over the head of the Rottnest Trench (Perth Canyon), some 130 km or more from the project area. Blue whales are also infrequently observed, typically from October to December, over the continental shelf between Rottnest Island and Cape Naturaliste (i.e. about 100 km from Binningup), and have been periodically observed to come close in-shore in the Cape Naturaliste area, about 70 km from Binningup.

Other species noted of particular concern by regulatory authorities are Bryde’s, pygmy right and killer whales. These are less frequently sighted in the waters around Binningup, but may nevertheless occur periodically in the area. Bryde’s whales are known to venture as far as 35° South, but are more common in warmer sea areas between 30° North and 30° South (Carwardine 1995). Reeves et al. (2002) and Carwardine (1995) both note that the pygmy right whale is the least known and most rarely sighted of all the baleen whales. On this basis, if sighted in the Binningup area this would arguably generate greater scientific interest than subject the species to risk from the proposed SSDP.

Other whales, such as minkes (*Balaenoptera acutorostrata*), long-finned pilot whales (*Globicephala melas*), false killer whales (*Pseudorca crassidens*) and various species of beaked whales may be expected periodically in the waters around Binningup. The nearby Busselton/Geographe Bay area is a scene of regular strandings by many species, including beaked, false killer and pilot whales (URS 2003). Any of these species encountered in the Binningup area would most likely be itinerant specimens as the location presents no particular preferred habitat for these other species.

The waters around Binningup are known to be visited by a number of dolphin species, the two most frequently sighted being bottlenose and common dolphins (*Delphnius delphis*). The Leschenault Estuary and nearby Bunbury Harbour are noted as the scene of a population of dolphins which have become habituated to human interaction and support an active dolphin watching industry. The entrance to the Leschenault Estuary is around 18 km from the proposed SSDP site. The waters off Binningup are not known to be of any particular or distinct importance to any dolphins, but are most likely within the range of the nearby Bunbury/Leschenault population.

2.2.2 Pinnipeds

The Australian sea lion is an uncommon animal and populations are thought to have declined significantly since European settlement, although the population has stabilized in recent years. The Australian sea lion may migrate through or feed in the area around Binningup, but is not known to be resident in the region. It is a bottom foraging species which generally favours reef areas as sources of prey and has been observed to forage out as far as the 200 m bathymetric contour, although juveniles and lactating females remain in shallower waters (Costa & Gales 2003). Although within the range distribution of the species, neither Shaungnessey (1999) in the *Action Plan for Australian Seals*, nor the WA Department of Fisheries (Campbell 2005), as the responsible conservation management authority, identified any particular habitat area for the Australian sea lion in the vicinity of Binningup. The nearest breeding sites were located some 300 km north of the project area at Butler Island, near Cervantes, and the nearest haul-out sites (i.e. non-breeding resting sites) are at Penguin and Seal Islands, Shoalwater, some 90 km distant. It is possible that sea lions migrating between south coast and mid-west coast breeding sites may migrate through the Binningup area.

2.2.3 Sharks

The grey nurse shark is a coastal species found on the continental shelf from the surf zone down to at least 190 m. The shark is often seen hovering motionless near the bottom in or near deep sandy-bottomed gutters or in rocky caves around inshore rocky reefs and islands at depths between 15 m and 25 m. These sites may play an important role in pupping and/or mating activities as grey nurse sharks often form aggregations at these locations. Unlike the east coast population, there are no confirmed aggregation sites off WA. In an assessment for the WA Department of Fisheries, Chidlow et al. (2006) identified 34 potential areas of interest based on anecdotal observations by commercial fishers, divers and others. Of these 34 sites and following further habitat evaluation, 25 potential aggregation sites were considered to warrant further survey. Note that none of the sites identified by Chidlow et al. (2006) are confirmed aggregation sites. The potential grey nurse aggregation site nearest to the proposed SSDP was at Naturaliste Reef, around 70 km almost directly out to sea from the project area.

The great white shark is potentially present all year round in WA coastal waters. It is generally more common in south west coastal waters during the humpback whale migration period, particularly the latter part of the southern migration as it preys on humpback calves. DEWHA (2007) notes that juvenile great white sharks are commonly encountered in inshore areas, often in the vicinity of the open coast beaches. These are more usually associated, however, with great white shark pupping grounds. The Australian *White Shark (Carcharodon carcharias) Recovery Plan* (Environment Australia 2002) proposes the Great Australian Bight, Victor Harbour/Coorong region (SA), areas off Portland and Ninety Mile Beach (Victoria), Garie Beach – Wattamolla and Port Stephens – Newcastle (NSW) and some areas off southern Queensland as seasonally important for juvenile white sharks and as possible pupping grounds. No areas are identified in WA, although the Plan concedes that more research is required.

Whale sharks have a broad distribution in tropical and warm temperate seas, including shallow coastal waters, usually between latitudes 30° North and 35° South (DEWHA 2007). Although most common in tropical areas, confirmed sightings have been made further south than Kalbarri, WA and Eden, NSW. These sharks are thought to prefer sea surface temperatures of 21°C to 25°C, so if it is to occur near Binningup, this would most likely be during the warmer summer months.

2.2.4 Marine turtles

Four species of marine turtle are known to infrequently visit the waters south of Perth and juveniles may be encountered on or near local beaches after winter storms and the Leeuwin Current have driven them south. Leatherback turtles are occasionally seen in these waters although this species is usually a non-nesting migrant visitor to WA. Based on records of stranded dead turtles, it is probable that at least some green turtles (*Chelonia mydas*) and loggerhead turtles stray into the region seasonally, possibly brought southward by the warmer Leeuwin Current in winter. The hawksbill turtle (*Eretmochelys imbricata*) is also an infrequent visitor. There are no turtle breeding or nesting sites near Bimmngup and none in WA south of the area of Ningaloo Reef (Marsh et al. 1995).

3. AMBIENT NOISE IN THE OCEAN

This section describes the characteristics of ambient noise in the ocean and the natural components of that noise to identify the range of noise levels to which marine fauna are naturally exposed. Natural sources are described in more detail in Section 4 and anthropogenic sources in Section 5.

Ambient noise refers to the overall background noise from both natural and human sources such that the contribution of a specific source is not readily identifiable. The term ‘ocean noise’ has been used by the US National Research Council (NRC 2003) to encompass not only background noise but also sounds from distinguishable nearby sources such as individual ships or pods of whales.

Ambient noise levels are generally reported as ranges of sound pressure level recorded over various sampling periods. Any consideration of ambient noise levels needs to recognise that the indicated levels are actually averages over the selected sampling period. The averaging period used influences the indicated noise level. Short period, transient natural events can produce noise spikes far in excess of the assigned average level for any particular natural phenomenon.

The primary sources of mid-ocean ambient noise are weather effects, tectonic activity, ocean wave interactions (‘microseisms’) thermal agitation and distant shipping traffic (Figures 3.1 and 3.2). Examples of the differences in ambient noise levels, make-up and energy spectra, including deep sea versus coastal waters and regional differences are given in Urick (1983) and Cato (2000). The ambient noise level and frequency spectrum can be predicted for most deep water areas from known shipping traffic density and the wind speed, Beaufort force or sea state. Heavy rainfall can cause significant but localised increases (Section 4.2.5), since this surface source has significant vertical directionality (to 45^o) and therefore less range than omnidirectional and horizontal near-surface sources (e.g. Cato 2000).

Broadband ambient noise spectrum levels[1] range from 45-60 dB in quiet regions (light shipping and calm seas) to 80-100 dB for more typical conditions and over 120 dB re 1 µPa [2] during periods of high winds, rain or biological choruses. In the 100-500 Hz range, Urick (1983) estimated average deep water ambient noise spectra of 73-80 dB for areas of heavy shipping traffic and relatively high sea states and 46-58 dB for areas with light shipping and calms.

Background levels in the 20-500 Hz range are frequently dominated by distant shipping, particularly in heavy traffic regions. Vocalisations of the great whales also contribute to this low frequency band, with the duration and frequency of these choruses increasing in breeding, migrating and feeding areas as stocks recover from past whaling (Croll et al. 2001, McCauley & Cato 2003). Above 300-400 Hz the level of weather-related sounds exceeds shipping noise, with wind wave conditions and nearby rainfall dominating the 500-50,000 Hz range.

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1 The level of a sound wave in a 1 Hz wide frequency band (Urick 1983; see also Figure 3.1). Reported spectrum levels are assumed to reflect mean square pressure unless otherwise stated.

2 Measure of underwater noise, in terms of sound pressure. Because the dB is a relative measure, rather than an absolute measure, it must be referenced to a standard “reference intensity”, in this case 1 micro Pascal (1µPa), which is the standard reference that is used. The dB is also measured over a specified frequency, which is usually either a one Hertz bandwidth (expressed as dB re 1µPa^2/Hz), or over a broadband which has not been filtered. Where a frequency is not specified, it can be assumed that the measurement is a broadband measurement.

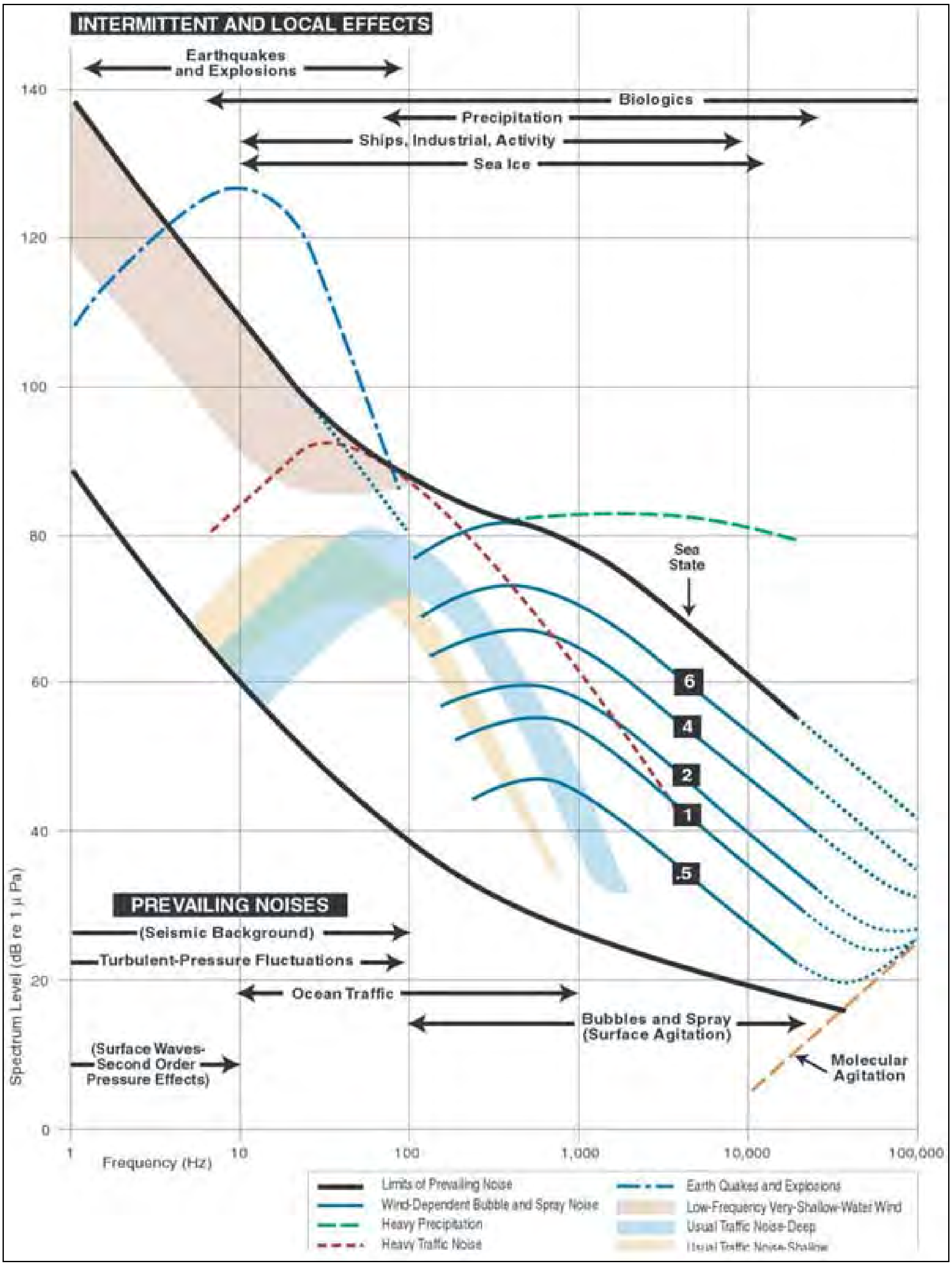


Figure 3-1 Generalised ambient noise spectra attributable to various sources

(compiled by Wenz 1962; reproduced from Richardson et al. 1995)

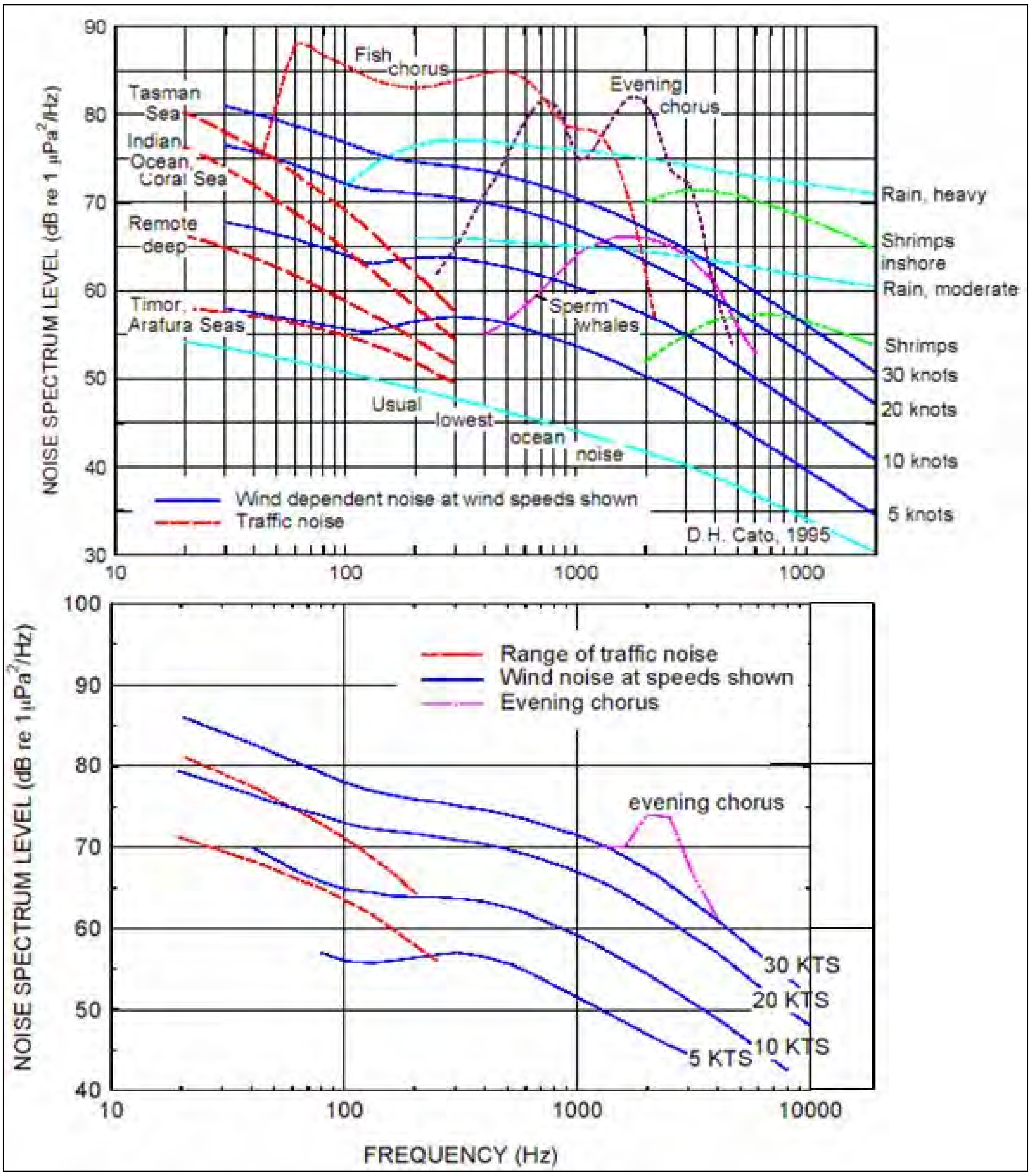


Figure 3-2 Pressure density curves of ambient noise components

Top: Australian waters (Cato 1995)
Bottom: From a Defence Science and Technology Organisation (DSTO) survey site off Perth

In contrast to deep sea regions, ambient noise levels and frequency components across shelfal and nearshore waters are far more variable with season, location and time of day and are less amenable to prediction without local measurements. While the key sources remain shipping and local weather patterns, contributions from marine biota as well as various fishing, boating and industrial noises near ports, harbours and marinas become significant, with the level and composition changing with time and place (Cato 2000; Urick 1983).

In regions with feeding or breeding great whales, whale vocalisations vary by season, week, day and hour and can boost background noise levels to over 120 dB re 1 µPa (e.g. 110-136 dB re 1 µPa [rms] at ⅓OB 300 Hz, with 123 dB re 1µPa peaks at 315 Hz[3]), as measured in March and April 1998 at four locations off Maui where humpback whales were not in the vicinity of the receivers (Au & Green 2000). The type, intensity and propagation of sources contributing to ambient noise in coastal waters are also more spatially variable as a consequence of finer scale changes in seafloor topography and seafloor substrate. Levels increase where more reflective rocky substrates are prevalent and decrease where thick absorptive layers of fine sediments and mud occur.

Turbulence and seafloor saltation noise induced by strong tidal streams can also become locally dominant, particularly in coastal parts of northern Australia with large tidal ranges, and where noise levels fluctuate widely according to local tidal flow rates and bottom types. Ambient noise in Kimberley embayments that contain coarse gravely sediments can exceed 110-120 dB on a diurnal basis, particularly during spring ebb and flood tides (C. Jenner, unpubl. data).

Published plots of low and high frequency ambient noise indicate that the waters surrounding Australia (Figure 3.2) are similar to those elsewhere except for the noisier areas of busy shipping traffic in south Asia, east Asia and NW Atlantic-European waters (see e.g. the colour global sound charts in NRC 2003).

[3] When evaluating the literature it is important to check the measure used when interpreting reported levels. Geophysical studies frequently record peak-to-peak values (dB re 1 µPa at 1 m), while the 'peak level' (zero-to-peak) for the same signal is typically some 6 dB less. Received sound levels of airgun pulses in biological reports are often given as the average level (root mean square; rms), which represents the mean sound pressure level over the duration of the pulse. These are typically some 10 dB lower than the zero-peak level and often 16 dB lower than the peak-peak value (e.g. Greene 1997, McCauley et al. 1998, 2000a). The energy level (dB re 1 µPa^2 per second) is less frequently used and is usually lower than rms pressure level because the peaks are less than 1 second.

4. NATURAL SOURCES OF NOISE IN THE OCEAN

4.1 CHARACTERISTICS OF NATURAL AMBIENT NOISE

The following section describes the naturally sourced sounds that contribute to the ambient background of ocean noise. In the absence of shipping, natural sources are the dominant sources of the long-term time-averaged ocean noise at all frequencies, including whale calling in many regions (e.g. McCauley & Cato 2003). Even in the presence of distant shipping, contributions from a range of natural sources dominate the ocean noise spectra below 5 Hz and from a few 100 Hz to 200 kHz.

The dominant source of natural noise across the 1 - 100,000 Hz range is associated with sea surface waves generated by wind acting on the sea surface. Non-linear interactions between ocean surface waves, previously called 'microseisms' (Section 4.2.2), are the dominant contributors below 500 Hz (referred to as '*Surface Waves—Second-Order Pressure Effects*' in the classical Wenz curves of ambient noise; Figure 3.1). The dominant contributor above 50,000 Hz is thermal noise, which arises from pressure fluctuations associated with the molecular agitation of the ocean medium itself (Section 4.2.6).

Natural biological sound sources make significant contributions in certain regions, seasons and times of day. For example the natural noise from snapping shrimps (from ~5 kHz to 300 kHz) forms an important component close to reefs and in rocky bottom regions in shallow waters in <40^{o} latitudes, reaching crescendo proportions in <60 m deep areas near tropical coasts. Fish choruses can significantly add to ocean noise in many locales, while groups of whistling and echo-locating dolphins can raise local noise levels in the frequency range of their signals. An almost infrasonic peak around 20 Hz created by calls of large baleen whales is often present in deep-ocean spectra, while choruses of humpback whales reach broad peaks near 300 Hz (e.g. Au & Green 2000).

4.2 COMPONENTS OF NATURAL AMBIENT NOISE

The frequency ranges of the following common natural physical and biological sources of relatively intense, persistent and/or frequent noise are shown in Figures 3.1 and 3.2, with their source levels listed in Table 4.1.

Physical: Subterranean vents, tremors, earthquakes, eruptions, sediment slumps and other tectonic activity, lightning strikes, microseisms, thermal noise, ice cracking, wind waves, surf, rainfall, tidal turbulence and seafloor saltation.

Biological: Sea urchins, snapping shrimp, Sciaenid croakers (jewfish, mulloway, etc), other fish choruses, high frequency whistles and echolocation clicks (dolphins and toothed whales), low frequency vocalisations (great whales, including near-infrasonic calls from rorqual species), unidentified 'biotics'.

Table 4-1 Examples of intense natural sound sources

Source Type	Location and Timing	Perceived Direction	Periodicity	Frequency range (Hz)	Source Level*
Tectonic quakes, tremors, eruptions	Unpredictable	Seafloor or circumferential	Sudden irregular transients (2-20 mins)	LF (10-100)	220-250
Lightning	Unpredictable	Surface	Sudden short pulse	Broadband	~260
Breaching and fluke slapping	Variable (often close)	Surface	Sudden pulse	Broadband	170-190
Baleen whale songs and moans	Variable (often close)	Variable	Variable continuous or transients	LF-MF + harmonics	170-195
Delphinid whistles and squeals	Variable (often close)	Variable	Mostly anticipated transients	HF – VHF (>10 kHz)	180-195
Sperm whale click, codas and creaks	Variable	Variable	Mostly anticipated transients	HF	180-235
Toothed whale echolocation sonar	Variable (often close)	Variable	Mostly anticipated pulses or click bursts	HF-VHF (>10 kHz)	190-232
Sea ice noises	Surface	Multiple surface points	Variable transients	Broadband	120-190
Rough weather and rain	Surface	Background	Irregular, continuous	Broadband	80-120*
Tide turbulence and saltation	Seafloor	Background	Regular, continuous	Broadband	80-120*
Fish choruses	Variable	Stationary / background	Regular continuous	LF and MF/HF tonals	80-120*
Snapping shrimps	Seafloor	Stationary / background	Regular, continuous	LF-MF	80-120*

* dB re 1 μPa at 1 m (peak-peak)

(from University of Rhode Island [undated], NOAA 2002, Cato 2000, Simon et al. 2003.)

4.2.1 Eruptions, tremors and other tectonic events

Seismic events from tectonic activity produce one of the most intense sources of natural noise. Undersea earthquakes, seafloor venting and volcanic activity frequently provide sources of intense low frequency sound. Sounds from volcanic eruptions and resonance tremors in the Pacific Ocean are routinely detected and recorded across distances of thousands of kilometres.

Fox et al. (2002) noted that seismic monitoring since 1991 shows that natural seismic activity in the Pacific Basin produces nearly 10,000 acoustic events annually that involve source levels >200 dB re 1 μPa 1m. Arriving signals often have sudden, sharp onsets and can last from several seconds to several minutes, with frequencies extending from the infrasonic to over 100 Hz.

Earthquakes produce a triangular-shaped acoustic energy signal known as 'T-waves'. The T-phase duration is related to the earthquake magnitude, and these produce the highest acoustic energy in the 5-35 Hz frequency range (e.g. Nishimura & Clark 2001). A T-wave showing the highest acoustic energy in the 5- 30 Hz range is shown in Figure 4.1 (the yellows and reds).

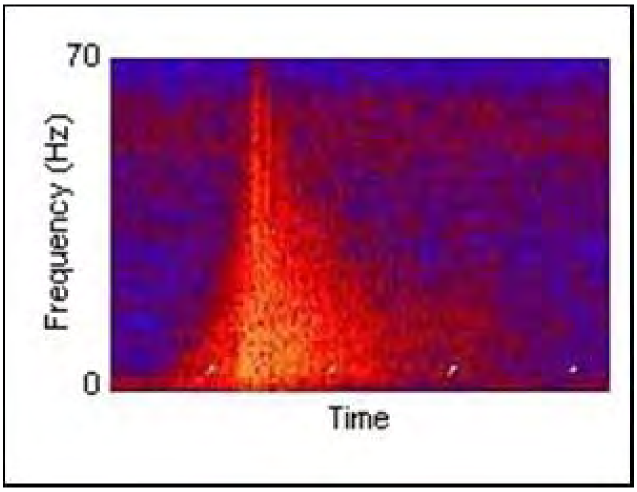


Figure 4-1 Triangular shaped low frequency signal from subsea earthquake.

Plots of T-waves recorded by both SOSUS[4] and the US National Oceanic and Atmosphere Administration's (NOAA) Eastern Equatorial Pacific autonomous hydrophone array[5] during the February 1996 Gorda eruption (near 42°40'N and 126 °48'W in the northeast Pacific), and the 1993 lateral magma injection and subsequent eruption at the 'CoAxial Segment' site (on the Juan de Fuca Ridge at 46°30'N) are shown in Figure 4.2(a,b). The latter event comprised a dike injection and eruption episode during June-July 1993, and intense T-waves were generated during the latter part of this event. The flow site was subsequently investigated by Canada's remotely operated vehicle ROPOS in mid-July 1993, where it found and mapped a fresh venting lava flow 2.5 km long plus extensive venting along a nearby 4 km tract.

[4] The SOund SUrveillance System (SOSUS) is a fixed component of the US Navy's Integrated Undersea Surveillance Systems (IUSS) network that was deployed for deep ocean surveillance during the Cold War. Installation of SOSUS began in the mid 1950s for use in anti-submarine warfare. SOSUS consists of bottom mounted hydrophone arrays connected by undersea communication cables to facilities on shore. The individual arrays are installed primarily on continental slopes and seamounts at optimal locations for receiving undistorted long range acoustic propagation. The combination of location within the oceanic sound channel and the sensitivity of large-aperture arrays allows the system to detect radiated acoustic power of less than one watt at ranges of several hundred kilometres. A brief history of SOSUS and its current use is at **http://www.globalsecurity.org/intell/systems/sosus htm.**

[5] In October 1990, NOAA was permitted to access the SOSUS arrays in the North Pacific for ocean environmental monitoring. The data collection systems developed by NOAA's VENTS Program were implemented in August 1991, with acoustic signals from the north Pacific Ocean recorded at NOAA's Pacific Marine Environmental Laboratory (PMEL) in Newport, Oregon. PMEL has subsequently deployed moored autonomous hydrophones for monitoring remote ocean areas not covered by fixed arrays such as SOSUS. PMEL is the primary centre for both continuous monitoring of low-level seismicity around the northeast Pacific Ocean and real-time detection of intense volcanic activity along the northeast Pacific spreading centres, in support of NOAA's VENTS research on ocean hydrothermal systems. Its first array was deployed in the eastern equatorial Pacific in May 1996 for long-term monitoring of the East Pacific Rise between 20N and 20S. Other arrays have since been deployed on the centre ridge of the Atlantic Ocean. Real time ridge crest monitoring permits timely on-site investigations of hydrothermal and magma emissions. Hydrophones were also deployed in the Gulf of Alaska for marine mammal monitoring in 2000. The sensitive PMEL arrays have recorded several airgun sources from around the Atlantic Basin, sometimes simultaneously. The most frequent originating locations are near Nova Scotia (Canada), northeast Brazil and northwest Africa. Airgun signals have occurred in approximately 75% of the annual data recordings of the Atlantic arrays. More information is at http://www.pmel.noaa.gov/vents/acoustics/haru_system html.

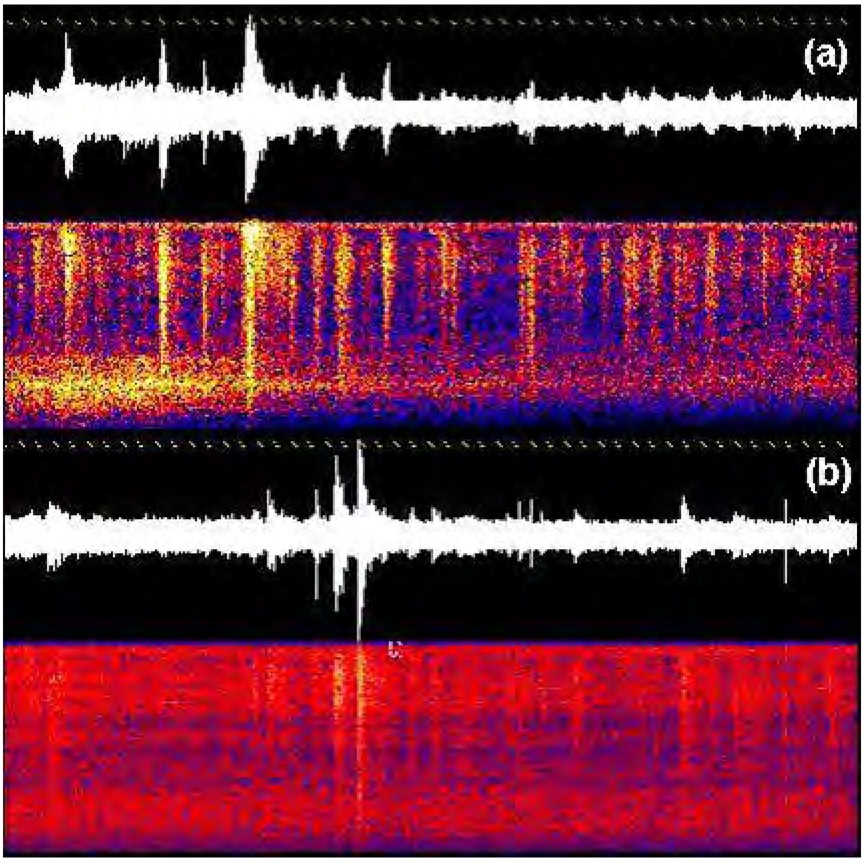
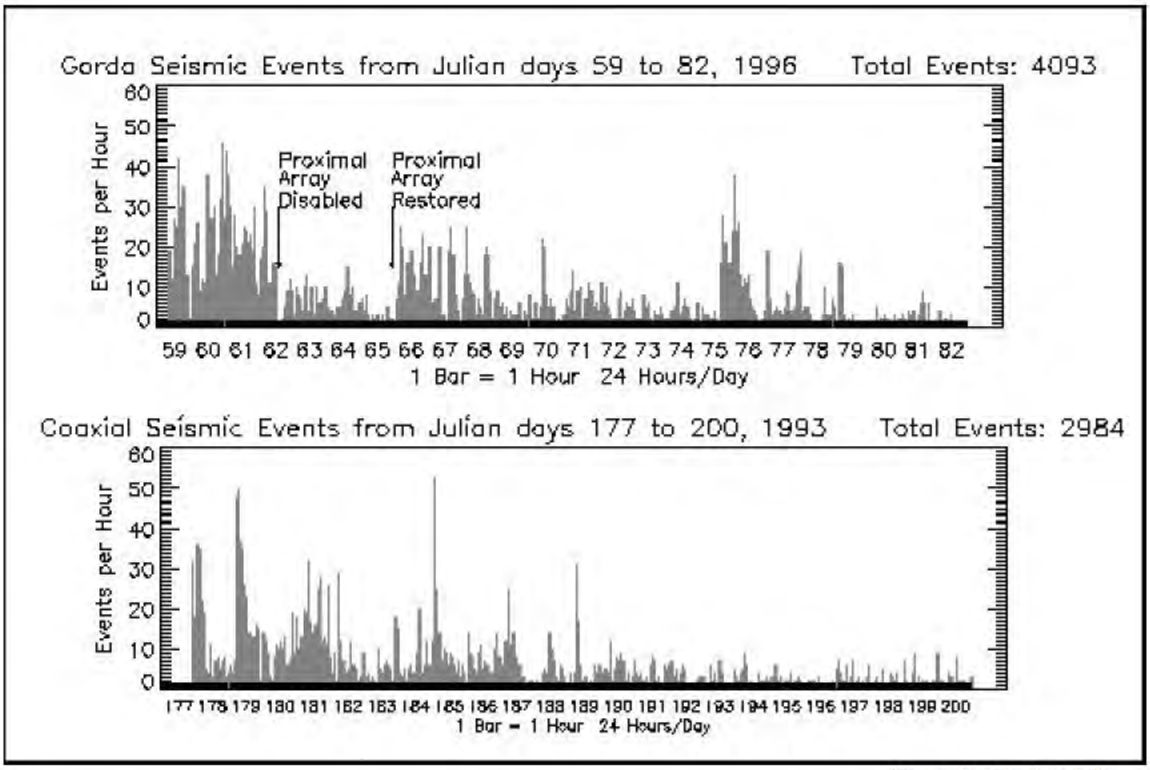


Figure 4-2 Colour spectrograms showing examples of T-waves

(a) Recorded during the 1996 Gorda eruption
(b) Recorded during the 1993 Coaxial segment magma injection
[one minute ticks along the x-axis, 0-75 Hertz along the y-axis; from PMEL (2006)].

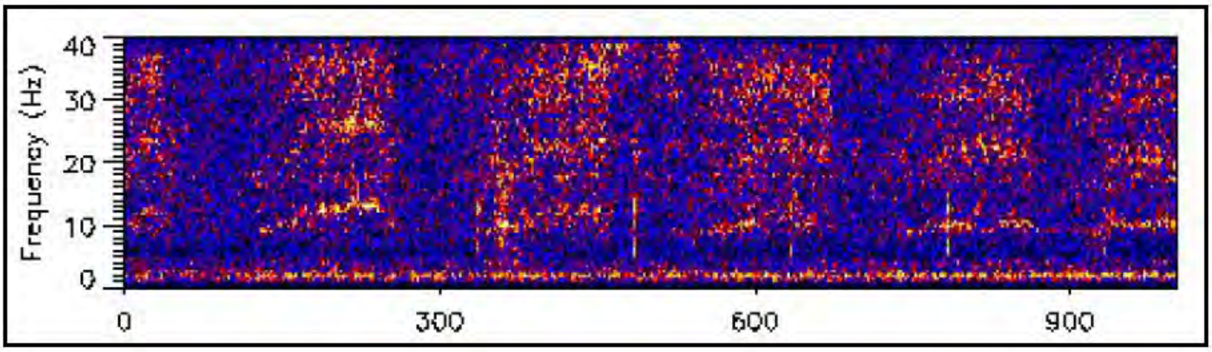
The seismicity of the Gorda and Coaxial segment events are very similar, in which a rapid series of earthquakes occurs without large ‘foreshocks’ (Figure 4.2(a,b)). The histogram in Figure 4.3 shows the number of events recorded per hour for each event. The apparent decline in activity of the Gorda seismic events from midday day 62 to late day 65 was probably due to loss of the closest array.

The various hydrophone arrays in the Pacific and Atlantic Oceans have been monitoring these types of seismic events for many years. A long-lasting example comprises the extremely loud tremor-like signals which emanated from the volcanically active island chain south of Japan. This is the so-called ‘Inferred Harmonic Tremor’ which developed on 30 separate occasions between May 1998 and December 1999 (PMEL 2006). The precise source was beyond the optimal array coverage but the best estimates place it between 22-27^{o}N and 138-141^{o}E. The signals were characterized by a high amplitude fundamental at ~10 Hz plus three harmonics at 20, 30, and 40 Hz. The signals typically appeared as discrete packets lasting 4-5 minutes, with brief quiescent periods of roughly 30 seconds followed by the beginning of the next packet of signals (Figure 4.4). During each signal packet, the spectral peaks typically rose by 5-10 Hz while maintaining their harmonic spacing. The largest peak amplitudes and longest durations occurred on four separate occasions during August 1998, on seven widely spaced occasions during 1999 and continued into 2000. The distinctive spectral characteristics have been previously seen in volcanic tremor signals recorded by seismic and airborne equipment from the Arenal and Pavlof volcanos in Costa Rica and Alaska (PMEL 2006).



(from PMEL [2006])

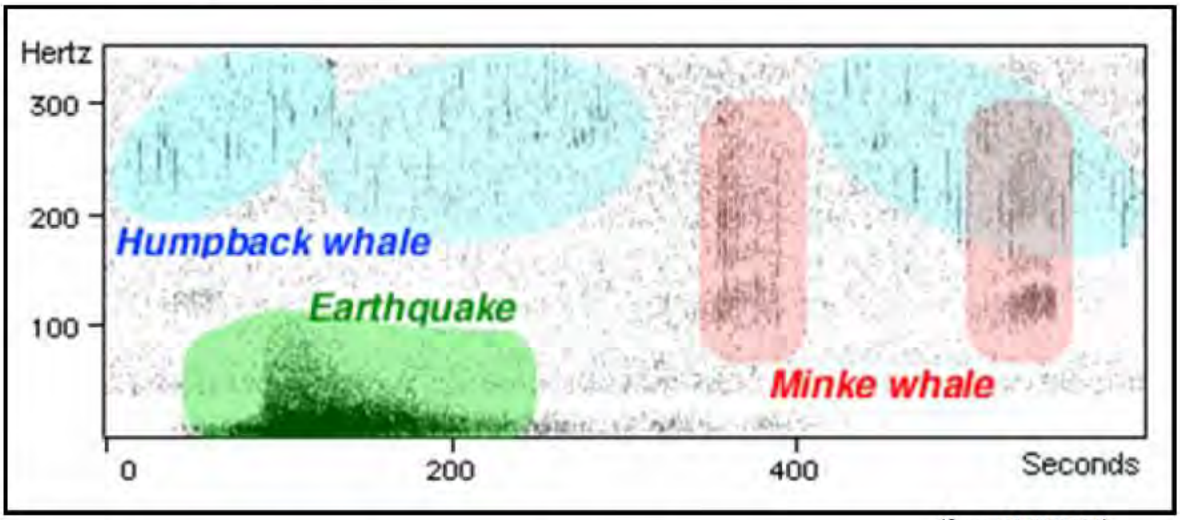
Figure 4-3 Frequency of events during the Gorda (top) and Coaxial segment (bottom) episodes.



(from PMEL [2006])

Figure 4-4 A 900 second portion of the 'Inferred Harmonic Tremor' that was detected south of Japan on many separate occasions in 1998-2000.

Figure 4.5 shows a 10-minute (600 second) spectrogram from SOSUS[2] autonomous deep water hydrophones in the western North Atlantic. The green-highlight shows a low frequency T-wave from an earthquake event in the mid-Atlantic, while the blue and pink-highlighted dark vertical streaks are vocalisations of humpback and minke whales in the vicinity of the array. The spectrogram and sound file show the earthquake produced a loud, low frequency rumble. This recording is on the Office of Marine Programs (OMP) sounds page as an example of how typical tectonic events do not apparently cause marked responses to baleen whale calling behaviour. Such statements would benefit from a longer spectrogram (i.e. showing the type and periodicity of calls recorded for at least the same period before the event of interest as that made after it). It is also unclear if the humpback auditory range is as sensitive to low frequency sounds as those considered likely for the minke and larger rorquals (i.e. the blue and fin whales).



(from OMP 2006)

Figure 4-5 600 second spectrogram showing whale calls recorded by the West Atlantic SOSUS array during and after a subsea earthquake

The northern waters of Australia are occasionally exposed to the intense low frequency sounds which emanate from major tectonic events along the Indonesian-Melanesian island chain, some of which also produce tidal waves that reach northwest Australian shorelines. Australian waters are not immune to local natural seismic sources, since smaller earthquakes (magnitude 4 or less) are not uncommon. On average 17 moderate-sized earthquakes occur annually on Australia's continental shelf, while seven seismic events were recorded in 21 days in the deep sound channel off Cape Leeuwin (southwest Australia) in June-July 1998 (Pidcock et al. 2003).

4.2.2 Ocean wave interactions ('Microseisms')

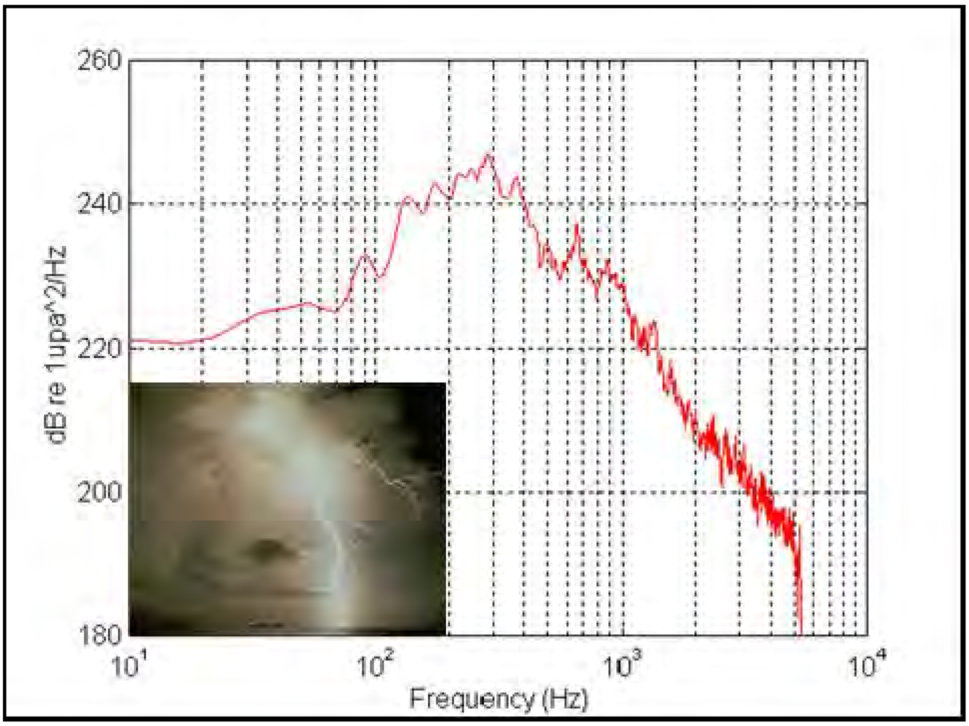
'Microseisms' are the dominant below 10 Hz natural noise source in the space and time averaged ocean noise spectra. This source is generated by non-linear interactions of ocean surface waves. Oppositely propagating waves produce a standing wave pattern that radiates sound with twice the frequency of that of the interacting surface waves. These waves are not related to tectonic processes but were termed 'microseisms' by seismologists because they are also the dominant source of noise in high quality, on-land seismometer measurements. The Wenz Curves include '*Seismic Background*' (Figure 3.1) but it is now known that earthquakes and other tectonic processes contribute only intermittently while the ocean wave interactions provide an almost continuous source of ocean noise in the low frequency range.

4.2.3 Surf

Breaking surf is a significant noise source in near coastal areas. Unlike open-ocean areas, wave noise in the surf zone is not predominantly dependent upon local winds, but is influenced by local as well as distant winds and ocean-derived swells. The NRC (2003) reported that breaking waves can increase ambient noise levels by more than 20 dB across the spectrum from 10 Hz to 10 kHz within several hundred metres of the surf zone. Heavy swells produced by storms many hundreds or thousands of kilometres away can arrive on exposed beaches to produce large plunging breakers which can raise local ambient levels over 20 dB for up to 1 km offshore from big surf beaches. In near shore areas, surf-induced noise is often the dominant character of the ambient acoustic environment.

4.2.4 Lightning strikes

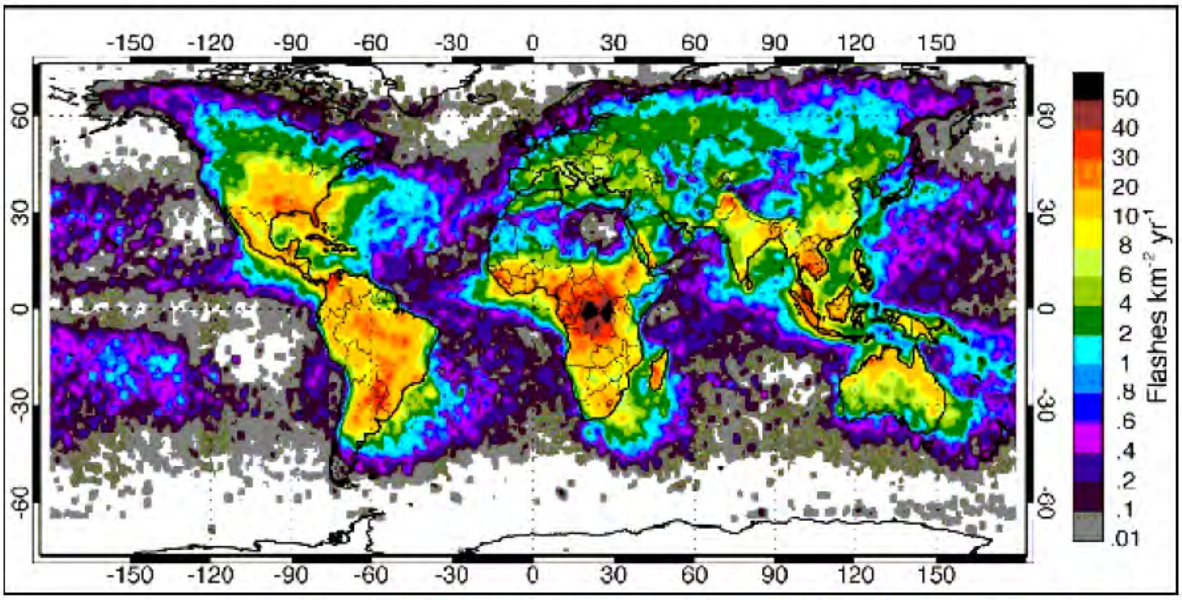
Underwater recordings of spectra of a received sound of thunder from a storm 5-10 km away show a peak between 50 and 250 Hz up to 15 dB above background levels, with detectable energy down to 10 Hz and up to 1 kHz (Dubrovsky & Kosterin 1993, in NRC 2003; Hill 1985). Lightning strikes produce one of the loudest natural sounds in the ocean, generating low tonal impulses with source levels close to the ocean surface of about 260 dB re 1 μPa at 1 m (Arnold, Bass & Atchley 1984; Hill 1985; OMP 2006). Analysis of underwater records indicates the sound has an inherent ability for substantial propagation as most of the energy is in the 10-1000 Hz range, with peaks between 100-300 Hz (Figure 4.6). Most lightning activity is recorded during thunderstorms which have lifetimes usually less than an hour and with fronts as small as 5-10 km. Sometimes thunderstorms are arranged in lines hundreds of kilometres long or form large circular clusters.



(recording from the DFO Institute of Ocean Sciences, British Columbia, Canada)

Figure 4-6 Spectrogram of an underwater recording of a lightning strike

As shown in Figure 4.7, lightning activity is generally less over the oceans than land, although the sea areas around Binningup receive around 2 to 4 flashes per km² per year. On this basis, the area out to sea for a radius of 10 km from the SSDP would be subject to the order of 300 or more lightning flashes per year, while the area within a 20 km radius would experience over 1200 lightning flashes per year.

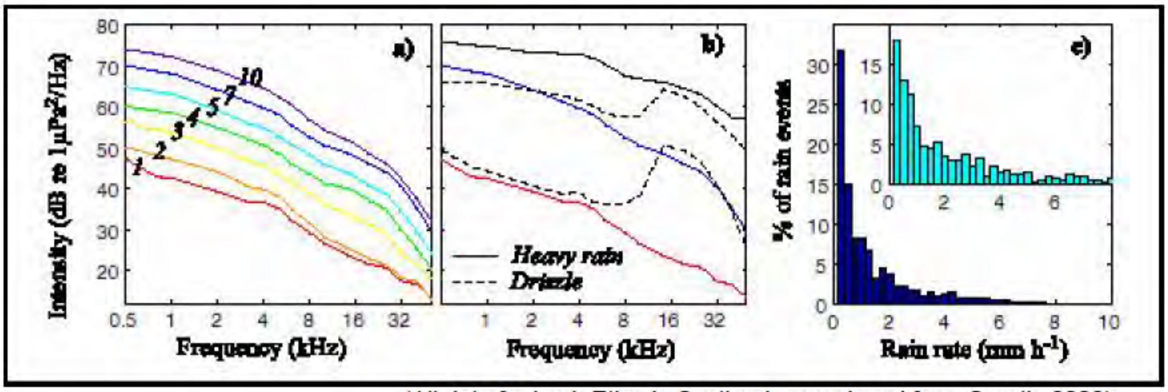


(from http://thunder.msfc.nasa.gov/otd/images/global_ltg_from_paper.JPG)

Figure 4-7 Global distribution of lightning flash density (km^2) per annum

4.2.5 Wind and rain sources

Wind is almost omni-present and its acoustic signature is discernible most of the time (e.g. Richardson et al. 1995, Quartly 2002, Figures 3.1 and 3.2). Wind generates subsurface sound via the production of breaking waves and generation of subsurface bubbles, with a frequency range from 200 to 50,000 Hz. Although the production of bubbles appears to visibly commence once wind speeds exceed ~5 ms^{-1} and breaking waves form 'white caps', bubbles are produced even under very light winds (Quartly 2002). The movement and breaking of these bubbles cause strong underwater sounds. The typical noise spectra due to wind-induced wave and bubble formation increase with wind speed and fall off with frequency (Figure 4.8(a)).



(All data for Loch Etive in Scotland, reproduced from Quartly 2002)

Figure 4-8 Underwater spectrograms for (a) different wind speeds (in m s^{-1}) and (b) rainfall, and (c) rainfall rate probability distributions when raining. (c) upper panel = Nov-Dec 1999; (c) lower panel = May-Jun 2000.

Recent meteorological events and shipping activity can have an effect, as both strong winds and heavy rain produce a sub-surface bubble layer that takes time to dissipate and attenuates the higher frequencies generated by any subsequent surface sources (Quartly 2002). Bubbles left in the wake of passing ships can be identified for almost an hour after the event.

Rain produces a loud, distinctive signal that can increase ambient noise by up to 35 dB across a wide band (100 Hz - 50 kHz; Figures 3.1, 3.2). Drizzle produces a characteristic ~14 kHz peak while the intensity of the frequency spectra of heavy rain often exceed that of wind (Figure 4.8(b,c)). Rain generates sound in several ways including the direct impact of droplets, although the bubbles produced by air entrainment during the splashes are the noisiest component. For most raindrop sizes and angles, the bubble sounds provide the loudest component. Small raindrops (0.8 -1.2 mm) generate frequencies between 10-25 kHz. Medium raindrops (1.2 - 2.0 mm) are quiet due to poor air entrainment while large (2.0 - 3.5 mm) and very large (>3.5 mm) raindrops trap large bubbles which generate frequencies as low as 1 kHz. Sound recordings of rainfall can be used to measure rainfall rate, raindrop size and other features, and are helping meteorologists, oceanographers and climatologists in climate change studies.

As different raindrop sizes produce distinctive sounds, the underwater sound can be inverted to quantitatively measure drop size distribution in the rain. Acoustical Rain Gauges (ARGs) are being deployed on oceanic moorings to make long-term measurements of rainfall using this acoustical technique.

4.2.6 Thermal noise

Thermal noise is generated by pressure fluctuations associated with the thermal molecular agitation of the ocean medium itself. It is what remains when all other noise sources are removed and so provides the lowest bound for noise levels in the ocean. Depending on sea state, thermal noise dictates the shape and level of ambient noise spectra above 50 kHz (Figures 3.1, 2.2; NRC 2003).

4.2.7 Biological sources

Before focusing on cetaceans, it is worth noting the sound levels and frequency ranges of some of the noises produced by other marine biota. These noises are dominated by sizzling and crackling sound of snapping shrimps, the croaks, grinding and grunting sounds of croaker fishes and fish choruses, which generate major peaks in the frequency ranges shown in Figures 3.1 and 3.2. The teeth grinding action of sea urchins resonates through their body shell and forms another significant biological sound in reef areas. Snapping shrimp are a dominant evening source in many sub-tropical and tropical shelfal waters, while loud fish choruses are common around Australia’s coasts, particularly after sunset and near dawn (Figure 3.2; see Cato 2000 for more details).

Whales, dolphins and porpoises produce a wide range of sound covering the frequencies between 10 and 20,000 Hz, and there are many web sites containing spectrograms and sound files of recorded vocalisations[6] covering a range of species. Some of these sites also provide

[6] The term ‘vocalisation’ refers to any sound intentionally produced by a marine animal that may be used for communication, orientation, prey detection, feeding or breeding. It does not imply that marine mammals use vocal folds, i.e. by exhaling lung air to vibrate vocal cords in base of the throat.

audio file examples of various unidentified 'bloops' 'slow-downs' and other presumed biological sounds (some possibly cetacean) whose source is unknown.

The dolphins and other toothed species (odontocetes) typically produce all of the higher frequency (> 5000 Hz) calls, whistles and echolocation pulses (with the exception of the songs of male humpback whales), while the baleen whales (mysticetes) vocalise in the low to mid range, with the larger rorquals producing low to very low (infrasonic) frequencies (Figure 4.9).

It is not exactly understood how the various types of call and echolocation pulses are generated, although the melon is known to be critical for focussing the typically intense echolocation pulses and clicks in the odontocetes. Estimates of the source level of the 38 microsecond broadband clicks produced by orcas when searching and feeding on Norway herring are in the 187-213 dB (re 1µ Pa [(peak-peak] at 1 m) range, with centre frequencies of 26-57 kHz; Simon et al. 2003). These frequencies lie in the highest sensitivity zone of the orca audiogram. By contrast, an underwater tail slap used by orcas to stun herring produces a broadband multi-pulsed sound with an estimated source level of 187 dB (re 1µ Pa [(peak-peak] at 1 m) (Simon et al. 2003).

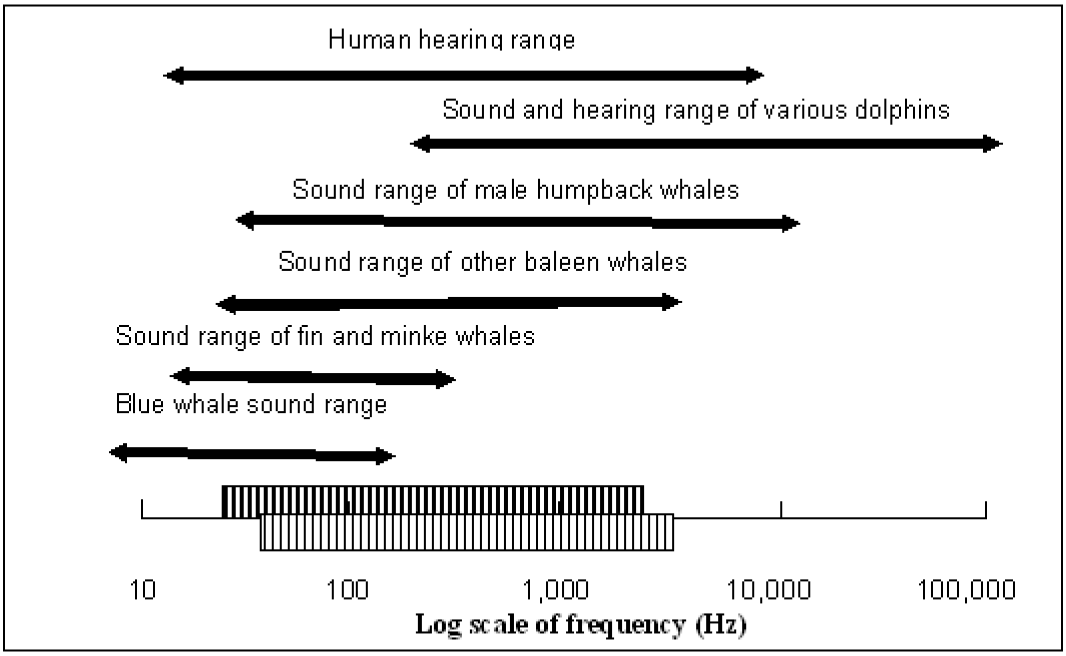


Figure 4-9 Frequency ranges for some baleen whales and dolphins
(Keyboard shows fundamental musical scale; adapted from McCauley [2003])

The following subsections describe the vocalisations of key species potentially occurring in the waters around Binningup.

4.2.7.1 Humpback whales

Humpback whales are probably the best known member of the rorqual group owing to the complex vocalisations of the mature males that cover many octaves. Sounds produced by the males are arranged in complex, repeating sequences that contain both tonal and pulsed components to form long 'songs', probably to help attract females. Some males will vocalise hundreds of times a day, sometimes for up to 20 hours without significant breaks. Large older males produce the longest and most complex songs, presumably to demonstrate fitness by maintaining a long song without interruption for surface breathing.

The loud songs directed in the breeding season by males towards females, other males or both, are now known to have estimated source intensities up to at least 189 dB (re 1 µPa 1 m) and frequencies in the 25 to 25000 Hz range (Payne 1970; Winn et al. 1970a; Thompson et al. 1986, in National Marine Fisheries Service [NMFS] 2002a; Mercado & Frazer 1999; NRC 2003). The songs differ among the regional populations and can change from year to year. Earlier estimates of their source levels (155-174 dB re 1 µPa 1 m) were considered to provide an effective 10-20 km range that could extend to 160 km depending on local conditions (Thompson et al. 1979, in NMFS 2002a).

Animals in mating groups produce a variety of sounds, and the sounds associated with apparent aggressive behaviour by males are different from the long songs. The shorter vocalisations extend from 50 Hz to at least 10 kHz, with most energy in the components below 3 kHz. The vocalisations appear to have audibly effective ranges of up to 9 km (Tyack 1981 1983; Silbert 1986; Tyack & Whitehead 1983; all in NMFS 2002a).

Songs from eight male humpback whales in a mating group were recorded by Mercado, Herman and Pack (2003) at very close ranges (20-40 m) by both single and vertical array hydrophones that had a uniform frequency response to 24 kHz. The equipment found many songs to comprise discrete bursts of sound. These bursts were organised into phrases, and phrases into themes. Most bursts had a mean duration between 1-2 seconds separated by similar intervals. Many of the recorded songs contained units that had high frequency harmonics extending to at least 22 kHz, implying that the broadband quality of the male songs is much wider than previously detected, providing further insight as to the possible high frequency limit in humpback hearing. The source levels of the different songs were estimated by considering the root mean square (rms) pressure level of the most intense units in each phrase of a song. Source levels varied between 171 and 189 dB (re 1 µPa 1m). The eight males were regularly observed within two whale lengths of females, indicating that male humpback whales exposed female whales to high sound intensity levels (Mercado, Herman & Pack 2003).

There is increasing evidence that similarly long, complex and intense humpback male calls are occurring in feeding areas, such as those sung daily in the summer feeding grounds in the North West Atlantic (Clark & Clapham 2004). Shorter sounds have also been recorded in the 75 m deep Soquel Canyon in Monterey Bay, California. These feeding-associated calls include low frequency grunts and higher frequency ‘eeeeees’ that may be used to coordinate group feeding, rally animals to feeding hotspots and/or concentrate the sardine schools that they target in this area. These distinctive sounds range from 20 Hz to 2 kHz, with median durations of 0.2-0.8 sec and estimated source levels of 175-192 dB (re 1 µPa 1 m) (Vincent et al. 1985, Thompson et al. 1986, Sharpe & Dill 1997, all in NMFS 2004).

In summary, humpback whales produce at least three types of sounds:

(1) Long complex songs with components ranging from 20 Hz to at least 4000 Hz (with some harmonics to 22 kHz) with estimated source levels in the 180-189 dB (re 1 µPa 1 m) range, as delivered by mature males in breeding areas.
(2) Male aggression sounds in the breeding areas, some extending from 50 Hz to over 10 kHz with most energy below 3 kHz.
(3) Less frequent but apparently increasing vocalisations in feeding areas, which are in the 20-2000 Hz range with estimated sources levels in the 175-192 dB (re 1 µPa 1m) range.

> Long complex songs from males form part of the apparently increasing repertoire in these areas.

The evidence of increasing vocalisations in humpback feeding grounds, as well as increasing call rates in winter breeding areas as humpback populations recover, lend further weight to the observation of McCauley and Cato (2003) that the ~40 year rise in low frequency oceanic background noise reported for some areas is not solely attributable to increased shipping.

4.2.7.2 Southern right whales

Right whale vocalisations are more concentrated in the lower frequencies, with their moans, groans, belches and pulses having most acoustic energy below 500 Hz. While moans are typically below 400 Hz some vocalizations have been reported to occasionally reach 2 kHz (in NMFS 2004). Right whales also produce a variety of low frequency sounds from noisy broadband blows and impulsive slaps, all with significant energies in the 50-1000 Hz range (Richardson et al. 1995). Source levels of southern right whales have been estimated as 172-187 dB (re 1 µPa at 1 m), although McCauley et al. (1998) found song components of southern right and humpback whales reaching an estimated 192 dB (re 1 µPa at 1 m).

Right whales use a variety of calls when socialising in a group, and recent studies indicate that the vocalising behaviour of the northern and southern right whale species are similar. However vocalisation rates are highly variable and individuals may remain silent for several hours. Vocalisation rates of North Atlantic right whales (*Eubalaena glacialis*) were measured using tagged and towed hydrophones by Matthews et al. (2001) in spring and summer 1999-2000 off Cape Cod (USA) and Bay of Fundy (Canada). Vocalisations were classed as either ‘moans’, 'low frequency calls' or 'gunshots'. Moan rates increased with size of whale aggregation. Individual whales produced 0 – 10 moans per hour. Small aggregations (2-10 individuals) produced 0-60 moans per hour, while larger aggregations (>10 individuals) typically generated 70-700 moans per hour. Higher moan rates were at night (as also noted for blue whales), and most moans were produced in clusters and within 10 m of the surface (Matthews et al. 2001).

Vocalisations made by North Pacific right whales (*Eubalaena japonica*) in the eastern Bering Sea in July 1999 were commonly detected to 20 km and once to 30 km via deployment of arrays of directional sonobuoys from a US Coast Guard vessel (McDonald & Moore 2002). Other cetaceans detected acoustically by these deployments included fin whales (19 times), killer whales (3 times) and sperm whales (once). From the deployments targeting the areas used by right whales, 26 acoustic detections were made while only five right whales were spotted, with only one making calls while under visual observation. Calls by the North Pacific right whales are similar in duration and frequency to those from South Atlantic right whales, *Eubalaena australis* (McDonald & Moore 2002). The predominant call (85% of 511 recorded calls) was the `up' call, a signal sweeping from 90 to 150 Hz in 0.7 seconds. Two other calls were termed `down' and `constant' calls based on the terms used for similar calls by other Southern right whales. Another call (`down-up') was considered unique to the North Pacific repertoire. As with the North Atlantic species (*E. glacialis*), the North Pacific right whales (*E. japonica*) typically produce a series of calls over several minutes then fall silent for an hour or more, with some animals not calling for four hours or more.

4.2.7.3 Blue whales

Blue whales are known to produce low-frequency moans which are lengthy, strong and often infrasonic by human standards. Recordings of blue whales off Chile noted the production of low-frequency moans at 12.5-200 Hz, lasting up to 36 seconds. Overall source levels were up to 188 dB (re 1 µPa-m). It was noted that a short pulse of 390 Hz was also produced during the moan (Richardson et al. 1995).

4.2.7.4 Bryde's whales

Data from recordings of Bryde's whales in the Gulf of California identified that this species produce short moans at a range of 70-245 Hz with a mean frequency of 124 Hz. Richardson et al. (1995) believe source levels could be ~152-174 dB (re 1 µPa-m), and have noted that Bryde's whales also produce short pulsed moans predominantly at 165-500 Hz. Calves may produce discrete pulses at 700-900 Hz (Richardson et al. 1995).

4.2.7.5 Dolphins

Bottlenose dolphins produce whistle sounds within a frequency range of 0.8-2.4 kHz, and between 3.5-14.5 kHz at maximum energy. Source levels for bottlenose dolphins are in the range of 125-173 dB (re 1 µPaat 1 m). The finless porpoise is known to produce click sounds within a frequency range of 1.6-2.2 kHz and at 2 kHz at maximum energy (Ketten 1998a).

4.2.7.6 Sea lions

While is there is some literature on the vocal behaviour and effects of noise on Californian sea lions, there are few published measurements of Australian sea lion vocalisations, and nothing on the effects of underwater or airborne noise on their behaviour (e.g. N. Gales, in Pidcock et al. 2003). California sea lions vocalise both in and out of water. Underwater sounds include barks, whinnies and buzzing, all below 4 kHz and associated with social interactions. Both males and females vocalise within the breeding colonies, with the loudest utterances in the 250 - 2000 Hz range (Richardson et al. 1995).

The Australian sea lion shares some life-style traits with Californian sea lions, including strong fidelity to seasonal breeding sites. Pidcock et al. (2003) considered that the Australian sea lion probably has a similar repertoire of sounds to the Californian species during both haul out and foraging periods.

4.2.7.7 Turtles

There is minimal information available regarding marine turtle generated noise, although Richardson et al. (1995) report that they have relatively weak vocalisation ability, mostly in the 100-700 Hz range.

5. ANTHROPOGENIC SOURCES OF NOISE IN THE OCEAN

5.1 COMPONENTS OF ANTHROPOGENIC NOISE

The main anthropogenic sources of noise in the marine environment include trading, working and recreational vessels, dredging activities, drilling and pile driving programmes, use of explosives, commercial sonar (depth sounders, fish finders and acoustic deterrents), geophysical sonar, and noise from low flying aircraft and helicopters. This section reviews what is known about these noise sources.

Table 5.1 shows the frequency range characteristics of a wide range of anthropogenic noise sources.

Table 5-1 Typical frequency ranges of anthropogenic noise sources

Frequency Band	Principal Contributors
<10 Hz	Ship propeller cavitation, seismic survey sources, explosives, aircraft sonic booms.
10 – 100 Hz	Distant ships, explosives, seismic survey sources, construction and industrial activities.
100 - 1,000 Hz	All sources of the 10-100 Hz band plus nearby ships, launches and other small craft and seismic air-gun arrays, low frequency active sonar.
1000 - 10,000 Hz	Shipping sources (close range), plus outboard powered boats, military tactical sonars, seafloor profilers and depth sounders.
10,000 - 100,000 Hz	Mine-hunting sonar, fish finders and some hydrographic survey systems.
>100,000 Hz	Mine-hunting sonar, fish finders, high-resolution seafloor mapping devices (side-scan sonar), some depth sounders, some oceanographic and research sonar for small-scale oceanic features and some hydrographic survey systems (e.g. Acoustic Doppler Current Profilers).

(from data in NRC 2003)

5.2 GENERAL SHIPPING

Surface shipping remains the most widespread source of low frequency (<1000 Hz) anthropogenic noise (e.g. Richardson et al. 1995, Simmonds & Hutchinson 1996, Popper et al. 1998). The US Navy (2001) has estimated that the +60,000 vessels of the world's merchant fleet annually emit low frequency sound into the world's oceans for the equivalent of 21.9 million days, on the basis that 80% of this fleet is at sea at any given time.

Ships generate substantial broadband noise from their propellers, motors, auxiliary machinery, gear boxes and shafts, plus their hull wake and turbulence. Diesel motors produce more noise than steam or gas turbines, but most long distance (low frequency) noise is generated by the 'hissing' cavitation of the spinning propeller. The characteristics of the principal sources of ship noise are as follows:

Propeller noise: Originates from the propeller blade cavitation that forms gas-filled cavities whenever the pressure of the water accelerating over the face and any rough edges on each blade falls below critical values (propeller blades 'suck' ships forward by the very low pressures generated on their forward faces, and these rapid pressure falls cause the 'boiling' effect). Intense broadband sound is created when the bubbles subsequently collapse in either a turbulent stream or against the surface of the propeller. Cavitation noise is directly related to vessel speed (the faster the propeller rotates, the more cavitation plus the larger the wave wake, in which further air bubble generation and collapse occur).

For ships with constant pitch propellers, the intense ‘hissing’ noise begins above the cavitation inception speed (typically 7-14 knots for most merchant ships). For tugs, rig supply tenders and dynamically-positioned drilling ships equipped with variable pitch propellers, and/or thrusters, cavitation noise occurs at both low and high speeds, with cavitation-free speeds often restricted to the 7-10 knot range. Propeller blades also generate the distinct ‘blade-rate’ tones that are proportional to the rotation rate of the propeller, while ‘singing’ propellers are not uncommon but usually restricted to a narrow band of the vessel’s overall speed range[7].

Flow noise: While most collapsing bubble noise is generated by propeller blade cavitation, other bubble noises emanate from obstructions on the hull and in the wave wake produced by the ship. Flow noise is sourced mainly from the external flow of water around the hull but also includes the noise of any fluids flowing through internal pipework that becomes transmitted through the hull. External flow noise includes vibrations and rattles in the hull plating and other external structures, plus the noise of the continuously breaking bow and stern waves and turbulence produced by protruding structures such as bilge keels, rudders and corrosion protection sacrificial anodes.

Machinery noise: A range of mechanical vibrations that are generated by the main motors and auxiliary units and transmitted through the hull to the water, contributing to both broadband and narrowband noises.

Compared to merchant ships, fighting ships and submarines are designed, built, maintained and operated to be much quieter for two operationally critical reasons. Firstly to limit their potential to become acoustically detected by an adversary’s sensors and underwater weaponry, and secondly to reduce acoustic ‘self-masking’ and thus maximise their detection and range-finding capabilities.

The noise spectrum radiated from merchant ships is typically 20-500 Hz with tonal peaks at approximately 50-60 Hz. Their low frequency noise components significantly contribute to the amount of low-frequency ambient noise, particularly in regions with heavy ship traffic. Thus ship noise needs to be treated in two categories; noise from nearby ships and that from distant traffic. Noise from nearby shipping is usually readily discernible as coming from individual vessels, with each ship producing a specific noise signature. The sound level and frequency characteristics (‘signature’) of discernible ships depend on their size, number of propellers, number and type of propeller blades, blade biofouling condition and machinery/transmission maintenance condition. In general, the larger the ship the louder the source level and the lower its tonals.

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[7] Ship builders report that approximately four of every 100 of new or refurbished propellers which meet all industry design standards are discovered to be a ‘singing’ propeller when fitted (e.g. **http://www henleyspropellers.com/faq htm).** Singing occurs when the frequency of the vortices shed in the vicinity of the blade trailing edge match the blade’s structural natural frequency, exciting the blade in a twisting mode in the same way a wine glass can be made to sing when its rim is gently rubbed. A singing propeller will usually excite the hull via the shaft and brackets, causing an annoyingly loud audible tone at particular RPM bands. This can occur on all vessel types, from small recreational cruisers to large ships, and involve one or both of a matched pair on twin installations. The loud airborne tone inside the hull is produced via the blade resonation through the drive train, shaft bracket or other hull components. In most cases the resonance-producing RPM band is narrow (Δ50 rpm) but in severe cases the audible tone occupies the normal operating range and/or may extend for over 400 RPM.

Figure 5.1 illustrates the energy spectra measured from large bulk carriers sailing into and out of the Port of Dampier in Western Australia. Peak average noise was in excess of 180 dB at a frequency of 10 Hz, with 1000 Hz tones at levels of 140 - 150 dB. The sound source levels of trading ships are compared with non-trading vessel types in Table 5.2.

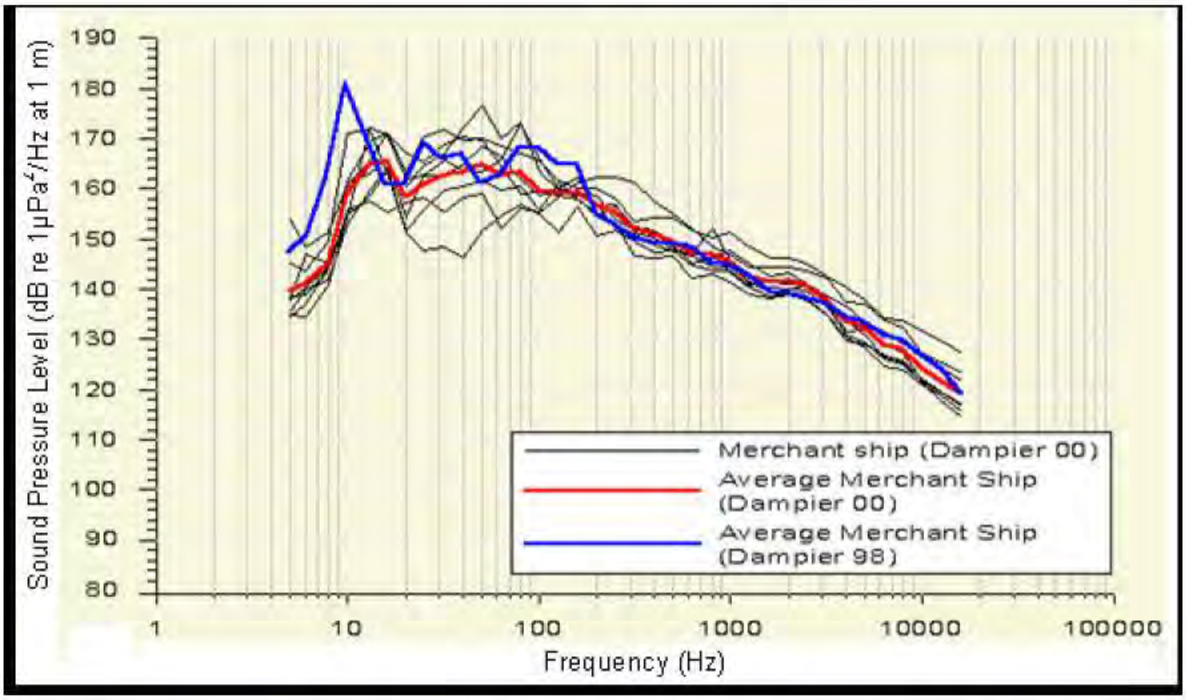


Figure 5-1 Merchant ship acoustic signatures measured in Dampier (WA) by DSTO

Table 5-2 Comparison of sound source levels from a range of anthropogenic sound sources

Source	Peak frequency or band	Peak source level/s (re 1 µPa 1 m)
Icebreaking ship (full power in ice)	10-1000 Hz	193 dB
Large tankers and bulk carriers*	10-30 Hz	180-186 dB
Container ship**	7-33 Hz	181 dB
64 m Rig supply tender*	*(broadband)*	*177 dB*
Tug towing barge*	1000-5000 Hz	145-171 dB
20 m Fishing vessel*	*(broadband)*	*168 dB*
Trawler#	100 Hz	158 dB
25 m SWATH ferry with 2 x 950 hp inboard diesels**	315 Hz	166 dB
13 m catamaran with 2 x 200 hp inboard diesels*	315 / 1600 Hz	159 / 160 dB
Bertram cabin cruiser with 2 x 165 hp inboard diesels*	400 Hz	156 dB
8 m RHIB with 2 x 250 hp outboards*	315-5000 Hz	177-180 dB
Power boat with 2 x 80 hp outboards#	630 Hz	156-175 dB
4.5 m inflatable with 1 x 25 hp outboard*	2500-5000 Hz	157-159 dB
Zodiac inflatable with 1 x 25 hp outboard#	6300Hz	152 dB
Cutter-suction dredge (working)	100 Hz tonal	~180 dB
Clamshell dredge (working)	250 Hz pulses	150-162 dB
Pile driving operations	Low tonal pulses	170-180 dB
Seismic survey	0-1000 Hz	200-232 dB
Drilling	10-4000 Hz	154-170 dB
Supply vessel	1-500 Hz	182 dB

* recorded at 10-11 knots; ** recorded at ~15 knots; # unrecorded speed or speed range.

Data sourced from Richardson et al. 1995; Dames & Moore 1996; Au and Green 2000, McCauley et al. 2002; University of Rhode Island, undated; and DSTO data for the Port of Dampier.

Distant shipping elevates local ambient levels across the 5-100 Hz band and no single ship is discernible. For a typical deep ocean case where propagation conditions are good, a large tanker with a source spectrum of ~180 dB (re 1 μPa^2/Hz at 1 m) at 50 Hz may contribute 85 dB at 20 km, 75 dB at 200 km and 65 dB at 2000 km. Thus for a typical North Atlantic ambient noise spectrum level of 85 dB at 50 Hz, this may be dominated by the contribution from a single nearby ship (20 km) or ten large ships within 200 km, or 100 large ships within 2000 km (e.g. Popper et al. 1998). Thus the actual level of traffic-induced background noise depends on the number, size and distribution of trading ships underway within the particular sea or ocean basin, plus their source levels and propagation conditions.

NRC (1994) estimated that the background ocean noise level at 100 Hz may have increased by about 1.5 dB per decade since the advent of propeller-driven ships, while Ross (1976) estimated that the increased number, size and speed of the global shipping fleet between 1950 and 1975 caused overall average ambient ocean noise levels to rise by as much as 10 dB in this period. From a review of historical acoustic recording data, Andrew et al. (2002) concluded that the increased size of the world fleet was responsible for the 10-15 dB increase they detected in low frequency ambient noise records since the 1960s.

These trend estimations, however, are by nature speculative since their scientific basis is compromised by inadequate data in the historical records and confounded by the rise in other contributing sources, particular the intense low frequency calls of the recovering rorqual populations (McCauley & Cato 2003). In addition, McCarthy et al. (2002) examined a range of anthropogenic sources (including petroleum exploration, shipping, academic research and military activities) and concluded that although general levels of shipping activity have increased, regional noise levels do not necessarily rise in direct proportion, and in some cases might have fallen, owing to introduction of larger ships, new technologies and other improved efficiencies. Shipping activity around Australia is shown in Figure 5.2. One of the busier areas is around the lower west coast of WA, in the vicinity of the SSDP.

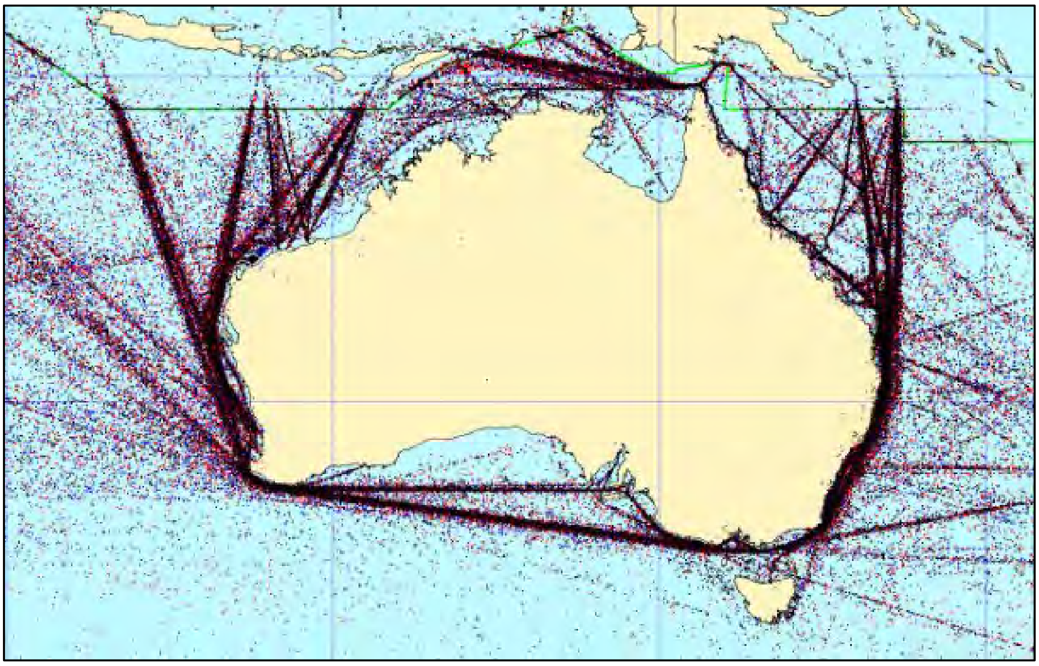


Figure 5-2 Vessel traffic density around Australia indicated via daily vessel movement reports (VMRs) to the Australian Maritime Safety Authority (AMSA)

5.3 TUGS

The propellers of most tugs are often heavily recessed and/or cowled to improve protection and thrust. These types of configurations reduce the forward and lateral transmission of the sound rays from propeller cavitation and blade rate tonals, but can also increase the directionality of sounds. Tugs towing barges produce less sound than larger or faster trading ships (Table 5.2).

5.4 DREDGES

Received sound levels from some large trailer suction hopper dredges operating in rocky areas have been recorded in excess of 150 dB re 1µPa at 1 km, while large cutter suction dredges can emit strong tones from the water pumps that are audible to 20-30 km ranges (Richardson et al. 1995, Dames & Moore 1996b). Underwater noise levels from the self-propelled hopper barges engaged in transferring dredge spoil are often higher than the noises from the dredge itself, particularly during the loading and dumping operation of rocky material.

Clamshell dredges emit varying sounds depending on the phase of the grab-retrieve-release operation, with strongest source levels (150-162 dB re 1µPa at 1 m) reported for the ⅓OB centred at 250 Hz. The highest level was from the bucket winch which generated a broadband source level of 167 dB re 1µPa 1 m (Miles et al. 1989 in Richardson et al. 1995).

5.5 LAUNCHES, FISHING VESSELS AND POWERBOATS

Underwater noise measurements of vessels of various designs and around 22 m length which carried whale-watchers in Hervey Bay, Queensland, showed that vessel speed was the primary factor which influences the amount of sound radiating from members of this 1-70 tonne fleet (McCauley et al. 1996). Small vessels produce significant directional noise patterns, with more noise radiating fore and aft than abeam. This has been attributed to the relative lack of hull noise shielding in the forward direction and only limited aft attenuation of propeller cavitation noise by the wake-induced bubble cloud. A number of vessels had 'singing' propellers (producing strong audible tones that significantly add to the noise signature at particular RPM ranges). The other key factor influencing vessel noise is size of vessel. In another example, McCauley (1998) noted the difference in broadband noise from a 20 m fishing vessel (168 dB re 1µPa) and a 64 m oil-rig tender (177 dB re 1µPa), as recorded when both were underway at 11-12 knots on different occasions in the Timor Sea. The difference of 9 dB represents a tripling of sound energy.

In the case of small power craft and patrol boats fitted with large outboard motors, these can produce relatively intense sound levels, particularly when travelling at planing speed. Single or twin outboard installations are the most common type of propulsion for <7 m long power boats in Australian coastal waters, i.e. inflatables, runabouts, small cabin cruisers, recreational fishing boats and rigid-hulled inflatable boats (RHIBs), and their fast rotating external machinery and small propellers produce intense and more complex sound spectra than those of launches fitted with inboard diesels (e.g. Gordon et al. 1992, Richardson et al. 1995, Au & Green 2000). Outboard motors produce broadband noise with many strong tonals and higher harmonics to 6000 Hz or more, with peak source levels in the 150-180 dB re 1 µPa 1 m range (Table 5.2). The development of four-stroke outboard motors, which are now becoming popular owing to their fuel efficiency, much quieter running and lack of oily exhaust pollution, may cause some reductions to outboard noise.

5.6 PIPELINES

5.6.1 Pipelaying

Noise of varying intensity and character is generated during all phases of marine pipelays. Noise sources may be continuous or impulsive and can be described as being transient or permanent, as shown in Table 5-3.

Table 5-3 Summary of noise sources and activities associated with pipelaying

	Activity	Source	Source Type	Duration (duty cycle)
Installation	Pile driving Pipe-laying Trenching Transport (equipment + personnel)	Pile driver +support vessel Pipe laying vessel + support Trenching vessel + support Helicopters + ships	Impulsive + Continuous Continuous Continuous	Transient (weeks) Transient (weeks) Transient (weeks) Transient (weeks)

There is likely to be some noise generated by movement and placement of the pipe, but this is of a transitory nature and of short duration, and is related to the size and type of pipe and method of placement. Most of the noise generated during pipelays is associated with the movement and operation of the dedicated pipelay and support vessels, as well as allied construction tasks such as trenching and rock armour dumping. This is the conclusion reached in the environmental impact assessment of a proposed underwater gas pipeline (Shapiro and Associates 2004).

5.6.2 Pipe operations

It may be speculated that movement of a fluid through an undersea pipe would generate noise that would be radiated into the water column beyond the pipe. Any such noise would be a function of several factors, such as: the fluid and its physical characteristics; its velocity through the pipe; the internal diameter of the pipe; the pipe length; the material from which the pipe was made, as this would influence both the transmission of vibration through the pipe and its acoustic coupling with the water; and any covering over the pipe, such as rock armour or bottom sediment.

This specific question was considered in the environmental assessment for an undersea gas pipeline across the Georgia Strait, in the north east Pacific. Data were obtained for an existing 250 mm epoxy-coated, high-pressure marine natural gas pipeline which identified radiated sound in the range of 60-72 dB (Birch et al. 2000). Further modelling and analysis concluded that the larger diameter gas pipeline proposed for the Georgia Strait would have a lower frequency for any given operating pressure than a smaller diameter line, with an estimated radiated noise equal to or lower than 30 dB at frequencies of 16 kHz and above (Shapiro and Associates 2004).

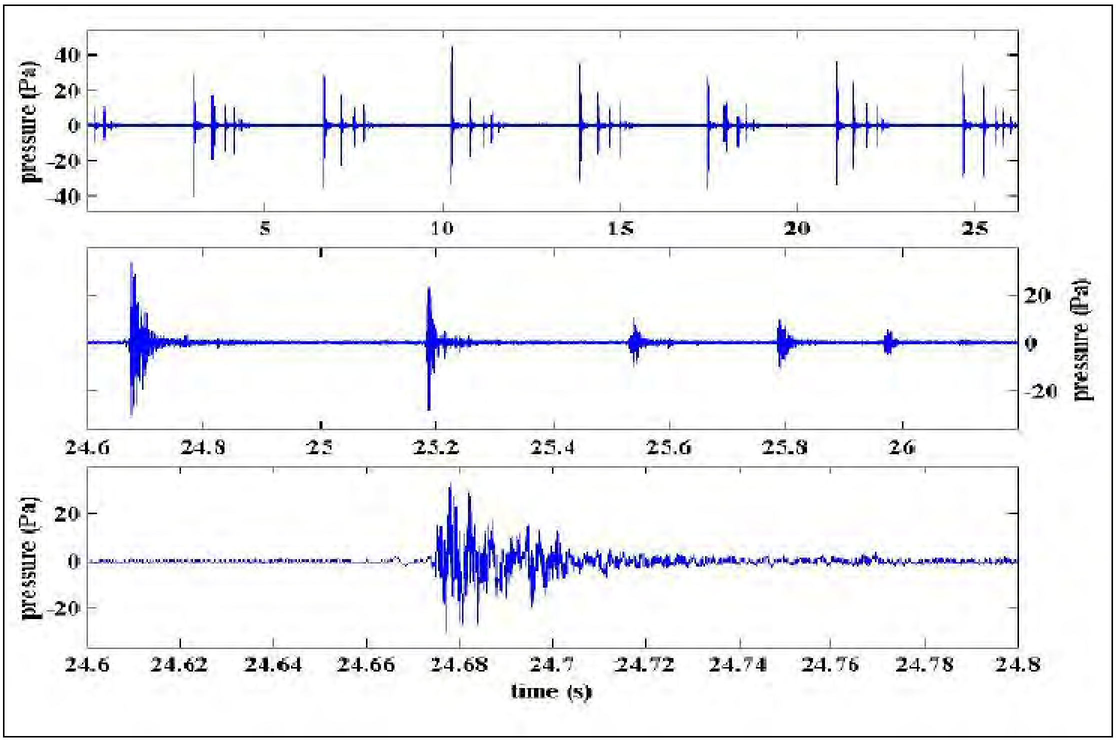
Marko (2003) considered sound propagation through bare and concrete-coated steel plates and longitudinal pipe sections. It was demonstrated that a concrete coating on a pipe acts as an acoustic insulator, and hence reduces radiated noise.

It is possible that the location of a pump near the marine portions of a pipeline, particularly if it exhibits a good acoustic couple with the pipeline, would cause an increase in the level of any radiated noise. The size, speed, power and other operational parameters of the pump be the principal determinants of any subsequent radiated noise, such as frequency and level.

5.7 PILE DRIVING

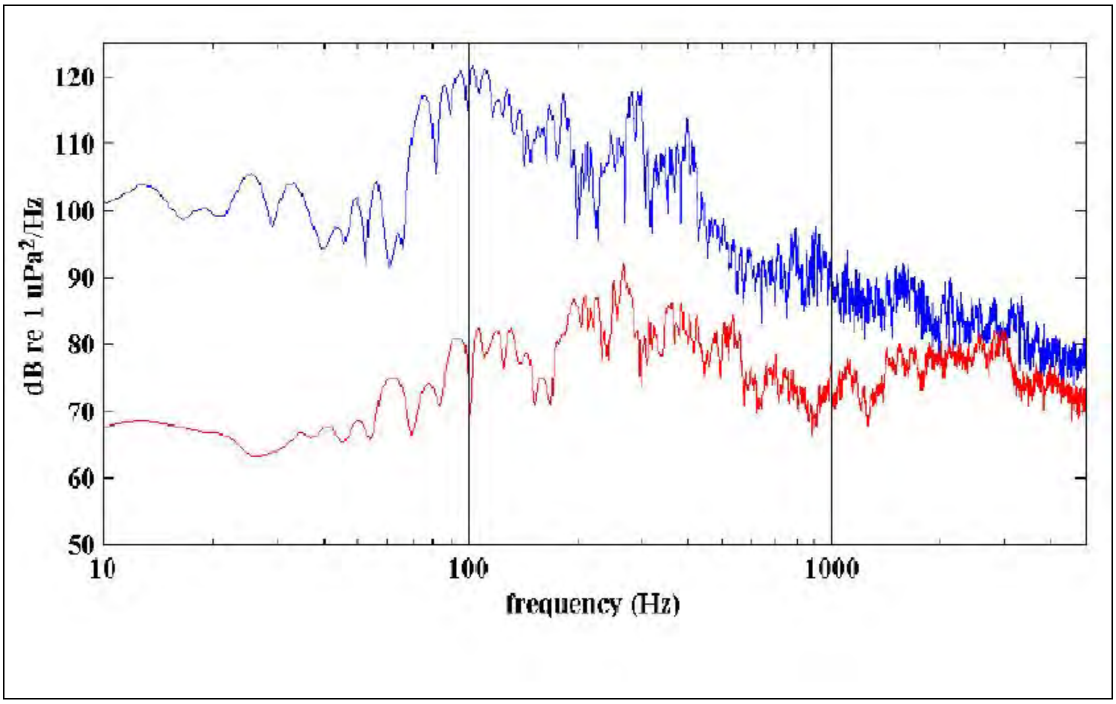
Noise from coastal construction and port activities includes hammering sounds from pile driving operations (e.g. 131 dB to 135 dB re 1 µPa at a range of 1 km, with audible ranges extending to 10-15 km from the source; Moore et al. in Dames & Moore 1996). A 2002 study of wharf pile driving operations to construct new Australian Defence Force (ADF) berths in Twofold Bay (Eden, NSW) by McCauley et al. (2002) provided sound level data that can be summarised as follows. Each pile driving event comprised a series of impulses associated with the weight being driven down. Power spectra showed peaks mostly between 100 Hz and 1 kHz. Individual signals typically fell by 20-30 dB between the initial drops and last bounces. Signal duration averaged 47 ± 0.5 milliseconds (range 10-200 milliseconds). The overall incidence of pile driving activities was low (only 2.5% of the samples recorded over a five day sequence contained pile driving signals). Average mean-squared-pressure of the signals was 167 dB (re 1 µPa) at 300 m from the operation, falling to 145 dB and 136 dB (re 1 µPa) at 1.8 and 4.6 km respectively. Curve-fitting of nine sets of measurements indicated average signal strengths fell from 150 dB to 140 dB (re 1 µPa) between 1 km and 3.1 km from the operation. The loudest recorded operation produced signals of which 6.5% at 4.8 km exceeded 140 dB (re 1 µPa) (McCauley et al. 2002).

Each pile driving impulse event comprises a primary pulse, which is immediately followed by 2-6 lower level ‘bounce’ signals if the drop-weight method is being used (Figure 5.3). The pile driving data were sourced from spectra plots (Figure 5.4) and other data reported by McCauley et al. (2002).



(from McCauley et al. 2002).

Figure 5-3 Example of seven pile drops and associated bounces (top), with the last set (middle) and its primary pulse (bottom) time-expanded



(from McCauley et al. 2002).

Figure 5-4 Frequency spectra plots of averaged primary pulses from 10-20 pile drops at ranges of 303 m (blue) and 590 m (red)

As a result of pile driving operations in British Columbian estuaries and waterways being linked with salmon mortalities, the impacts of pile driving projects, plus the mitigating value of using simple noise-reducing bubble curtain rings for each pile, have been examined by the

Canadian Department of Fisheries and Oceans (Vagle 2003). Their preliminary studies of four pile driving projects in the Vancouver region have shown that:

- the intensity and frequency spectra generated from each project site, pile and hammer strike vary markedly according to the pile driving equipment used (e.g. diesel hammering versus 1 tonne or 3.5 tonne drop-weight hammers), the hammer drop height (1-7 m), the use of a wood block shock-absorber, the material, diameter and design of the pile (e.g. cedar versus 36" and 8" diameter steel piles, with closed-end steel piles causing more salmonid deaths), the driven depth, and the type and density of the seabed strata;
- impulses need to exceed 30 kPa to induce observable changes to fish movements and density; with fatal swim-bladder injuries to chum, chinook salmon and herring associated with 120-150 kPa impulses;
- small bubble/low supply volume curtains can attenuate source levels by between 8-20 dB re 1 $\mu Pa^2/Hz$ in the 50-1000 Hz range, and by 18-30 dB in the 10-20 kHz range, while large bubble/ high supply volume designs produce little effect;
- bubble curtain attenuation efficiency decreases with increased bubble ring depth and larger bubble size (becoming agglomerated 'blobs' of air separated by large gaps);
- bubble curtain rings and apertures require careful maintenance to prevent gaps and 'holes' in the bubble screen from uneven bubble distribution, while tidal currents readily cause asymmetric distortions to the curtain.

5.8 BLAST AND CAVITATION

5.8.1 Explosive effects

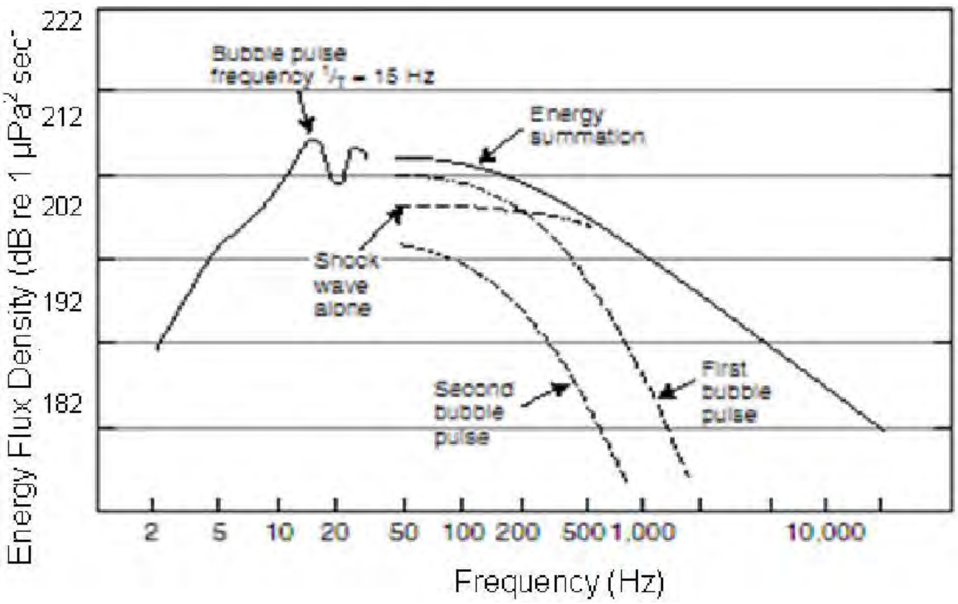
Blast refers to any shock wave generated in water (e.g. by detonation of a high explosive charge) or air (e.g. a sonic boom from a supersonic aircraft). A shockwave is an acoustic wave where the amplitude of the field is so large and non-linear that portions of the medium become torn and bodily shifted, with discontinuities in pressure and particle velocity invalidating the physics behind normal sound equations. Both an explosive blast and sonic boom start as a non-linear shock wave which, through dissipation and absorption, eventually evolves into a linear acoustic wave some distance from the source.

Explosive sources produce broadband signals with a very high zero-to-peak source level and a relatively flat spectral structure, in which the largest-amplitude component in the detonation time series comprises the initial shock wave (Figure 5.5). The zero-to-peak source pressure level produced by an explosive device can be predicted using its charge weight and detonation depth with the following equation from Urick (in NRC 2003):

$$SL(0\text{–}pk) \text{ dB re } 1\ \mu\text{Pa at } 1\text{ m} = 271.8 \text{ dB} + 7.533 * \log(w)$$

where w is the charge weight in pounds. Thus a ~0.45 kg (1 lb) detonation of high explosive at 37 m depth yields a maximum zero-to-peak pressure of 272 dB re µPa at 1 m, while ~45 kg (100 lb) produces an initial zero-to-peak pressure of 287 dB re 1 Pa at 1 m (Urick, in NRC 2003).

Cavitation is the tearing apart of water when the negative component of a pressure wave exceeds the surrounding hydrostatic pressure and becomes sufficiently large to cause bubble formation. Water becomes readily 'torn' into many bubbles as it cannot support much tension. 'Bulk' cavitation is the process where the water is torn apart by the surface-reflected shock wave of an underwater explosion. As discussed by Lewis (1996a), when a shock wave hits the water-air interface its outgoing (positive) pressure wave is reflected back down into the water as a negative pressure (tension) wave, which is an inverted image of the outgoing wave. As a result, the pressure wave at a particular point in the water column is a combination of the outgoing compression wave and the reflected tension wave that arrives soon after. Figure 5.5 shows how the shock-wave and bubble pulse energies combine at frequencies greater than 1/T (T = time (seconds) between the shock wave and first bubble pulse).



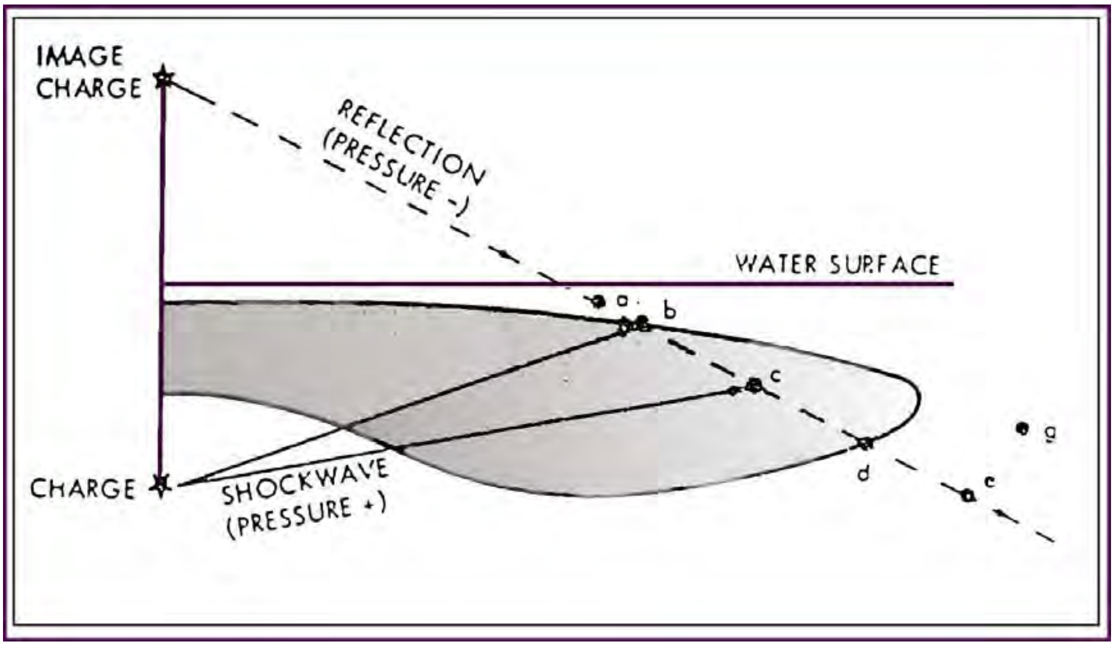
(modified from Urick, in NRC 2003)

Figure 5-5 Spectrum showing the broadband source from detonating ~0.45 kg (1 lb) of high explosive at 37 m depth

[N.B. Energy flux density = the squared instantaneous pressure amplitude summed over the duration of one second]

A schematic of the zone of bulk cavitation around an underwater explosion is shown in Figure 5.6. Below this zone no cavitation occurs since the tension never exceeds the hydrostatic pressure (which increases relatively rapidly with depth). While charge size influences the maximum depth (thickness) of the cavitation zone, the zone's horizontal limit (radial distance from the detonation point) is far more influenced by the depth of the detonated charge than its size. For example, increasing the charge size by ten times (a magnitude increase) roughly doubles the maximum depth of the cavitation zone but its horizontal distance is increased by only about 20% (for further detail see Lewis 1996a).

Interpretation of pressure time records recorded for underwater detonations normally includes determining the impulse of the pressure pulse (Pa.seconds; as calculated from the area under the curve of the first positive pressure pulse), its maximum zero-to-peak pressure and arrival time, the time constant of the decaying pressure-time signal, and the 'bubble' period. Impulsive sounds can be defined as the generation of an acoustic energy field in which the overall sound pressure level measured for 0.5 - 1 seconds via F time-weighting is more than 12 dB above the average maximum sound level.



[from Christian, in Lewis 1996a]

Figure 5-6 Diagrammatic representation of the zone of bulk cavitation

In a classic pressure pulse signal, the first positive peak usually provides the highest zero-to-peak pressure. However detonations in shallow water (<5 m) focus the shock wave towards the surface and markedly reduce the amount of lateral blast propagating into the surrounding water column. This feature can lead to unusually complex pressure-time histories in nearshore environments where the second peak may have a greater value (e.g. Box et al. 2000). In complex cases, measuring the impulse may require calculating both the positive and negative areas for several oscillations after the initial peak to ensure all significant pressure excursions are included.

Cavitation imposes an upper limit to the maximum acoustic power output of sound sources. For example, for a 3 kHz source in shallow water, the cavitation threshold is slightly more than 1.013 bar (= 220 dB [re 1 µPa]; Urick, in NRC 2003). Since some cavitation can be tolerated the effective sound level can be 2-3 times larger than this threshold (i.e. close to 230 dB [re 1 µPa]; NRC 2003).

The most damaging component of an underwater shock wave is the initial fast rise in pressure. The area over which this has a significant effect is limited however due to the rapid loss of the component frequencies which form the sharp leading edge of the pulse. After propagating through the water column these higher frequency components diminish such that the initial shockwave rapidly attenuates into a broad spectrum of frequencies with most energy in the sub-1 kHz range.

5.8.2 Use of explosive charges in the marine environment

Various explosive devices are occasionally used for research, removal of navigational hazards, removal of rocky outcrops during capital dredging programs, deconstruction of abandoned structures, scuttling hulks for artificial reefs, military exercises and (rarely) for hull-shock trials. They are also sometimes used for geophysical seismic surveys in shallow nearshore and transitional (littoral) areas. For example, 0.2-0.3 kg charges of Geoflex primacord and similar charge types have provided seismic sources in intertidal and shallow sublittoral sites where vibrators or airguns cannot be deployed due to rapid depth changes, navigational hazards and environmental constraints (e.g. LeProvost Environmental Consultants 1992).

Charges used for ship scuttling or underwater rock blasting are typically small (0.1 - 5 kg TNT). Use of explosive discharges by the research community has declined in recent decades, partly because of environmental and safety concerns but also because of the lack of control and the non-reproducible nature of the source waveform and the precise detonation depth.

The range of explosive ordnance and special purpose items containing high explosives (HE) which may be detonated at or beneath the surface during ADF live-fire practices and other maritime activities were reviewed by URS (2003). The HE content of these items ranged from 0.02 kg up to 428 kg.

6. BEHAVIOURAL AND PHYSIOLOGICAL EFFECTS OF NOISE

The purpose of this section is to summarise what is known about the behavioural and physiological effects of various levels of noise on marine fauna. However, prior to describing the range of sound impact categories and zones of sound influence, a summary description of the auditory system of the marine fauna of interest is presented.

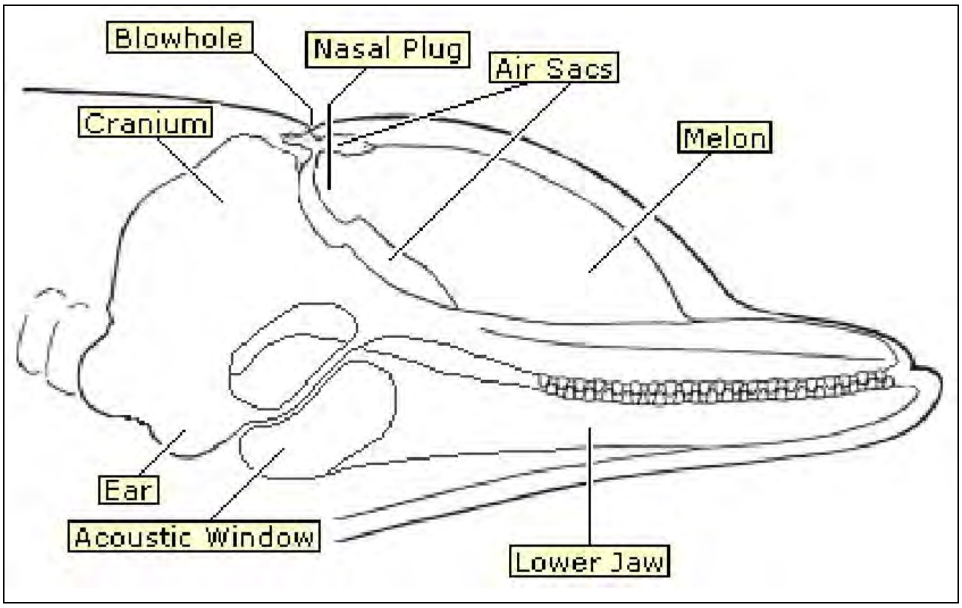
6.1 AUDITORY SYSTEMS OF MARINE FAUNA

6.1.1 Cetaceans

6.1.1.1 Overview

With some key modifications to meet the demands of underwater hearing, cetaceans have an auditory anatomy that follows the basic mammalian pattern, i.e. outer, middle and inner ear components are present. The outer ear is separated from the middle and inner ear by the tympanic membrane (eardrum), and the inner ear is where sound energy is converted into neural signals which are transmitted to the brain via the auditory nerve.

However, while the air-filled external canal and middle ear of terrestrial mammals transmit airborne sound to the fluid-borne hair cells lining the inner ear (cochlea), this matching is not required underwater and cetaceans have no air-filled ear cavities. Thus the ear canal of cetaceans is filled with debris and wax, and external sounds are channelled to the middle ear through the lower jaw. The core of the lower jaw is filled with fats that conduct sound to the tympanic membrane of the middle ear via a thin bony area called the pan bone or 'acoustic window'. While toothed whales and dolphins receive sound through their lower jaw, they produce sounds by passing air through sacs in their head (Figure 6.1).



(adapted from Scheifele [1991])

Figure 6-1 Hearing and sound production structures in the dolphin

Another difference between cetaceans and terrestrial mammals is that the middle and inner ear complex of all whales and dolphins is located <u>outside</u> their skull. While the complex is suspended by ligaments in a cavity outside the skull, it is encased by other bones, and the precise functioning of the cetacean middle ear continues to be investigated. Much more is understood about the inner ear as the cochlea is very similar to that of land mammals.

Thus acoustic energy transmitted to the inner ear causes the basilar membrane in the cochlea to vibrate. Sensory hair cells are excited by different sound frequencies according to their position along this membrane.

6.1.1.2 Determining cetacean hearing ranges

When assessing the potential effects of a particular sound source, it is important to compare its frequency spectrum with the known or estimated auditory range of the marine mammal of interest. For example, Swift et al. (2003) used a speculative baleen whale audiogram from Clark and Ellison to help assess the potential of vessels engaged in petroleum field development operations west of the Shetland Islands to be detected by fin whales in the region. Vessel noise levels recorded for two of the fin whale vocalising bands (18-22 Hz and 22-28 Hz) varied between 120 and 49 dB re 1 $\mu Pa^2/Hz$ at recording sites between 8.5 - 40 km from the source. Without a model for fin whale hearing it would not be possible to estimate that the levels in ⅓rd octave bands had exceeded the predicted lower limit of the threshold of fin whale hearing in 50% of cases (ambient +16 dB; Urick 1983), and exceeded the predicted upper limit of the hearing threshold in 25% of cases (ambient +24 dB; Urick 1983).

The anatomical components of the ears of any mammal, particularly that of its cochlea, dictates the frequency range it can perceive. Hearing sensitivity in particular low or high frequency ranges is dependent on the stiffness and mass along the inner-ear membrane and how the membrane is organized mechanically.

For dolphins, porpoises and seals that can fit inside computed topography (CT) scanners (Figure 6.2), suction electrodes are placed on the surface of an animal's head, tones are played and the brainwaves are recorded using a fixed or portable acoustic brainwave recorder (ABR). The scans allow precise anatomical measurements of the cochlea plus a 'gold standard' audiogram with respect to obtaining reliable narrowband frequency sensitivity. However CT scanners cannot accommodate larger heads and ABRs are unable to detect baleen whale brainwaves because of the interference caused by the huge mass of intervening bone, muscle and fat versus the relative small size of the brain[8].

The middle/inner ear complex in baleen whales is two to three times bigger than that of toothed whales, and all mysticetes studied to date have inner ears that appear well specialised for low-frequency hearing. For example, Ketten (1997) deduced from comparative morphological studies of the blue whale auditory apparatus that these rorquals have good infrasonic hearing (10-20 Hz). Because there are no other humane methods for obtaining direct measurement audiograms for baleen whales, comparative anatomical modelling studies using mathematical functions have been devised (Ketten 2000).

[8] When compared to body weight, the brain of baleen whales is more than an order of magnitude smaller than that of humans and dolphins.

(Ketten 2003)

Figure 6-2 Measuring inner anatomy and determining an audiogram using a CT scanner

The mathematical functions used to estimate frequency sensitivity of the humpback whale were obtained by relating the relative length of the basilar membrane with known data for cats and humans. The predicted audiogram was the typical mammalian U-shape that suggested 200-10,000 Hz auditory range with maximum sensitivity between 2000-6000 Hz (e.g. Houser et al. 2001). A model of humpback hearing was subsequently created as a series of pseudo-Gaussian bandpass filters. Model sensitivity optimised to the predicted audiogram by using programs to evolve the number, frequency distribution and shape of the model filters, and the sensitivity of the model was evaluated through a simulated hearing test. Maximum deviations between model sensitivity and predicted humpback whale sensitivity remained below 10%. This integrated approach provided the first predicted audiogram for humpback whales and was used to develop the first bandpass model of the humpback ear (Houser et al. 2001).

Similar comparative auditory analysis work has been undertaken to examine the capacity of right whales to hear oncoming ships (Ketten 2003), as appears to be the case by recent field studies using ship-source surrogate devices (Tyack 2003). This study included checking for the presence of pathogens in ears from stranded right whales, particularly animals showing evidence of a ship-strike. Since noise from shipping, seismic surveys and long distance sonar have all or most energies in 5 Hz to 500 Hz range, these sources overlap the current estimates for the sensitive parts of the auditory range of baleen whales.

6.1.2 Sea Lions

Compared to the cetaceans and sirenia, all other marine mammals, including pinnipeds, spend periods of time on land. Consequently their ears have not evolved major differences from those of land mammals (the external ear flaps [pinnae] in the pinnipeds are reduced or absent, but their external ear canals remain open). Eared seals (otariids), such as the Australian sea lion, have small ear flaps and broad ear canals. Muscles around the ear canal close it to water during dives, and the middle and inner ear are still attached to the skull. The middle and inner ears of pinnipeds are more similar to those of land mammals and do not display any specialisations for detecting either very high or low frequency sounds.

The functional hearing range of Australian sea lions in water is around 1 kHz to 30 kHz, with best hearing from 2 kHz to 16 kHz. Sensitivity in the lower range (below 1 kHz) deteriorates rapidly in both air and water and their hearing sensitivity is better underwater than in air, although the latter is very adequate and on a par with humans above 10 kHz.

Australian sea lions have no echolocation ability but are understood to vocalise while in the water. Their underwater repertoire includes barks, whimpers, buzzes and clicking sounds, all below 4 kHz. Based on research concerning Californian sea lions (Richardson et al. 1995) it is surmised that these vocalisations are associated with social interactions rather than feeding.

6.1.3 Marine Turtles

The auditory sensitivity of sea turtles is reported to be centred in 400 – 1000 Hz range, with a rapid drop-off in noise perception on either side of this range. This auditory range matches their weak vocalisation abilities which are also in the low frequency range (100-700 Hz). This is supported by electro-physical studies which have shown that the hearing range for marine turtles is approximately 100–700 Hz (McCauley 1994). No information, however, is available regarding the threshold level necessary for behavioural effects.

6.1.4 Sharks

The range of hearing sensitivities in the bony fishes is better known than in the sharks and rays (about 80 fish species audiograms have been determined versus four for sharks and rays - the bull shark [*Carcharhinus leucas*], the lemon shark [*Negaprion brevirostris*], the horn shark [*Heterodontus francisi*] and the little skate [*Raja erinacea*]; e.g. Casper et al. 2003, Mann et al. 2006). However all fishes tested to date appear capable of performing the same basic hearing tasks as terrestrial and marine vertebrates, such as discriminating between sounds, determining sound direction and filtering biologically relevant signals in the presence of ambient noise (Popper et al. 2003).

The best hearing sensitivity of the sharks is within the 20 Hz to 800 Hz low frequency range. In addition, sharks also have at least some ability to perceive infrasounds (0.1 Hz to 10 Hz) at particle acceleration levels from <10~6 to >10~4 ms-^{2} (sufficient to detect 120-180 dB re. 1 µPa at 0.1 Hz). Sharks appear to use infrasound to detect potential prey such as struggling fish.

6.2 CATEGORIES OF SOUND IMPACTS

Reviews such as Richardson et al. (1995), Gisiner (1998), McCauley and Cato (2003) and URS (2003) note how sound waves from nearby, discernible sound sources affect marine fauna, and mammals in particular, differently to those from distant, undiscernible ships and other low frequency sources which add to background ambient noise.

There is evidence that the development of harbour facilities serviced by heavy vessel traffic will elevate local background levels, and may cause some species to avoid former nearby breeding or feeding areas owing to the amount of vessel movement disturbances as well as the noise. For example, gray whales temporarily abandoned a breeding lagoon in Baja California during a period of extensive coastal industrial activity involving heavy vessel traffic. The whales did not return to the lagoon until the vessel activity had decreased (Gard 1974).While some marine mammals can appear more capable of habituating to such activities than others (such as dolphins in noisy urbanised estuaries and embayments, and sperm whales feeding in busy shipping lanes), their calving or pupping areas are almost invariably restricted to less disturbed locations.

The above effects are due to essentially permanent vessel traffic and other noise generating activities. These are not addressed in the following sub-sections, which focus on the effects of noise from discernible sources generated by relatively short-term human activities (as summarised in Table 6.1).

Table 6-1 Summary characteristics of some common human sound sources

Source	Perceived location/s	Perceived speed and direction of source	Sound periodicity	Frequency range (Hz)	Source Level[1]
Seismic airgun array	Moving	Slow (4-6 knts) and steady direction	Very regular short pulses	LF (8-1000) Most <500	215-240[3] (ramped)
Well drilling	Fixed	Fixed	Steady continuous	Tonals	130-150
Field development support vessels	Almost fixed	Slow with variable direction	Irregular periods of continuous or transients	LF + tonals	170-190
Trading ships	Moving	Fast (12-22 knots) and steady	Steady continuous	LF (10-500) + tonals (1 kHz)	160-186
Whale watching vessels[2]	Multiple, moving	Variable speeds and directions	Variable (continuous and transients)	LF-MF + HF tonals	140-190
Pile driving	Fixed	Stationary	Irregular periods of regular pulses	LF-MF tonals	170-180
Detonations[4]	Unpredicted	N/A	Unpredictable sudden short pulse	Wideband	240-260
Dredging	Fixed	Stationary	Variable continuous sounds	LF-MF + tonals	150-195
Sea dumping	Unpredicted	Stationary, or slow with variable direction	Unpredictable sudden transients (2-10 mins)	LF-MF	140-190
MF tactical sonar	Multiple and moving	Erratic	Unpredictable sudden short pulses	MF (2-4 kHz)	180-225
LF surveillance sonar	Moving	Slow and steady	Regular long pulses	LF (100-400)	230-250 (ramped)
NPAL research sonar	Fixed	Stationary	Regular 20 minute pulses	LF (40-300)	195 (ramped)

(1) dB re 1 µPa @ 1m / dB re 1 μPa^2 @ 1m msp.
(2) small ferries, launches, outboard RHIBS, various recreational.
(3) for 2,000-2,800 cubic inch arrays in Aus. waters.
(4) e.g. rock blasting, hulk scuttling, removals, bay cable survey.

Different types of noise can be broadly categorised as follows:

- Continuous or near-continuous sources that may prevent marine mammals or turtles from hearing social communications or other acoustic cues (= temporary masking effects).
- Noise that induces behavioural changes and responses in marine mammals and turtles.
- Noise that induces behavioural responses by the prey of toothed whales (fish, cephalopods).
- Very intense noise that may cause temporary or possibly permanent loss of hearing sensitivity to marine mammals via damage to the auditory hair cells (or other tissue trauma via possible excitatory and organ resonance mechanisms).

To assess the potential scale and likelihood of these effects, ‘safety ranges’ or zones of influence have been developed for predicting, measuring and managing noise-generating activities, in the same way that zones of lethality[9] have been used for assessing the spatial extent of possible marine animal injuries from the non-acoustic blast impulses of underwater explosions**.**

6.2.1 Zones of Influence

Depending on the type of source, the species of interest, its known or assumed habits and acoustic behaviours, one or several of the following zones can help determine an appropriate safety range. For a given source, these zones can be roughly ordered from likely largest to smallest as follows:

- Zone of audibility (pertinent for sudden sounds with designed or inadvertent capacity to scare off individuals, such as acoustic deterrent devices or the pulsed tone of a research sonar).
- Zone that induces behavioural avoidance or other undue stress (e.g. for calving and resting areas, turtle nesting areas, commercial fish grounds).
- Zone that masks distant (LF) or nearby (HF) communication calls, echolocation pulses and possible navigation cues (e.g. for social calls, prey detection and/or local orientation by groups of toothed whales or dolphins).
- Zone eliciting discomfort, flight and possible temporary hearing shift (for marine mammals or turtles).
- Zone of pain, possible permanent hearing shift or other tissue injury (for marine mammals, turtles, fish or cephalopods).

Further detail on each of these zones is provided below.

6.2.2 Zone of Audibility

The zone of discernible audibility represents the maximum possible radius of influence by a particular source. This range can vary markedly according to the species and individuals of interest, plus their specific location, source-receiver-seabed geometry, season and time of day. Factors which can cause the boundary of these zones to expand and contract on an almost moment by moment basis include:

- the frequency, temporal characteristics, directionality, depth and orientation of the source
- the host of physical factors dictating the transmission loss rate and propagation of the peak frequency band/s towards the receiver
- the particular depth of the receiving individuals of interest and their hearing thresholds with respect to the peak frequency components of the source’s bandwidth
- the levels of the various physical, biological and other human sources that form the ambient noise intensity spectrum at the receiver’s location
- the level of attention and habituation (previous signal experience) of the receivers, which will influence their ability and motivation to perceive and interpret the signal.

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9 The maximum amplitudes of acoustic waves that do not contain sufficient energy to kill, maim or stun marine mammals or turtles outright (e.g. Lewis 1996, Richardson et al. 1995, URS 2003).

Many of the above factors can vary minute by minute as well as differ substantially between regions and locations, and thus limit the significance and value of determining this zone for most sources and species. Nevertheless estimates of maximum audibility of specific noise sources are occasionally reported for marine mammals with known or estimated spectral audiograms and hearing thresholds. For example, the absolute auditory threshold to a 1000 Hz tone for a captive beluga whale has been measured as 104 dB re 1 µPa. The critical signal to noise ratio (SNR) at this frequency (i.e. the amount by which the signal must exceed background noise to become audible) was determined to be 17 dB.

Such measurements imply that beluga whales experiencing typical arctic ocean ambient noise conditions cannot detect icebreaker noise at ranges beyond 20 km, even at full power (Table 6.2). This example contrasts with earlier findings by Finley et al. (1990), who had previously attributed a substantial movement of beluga whales to avoid icebreaker noise. In this case, the beluga whales were reported to stop feeding and swim away from approaching icebreakers, travelling up to 80 km from feeding areas before returning after 1-2 days (Finley et al. 1990). The apparent contradictory evidence highlights the problem of attributing cause/effects in field conditions where the auditory sensitivity is unclear and where control examples are unavailable or involve different conditions.

For cases involving the maximum audibility of continuous or regular periods of low broadband noise (such as the sound of distant shipping traffic, a slow-moving icebreaker or a stationary drilling operation), there is little in the weakly discernible signals to invoke a particular behavioural effect, learned or otherwise, and the issue turns toward masking effects. In the case of repetitive short pulses of low frequency sound from distant airgun or pile driving sources, their pulsed nature would make them more readily perceivable at long distance, but the separation of the weak and distant pulses by intervals of many seconds (typically >10) lessens their ability to mask out any long distance calling sequences of the larger rorquals (which last >20 seconds or, in the case of humpbacks, many minutes; Section 4.2.7.1). Sources that propagate near-continuous and essentially non-discernible broadband sound contribute to ambient noise, and it is more useful to assess their capacity to mask incoming sounds and cues of import to local receivers.

The audible zone has more relevance for acoustic deterrent or harassment devices which emit aperiodic pulsed signals as these have the capacity to startle marine fauna, as could the sudden appearance of a research or military sonar tone. Thus the value of assessing a source's audible range increases (a) the more its signal is readily distinguishable from ambient background and (b) the more likely the characteristics of this signal will invoke interpretation and potentially adverse responses by individuals of the species of interest. This switches our attention to zones which induce behavioural reactions to noise such as the startle response and avoidance. These ranges are also more amenable to monitoring and mitigation.

6.2.3 Zone of Behavioural Responses

The zone of behavioural response is logically smaller than the zone of audibility, and is based on the received sound level which evokes changes in behaviour that may result in adverse effects on the well-being of individuals and populations of protected species.

The capacity of an unmanaged sound source to cause startle responses, or other types of undue interference and stress that may lead to biologically significant consequences to a protected marine species, varies markedly according to the source characteristics. Not all human sounds cause undue behaviour responses, and some are more amenable to habituation than others. Sound source features which increase a source's capacity to receive attention from and interfere with marine mammals or turtles engaged in feeding, breeding or resting activity are summarised in Table 6.2.

Table 6-2 Features of an audible source likely to increase level of attention and invoke behavioural responses in marine fauna

Source characteristic	Increased biological significance	Response
Frequency range	Within sensitive part of receiver's auditory range	Increasing attention / curiosity
Narrowband signal	Easier to detect (>SNR*); imparts potential meaning	
Pulsed signal	Easier to perceive, potentially disruptive	
Moving	Invokes more attention (e.g. vectoring to discern direction)	
Sudden / aperiodic	Increases likelihood of causing a startle response	Increasing stress/alarm
Moving fast (>10 knots)	Increases chance of alarm and flight unless the source is common with steady direction (habituation effect)	
Position or heading	Between receiver and its intuitive pathway to safety	
Erratic direction and speed	Unpredictable movements invoke continual vectoring, sense of alarm, disengagement of previous activities, avoidance/defensive reactions.	

* = Signal to (ambient) Noise Ratio

The types of observable reaction have depended on the nature and affordability of the particular physiological or behavioural responses that can be measured in research aquaria (i.e. for captive dolphins or the occasional small toothed whale) or observed visually and/or acoustically in natural open waters for the larger whales. Field methods are constrained by the availability, amenability and 'repertoire' of measurable behaviours of the species of interest, while both field and laboratory studies are constrained by ethical considerations regarding the effect of deliberate sound exposures to the welfare of tested subjects[10].

Behavioural reactions to sound vary with the species and individuals of interest, including their state of attention and activity, maturity, experience and parental duty, all of which will alter with season, location and times of day, etc. Reactions involving relatively small avoidance responses by individuals are clearly not biologically significant, whereas those produced in scenarios involving a near permanent sound source displaces animals from key feeding or breeding grounds over month or seasonal time scales have obvious import to growth, stress levels, breeding success, survivorship and hence population recovery rates.

A range of surface-visible and acoustic behaviour features of whales have been monitored as direct or surrogate measures of potentially adverse responses to the onset or approach of a sound source (or its surrogate device), with the level of success highly dependent on weather

10 There has been development of increasingly sophisticated and affordable digital telemetry acoustic tags (DTAGs) which can be temporarily attached to large whales in open waters by suction cap (some with depth and inertial motion detectors for diving studies or positioning systems for satellite monitoring). This is widening the number of observable responses that previously were constrained to captive dolphins or small odontocete whales within the confines of research aquaria.

conditions, whale abundance and activity, and/or the appearance of unanticipated confounding factors, versus the amount of available study time, observation platform/s, reliable hydrophone systems and field personnel.

Behavioural changes monitored during open water studies of specific sound sources typically include one or more of the following (depending on the particular source, species and the level of activity of the individuals[11] at the location of interest):

- course alterations to directions away from or towards the source and speed changes
- cessation or change to previous activity
- altered local/regional distribution patterns of individuals/groups (typically by aerial survey)
- close up (bunching) of group members or pairs
- alterations to cow-calf interactions
- alterations to surfacing interval and/or number of breaths between dives
- absence of 'fluke-ups' (marking feeding dives in some species)
- alterations to dive patterns and durations
- alteration of call type, rate, duration, depth and timing
- alteration of echolocation rate, type, duration, depth and timing
- changes to spy-hopping, breaching or fin slap rates (interpreted as evidence of curiosity, defensive or annoyance behaviours respectively).

For any given location and propagation conditions, the range at which the received sound of a source invokes a behavioural response will depend on the auditory sensitivity of the species of interest, while the biological significance of this response will vary according to the type of activity being undertaken. Not all behaviour responses increase risk of harm to individuals, breeding success or population recovery rates. Some responses may be momentary inconsequential reactions such as the turn of a head, or have limited duration and lie within the bounds of natural behaviour variations. Table 6.3 summaries the potential significance of possible diverted attention, avoidance and alarm responses by large whales as a result of a human noise source, in the context of feeding, migrating, resting, calving or mating activities.

Early studies had pointed to the baleen whales and possibly sperm whales as the most sensitive to seismic surveys (a source of intense, low frequency broadband noise) of marine mammals in terms of behavioural responses and the eared seals and sea lions (otariids) as the least sensitive (Richardson et al. 1995). Work during and since the 1990s has shown this generalisation is not uniform and is untrue for sperm whales (e.g. Madsen et al. 2003; Richardson et al. 1999; Stone 2003).

Seals and sea lions have been known to rapidly habituate to various acoustic scaring devices, especially if attracted due to the feeding opportunities being protected, such as occurs with aquaculture facilities. Off California, observations from a seismic vessel found California sea lions ignored the array, with some individuals occasionally attracted to it, even when operating (URS 2004). Monitoring was conducted in the Alaskan Beaufort Sea over the period 1996 to 2001 on the behaviour of seals exposed to seismic pulses from 6–16 airgun arrays with total volumes of 560 -1500 cubic inches (Harris et al. 2001, Moulton & Lawson 2002). Results found some seals will avoid the immediate area of seismic vessels, with small avoidance movements of one to several hundred metres. Many other seals, however, remained within 100 - 200 m of the track line of the passing array.

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[11] Whales engaged in an intensive activity such as feeding are generally more preoccupied and less responsive to external stimuli and cues than when inactive, resting or migrating (Richardson et al. 1995).

Marine turtles have been recorded as demonstrating a startle response to sudden noises (Lenhardt et al. 1983; McCauley et al. 2000b). Although turtles are often observed approaching offshore oil and gas facilities, it is possible that anthropogenic noise may cause some turtles to avoid certain areas.

Based on caged turtle trials and extrapolated response levels for a large air-gun array operating in 100 m of water, McCauley et al. (2000) predicted that sea turtles would, in general, commence displaying behavioural responses at 2 km and avoidance behaviour at 1 km (Table 6.3). However, McCauley et al. (2000) also noted that such rules of thumb for intensive acoustic sources with peak frequencies in their range of hearing (i.e. below 1 kHz) cannot be reliably applied to turtles in shallower coastal waters (i.e. less than 20 m where propagation conditions differ and transmission losses are usually higher than in open ocean deep water areas). It is also worth noting that the response predictions were derived from two caged trials with the same two animals (a green and a loggerhead turtle) held in relatively cold water (i.e. at the lower end of the turtles' sea temperature distribution range). It remains to be seen if these predicted range responses to sound pressure levels would be shown by free-swimming individuals engaged in feeding.

Table 6-3 Effects reported for airgun pulses on two turtle species

Species	Received Level (dB re 1 µPa rms)	Effect	Source
Loggerhead turtle	175-176	Avoidance response	O'Hara and Wilcox 1990
One Green and one Loggerhead turtle	166	Noticeable increase in swimming behaviour, presumed avoidance response	McCauley et al. 2000
One green and one Loggerhead turtle	175	Behaviour becomes increasingly erratic, presumed alarm response	McCauley et al. 2000

(modified from table in McCauley et al. 2000)

In the case of pulsed low frequency sound effects on turtle nesting behaviour, nest numbers monitored on beaches near the Port of Hay Point (Queensland) before, during and after a pile driving program lasting several months in 1996-97 were compared. Results showed no significant trend in nest numbers, indicating that the female turtles had not been particularly sensitive to this pulsed source (Dames & Moore 2000), but nest numbers were too few to provide a conclusive result.

6.2.4 Zone of Potential Masking

Zones of masking depend on the amount of overlap between received source peak frequencies and the communication band/s of the species in question, plus the proximity of habitat deemed critical to the conservation and well-being of its local population or regional stock. As noted in Section 6.2.2, examining the potential of a near-continuous low frequency broadband source to mask long distance communications is more useful than estimating its maximum discernible audible range, particularly for a whale frequented locality already experiencing elevated background noise levels from other human sources.

Table 6-4 Type and possible consequences of behaviour changes from exposure to human noise source

Activity	Possible Effect / Response	Potential Consequence	Significance*
Intense feeding on important but possibly ephemeral or seasonally restricted prey	Influences normal diving and recovery sequences, group working, use of echolocation, or causes other behaviour change that reduces feeding	Reduced feeding efficiency causes reduced net energy intake (size of reduction depends on number and duration of encounters)	Low if encounters are brief and few. If prey is limiting, increases with percent of feeding time affected. May stabilise if habituation occurs.
Long distance migration to/from feeding ground	Alter course to avoid source	Course deviations involving +10 km add a fraction of time and energy loss to the overall journey budget of >2000 km	Low (equivalent to detouring around the approaches to a busy port)
Resting	Increased sensitivity to novel or unexpected noise reduces sound level tolerance. Forced to move away from source.	Unplanned exertion and use of energy	Increases with number of disturbances before or after calving
Calving	Increased stress, avoidance or defensive behaviour increases risk of injury to calf and cow	Disrupted birthing or suckling increases risk of cow/calf injury, calf oxygen debt, reduced milk intake, exposure to predators.	Risk of mortality increases with number of interactions (risk of reduced population recovery rate).
Social interactions and mating in winter breeding grounds	Diverted attention, disrupted vocalisations, and/or avoidance behaviour disrupts mate selection, courtship and mating.	Reduction in factors facilitating adequate insemination, conception and embryo implantation.	As above, with respect to reduced pregnancy rate.

* Assumes exposure to a novel noise source. May stabilise/reverse if the characteristics and commonality of the particular source facilitate habituation.

Both toothed and baleen whales have been observed to respond to increased background noise by producing more calls, louder calls, longer calls and/or shifting call frequencies. In the case of dolphins and toothed whales, these tend to remain in large family groups, specialise in high frequency (short-distance) vocalisations and do not generate low frequency sounds capable of long distance communication. In noisy localities and embayments bottlenose dolphins have been shown to echolocate louder (Au & Penner 1981) and change the frequency characteristics of their whistles and echolocation clicks (Au et al. 1974, plus recent Hervey/ Moreton/Port Philip Bay comparative studies).

6.2.5 Zone-inducing Possible Temporary Threshold Shifts in Hearing

When exposed to a sufficiently intense sound source, the inner ear hair cells of marine mammals can receive excessive excitation and subsequently cause a temporary decline in hearing sensitivity, in the same way as land mammals and humans. This is called a 'temporary threshold shift' (TTS), and its appearance due to the 'tiring out' of the hair cells is a function of the strength of the sound and duration of exposure. In the case of human health and safety regulations, the typical workplace regulations to prevent TTS via 8 hour shift exposures are 80 or 90 dB re 20 μPa, which are equivalent to underwater levels of roughly 142 to 152 dB re 1 μPa**.**

The TTS threshold is a time versus energy exposure function of the received sound, with the measured loss in hearing sensitivity (3-6 dB at or just above the frequency of the received sound) related to the total received energy (e.g. Finneran et al. 2002). When a TTS is present, the hearing threshold rises and a sound must be stronger in order to be heard. A TTS typically lasts for minutes, but may extend to hours or even days in cases of a strong TTS. The affected region remains at and just above the frequency range of the offending TTS-causing sound.

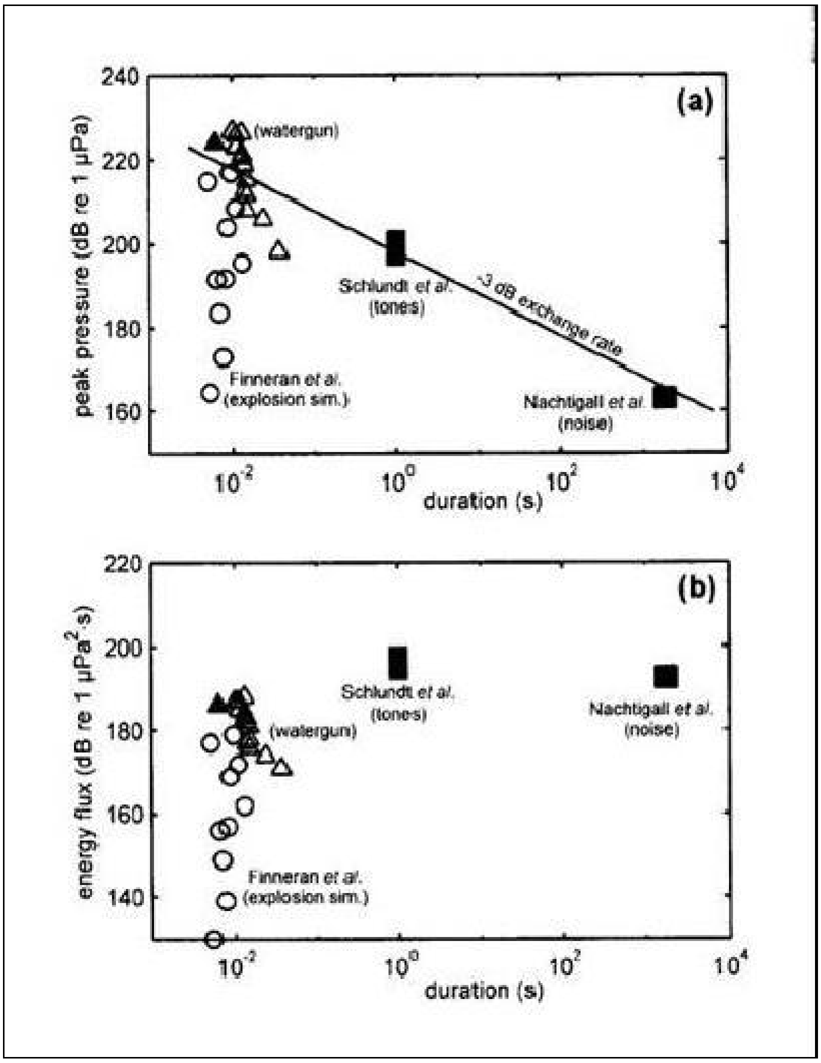
Repeated TTS events without sufficient intervening recovery periods can lead to irreparable damage to the hair cells, thereby leading to a Permanent Threshold Shift (PTS). The potential significance of TTS to long lived mammals such as the larger whales is therefore twofold: a temporary period when the ability to perceive a social signal, echolocation image or orientation cue may be impaired, plus an increase in the long term risk of accelerated hearing loss in old age. However, as with humans and terrestrial mammals, the auditory system is resilient and can experience the occasional TTS without undue risk of PTS developing. Thus some workers maintain that mild TTS is not injury *per se*, as it is a natural phenomenon experienced by humans and terrestrial mammals and has also been shown in marine fauna. In this context, there are a range of natural sources that can emit intense LF, MF and/or HF sounds that, during the lifespan of a larger whale, could be capable of producing a mild TTS (Table 4.1).

Since the capacity of neonates and young juveniles to receive several TTS with the same likelihood of avoiding an early onset of PTS is unclear, the biological significance of TTS-inducing levels is arguably higher in calving areas and for cow-calf pairs on their first migration to feeding grounds.

While the potential for TTS to occur in marine mammal ears has been recognised for several decades, reliable data regarding the sound levels inducing TTS did not begin to emerge until the late 1990s. Before these results, expert opinion sought by the US NMFS (e.g. HESS 1999, US Marine Mammal Commission 2004**)** had indicated that, for precautionary reasons including possible TTS, cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding 180 dB and 190 dB re 1 µPa (rms) respectively. The more recent studies have since identified that pulsed sounds which cause mild TTS in dolphins and small toothed whales need to exceed >200 dB re 1 µPa (rms) (e.g. Kastak et al. 1999, Schlundt et al. 2000, Finneran et al. 2002; refer Figure 6.3).

Recent laboratory results of TTS testing in delphinid species indicate the received level of a single seismic pulse needs to be ~210 dB re 1 µPa rms (approx. 221–226 dB re 1 µPa peak–peak) to induce brief TTS (i.e. minutes of reduced hearing sensitivity). Exposure to several seismic pulses over a 30-60 minute period may require received levels of 200–205 dB (rms) to cause the same level of TTS in a dolphin or small toothed whale. Exposure levels inducing a mild TTS by typical seismic survey sounds (i.e. a series of very short pulsed sounds each separated by 8-15 second intervals) have not been determined, but can be assumed to be the roughly the same as the values inducing TTS reported for short (1 second) pulses (e.g. Finneran et al. 2002) versus the long exposure periods (>20 minutes) (e.g. Nachtigall et al. 2003).

The ability of the 5-15 second inter-pulse intervals to provide an ameliorative 'mini' recovery phase may be low. Nevertheless, the zone of potential temporary hearing loss and discomfort near an airgun array is relatively small, with geometrical spherical spreading causing a decline in sound levels to <200 dB re 1 µPa within 500 m of the largest commercial arrays.



(from Finneran et al. 2002)

Figure 6-3 Plot indicating sound exposure regimes (a) and energy flux densities (b) that can induce measurable TTS in odontocetes

Most experiments on TTS have been undertaken on bottlenose dolphins and beluga whales. The test tones were in the range of 40 to 7500 Hz with levels up to 202 dB re 1 μPa (Schlundt et al. 2000). Evidence of TTS was obtained, disappearing within a few days. The following account summarises the methods and findings of TTS experiments reported by Finneran et al. (2002). A behavioural response paradigm was used to measure masked underwater hearing thresholds in a bottlenose dolphin (*Tursiops truncatus*) and a beluga whale (*Delphinapterus leucas*) before and after exposure to single underwater impulsive sounds produced by a seismic watergun[12].

Pre- and post-exposure thresholds were compared to determine if a temporary shift in masked hearing thresholds (MTTS), defined as a 6-dB or larger increase in the post-exposure threshold, had occurred. Hearing thresholds were measured at 400 Hz, 4000 Hz and 30 kHz. MTTSs of 7 and 6 dB were observed in the beluga at 400 Hz and 30 kHz respectively, for approximately 2 minutes after exposure to single impulses with peak pressures of 160 kPa, peak-to-peak pressures of 226 dB re 1 μPa and total energy fluxes of 186 dB re 1 μPa^2·s.

[12] Watergun impulses probably contain proportionally more energy at higher frequencies because there is no significant gas-filled bubble (Hutchinson & Detrick 1984).

Thresholds returned to within 2 dB of the pre-exposure value approximately 4 min after exposure. No MTTS was observed in the dolphin at the highest exposure conditions: 207 kPa peak pressure, 228 dB re 1 µPa peak-to-peak pressure, and 188 dB re 1 $\mu Pa^2 \cdot s$ total energy flux.

Finneran et al. (2002) also compared their findings with results from other TTS studies using different sound exposure regimes (Figure 6.3). The plots show that inducing TTS in cetaceans involves a sound dosage function in which the critical energy flux density for species tested to date is above 185 dB re 1 $\mu Pa^2\ sec^{-1}$. There are no measured data on sound levels that induce TTS in baleen species.

6.2.6 Zone-inducing Possible Permanent Threshold Shift or Other Tissue Damage

PTS results from irreparable injury to the hair cell receptors that line the basement membrane of the inner ear (unlike birds and reptiles, these are not replaced during adult mammal life). If relationships between TTS and PTS thresholds in marine mammals are similar to those studied in humans and other terrestrial mammals, PTS requires an exposure to ~20 dB higher peak-to-peak sound pressure levels than TTS.

Extreme PTS cases involve partial or total deafness that occurs by exposure to non-acoustic blast pressures, i.e. via proximity to detonations of high explosives. Exposure to explosive energies causes PTS owing to the more rapid rise time of the blast pressure wave (i.e. microseconds versus the milliseconds of airgun pulses). Humans and mammals with a PTS have continually impaired ability to hear sounds over various frequency ranges, which widen and worsen in older life, particularly for the higher frequencies.

If marine mammals have an inherently high behavioural tolerance to intense levels of pulsed noise (~200 dB re 1 µPa rms), this does not necessarily mean their hearing sensitivity may not become impaired over the long-term. For example, McCauley and Duncan (2001) have noted that while humans can tolerate short, repetitive explosive signals such as gunfire (because <200 millisecond sounds are not interpreted by the auditory brain stem or consciously perceived as excessively loud), such energies can still over-drive the inner ear and result in TTS and PTS.

Other effects as a result of sudden, very intense underwater sounds include stress, startle and ‘panic-flight’ responses, plus possible neurological effects. In the case of a severe startle reaction, this would be more likely to occur if there is no previous experience of the sound type (no learning or habituation), and the sound is both sudden and unanticipated by the receiving animal (no accommodation). Anticipation of a loud sound causes automatic tensing of ocular structures and head musculature, in part as an adaptation to increase head shadowing and reduce middle-ear gain to prevent ‘self-deafening’ when mammals vocalise loudly (e.g. Gisiner 1998).

Incidents involving beaked whale strandings have led some workers to suggest the possibility that intense tonal sounds might have the capacity to injure non-auditory tissue via resonance, such as to gas-filled sacs/sinuses (but only if the latter have an inherent fundamental frequency capable of excitement by the action of continuous sound waves at that frequency, with the ensuing vibrations sufficiently strong to be capable of damaging delicate membranes and capillary walls). In the case of the very short pulse lengths and long inter-pulse intervals of airgun seismic, this source would not provide sufficient energy to induce or maintain a tissue resonance.

While there is no known mechanism for the low frequency broadband pulses of airgun arrays to induce resonance in marine mammals, some workers have raised the possibility that relatively intense mid-frequency sonar tones could induce resonance, or cause gas bubble formation in the blood of deep-diving mammals. These conjectures arose following the March 2000 beaked whale stranding event in the Bahamas which had coincided with a US Navy exercise involving tactical mid-frequency sonar. It was speculated that if newly formed or coalesced micro-bubbles enter the blood system of marine mammals, these in turn might induce a pulmonary or cerebral artery gas embolism, as can occur in severe forms of decompression sickness (DCS; ‘bends’) experienced by human divers (e.g. Gisiner 1998, Houser et al. 2001).

Subsequent workshops convened to examine the Bahamas and more recent Canary Island beaked whale stranding incidents have concluded that resonance in air-filled structures was unlikely to be the cause as the air spaces in marine mammals are too large to resonate with both the frequencies and short pulse lengths emitted by mid- and low-frequency sonar (Gentry et al. 2002, cf. Finneran 2003). Following the September 2002 beaked whale stranding incident, Jepson et al. (2003) undertook biopsies and suggested that mid-frequency sonar might have caused *in vivo* formation of gas bubbles in some of the 14 stranded beaked whales which showed possible evidence of such tissue damage, but their results and conclusions were refuted by several commentators, such as Piantadosi and Thalmann (2004).

It also appears that the received levels of sonar (estimated at ~160 dB re 1 μPa rms) are too weak to cause the possibility of sonar-induced nitrogen gas bubble formation/coalescence, and that a ‘panic-flight’ response which caused the beaked whales to surface too rapidly may have been the cause of the possible DCS. Little is known about acoustic tissue damage and DCS signs in the poorly studied beaked whales because this can be reliably measured and assessed only very soon after death. All workers have agreed that more work is needed to resolve both the potential mechanisms and clinical signs of possible sonar-induced DCS in beaked whales.

In summary, the biological assessment of underwater acoustic impacts is an emerging science that promises to fill knowledge gaps which may allow previous ‘rule of thumb’ sound level criteria and safety range regulations to be adjusted or customised. When reliable estimates for TTS and PTS become available for the baleen whales, current use of the precautionary 182 dB US NMFS criterion as an acceptable exposure level to pulsed sounds[13] for all marine mammals may therefore become refined.

6.3 EXPLOSIVE BLAST IMPACTS

In the case of explosives, Lewis (1996a) described three zones of effect which have commonly been used for humans or marine fauna, as follow:

- one involving the likelihood of discomfort, temporary hearing loss or minor injury;
- one involving serious injury and high risk of permanent hearing loss; and
- the third comprising the innermost lethal zone.

[13] US regulatory standards for endangered species ‘take’ permits refer to received levels of 120 dB re 1 μPa for continuous sound, 160 dB for intermittent sound, and 180 dB re 1 μPa for sounds of all frequencies and durations.

As well as the magnitude of the blast and the character of its associated pressure wave, the size of these zones is related to the morphology and anatomy and size of the subject receptor organism. The tissues and organs of fish, turtles and marine mammals most susceptible to pressure wave injury are the hair cells of the auditory system, and the blood vessels and organs that lie beside flexible gas-filled spaces. For a pressure wave to induce immediate physical damage, the animal must be located inside the range where sufficient attenuation has occurred to reduce and ameliorate the steep rise time, peak amplitude and shape of the impulse. The ‘blow-out’ effect of the sudden rarefraction (negative pressure pulse) on any gas-filled or spongy chamber associated with buoyancy control or hearing explains why swim bladder fish, as well as turtles and marine mammals, are killed or injured over larger ranges than other types of marine fauna. Lethal injuries typically include organ rupturing and blood vessel haemorrhaging around the swim bladder and hearing organs (Ketten 1995, 1998; Lewis 1996a). As with the bulk cavitation zone, the fish kill zone around a large explosion is often asymmetric, with swim bladder fish near the surface typically more vulnerable than fish deep in the water column (Lewis 1996a). Fish very close to the surface tend to have little or no injury owing to the attenuating influence of the ‘Lloyd mirror effect’ on the size and shape of the pressure pulse.

While the large body mass of larger fauna, such as marine mammals, means that pressure induced injuries are almost always sublethal, they are capable of causing subsequent mortality. For example, damage to the auditory tissues may lead to secondary infection, or produce sufficient pain, hearing loss and disorientation to prevent adequate navigation, communication or hunting.

Based on the use of 100 kg charges, an environmental assessment of Australian navy mine warfare activities using submerged explosives in shallow water (as reported in URS 2003) estimated that:

- fish with swim bladders would be affected for distances up to 200 m;
- fish without swim bladders, molluscs and crustaceans would be affected to distances of substantially less than 100 m;
- marine mammals and turtles could be exposed to pressure at levels sufficient to cause sub-lethal damage at distances varying between 750 m to 1,500 m, dependent upon their size (e.g. 750 m for a whale, 1,000 m for a dolphin, 900 m for a turtle, and that marine mammals may suffer acoustic-induced sub-lethal damage at distances less than 1,500 m (based on a 90 kg charge).

PTS is typically taken as the (conservative) threshold indicator of sub-lethal injuries. PTS results from irreparable injury to the hair cell receptors that line the basement membrane of the inner ear (unlike birds and reptiles, these are not replaced during adult mammal life). If relationships between TTS and PTS thresholds in marine mammals are similar to those studied in humans and other terrestrial mammals, PTS requires an exposure to ~20 dB higher peak-to-peak sound pressure levels than TTS.

Extreme PTS cases involve partial or total deafness that occurs by exposure to non-acoustic blast pressures, i.e. via proximity to detonations of high explosives. Exposure to explosive energies causes PTS owing to the more rapid rise time of the blast pressure wave (i.e. microseconds versus the milliseconds of airgun pulses). Humans and mammals with a PTS have continually impaired ability to hear sounds over various frequency ranges, which widen and worsen in older life, particularly for the higher frequencies. However there is no evidence that airgun array pulses can or have caused PTS in marine mammals, as this would require frequent multiple exposure to TTS events with short intervening periods.

On the other hand, if marine mammals have an inherently high behavioural tolerance to intense levels of pulsed noise (~200 dB re 1 μPa rms), this does not necessarily mean their hearing sensitivity may not become impaired over the long-term. For example, McCauley and Duncan (2001) have noted that while humans can tolerate short, repetitive explosive signals such as gunfire (because < 200 millisecond sounds are not interpreted by the auditory brain stem or consciously perceived as excessively loud), such energies can still over-drive the inner ear and result in TTS and PTS.

Other effects as a result of sudden, very intense underwater sounds include stress, startle and 'panic-flight' responses, plus possible neurological effects. In the case of a severe startle reaction, this would be more likely to occur if there is no previous experience of the sound type (no learning or habituation), and the sound is both sudden and unanticipated by the receiving animal (no accommodation). Anticipation of a loud sound causes automatic tensing of ocular structures and head musculature, in part as an adaptation to increase head shadowing and reduce middle-ear gain to prevent 'self-deafening' when mammals vocalise loudly (e.g. Gisiner et al.1998).

It is recognised that the impulsive effect from even small explosive charges generates a detectable impulse and acoustic perturbation over a wide field, with charge size being the principal determinant of the extent of the field of potential influence. Many other factors influence the rate of attenuation of the impulse, as well as the extent and shape of its potential field of influence upon sensitive marine fauna. These factors include:

- depth of water
- depth of charge in water column/depth of detonation
- water turbidity
- bottom composition
- bathymetry
- background noise

As previously noted, the most damaging frequency components of an underwater shock wave are rapidly depleted. Thus the area within which the blast and shock effect plays a dominate role constrained before the blast effect deteriorates to an expression of a broadband noise impulse, with most energy in the sub-1 kHz range.

7. EFFECTS OF NOISE ON MARINE FAUNA

This section reviews the known effects on marine mammals, turtles and sharks of noise sources, including exploration drilling, shipping, whale-watching vessels and pile driving operations.

It is difficult to predict which species will be most vulnerable to man-made noise because of the wide range of individual and population sensitivities as well as differences in wariness or motivation. Currently, it may only be possible to make generalisations about the vulnerability of species groups based on behavioural observations of responses to man made sounds, habits and what is known about a species' auditory sensitivity or vocal range.

When evaluating likely impacts, consideration should also be given to differences in local conditions that may affect sound propagation, e.g. depth, bottom type, size and type of source. A majority of man-made sounds have significant amounts of energy at low frequencies, thereby leading to potential disturbance, damage or interference to the mysticete whales. There is evidence of low frequency hearing in sperm whales (Ketten 1992, 1997) and this species appears to be extremely sensitive to disturbance from a variety of sound sources. Deep diving odontocetes may also be at risk as their behaviour puts them in the deep sound channel or Sound Fixing and Ranging (SOFAR) channel, along which sound is believed to travel efficiently for distances of hundreds to thousands of kilometres.

7.1 DREDGING

Reported source levels for general marine dredging operations range from 160 to 180 dB re 1 µPa @ 1 m for 1/3 octave bands with peak intensity between 50 and 500 Hz (Greene & Moore 1995). One of the most comprehensive studies of underwater noise emissions from dredging was carried out by the United States Army Corps of Engineers in Cook Inlet, Alaska (Dickerson et al. 2001). The research provides detailed records of the underwater noise generated by a bucket (grab) dredging operation. Measurements of the dredging in Cook Inlet, showed that the bucket striking coarse gravels on the seabed generated the most noise with a recorded peak of 124 dB (re 1 µPa) at 150m from the dredge site which attenuated by 30 dB (re 1 µPa) over a distance of 5 km. The digging operation was characterised by a grinding noise with a recorded peak of 113.2 dB (re 1 µPa) at 150 m from the dredging site to 94.97 dB (re 1 µPa) 5 km away.

Recorded noise levels for large cutter suction dredgers are higher than those associated with grab dredgers. Recorded broadband noise data for the large cutter suction dredger *JFJ de Nul* are given as 183 dB (re 1 µPa at 1 m) at Sakhalin Island, 2004. Measurements of two suction dredgers, *Aquarius* and *Beaver Mackenzie*, are reported in Nedwell and Howell (2004). Their octave band spectra peak between 80 and 200 Hz, with the Aquarius having the higher of the two spectra peaking at approximately 177 dB (re 1 µPa at 1 m). In the 20-1000 Hz band, *Beaver Mackenzie* and the *Aquarius* were measured to have a 133 dB (re 1 µPa) level at 0.19 km and a 140 dB (re 1 µPa) level at 0.2 km respectively.

Information from a number of studies indicates that acute damage to fish caused by sound does not occur below about 160 dB (re 1 µPa). During grab dredging activities, this noise level is unlikely to be generated, even when dredging through partially consolidated rock. However, noise levels as high as, or higher than, 160 dB (re 1 µPa) could have been generated in close proximity to the cutter suction dredger. Available data indicates that in shallow coastal waters, underwater noise transmission loss is typically of the spherical spreading type (Nedwell & Howell 2004). This means that for each tenfold increase in distance from the source the sound level will reduce by 20 dB. For the source measurements for the cutter suction dredgers provided above, this means that a noise level of approximately 160 dB/1 Pa would occur at a distance of 10 m from the cutter head and 140 dB (re 1 μPa) at 100 m. This calculation, although broad brush, demonstrates that potential acute damage to fish would only be likely to occur up to 100 m of the cutter head and probably at a distance significantly less than this.

Thus, at distances greater than a 100 m, acute damage would not have been likely to occur. Fish would have avoided moving close to the working dredger head as the sound would have caused an avoidance response, and therefore acute damage would only occur if fish were present in the vicinity when dredging operations started. This in itself would be highly unlikely given the physical disturbance that this activity would have caused.

It has also been calculated that the majority of fish would not be able to detect the noise made by dredging activity at a distance greater than 1km from the activity. Henderson (2003), assuming spherical spreading of sound, calculated that the predicted sound level from a suction cutter dredger would be 100 dB/1 μPa at 1km. On this basis it is considered that the noise generated during dredging would not lead to fish mortality and at worse would lead to temporary avoidance of nearshore waters immediately adjacent to the dredging activity.

Dredging noise varies through time and periodically dredging ceases whilst the dredged material is taken away for disposal. This creates periods of calm and quiet, during which fish can move through the area undisturbed.

Table 7.1 lists the sound source levels and estimated sound levels at different distances from dredging activities/techniques and it shows that the activities typically produce noise levels less than 160 dB and therefore, auditory damage to fish would not be expected.

Table 7-1 Sound sources from dredging activities

Dredging Technique	Frequency Range	Average Source Level	Estimated Received Level at Different Distances (km) by Spherical Spreading			
	(kHz)	dB	0.1	1.0	10.0	100
Mechanical dredge	-	130	90	70	49	28
Suction dredge	0.38	160	120	100	79	58

7.2 PILE DRIVING

The intense pulses of pile driving can injure swim bladders and kill salmonid fishes, and they have the potential to elicit a startle response to cetaceans if the hammering operation is commenced without any form of soft-start procedure. A 'worst-case' scenario in terms of invoking undue stress to whales would involve start-up of a three month operation at a site located in a shallow embayment that is being used for calving or resting, or as a temporary stop-over by humpback cow-calf pairs migrating slowly southward. There is no evidence of any piling operation having caused a panic-flight response to pilot whales or other small toothed whales which can enter these areas.

Nedwell et. al. (2003) reports on monitoring measurements of the waterborne noise resulting from impact piling and vibropiling at Town Quay, Southampton, UK, during construction of a ferry terminal. Underwater noise levels were monitored during the vibropiling operation at a location 417 m from the actual site of piling. The recorded levels showed that there was no discernible increase in the background noise signal at this point during the vibropiling operation (with recorded background levels periodically reaching 150 dB, but typically in the region of 110-120 dB). However, it should be noted that background noise levels in Southampton Water, as a result of the high level of shipping traffic and other water-based activities, are likely to be significantly greater than those for Aniva Bay. Caged brown trout (*Salmo trutta*) placed at 25 m from vibropiling locations reportedly showed no discernible behavioural reaction to the works (Nedwell et. al. 2003).

Nedwell and Edwards (2002) report on underwater noise measurements obtained during vibropiling operations for a wharf extension at Littlehampton in the UK. The recorded noise levels from a number of points showed a considerable degree of scatter indicating that the level of sound generated by the source varied. They attributed this variation to differing propagation conditions caused by variations in soil density near to the piles. The average (root mean square RMS) noise level for each measurement location varied between 132-152 dB/1 μPa at distances of 20-80 m from the piling works.

Noise spectra obtained for the piling shows that there was a strong signal in the region of 27 Hz but with most of the signal being concentrated in the midfrequencies (200 Hz – 2 kHz). Nedwell et. al. (2003) measured underwater noise levels associated with seabed drilling operations (from a jack-up rig) into sandstone for the installation of piles for offshore wind turbines. Although a source noise level for the drilling could not be obtained, all of the measurements from 100 m to 9 km from the drilling location were below a level at which significant behavioural effects in marine mammals and fish might be expected to occur (Nedwell et. al. 2003).

Much higher noise levels are generated during pile driving operations using the impact piling technique. An assessment of the effect of impact pile driving noise on fish species predominant near Rødsand, Denmark has been made by Engell-Sørensen (2000). This work assessed the potential behavioural and physical effects of the noise levels of pile driving associated with construction of offshore wind turbines. Sound exposure levels for four measurement positions between 30 m to 720 m from the activity gave levels ranging from 166 dB to 188 dB (re 1 μPa), with a calculated source level of 210 dB (re 1 μPa at 1 m). Engell-Sørensen (2000) concluded that: avoidance reactions would be likely to occur up to 30 m from the source, especially for species with swim bladders; the measured noise levels could harm the hearing ability of clupeids such as herring (*Clupea harengus*) and sprat (*Sprattus sprattus*), but this may regenerate over time; and, other than those already mentioned, the noise from pile driving is unlikely to cause any other physical effect.

The data from this and other studies demonstrate that the noise generated by impact pile driving works in the marine environment has the potential to cause acute damage and in cases of extreme exposure, mortality to fish. For pelagic fish and sharks, the most likely behavioural response during piling would be avoidance of the area in which the noise signals reach a threshold at which discomfort or annoyance is reached.

Nedwell and Edwards (2000), processed recorded noise levels from vibropiling works into levels that are indicative of how much a species would be affected by sound. These figures indicated that the noise levels generated by vibropiling were considered to be unlikely to induce any significant behavioural response in fish species such as salmon or flatfish. Recorded source noise levels for vibropiling are below levels at which mortality and acute harm to fish would be likely to occur and data also suggests that significant behavioural responses in species such as salmon would also be unlikely. Even so, if disturbance threshold levels were exceeded there would be extensive acoustically undisturbed areas available for fish to move into without detriment to their survival.

7.3 SHIPPING NOISE

It is widely considered that the baleen whales have evolved their low frequency vocalisations as a result of the selective advantages of achieving long distance communications, with the largest species most capable of exploiting the ocean's natural sound ducts. The apparent 'male-only' intense calling behaviour now known for the three blue whales plus the fin and humpback whales implies a reproductive strategy. If only the males make the loudest, longest and most complex calls among the range of vocalisations emitted by both sexes, these may help females select fit males to help ensure successful calving and genetic quality of their progeny. In this context, Croll et al. (2002) speculated that if breeding is "*limited by the encounter rate of receptive females with singing males, the recovery of fin and blue whale populations from past exploitation could be impeded by low-frequency sounds generated by human activity*". If it is accepted that the two sexes possess no other mechanisms for (a) navigating to their usual breeding area during the same season, and (b) undertaking relatively simple random-search strategies to yield audible range encounters (e.g. 50-100 km wide cross-tracks), this concept increases the impact significance of potential call-masking sound sources (i.e. a breeding area where low frequency background noise is continuously elevated by heavy shipping traffic).

In the case of the potential for shipping or other low frequency sources to mask the long distance calls of baleen whales in Australian waters, there are few locations where ambient noise is significantly elevated by heavy shipping traffic (see Section 5.2) and there are no concentrated offshore petroleum developments where supply vessels, rig tenders and oil tankers are sufficiently numerous to contribute markedly to regional ambient noise, as can occasionally occur in parts of the North Sea, north-east Atlantic and Gulf of Mexico[14].

In this context, McCauley and Cato (2003) have criticised Andrew et al. (2002) who claimed, from a comparison of records from an established deep sound channel acoustic monitoring system off Point Sur (north California), that current ambient noise levels in the North Pacific had increased in selected low frequency bands (20–80 Hz and 200–300 Hz) compared to levels measured from the same equipment in the 1960s, offering support to the concept that rising vessel traffic noise is significantly limiting communications between baleen species which produce sounds at the same frequencies (Payne & Webb 1971). McCauley and Cato (2003) considered that the records comparison by Andrew et al. (2002) was marred by a recent calibration of the Point Sur equipment, by the dismissal in their calculations of the contribution of distant great whale calling, and that traffic noise reference levels were based on limited knowledge from 30–35 year old samples. Great whale numbers in the Pacific during the 1960s were historically at their lowest levels due to commercial whaling and hence would have contributed little to the low frequency components of ambient noise. Recoveries in their numbers over the recent decades mean that great whales calling from thousands of kilometres away could well be adding to the ambient noise in the deep sound channel where the Point Sur measurements are made.

Arguments that shipping traffic noise is significantly masking great whale communications in all regions also assume that the northern hemisphere, with its high density of busy shipping

[14] The north-west Atlantic, west Shetland area and parts of the Mediterranean represent regions where limited rorqual stocks and such activities overlap, and the potential for excessive background noise in these areas to affect the recovery of northern fin and blue whale stocks has been raised by some workers such as Croll et al. (2001).

lanes, is typical of all oceans and seas including those in the southern hemisphere (McCauley & Cato 2003). Yet even in the high traffic areas of the Tasman Sea, wind-induced sea surface noise drowns out shipping noise whenever wind speeds attain 20 knots or more (see Figure 3.2). McCauley and Cato (2003) have also noted that whales have always had to contend with noise levels that are as high as, or higher than, ship traffic noise, and that in some areas their own calls are producing greater ambient noise levels than traffic noise when averaged over time.

In another study, shipping noise levels were examined with respect to resident sperm whales feeding in the Canary Islands (André & Degollada 2003). This study was undertaken following fears that the sperm whales, which are exposed to heavy ferry and merchant ship traffic, were suffering increased collision rates due to adverse effects from the local acoustic budget. However controlled exposure experiments to test the ability of underwater sound system to repel sperm whales from ferry routes and thus reduce collision risks found that none of the low frequency sounds tested altered their behaviour or location. This is perhaps unsurprising given the apparent disdain displayed to merchant ships by sperm whale groups when feeding and surface resting in the busy shipping lane off Sri Lanka. In a recent (May 2003) example of this behaviour, a family group of 40-50 sperm whales were monitored for some 12 hours while feeding and socialising in the busy shipping lane 50 miles south of Dondra Head (south Sri Lanka). “Numerous tankers” were passing during this period since the whales were inside the very busy oil tanker and container ship lane between Asia and the Gulf and Suez Canal, and it was speculated that the whales had been attracted to an area containing abundant prey (Madsen 2003). During the observations, a subgroup of 10 were observed to show no apparent change in their surface resting behaviour and slow swimming speed as a large, fast-moving container ship passed just behind their own surface wake.

Erbe (2002) modelled the potential effects of underwater noise from whale-watching vessels on orcas off southern Canada. Results indicated that faster boats made more noise, being audible to killer whales over 16 km away, to mask killer whale calls over 14 km, to elicit behavioural response over 200 m and to cause changes in hearing of 5 dB after 30 minutes within 450 m. For slower vessel speeds the predicted ranges were 1 km for audibility and masking, 50 m for behavioural responses, and 20 m for hearing changes. The effects of combined vessel noise around a group were close to a level considered likely to cause a permanent hearing loss if there was prolonged exposure.

Concerns about long distance masking would require a major rise in shipping traffic, discovery of offshore oil reservoirs on a par with the size of those off Scotland or Norway, or a major new industrial port complex proposed near a recognised significant baleen whale locality. In this context, experience from the right, humpback and sperm whale stocks in the North Atlantic and Mediterranean indicates that increased rates of ship strikes rather than call masking would be a more plausible concern regarding the ability of vessel traffic to influence population recovery rates.

A considerable body of fisheries literature exists on the behavioural response of fish to the noise of approaching vessels (e.g. Olsen 1990). These studies have shown that fish avoid approaching vessels when the radiated noise levels exceed their threshold of hearing by 30 dB or more, usually by swimming down or horizontally away from the vessel path. Environmental and physiological factors play a part in determining the noise levels that will trigger an avoidance reaction in fish. For many vessels fish avoidance reaction distances are 100 - 200m but for the noisiest 400 m is more likely. The degree of observed effect weakens with depth, with fish below about 200 m depth being only mildly affected and the effect is only temporary with normally schooling patterns resuming shortly after the noise source has passed. Surface and mid-water dwelling fish may theoretically be adversely affected by noise generated during vessel movement, however the clear and abundant presence of fish that accumulate adjacent to operating industrial infrastructure (oil/gas production platforms, wharves, shiploaders, etc.) indicates that they are able to habituate to some noise with no apparent detriment.

7.4 VESSEL PRESENCE

Many pinniped and cetacean species display considerable tolerance of shipping and boating traffic, and several delphinids (and occasionally other toothed whales such as humpback and pilot whales) are often attracted to vessels both large and small, most commonly for bow wave or wake riding in the case of dolphins and porpoises. However the responses to ships and boats by many cetaceans comprise a vast, heavily anecdotal and often self-contradicting 'database' that hinders systematic robust analysis. Why individuals of a certain species appear attracted to vessels on some occasions and actively avoid them on others requires detailed background information if patterns and common factors are to be identified for that species. Clearly there is a wide range of external, internal and intrinsic factors which can influence any cetacean's perception as to where, when and what particular vessel represents an acoustic irritant, a physical intrusion, an object of interest or merely part of the general seascape, and thus whether an avoidance action is initiated or not.

Humpback whales have been reported to show various responses to moving sources such as whale-watching vessels, fishing boats and recreational craft (Beach & Weinrich 1989, Clapham et al. 1993, Atkins & Swartz 1989). The types of approach, avoidance and apparent non-responses in behaviour to vessels have been related to the type, number and activity of the whales at the time of the observed interactions (Herman et al. 1980, Watkins. 1981, Krieger & Wing 1986). In early research, some investigators suggested that vessel traffic would cause humpback whales to avoid or leave both winter feeding and summer calving areas (Jurasz & Jurasz 1979b), while subsequent researchers have noted evidence suggesting that humpback whales can habituate to vessel traffic but may become more vulnerable to ship strikes once habituated (Swingle et al. 1993; Wiley et al. 1995).

Humpback whales are occasionally killed by ship strikes along both US coasts. On the Pacific side a humpback whale is killed about every other year, while six out of 20 humpback whales stranded along the mid-Atlantic coast had evidence of a major ship strike. In Alaska, the number of cruise ships entering Glacier Bay has been limited to reduce their possible disturbance to feeding humpback whales. In Hawaii, regulations prohibit vessels including whale-watching boats from approaching within 91 m (100 yards) of humpback whales and within 274 m (300 yards) in areas designated additional protection to cow-calf pairs.

In a long-term study over 25 years of whale responses to vessel approaches (Watkins 1986), the most vigorous responses by whales came from vessel noise sources that changed suddenly, rapidly, increased or were unexpected. Watkins was one of the first to recognise that preoccupied whales were typically less responsive than inactive whales. Later workers have found similar results where rapidly changing vessel noise often evokes a strong avoidance response, while a slow non-aggressive vessel approach results in little response from the whales, noting that feeding whales may be less responsive to vessel traffic as they are involved in a biologically important, directed activity (Richardson et al. 1995; McCauley et al. 1996).

Vessel activity has been implicated in long-term and short term changes in distribution of humpback whales in Hawaiian waters (Norris & Reeves 1978, Jurasz & Palmer 1981, Baker & Herman 1989). Results from a long-term study (27+ years) of southern right whales in

Argentina imply flexibility in several aspects of their habitat use (Rowntree et al. 2001). This included the apparent abandonment of one calving/resting ground and establishment of a new 'nursery' beside the centre of a growing whale-watching industry, plus some small-scale shifts in distribution possibly in response to natural and human disturbances. Southern right whales are increasingly observed in Albany's harbours, suggesting at least a tolerance of local ship and boat traffic.

While family groups of sperm whales can exhibit apparent *en masse* indifference to the relatively intense emissions of nearby large and fast-moving ships that maintain steady courses (e.g. Sri Lanka, Canary Islands), individual sperm whales in New Zealand's famous nearshore feeding area off Kaikoura displayed individualistic, contrasting reactions to outboard-powered RHIBs used for commercial whale-watching, as studied in the early 1990s (Gordon et al. 1992). 'Resident' whales appeared more tolerant of these vessels but spent shorter surface intervals and a more erratic and overall lower number of ventilations when RHIBs were present. 'Non-resident' sperm whales were much less tolerant of RHIB approaches and also reduced their surface intervals and ventilations when one or more of these vessels was present in the area. Evidence for slightly slower rates of initial descent were apparent in the rates of change of the bouts of clicks following the start of a feeding dive (marked by a fluke-up). No change to vocalisation or fluke-up could be related to RHIB presence/absence (Gordon et al. 1992).

7.5 ROCK AND SLUDGE DUMPING

Minimal information is available regarding noise generated from rock dumping activities, however, it is reasonable to expect that any noise will be dominated by the splash, tumble and grinding of rocks, possibly associated with mechanical transients generated by the operating gear. Given the normal pattern of rock dumping activities, it may be anticipated that any noise will be intermittent.

It is reasonable to assume that noises associated with the dumping, movement and settling of the rocks themselves would be low frequency broadband. Intensity and period of the noise event would be influenced by factors such as the amount, size and mass of rocks dumped, the depth of water in which they were dumped and the type of surface upon which they landed and settled. In any event, it is unlikely that the noise levels attained would be of any great significance.

The dumping of sludge itself and its movement through the water column and settlement or dispersion upon the bottom is unlikely to generate any tangible noise. This is due to the usually viscous, semi-fluid nature of the sludge or slurry.

Depending upon the method of rock or sludge dumping employed, the operation may also be the source of mechanical transients. These would be due to the operation of bottom hopper doors, if employed. Although no data are available, it is illustrative to consider the noise associated with the operation of a clamshell dredge as a useful surrogate. Richardson et al. (1995) described noise from a clamshell dredge as variable depending on the operating status. It was noted that the strongest sounds are usually from the winch motor pulling a loaded clamshell back to the surface. This noise had a broadband source level of ~167 dB (re 1 µPa at 1 m) and included a fundamental tone of 125 Hz with many harmonics. Richardson et al. (1995) also noted that noise from the tug and barge used to transfer dredged material was greater than that produced by the dredge itself.

7.6 EXPLOSIVES

7.6.1 Marine Mammals

Richardson et al. (1995) reported on observed effects of explosives upon the behaviour of marine mammals. Humpback whales in the vicinity of explosives being detonated near Bermuda displayed no interruption to their vocalisations. Similarly, humpbacks within 2 km of explosions in sub-bottom rocks off Newfoundland displayed no obvious reactions when 200 to 2,000 kg charges were detonated. Gray whales within a ‘few’ kilometres of detonations of 9 to 36 kg charges used during seismic survey have been observed to alter swimming behaviour, while other observers (Fitch and Young 1948, in Richardson et al. 1995) report the whales “were seemingly unaffected and in fact were not even frightened from the area”.

Toothed whales show a tolerance for impulsive acoustic disturbances, although the initial reaction may be one of avoidance. Captive false killer whales showed no obvious reaction to small charges, and other odontocetes have been found to be attracted to the location of detonations (Richardson et al. 1995), presumably in search of dead, injured or disoriented fish as prey.

Pinnipeds have also been widely observed to develop habituation to explosive detonations, as ‘seal bombs’, used to keep seals and sea lions away from fishing vessels and aquaculture pens, have been found to have limited long-term effect (Lewis 1996a).

Risk of physical injury or mortality does exist for large fauna, but these are only realistic probabilities in the immediate zone around the point of detonation and only for charges substantially larger than those likely to be used for the SSDP; these risks are ameliorated by standard marine fauna observation and clearance procedures.

Although any use of explosives during construction of the SSDP will be detectable over a wide area by potentially sensitive fauna, this risk is considered minimal when it is noted that use of explosives will be irregular, dispersed over time and intermittent. This conclusion is supported by Richardson et al. (1995), who summarised that while some pinnipeds and odontocetes, in particular, display short-term avoidance reactions to explosive impulses, overall, marine mammals show considerable tolerance of noise pulses from explosions. This conclusion is supported by observed reactions to explosives used singly or repetitively. The observed tolerance of marine mammals may be linked to their experience of the intense, impulsive nature of many acoustic events of natural origin, such as lightning strikes and whale breaching and tail slapping.

7.6.2 Sharks

Sharks may be less susceptible to blast and impulse effects than are many fish. This is due to the absence of a swim bladder, their physical size and arguably also due to their general morphology. While fish without swim bladders are much less sensitive to blast pressure damage than swim bladder fish, it is worthy of note that fish with a cylindrical body shape (e.g. barracuda, queenfish, kingfish) have been found less vulnerable than laterally compressed fish with thin-walled bladders (Lewis 1996a).

7.6.3 Marine Turtles

In the case of shockwave effects, there are very little hard data available on the types and extent of turtle tissue damage due to underwater detonations, and most workers assume that turtle lungs, ear drums and other gas-containing organs would be affected to the same degree as their counterparts in marine mammals (Lewis 1996a).

Due to the lack of specific injury response curves for turtles, Young (1991) followed US National Marine Fisheries Service criteria for sea turtles in the Gulf of Mexico and provided safe-distance ranges plots for sea turtles based on cube-root scaling, where:

$$\text{Turtle Safe Range (feet)} = 560 \times \text{NEQ TNT (lbs)}^{1/3}$$

Three specific predictions listed by Lewis (1996a) support Young's (1991) prediction plot; namely that organ tissue damage in sea turtles may occur at range distances less than 750 m from a 100 kg HE charge, with hearing damage at range distances less than 1500 m from charge weights exceeding 90 NEQ kg TNT (Lewis 1996a).

These predictions match limited aerial monitoring observations obtained during a training exercise in the Shoalwater Bay Training Area (SWBTA), where an apparently healthy green turtle was spotted in shallow water seagrass beds within 800 m from a site where, less than 40 minutes previously, a large detonation of ~100 kg NEQ TNT ordnance had been conducted. No drifting or disoriented turtles were seen by the low-level aerial survey crew nor by the on-site observers (URS 2002).

Lewis (1996a) also describes an incident involving three sea turtles in the vicinity of an underwater shock trial involving detonation of a 545 kg TNT charge at 37 m depth off Florida in 1981. A large adult turtle (182 kg) that was between 153-214 metres from the detonation was killed, a ~120 kg turtle that was 366 m away was slightly injured, while the third turtle (~120 kg) that was at a range of 908 m was uninjured. From these data it was considered that a conservative safety range for turtles could be predicted by the formula of 80 m per $kg^{1/3}$ of HE (O'Keefe and Young, in Lewis 1996a).

The results of the Florida test are in agreement with the aerial observations in Shoalwater Bay in 2001 (i.e. uninjured adult green turtle at 700-800 m from a shallow water (~3 m) detonation of 100 kg TNT; URS 2002). While there are no observations or data on the range thresholds for either acoustic injury or behavioural responses for the five other marine turtle species found in Australian waters, there is no anatomical evidence to suggest these species should be any more sensitive than either green or loggerhead turtles.

7.7 PIPELINE LAYING AND OPERATION

In their review of marine mammals and noise, Richardson et al. (1995) did not specifically note piplelaying as a distinct source of marine anthropogenic noise, although they did address a range of other marine construction activities. It is reasonable to conclude that the pipelay itself is unlikely to be a source of any noise of environmental significance; more tangible sources of noise during pipelay will be as a result of vessel movements and associated construction activities, such as trenching, pile driving and rock dumping.

There is a general paucity of information in the literature about the noise effects of the operation of undersea pipelines, possibly as a reflection of either a direct lack of research, or indirectly because this is not considered to be a likely source of significant environmental disturbance. In recent reviews of offshore petroleum activities (ENTRIX, Incorporated 2004; Minerals Management Service 2001 & 2006; NMFS 2002b), marine noise in general (Richardson et al. 1995) and the construction and operation of a seawater desalination plant in New South Wales (The Ecology Lab 2005), no specific consideration or assessment was made of the noise of operation of undersea pipelines.

As previously noted, Shaipro and Associates (2004) estimated that a high velocity gas pipeline proposed for the Georgia Strait would exhibit radiated noise equal to or lower than 30 dB at frequencies of 16 kHz and above. A larger diameter pipeline as planned for the SSDP, with a slower moving fluid (around 0.5 ms^{-1} for the SSDP outfall[15] and 0.15 ms^{-1} for the intake [WAWC 2008]), would reasonably be expected to radiate noise at a lower level and lower frequency than for a smaller diameter, high pressure gas pipeline, where velocities are typically in the order of 15 ms^{-1}.

The conclusions of the regulatory authority, the US Minerals Management Service (2001 & 2006) are illustrative. For the cited assessments, the whale species of greatest concern was the California gray whale (*Eschrichtius robustus*), which has similar acoustic acuity and an analogous migration habit to the humpback. Thus, it may be considered that the California gray whale and its apparent indifference to the operation of undersea pipelines represents a useful surrogate for the SSDP pipelines and their effect or otherwise upon migratory baleen whales, particularly humpbacks. In the case of an Alaskan offshore oil development including pipelines, the NMFS (2002b) came to a similar conclusion with regard to bowhead whales (*Balaena mysticetus*), which typically exhibit perhaps the greatest sensitivity to anthropogenic noise of any of the baleen whales (Richardson et al. 1995).

Any radiated noise from the operation of the SSDP outfall would be further ameliorated by the intended trenching and rock armouring of some sections. Furthermore, any outer coating of concrete or similar would further attenuate radiated noise.

[15] This estimate is based on data for the existing Kwinana Seawater Desalination Plant, as presented in Olkely et al. (2007).

8. ASSESSMENT OF RISK FROM THE PROPOSED ACTIVITIES

8.1 CHARACTERISTICS OF NOISE GENERATING ACTIVITIES

As described previously, it is likely that the following activities will generate noise, and may therefore pose a risk to marine fauna in the area:

i. dredging;
ii. pile driving;
iii. rock armour dumping and sand/sludge dumping;
iv. general shipping/vessel traffic;
v. explosive blasting; and
vi. pipeline installation and operation

8.1.1 Dredging

The noise generated from dredging activities will vary depending on the dredging method used, details of which will be determined during later stages of the project development. Research shows that noise levels are higher from cutter suction dredgers compared to grab dredgers (Richardson et. al. 1995). Nevertheless, source levels from dredges are relatively modest, at around 160 – 170 dB (re 1 μPa).

8.1.2 Pile Driving

Pile driving is only likely to be undertaken over a period of a few weeks and noise generated will be periodically persistent and confined to daylight working hours. Noise levels will also vary depending on the substrate and the pile driving method used, with the impact piling technique likely to create greater noise. Pile driving is arguably the most noise intensive activity in the proposed package of works, with its inherent repetitive, impulsive nature possibly accentuating its ability to startle or lead to avoidance behaviour by marine fauna. Any effects arising from pile driving would most likely be more acute during the initial start-up phase.

8.1.3 Rock Armour Dumping and Sand/Sludge Dumping

These activities are likely to be intermittent during the construction phase. Noise from rock dumping is likely to be broadband low frequency, although at relatively modest source levels. Sand/sludge dumping is not expected to generate noise to any appreciable extent, except for that generated by the vessels themselves.

8.1.4 General Shipping/Vessel Traffic

Noise generated from vessel traffic associated with this project will mainly occur during the construction phase. Most information available is in regard to whales where it has been identified that noise from shipping can occasion disturbance to some degree, but they are generally tolerant of such activities.

Noise from vessels associated with this activity is unlikely to be of any significance in the broader field, particularly noting the close proximity of the project site to the commercial port of

Bunbury and standard shipping routes and level of shipping activity around the south west of WA.

8.1.5 Explosives Blasting

If used during SSDP marine construction activities, explosive charges do pose a risk to marine fauna. In a relatively small area around the point of detonation, there is a risk of mortality, with a wider, albeit relatively small, zone where injury is possible. Beyond the immediate vicinity of detonation there is a wider area where minor injury, in the form of PTS, is also possible. The greatest likely effect from the use of explosives, however, is as a result of noise disturbance, rather than blast or impulse. The zone of influence of noise-related potential impacts as a result of underwater detonations is substantially larger than that for lethality or injury, but still relatively confined.

Risks to marine fauna from the use of explosives will be inherently limited due to the modest number and small size of charges likely to be used, if at all. This risk can be further mitigated by the establishment of marine fauna safety zones around the detonation site/s in the period leading up to and at the time of detonation. It is suggested that an exclusion zone of 2 km radius be established around detonation sites. From 30 minutes before the planned time of detonation this zone should be checked to be clear of large marine fauna such as whales, dolphins, sharks and turtles. If any are observed to be within the zone then detonation should be delayed until such time as the observed fauna are outside the zone. To enhance the effectiveness of surveillance, detonation should only be conducted in daylight conditions and with benign sea conditions (e.g. sea state 3 or below) so that boat and land-based observers have a reasonable probability of sighting any marine fauna incursion into the safety zone.

Although not considered critical, residual risks could be further reduced by conducting underwater blasting outside of the recognised migration periods in that area for southern right whales (May to October) and humpback whales (May to November).

8.1.6 Pipeline Installation and Operation

Installation of the pipeline itself is unlikely to be a source of any distinct acoustic disturbance. As previously noted, however, the pipelay operation will generate noise as a result of associated activities, such as vessel movements, dredging/trenching, pile driving and rock dumping. Some noise arising from vessel movements will also arise from periodic inspection and maintenance of the pipe.

The actual operation of the pipeline is unlikely to generate any noise of any biological significance. Any noise that is generated would be minimal and inconsequential in comparison with the ambient noise environment of the near-surf zone where the pipelines will be located.

8.2 ASSESSMENT OF RISK TO MARINE FAUNA

8.2.1 Cetaceans

Baleen Whales

It is likely that noise generated from this project will be within the hearing ranges of baleen whales. However, as these whales have, with the periodic exception of southern right whales, minimal presence in the nearshore coastal area in which the pipeline will be located, and recognising that the construction activities will be short-term, there is likely to be no significant risk. Any audibility of the pipeline and the associated construction activities is likely to be significantly masked by the persistent, ambient noise emanating from the nearby surf zone.

Toothed Whales

Noise generated from this project may be audible to toothed whales (including dolphins), although at frequencies below their optimal hearing ranges. Effects upon dolphins, if any, are likely to be behavioural and most likely confined to the immediate area and most likely only during any period of pile driving.

8.2.2 Sea Lions

As summarised by McCauley (1994), seals and sea lions have poor hearing at low frequency and, therefore, can approach low frequency noise sources, such as seismic survey vessels, without suffering adverse effects. On this basis, it may be concluded that the construction and operation of the SSDP, and the associated noise sources, is unlikely to have any deleterious impacts upon the Australian sea lion.

Pinnipeds have also been widely observed to develop habituation to explosive detonations, as ‘seal bombs’, used to keep seals and sea lions away from fishing vessels and aquaculture pens, have been found to have limited long-term effect (Lewis 1996a). On this basis, it is conceivable that sea lions may be attracted to explosions causing fish kills and may then be caught in the next explosion if these were to be conducted with any regularity and repetition. This risk can be mitigated by application of an exclusion zone around blast sites and the employment of a suitable interval between detonations.

8.2.3 Marine Turtles

Turtles have been known to demonstrate a startle response to sudden noise, such as occurs with pile driving or the detonation of explosives. Thus, any turtles in the project area may experience short-term behavioural effects, including some avoidance of the site. Any such effect may impact on feeding but is likely to only occur during the limited pile driving activities which will occur at the site. Dredging, rock dumping, vessel movements and pipe operation are less likely to elicit any significant response.

There is no risk of adverse effect upon turtle nesting or hatching as the project area is not anywhere near turtle breeding areas.

8.2.4 Sharks

Sharks within the area will be able to detect the low frequency noises generated by the construction activities, particularly the pile driving. However, no critical habitat or aggregation areas are known to occur within the vicinity of the project site, so any acoustic-induced impact is likely to be short-term and non-persistent.

Any potential effects from the use explosives can be mitigated by application of an exclusion zone around blast sites.

8.3 CONCLUSIONS

Some noise, generally low frequency broadband, will be generated from the proposed activity, particularly during the construction phase. It may be concluded that this should be considered as unlikely to trigger any long-term, persistent, deleterious impact upon marine fauna in the area. This conclusion is founded upon several key points, namely:

- the relatively low levels of noise expected to be generated;
- the temporary nature of the predicted acoustic disturbance;
- the high levels of persistent, broadband noise expected in the project area emanating from the nearby surf zone; and
- the absence of any identified critical or important habitat in the project area for sharks, turtles or cetaceans, and the availability of nearby alternative areas for temporary refuge.

It is possible that the proposed activities, particularly the pile driving, will elicit some short-term behavioural changes. These are likely to be confined to startle responses, changes to feeding patterns and temporary avoidance of the project area. None of these are considered likely to result in long-term harm to either individuals or populations of any of the marine fauna considered.

Explosive blasting could potentially cause mortality or sub-lethal injury, but the areal extent of the zones in which these types of impact may be experienced are exceedingly small. More likely, the impact of explosives would be limited to acoustic-induced startles. The limited risks presented by any use of explosives can be significantly ameliorated by the establishment and surveillance of effective marine fauna exclusion zones around the blasting sites.

The intermittent presence and lack of any specific residency of the nominated species of concern in the project area suggests minimal risk of exposure to any noise or shock effects from the proposed SSDP. Furthermore, potential noise and shock effects are intrinsically low and will be further attenuated by the intended risk mitigation measures. Taking these factors into account, it is unlikely that the construction and operation of the proposed SSDP would occasion any significant noise or shock-related impact upon any individual of the nominated species of concern, with population level effects a significantly less remote possibility.

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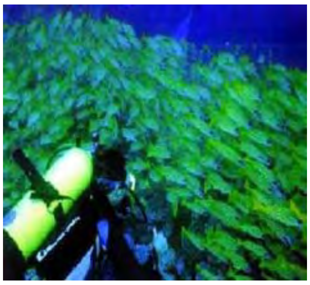
REPORT

Review of Literature on the Effects of Desalination Plant Brine Discharge Upon Cetaceans







Prepared for
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URS Project No.: 42906896-1892 : R1339

8 July 2008

URS

R E P O R T

Review of Literature on the Effects of Desalination Plant Brine Discharge Upon Cetaceans

Prepared for

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8 July 2008

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1. INTRODUCTION

1.1 BACKGROUND

The Western Australian Water Corporation (WAWC) has proposed the installation of a desalination plant at Binningup, Western Australia as part of the Southern Seawater Desalination Project (SSDP). The seawater desalination plant will produce potable water by the seawater reverse osmosis (RO) process. The RO process involves gravitating seawater in through the seawater intake structure to the seawater pump station, pre-treating it (using filtration and/or coagulation) and then pressurising it over a membrane so that freshwater is driven through and higher salinity seawater (brine) is left behind. The brine, which is approximately twice as saline as seawater, passes through energy recovery devices before being discharged via the brine discharge pipeline and diffuser at high velocity and rapidly mixes with the surrounding seawater.

1.2 THIS REVIEW

The purpose of this review is to identify the potential environmental issues associated with brine discharge at the proposed SSDP and discuss their possible effects on cetaceans. Primary literature has been sourced for review where possible. However, little information is available on the potential effects upon cetaceans of the discharge of brine from desalination plants into nearshore waters. While a wide range of the potential environmental impacts of discharge from desalination plants has been identified, few studies have been published in scientific literature that examined the actual effects of discharge from desalination plants on large marine fauna. Secondary literature and anecdotal information, with appropriate qualification, have been used where gaps in knowledge exist.

1.3 BINNINGUP AREA

1.3.1 Binningup discharge area

During operation the SSDP will discharge brine through the ocean outfall diffuser(s) located between 600 m and 1100 m offshore with a total diffuser length of up to 450 m. The brine will be discharged at high velocity through angled nozzles and will mix rapidly with the surrounding seawater. The diffuser will consist of up to four outlet pipes, each to 3 m in diameter. The outlet pipes will be no more than 1 m, or 10% of the water column depth above the seabed.

The proposed discharge area and mixing zone is located in a Low Ecological Protection Area (LEPA). Based on measurements of the Perth Seawater Desalination Plant (PSDP) diffuser discharge, the near field (i.e. the mixing zone) extends around 100 m either side of the diffuser. For this reason the LEPA is proposed to be a rectangular zone that extends 100 m in all directions around the diffuser with an area of approximately 12.5 ha.

1.3.2 Water conditions

Local water temperature and salinity concentrations vary on a seasonal basis. Salinity has a peak of around 36.5 ppt in summer-autumn and a minimum of around 34.5 ppt in winter-spring. During rainfall events, freshwater outflow from the Harvey diversion drain (located approximately 2 km north of the proposed desalination plant) mixing into the Binningup marine waters can result in salinities as low as 30 ppt (WAWC 2008).

Water temperature reaches a peak of around 24ºC in summer-autumn and a minimum of around 15ºC in winter-spring. Analysis of temperature data shows that the site experiences well mixed conditions the majority of the time. A regular diurnal stratification / de-stratification cycle was observed where solar heating stratified the water column in temperature, which was then well mixed by wind and overnight cooling (WAWC 2008).

Dissolved oxygen (DO) concentrations in the Binningup area show diurnal fluctuations due to naturally occurring biological activity (photosynthesis and respiration). DO concentrations are generally between 6.5 and 8.5 mg/L. There are only a few instances in isolated locations where the instantaneous DO dropped to around 5 mg/L (Water Corporation 2008).

1.3.3 Characteristics of the brine discharge

The first stage of the plant will have a nominal production of 50 GL/yr of potable water. This will require approximately 120 GL/yr of seawater to be brought into the desalination plant and 70 GL/yr of brine discharge to be returned to the ocean. These flows will double when the second stage of the plant is completed. The brine discharge rate will be at a peak of 240 ML/d during the first stage and 480 ML/d during the second stage. The actual production rate varies somewhat from season to season, with higher production on days with higher seawater temperatures and clear water, and lower production in winter when the seawater is cooler and more turbid.

The potential impacts on the marine environment associated with the brine discharge (WAWC 2008) are:

- reduction in light
- reduction in pH
- increase in nutrients
- increase in salinity
- chemicals in the brine
- lower DO levels.

WAWC (2008) also identifies that brine discharge temperature will be up to 2^{o}C above that of ambient seawater.

1.3.4 Cetaceans

Western Whale Research (2008) has identified that the cetaceans most likely to occur at Binningup are dolphins (bottlenose) and southern right whales. According to

WAWC (2008) species of cetaceans with the possibility of occurring in the Binningup marine environment include:

- humpback whale *(Megaptera novaeangliae*)
- southern right whale (*Eubalaena australis*)
- blue whale (*Balaenoptera musculus*)
- Bryde's whale (*Balaenoptera edeni*)
- pygmy right whale (*Caperea marginata*)
- southern right whale (*Eubalaena australis*)
- bottlenose dolphin (*Tursiops sp.*)
- killer whale, Orca (*Orcinus orca*).

2. ASPECTS AND IMPACTS

The following section discusses each of the potential environmental impacts associated with brine discharge in respect to potential impact on cetaceans.

2.1 LIGHT

The water entering the SSDP will be filtered through dual media filters prior to the RO process, thereby removing suspended marine material such as silt, sand and algae. It is this suspended material that reduces light penetration into water. As a result, the discharge of the SSDP will have less suspended particles and therefore may increase light penetration into marine waters (WAWC 2008). A slight increase in water clarity and hence light penetration is not expected to affect cetaceans.

The Ecology Lab (2005) undertook a marine ecology assessment for the intake and outlet pipelines for an RO desalination plant in Sydney, Australia. The Ecology Lab (2005) noted that greater light penetration may increase the growth of seagrass. Seagrass beds support a variety of fishes and invertebrates, some of which may provide prey for some species of cetaceans, or at least support production at lower trophic levels of the cetacean food pyramid.

2.2 pH

Seawater (such as occurs naturally at Binningup) typically has a pH of approximately 8. The discharge will range from pH 6 to 8. The buffering capacity of seawater (i.e. the ability to neutralise pH) coupled with the high level of dilution of the desalination discharge means that pH of any desalination discharge will be rapidly converted to ambient levels (WAWC 2008). No information was available from WAWC (2008) on the expected distance it would take from the diffuser before ambient levels are reached. However, ambient levels are expected to be reached well within the mixing zone (Lattemann & Hopner 2003). The Ecology Lab (2005) discussed the possible impacts of brine output on the marine environment. This report did not specifically discuss the effects of slightly reduced pH on the marine environment as impacts were expected to be negligible.

2.3 NUTRIENTS

Nitrogen can be a nutrient of concern in marine environments with regard to stimulating primary productivity (Morris et al. 2007). Morris et al. (2007) linked an increase of bioavaliable nitrogen in the marine environment to a loss of sea grass (*Zostera muelleria*) in Western Point, Victoria, Australia. An increase in nitrogen may stimulate algal growth on seagrass, limiting the amount of sunlight that it receives for photosynthesis. A number of process chemicals that contain nitrogen (polyelectrolytes, biocides and acid detergents) are used in the reverse osmosis process. Measurements on the PSDP show that any nitrogen added in the RO process is equal to that removed in the filter backwash cake (i.e. sludge that is taken away to landfill).

It can be concluded that the operation of the SSDP is unlikely to increase nitrogen levels in marine waters. Therefore nutrients derived from the operation of the SSDP are unlikely to impact upon cetaceans, either directly or indirectly.

2.4 SALINITY

Salinity of the brine at the discharge point of the diffuser will be up to 65 ppt. The brine will rapidly mix with the surrounding seawater due to turbulence caused by the velocity of the output. The WAWC has committed to the SSDP desalination discharge not causing an increase in salinity at the boundary of LEPA that is:

1. greater than 1 part per thousand (ppt) 95% of the time
2. greater than 1.3 ppt at any time.

The brine is heavier than the surrounding seawater due to its higher salinity. The region where the brine settles to the seafloor is termed the nearfield and is predicted to be fully contained within the LEPA. Once the diluted brine reaches the seabed it will continue to dilute due to natural mixing processes. It will also be advected by currents and move down slope (i.e. offshore) due to being slightly denser than the surrounding seawater (WAWC 2008).

There is no potential for long-term build-up of salinity due to the discharge being sited on an open coastline. The brine discharge is predicted to increase the average density stratification by no more than 0.1 kg/m^3 at 0.5 km from the diffuser. This stratification reduces with distance away from the diffuser and there is only a minor change to the duration of stratification 2 km and more from the diffuser (WAWC 2008).

Claims have been made that hypersaline water can harm whales. This is largely based upon a 1999 incident where at least 65 gray whales (*Eschrichtius robustus*) were reported to have washed up on Mexico’s Baja Peninsula, where the animals migrate each winter to bear their young. Additional whale corpses were also discovered along California shores in March and April during the migration of the whales north to their feeding grounds (CNN 1999).

The apparent higher-than-average mortality rate generated widespread speculation in the media and amongst conservation activists on the cause of the deaths. One of the more popular explanations reported in the media was that the whales were being killed by cyanide in a fluorescent dye used by drug smugglers to mark the sea during air drops of illegal narcotics.

Another of the many explanations proliferated was pollution or changes to seawater conditions caused by a salt production facility in Guerro Negro lagoon, although there is no evidence of either occurring. The industrial salt production facility, ESSA, is a company jointly owned by the Mitsubishi Corporation and the Mexican government. The company, which has been operating in the area for over 40 years, produces approximately seven million tons of salt a year, making it the largest producer of salt in the world. The salt is produced by drawing seawater into large shallow evaporation ponds. Solar and wind energy then evaporate the water leaving the salt ready to harvest (Gustafsom et al. 1998).

Weng (1997) of the University of California speculated that warm, salty water that was being removed from Guerro Negro lagoon by the salt-evaporation plant was being replaced with colder, less saline water from the open ocean. Weng (1997) stated that whales were less buoyant in cooler, less saline waters and thus would expend more energy while in the bay, causing more stress on the animals. However, there has been no evidence to support this claim.

According to CNN (1999), Dr Bruce Mate, a marine mammal specialist at Oregon State University, stated the most likely cause could be massive changes to animal communities in the Bering Sea where the whales spend their summers feeding and rearing their young. Mate also commented that, although it was the highest number of fatalities seen in the 24 years that people had kept records, it may just have been that more were recorded in that particular season.

To date there has not been further research done on the cause of the whales' deaths in 1999, nor have there been repeated high mortality rates.

Information for this review was also sought regarding physiological effects of hypersaline or hypertonic solutions on cetaceans and on parasites that use cetaceans as a host. No information could be found regarding these effects.

Anecdotal evidence of cetaceans' ability to live in hypersaline environments is provided in the Red Sea and the Arabian Gulf. Swenson (2005) reports that the salinity in the Red Sea can reach up to 40 ppt and in the Arabian Gulf can reach up to 41 ppt (Swift & Bower 2003). These waters support a number of cetaceans (Culik 2004) including:

- Risso's dolphin (*Grampus griseus*)
- Blainville's beaked whale (*Mesoplodon densirostris*)
- ginkgo-toothed Whale (*Mesoplodon gingodens*)
- false killer whale (*Pseudorca crassidens*)
- killer whale (*Orcinus orca)*
- Indian humpback whale (*Sousa plumbea*)
- pantropical spotted dolphin (*Stenella attenuata*)
- striped dolphin (*Stenella coeruleoalba*)
- rough-toothed dolphin (*Steno bredanensis*)
- bottlenose dolphin (*Tursiops truncatus*)
- sei whale (*Balaenoptera borealis)*
- Bryde's whale (*Balaenoptera sp.)*
- blue whales (*Balaenoptera musculus).*

According to de Silva Samarasinghe et al. (2003), water in Gulf St Vincent, South Australia, can exceed 42 ppt in summer when evaporation is at a maximum and the rainfall is minimal. According to Shepherd et al. (2008) the gulf is an environment commonly used by many species of dolphins and whales, including the bottlenose dolphin and the southern right whale.

Tomczak (2003) notes that when sea ice is formed in polar regions during winter hypersaline brine is ejected during the freezing process. It is known that these polar habitats support marine mammals such as whales. This observation provides further support that whales can tolerate areas of elevated salinity.

Bays et al. (1992) undertook a study to measure the toxic effects of increased salinity on marine species and determine the toxic effects of waste brine and the interactions between waste brine and sewage on toxicity. The study tested the effects of increased salinities on spores of giant kelp (*Macrocystis pyrifera*), an amphipod (*Rhepoxynius abronius*) and sea urchin embryos (*Strongylocentrotus purpuratus*). Sea urchin embryos were used in the experiment as they are among one of the most sensitive marine species. The salinities were based on the predictions from plume models for the Santa Barbara reverse osmosis desalination plant.

The study concluded that desalination plant brine and elevated salinity did not produce toxic effects on amphipods, kelp spores or sea urchin embryos at concentrations expected in the field. However, the combined effect of increased salinity and sewage effluent had a significant effect on sea urchin development. As the brine output in the SSDP will not be mixed with effluent it is unlikely that the brine plume will have any effects on sensitive marine species. Thus secondary effects of brine plumes on cetaceans are not likely to be seen in the Binningup area.

WAWC (2008) states that marine mammals such as whales and dolphins are unlikely to be affected by the saline discharge as they are able to sense changes in salinity and avoid if necessary (Western Whale Research 2008). It can be concluded that the operation of the SSDP Plant is unlikely to increase salinity to a level that will affect flora and fauna outside of the LEPA (WAWC 2008).

In the environmental assessment of the proposed Sydney seawater desalination plant, The Ecology Lab (2005) highlighted the possible impacts of increased salinity on the marine ecosystem. They state that increased salinity may impact upon small sessile organism and that mobile biota such as fish were likely to be able to avoid the zone of higher salinity in the immediate area of the discharge.

2.5 CHEMICALS

A number of chemicals are required for the efficient and effective operation of a desalination plant. These may include sulfuric acid, ferric sulphate/chloride, polyelectrolyte, antiscalants, sodium hypochlorite and sodium bisulphate. The actual chemical dosing regimes for the SSDP will be determined following pilot testing and will be refined during commissioning. All of the treatment chemicals to be used are either non-hazardous, form harmless byproducts or biodegrade relatively rapidly (WAWC 2008). Accordingly, it is unlikely that there will be any bioaccumulation of substances associated with the SSDP.

The seawater drawn into the seawater plant naturally contains metals whose concentrations will be approximately doubled before being discharged in the brine stream. Dilutions of 28 to 50 times within the LEPA would result in these substances being around 4% to 2% higher in concentration at the LEPA boundary compared to background seawater. Additional dilution beyond the LEPA will reduce this increase in concentration even further. Hence, it is only if a substance is added during the treatment process, as opposed to being present in the seawater intake stream, that there is the potential for any measurable environmental impact (WAWC 2008).

Given the potential toxicity of some metals, monitoring of the desalination discharge stream for metals will be carried out as part of the Discharge Water Quality

Monitoring Management Plan (WAWC 2008). The results of this monitoring should be reviewed in regards to potential effects on cetaceans.

2.6 DISSOLVED OXYGEN

The WAWC (2008) reported, as a worst case estimate, the brine from the SSDP could be up to 2 to 2.5 mg/L lower in DO than the ambient seawater. Following dilution with seawater, the largest decreases in dissolved oxygen that could occur are 0.09 mg/L (1.3 % sat) and 0.14 mg/L (2 % sat) at the LEPA boundary and within the LEPA respectively. Such changes, if they were to occur, would not be discernable against background variations in DO concentrations. The Ecology Lab (2005) did not specifically discuss the effects of slightly reduced DO levels on the marine environment as impacts were expected to be negligible.

Centre for Water Research (2007) concluded that there is not likely to be any significant change in DO, beyond natural variation, in any ecological or biological indicators that are affected by poorly oxygenated water in deeper waters. Thus as cetaceans are air breathing, and there is not likely to be any significant reduction of DO in the receiving environment, no tangible effect is contemplated.

2.7 TEMPERATURE

The temperature of the brine at the discharge diffuser will be within 2^{o}C of the ambient seawater temperature. According to Silva (2004) cetaceans are the only homeotherms that spend their entire life in the open sea, subject to water temperatures ranging from -2ºC to about 30ºC. Because of this cetaceans have a highly developed thermoregulation system. Thus the temperature differences caused by the brine discharge are most likely to be within their tolerance range.

The Ecology Lab (2005) suggested that a change in seawater temperature in the order of 1—2^{o}C above ambient conditions may attract biota more suited to warm conditions, which could affect the structure of animal assemblages in a very small area around the outlet. This is unlikely to affect the feeding behavior of cetaceans.

3. CONCLUSION

Despite the large number of desalination plants operating around the world, there are many knowledge gaps and uncertainties regarding the impacts of desalination projects on the marine environment, as monitoring results of operating plants are only available to a limited extent. Even less information is available on the effects that RO desalination plants have on large marine fauna.

The environmental effects of brine discharge on cetaceans have not been studied at other RO desalinisation plants. However, there is no information available that suggests brine discharge will have a negative effect on cetacean health. In the case of the ESSA saltworks in Mexico there was no evidence to suggest that hypersaline brine discharge was the cause of gray whale deaths in 1999 and there has been no apparent recurrence of this episode. There are, however, many examples of cetaceans living in sea areas with elevated salinities.

Cetaceans are large, highly mobile organisms in relation to the size of the brine mixing zone proposed at the SSDP. Because of their mobility, it is expected that exposure to environmental conditions within the mixing zone, even if they were to be adverse, will be minimal. Hence it is considered highly unlikely that there will be adverse impacts on cetaceans due to brine discharge from the SSDP.

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5. LIMITATIONS OF REPORT

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Western Australian Water Corporation and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 23 June 2008.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works, and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between 23 June and 8 July 2008, and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

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Water Corporation

Report for the Proposed Southern Seawater Desalination Project

Social Impact Assessment

May 2008

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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List of Acronyms

ABS	Australian Bureau of Statistics
BDAG	Binningup Desalination Action Group
CO	Communications Officer
EMP	Environmental Management Plan
GL	Gigalitre = 1 x 10^9 litres or 1,000,000,000 litres (also GL / yr = gigalitres per year)
IRSEAD	Index of Relative Socio-Economic Advantage and Disadvantage
IWSS	Integrated Water Supply Scheme
MIAESR	Melbourne Institute of Applied Economic and Social Research
S1	Telephone Survey 1 conducted by Synovate on August 2007
S2	Telephone Survey 2 conducted by Synovate on November 2007
SAG	Stakeholder Advisory Group
SIA	Social Impact Assessment
SIMP	Social Impact Management Plan
SSDP	Southern Seawater Desalination Project
SWR	South West Region
ToR	Terms of Reference
WA	Western Australia

Acknowledgements

GHD would like to acknowledge the participation of stakeholders and community members who volunteered their time to provide input to the SIA. Their participation made a significant contribution to gaining an understanding of the issues and concerns of their communities and in identifying potential impacts and mitigation / enhancement strategies. Thank you for your time and willingness to contribute.

Executive Summary

Introduction

Average water flow into Perth's metropolitan dams has dropped significantly while increasing growth across the State has meant demand for water continues to increase. In response to these changing conditions, the Water Corporation is developing a range of alternatives to reduce water consumption and increase supply.[1]

Desalination is a climate independent water source and is a key part of the plan to secure water supply. On 15 May 2007, WA Premier, Alan Carpenter, announced that a new desalination plant is proposed to be built at a site north of Binningup: the Southern Seawater Desalination Project (SSDP or the project). The SSDP will initially provide 50 GL/yr of potable water, with a potential to upgrade to 100 GL/yr in the future. It will provide water to the Perth metropolitan area and Mandurah via the Integrated Water Supply Scheme (IWSS) through a connection north of Harvey. The Western Australian Government has committed to the SSDP being powered by renewable energy[2].

The Water Corporation has engaged consultants to undertake many studies to assist with project design. As part of these studies, the Water Corporation has engaged GHD to undertake a voluntary (i.e. not required for project approval) Social Impact Assessment (SIA).

Social Impact Assessment is a "systematic analysis in advance of impacts on the day-to-day quality of life of persons and communities whose environment is affected by a proposed plan, program, project or policy change"[3] (Burdge, 2004: 2). The SIA for the SSDP also identifies opportunities for mitigating the negative impacts, enhancing the positive impacts and monitoring the mitigation of impacts.

The purpose of the Social Impact Assessment is threefold:

1. To identify and assess how the construction and operation of the desalination project will change the lives of the community directly and indirectly affected by the Project;
2. To provide a list of likely social impacts and determine those that are significant; and
3. To identify mitigation, enhancement and monitoring measures to minimise the negative effects of the project and maximise positive impacts.

Project Description

The SSDP will be located on an 84-hectare block on Lots 32, 33 and part of Lot 8 Taranto Road, Binningup between the towns of Binningup and Myalup.The project includes:

1. A 50 GL/yr desalination plant with the potential to upgrade to 100 GL/yr;
2. Offshore pipelines (to carry seawater from the ocean into the plant and return the brine to the ocean);

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[1] Water Corporation (2005) *Security Through Diversity* strategy [on line]. Accessed 01 October 2007 <www.watercorporation.com.au/P/publications_diversity.cfm>

[2] Media Statement by Alan Carpenter MLA on 15 May 2007 [online]. http://www.mediastatements.wa.gov.au/media/media.nsf

[3] Burdge (2004) *A Community Guide to Social Impact Assessment*. 3rd Edition. Social Ecology Press.

3. Onshore pipeline to carry the water from the desalination plant to water tank/s; and
4. Up to four 32 ML water tanks (or ‘summit tanks’) and a 20-50 ML sump to be built north east of Harvey (initially one tank).

The scope of the SIA extends to all parts of the project. Other impacts from supporting infrastructure, such as powerlines and workforce camps will be considered although these are not part of the scope of the environmental approval submitted to the EPA by the Water Corporation. The proponents for these components will be Western Power and an Alliance respectively. Social impacts will be identified and assessed for the immediate, local and regional study areas and for the Project’s construction and operation.

Methodology

The key stages in the SIA methodology include:

Stage 1 **Project Description and Scoping** – gather information about the project including its purpose, scope, history and construction and operation information in order to conduct a scoping exercise to identify potential issues and concerns.

Stage 2 **Community Profile** – description of the potentially affected communities including demographics, the history and background, the community services and facilities available and the community values and use of the study area.

Stage 3 **SIA Stakeholder Input –** contribution from key stakeholders and community members in the process of identifying social impacts and identifying mitigation and enhancement measures.

Stage 4 **Identification, assessment and ranking the Social Impact Assessment** – analysis of the community profile and project information to identify and rank social impacts.

Stage 5 **Mitigation, enhancement and monitoring measures** – strategies for mitigating impacts to enhance positive and minimise negative consequences of the Project.

Stage 6 **Production of SIA Report**

Following this SIA, a Social Impact Management Plan will be developed in consultation with the community to ensure the effective implementation of the mitigation, management and monitoring recommendations identified in this study. This part of the project is referred to as Phase Two of the SIA.

The SIA process is outlined at Figure 7.

Study Limitation

The identification of social impacts relies heavily on data from social research, case studies, project information, relevant studies and past experience. The information available to this study was sufficient to assess most, but not all of the potential social impacts identified. Given that this report was prepared in parallel to other studies, it was not possible to obtain all the necessary information to comprehensively assess all the potential social impacts associated with the construction phase of the project. Namely, construction methods, powerline routes, workforce arrangements and construction traffic details have not been finalised. Where there has been some relevant data provided, the consultants have made some assumptions about the potential social impacts based on the available information and their experience with similar projects. Where sufficient information was not obtainable about potential social impacts, they are identified but no assessment has been made. These impacts should be reviewed by the Water Corporation as more information becomes available to ensure that they are assessed, monitored and evaluated. The recommendation of this report to develop a Social Impact Management Plan (SIMP) will ensure that new information about impacts is considered in gaining an understanding of the impact, its significance and any new management actions required.

Study Area

In determining the immediate study area, the SIA's objectives were to define the area that may experience most of the social impacts and opportunities and for which socio-demographic information is available. The SIA has defined four study areas: immediate, local, regional and state.

In the case of the SSDP, the immediate study area was the towns of Binningup and Myalup. Similarly, in determining the local study area, the SIA's objectives were to define an area that would include the entire project (plant, pipelines and tanks) and the surrounding areas in which most of the impacts may be experienced and for which information was available. The Australia Bureau of Statistics collection districts and state suburbs surrounding all of the project components resulted in the same local study area shown in Figure 8.

The SIA also defined a regional study area and a state study area. The regional study area was defined as the region beyond which it was unlikely that social impacts and opportunities would be experienced. This study area was defined using local government areas and is comprised of the City of Bunbury and the Shire of Harvey. The state study area is Western Australia.

The study areas are outlined in the table below.

SIA Study Areas

Immediate Study Area	This study area is comprised of the following State Suburbs: • Myalup (SSC54976); and • Binningup (SSC53206).
Local Study Area	This study area is comprised of the following State Suburbs: • Myalup (SSC54976); • Binningup (SSC53206); • Wellesley (SSC55896); • Wokalup (SSC56021); and • Harvey (SSC54081).

Regional Study Area	This study area is comprised of the following Local Government Areas: • Shire of Harvey (LGA53990); and • City of Bunbury (LGA51190).
State Study Area	This study area is comprised of the State of Western Australia.

Impacts will be identified, discussed and assessed for the immediate, local and regional study areas. Impacts at the state level have not been assessed in this SIA because the negative effects of the project are expected to be contained within the regional area.

Stakeholder Input

Stakeholder input for this SIA was obtained through meetings, interviews with key community members and stakeholders and information from telephone surveys undertaken by Synovate Research for the Water Corporation.

Telephone Survey

Two telephone surveys were conducted by Synovate Research for the Water Corporation (stage 1 on August 2007 - S1 and stage 2 on November 2007 - S2)[4]. The telephone surveys explored the community's level of awareness about the desalination project and obtained feedback about their concerns about the project. A specific question was added to the S2 survey to ask the community what they perceive the impacts of the desalination project will be and any suggestions for improvement.

SIA Stakeholder Consultation

One-on-one semi-structured interviews and small group interviews were conducted with stakeholders from Binningup, Myalup, Harvey and Australind in October and November 2007. The following themes emerged from the feedback obtained during the stakeholder interviews:

- Lack of community consultation prior to the announcement of the project resulting in distrust
- Community identity and sense of place
- Impacts of the construction workforce
- Potential impacts on facilities and services
- Environmental impacts
- Future development and land values
- Visual impact
- Noise
- Dust
- Public safety and risk

[4] *Southern Seawater Desalination Project – Community Consultation Report, Synovate (November 2007)*

- Closure between Binningup and Myalup beach
- Equity in the distribution of costs and benefits
- Increase in traffic
- Powerlines
- Secure water supply

Identifying and assessing potential Social Impacts

Potential social impacts have been identified based on a comparison of the implications and results from the following sources:

- SIA stakeholder consultation;
- Minutes from the previous consultation meetings held by the Water Corporation;
- Project information and reports;
- Observations made during site visits; and
- Telephone survey stage 1 on August 2007 and stage 2 on November 2007 (Synovate Research for the Water Corporation).

Information from these sources was compared to identify potential social impacts. Impacts were then discussed and their significance was assessed by comparing the future situation with and without the project, and without considering mitigation and management measures.

Assessing and Ranking Social Impacts

The significance of the potential social impacts was defined using a risk assessment approach in which significance is the product of the likelihood and severity of the potential social impact. *Likelihood* is defined as the possibility of the impact occurring. *Severity* refers to the degree of the consequences of the social impact. The scales for likelihood and severity are described in the table below.

Measures of Social Impact Significance

Likelihood	Severity
Highly Likely (HL)	High Severity (HS)
Moderately Likely (ML)	Moderate Severity (MS)
Unlikely (UL)	Low Severity (LS)

The ratings for the likelihood and the severity of impacts have been adapted to each individual impact in order to assess the characteristics of each impact. Although the three-point scale has uniform descriptions for each level, the way these scales are applied to each impact is discussed in detail in Section 5.1 and Section 5.2.

Likelihood and severity are combined as shown in the table below to estimate the significance of the impact. Impacts can be of high, moderate or low significance. The potential to manage the impacts is addressed by assessing the significance of social impacts twice: first without considering the effect of any mitigation measures and then, by assessing the significance of the impact after mitigation measures are implemented. The potential to manage impacts is shown in Table 8 and Table 9.

Significance table for social impacts

Likelihood \ Severity	High Severity	Moderate Severity	Low Severity
Highly Likely	High Significance	High Significance	Moderate Significance
Moderately Likely	High Significance	Moderate Significance	Low Significance
Unlikely	Moderate Significance	Moderate Significance	Low Significance

Potential social impacts identified for the construction and operation stages of the project at the immediate (I), local (L) and regional (R) study areas are summarised in the table below. The table shows the significance of the majority of potential impacts can be effectively reduced through mitigation actions. It also provides a discussion of each of the impacts identified and their level of significance.

Potential Social Impact	Significance without Management Actions			Significance with Management Actions		
High Significance Moderate Significance Low Significance	Immediate Study Area	Local Study Area	Regional Study Area	Immediate Study Area	Local Study Area	Regional Study Area
CONSTRUCTION						
Loss of trust in the Water Corporation			N/A	NI	NI	N/A
Impact on community character and amenity	ID	ID	ID	ID	ID	ID
Impact on community cohesion			N/A		NI	N/A
Change in beach and ocean-based recreational opportunities						
Impact of the construction of the plant on the visual amenity of the area	ID	N/A	N/A	ID	N/A	N/A
Impact of the construction of the pipelines on the visual amenity of the area	N/A	ID	N/A	N/A	ID	N/A
Impact of the construction of the tanks on the visual amenity of the area	N/A	ID	ID	N/A	ID	ID
Disruption to properties along the pipeline	N/A		N/A	N/A		N/A
The project could restrict the potential for future residential		N/A	N/A	NI	N/A	N/A

Potential Social Impact	Significance without Management Actions			Significance with Management Actions		
High Significance Moderate Significance Low Significance	Immediate Study Area	Local Study Area	Regional Study Area	Immediate Study Area	Local Study Area	Regional Study Area
development						
The project could result in an increase in industries		N/A	ID		N/A	ID
Impacts of the overhead powerlines required to provide energy for the proposed desalination plant	ID	ID	ID	ID	ID	ID
Public Safety and Risk	EIA / RA	EIA / RA	EIA / RA	EIA / RA	EIA / RA	EIA / RA
Increased demand on community facilities and services	ID	ID	ID	ID	ID	ID
Increase in economic activity (positive impact)	+	+	+	+	+	+
Increase in cost of labour for industries and businesses in the region	ID	ID	ID	ID	ID	ID
Disruption to businesses during construction			N/A	NI		N/A
Unequal distribution of costs and benefits of the project						
Increased traffic in the area causing delays and increasing risk for local communities and commuters	ID		ID	ID		ID
Impacts from expanding the plant to 100 GL/yr			N/A			N/A
Reduced tourism to Binningup and Myalup beaches						
OPERATION						
Increased provision and security of water supply to IWSS (positive impact)	+	+	+	+	+	+
Communities living with uncertainty	EIA	EIA	EIA	EIA	EIA	EIA
Change in beach and ocean-based recreational opportunities because of environmental impacts of brine release				NI	NI	NI
Impact on community character and amenity			NI			NI
Impact of the plant on the visual amenity		N/A	N/A		N/A	N/A
Impact of the summit tanks on the visual amenity	N/A			N/A		
Increase in economic activity	+	+	+	+	+	+
Public safety and risks as a result of chemical and fuel spillage / leaks	EIA / RA	EIA / RA	EIA / RA	EIA / RA	EIA / RA	EIA / RA
Risk of terrorist attack because of the presence of infrastructure of State significance	EIA / RA	EIA / RA	EIA / RA	EIA / RA	EIA / RA	EIA / RA

Potential Social Impact		Significance without Management Actions			Significance with Management Actions		
	High Significance	Immediate Study Area	Local Study Area	Regional Study Area	Immediate Study Area	Local Study Area	Regional Study Area
	Moderate Significance						
	Low Significance						
Increased traffic in the area increasing risk for local communities and commuters					NI	NI	NI

NOTE: N/A = Impact does not apply in this study area, ID = Insufficient Data, EIA / RA = Impact dealt with in Environmental Impact Assessment and Risk Assessment, NI = Assessment determined No Impact in this study area, + = Assessment determined Positive Impact in this study area.

Positive Impacts

The positive impacts resulting form this project are:

- Increase in economic activity in the Immediate, Local and Regional study areas during construction and operations of the project (during construction: moderate positive impact for Immediate study area, high positive impact for Local Study area and Regional Study area; during operation: low positive impact for all study areas); and
- Increased provision and security of water supply to IWSS for the Immediate and Local study areas (high positive impact for Immediate Study area and Local Study area).

Impacts that cannot be mitigated

The impacts that cannot be mitigated during the construction of the project are:

- Change in beach and ocean-based recreational opportunities (Low in the Immediate, Local and Regional Study areas);
- The project could result in an increase in industries (Low in the Immediate Study Area); and
- Reduced tourism to Binningup and Myalup beaches (Low in the Immediate, Local and Regional Study areas)

There are no impacts that cannot be mitigated during the operation of the project.

With the current available information there are no fatal flaws[5] or unacceptable impacts[6] identified for the SSDP.

Table of Recommendations

[5] A fatal flaw is defined as an impact that cannot be managed and/or mitigated in order for it to have significance lower than high.

[6] Unacceptable impacts are those that can be managed and/or mitigated but still have a moderate residual significance after considering the effect of suggested management and mitigation measures (residual significance).

Table 1 Impact Management Strategies and Residual Significance: Construction Stage

Social Impact	Significance w/out Management			Management Strategies		Residual Significance		
	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Loss of trust in the Water Corporation			Impact not identified for this study area	Develop a Commitments Register that records the commitments made to stakeholders and the community. This register should be a public document that outlines the response and progress to each of the commitments made. Provide a permanent and local contact person to provide information to and obtain feedback from the community throughout the design and construction of the project. Raise awareness of the Water Corporation's business. Provide easy access and readily available information about the project at all stages including design, construction and operation especially related to social, environmental and economic impacts.	Develop and maintain a Communication Strategy designed to guide communications between the Water Corporation and the community. Evaluate this strategy on an ongoing basis. Create a Stakeholder Advisory Group (SAG)[7] and use it as a channel to communicate both ways. Develop and implement a Social Impact Management Plan (SIMP).	No Impact	No Impact	Impact not identified for this study area

[7] It is recommended that the SAG consist of a broad representation of different stakeholder and community interests and views to provide advice and feedback to Water Corporation about key issues and at key stages during planning, construction and operation of the project. The SAG should have representation from local government, relevant state government agencies, representatives from recreational groups such as the Water Sports Club, Surf Life Saving Club, representatives from local groups such as senior citizens, youth and residents associations, representatives of special interest groups such as environmental groups, heritage groups and action groups, and representative from businesses such as local businesses and the Chamber of Commerce. The group should be representative of the broader population to ensure that the views obtained during consultation with the SAG are representative of the broader community.

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impact on community character and amenity	Insufficient Data	Insufficient Data	Insufficient Data	The decision on the location of the construction camp should take into account the potential impact the camp would have on the local community. Induction kit for all construction employees that introduces them to the community where they will be working to assist with increasing understanding. Develop a code of conduct for the construction workforce. Ensure that the community can easily communicate concerns. Investigate establishing a funding program for local environmental groups. Implement the recommendations contained in the Construction Environmental Management Plan (CEMP) to manage dust, noise and light.	Provide mechanisms for SAG involvement in the mitigation measures implemented.	Insufficient Data	Insufficient Data	Insufficient Data

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impact on community cohesion			Impact not identified for this study area	Where practical, inform and involve stakeholders and the community in decisions associated with the design, construction and operation of the project. Provide a permanent and local contact person to provide information to and obtain feedback from the community throughout the design and construction of the project. Induction kit for all construction employees that introduces them to the communities where they will be working to assist with increasing understanding of the Immediate and Local Study Areas. Develop a code of conduct for the construction workforce.	Provide mechanisms for SAG involvement in the mitigation measures implemented. Monitor the implementation of the code of conduct and the employee induction process.		No Impact	Impact not identified for this study area
Change in beach and ocean-based recreational opportunities				Wherever possible, minimise the extent and optimise timing of the restriction to the beach and ocean during construction. IImplement a construction process that minimises the scale and duration of beach and ocean closure. Provide clear and timely information about closures, including details about timeframes or potential dangers.	Work with the SAG and relevant user groups to evaluate potential problems and additional mitigation strategies. Create and manage an Issues Register to monitor responses/actions. Clearly communicate to the community incidences reported and the actions taken and identify any opportunities for improvement.			

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impact of the construction of the plant on the visual amenity of the area	Insufficient Data	Impact no identified for this study area	Impact not identified for this study area	Ensure that management strategies for visual impacts during construction of the plant are contained in the Construction Environment Management Plan and Social Impact Management Plan. Communicate with the community well in advance of major construction activities that may be visible from local areas.	Work with the SAG to evaluate potential problems and additional mitigation strategies.	Insufficient Data	Impact not identified for this study area	Impact not identified for this study area
Impact of the construction of the pipelines on the visual amenity of the area	Impact not identified for this study area	Insufficient Data	Impact not identified for this study area	Communicate with affected residents and the community well in advance of pipeline construction and discuss timeframes. Negotiate with directly affected landowners to ensure the inconvenience of pipeline construction is minimised.	Work with the SAG to evaluate potential problems and additional mitigation strategies.	Impact not identified for this study area	Insufficient Data	Impact not identified for this study area
Impact of the construction of the tanks on the visual amenity of the area	Impact not identified for this study area	Insufficient Data	Impact not identified for this study area	Communicate with affected residents and the community will in advance of tank construction and discuss timeframes.	Work with the SAG to evaluate potential problems and additional mitigation strategies.	Impact not identified for this study area	Insufficient Data	Impact not identified for this study area

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Disruption to properties along the pipeline	Impact not identified for this study area		Impact not identified for this study area	Compensate affected property owners and inform stakeholders of the construction and compensation processes. Keep the width of the pipeline construction corridor to the minimum possible when constructing near properties. Avoid undertaking construction activities overnight when constructing near properties. Inform and coordinate works with potentially affected property owners well ahead of construction in order to allow them to plan ahead.	Develop and maintain a Communication Strategy designed to provide communication channels between the Water Corporation and the Immediate and Local Study Area. Evaluate the implementation of this strategy during the project execution.	Impact not identified for this study area		Impact not identified for this die area
The project could restrict the potential for future residential development		Impact not identified for this study area	Impact not identified for this study area	Ensure that the project design takes into consideration future residential development. Implement a landscape management plan. Implement onsite mitigation strategies such as bunding / berms, screens, noise management etc.	Evaluate the implementation of the mitigation or enhancement measures to ensure that they have been implemented.	No Impact	Impact not identified for this study area	Impact not identified for this study area
The project could result in an increase in industries		Impact not identified for this study area	Insufficient Data	N/A	N/A		Impact not identified for this study area	Insufficient Data

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impacts of the overhead powerlines required to provide energy for the plant for the proposed desalination plant	Insufficient Data	Insufficient Data	Insufficient Data	N/A	N/A.	Insufficient Data	Insufficient Data	Insufficient Data
Public Safety and Risk	Impact will be dealt with in the EIA and Risk Assessment	Impact will be dealt with in the EIA and Risk Assessment	Impact will be dealt with in the EIA and Risk Assessment	Undertake an assessment of public safety and risks and implement appropriate risk management plans. Refer to recommendations in the CEMP. Implement safety procedures to ensure the safe management and storage of chemicals and fuel. Raise community awareness about the public safety measures of the project to build community understanding. The Water Corporation / Alliance should develop an Emergency Response Plan.	Provide channels for communities and stakeholder to be able to report any public safety and risks questions, issues or concerns. Evaluate incidences of public safety and risks and responses to incidences and identify ways of enhancing procedures.	Impact will be dealt with in the EIA and Risk Assessment	Impact will be dealt with in the EIA and Risk Assessment	Impact will be dealt with in the EIA and Risk Assessment
Increased demand on community facilities and services	Insufficient Data	Insufficient Data	Insufficient Data	Once the location of the construction camp has been decided and its proximity to community facilities and services has been considered: Conduct a needs assessment of the workforce to identify requirements for and impact on community facilities and services. Provide recreational opportunities for construction workforce. Provide transport to appropriate leisure activities or facilities in the regional area.	Consult recreational services and facilities providers in the immediate and local study areas to monitor increases in demand and impact on levels of services. Monitor employee satisfaction with recreational opportunities, leisure activities and services.	Insufficient Data	Insufficient Data	Insufficient Data

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Increase in economic activity	POSITIVE IMPACT	POSITIVE IMPACT	POSITIVE IMPACT	The Water Corporation / Alliance to consider giving priority to employment and businesses in the immediate and local study areas. Provide on the job training or traineeships where possible.	Monitor number of people and businesses working with the SSDP Alliance. Monitor the fair implementation of prioritising employment and businesses for the immediate and local study areas.	POSITIVE IMPACT	POSITIVE IMPACT	POSITIVE IMPACT
Increase in cost of labour for industries and businesses in the region	Insufficient Data	Insufficient Data	Insufficient Data	Consider undertaking an economic assessment. SSDP Alliance to investigate employing unemployed people in the immediate and local study area.	Consult with industries and businesses in the region to monitor any impacts on the cost of labour.	Insufficient Data	Insufficient Data	Insufficient Data
Disruption to businesses during construction			Impact not identified for this study area	Coordinate construction process and timing with affected landowners and business owners. Provide communication channels for businesses to be able to ask questions or discuss issues or concerns. Provide fair compensation for any losses incurred. Inform stakeholders about construction progress and impacts in a timely manner.	Monitor the complaints register. Work with the SAG to identify unexpected impacts and additional mitigation measures. Evaluate questions, issues or concerns raised and the actions taken and identify opportunities for improvement.	No Impact		Impact not identified for this study area
Unequal distribution of costs and benefits of the project				Develop a local / regional benefits 'package' in consultation with stakeholders and the community.	Establish a SAG to work with the Corporation in developing local / regional benefits.			

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Increased traffic in the area causing delays and increasing risk for local communities and commuters	Insufficient Data		Insufficient Data	Implement traffic management measures in order to warn commuters of any changed road conditions, risks and alternative routes. Provide transport for the workforce in order to avoid large increases in traffic in the area. Consult with the SAGs and affected groups in the immediate and local study areas to identify / mitigate any additional traffic impacts/risks potentially identified.	Monitor the number, type, and consequence of traffic accidents and involvement of SSDP Alliance employees and develop strategies for reducing incidences.	Insufficient Data		Insufficient Data
Impacts from expanding the plant to 100 GL/yr			Impact not identified for this study area	Inform communities and stakeholders well in advance about timing and activities that would need to be undertaken for the expansion of the plant.	Monitor community and stakeholder concerns about the positive and negative effects of the expansion. Reconvene a SAG to work together with the Water Corporation in order to improve the social performance of the expansion.			Impact not identified for this study area
Reduced tourism to Binningup and Myalup beaches				Raise awareness about the importance of the project. Ensure there is appropriate signage to inform tourists of the location of impact and of timeframes.	Monitor the number of visitors to the beaches before, during and after construction.	No Impact	No Impact	No Impact

Table 2 Impact Management Strategies and Residual Significance: Operation Stage

Social Impact	Significance w/out Management			Management Strategies		Residual Significance		
	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Increased provision and security of water supply to the IWSS	POSITIVE IMPACT	POSITIVE IMPACT	POSITIVE IMPACT	N/A	N/A	POSITIVE IMPACT	POSITIVE IMPACT	POSITIVE IMPACT
Communities living with uncertainty	Addressed in Environmental Impact Assessment	Addressed in Environmental Impact Assessment	Addressed in Environmental Impact Assessment	Provide a permanent local contact person to provide information to and obtain feedback from the community throughout the operation of the project. Develop a Commitments Register that records the commitments made to stakeholders and the community. This register should be a public document that outlines the response and progress to each of the commitments made. Provide clear information about the project specifically related to social, environmental and economic impacts.	Develop and maintain a Communication Strategy designed to provide communication channels between the Water Corporation and the community. Evaluate the implementation of this strategy during the project execution. Reconvene a SAG to obtain feedback about the plant's operations and its impact on the community and stakeholders.	Addressed in Environmental Impact Assessment	Addressed in Environmental Impact Assessment	Addressed in Environmental Impact Assessment

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Change in ocean-based recreational opportunities because of environmental impacts of brine release				Make all findings of the environmental monitoring studies available to stakeholders and communities. Assist the community in understanding the environmental studies by preparing simple information materials.	Continuously monitor the environmental impacts as per the Public Environmental Review.	No impact	No impact	No impact
Impact on community character and amenity			No impact	Conduct open days and tours to educate communities about the project. Implement the recommendations in the Operational Environmental Management Plan (CEMP) to manage dust, traffic and noise. Induction kit for all construction employees that introduces them to the communities where they will be working to assist with increasing understanding of the Immediate and Local Study Areas. Develop a code of conduct for the construction workforce. Collaborate with key community groups to organise a series of community events which encourage social interaction between residents and employees.	Obtain feedback from the SAGs regarding the status of the mitigation measures implemented. Monitor the implementation of the code of conduct and employee induction process.			No impact

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impact of the plant on the visual amenity		Impact not identified for this study area	Impact not identified for this study area	Encourage a plant design that blends with the local environment. Continue to undertake visual impact assessments of the plant as the design is finalised and communicate this to stakeholders and the community. Plant mature trees for screening to reduce the time required for vegetation screening and minimise visual impact.	Obtain feedback from the SAG regarding the status of the mitigation measures implemented.		Impact not identified for this study area	Impact not identified for this study area
Impact of the summit tanks on the visual amenity	Impact not identified for this study area			Landscape for screening to minimise visual impact.	Obtain feedback from the SAG regarding the status of the mitigation measures implemented.	Impact not identified for this study area		
Increase in economic activity				The Water Corporation, through contractual arrangement, should request the successful SSDP Alliance to give priority to employment and businesses in the immediate and local study areas and provide on-the-job training or traineeships where possible.	Monitor the fair implementation of prioritising employment and businesses in the immediate and local study areas.			

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Public safety and risks as a result of chemical and fuel spillage/leaks	Impact dealt with in the EIA and Risk Assessment	Impact dealt with in the EIA and Risk Assessment	Impact dealt with in the EIA and Risk Assessment	Undertake an assessment of public safety and risks and implement public safety and risk management procedures. Implement safety procedures to ensure the safe management and storage of chemicals and fuel Increase community awareness of the chemicals used in the desalination process, the risks and the safety and emergency procedures in place.	Provide channels for communities and stakeholder to be able to report any public safety and risks questions, issues or concerns. Evaluate incidences of public safety and risks, responses to incidences and identify ways of enhancing procedures.	Impact dealt with in the EIA and Risk Assessment	Impact dealt with in the EIA and Risk Assessment	Impact dealt with in the EIA and Risk Assessment
Risk of terrorist attack because of the presence of infrastructure of State significance	Impact dealt with in Risk Assessment	Impact dealt with in Risk Assessment	Impact dealt with in Risk Assessment	Develop anti-terrorism response plan.	Test the anti-terrorism response plan to ensure its effectiveness.	Impact dealt with in Risk Assessment	Impact dealt with in Risk Assessment	Impact dealt with in Risk Assessment
Increased traffic in the area increasing risk for local communities and commuters				Undertake a traffic assessment of the safety of the intersection between Taranto Road and the Old Coast Road and liaise with Main Roads WA and Shire of Harvey to improve the safety of this intersection if required. Implement a traffic management plan.	Monitor the number, nature and involvement of SSDP employees in traffic incidents near the plant and develop appropriate response.	No Impact	No Impact	No Impact

1. Introduction

Average water flow into Perth's metropolitan dams has dropped significantly while increasing growth across the State has meant demand for water continues to increase. In response to these changing conditions, the Water Corporation is developing a range of alternatives to reduce water consumption and increase supply.[8]

Desalination is a climate independent water source and is a key part of the plan to secure water supply. On 15 May 2007, WA Premier, Alan Carpenter, announced that a new desalination plant would be built at a site north of Binningup: the Southern Seawater Desalination Project (SSDP or the project). The SSDP will supply water to the Perth metropolitan area and Mandurah via the Integrated Water Supply Scheme (IWSS). It will be the next major water source for the IWSS.

"The Integrated Water Supply Scheme (IWSS) supplies water to 1.5 million of the 1.9 million people living in Western Australia. The Scheme's service area takes in towns in the South West, metropolitan Perth and, through the Goldfields Pipeline from Mundaring Weir to towns and farmlands in the Central Wheatbelt out to Kalgoorlie Boulder. The Scheme is supplied from multiple groundwater and surface (dam) water sources located over a wide geographic area including the Perth Seawater Desalination Plant at Kwinana.[9]"

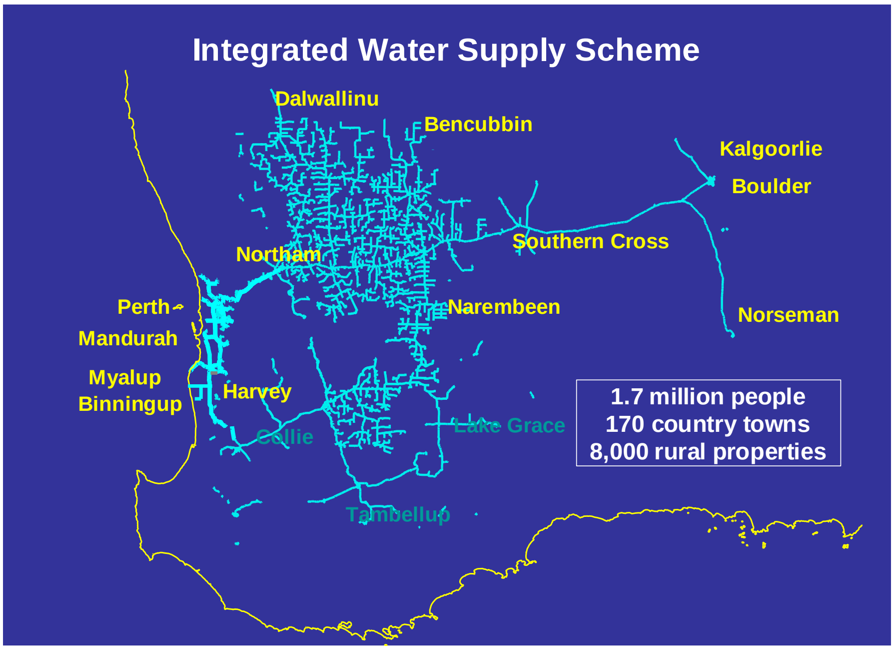


Figure 1: IWSS Network

The SSDP will add to the overall water supply scheme which helps to secure water for all system users.

[8] Water Corporation (2005) *Security Through Diversity* strategy [on line]. Accessed 01 October 2007 <www.watercorporation.com.au/P/publications_diversity.cfm>

[9] Water Corporation (April, 2005). Integrated Water Supply Scheme Source Development Plan 2005 - 2050: An Overview. Perth, Western Australia.

The Water Corporation has engaged consultants to undertake several studies to assist with project design. As part of these studies, the Water Corporation has engaged GHD to undertake a voluntary (i.e. not required for project approval) Social Impact Assessment (SIA).

Social Impact Assessment is a "systematic analysis in advance of impacts on the day-to-day quality of life of persons and communities whose environment is affected by a proposed plan, program, project or policy change"[10] (Burdge, 2004: 2). The SIA for the SSDP also identifies opportunities for mitigating the negative impacts, enhancing the positive impacts and monitoring the mitigation of impacts.

1.1 SIA Objectives

The purpose of the SIA is threefold:

1. To identify and assess how the construction and operation of the desalination project will change the lives of the community directly and indirectly affected by the Project;
2. To provide a list of likely social impacts and determine those that are significant; and
3. To identify mitigation, enhancement and monitoring measures to minimise the negative effects of the project and maximise positive impacts.

1.2 Project Description

The SSDP includes:

1. A 50 GL/yr desalination plant with the potential to upgrade to 100 GL/yr;
2. Offshore pipelines (to carry seawater from the ocean into the plant and return the brine to the ocean);
3. A 30 km below ground onshore pipeline to carry the water from the desalination plant to water tank/s to be built north east of Harvey; and
4. Up to four 32 ML water tanks (or 'summit tanks') and a 20-50 ML sump to be built north east of Harvey.

The project is depicted in Figure 2: Location of the SSDP, and each component is explained in more detail below.

[10] Burdge (2004) *A Community Guide to Social Impact Assessment*. 3rd Edition. Social Ecology Press.

Desalination plant

- A 50 GL / yr plant with the potential to upgrade to 100 GL / yr in the future if required. All marine works and underground on site works will be built to cater for 100 GL / yr to minimise social and environmental impact.
- The desalination plant site consists of 84 hectares on Lots 32, 33 and Part Lot 8, Taranto Road, Binningup.
- The site contains a wastewater treatment plant, which will remain on site alongside the desalination plant. A 500 metre wastewater buffer is in place around the existing wastewater treatment plant. This buffer falls just outside the property boundary at some points. The desalination plant will require a 250-metre chlorination buffer which would fall within the site boundary.
- A construction workforce of between 250 – 500 will be required for the construction of the plant. This will reduce to approximately 20 for the operation of the plant.
- A workforce camp may be required to house the construction workforce. At this stage no site has been chosen for this camp.
- The traffic route associated with the construction and operation of the plant has not yet been determined. It is estimated that the construction period will see an average of 20 truck movements per day. Car movements during construction could be high (approximate 250), but this depends on the location of the workforce camp and the means by which they are transported to the site (for example if transported by bus the traffic movements would be significantly reduced). It is estimated that during operation of the plant the number of truck and car movements will significantly decrease, with an average of 1 truck movement per day, and 20 car movements per day.
- The chemicals use at the desalination plant will be confirmed once the design and process have been finalised in late 2008. It is unlikely that chemicals will be used during construction of the plant, except for small quantities if a pilot plant is established. Chemicals used during the operation may be similar to those used at the Perth Seawater Desalination Plant, in Kwinana. See Appendix B for a list of those chemicals. The transportation of chemicals is covered under the Dangerous Goods (Transport) Act 1998 (WA). In addition, Water Corporation will finalise an Emergency Response Plan to prevent and manage any potential incidents.
- A 132 kV transmission line will be required to power the SSDP. The route for the transmission line will be determined by Western Power.
- Construction of the 50 GL/yr plant is expected between 2009 – 2011 and involves the following stages:

Stage		**Approximate Duration**
1	Clearing the area required on the site (vegetation clearance, level areas)	2 months
2	Earthworks (excavation, roads, trenches)	4 months
3	Civil works (pouring concrete, erecting buildings)	12 months

4	Marine works (installation of marine pipelines and temporary structures such as jetties if required)	12 months
5	Mechanical installation (installation of plant and equipment, typically pumps, tanks)	6 months
6	Electrical installation (installation of transformers, switchyard, lighting)	6 months
7	Inspection and testing	6 - 9 months
8	Commissioning	Parallel with inspection and testing
9	Decommissioning *The plant is a permanent installation built for 100 year life. The Water Corporation has advised that the decision as to whether the plant would be decommissioned, upgraded or maintained will be made in the future.*	
Note: These timeframes will be further refined in consultation with the Alliance partner who will be chosen in late 2008.		

Offshore pipelines

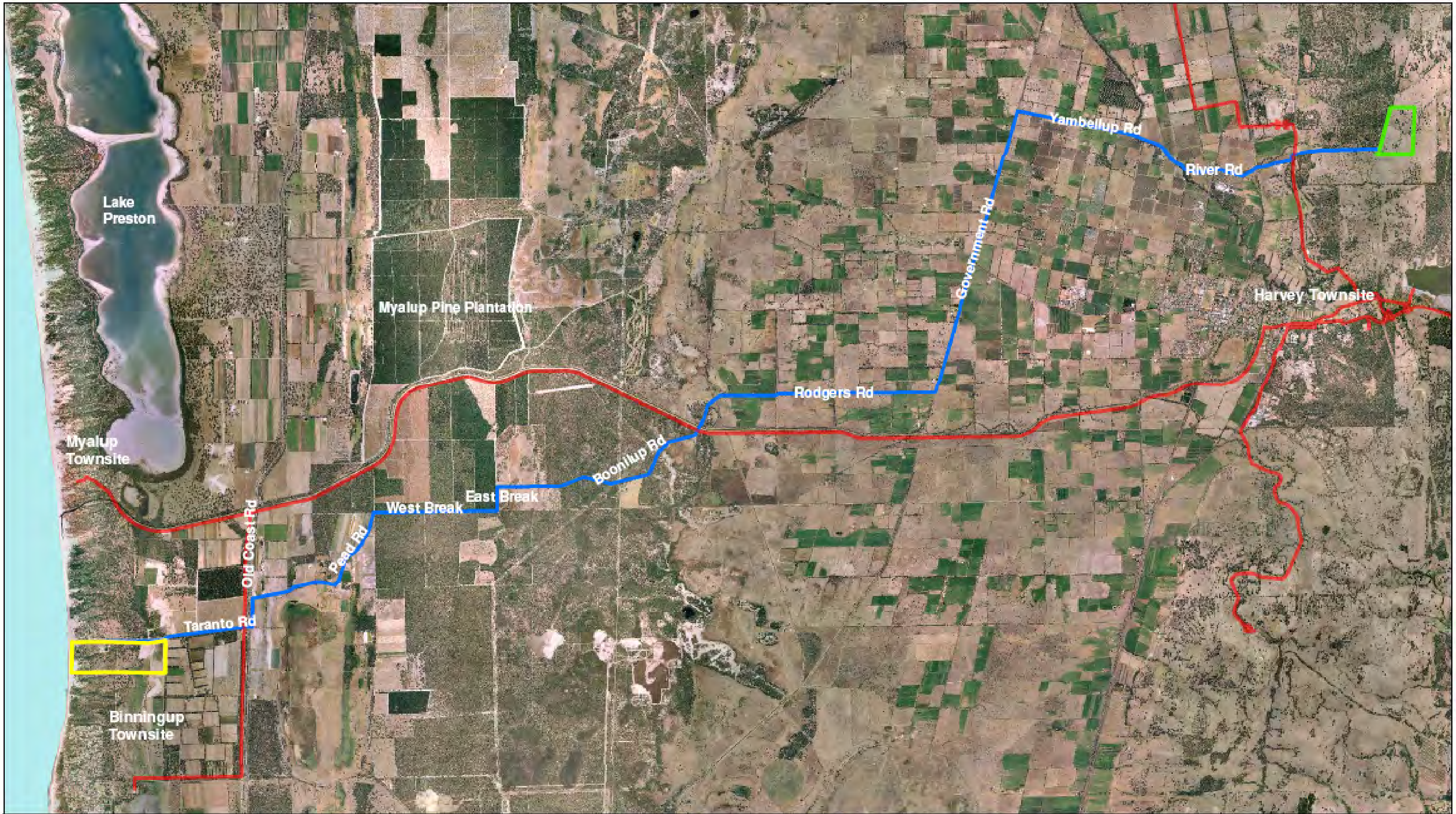
- A pipeline from 400 – 600 metres offshore will be built to carry the seawater from the ocean to the desalination plant.
- A pipeline to 600 - 1100 metres offshore will be built to carry the brine from the desalination plant to the ocean. Special diffusers are built into this pipeline to facilitate mixing back into the ocean environment.
- The pipelines in the area around the plant will not be visible as they will be buried underground. Any dunes that are disturbed during the construction process will be restored.
- Approximately 400 metres of beach immediately adjacent to the desalination plant site may need to be closed during construction, for a maximum of 18 months. This is to ensure public safety during construction of the offshore pipelines. The exact timeframes depend on the construction method chosen by the Alliance.
- A marine construction exclusion zone will be in place during construction and consists of an area to 1000 metres (north/south) and 1250 metres (east/west).

Onshore pipeline

- A 30km below ground onshore pipeline will be built from the desalination plant to the new water tanks (see below), north east of Harvey.
- The design life of the pipeline is estimated at 110 years. The pipe is made steel which is the highest grade of pipe available.
- Once buried the pipeline will remain undisturbed for a long period of time, unless repairs are needed. Inspections will consist of Water Corporation staff travelling along the route every few years.
- The pipeline is constructed in sections, estimated at a rate of 100 metres of pipeline per day, depending on the terrain.
- Around 26 properties will be directly impacted by the pipeline (pipeline being built on their land) and 72 properties indirectly impacted (pipeline being built on their road frontage).
- Landowners who are directly impacted will be paid compensation. There are two forms of compensation for landowners. The first is compensation for damages occurring during construction (for example loss of crops or damage to irrigation system). The second is compensation for taking an easement. For both forms of compensation, the Water Corporation uses independent assessors and, upon request, will pay for the landowner to obtain an independent assessment by an assessor of their choice. The assessor remains in contact with the landowner during and post construction. There is no standard amount of compensation, it is determined on a case by case basis.
- Figure 4 illustrates a typical excavation process for a pipeline in open ground. The images in Figure 5 are examples of the pipeline construction before, during and after construction.

Harvey Summit Tanks

- An important design requirement of the project is that water from the desalination plant is fed into a summit tank prior to it being fed into the IWSS. A further non-negotiable design requirement is that each stage of the desalination plant requires at least one 32 ML storage tank situated at a level of 145 mAHD. Another design stipulation is that the water from the tanks gravity feed into the IWSS. Low visibility from surrounding areas is also an important factor. These factors limited the number of choices of where to locate the tanks. The preferred site at Lot 544, Honeymoon Road, Harvey, was identified as fulfilling these requirements and negotiations with the landowner are continuing.
- There will up to four 32ML tanks built. One tank will initially be built for the 50 GL / yr plant.
- It will take approximately nine months to build each tank including access roads.
- Figure 6 is a photo of a 25 ML tank, which is a comparable size to the 32 ML water tank/s being built for the SSDP.



0 0.5 1 2 3 4 5 Kilometers

Exisiting IWSS Infrastructure

Proposed Seawater Desalination Plant Site

Preferred Water Transfer Pipeline Route

Proposed Water Storage Facility Site

N
W E
S

Figure 2

WATER CORPORATION

Proposed Southern Seawater Desalination Plant and Associated Infrastructure

Date: 19/11/2007 Created By: FF Revision: 0
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THIS DOCUMENT MAY ONLY BE USED FOR THE PURPOSE FOR WHICH IT WAS CREATED.
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The scope of the SIA extends to all four of the project components. Other impacts from supporting infrastructure, such as powerlines and workforce camps will be considered although these are not part of the scope of the environmental approval submitted to the EPA by the Water Corporation. The proponents for these components will be Western Power and an Alliance respectively. Social impacts will be identified and assessed for the immediate, local and regional study areas and for the Project's construction and operation.

The key process in desalination is reverse osmosis. This process uses pressure to push water through a semi-permeable membrane. Fresh water passes through the membrane while salts and other impurities are retained and discharged back into the ocean. Refer to Figure 3.

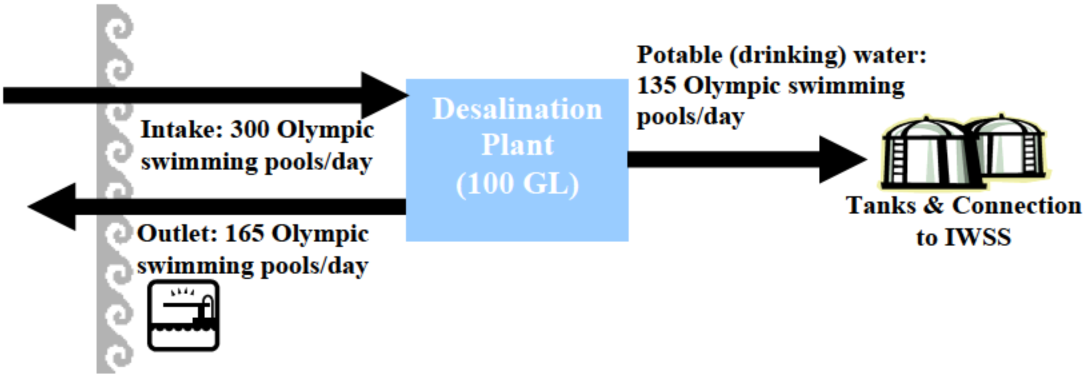


Figure 3: Process for the SSDP at 100 GL/yr capacity[11]

1.3 Project Inputs

The following project inputs need to be considered in the SIA.

Visual Assessment

The Water Corporation undertook a visual impact assessment of the operating desalination plant on the surrounding area. A copy of the full report, Southern Seawater Desalination Project, Visual Impact Assessment, March 2008, can be viewed as part of the project's Public Environmental Review Document.

As the desalination plant's design will not be finalised until late 2008, a 3D model was developed as the basis of the assessment, on the following assumptions:

- The desalination plant construction area will be cleared and levelled to 4 metres above sea level;
- A man-made and vegetated berm (or bund) will be built along the southern and eastern boundary of Part Lot 8. The purpose of this berm is to act as a visual screen between the site and existing and future southern / eastern properties and Binningup townsite;
- The construction area was set at the following block heights:

[11] Adapted from page 8, Water Corporation (2007) *Second Seawater Desalination Plant: Site alternatives and considerations* [on line]. Accessed on 20 November 2007 <www.watercorporation.com.au/_files/Site%20Alternatives%20Report,%20July%202007.pdf >

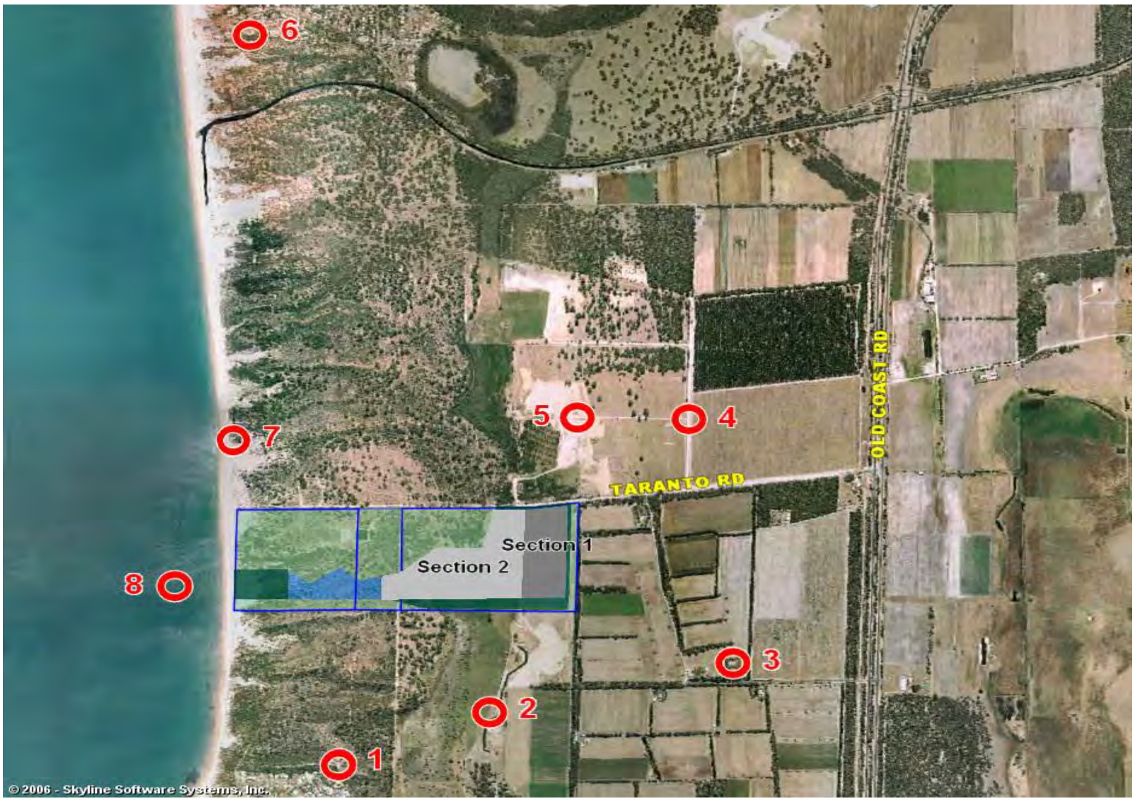
- Section 1 (eastern section of Part Lot 8) set at 8 metres;
- Section 2 (remainder of Part Lot 8 and a small section of Lot 32) set at 14 metres. Section 2 also included three indicative locations for a lime storage tower set at 18 metres; and
- The remainder of Lot 32 and the entire Lot 33 will consist of underground pipelines and a below ground seawater pump station.

These block heights depict a 'worse-case-scenario' of the construction area being covered in buildings at the maximum height, which the Corporation advises is highly unlikely.

The image below illustrates these assumptions further.

The visual impact assessment involved a 'sight line analysis' which determined the visual impact of the plant at certain locations surrounding the site. The sight line points are illustrated in the image below.

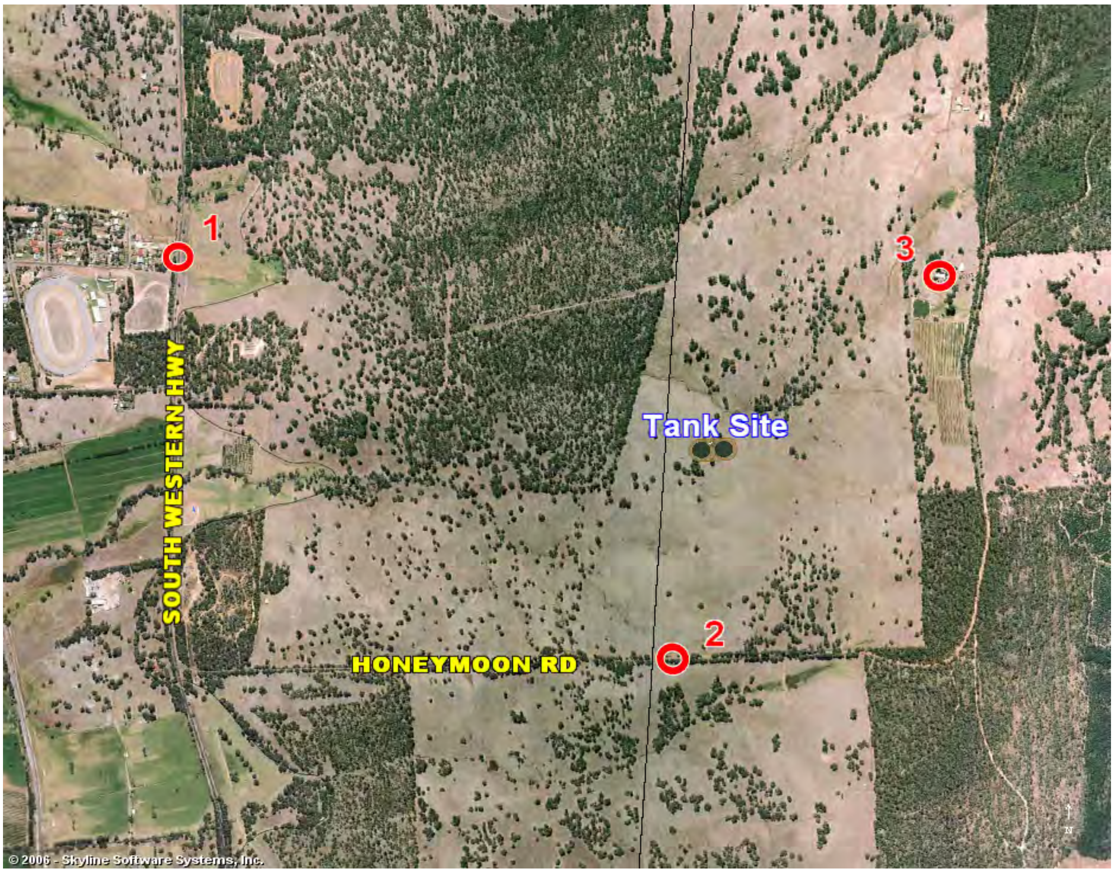
The report concluded that from all nine points, the visual impact was minimal, with only the lime storage towers being visible from a small number of locations, with the remainder of the block heights being screen by the terrain, existing vegetation and/or berm.



Desalination Plant Visual Impact Assessment Sight Line Points

The Water Corporation undertook a visual impact assessment of the Harvey Summit Tank/s on the surrounding area. A copy of the full report, Southern Seawater Desalination Project, Visual Impact Assessment, March 2008, can be viewed as part of the project's Public Environmental Review Document.

The visual impact assessment of the Harvey Summit Tank/s included a 'sight line analysis' from three points surrounding the site, as depicted in the image below.



Harvey Summit Tank Visual Impact Assessment Sight Line Points

The report concluded that from the three points surrounding the proposed site (still under negotiation with the landowner); the visual impact of the tanks was minimal, as they are effectively screened by the terrain and existing vegetation.

Environmental Noise Assessment

The Water Corporation commissioned Herring Storer Acoustics to develop an acoustic model to predict noise emissions from the desalination plant. The assessment was based on a 100GL / year plant. A copy of the full report, Environmental Noise Assessment, March 2008, can be viewed as part of the project's Public Environmental Review Document.

The report concluded that the noise emissions from the desalination plant will have negligible effect on noise levels at existing residential premises. It also recommends that the selected construction contractor prepare a Noise Management Plant for the project, to ensure that construction noise issues are considered.

Workforce Accommodation

A workforce camp may need to be built to house construction workers. The workforce camp options were still being developed at the time of preparing the SIA. For the purpose of this assessment, two assumptions have been made. The first is that the camp will be located in the immediate or local study area, and the second is that it is located in the regional study area.

If a workforce camp is built, it is likely that workers will be transported to the site by bus to minimise traffic and related impacts on local roads, however this will be confirmed at a later date.

Workforce Characteristics

Based on the experience of the Perth Seawater Desalination Plant, there will be anywhere between 250 to 500 workers during the construction of the SSDP. Approximately 70% of the workforce will be skilled labour (tradesmen) including electricians, welders, fitters, scaffolders, civil construction, concreters, and heavy machinery operators. The remaining 30% will be unskilled workers. During operations of the SSDP, there will be approximately 20 workers.

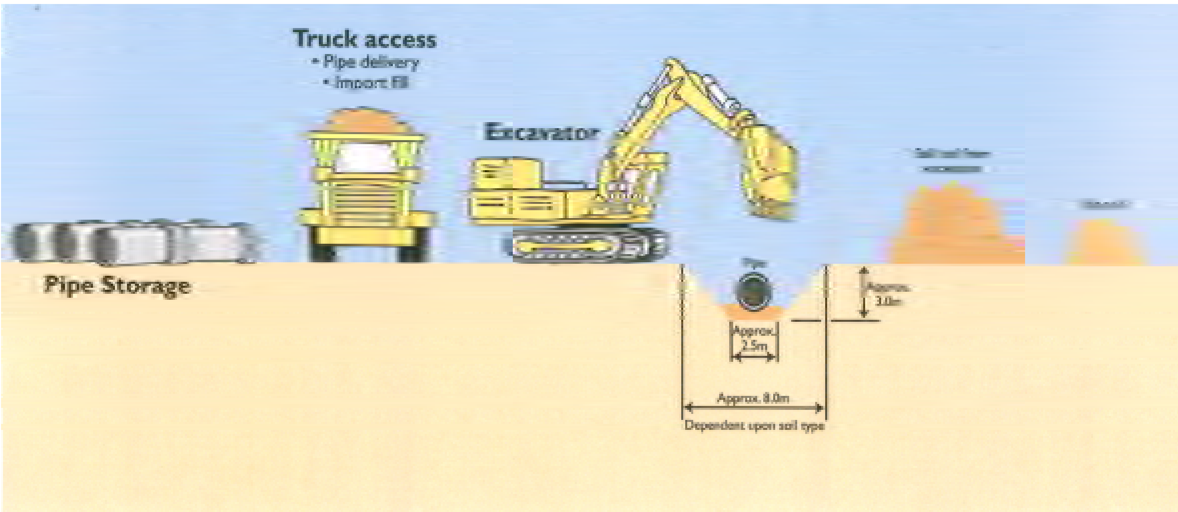


Figure 4: Typical Pipeline Excavation in Open Ground

Before construction During construction After construction

Figure 5: Pictures before, during and after construction of a section of pipeline (Water Corporation 2007)


Figure 6: Example of 25 ML Tank (Summit Tank)

2. Methodology

The SIA methodology is outlined at Figure 7 and includes:

Phase One – Social Impact Assessment

Stage 1 **Project Description and Scoping** – information about the project including its purpose, scope, history and construction and operation information. Conducting a scoping exercise to identify potential issues and concerns.

Stage 2 **Community Profile** – description of the potentially affected communities including demographics, the history and background, the community services and facilities available and the community values and use of the study area.

Stage 3 **SIA Stakeholder Input –** contribution from key stakeholders and community members in the process of identifying social impacts and identifying mitigation and enhancement measures.

Stage 4 **Identifying, assessment and ranking the Social Impact Assessment** – analysis of the community profile and project information to identify and rank social impacts.

Stage 5 **Mitigation, enhancement and monitoring measures** – strategies for mitigating impacts to enhance positive and minimise negative consequences of the Project.

Stage 6 **Production of SIA Report**

Phase Two – Social Impact Management

Following this SIA, a management plan will be developed in consultation with the Water Corporation and Alliance partners to ensure the effective mitigation, management, monitoring and evaluation of social impacts. This part of the project is referred to as Phase Two of the Social Impact Assessment.

The social impacts assessment process is outlined at Figure 7.

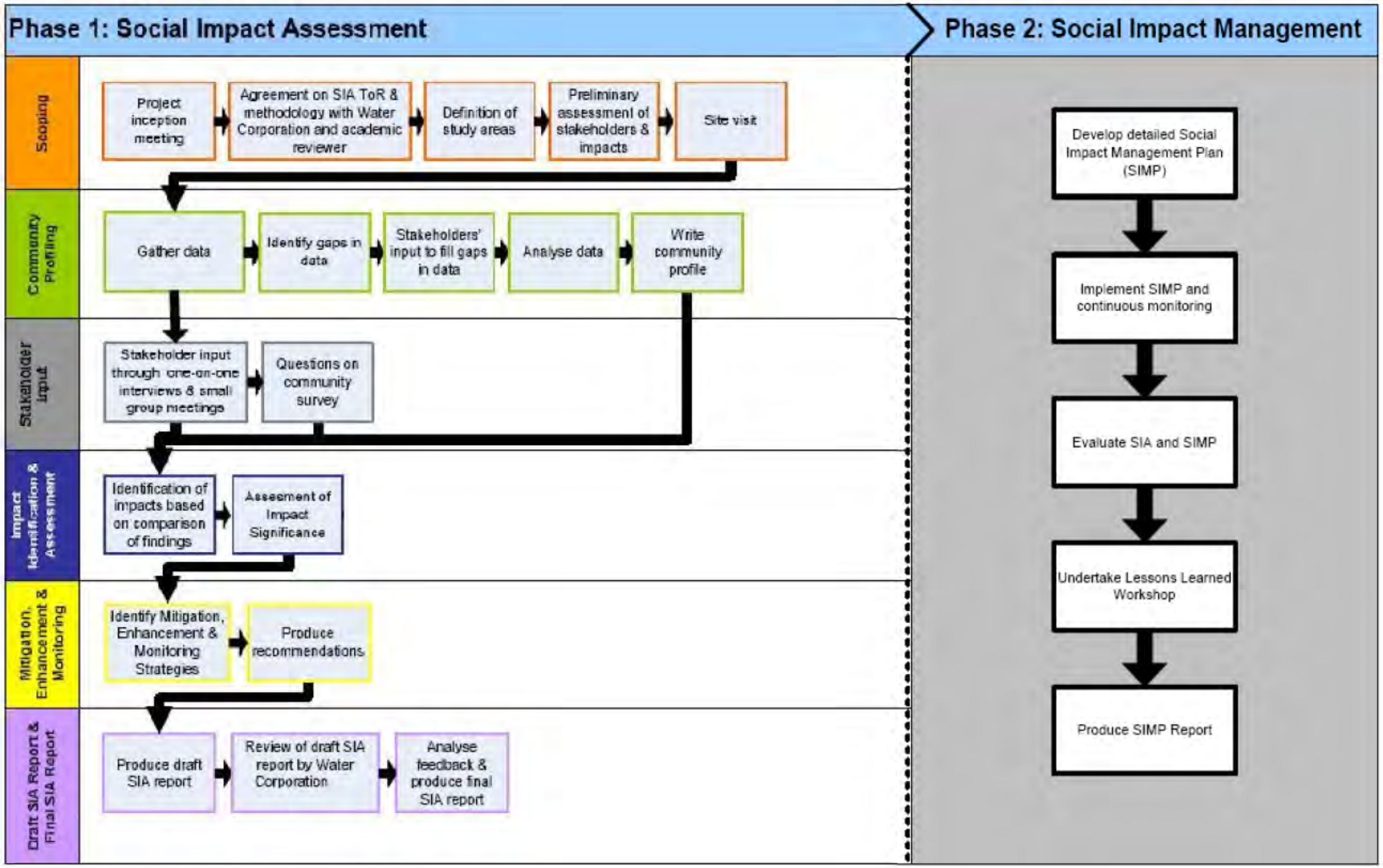
Study Limitations

The reader should consider the following limitations of this SIA:

- The identification of social impacts relies heavily on the availability of data including social research, case studies, project information, relevant studies and past experience. Given that this report was prepared in parallel to other studies, it was not possible to obtain all the necessary information to comprehensively assess all the potential social impacts. Where there has been some relevant data provided, the consultants have made some assumptions about the potential social impacts based on the available information and their experience with similar projects. Where sufficient information was not obtainable about potential social impacts, no assessment has been made. These impacts should be reviewed by Water Corporation as more information becomes available to ensure that these are assessed, monitored and evaluated. It is also recommended that the findings and recommendations of this report be monitored using a Social Impact Management Plan (SIMP) to ensure that new information about impacts is considered in gaining an understanding of the impact, its significance and the management actions required.

- While the scale for ranking the significance of social impacts (presented in Table 6) reduces the complexity of significance assessment by having less numbers of levels of significance, it does however mean that small reductions of significance brought about by implementing mitigation measures might not change significance levels.

Figure 7: SIA methodology flowchart



2.1 Social Impact Assessment (Phase One)

2.1.1 Project Description and Scoping

To gain an understanding of the project, information about the project including its purpose, scope, history and construction and operation was collected. The information was used to conduct a scoping exercise. Scoping is a preliminary investigation of the potential social impacts that may occur as a result of the SSDP. It identifies potential issues and concerns identified in secondary data and preliminary consultations with key stakeholders and the community to focus the Social Impact Assessment on these key variables and their management. Further, a brainstorming of the flow and chain of effects was undertaken by GHD to understand the potential impacts from the construction and operation of the SSDP (see Appendix C).

Site Visit

A site visit was conducted to observe the services, housing and recreation facilities in the potentially affected areas (Binningup, Myalup, Harvey, proposed pipeline route between Wellesley and Wokalup) and identify the following:

- Educational facilities in the area (Binningup, Myalup, Harvey, proposed pipeline route between Wellesley and Wokalup);
- Leisure and recreational facilities;
- Community services and facilities;
- Available transportation;
- Community organisations;
- Features of the study area; and
- Health and related services/facilities.

A site visit schedule was used to guide the observations (Appendix D). The results of the site visit are discussed throughout the report.

Terms of Reference

Terms of Reference are the identified variables that will be investigated during the assessment to be able to assess the change in the community that will be created by the implementation of the project. GHD drafted a list of potential variables to be evaluated during the assessment. The detailed Terms of Reference (ToR) for the SIA can be found in Appendix E.

Study Area

In determining the immediate study area, the SIA's objectives were to define the area that may experience most of the social impacts and opportunities and for which socio-demographic information is available. The SIA has defined four study areas: immediate, local, regional and state.

In the case of the SSDP and based on the scoping of the SIA, the immediate study area was the towns of Binningup and Myalup. Similarly, in determining the local study area, the SIA's objectives were to define an area that would include all of the project components (pipelines, plant and tanks) and the surrounding areas in which most of the impacts may be experienced and for which information was available. The ABS collection districts and state suburbs surrounding all of the project components resulted in the same local study area shown in Figure 8.

The SIA also defined a regional study area and a state study area. The regional study area was defined as the region expected to encompass most of the social impacts and opportunities. This study area was defined using local government areas and is comprised of the City of Bunbury and the Shire of Harvey. The state study area is Western Australia.

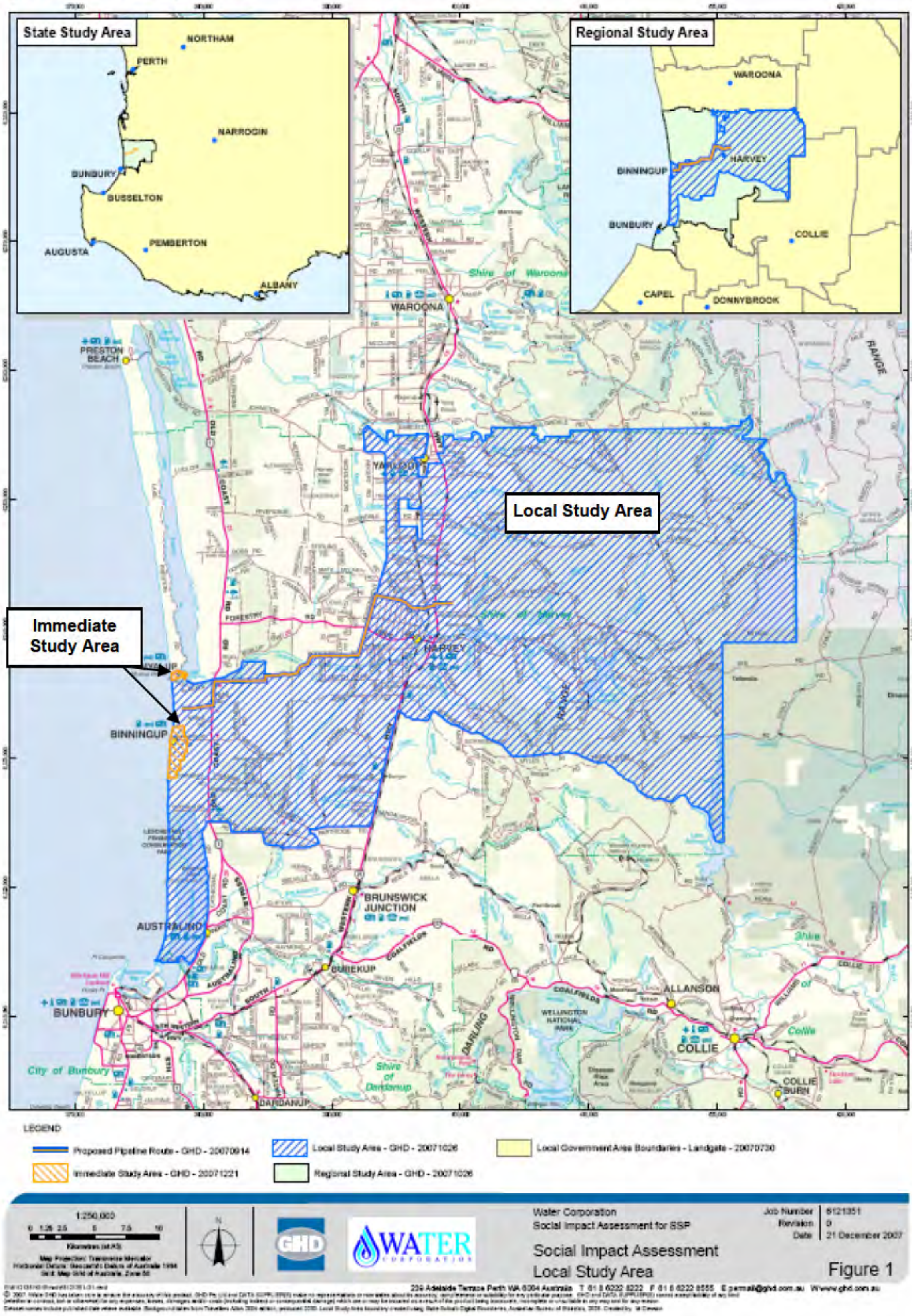
The study areas are outlined in Table 3 and shown in Figure 8.

Table 3 SIA Study Areas

Immediate Study Area	This study area is comprised of the following State Suburbs: • Myalup (SSC54976); and • Binningup (SSC53206).
Local Study Area	This study area is comprised of the following State Suburbs: • Myalup (SSC54976); • Binningup (SSC53206); • Wellesley (SSC55896); • Wokalup (SSC56021); and • Harvey (SSC54081).
Regional Study Area	This study area is comprised of the following Local Government Areas: • Shire of Harvey (LGA53990); and • City of Bunbury (LGA51190).
State Study Area	This study area is comprised of the State of Western Australia.

Impacts will be identified, discussed and assessed for the immediate, local and regional study areas. Impacts at the state level have not been assessed in this SIA because the effects of the project are expected to be contained within the regional area.

Figure 8: SIA Study Areas



2.1.2 Community Profile

The community profile is a description of the communities in the study areas including demographics, the history and background, the community services and facilities available and the community values and use of the study area. The profile provides a snapshot of the community in order to facilitate understanding of how and to what extent it may be impacted by the project.

The community profile includes:

- History of the community
- Description and use of the study area
- Social demographics
- Housing
- Transport and mobility
- Leisure and recreation
- Tourism
- Community identity and cohesion
- Community services and facilities
- Future planning and projects
- Health
- Crime and safety
- Economic environment
- Education

A summary of the community profile is outlined in Section 3 and the detailed community profile is at Appendix F.

2.1.3 SIA Stakeholder Input

The SIA for the Southern Seawater Desalination Project was a participatory exercise in which stakeholders and community members within the four study areas were informed and involved during the assessment to provide feedback about their issues and concerns with the project and offer suggestions for enhancing the project. The following stakeholders participated:

- Binningup Community Association
- Binningup Desalination Action Group (BDAG)
- Binningup Real Estate Agent
- Binningup Senior Citizens Association
- Bunbury Regional Chamber of Commerce
- Coastal Green Turf Supplies

- Harvey Beef
- Harvey Community Radio
- Harvey Country Women's Association
- Harvey District Water Sports Association
- Harvey Primary School
- Harvey Primary School
- Harvey Recreational Centre
- Harvey Senior High School
- Harvey Visitors Centre
- Landowners and Residents from Binningup, Myalup and Harvey
- Myalup Community Association
- Shire of Harvey staff
- The Escape Youth Centre / Mulgara Family Centre
- Walking Group – Be Active
- Water Corporation
- Wellesley Land Conservation District Committee

During the scoping stage, a stakeholder assessment was conducted to identify potentially affected and interested stakeholder groups in the study areas. Further investigations were conducted to identify existing stakeholder groups within each community (Appendix G for the Stakeholder List).

Stakeholder Interviews

Stakeholders and community members were contacted by telephone and / or email to arrange a meeting to discuss the SSDP. One-on-one semi-structured interviews and small group discussions were conducted with stakeholders from Binningup, Myalup, Harvey and Australind in October and November 2007. An interview schedule was used to guide the discussions, complemented with information sheets to ensure that the information provide to stakeholders was consistent (Appendix H).

Telephone Survey

Two telephone surveys were conducted by Synovate Research for the Water Corporation (stage 1 on August 2007 - S1 and stage 2 on November 2007 - S2)[12]. The telephone surveys explored the community's level of awareness about the desalination project and obtained feedback about their concerns about the project. A specific question was added to the S2 survey to ask the community what they perceive the impacts of the desalination project will be and any suggestions for improvement.

A census of Binningup, Myalup and the pipeline stakeholders was conducted and a random sample of the Bunbury population was selected using Synovates Oz on Disk database. Survey samples were composed as shown in Table 4.

[12] *Southern Seawater Desalination Project – Community Consultation Report, Synovate (November 2007)*

Table 4 Telephone Survey Sample Size

Area	Stage 1 Sample Size	Stage 2 Sample Size
Binningup	88	94
Myalup	38	40
Bunbury	203	100
Pipeline	N/A	20
Total	**329**	**254**

2.1.4 Identifying, assessing and ranking potential Social Impacts

Identifying and Describing Social Impacts

Potential social impacts have been identified based on a comparison of the implications and results from the following sources:

- SIA stakeholder consultation (refer to Section 4: Stakeholder Input);
- Minutes from previous consultation meetings held by the Water Corporation:
  - Southern Seawater Desalination Plant: Pipeline Investigation Area-Landowner workshop findings, 5 September 2007 (Water Corporation);
  - Attendance at the Water Corporation meeting on the release of the Environmental Scoping Document at the Binningup Water Sports Centre on 03 December 2007;
  - Southern Seawater Desalination Plant: Myalup Community Meeting – 30 May 2007 at the Myalup Community Recreation Centre (Sticky note questions and issues, and questions and answers minutes from the meeting);
  - Southern Seawater Desalination Plant: Binningup Community Meeting – 29 May 2007 at the Binningup Country Club (presentation minutes, sticky note questions and issues, and questions and answers minutes from the meeting);
  - Questions and Answers from the Binningup Desalination Action Group. July 2007.
- Project information and reports:
  - Harvey Coastal Management Plan. August 2006. (Belton-Taylforth Planning and Environmental Consultants and Shire of Harvey.)
  - Summary of Investigations into the Impact of the Perth Seawater Desalination Plant Discharge on Cockburn Sound-final Report. August 2007 (P. Okely et al. from the Centre for Water Research, University of Western Australia)
  - Southern Seawater Desalination Project: Environmental Scoping Document-Draft for Public Comment. November 2007 (Water Corporation);
  - Southern Seawater Desalination Project: Environmental Scoping Document-Public Submissions Received December 2007 (Water Corporation);
  - Southern Seawater Desalination Project: Environmental Scoping Document-Response to Public Submissions December 2007 (Water Corporation);

- Second Seawater Desalination Plant: Site alternatives and Considerations. July 2007 (Water Corporation);
- Southern Seawater Desalination Project: Public Environment Review Fact Sheet. November 2007 (Water Corporation);
- Southern Seawater Desalination Project: Desalination is Part of our Water Future Fact Sheet. November 2007 (Water Corporation);
- The Southern Seawater Desalination Project Pamphlet. 2007 (Water Corporation);
- Southern Seawater Desalination Project: The Environmental Approval Process Fact Sheet. September 2007 (Water Corporation);
- Southern Seawater Desalination Plant: Newsletter August 2007 (Water Corporation);
- Southern Seawater Desalination Plant: Newsletter September 2007 (Water Corporation);
- Southern Seawater Desalination Plant: Newsletter November 2007 (Water Corporation);
- Southern Seawater Desalination Plant: Community Update No 2 Letter by Chris Elliott, Regional Business Manager-South West (Water Corporation);
- Southern Seawater Desalination Project: Environmental Monitoring Fact Sheet. September 2007 (Water Corporation);
- Southern Seawater Desalination Project Website <www.watercorporation.com.au/D/desalination_plant2.cfm> (Water Corporation);
- Southern Seawater Desalination Plant: Comparison of Sites in the Kemerton Industrial Park. August 2007 (Worley Parsons and Zero Harm for the Water Corporation);
- Southern Seawater Desalination Plant - Summit Tanks: Environmental and Social Analysis. August 2007 (GHD Pty Ltd);
- Southern Seawater Desalination Plant – Transfer Main: Environmental and Social Analysis. October 2007 (GHD Pty Ltd);

* Observations made during site visits;
* Telephone survey stage 1 on August 2007 and stage 2 on November 2007 (Synovate Research for the Water Corporation).

Information from these sources was compared to identify potential social impacts. Impacts were then discussed and their significance was assessed by comparing the future situation with and without the project, and without considering mitigation and management measures. Several other studies such as the noise and visual impact assessments were being conducted at the time of the SIA. These findings were not incorporated into this SIA because these studies had not been completed. It is recommended that the Social Impact Management Plan (SIMP) take into account the findings of those studies incomplete at the time of undertaking this SIA.

Assessing and Ranking Social Impacts

The significance of the potential social impacts has been defined using a risk assessment approach in which significance is the product of the likelihood and severity of the potential social impact. *Likelihood* is defined as the possibility of the impact occurring. *Severity* refers to the degree of the consequences of the social impact. The scales for likelihood and severity are described in Table 5.

The ratings for the likelihood and the severity of impacts have been adapted to each individual impact in order to assess the characteristics of each impact. Although the three-point scale has uniform descriptions for each level, the way these scales are applied to each impact is discussed in detail in Section 5.1 and Section 5.2.

Table 5 Measures of Social Impact Significance

Likelihood	Severity
Highly Likely (HL)	High Severity (HS)
Moderately Likely (ML)	Moderate Severity (MS)
Unlikely (UL)	Low Severity (LS)

Likelihood and severity are combined as shown in Table 6 to estimate the significance of the impact. Impacts can be of high, moderate or low significance. The potential to manage the impacts is addressed by assessing the significance of social impacts twice: first without considering the effect of any mitigation measures and then, by assessing the significance of the impact after mitigation measures are implemented. The potential to manage impacts is shown in Table 8 and Table 9.

Table 6 Significance table for social impacts

Likelihood \ Severity	High Severity	Moderate Severity	Low Severity
Highly Likely	High Significance	High Significance	Moderate Significance
Moderately Likely	High Significance	Moderate Significance	Low Significance
Unlikely	Moderate Significance	Moderate Significance	Low Significance

Sections 5.1 and 5.2 show the social impacts that have been identified throughout the assessment for the construction and operation stages of the project and for the immediate (I), local (L) and regional (R) study areas. It also provides a discussion of each of the impacts identified and their level of significance.

2.1.5 Mitigation, enhancement and monitoring measures

This section of the SIA recommends mitigation, enhancement and monitoring measures that could be implemented to manage potential social impacts identified throughout this assessment. Mitigation measures are defined as actions that can be implemented by the SSDP Alliance and which are aimed at avoiding or reducing the effect of negative social impacts. Enhancement measures are those actions aimed at augmenting the effect of positive social impacts. Monitoring measures are recommended in order to inform the implementation of mitigation and enhancement measures and to detect and manage any unforseen social impacts.

Phase two of the social impact assessment involves the development of a detailed Social Impact Management Plan (SIMP) to manage social impacts throughout the design, construction and operation of the SSDP. The SIMP will further investigate the recommendations made in this SIA, in consultation with the SSDP Alliance and relevant stakeholders, to develop a plan for implementing mitigation, enhancement and monitoring measures and ensure that the plan is feasible and effective.

2.1.6 SIA Report

The full SIA is documented in the final SIA report.

3. Community Profile

A community profile is a description of the characteristics of the potentially affected communities in the study area. The profile facilitates a better understanding of the relationship between the potential impacts of the project and those who may be affected (refer to Appendix F for the full community profile). The information in the community profile has primarily been sourced from the Australian Bureau of Statistics Census of Population and Housing 2006. Information obtained from different sources is referenced in text. Unless otherwise specified, the data reported in this section refers to the 2006 calendar year.

3.1 Demographics

The population of the study areas are:

- Immediate Study Area – 1,093
- Local Study Area – 5,093
- Regional Study Area – 49,258
- State Study Area – 1,959,086

The South West Region[13], of which the immediate, local and regional study areas are part of, has the state's largest regional population with a 10-year average annual population growth rate of 2.5% in 2005 (DLGRD 2006). Moreover, the Shire of Harvey has a higher average annual growth rate of 3.0% (DLGRD 2006). The populations in the four study areas are ageing and young people are decreasing. The population growth being experienced by towns potentially affected by the SSDP mean that there will be increasing needs for community and public services to sustain such population growths.

3.2 Education

The immediate study area has a higher proportion of people that have completed Year 12 compared to the local and regional study area. However the state study has the highest proportion of people that have completed Year 12.

The immediate, local and regional study areas tend to have more people that have completed post school education at a Certificate level while the state study area have higher proportions of people that have completed higher degrees including Post Graduate Degree, Bachelors Degree, and Advanced Diploma / Diploma. The most frequent non-school qualifications studied in the immediate, local and regional study areas are engineering and related technologies, management and commerce and education.

The education profile of the immediate study area suggests that it could have the skills that the SSDP would require during construction and operation of the project. However, low unemployment rates and labour force participation (due to undetermined factors for example retirement, caring for children or the elderly) may hinder the opportunities for taking advantage of employment from the project.

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[13] The South West Region is comprised of the City of Bunbury and the shires of Harvey, Collie, Dardanup, Capel, Busselton, Augusta-Margaret River, Nannup, Manjimup, Bridgetown-Greenbushes, Boyup Brook and Donnybrook-Balingup (DLGRD 2006).

3.3 Land and Housing

In 2006, there were 355 dwellings in the immediate study area and 1,739 dwellings in the local study area. The majority of dwellings in these study areas were separate houses. In the regional and state study areas, separate houses were also the predominant dwelling but in lower proportions. The regional and state study areas also had higher proportions of semi-detached dwellings (e.g. terrace or town-house), flats, units and apartments than the local and immediate study areas.

Most dwellings in the immediate, regional and state study areas are being purchased. In the local study area, the most frequent tenure situation is full ownership. The immediate study area has a higher percentage of rented dwellings and a lower percentage of fully owned dwellings in comparison to the other study areas. The median housing loan repayment in the immediate study area was $1,184.3 /month, which is similar to that in the state but higher than that in the local and regional study areas by up to $100 /month. The immediate, regional and state study areas have similar median weekly rents that fluctuate around $170 /week. This is higher than the median weekly rent in the local study area, which was $139 /week.

3.4 Recreation and Tourism

There are 58 registered recreation organisations in the Shire of Harvey. The majority of organisations are located in Harvey and Australind, however only three sport organisations were located in the towns of Binningup and Myalup.

In 2004, the Shire of Harvey had 362 people employed in the tourism industry, which represents 7.9% of the employed population of the Shire, a proportion higher than the state average of 6% (Tourism Western Australia 2006a). It is estimated that the annual average expenditure of domestic and international tourists in the South West Region[14] of Western Australia in 2004 and 2005 was $628,509,290.

The top ten activities of domestic visitors to the South West Region included (in ranked order):

1. Eat out at restaurants
2. Visit friends and relatives
3. General sight seeing
4. Go to the beach (including swimming)
5. Go shopping (pleasure)
6. Visit wineries
7. Pubs, clubs, discos, etc
8. Bushwalking or rainforest walks
9. Visit national parks or State parks
10. Picnics or BBQs

3.5 Community Services and Facilities

The immediate study area, with its population of 1,093 people, has limited recreational and community services and facilities. It has no educational, health or childcare facilities in Binningup and Myalup and these communities have to access services provided in other towns such as Harvey, Australind and

[14] Detailed economic information was not available for small geographic areas. The data for the South West Region, of which the local and regional study areas are a part, was used to obtain an indication of the tourism trends in the areas. The South West region includes the local government areas of: Augusta-Margaret River, Boyup Brook, Bridgetown-Greenbushes, Bunbury, Busselton, Capel, Collie, Dardanup, Donnybrook-Balingup, Harvey, Manjimup, and Nannup (Tourism Western Australia 2006).

Bunbury. Similarly, there is no police station in the immediate study area and police presence occurs when there are activities in town. Generally, Binningup and Myalup are patrolled every two to three days.

If the workforce construction camp were to be located in the immediate study area, attention would have to be given to providing enough recreation and community services for the workforce in order not to strain those services provided locally. Considering that the project would rapidly increase the population in the immediate study area, the SSDP Alliance would have to work with local providers of essential services (e.g. police, hospitals and emergency services) in order to find ways in which to improve the provision of essential services in the immediate study area.

3.6 Transport and Mobility

There is a higher percentage of the population in the immediate and local study areas that travel to work as a driver in a car compared to the regional and state study areas. Additionally, households in the immediate and local study areas tend to have more cars than their counterparts in the regional and state study areas. The importance of private transport and the limited availability of public transport suggest that changes to traffic conditions and road safety issues as a result of the SSDP could potentially impact the immediate study area.

3.7 Community Identity and Cohesion

Anecdotal evidence suggests that Binningup and Myalup have a mix of permanent residents and temporary residents who visit the town on weekends and at holiday time. These towns have fluctuating populations due to the inflow of these temporary residents. The population that usually resides in the immediate and local study areas show significantly higher proportions (27.7% and 24.3% respectively) of people volunteering time to organisations or groups in their communities. This proportion is 18.3% in the regional study area and 16.8% in the state.

3.8 Description and Use of the Study Area

In October 2007, GHD prepared an Environmental and Social Analysis of the pipeline options for the SSDP (Appendix I). This assessment identified the following six land uses crossed by the pipeline:

- **Coastal strip**: the Coastal Strip consists of the area between the SSDP site on Taranto Road and the eastern side of Old Coast Road. The area generally consists of sand dunes and native vegetation to the west, sand quarries further east, and farmland in the vicinity of Old Coast Road.

  Interviews with stakeholders and community members from the Binningup and Myalup communities and site visits to the area indicate that the beach and dunes near the proposed plant site are used for recreational activities. These activities include:

Boating	Surfing
Camping	Swimming
Fishing	Walking
Four wheel driving	General experience of the natural environment
Quad bike and motorbike riding	

- **Market Garden Strip**: the Market Garden Strip consists of the area just to the east of Old Coast Road and to the west of the Vegetated Strip. The eastern boundary of the Market Garden Strip is assumed to be West Break (running south off Forestry Road) and the Runnymede Road reserve (running south from Myalup Road). Land in this area generally consists of small farms and market gardens. Main features in this area where impacts are to be avoided or mitigated include houses, sheds, a roadside business (just south of the Old Coast/Rigg Road intersection) and a communications tower (adjacent the bend in Old Coast Road just north of the Myalup Road intersection).

- **Vegetated Strip**: the Vegetated Strip consists of the area just to the east of West Break/Runnymede Rd road reserve. The strip is bounded to the east by the unmade road reserve running south off Forestry Road just east of Richardson Road. Land in this area mainly consists of blocks of native vegetation and pine plantations.
- **Large Irrigated Paddock Strip**: the Large Irrigated Paddock Strip consists of the area between the road reserve marking the Vegetated Strip eastern boundary and Government Road. Land in this area generally consists of large farming blocks with some irrigated paddocks.
- **Town (& Surrounds) Strip**: the Town (& Surrounds) Strip consists of the area bounded by Government Road to the west and South Western Highway to the east. Land in this area generally consists of smaller irrigated paddocks, orchards, and vineyards as well as the town itself.
- **Scarp Strip**: the Scarp Strip consists of the area between South Western Highway and the proposed tank site (D). The Darling Scarp rises to the east of the highway and this land mainly consists of larger blocks of farmland used for dairies and native vegetation.

3.9 Health

There are no health services offered in the towns of Binningup and Myalup. However, communities in the Shire of Harvey have access to the following health services:

- Harvey Yarloop Health Service (including podiatrist, immunisation and disease control, child development, child health nurse, speech pathologist, school health, dietician, occupational therapist, physiotherapy, continence adviser);
- Ladies Harvey District Hospital Auxiliary;
- Harvey Districts Therapy Centre;
- Two Red Cross facilities;
- St. John Ambulance servicing Australind, Brunswick and Harvey Sub Centre;
- Australind Medical Centre;
- Harvey Medical Centre;
- Wellington Medical Centre;
- Community palliative care services (three HOPE Harvey services, three physiotherapists, two dental health services);
- Two counselling services; and
- Four veterinarians.

Additionally, communities in the Shire of Harvey are located close to the City of Bunbury, which offers a wider variety of health services. This section does not include community groups offering health support services, which are reported in the Community Services and Facilities section.

It is important to conduct a needs assessment of the construction workforce and a gap analysis to ensure that there are sufficient services to cater for the existing communities and the additional workforce.

3.10 Crime and Safety

There are three police stations in the Shire of Harvey located at Yarloop, Harvey and Australind. Myalup is serviced by the Harvey Police Station and Binningup is serviced by the Australind Police Station. These towns are patrolled several times a week and the frequency of patrol depends on the level and nature of activities happening in town, generally these towns are patrolled every two to three days.

Offence rates were lower for the Shire of Harvey than those for the South West Region and state across all offence categories. Moreover, compared to 2003, the number of offences in 2004 in the Shire has decreased for most offence categories. The long term trend between 1996 and 2004 reveals that for most years and offence categories the Shire of Harvey has experienced lower crime rates than those in the South West Region and in the State (Office of Crime Prevention 2004).

The Office of Crime Prevention (2004: 14) indicates that there is international research that associates rapid population growth with higher rates of crime. Although the construction of the SSDP is likely to be composed of a higher proportion of young males, this study has not identified any link between construction camps and higher rates of crime.

3.11 Economic Environment

The immediate and local study areas have lower labour force participation[15] (55.1% and 57.5%) in comparison to the regional (61.5%) and the state (62.3%) study areas. This is also reflected by the percentage of the population not in the labour force, which in the immediate and local study areas is between 4.6% and 0.5% higher than in the other two study areas. However, the unemployment rate based on the total labour force is similar or slightly lower in the local study area (3.8%) in comparison to the regional (4.0%) and state (3.8%) study areas. In the immediate study area, the unemployment rate is 4.7%, which is slightly higher to that of the other three study areas.

The percentages of people in full and part-time employment in the immediate and local study areas were between 1.8% and 3.8% lower than the regional and state study areas. The four most frequent occupations in the immediate, local and regional study areas were labourers, managers, professionals and technicians and trades workers.

The immediate study area has median incomes (individual, family and household) that are higher than those of the local and regional study areas and comparable to those of the state. The local study area has the lowest median household and family incomes of all the four study areas.

3.12 Future Planning

The Greater Bunbury Region Scheme[16] indicates that the future planning for the Binningup townsite is Urban Development with areas along the coast zoned Regional Open Space. The Myalup townsite has a small area zoned Urban Development surrounded by Regional Open Space which covers the Yalgorup

[15] The potential labour force is considered to be the population aged 15 years and over. Labour force participation is the proportion of people aged 15 years and over that are employed or unemployed but looking for employment.

[16] Greater Bunbury Region Scheme. Department for Planning and Infrastructure, October, 2007

National Park and Myalup Beach. The desalination plant site Lots 32 and 33 are zoned Public Purposes which includes Public Utilities. Part Lot 8 is zoned rural and will be re-zoned to Public Purposes as a result of the proposal. The remaining area in between Binningup and Myalup is zoned Rural.

4. Stakeholder Input

Stakeholder input for this SIA was obtained through meetings, interviews with key stakeholder and community members and information from telephone surveys as described in section 2.1.3. This section reports the key issues and concerns as they were expressed by stakeholders and community members during the SIA consultation process. These issues and concerns are further considered and assessed in Section 5 to measure their potential impact.

4.1 Telephone Survey

Survey respondents were asked an open ended question to indicate what they believe the effects of the desalination project will be on their community, their household or themselves during the S2 survey.

Q3E What do you think could be the effects of the Desalination Project on yourself, your household and the community?

The community identified both negative and positive impacts as follows:

Negative Impacts

- 30% of Binningup residents, 25% of Myalup residents and 20% of landowners affected by the pipeline believe that the project will have a 'negative impact on the ocean / coastline' while only 6% of Bunbury residents believe that there will be a negative impact.
- 26% of Binningup residents and 6% of Myalup residents believe that the project will 'create noise pollution'. No Bunbury residents or landowners affected by the pipeline identified noise pollution as a potential impact of the project, however this could be related to their distance from the plant.
- 21% of Binningup residents and 5% of landowners affected by the pipeline believe that the project will have a 'negative environmental impact'.
- 12% of Binningup residents and 2% of Bunbury residents believe that the project will 'devalue housing prices'.
- 8% of Myalup residents, 5% of landowners affected by the pipeline and 2% of Bunbury residents believe that the project will have a 'negative visual impact because it will look bad'.

Positive Impacts

- 42% of Bunbury residents, 15% of landowners affected by the pipeline and 13% of Myalup residents believe that the 'project will provide an extra water source'.

Respondents were asked to indicate their level of concern using closed ended questions about specific impacts including the perceived impact of the project on the marine and coastal environment, the noise generated by the plant, the lighting from the plant, and the impact on the local[17] community during construction.

Q4 I'd like to understand some more about the impact you think the Desalination Project will have on yourself, your household or your community. Firstly, in terms of the__________, do you believe there will be… (READ OUT IMPACT LEVELS)						
	(ROTATE)	No impact	Minimal impact	Some impact	Major impact	Don't know
A	Site on which it will be built	1	2	3	4	8
B	Marine and coastal environment	1	2	3	4	8
C	Noise generated by the Plant	1	2	3	4	8
D	Lighting from the Plant	1	2	3	4	8
E	Local community during construction	1	2	3	4	8

As outlined in Table 7 below, the majority of respondents indicated that they believe there will be *some* or *major* impact for all of the impacts listed.

Table 7 Percentage of people who believe there will be some or major impact

Perceived Impact of the Desalination Project	Binningup		Myalup		Bunbury		Pipeline	
	S1	S2	S1	S2	S1	S2	S1	S2
Site on which it will be built	71%	62%	47%	47%	66%	40%	N/A	35%
Marine and coastal environment	68%	71%	55%	42%	62%	43%	N/A	65%
Noise generated by the Plant	57%	49%	29%	30%	39%	26%	N/A	40%
Lighting from the Plant	51%	35%	34%	22%	49%	24%	N/A	35%
Local community during construction	78%	60%	56%	58%	71%	52%	N/A	60%

4.2 SIA Stakeholder Consultation

The following themes emerged from the feedback obtained during the stakeholder interviews:

4.2.1 Lack of Community Consultation and Trust

The community feel that the sudden announcement of the desalination project and the site selection did not allow for appropriate consultation. They felt shocked by the decision and concerned about the potential impacts of the project on their livelihoods and the environment. The lack of consultation in making the decision prior to the announcement of the SSDP as well as the lack of information provided about the project and the potential impacts once the announcement had been made has left the community feeling angry and distrusting of the Water Corporation.

[17] The word 'local' in the telephone survey was not defined. The question was asked in a way that relied on the respondent's interpretation of the word 'local'. No further information about what was interpreted as local was collected.

The community feel that the site was selected, not because it has the least impacts in comparison to other alternatives, but because it is politically motivated. It feels that the small number of people in the area could not lobby to overturn the decision and that the number of votes in the area would not make an impact at an election. This has made the community feel disempowered in influencing the decision about the desalination project site and concerned about their ability to influence other aspects of the project including design, construction and operation.

4.2.2 Community Identity and Sense of Place

The Binningup and Myalup communities feel that their towns provide a distinct lifestyle. Community members explained that the majority of residents have chosen to live in the area and feel very connected to their community. They rely extensively on volunteers to maintain the environment and run facilities and services in the area. Due to the low police presence and the small number of community members, they actively discuss crime and safety issues and try to resolve them as a community. The community is very connected to the natural environment because it provides a beautiful place to live, creates a natural and tranquil environment, has a range of environmentally significant features including the beach and the Yarloop National Park, attracts marine life and birds, and has a beach that provides several recreational opportunities. It is a small community, geographically secluded from other areas.

The community is concerned that an industrial site and all its associated impacts including noise and light, located in the middle of bushland so close to the ocean, will contrast and conflict with the natural surroundings and therefore detract from their sense of place. The community feel that the desalination plant nestled in the area between two small communities will change the community identity in a negative way.

The community also expressed concerns about the potential workforce that may be living in the area during construction of the project if the workforce camp is in the immediate study area. They believe that, because the workers will be from outside the area and have not chosen to live in the community, they will not appreciate the established community values and way of living. This may create conflict between the community and the potential workforce. Also, because there are limited facilities in the community, there is a perception that there will not be sufficient leisure activities to cater for such a large increase in the population. This may lead to frustrated and dissatisfied construction workers which may lead to antisocial behaviour and greater disconnection with the community in the immediate study area. There is a perception that the workforce will largely be composed of younger men who will be away from their families and who will have very different leisure needs to the existing community, such as wanting to spend their spare time at the pub.

4.2.3 Facilities and Services

The community expressed concerns about the lack of facilities and services available in the immediate study area to service such a large project and influx of workers during construction if the workforce camp is in the immediate study area. There are limited facilities to cater for the leisure requirements of additional people. There is only one country club in Binningup with restricted membership numbers. There are no health or education facilities to cater for the children of the potential workforce population and no police or emergency services to address any potential increases in crime.

It is critical to the community that their needs continue to be serviced to the existing standard and that they do not suffer a decrease in service delivery due to the increasing demands of the construction workforce.

The list of facilities and services in the immediate, local and regional study areas is outlined in the Community Profile at Appendix C Table D4.

4.2.4 Environment

The community is very concerned that there is insufficient information and data about the health and environmental effects of desalination technology because they believe it is relatively new. They believe that the scientific evidence regarding the potential impacts of desalination is not necessarily reliable as the technology has not been around long enough. This lack of faith in the scientific information means that the community remains concerned about the impacts of desalination on their health and the ocean environment.

There are concerns that the nature of the ocean water will change as a result of the desalination process and that it will negatively affect the marine environment including the coral and marine life. There were specific concerns about the impact of desalination on the whales that come very close to the shore. The whales are seen as a significant attraction to the local residents. There are fears that if the marine environment changes, it may become unsuitable for the whales. Additionally, there are concerns that changes to the ocean environment may impact on water based recreational activities such as snorkelling (because the reef may deteriorate due to the desalination process), swimming (because the water may become unsafe for humans) and fishing (because the desalination process may make the water unsafe for fish).

4.2.5 Future Development and Land Values

The community feel that the proposed site and the land surrounding it are likely to be residential development in the future. They are concerned that the presence of a desalination plant will at worst prevent, and at best impede future residential development in the area. The Binningup community is very concerned that the desalination plant will reduce property values, as they believe people will expect to pay less if living near a desalination plant. The Shire of Harvey expressed an interest in supporting opportunities for residential development in the area between Binningup and Myalup.

Property values have not been included in our list of social impacts as it outside the scope of study outlined by the Water Corporation. However it is acknowledged that this is a very real concern to community members, especially those that are relying on their property investment to fund their retirement.

There is a concern that the desalination plant will attract further industrial development in the area. This industrialisation may impact on the look and feel of the area, compromising the community identity as a natural and attractive environment. The community believe that this would lead to reduced tourism in the area, lower property prices and create environmental impacts due to the industrialisation process.

4.2.6 Visual Impact

The community is concerned that the desalination plant will impact the natural landscape of the area because they believe it will be visible from the Binningup town site and / or the beach. They are concerned that the plant's height and footprint will be too large to screen or hide. It is important to the community that the plant is not visible from the Binningup townsite or the beach and that it is appropriately screened with vegetation and other possible engineering solutions to minimise the visual impact of the plant in the area.

Community members were also concerned at the time of the SIA that they did not have enough information about the actual design of the plant, the location of the plant on the site and the visual impact it will have. There are concerns that the desalination plant building in a coastal setting will deter people from visiting or using Binningup Beach.

4.2.7 Noise

The community is concerned that the construction of the plant and plant operations will generate noise that will interrupt the peace and tranquillity of the area. They are also concerned that this noise will interrupt their ability to hear the sounds of the ocean and nature, creating unease and potentially disrupting their ability to rest. Also, these contrasting and intrusive noises may lead to stress and interrupted sleep, potentially causing health problems. The community also mentioned that the Water Corporation made a promise to the local Binningup residents that the noise impacts of the operation of the plant would not be any louder than the sound of the ocean. Although residents would like to believe this, there are concerns that this promise is not realistic or achievable.

4.2.8 Dust

The community mentioned the impact of dust associated with the construction or operation of the desalination plant as a minor concern. The community requested that dust be managed appropriately to prevent impacts on the immediate study area.

4.2.9 Public Safety and Risk

There were several concerns relating to the potential public safety and risk of the plant on the immediate study area. The greatest concern was the risks associated with the transportation and storage of chemicals. The community is concerned that if chemicals are mishandled or an accident occurs it may have devastating and toxic effects on the local environment, marine life and the community.

There are concerns that the chemicals used on the site during the desalination process may have health implications for the immediate study area. There is a lack of information and understanding about the chemicals that will be used and therefore uncertainty about the potential health risks to the immediate study area. There is an existing wastewater treatment plant on the site however no chemicals are used in this process.

Stakeholders are also concerned about the potential risks to the environment and the landowners along the pipeline corridor and surrounding residents associated with disturbing contaminated soils such as acid sulphate soils and soils contaminated with organo-chlorides from pesticides used in previous farming practices.

The community was concerned that the desalination plant could become a terrorist target, as it is a public utility of state significance.

The community requested that the Water Corporation provide emergency response services to deal with any public safety and risk issues. It was also suggested that these services could be extended to the community as a community benefit.

4.2.10 Closure between Binningup and Myalup Beach

Feedback from Binningup residents indicated that Binningup Beach is used for the following recreational purposes:

- Beach and dirt track access for pedestrians walking along the beach and for four wheel drive, quad and motor bike vehicles between Myalup and Binningup (although this has recently been blocked at the Myalup end);
- Fishing and crabbing;
- Boating;
- Swimming;
- Snorkelling; and
- Surfing and surfing lessons.

Residents from the immediate study area are concerned about the temporary closure of a portion of the beach between Binningup and Myalup during construction of the plant and the impact this will have on the recreational activities in the area. Also, there are concerns that the desalination plant operations may contaminate the marine life and environment in the area which would impact on the water based recreational activities in the area especially fishing, crabbing, snorkelling, swimming and surfing. More information is needed about the timing and duration of restricted access during construction.

Binningup Beach receives an influx of visitors and tourists during the summer months to enjoy the tranquil environment and recreational activities. These visitors are mostly semi permanent residents who own a holiday house in the area. There is currently limited accommodation available for tourists in the area as the Binningup Caravan Park was recently sold to developers and will be redeveloped to provide chalet and caravan accommodation for tourists. There are concerns that restricting access to the beach during construction or the potential contamination of the ocean during operations will discourage people from visiting the area.

4.2.11 Equity

Some residents in the immediate study area feel that they are bearing the social, environmental and economic costs of the project without any direct benefit. The main local benefit is that the SSDP will increase water security for all communities connected to the IWSS, which includes Binningup and Myalup. However, these communities will experience more impact from the project than other towns connected to the IWSS because of their proximity to the site and construction activities.

There are concerns about the impact of construction on the farming operations of landowners affected by the pipeline. Landowners would like to provide input into the construction process to ensure that it has minimal impact on their farming operations and therefore on their revenue and business reputation. Also, it was requested that fair and adequate compensation is paid for any direct or indirect impacts to the communities surrounding the desalination plant, landowners affected by the pipeline and affected businesses as a result of the desalination plant and associated infrastructure.

The community is also concerned that continuing to address the water crisis by providing additional water sources is only addressing half of the problem. They are concerned that the continued provision of easy access to water for metropolitan residents continues to support unsustainable use of water. It was suggested that the Water Corporation focus their energies on minimising demand as well as increasing supply.

4.2.12 Traffic

The community requested information about the number of traffic movements that will occur in the immediate study area during construction and operation of the plant. There are concerns that increased traffic will increase the travel time for commuters and create access problems within the area. Also, there are fears that increased traffic will increase the likelihood of accidents on the road.

4.2.13 Powerlines

The powerlines that will be required to provide energy to the site are perceived to be sizeable structures that will have a significant visual impact. The community suggested that the powerlines should be undergrounded from the eastern side of Old Coast Road to minimise the visual impact on the coastal strip and the immediate and local study areas. There are concerns that some elements of the community are focusing their attention on the effects of the desalination plant and overlooking the impacts of this associated infrastructure.

4.2.14 Secure Water Supply

Stakeholders recognise that the desalination plant will help to meet the increasing demands for water and that it will provide a secure water source for communities connected to the IWSS.

5. Identification, Discussion and Significance of Social Impacts

5.1 Construction Stage

The following social impacts were identified for the construction of the desalination plant to its initial capacity of 50 GL/yr.

Impact Name	**Loss of trust in the Water Corporation**
Description	There is no information on the pre-existing level of trust in the Water Corporation before the announcement of the proposed SSDP. Therefore the assessment of the significance of this impact assumes that there was neither trust nor distrust in the Water Corporation before the project. There are several factors that are affecting communities' trust in the Water Corporation. First, communities feel that the desalination plant and site selected were announced suddenly and that there was a lack of consultation and community involvement into the decision. Second, communities feel that the Water Corporation has not fulfilled promises made in past projects. This matter was further compounded by promises made by the Water Corporation that were perceived to be unrealistic such as '…noise levels will be below the sound of the ocean' (Water Corporation 2007). Therefore, there is concern that the Water Corporation may not fulfil commitments made for the desalination project and will not do everything it can to minimise or mitigate the negative impacts of the project. Data on the track record of the Water Corporation on fulfilment of promises made in previous projects was not available to assess the legitimacy of this concern.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If it can be estimated that almost all communities / stakeholders are experiencing loss of trust	**Moderately Likely** If it can be estimated that segments/groups within communities / stakeholders are experiencing loss of trust	**Unlikely** If loss of trust was not identified as an issue
Severity	**High Severity** When loss of trust could affect project sustainability or success	**Moderate Severity** When loss of trust could present some difficulties for project sustainability or success	**Low Severity** When loss of trust has minor implications for project sustainability or success
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Loss of trust in the Water Corporation			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***Moderate Significance***	***Moderately Likely*** Although the stakeholder consultation process was not designed to produce findings that are representative of all stakeholders and communities, loss of trust was identified as an issue during the consultation process. Therefore, it is estimated that segments/groups within communities/stakeholders are experiencing loss of trust.	***Moderate Severity*** Lack of trust could affect the relationship between the Water Corporation and some stakeholder groups and could undermine some of the initiatives that would be undertaken by the Water Corporation to improve the project's performance and achieve project success during the construction phase.
LOCAL	***Moderate Significance***	***Moderately Likely*** Although the stakeholder consultation process was not designed to produce findings that are representative of all stakeholders and communities, loss of trust was identified as an issue during the consultation process. Therefore, it is estimated that segments/groups within communities/stakeholders are experiencing loss of trust.	***Moderate Severity*** The local study area covers all components of the project (including pipelines and tanks). As in the immediate study area, lack of trust could affect the relationship between the Water Corporation and some stakeholder groups and could undermine some of the initiatives that would be undertaken by the Water Corporation to improve the project's performance and achieve project success during the construction phase.
REGIONAL		***Impact was not identified for this study area*** It is expected that the construction of the project will have minimal effects beyond the local study area and into the regional study area and trust will not be an issue for stakeholders located in the regional study area.	

Impact Name	Impact on community character and amenity
Description	The Binningup and Myalup communities feel that their town provides a distinct lifestyle that they'd like to preserve. Some residents and stakeholders are concerned about the impact of a workforce construction camp on their community. During the construction phase, the desalination plant may require between 250 - 500 workers. This workforce may have a different age and gender composition to the existing communities at Binningup and Myalup, and this may cause issues. The construction workforce may also have a different appreciation of the local community and environment, which may result in friction with the local values and lifestyle. As the workforce camp options have not yet been finalised, the extent of this impact is difficult to predict. It will depend on the location of the workforce camp. If the camp is located closer to Binningup or Myalup (immediate study area), it may have a greater impact on the sense of community in these areas. If the camp is located away from Binningup or Myalup in a larger urban area, the impact may be reduced. The impact should be compared against the potential benefits of having a construction camp near these towns such as increased economic activity. Although Binningup and Myalup are made up of a core of permanent residents, there are also semi permanent residents who own holiday homes in the area and tourists who visit the town. Therefore, these communities already experience increases and decreases in population during the holiday periods when the semi permanent residents and tourists visit the area.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the construction camp is located at Binningup or Myalup.	**Moderately Likely** If the construction camp is located in the vicinity of Binningup or Myalup.	**Unlikely** If the construction camp is located in a larger urban centre.
Severity	**High Severity** The construction workforce lives in Binningup or Myalup and desired lifestyle does not correspond to that of these towns.	**Moderate Severity** The construction workforce lives in close to Binningup or Myalup but satisfies some of their lifestyle needs from these towns.	**Low Severity** The construction workforce lives in a larger urban centre and satisfies its lifestyle needs there.
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Impact on community character and amenity			
Study Area / Significance		Likelihood	Severity
IMMEDIATE	*Insufficient data*	*The significance of impact will be based on the location of the construction camp.*	
LOCAL	*Insufficient data*	*The significance of impact will be based on the location of the construction camp.*	
REGIONAL	*Insufficient data*	*The significance of impact will be based on the location of the construction camp.*	

Impact Name	Impact on community cohesion
Description	In 2006, volunteerism in Binningup and Myalup was 10% higher than the regional and state averages, suggesting greater cohesion and involvement in community life. Some stakeholders interviewed during the SIA stakeholder consultation processes stated that the community has become divided over the desalination issue with some members strongly opposing the project and others supporting it. This has created conflict between community members and a feeling of division between those that support the project and those that oppose it. During consultation at Binningup, comments were made on how regular social events/activities are sometimes disrupted and even shortened by heated discussions about the SSDP. Community division is also evident in the results of the second wave of the Telephone Survey undertaken by the Water Corporation. Overall support for the SSDP in Binningup, Myalup and along the pipeline corridor is generally around 50% (Synovate 2007). Similarly, previous consultation undertaken by GHD (2007) also suggests that there may be tension and conflict between affected and unaffected landowners located along the pipeline corridor. This tension and conflict is related to perceptions of the fairness of the selection of the pipeline alignment. This issue is also observed in the almost equal split (56%) in overall support for the SSDP in communities along the pipeline corridor (Synovate 2007). Notably, the construction of the pipeline will affect fewer stakeholders and for a shorter period. The construction of the pipeline is undertaken by sections with approximately 100 m of pipeline being laid per day. In this process, a trench could remain open for approximately for 1 to 7 days. In terms of potentially affected landowners, there are 9 landowners and 9 agencies directly impacted by the construction of the pipeline. The construction of the tanks will affect one landowner and will take approximately 9 months per tank.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If it can be estimated that almost all communities/stakeholders are experiencing disruption of their social activities because of the project	**Moderately Likely** If it can be estimated that segments/groups within communities/stakeholders are experiencing disruption of their social activities because of the project	**Unlikely** If disruption to social activities was not identified as an issue
Severity	**High Severity** Social networks/events are broken/discontinued	**Moderate Severity** Social networks/events regularly engage in or are affected by discussions about the project	**Low Severity** Social networks/events sporadically engage in or are affected by discussions about the project
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Impact on community cohesion			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***Moderate Significance***	***Moderately Likely*** Although the stakeholder consultation process was not designed to produce findings that are representative of all stakeholders and communities, some stakeholders interviewed did observe that social networks and events are being affected by heated discussions about the SSDP. Therefore, it is estimated that segments/groups within communities/stakeholders are already experiencing this impact.	***Moderate Severity*** Some stakeholders interviewed during SIA consultation stated that discussions about the project are becoming regular and heated in social events
LOCAL	***Low Significance***	***Moderately Likely*** Although the stakeholder consultation process was not designed to produce findings that are representative of all stakeholders and communities, feedback received during pipeline corridor discussion suggest that some neighbours along the route are in have experienced conflict and therefore, it is estimated that segments/groups within communities/stakeholders are already experiencing this impact.	***Low Severity*** The construction of the pipeline and tanks will affect fewer landowners and for shorter periods. It is expected that this will result in fewer effects on social networks and events for stakeholders in the local study area.
REGIONAL		***Impact was not identified for this study area*** It is expected that the construction of the project will have minimal effects beyond the local study area and into the regional study area and character and social networks and events for stakeholders located in the regional study area will not be affected.	

Impact Name	Change in beach and ocean-based recreational opportunities
Description	The construction of the offshore pipelines may result in the temporary closure (no greater than 18 months) of: • Approximately 400 m of beach in front of the desalination plant site; and • Approximately 1.25km^2 of ocean immediately adjacent the desalination plant site. Both of these temporary changes need to occur to ensure public safety during construction. As the beach closure is temporary and localised to a section of the beach, it would not restrict access to other sections of beach at Binningup and Myalup. The effect of the closure relates to the continuity of the beach and to those activities that need long stretches of beach like 4WD, motorbike and walking. The immediate, local and regional study areas have several alternatives where these activities can be practiced. Similarly, as the restricted ocean access is temporary and localised, it does not restrict access to other sections of ocean at Binningup and Myalup. Despite this, it is clear that communities in the immediate study area value convenient and local access to the beach and any change to current arrangements will be felt by the community.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** No beach alternatives and irreversible impact	**Moderately Likely** No beach alternatives and impacts are temporary	**Unlikely** There are beach alternatives and impacts are temporary
Severity	**High Severity** Existing and future residents would permanently not visit Binningup and Myalup beaches	**Moderate Severity** Existing and future residents would temporarily not visit Binningup and Myalup beaches	**Low Severity** Existing and future residents would continue to visit but will be temporarily inconvenienced when visiting Binningup and Myalup beaches
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Change in beach and ocean-based recreational opportunities			
Study Area	**Significance**	**Likelihood**	**Severity**
IMMEDIATE	***Moderate Significance***	***Highly likely***	***Low Severity***
		The project will temporarily affect 400 m of beach and there are other alternatives for people in this study area	Existing and future residents would continue to visit the beaches at Binningup and Myalup but walking from one beach to the other may not be possible
LOCAL	***Moderate Significance***	***Highly likely***	***Low Severity***
		The project will temporarily affect 400 m of beach and there are other alternatives for people in this study area	Existing and future residents would continue to visit the beaches at Binningup and Myalup but walking from one beach to the other may not be possible
REGIONAL	***Moderate Significance***	***Highly Likely***	***Low Severity***
		The project will temporarily affect 400 m of beach and there are other alternatives for people in this study area	Existing and future residents would continue to visit the beaches at Binningup and Myalup but walking from one beach to the other may not be possible

Impact Name	Impact of the construction of the plant on the visual amenity of the area
Description	The visual impact during construction of the plant involves the ability to see construction equipment, a jetty for the construction of offshore pipelines, fences, open trenches, parking, areas for temporary storage of materials and equipment, earthwork and vegetation clearing. These activities are not typical of those practiced in the existing environment and may have a temporary impact on the visual amenity of the area. The Water Corporation will not be conducting a visual impact assessment of construction of the plant as the impact will be localised and temporary. However construction of the plant will occur in line with the Construction Environment Management Plan.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the area impacted by visual intrusion and lighting extends to properties	**Moderately Likely** If the area impacted by visual intrusion and lighting extends to the immediate surroundings of properties	**Unlikely** If the area impacted by visual intrusion and lighting is at a distance of more than 200 m from properties
Severity	**High Severity** If the area affected is a high density residential area and for periods greater than 6 months.	**Moderate Severity** If the area affected is a moderately dense residential area and for periods greater between 2 and 6 months.	**Low Severity** If the impact affects only a few properties and for periods less than 1 month.
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Impact of the construction of the plant on the visual amenity of the area			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***Insufficient data***	A visual impact assessment of the construction of the plant is not available in order to produce an assessment of the significance of this impact. The Water Corporation has advised that construction of the plant will occur in line with the CEMP.	
LOCAL		***Impact was not identified for this study area*** It is expected that the construction of the plant will have minimal effects beyond the immediate study area and into the local study area and visual intrusion and lighting would not affect stakeholders located in this study area.	
REGIONAL		***Impact was not identified for this study area*** It is expected that the construction of the plant will have minimal effects beyond the local study area and into the regional study area and visual intrusion and lighting would not affect stakeholders located in this study area.	

Impact Name	Impact of the construction of the pipelines on the visual amenity of the area
Description	The visual impact resulting from the construction of the pipeline includes open trenches, vegetation clearing of the corridor, heavy machinery, areas for temporary storage of materials and equipment, traffic of heavy vehicles and parking space. Figure 5 shows an example of the construction of a section of pipeline on a road reserve. The construction of the pipeline will be undertaken by sections. Approximately 100 m of pipeline will be laid per day and the trench may remain open for up to 7 days. The impact of the pipeline on residents and stakeholders will be constrained and for shorter periods of time in comparison to the impact resulting from the construction of the desalination plant. The Water Corporation estimates that the construction of the pipeline will impact directly (by crossing the property) on 26 properties and indirectly (by crossing the adjacent road frontage) on 72 properties. The construction of the pipeline would not impact on any residences in the immediate study area. The Water Corporation will not be conducting a visual impact assessment of the construction of the pipelines as the impacts will be constrained and temporary. However construction of the pipelines will occur in line with the Construction Environment Management Plan.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the area impacted by visual intrusion and lighting extends to residences	**Moderately Likely** If the area impacted by visual intrusion and lighting extends to the immediate surroundings of residences	**Unlikely** If the area impacted by visual intrusion and lighting is at a distance of more than 200 m from residences
Severity	**High Severity** If the area affected is a high density residential area and for periods greater than 6 months.	**Moderate Severity** If the area affected is a moderately dense residential area and for periods greater between 2 and 6 months.	**Low Severity** If the impact affects only a few residences and for periods less than 1 month.
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Impact of pipeline construction on the visual amenity of the area			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE		***Impact was not identified for this study area*** The construction of the pipeline will not affect directly or indirectly any residences in the immediate study area.	
LOCAL	***Insufficient Data***	*A visual impact assessment of the construction of the pipeline is not available in order to produce an assessment of the significance of this impact. The Water Corporation has advised that construction of the pipeline will occur in line with the CEMP.*	
REGIONAL		***Impact was not identified for this study area*** It is expected that the construction of the pipelines will have minimal effects beyond the local study area and into the regional study area and visual intrusion and lighting from the construction of the pipeline would not affect stakeholders located in this study area.	

Refer to Figure 5: Pictures before, during and after construction of a section of pipeline (Water Corporation 2007).

Impact Name	Impact of the construction of the tanks on the visual amenity of the area
Description	The construction of up to four 32 ML tanks will involve traffic of heavy vehicles, vegetation clearing, as well as the usage of heavy machinery, areas for temporary storage of materials and equipment and earth works. The tank/s site is proposed to be located on 21 hectares of privately owned land on the Darling Scarp north east of the town of Harvey and will affect one private property, subject to agreement with that landowner. The Water Corporation chose the site for the tanks in consultation with the Shire of Harvey and with the objective of minimising visual impacts on the surrounding area. The total area affected by the four tanks will be five hectares and the remainder will be used for farmland, trees and vegetation for tank camouflage. It is estimated that it will take around 9 months to build one tank (including access road). The Water Corporation will not be conducting a visual impact assessment of the construction of the tanks as the impacts will be localised and temporary. However construction of the tank/s will occur in line with the Construction Environment Management Plan.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the area impacted by visual intrusion and lighting extends to residences	**Moderately Likely** If the area impacted by visual intrusion and lighting extends to the immediate surroundings of residences	**Unlikely** If the area impacted by visual intrusion and lighting is at a distance of more than 200 m from residences
Severity	**High Severity** If the area affected is a high density residential area and for periods greater than 6 months	**Moderate Severity** If the area affected is a moderately dense residential area and for periods greater between 2 and 6 months	**Low Severity** If the impact affects only a few residences and for periods less than 1 month
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance – Impact of the construction of the tanks on the visual amenity of the area			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE		***Impact was not identified for this study area*** The tanks are not located in the immediate study area.	
LOCAL	***Insufficient data***	*A visual impact assessment of the construction of the tank/s is not available in order to produce an assessment of the significance of this impact. The Water Corporation has advised that construction of the tank/s will occur in line with the CEMP.*	
REGIONAL	***Insufficient data***	*A visual impact assessment of the construction of the tank/s is not available in order to produce an assessment of the significance of this impact. The Water Corporation has advised that construction of the tank/s will occur in line with the CEMP.*	

Refer to Figure 6: Example of 25 ML Tank (Summit Tank) on page 32.

Impact Name	Disruption to properties along the pipeline
Description	The effect of the construction of the pipeline on properties could include removal of fences, earthworks, dust, lighting, noise, traffic and increase in traffic on local roads. (The impact on business is assessed separately). The construction of the pipeline will be undertaken in sections. Approximately 100 m of pipeline will be laid per day and a trench may remain open for up to 7 days. The impact of the construction of the pipeline on residents and stakeholders will be constrained and for shorter periods of time in comparison to the impact resulting from the construction of the desalination plant. The Water Corporation estimates that the construction of the pipeline will impact directly (by crossing the property) on 26 properties and indirectly (pipeline along the road frontage) on 72 properties. The construction of the pipeline would not impact on any residences in the immediate study area.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the pipeline will cross properties	**Moderately Likely** If the pipeline will be constructed on the boundary of properties	**Unlikely** If the pipeline will be constructed close to properties
Severity	**High Severity** If the impact affects more than 100 properties and for periods greater than 6 months.	**Moderate Severity** If the impact affects between 25 and 100 properties and for periods between 2 and 6 months.	**Low Severity** If the impact affects less than 25 properties and for periods less than 1 month.
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Disruption to properties along the pipeline			
Study Area / Significance		Likelihood	Severity
IMMEDIATE		***Impact was not identified for this study area*** The construction of the pipeline will not affect directly any residences in the immediate study area.	
LOCAL	High Significance	***Highly Likely*** The construction of the pipeline will traverse approximately 26 properties and will cross the road frontage of approximately 72 other properties	***Moderate Severity*** This impact will affect 98 properties. The majority of the effects will last less than a month as construction moves from one section of pipeline to the next. However, the increase of traffic in local roads could last longer.
REGIONAL		***Impact was not identified for this study area*** It is expected that the construction of the project will have minimal effects beyond the local study area and into the regional study area and the construction of the pipeline would not affect properties located in this study area.	

Impact Name	The project could restrict the potential for future residential development
Description	Findings from the SIA stakeholder consultation suggest that the area between Binningup and Myalup is expected to be used for future residential development. There are concerns that the desalination plant could restrict residential development in the area surrounding the site. However, the project will not result in any buffer zones that extend beyond the project boundary and therefore, it does not incorporate any new restrictions to residential development. Moreover, the project has only required the acquisition of an additional lot east of the one currently owned by the Water Corporation. This additional lot is already disturbed by mining operations and it is considered that the project will not significantly reduce the area available for residential development.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the project would result in a change of zoning for planning purposes or a buffer that would restrict residential development	**Moderately Likely** Not applicable.	**Unlikely** If the project would not result in the change of zoning of any area for planning purposes or the creation of buffers that would restrict residential development
Severity	**High Severity** If there are no alternative areas for future residential development	**Moderate Severity** If there are alternative areas for future residential development but the area affected by the project is of top quality for this use	**Low Severity** If there are alternative areas for future residential development and the area affected by the project is not of top quality for this use
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - The project could restrict the potential for future residential development			
Study Area / **Significance**		**Likelihood**	**Severity**
IMMEDIATE	***Low Significance***	***Unlikely*** The project will not result in any change of zoning or the creation of buffers	***Low Severity*** The project would not create any restrictions for residential development in Binningup or Myalup and there are alternative areas for this purpose
LOCAL		***Impact was not identified for this Study Area*** Impact on future potential residential development of the areas around the pipeline and tanks is not considered an issue	
REGIONAL		***Impact was not identified for this Study Area*** The project will have no impact on the potential for residential development beyond the local study area and into the regional study area	

Impact Name	The project could result in an increase in industries
Description	The findings of the SIA stakeholder consultation suggest that there is a concern that the construction of the plant could attract further industrial development to the area. It is thought that industrialisation could impact on the look and feel of the area, compromising the community identity as a natural and attractive environment. The concern also relates to a perception that industrialisation could result in lower property prices and environmental impacts. The area surrounding the desalination plant site is not zoned for industrial land uses, and any intentions to place industrial or public utilities in the area will require approval through the standard statutory processes. This is in itself subject to stringent consultation and environmental processes. It is highly unlikely that the Shire will support private industrial land uses in the area without the support of its residents. However, the State Government has powers to resume privately owned land through a compulsory acquisition process in the area for public utilities should they deem it necessary. However, there is no known intention for resuming and rezoning land in the area for public utilities. The Shire of Harvey is in the process of reviewing their planning scheme and it is not available for consideration in this SIA. At the regional study area level, the SSDP could result in an expansion of existing or creation of new industries as a result of the need for resources and services.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the project is located in an area with a zoning that would allow further industrial development and/or the project could provide incentives for the location of other industries	**Moderately Likely** If the project could result in changes to zoning and/or the project could provide incentives for the location of other industries	**Unlikely** If the project could not result in changes to zoning and/or would not provide incentives for the location of other industries
Severity	**High Severity** *Impact:* If additional industries are developed near residential, recreational or valued natural environments; *Opportunity:* The project could result in the expansion of existing or creation of new industries	**Moderate Severity** *Impact:* If additional industries are developed within a distance of one kilometre from residential, recreational or valued natural environments *Opportunity:* The project could result in significant expansions of existing industries	**Low Severity** *Impact:* If additional industries are developed within a distance of two kilometres from residential, recreational or valued natural environments *Opportunity:* The project could result in minor expansions of existing industries
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

<table>
<tr><th colspan="4">Social Impact Significance - The project could result in an increase in industries</th></tr>
<tr><th colspan="2">Study Area / Significance</th><th>Likelihood</th><th>Severity</th></tr>
<tr><td>IMMEDIATE</td><td>Low Significance</td><td>Unlikely

The project is unlikely to result in changes to the zoning of the land around the site and the project would not provide incentives for the location of industries in the immediate study area</td><td>Low Severity

Planning schemes do not identify the area surrounding the potential plant site as for industrial development</td></tr>
<tr><td>LOCAL</td><td></td><td colspan="2">Impact was not identified for this Study Area

It is not predicted that the construction of the pipeline or tanks could trigger industrial development in the vicinity of the pipeline or tanks</td></tr>
<tr><td>REGIONAL</td><td>Insufficient data</td><td>Highly Likely

The project could provide incentives for the expansion of existing or the creation of new industries in the regional study area</td><td>Data not available

There is insufficient data in order to predict the extent of the positive economic effect of the project on the development of the existing or new industries</td></tr>
</table>

Impact Name	Impacts of the overhead powerlines required to provide energy for the proposed desalination plant
Description	A 132 KV transmission line from the Kemerton Industrial Estate to the plant site at Taranto Road is required to power the proposed desalination plant. Construction of transmission lines is known to potentially have a range of impacts including visual impact, land resumption, environmental impacts, noise, dust and visual intrusion. No route has been determined for the transmission line and this will be undertaken by Western Power. Similarly, it has not been determined whether the transmission line will be overhead or underground.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** Not Applicable as several transmission line impacts have been grouped	**Moderately Likely** Not Applicable as several transmission line impacts have been grouped	**Unlikely** Not Applicable as several transmission line impacts have been grouped
Severity	**High Severity** Not Applicable as several transmission line impacts have been grouped	**Moderate Severity** Not Applicable as several transmission line impacts have been grouped	**Low Severity** Not Applicable as several transmission line impacts have been grouped
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Impacts of the overhead powerlines required to provide energy for the proposed desalination plant			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***Insufficient data***	*No data is available about the route and specific characteristics of the transmission line as to produce an assessment of the significance of this impact. This aspect of the project will be managed by Western Power.*	
LOCAL	***Insufficient data***	*No data is available about the route and specific characteristics of the transmission line as to produce an assessment of the significance of this impact. This aspect of the project will be managed by Western Power.*	
REGIONAL	***Insufficient data***	*No data is available about the route and specific characteristics of the transmission line as to produce an assessment of the significance of this impact. This aspect of the project will be managed by Western Power.*	

Impact Name	Public Safety and Risk
Description	The construction of the project will create temporary noise, light and dust that were previously not present in the area. The Water Corporation has advised that the construction process will not involve any chemicals. Small quantities will be used in the operation of a pilot plant. The Environmental and Social Analysis of the Southern Seawater Desalination Project: Transfer Main (GHD Pty Ltd 2007) identified that there could be risks of contamination from disturbance of acid-sulphate soils and soils contaminated with organo-chlorides. The report found a moderate to low risk of acid sulphate soil disturbance based on data from the Department of Environment and Conservation. This study also conducted a search of the Department of Environment and Conservation's Contaminated Site Database, which did not identify any known contaminated sites within the project area. GHD's report suggests that they might be present due to previous farming practices in the area and that the Water Corporation should consult with the Department of Agriculture and Food to identify any potentially contaminated sites along the pipeline corridor.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** Not applicable. Impact dealt with in EIA and Risk Assessment.	**Moderately Likely** Not applicable. Impact dealt with in EIA and Risk Assessment.	**Unlikely** Not applicable. Impact dealt with in EIA and Risk Assessment..
Severity	**High Severity** Not applicable. Impact dealt with in EIA and Risk Assessment.	**Moderate Severity** Not applicable. Impact dealt with in EIA and Risk Assessment.	**Low Severity** Not applicable. Impact dealt with in EIA and Risk Assessment.
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Public Safety and Risk			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE		*Impact will be dealt with in the EIA and Risk Assessment.*	
LOCAL		*Impact will be dealt with in the EIA and Risk Assessment.*	
REGION AL		*Impact will be dealt with in the EIA and Risk Assessment.*	

Impact Name	Increased demand on community facilities and services
Description	The project may result in a temporary increase of the population at Binningup and/or Myalup during the two year construction phase of the project. At peak time, the construction of the plant will require 500 workers. Current services and facilities that could be affected include the Binningup Country Club, Lakewood Shores Golf Course, Lion's Park, Binningup Water Sports Club, Myalup Caravan Park, Binningup Caravan Park, police service, life-savers, school bus service, local shops at Binningup and Myalup and petrol pump at Binningup. Neither Binningup nor Myalup have schools, a police station or health services in town. This could translate into an economic cost for local communities which may need to access alternative services located in other towns in the Shire of Harvey or Bunbury. When undertaking this SIA, the Water Corporation advised that there were no official workforce camp options.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the construction camp is located at Binningup or Myalup	**Moderately Likely** If the construction camp is located close to Binningup or Myalup	**Unlikely** If the construction camp is located in a larger urban centre
Severity	**High Severity** If the SSDP Alliance does not provide facilities and services that would be needed by the workforce and they become dependent on facilities and services offered at Binningup or Myalup	**Moderate Severity** If the SSDP Alliance provides some facilities and services that would be needed by the workforce and their dependence on facilities and services offered at Binningup or Myalup is limited	**Low Severity** If the SSDP Alliance provides all facilities and services that would be needed by the workforce and they almost don't depend on facilities and services offered at Binningup or Myalup
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Increased demand on community facilities and services			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	*Insufficient data*	*No data is available about the potential workforce camp locations as to produce an assessment of the significance of this impact.*	
LOCAL	*Insufficient data*	*No data is available about the potential workforce camp locations as to produce an assessment of the significance of this impact.*	
REGIONAL	*Insufficient data*	*No data is available about the potential workforce camp locations as to produce an assessment of the significance of this impact.*	

Impact Name	Increase in economic activity
Description	There could be an economic benefit for the immediate, local and/or regional study areas if the project promotes local employment, training opportunities, buying local resources and contracting local services. The economic effect could 'flow on' and stimulate economic activity in the local and regional study areas. For employment benefits to be realised, the skill sets and training of local residents need to match those required for the construction of the project in order to maximise employment benefits for local people. The community profile suggests that the immediate, local and regional study areas tend to have more people who have finished certificate compared to the state average and that the most frequent post school education qualifications are engineering and related technologies, management and commerce and education. This suggests that communities in the immediate, local and regional study areas could have the skills required for the construction of the project. However, low unemployment rates and labour force participation (due to undetermined factors for example retirement, caring for children or the elderly) may hinder the opportunities for taking advantage of employment from the project. In terms of an increase in business opportunities, the immediate study area may have limited businesses and industries to take advantage of the opportunities brought by the project. This is different at the local and regional study area level, which have a greater industry and business sector. The construction of the project will be subcontracted, which could result in the loss of control over the number and type of local employees that are contracted, and the number and value of contracts awarded to businesses and industries in the immediate, local and regional study areas during the construction of the project.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If policies are adopted to require the SSDP Alliance to prioritise sourcing employment and business from the immediate, local and/or regional study areas	**Moderately Likely** If policies are adopted to motivate the SSDP Alliance to prioritise sourcing employment and business from the immediate, local and/or regional study areas	**Unlikely** If no policies are adopted to require or motivate sourcing employment and business from the immediate, local and/or regional study areas
Severity	**High Severity** If the study area has the required skills and/or business and industry base to take advantage of opportunities brought by the project	**Moderate Severity** If the study area has some of the required skills and/or a small business and industry base to take advantage of opportunities brought by the project	**Low Severity** If the study area does not count with the required skills and/or a business and industry base to take advantage of opportunities brought by the project
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Increase in economic activity			
Study Area	**Significance**	**Likelihood**	**Severity**
IMMEDIATE	*Low Significance*	***Unlikely*** No policies exist to require or motivate sourcing employment and business from the immediate study area	***Low Severity*** The immediate study area has limited opportunities to take advantage of the potential benefits of the project because of a low unemployment rate, lower labour force participation and smaller business and industry base
LOCAL	***Moderate Significance***	***Unlikely*** No policies exist to require or motivate sourcing employment and business from the local study area	***Moderate Severity*** This study area has a larger business and industry sectors as to take greater advantage of opportunities brought by the project
REGIONAL	***Moderate Significance***	***Unlikely*** No policies exist to require or motivate sourcing employment and business from the regional study area,	***Moderate Severity*** This study area has a larger business and industry sectors as to take greater advantage of opportunities brought by the project

Impact Name	Increase in cost of labour for industries and businesses in the region
Description	Given the current labour shortage, low unemployment rates and if the project employs labour already working in other industries in the region, the project may result in competition for scarce labour. This would result in an increase in the cost of labour potentially affecting the performance and viability of some local businesses/industries. At the moment of undertaking this SIA there was no information on the potential SSDP Alliance partners and the wages that could be awarded in order to compare them with those prevailing in the immediate, local and regional study areas.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If there is a labour shortage in the study area and wages are lower in the study area compared to those paid by the project	**Moderately Likely** If there is a labour shortage in the study area and wages are similar between those paid in the study area and those paid by the project	**Unlikely** If there is no labour shortage in the study area
Severity	**High Severity** If the project could assist in reducing unemployment or expand the industry or business sector in the study area	**Moderate Severity** If the project has some capacity to assist in reducing unemployment or expand the industry or business sector in the study area	**Low Severity** If the project can not assist in reducing unemployment or expand the industry or business sector in the study area
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Increase in cost of labour for industries and businesses in the region			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***Insufficient data***	**Insufficient data to assess the significance of this impact** An economic assessment would be needed in order to assess the significance of this impact	
LOCAL	***Insufficient data***	**Insufficient data to assess the significance of this impact** An economic assessment would be needed in order to assess the significance of this impact	
REGIONAL	***Insufficient data***	**Insufficient data to assess the significance of this impact** An economic assessment would be needed in order to assess the significance of this impact	

Impact Name	Disruption to businesses during construction
Description	The construction of the project could result in disruption of farming practices and productivity, and loss of capital invested in farms (e.g. preparation of land and irrigation systems). The construction of the pipeline will be undertaken by sections. The Water Corporation estimates that approximately 100 m of pipeline will be laid per day and that a trench will remain open approximately for up to 7 days. The impact of the construction of the pipeline on stakeholders will be constrained and for shorter periods of time in comparison to the impact resulting from the construction of the desalination plant. The Water Corporation estimates that the construction of the pipeline will impact directly (by crossing the property) on 26 properties and indirectly (pipeline along the road frontage) on 72 properties. This impact during the construction of the tanks will be limited to one property.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the project crosses farms or businesses and disruption is for more than six months	**Moderately Likely** If the project borders farms or businesses, or affects accessibility to farms or businesses, and disruption is for a length of time between one and six months	**Unlikely** If the project does not cross farms or businesses, or affects key access routes to businesses/farms, or the duration of the impact is less than a month
Severity	**High Severity** The impact affects a key or disadvantaged industry or business in the study area; and/or the impact affects reputation or viability of businesses/industry	**Moderate Severity** The impact does not affect a key or disadvantaged industry or business in the study area; and impact can result in a moderate loss in profit	**Low Severity** The impact does not affect a key or disadvantaged industry or business in the study area; and impact can result in a minor loss in profit
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Disruption to businesses during construction			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***Low Significance***	***Unlikely*** There are few businesses and farms that could be affected by the project in the immediate study area	***Low Severity*** The impact will be experienced by very few businesses and farms along Taranto Road
LOCAL	***Moderate Significance***	***Moderately Likely*** The project borders and could affect accessibility to farms and businesses along the pipeline. Some of the impacts (e.g. accessibility) could be experienced for more than a month	***Moderate Severity*** Direct (e.g. physically crossing a farm) or indirect (e.g. road closures during harvest time and dust) impacts on businesses could result in loss of productivity/profit and business reputation.
REGIONAL		***Impact was not identified for this Study Area*** It is not expected that the impact of the project on businesses will extend beyond the local study area and into the regional study area	

Impact Name	Unequal distribution of costs and benefits of the project
Description	Some residents and stakeholders feel that they are bearing the social, environmental and economic costs of the project without local or regional benefits to offset this. The local or regional benefits from the desalination project currently include security of water supply, which extends to all users of the IWSS, and infrastructure investment that will support future growth in the south west region. Despite these benefits, the immediate study area will experience more impact from the construction of the project than other towns connected to the IWSS, simply because of its proximity to the site and construction activities. The local and regional study areas will also experience impact from construction of the project, albeit to a lesser degree.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If potentially affected communities in the study area perceive costs without any benefits from the project	**Moderately Likely** If potentially affected communities in the study area would perceive some costs and some benefits from the project	Unlikely If potentially affected communities in the study area would perceive benefits from the project
Severity	**High Severity** If the costs for potentially affected communities considerably outweigh the benefits	**Moderate Severity** If the costs for potentially affected communities slightly outweigh the benefits	Low Severity If the costs for potentially affected communities equal the benefits
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Unequal distribution of costs and benefits of the project			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***Moderate Significance***	***Moderately Likely*** The local study area will perceive some costs and some benefits from the project	***Moderate severity*** The costs for the local study area slightly outweigh the benefits
LOCAL	***Moderate Significance***	***Moderately Likely*** The local study area will perceive some costs and some benefits from the project	***Moderate Severity*** The costs for the local study area slightly outweigh the benefits
REGIONAL	***Moderate Significance***	***Moderately Likely*** The regional study area will perceive some costs and some benefits from the project	***Moderate Severity*** The costs for the regional study area slightly outweigh the benefits

Impact Name	Increased traffic in the area causing delays and increasing risk for local communities and commuters
Description	The construction workforce and the trucks delivering resources to the various construction sites could increase the traffic in the area. The Water Corporation estimates that during construction, the average number of truck movements will be 20 per day and the average number of car movements would be 250 per day. The number of car movements would be significantly lower if the construction workforce would be transported to the site by bus. No traffic assessment data was available to understand the current condition, levels of traffic and capacity of the Old Coast Road. The impact on local study area traffic as a result of the construction of the pipeline has been reduced by choosing the pipeline alignment option that avoided the most important roads connecting the Old Coast Road and the town of Harvey.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the increases in heavy and light vehicles would result in deterioration of road conditions and in roads exceeding their design capacity	**Moderately Likely** If the increases in heavy and light vehicles would result in roads meeting their design capacity	**Unlikely** If the increases in heavy and light vehicles does not result in roads meeting their design capacity
Severity	**High Severity** Increases in heavy and light vehicles could result in significant increases in travel costs and increases in risk for commuters	**Moderate Severity** Increases in heavy and light vehicles could result in some increases in travel costs	**Low Severity** Increases in heavy and light vehicles could result in greater traffic but does not affect travel costs or safety for commuters
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Increased traffic in the area causing delays and increasing risk for local communities and commuters			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***Insufficient data***	**Insufficient data as to assess the significance of this impact** There was no data available on the condition, traffic levels, safety and capacity of the Old Coast Road and intersection with Taranto Road	
LOCAL	***Moderate Significance***	***Unlikely*** The pipeline alignment has been chosen in order to avoid the most important roads connecting the Old Coast Road and the town of Harvey	***Moderate Severity*** Increases in heavy and light vehicles could result in some increases in travel costs.
REGIONAL	***Insufficient data***	**Insufficient data as to assess the significance of this impact** There was no data available on the condition, traffic levels, safety and capacity of road network in the regional study area as to assess the significance of this impact	

Impact Name	Impacts from expanding the plant to 100GL/yr
Description	The plant will be constructed to produce 50 GL/yr by 2011 and may later be expanded to 100 GL/yr. All underground works onsite, marine works offshore and all buried pipes will be built to 100 GL/yr capacity during first phase of construction. This is aimed at minimising economic, environmental and social impacts of the future potential upgrade. To upgrade the plant to a 100 GL/yr operation this will require electrical upgrades, pumps and the erection of buildings, which will be contained within the site and will translate into a lesser number of impacts and of lower significance. The construction of a new summit tank next to the first summit tank for the 50 GL/yr will also be required.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the project gets upgraded	**Moderately Likely** Not applicable	**Unlikely** If the project does not get upgraded
Severity	**High Severity** If the upgrade of the project requires similar works as the construction of the first phase	**Moderate Severity** If the upgrade of the project requires minor works compared to the construction of the first phase	**Low Severity** If the upgrade of the project requires works that are limited to Water Corporation owned property
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

<table>
<tr><th colspan="4">Social Impact Significance - Impacts from expanding the plant to 100GL/yr</th></tr>
<tr><th colspan="2">Study Area / Significance</th><th>Likelihood</th><th>Severity</th></tr>
<tr><td>IMMEDIATE</td><td>Moderate Significance</td><td>Highly Likely

It is expected that the project will be upgraded</td><td>Low Severity

Because most of the project infrastructure required for the potential future upgrade to a 100 GL/yr operation would have been constructed during the first construction phase of the project and the works required for the expansion will be constrained to the plant property.</td></tr>
<tr><td>LOCAL</td><td>Moderate Significance</td><td>Highly Likely

It is expected that the project will be upgraded</td><td>Low Severity

The construction of the additional tank for the expansion will require the delivery of materials to the site as well as the construction of the tanks. The works are minor compared to the construction of the first stage as the property will have already been purchased and the vegetation cleared.</td></tr>
<tr><td>REGIONAL</td><td></td><td colspan="2">Impact was not identified for this Study Area

The expansion of the capacity of the SSDP from 50 GL/day to 100 GL/day may have insignificant effects at the regional study area level</td></tr>
</table>

Impact Name	Reduced tourism to Binningup and Myalup beaches
Description	The construction of the project will require the temporary closure of 400 m of beach and 1.25 km2 of ocean in front of the proposed desalination plant site. The immediate, local and regional study areas have access to other beaches not affected by the project. Additionally, the project will not affect the beaches at Binningup or Myalup. Tourism activity may be influenced during the construction phase. However, the ability to assess this potential impact is limited by the lack of availability of historical tourism data for the immediate study area.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If there are no beach and ocean alternatives, and impacts are permanent and irreversible	**Moderately Likely** If there are no beach and ocean alternatives, and impacts are temporary	**Unlikely** If there are beach and ocean alternatives and impacts are temporary
Severity	**High Severity** Existing and future visitors will permanently not visit the Binningup and Myalup beaches	**Moderate Severity** Existing and future visitors will temporarily not visit the Binningup and Myalup beaches	**Low Severity** Existing and future visitors will continue to visit the Binningup and Myalup beaches but will be temporarily inconvenienced
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Reduced tourism to Binningup and Myalup beaches			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	*Low Significance*	***Unlikely*** Although no data was available on the number of tourists that visit the section of beach/ocean in front of the project during the year, the data provided by the Water Corporation indicates that visitors will be inconvenienced by a small section of the beach that will be closed however there will continue to be access to the Binningup and Myalup Beach throughout the construction of the project. In addition, there are several other beaches in the region.	***Low Severity*** Existing and future visitors should continue to visit the Binningup and Myalup beaches, as access to these beaches will not be restricted. Some beach users who currently use the portion of the beach that will have restricted access will be inconvenienced during the construction of the project.
LOCAL	*Low Significance*	***Unlikely*** Although no data was available on the number of tourists that visit the section of beach/ocean in front of the project during the year, the data provided by the Water Corporation indicates that visitors will be inconvenienced by a small section of the beach that will be closed however there will continue to be access to the Binningup and Myalup Beach throughout the construction of the project. In addition, there are several other beaches in the region.	***Low Severity*** Existing and future visitors should continue to visit the Binningup and Myalup beaches, as access to these beaches will not be restricted. Some beach users who currently use the portion of the beach that will have restricted access will be inconvenienced during the construction of the project.
REGIONAL	*Low Significance*	***Unlikely*** Although no data was available on the number of tourists that visit the section of beach/ocean in front of the project during the year, the data provided by the Water Corporation indicates that visitors will be inconvenienced by a small section of the beach that will be closed however there will continue to be access to the Binningup and Myalup Beach throughout the construction of the project. In addition, there are several other beaches in the region.	***Low Severity*** Existing and future visitors should continue to visit the Binningup and Myalup beaches, as access to these beaches will not be restricted. Some beach users who currently use the portion of the beach that will have restricted access will be inconvenienced during the construction of the project.

5.2 Operation Stage

Impact Name	Increased provision and security of water supply to the IWSS
Description	Western Australia is experiencing rapid growth and drought. The SSDP would provide an additional source of drinking water that will increase the security of supply to all users of the IWSS. All users of the IWSS, no matter their location or volume of water consumption, benefit from a secure water supply. Binningup, Myalup and Harvey are connected to the IWSS and therefore, benefit from the SSDP. Some stakeholders potentially affected by the project understand the importance of the benefits brought by the project. The results from the second telephone survey undertaken by Synovate for the Water Corporation (2007) show that at that time support for the project was at 43% for Binningup residents and 56% for Myalup residents and those located in the vicinity of the proposed pipeline corridor. The main reasons for supporting the project were 'water is necessity', 'new water source' and 'good solution/process'.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the SSDP is constructed	**Moderately Likely** Not applicable	**Unlikely** If the SSDP is not constructed
Severity	**High Severity** If the project results in an increase in water or security in the provision of water for towns in the study area	**Moderate Severity** If in the future, towns in the study area could connect to the project resulting in an increase in water or security in the provision of water	**Low Severity** If the project will not benefit towns in the study area and there are no plans for this in the future
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Increased provision and security of water supply to the IWSS			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***High Significance***	***Highly Likely*** The Western Australia Premier has announced that the project will be constructed	***High Severity*** Binningup and Myalup are connected to the IWSS and for the reasons discussed above, they would benefit from the project
LOCAL	***High Significance***	***Highly Likely*** The Western Australia Premier has announced that the project will be constructed	***High Severity*** The town of Harvey is also connected to the IWSS and would benefit from the project.
REGIONAL	***High Significance***	***Highly Likely***	***High Severity***
		The Western Australia Premier has announced that the project will be constructed	There are several towns in the regional study area which are also connected to the IWSS and would benefit from the project.

Impact Name	Communities living with uncertainty
Description	During consultation with SIA stakeholders, some interviewees expressed concern about the long-term health and environmental effects of the desalination process. This was also observed in the results from the second (2007) telephone survey undertaken by Synovate for the Water Corporation shows that interviewees would like more 'environmental management information'. The findings from the SIA stakeholder consultation also suggest that there could be a low awareness and understanding about desalination and a perception that the long-term effects of continuous exposure to desalination impacts are unknown. Environmental impacts will be addressed in the Public Environmental Review.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the environmental assessments reveal that there are highly likely environmental impacts	**Moderately Likely** If the environmental assessments reveal that there are moderately likely environmental impacts	**Unlikely** If the environmental assessments reveal that environmental impacts are unlikely
Severity	**High Severity** If the environmental assessments reveal that there are environmental impacts of high severity	**Moderate Severity** If the environmental assessments reveal that there are environmental impacts of moderate severity	**Low Severity** If the environmental assessments reveal that there are environmental impacts of low severity
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Communities living with uncertainty			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	***Addressed in EIA***	**Addressed in Environmental Impact Assessment**	
LOCAL	***Addressed in EIA***	**Addressed in Environmental Impact Assessment**	
REGIONAL	***Addressed in EIAe***	**Addressed in Environmental Impact Assessment**	

Impact Name	Change in beach and ocean-based recreational opportunities because of environmental impacts of brine release
Description	Stakeholders interviewed during the SIA stakeholder consultation were concerned that the release of brine into the ocean would result in a loss of marine life impacting on their opportunity to enjoy this resource. Investigations of the Perth Seawater Desalination Plant on Cockburn Sound (Okely et al. 2007) indicate that there is no impact resulting from the brine discharge. Moreover, the *Environmental Literature Review and Position Paper for Reverse Osmosis Desalination Plant Discharges* (Water Consultants International 2006) reviewed international literature on the impacts from seawater reverse osmosis desalination plants and reported that there are several experiences that suggest that there are little or no impacts resulting from desalination discharges on marine life and that these can be minimised through proper facility design, siting and operation. The report also compared environmental information provided by the Water Corporation with international information from other plants and authors and concluded that the Corporation's projects in Perth have undertaken a more thorough job of evaluating and mitigating potential environmental impacts and that the discharge designs exceed the best current practice to ensure the environment is protected from potential impacts.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If assessments suggest that the marine environment could be impacted	**Moderately Likely** If assessments suggest that it is unknown wether the marine environment could be impacted	**Unlikely** If assessments suggest that it is unlikely that the marine environment could be impacted
Severity	**High Severity** Irreversible impacts on the marine environment and the area is heavily used for ocean and beach-based activities	**Moderate Severity** Temporary impacts on the marine environment and the area is heavily used for ocean and beach-based activities	**Low Severity** Temporary or no significant impacts on the marine environment and the area is not heavily used for ocean and beach-based activities
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Change in beach and ocean-based recreational opportunities due to environmental impacts of brine release			
Study Area	**Significance**	**Likelihood**	**Severity**
IMMEDIATE	Low Significance	***Unlikely*** Previous environmental assessments suggest that significant impacts on the marine environment as a result of brine discharge is unlikely	***Low Severity*** Previous environmental assessments suggest that it is unlikely that there would be significant environmental impacts on the marine environment as a result of seawater reverse osmosis desalination plants and the area affected by the project is not part of the main beaches of Binningup and Myalup
LOCAL	Low Significance	***Unlikely*** Previous environmental assessments suggest that significant impacts on the marine environment as a result of brine discharge is unlikely	***Low Severity*** Previous environmental assessments suggest that it is unlikely that there would be significant environmental impacts on the marine environment as a result of seawater reverse osmosis desalination plants and the area affected by the project is not part of the main beaches of Binningup and Myalup
REGIONAL	Low Significance	***Unlikely*** Previous environmental assessments suggest that significant impacts on the marine environment as a result of brine discharge is unlikely	***Low Severity*** Previous environmental assessments suggest that it is unlikely that there would be significant environmental impacts on the marine environment as a result of seawater reverse osmosis desalination plants and the area affected by the project is not part of the main beaches of Binningup and Myalup

Impact Name	Impact on community character and amenity
Description	Stakeholders and residents expressed concern that the operation of the plant may create noise, dust and increased traffic. These impacts could change the character of Binningup and Myalup. The Water Corporation has undertaken an environmental noise assessment of the operating plant to determine the significance of this impact. Refer to Southern Seawater Desalination Plant, Environmental Noise Assessment, March 2008 (Herring Storer Acoustics). The environmental noise assessment concluded that the noise emissions from the desalination plant will have negligible effect on noise levels at existing residential premises, and recommended that a Noise Management Plan be established by the chosen contractor for the construction phase. Traffic and dust will be managed as part of the Construction Environment Management Plan which forms part of the Public Environmental Review.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the areas impacted by noise, lighting, dust and traffic extend to properties in the study area.	**Moderately Likely** If the areas impacted by noise, lighting, dust and traffic extend to the immediate surroundings of properties in the study area.	**Unlikely** If the areas impacted by noise, lighting, dust and traffic are more than 200 m from properties in the study area.
Severity	**High Severity** More than 15% of properties in communities are directly affected by these impacts and for periods greater than 6 months.	**Moderate Severity** Between 5% and 15% of properties in communities are directly affected by these impacts and for periods between 2 and 6 months.	**Low Severity** Less than 5% of properties in communities are directly affected by these impacts and for periods less than 1 month.
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Impact on community character and amenity			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	*Low Significance*	*Unlikely*	***Low Severity***
		The environmental noise assessment concluded that the noise emissions from the desalination plant will have negligible effect on noise levels at existing residential premises.	**The environmental noise assessment concluded that the noise emissions from the desalination plant will have negligible effect on noise levels at existing residential premises.**
LOCAL	*Low significance*	*Unlikely* The environmental noise assessment concluded that the noise emissions from the desalination plant will have negligible effect on noise levels at existing residential premises.	***Low Severity*** The environmental noise assessment concluded that the noise emissions from the desalination plant will have negligible effect on noise levels at existing residential premises.
REGIONAL		***Impact was not identified for this Study Area*** The impact on community amenity and character is unlikely to effect the regional study area level	

Impact Name	Impact of the plant on the visual amenity
Description	Stakeholders interviewed during the SIA are concerned that they will be able to see the plant or its lighting at night from the beach or major roads around the plant. Visual impacts could interfere with the natural surrounds and affect the way in which people experience the area. The visual impact would be limited to the immediate study area around the plant. The Water Corporation has undertaken a visual impact assessment to determine the significance of these impacts. Refer to Southern Seawater Desalination Project, Visual Impact Assessment, March 2008 (Water Corporation). The visual impact assessment concluded that from the nine sight line points, the visual impact of the desalination plant was minimal, with only the 18 metre lime storage silo being visible above the existing vegetation and man-made berm.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the area impacted by visual intrusion and lighting extends to residences	**Moderately Likely** If the area impacted by visual intrusion and lighting extends to the immediate surroundings of residences	**Unlikely** If the area impacted by visual intrusion and lighting is at a distance of more than 200 m from residences
Severity	**High Severity** If the area affected is a high density residential area and for periods greater than 6 months	**Moderate Severity** If the area affected is a moderately dense residential area and for periods greater between 2 and 6 months	**Low Severity** If the impact affects only a few residences and for periods less than 1 month
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Impact on community character and amenity			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	*Low Significance*	*Unlikely* The operating plant will have negligible visual impact on surrounding residences as demonstrated by the visual impact assessment conducted by the Water Corporation.	***Low Severity*** The operating plant will have negligible visual impact on surrounding residences as demonstrated by the visual impact assessment conducted by the Water Corporation.
LOCAL		*Impact was not identified for this Study Area* Visual impact of the operating plant was not identified for the local study area.	
REGIONAL		*Impact was not identified for this Study Area* Visual impact of the operating plant was not identified for the regional study area.	

Impact Name	Impact of the summit tanks on the visual amenity
Description	Up to four water tanks will be located on the Darling Scarp north east of Harvey. These tanks could be visible by neighbouring landowners and/or commuters travelling along the South Western Highway. The Water Corporation has undertaken a visual impact assessment to determine the significance of these impacts. Refer to Southern Seawater Desalination Project, Visual Impact Assessment, March 2008 (Water Corporation). The visual impact assessment concluded that from the three sight line points, the visual impact of the summit tanks was minimal, with the terrain and vegetation effectively screening the tanks from surrounding areas.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the area impacted by visual intrusion and lighting extends to residences	**Moderately Likely** If the area impacted by visual intrusion and lighting extends to the immediate surroundings of residences	**Unlikely** If the area impacted by visual intrusion and lighting is at a distance of more than 200 m from residences
Severity	**High Severity** If the area affected is a high density residential area and for periods greater than 6 months	**Moderate Severity** If the area affected is a moderately dense residential area and for periods greater between 2 and 6 months	**Low Severity** If the impact affects only a few residences and for periods less than 1 month
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Impact of the summit tanks on the visual amenity			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE		**Impact was not identified for this Study Area** The tanks are not located in the immediate study area.	
LOCAL	***Low significance***	*Unlikely* The summit tanks will have very little visual impact on the surrounding area as demonstrated by the visual impact assessment conducted by the Water Corporation.	***Low Severity*** The summit tanks will have very little visual impact on the surrounding area as demonstrated by the visual impact assessment conducted by the Water Corporation.
REGIONAL	***Low significance***	*Unlikely* The summit tanks will have very little visual impact on the surrounding area as demonstrated by the visual impact assessment.	***Low Severity*** The summit tanks will have very little visual impact on the surrounding area as demonstrated by the visual impact assessment.

Impact Name	Increase in economic activity
Description	There could be an economic benefit for the local area if the project promotes local employment, buying local resources and contracting local services. If this were the case, the economic effect will 'flow on' and stimulate further economic activity in the local area. The plant will need approximately 20 employees to operate and some of these will need to have technical skills that may not be available in the local community Additionally, there is a very low unemployment rate and labour force participation, which could limit communities' opportunity to take advantage of employment opportunities provided by the project. In terms of an increase in business opportunities, the immediate study area may have limited capacity to be able to take advantage of the opportunities brought by the project. This is different at the immediate and regional study area level, which have more developed industry and business enterprises. The operation of the project will be subcontracted, which could result in the loss of control over the number and type of local employees that are contracted, and the number and value of contracts awarded to businesses and industries in the immediate, local and regional study areas during the construction of the project.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If policies are adopted to require the SSDP Alliance to prioritise sourcing employment and business from the immediate, local and/or regional study areas	**Moderately Likely** If policies are adopted to motivate the SSDP Alliance to prioritise sourcing employment and business from the immediate, local and/or regional study areas	**Unlikely** If no policies are adopted to require or motivate sourcing employment and business from the immediate, local and/or regional study areas
Severity	**High Severity** If the study area has the required skills and/or business and industry base to take advantage of opportunities brought by the project	**Moderate Severity** If the study area has some of the required skills and/or a small business and industry base to take advantage of opportunities brought by the project	**Low Severity** If the study area does not count with the required skills and/or a business and industry base to take advantage of opportunities brought by the project
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Increase in economic activity			
Study Area / Significance		**Likelihood**	**Severity**
IMMEDIATE	*Low Significance*	***Unlikely*** No policies currently exist to require or motivate sourcing employment and business from the immediate study area	***Low Severity*** The immediate study area has limited opportunities to take advantage of the potential benefits of the project because of a low unemployment rate, lower labour force participation and smaller business and industry base however the number of opportunities brought about by the project will be minimal
LOCAL	*Low Significance*	***Unlikely*** No policies currently exist to require or motivate sourcing employment and business from the immediate study area	***Low Severity*** This study area has larger business and industry sectors to take greater advantage of opportunities brought by the project however the number of opportunities brought about by the project will be minimal
REGIONAL	*Low Significance*	***Unlikely*** No policies currently exist to require or motivate sourcing employment and business from the immediate study area	***Low Severity*** This study area has larger business and industry sectors to take greater advantage of opportunities brought by the project however the number of opportunities brought about by the project will be minimal

Impact Name	Public safety and risks as a result of chemical and fuel spillage/leaks
Description	The operation of the project will create noise, lighting and dust that were previously not present in the area. The presence of chemicals for the treatment of desalination water and maintenance of equipment during the operation of the plant create the risk of spillage or leaks. The Water Corporation will require the SSDP Alliance to develop emergency response plans and to have their own emergency response team. The Water Corporation will develop emergency response plans and follow standard best practice risk management protocols for these types of chemicals. This impact has been identified as a potential social impact but is to be dealt in the Environmental Impact Assessment and the Risk Assessment for the project.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** Not applicable. Impact dealt with in EIA and Risk Assessment.	**Moderately Likely** Not applicable. Impact dealt with in EIA and Risk Assessment.	**Unlikely** Not applicable. Impact dealt with in EIA and Risk Assessment.
Severity	**High Severity** Not applicable. Impact dealt with in EIA and Risk Assessment.	**Moderate Severity** Not applicable. Impact dealt with in EIA and Risk Assessment.	**Low Severity** Not applicable. Impact dealt with in EIA and Risk Assessment.
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Public safety and risks as a result of chemical and fuel spillage/leaks			
Study Area / Significance		Likelihood	Severity
IMMEDIATE		*Impact will be dealt with in the EIA and Risk Assessment.*	
LOCAL		*Impact will be dealt with in the EIA and Risk Assessment.*	
REGIONAL		*Impact will be dealt with in the EIA and Risk Assessment.*	

Impact Name	**Risk of terrorist attack because of the presence of infrastructure of State significance**
Description	During SIA stakeholder consultation, concern was expressed for the risk of a terrorist attack on the desalination plant because it is State significant infrastructure. The Water Corporation has made a commitment to assess this impact as part of the project risk assessment.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** Not applicable. Impact dealt with in Risk Assessment.	**Moderately Likely** Not applicable. Impact dealt with in Risk Assessment.	**Unlikely** Not applicable. Impact dealt with in Risk Assessment.
Severity	**High Severity** Not applicable. Impact dealt with in Risk Assessment.	**Moderate Severity** Not applicable. Impact dealt with in Risk Assessment.	**Low Severity** Not applicable. Impact dealt with in Risk Assessment.
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Risk of terrorist attack because of the presence of infrastructure of State significance			
Study Area / **Significance**		**Likelihood**	**Severity**
IMMEDIATE		*Risk will be dealt with in the EIA and Risk Assessment.*	
LOCAL		*Risk will be dealt with in the EIA and Risk Assessment.*	
REGIONAL		*Risk will be dealt with in the EIA and Risk Assessment.*	

Impact Name	Increased traffic in the area increasing risk for local communities and commuters
Description	There is a concern that trucks delivering chemicals to the plant and removing waste from the plant could result in higher road risks to local commuters. The Water Corporation estimates that, during operation, the average number of truck movements will be one per day and that the average number of car movements will be 10 per day. Therefore, the increase in traffic is not significant. The potential impact of this increase in traffic would depend on the condition, traffic levels, safety and capacity of the Old Coast Road and intersection with Taranto Road. Although there was no data available on the condition, traffic levels, safety and capacity of the Old Coast Road and intersection with Taranto Road, an additional truck and ten vehicles per day does not increase the likelihood of increasing risk for local communities and commuters.

Social Impact Significance Scales for this Impact			
Likelihood	**Highly Likely** If the increases in heavy and light vehicles would result deterioration of road conditions and in roads exceeding their design capacity	**Moderately Likely** If the increases in heavy and light vehicles would result in roads meeting their design capacity	**Unlikely** If the increases in heavy and light vehicles does not result in roads meeting their design capacity
Severity	**High Severity** Increases in heavy and light vehicles could result in significant increases in travel costs and increases in risk for commuters	**Moderate Severity** Increases in heavy and light vehicles could result in some increases in travel costs	**Low Severity** Increases in heavy and light vehicles could result in greater traffic but does not affect travel costs or safety for commuters
Significance	Significance is determined by the combination of the above scales of Likelihood and Severity as per Table 6.		

Social Impact Significance - Increased traffic in the area increasing risk for local communities and commuters			
Study Area	**Significance**	**Likelihood**	**Severity**
IMMEDIATE	Low Significance	***Unlikely*** Although there was no data available on the condition, traffic levels, safety and capacity of the Old Coast Road and intersection with Taranto Road, an additional truck and ten vehicles per day does not increase the likelihood of increasing risk for local communities and commuters.	***Low Severity*** Although there was no data available on the condition, traffic levels, safety and capacity of the Old Coast Road and intersection with Taranto Road, increases in heavy and light vehicles resulting in greater traffic but not affecting travel costs or safety for commuters is highly unlikely.
LOCAL	Low Significance	***Unlikely*** Although there was no data available on the condition, traffic levels, safety and capacity of the Old Coast Road and intersection with Taranto Road, an additional truck and ten vehicles per day does not increase the likelihood of increasing risk for local communities and commuters.	***Low Severity*** Although there was no data available on the condition, traffic levels, safety and capacity of the Old Coast Road and intersection with Taranto Road, increases in heavy and light vehicles resulting in greater traffic but not affecting travel costs or safety for commuters is highly unlikely.
REGIONAL	Low Significance	***Unlikely*** Although there was no data available on the condition, traffic levels, safety and capacity of the Old Coast Road and intersection with Taranto Road, an additional truck and ten vehicles per day does not increase the likelihood of increasing risk for local communities and commuters.	***Low Severity*** Although there was no data available on the condition, traffic levels, safety and capacity of the Old Coast Road and intersection with Taranto Road, increases in heavy and light vehicles resulting in greater traffic but not affecting travel costs or safety for commuters is highly unlikely.

6. Recommendations

6.1 Impact Management Strategies and Residual Significance

The following table outlines the potential impacts and recommends ways for mitigating, enhancing and monitoring them. It then predicts the residual significance of the impacts after management actions are implemented.

In phase two of the SIA, as outlined in Figure 7, it is recommended that a Social Impact Management Plan (SIMP) is developed to manage social impacts throughout the design, construction and operation of the SSDP. The SIMP should consider the mitigation, enhancement and monitoring measures suggested in Table 8 and Table 9 and be developed in consultation with the SSDP Alliance and relevant stakeholders. Efficacy of mitigation, enhancement and monitoring measures should be periodically evaluated.

Table 8 Impact Management Strategies and Residual Significance: Construction Stage

Social Impact	Significance w/out Management			Management Strategies		Residual Significance		
	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Loss of trust in the Water Corporation			Impact not identified for this study area	Develop a Commitments Register that records the commitments made to stakeholders and the community. This register should be a public document that outlines the response and progress to each of the commitments made. Provide a permanent and local contact person to provide information to and obtain feedback from the community throughout the design and construction of the project. Raise awareness of the Water Corporation's business. Provide easy access and readily available information about the project at all stages including design, construction and operation especially related to social, environmental and economic impacts.	Develop and maintain a Communication Strategy designed to guide communications between the Water Corporation and the community. Evaluate this strategy on an ongoing basis. Create a Stakeholder Advisory Group (SAG)[18] and use it as a channel to communicate both ways. Develop and implement a Social Impact Management Plan (SIMP).	No Impact	No Impact	Impact not identified for this study area

[18] It is recommended that the SAG consist of a broad representation of different stakeholder and community interests and views to provide advice and feedback to Water Corporation about key issues and at key stages during planning, construction and operation of the project. The SAG should have representation from local government, relevant state government agencies, representatives from recreational groups such as the Water Sports Club, Surf Life Saving Club, representatives from local groups such as senior citizens, youth and residents associations, representatives of special interest groups such as environmental groups, heritage groups and action groups, and representative from businesses such as local businesses and the Chamber of Commerce. The group should be representative of the broader population to ensure that the views obtained during consultation with the SAG are representative of the broader community.

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impact on community character and amenity	Insufficient Data	Insufficient Data	Insufficient Data	The decision on the location of the construction camp should take into account the potential impact the camp would have on the local community. Induction kit for all construction employees that introduces them to the community where they will be working to assist with increasing understanding. Develop a code of conduct for the construction workforce. Ensure that the community can easily communicate concerns. Investigate establishing a funding program for local environmental groups. Implement the recommendations contained in the Construction Environmental Management Plan (CEMP) to manage dust, noise and light.	Provide mechanisms for SAG involvement in the mitigation measures implemented.	Insufficient Data	Insufficient Data	Insufficient Data

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impact on community cohesion			Impact not identified for this study area	Where practical, inform and involve stakeholders and the community in decisions associated with the design, construction and operation of the project. Provide a permanent and local contact person to provide information to and obtain feedback from the community throughout the design and construction of the project. Induction kit for all construction employees that introduces them to the communities where they will be working to assist with increasing understanding of the Immediate and Local Study Areas. Develop a code of conduct for the construction workforce.	Provide mechanisms for SAG involvement in the mitigation measures implemented. Monitor the implementation of the code of conduct and the employee induction process.		No Impact	Impact not identified for this study area
Change in beach and ocean-based recreational opportunities				Wherever possible, minimise the extent and optimise timing of the restriction to the beach and ocean during construction. IImplement a construction process that minimises the scale and duration of beach and ocean closure. Provide clear and timely information about closures, including details about timeframes or potential dangers.	Work with the SAG and relevant user groups to evaluate potential problems and additional mitigation strategies. Create and manage an Issues Register to monitor responses/actions. Clearly communicate to the community incidences reported and the actions taken and identify any opportunities for improvement.			

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impact of the construction of the plant on the visual amenity of the area	Insufficient Data	Impact no identified for this study area	Impact not identified for this study area	Ensure that management strategies for visual impacts during construction of the plant are contained in the Construction Environment Management Plan and Social Impact Management Plan. Communicate with the community well in advance of major construction activities that may be visible from local areas.	Work with the SAG to evaluate potential problems and additional mitigation strategies.	Insufficient Data	Impact not identified for this study area	Impact not identified for this study area
Impact of the construction of the pipelines on the visual amenity of the area	Impact not identified for this study area	Insufficient Data	Impact not identified for this study area	Communicate with affected residents and the community well in advance of pipeline construction and discuss timeframes. Negotiate with directly affected landowners to ensure the inconvenience of pipeline construction is minimised.	Work with the SAG to evaluate potential problems and additional mitigation strategies.	Impact not identified for this study area	Insufficient Data	Impact not identified for this study area
Impact of the construction of the tanks on the visual amenity of the area	Impact not identified for this study area	Insufficient Data	Impact not identified for this study area	Communicate with affected residents and the community will in advance of tank construction and discuss timeframes.	Work with the SAG to evaluate potential problems and additional mitigation strategies.	Impact not identified for this study area	Insufficient Data	Impact not identified for this study area

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Disruption to properties along the pipeline	Impact not identified for this study area		Impact not identified for this study area	Compensate affected property owners and inform stakeholders of the construction and compensation processes. Keep the width of the pipeline construction corridor to the minimum possible when constructing near properties. Avoid undertaking construction activities overnight when constructing near properties. Inform and coordinate works with potentially affected property owners well ahead of construction in order to allow them to plan ahead.	Develop and maintain a Communication Strategy designed to provide communication channels between the Water Corporation and the Immediate and Local Study Area. Evaluate the implementation of this strategy during the project execution.	Impact not identified for this study area		Impact not identified for this die area
The project could restrict the potential for future residential development		Impact not identified for this study area	Impact not identified for this study area	Ensure that the project design takes into consideration future residential development. Implement a landscape management plan. Implement onsite mitigation strategies such as bunding / berms, screens, noise management etc.	Evaluate the implementation of the mitigation or enhancement measures to ensure that they have been implemented.	No Impact	Impact not identified for this study area	Impact not identified for this study area
The project could result in an increase in industries		Impact not identified for this study area	Insufficient Data	N/A	N/A		Impact not identified for this study area	Insufficient Data

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impacts of the overhead powerlines required to provide energy for the plant for the proposed desalination plant	Insufficient Data	Insufficient Data	Insufficient Data	N/A	N/A.	Insufficient Data	Insufficient Data	Insufficient Data
Public Safety and Risk	Impact will be dealt with in the EIA and Risk Assessment	Impact will be dealt with in the EIA and Risk Assessment	Impact will be dealt with in the EIA and Risk Assessment	Undertake an assessment of public safety and risks and implement appropriate risk management plans. Refer to recommendations in the CEMP. Implement safety procedures to ensure the safe management and storage of chemicals and fuel. Raise community awareness about the public safety measures of the project to build community understanding. The Water Corporation / Alliance should develop an Emergency Response Plan.	Provide channels for communities and stakeholder to be able to report any public safety and risks questions, issues or concerns. Evaluate incidences of public safety and risks and responses to incidences and identify ways of enhancing procedures.	Impact will be dealt with in the EIA and Risk Assessment	Impact will be dealt with in the EIA and Risk Assessment	Impact will be dealt with in the EIA and Risk Assessment
Increased demand on community facilities and services	Insufficient Data	Insufficient Data	Insufficient Data	Once the location of the construction camp has been decided and its proximity to community facilities and services has been considered: Conduct a needs assessment of the workforce to identify requirements for and impact on community facilities and services. Provide recreational opportunities for construction workforce. Provide transport to appropriate leisure activities or facilities in the regional area.	Consult recreational services and facilities providers in the immediate and local study areas to monitor increases in demand and impact on levels of services. Monitor employee satisfaction with recreational opportunities, leisure activities and services.	Insufficient Data	Insufficient Data	Insufficient Data

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Increase in economic activity	POSITIVE IMPACT	POSITIVE IMPACT	POSITIVE IMPACT	The Water Corporation / Alliance to consider giving priority to employment and businesses in the immediate and local study areas. Provide on the job training or traineeships where possible.	Monitor number of people and businesses working with the SSDP Alliance. Monitor the fair implementation of prioritising employment and businesses for the immediate and local study areas.	POSITIVE IMPACT	POSITIVE IMPACT	POSITIVE IMPACT
Increase in cost of labour for industries and businesses in the region	Insufficient Data	Insufficient Data	Insufficient Data	Consider undertaking an economic assessment. SSDP Alliance to investigate employing unemployed people in the immediate and local study area.	Consult with industries and businesses in the region to monitor any impacts on the cost of labour.	Insufficient Data	Insufficient Data	Insufficient Data
Disruption to businesses during construction			Impact not identified for this study area	Coordinate construction process and timing with affected landowners and business owners. Provide communication channels for businesses to be able to ask questions or discuss issues or concerns. Provide fair compensation for any losses incurred. Inform stakeholders about construction progress and impacts in a timely manner.	Monitor the complaints register. Work with the SAG to identify unexpected impacts and additional mitigation measures. Evaluate questions, issues or concerns raised and the actions taken and identify opportunities for improvement.	No Impact		Impact not identified for this study area
Unequal distribution of costs and benefits of the project				Develop a local / regional benefits 'package' in consultation with stakeholders and the community.	Establish a SAG to work with the Corporation in developing local / regional benefits.			

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Increased traffic in the area causing delays and increasing risk for local communities and commuters	Insufficient Data		Insufficient Data	Implement traffic management measures in order to warn commuters of any changed road conditions, risks and alternative routes. Provide transport for the workforce in order to avoid large increases in traffic in the area. Consult with the SAGs and affected groups in the immediate and local study areas to identify / mitigate any additional traffic impacts/risks potentially identified.	Monitor the number, type, and consequence of traffic accidents and involvement of SSDP Alliance employees and develop strategies for reducing incidences.	Insufficient Data		Insufficient Data
Impacts from expanding the plant to 100 GL/yr			Impact not identified for this study area	Inform communities and stakeholders well in advance about timing and activities that would need to be undertaken for the expansion of the plant.	Monitor community and stakeholder concerns about the positive and negative effects of the expansion. Reconvene a SAG to work together with the Water Corporation in order to improve the social performance of the expansion.			Impact not identified for this study area
Reduced tourism to Binningup and Myalup beaches				Raise awareness about the importance of the project. Ensure there is appropriate signage to inform tourists of the location of impact and of timeframes.	Monitor the number of visitors to the beaches before, during and after construction.	No Impact	No Impact	No Impact

Table 9 Impact Management Strategies and Residual Significance: Operation Stage

Social Impact	Significance w/out Management: Immediate SA	Significance w/out Management: Local SA	Significance w/out Management: Regional SA	Management Strategies: Mitigation or Enhancement	Management Strategies: Monitoring Recommendations	Residual Significance: Immediate SA	Residual Significance: Local SA	Residual Significance: Regional SA
Increased provision and security of water supply to the IWSS	POSITIVE IMPACT	POSITIVE IMPACT	POSITIVE IMPACT	N/A	N/A	POSITIVE IMPACT	POSITIVE IMPACT	POSITIVE IMPACT
Communities living with uncertainty	Addressed in Environmental Impact Assessment	Addressed in Environmental Impact Assessment	Addressed in Environmental Impact Assessment	Provide a permanent local contact person to provide information to and obtain feedback from the community throughout the operation of the project. Develop a Commitments Register that records the commitments made to stakeholders and the community. This register should be a public document that outlines the response and progress to each of the commitments made. Provide clear information about the project specifically related to social, environmental and economic impacts.	Develop and maintain a Communication Strategy designed to provide communication channels between the Water Corporation and the community. Evaluate the implementation of this strategy during the project execution. Reconvene a SAG to obtain feedback about the plant's operations and its impact on the community and stakeholders.	Addressed in Environmental Impact Assessment	Addressed in Environmental Impact Assessment	Addressed in Environmental Impact Assessment

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Change in ocean-based recreational opportunities because of environmental impacts of brine release				Make all findings of the environmental monitoring studies available to stakeholders and communities. Assist the community in understanding the environmental studies by preparing simple information materials.	Continuously monitor the environmental impacts as per the Public Environmental Review.	No impact	No impact	No impact
Impact on community character and amenity			No impact	Conduct open days and tours to educate communities about the project. Implement the recommendations in the Operational Environmental Management Plan (CEMP) to manage dust, traffic and noise. Induction kit for all construction employees that introduces them to the communities where they will be working to assist with increasing understanding of the Immediate and Local Study Areas. Develop a code of conduct for the construction workforce. Collaborate with key community groups to organise a series of community events which encourage social interaction between residents and employees.	Obtain feedback from the SAGs regarding the status of the mitigation measures implemented. Monitor the implementation of the code of conduct and employee induction process.			No impact

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Impact of the plant on the visual amenity		Impact not identified for this study area	Impact not identified for this study area	Encourage a plant design that blends with the local environment. Continue to undertake visual impact assessments of the plant as the design is finalised and communicate this to stakeholders and the community. Plant mature trees for screening to reduce the time required for vegetation screening and minimise visual impact.	Obtain feedback from the SAG regarding the status of the mitigation measures implemented.		Impact not identified for this study area	Impact not identified for this study area
Impact of the summit tanks on the visual amenity	Impact not identified for this study area			Landscape for screening to minimise visual impact.	Obtain feedback from the SAG regarding the status of the mitigation measures implemented.	Impact not identified for this study area		
Increase in economic activity				The Water Corporation, through contractual arrangement, should request the successful SSDP Alliance to give priority to employment and businesses in the immediate and local study areas and provide on-the-job training or traineeships where possible.	Monitor the fair implementation of prioritising employment and businesses in the immediate and local study areas.			

	Immediate SA	Local SA	Regional SA	Mitigation or Enhancement	Monitoring Recommendations	Immediate SA	Local SA	Regional SA
Public safety and risks as a result of chemical and fuel spillage/leaks	Impact dealt with in the EIA and Risk Assessment	Impact dealt with in the EIA and Risk Assessment	Impact dealt with in the EIA and Risk Assessment	Undertake an assessment of public safety and risks and implement public safety and risk management procedures. Implement safety procedures to ensure the safe management and storage of chemicals and fuel Increase community awareness of the chemicals used in the desalination process, the risks and the safety and emergency procedures in place.	Provide channels for communities and stakeholder to be able to report any public safety and risks questions, issues or concerns. Evaluate incidences of public safety and risks, responses to incidences and identify ways of enhancing procedures.	Impact dealt with in the EIA and Risk Assessment	Impact dealt with in the EIA and Risk Assessment	Impact dealt with in the EIA and Risk Assessment
Risk of terrorist attack because of the presence of infrastructure of State significance	Impact dealt with in Risk Assessment	Impact dealt with in Risk Assessment	Impact dealt with in Risk Assessment	Develop anti-terrorism response plan.	Test the anti-terrorism response plan to ensure its effectiveness.	Impact dealt with in Risk Assessment	Impact dealt with in Risk Assessment	Impact dealt with in Risk Assessment
Increased traffic in the area increasing risk for local communities and commuters				Undertake a traffic assessment of the safety of the intersection between Taranto Road and the Old Coast Road and liaise with Main Roads WA and Shire of Harvey to improve the safety of this intersection if required. Implement a traffic management plan.	Monitor the number, nature and involvement of SSDP employees in traffic incidents near the plant and develop appropriate response.	No Impact	No Impact	No Impact

6.2 Positive Impacts

The positive impacts resulting from this project are:

- Increase in economic activity in the Immediate, Local and Regional study areas during construction and operations of the project (moderate positive impact for Immediate study area, high positive impact for Local Study area and Regional Study area); and
- Increased provision and security of water supply to IWSS for the Immediate and Local study areas (high positive impact for Immediate Study area and Local Study area).

6.3 Impacts that cannot be mitigated

The impacts that cannot be mitigated during the construction of the project are:

- Change in beach and ocean-based recreational opportunities (Low in the Immediate, Local and Regional Study areas);
- The project could result in an increase in industries (Low in the Immediate Study Area); and
- Reduced tourism to Binningup and Myalup beaches (Low in the Immediate, Local and Regional Study areas).

There are no impacts that cannot be mitigated during the operation of the project.

Based on existing information there are no fatal flaws[19] or unacceptable impacts[20] identified for the SSDP.

6.4 Social Impact Management Plan Recommendations

For this project, the first stage towards managing social impacts has been the undertaking of this SIA as shown in Figure 7. The second stage of this process is the development of a Social Impact Management Plan (SIMP) that should be implemented during the construction and operation of the project.

The mitigation, enhancement and monitoring recommendations should be brought together in a SIMP, which would be the ultimate responsibility of a project manager during construction, and the operations manager during the operations phase.

The SIMP should integrate and communicate all findings to the Alliance in order to enhance the social performance of the project and build stronger relationships with the community. The SIMP should be flexible and adaptive to be able to identify unexpected impacts and respond to them accordingly. It should also be reviewed on an ongoing basis to ensure that emerging information which identifies new impacts or provides additional knowledge about existing impacts is considered.

---

[19] A fatal flaw is defined as an impact that cannot be managed and/or mitigated in order for it to have significance lower than high.

[20] Unacceptable impacts are those that can be managed and/or mitigated but still have a moderate residual significance after considering the effect of suggested management and mitigation measures (residual significance).

7. Glossary of Terms

Australian Bureau of Statistics (ABS) *Source:* *www.abs.gov.au*	Australia's official statistical collection organisation.
Buffer Zone	A designated zone surrounding a site or structure, which is intended to keep two or more areas separate from one another.
Bunding / berms *Source:* *http://en.wikipedia.org/wiki/Bunding#Access_containment*	Bunding, also called a bund wall, is the area within a structure designed to prevent inundation or breaches of various types.
Environmental Protection Authority (EPA) *Source:* *www.epa.wa.gov.au*	The EPA was established by Parliament as an independent Authority with the broad objective of protecting the State's environment. This is undertaken through the process of providing overarching environmental advice to the Minister for the Environment through the preparation of environmental protection policies and the assessment of development proposals and management plans, as well as providing public statements about matters of environmental importance.
Greater Bunbury Region Scheme *Source:* *www.wapc.wa.gov.au*	Prepared by the Western Australian Planning Commission and approved with modifications by the Governor in Executive Council. The scheme applies to the Greater Bunbury region which comprises all of the districts of the City of Bunbury and the shires of Capel, Dardanup and Harvey. The purposes of the Scheme are to (a) provide for the reservation and protection of land for regional transport, infrastructure, conservation, recreation and public purposes; (b) provide for the zoning of land for living, working and rural land uses; (c) provide a mechanism for landowners to be compensated in a fair and equitable manner where land is reserved for a public purpose; (d) provide an opportunity for the formal environmental assessment of regional planning proposals and provide increased certainty to such proposals; (e) provide a mechanism for certain development of regional significance, and development in areas of regional significance, to be considered and approved by the Commission; and (f) identify and protect land having strategic importance for industrial and future urban use.

Henderson Poverty Line *Source:* *Facts, figures and suggestions for the future Poverty* *http://www.bsl.org.au/pdfs/poverty.pdf*	One well-known measure of poverty in Australia is the Henderson Poverty Line. It estimates the amount of money which families of different sizes need to cover essential needs.
Index of Relative Socio-Economic Advantage and Disadvantage (IRSEAD) *Source:* *Moreland City Council: Fawkner suburb profile, 2004* *http://www.moreland.vic.gov.au/pdfs/profile/Fawkner%20Suburb%20Profile%202004%20d.pdf*	The Index of Relative Socio-Economic Disadvantage is derived from attributes such as low income, low educational attainment, high unemployment, jobs in relatively unskilled occupations and variables that reflect disadvantage rather than measure specific aspects of disadvantage (for example, Indigenous and separated/divorces). High scores on the Index of Relative Socio-Economic Disadvantage occur when the area has few families of low income and few people with little training or in unskilled occupations. Low scores on the Index occur when the area has many low income families and many people with little training or working in unskilled occupations. It is important to understand that a high score here reflects lack of disadvantage rather than high advantage, a subtly different concept.
Integrated Water Supply Scheme (IWSS) *Source:* *Integrated Water Supply Scheme Source Development Plan 2005-2050* *http://www.watercorporation.com.au/_files/publicationsregister/22/SourcePlan_2005_Summary.pdf*	The Integrated Water Supply Scheme (IWSS) supplies water to 1.5 million of the 1.9 million people living in Western Australia. The Scheme's service area takes in towns in the South West, metropolitan Perth and, through the Goldfields Pipeline from Mundaring Weir to towns and farmlands in the Central Wheatbelt out to Kalgoorlie Boulder. The Scheme is supplied from multiple groundwater and surface (dam) water sources located over a wide geographic area.
Office of Crime Prevention *Source:* *www.crimeprevention.wa.gov.au*	The lead government agency responsible for coordinating crime prevention and community safety initiatives within Western Australia.
Public Environmental Review *Source:* *www.epa.wa.gov.au*	The primary purpose of the Public Environmental Review is to provide to the EPA information on the proposal within the local and regional framework, with the aim of emphasising how the proposal may impact the key environmental factors and how those impacts may be mitigated and managed so as to be environmentally acceptable.

Social Impact Assessment (SIA) *Source:* *Burdge, Ravel (2004: 2)*	A "systematic analysis in advance of impacts on the day-to-day quality of life of persons and communities whose environment is affected by a proposed plan, program, project or policy change."
Social Impact Management Plan	A management plan intended to mitigate, monitor and evaluate social impacts throughout the life of a project.
Stakeholder Advisory Group (SAG)	A group of stakeholder and community representatives with various interests and perspectives whose purpose is defined by an agreed Terms of Reference. The advisory group may have input, provide feedback and request information about project communications and decisions.
Viewshed	All things within direct line of sight from a nominated place.

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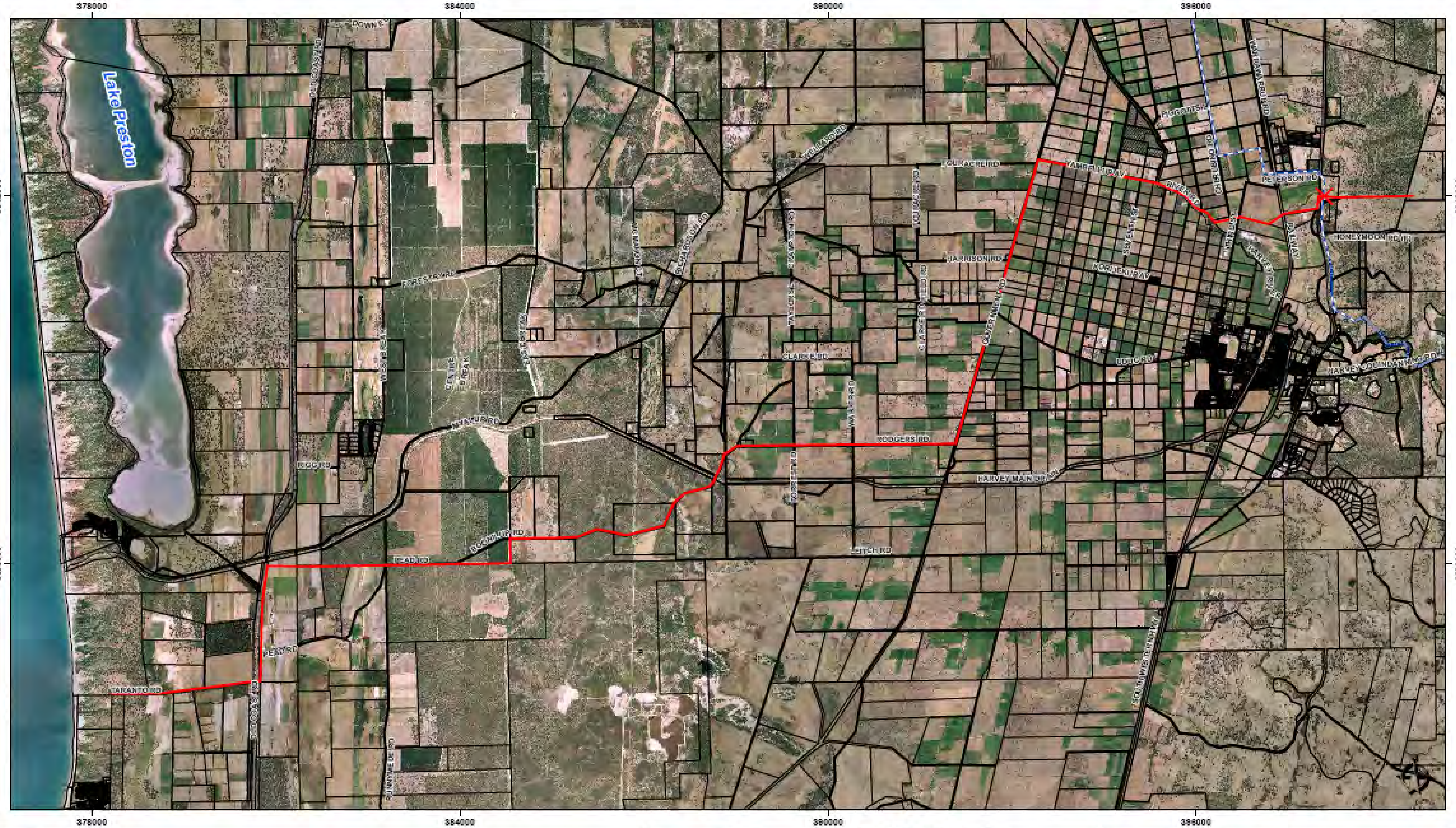
Appendix A

Preferred Pipeline Corridor

Source:

Water Corporation Website
http://www.watercorporation.com.au/D/desal2_reports.cfm

- Preferred Pipeline Corridor Map
- Preferred Pipeline Corridor Map Description



LEGEND

Potential Pipeline Routes - GHD - 2007

- Preferred Pipeline Route
- Existing Regulating Valve
- DN1400 Stirling Trunk Main
- Cadastral Boundaries - Landgate - 200703

ALL DATA SOURCED FROM WATER CORPORATION UNLESS OTHERWISE STATED
MAP UNITS PROJECTED IN MGA ZONE 50
NOTE THAT POSITIONAL ERRORS CAN BE > 5M IN SOME AREAS
AERIAL PHOTOGRAPHY DATED MARCH 2006 SOURCED FROM WATER CORPORATION

SCALE

600 0 600 1,200 1,800 m

1:60,000 at A3

LOCALITY MAP

Harvey Region

CREATED BY	CHECKED	APPROVED
CR	ML	

HORIZONTAL DATUM: GDA 94 PROJECTION: MGA ZONE 50

HEIGHT DATUM: NA METADATA RECORDED: 100%

DATE	FILE LOCATION
17.09.07	G:\61\21216\GIS\MXDS\6121216-G14.MXD
REVISION	**DRAWING NO**
0	6121216-G14

COPYRIGHT

WATER CORPORATION

GHD CLIENTS | PEOPLE | PERFORMANCE

SOUTHERN SEAWATER DESALINATION PLANT
PRELIMINARY DESIGN

Transfer Main Route

SOUTHERN SEAWATER DESALINATION PLANT[21]

WATER TRANSFER PIPELINE – PREFERRED ROUTE

A preferred route for the water transfer pipeline to connect the Southern Seawater Desalination Plant to the Integrated Water Supply System has been prepared. The preferred route has been prepared based on field observations, aerial photographs and discussions with the community and seeks to have minimal impact on social, environmental and economic values of the area. The preferred route could be subject to change following discussions with affected landowners, and environmental and geological surveys.

Taranto Road

- The preferred alignment is in an east-west direction on the northern side of Taranto Road in agricultural land, parallel to Taranto Road.
- Minimal vegetation clearing will be required.

Perth-Bunbury Highway (Old Coast Road)

- The preferred alignment is in a north-south direction on the eastern side of Old Coast Road within agricultural land, from Taranto Road to approximately 50m south of Myalup Road.
- Minimal vegetation clearing will be required.

No Name Road

- The preferred alignment is in an east-west direction within agricultural land and then within the road reserve of No Name Road.
- The vineyard immediately to the south of No Name Road will be avoided.

State Forest

- The preferred alignment is in an east-west direction in State Forest utilising an existing cleared track approximately 5m wide. The track will require widening to approximately 20m width for construction.
- Further in State Forest, the preferred alignment is in an east-west direction utilizing an existing cleared track approximately 20-30m wide. No vegetation clearing will be required.
- The preferred alignment then changes to a north-south direction on East Break until Boonilup Road, utilising an existing 20m cleared track.

Boonilup Road

- The preferred alignment is within the road reserve of Boonilup Road. Boonilup Road is an existing unsealed track of 5-10m width. The remainder of the road reserve will be cleared for construction. The preferred alignment includes a crossing of the Harvey-Myalup Main Drain.
- Agricultural land will be avoided with the pipeline located within the road reserve.

Rodgers Road

- At the western end of Rodgers Road the preferred alignment is within the road reserve to miss the existing dwellings.
- The preferred alignment for the remainder of Rodgers Road is within agricultural land on the northern side of Rodgers Road in an east-west direction.

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[21] This document was produced in December 2007.

- Locating the pipeline within the agricultural land will avoid the large stands of native vegetation contained in the road reserve.

Government Road

- The preferred alignment along Government Road is in a north-south alignment within the road reserve under the road.
- Some vegetation clearing within the road reserve will be required for construction.

Yambellup Avenue

- The preferred alignment along Yambellup Avenue is in an east-west alignment. Further investigation and consultation with affected landowners is required to identify a preferred route.

River Road

- The preferred alignment along River Road is predominantly within the road reserve with minor incursions into agricultural land.
- The orchards/vineyards on River Road will be avoided where possible. Minor vegetation clearing along River Road will be required.

Agricultural Land

- On River Road the preferred alignment crosses in an east-west direction through agricultural land to Third Street, and again crossing agricultural land from Third Street to Warrawarrup Road.
- From Warrawarrup Road eastwards to South Western Highway the preferred alignment is within a combination of road reserve and agricultural land. The alignment changes to a north-south direction parallel to South Western Highway within agricultural land.

East of South Western Highway

- East of South Western Highway the preferred alignment is in an east-west direction predominantly within cleared agricultural land. Some vegetation clearing will be required for construction.

Appendix B

Chemicals Used for Treatment of Water Supplied

Source:

Water Corporation Website

http://www.watercorporation.com.au/_files/PublicationsRegister/15/Chemicalsusedfortreatment.pdf

Chemicals used for treatment of drinking water supplies (1989)

The NHMRC has examined a wide range of chemicals for treating water in Australia and has recommended those listed for use. To be acceptable, a chemical must have practical application (eg clarify dirty water or removing harmful microorganisms) and none must be toxic when ingested in small doses in drinking water.

Chemical	*Formula*	*Reference*
Aluminium sulfate	$Al_2(SO_4)_3$	AWWA B403-82
Ammonia (ammonium hydroxide)	$NH_3(aq)$	FCC p20-21
Ammonium sulfate	$(NH_4)_2SO_4$	AWWA B302-81
Calcium hydroxide	$Ca(OH)_2$	AWWA B202-83
Calcium hypochlorite	$Ca(OCl)_2$	AWWA B300-80
Calcium oxide	CaO	AWWA B202-83
Calcium/sodium poly-phosphate silicate	_	NHMRC 1980 (90th Session p22)
Carbon, powdered activated	C	AWWA B600-78
Chlorine	Cl_2	AWWA B301-81
Copper sulfate	$CuSO_4.5H_2O$	AWWA B602-80
Ferric chloride	$FeCl_3.6H_2O$	AWWA B407-83
Ferric sulfate	$Fe_2(SO_4)_3$	NHMRC 1983 (95th Session p27)
Hydrofluorosilicic acid (Fluorosilicic acid)	H_2SiF_6	AWWA B703-84
Hydrogen peroxide	H_2O_2	FCC p 146-147
Magnetite	Fe_3O_4	-
Polyaluminium chloride	$Al_8(OH)_{10}SO_4Cl_{12}$	NHMRC 1979 (88th Session p 17-18)
Polydimethyldiallyl ammonium chloride	-	NHMRC 1982 (93rd Session p 19-20)
Polyacrylamides and acrylic acid (polymers and copolymers)	$(CH_2CHCONH_2)_n$ and $(CH_2CHCOOH)_n$	NHMRC 1977, 1979 (84th Session p22 and 88th Session p21)
Potassium permanganate	$KMnO_4$	AWWA B603-83
Silver hydrogen peroxide	$Ag^+.H_2O_2$	NHMRC 1989 (107th Session p17)
Sodium alginate	-	FCC p274

Sodium aluminate	$NaAlO_2$	AWWA B405-83
Sodium bicarbonate	$NaHCO_3$	FCC p278
Sodium carbonate	Na_2CO_3	AWWA B201-80
Sodium chloride	$NaCl$	AWWA B200-78
Sodium fluoride	NaF	AWWA B701-84
Sodium fluorosilicate (Sodium silicofluoride)	Na_2SiF_6	AWWA B702-84
Sodium hexametaphosphate	$(NaPO_3)_6$	AWWA B502-83
Sodium hydroxide	$NaOH$	AWWA B501-80
Sodium hypochlorite	$NaOCl$	AWWA B300-80
Sodium silicate	$Na_2O.xSiO_2$ ($x = 3 - 5$)	AWWA B404-80
Sulphuric acid	H_2SO_4	FCC p 317-318
Zinc ortho-phosphate	$Zn_3(PO_4)_2$	NHMRC 1987 (104th Session p32)

* NHMRC – National Health and Medical Research Council
AWWA – American Water Works Association Standards
FCC – Food Chemicals Codex, 3rd Edition, 1981

Appendix C
Scoping

SIA Scoping

Scoping is a preliminary investigation of the potential social impacts that may occur as a result of the SSDP. It identifies potential issues and concerns identified in secondary data and preliminary consultations with key stakeholders and the community to focus the Social Impact Assessment on these key variables.

Webbing and Chaining

A brainstorming of the flow and chain of effects was undertaken by GHD to understand the potential impacts from the construction and operation of the SSDP. Figure A1 shows the chain of impacts that are presented in the form of a web diagram to illustrate the interrelationships of potential social impacts during construction of the SSDP and Figure A2 shows the impacts during operations.

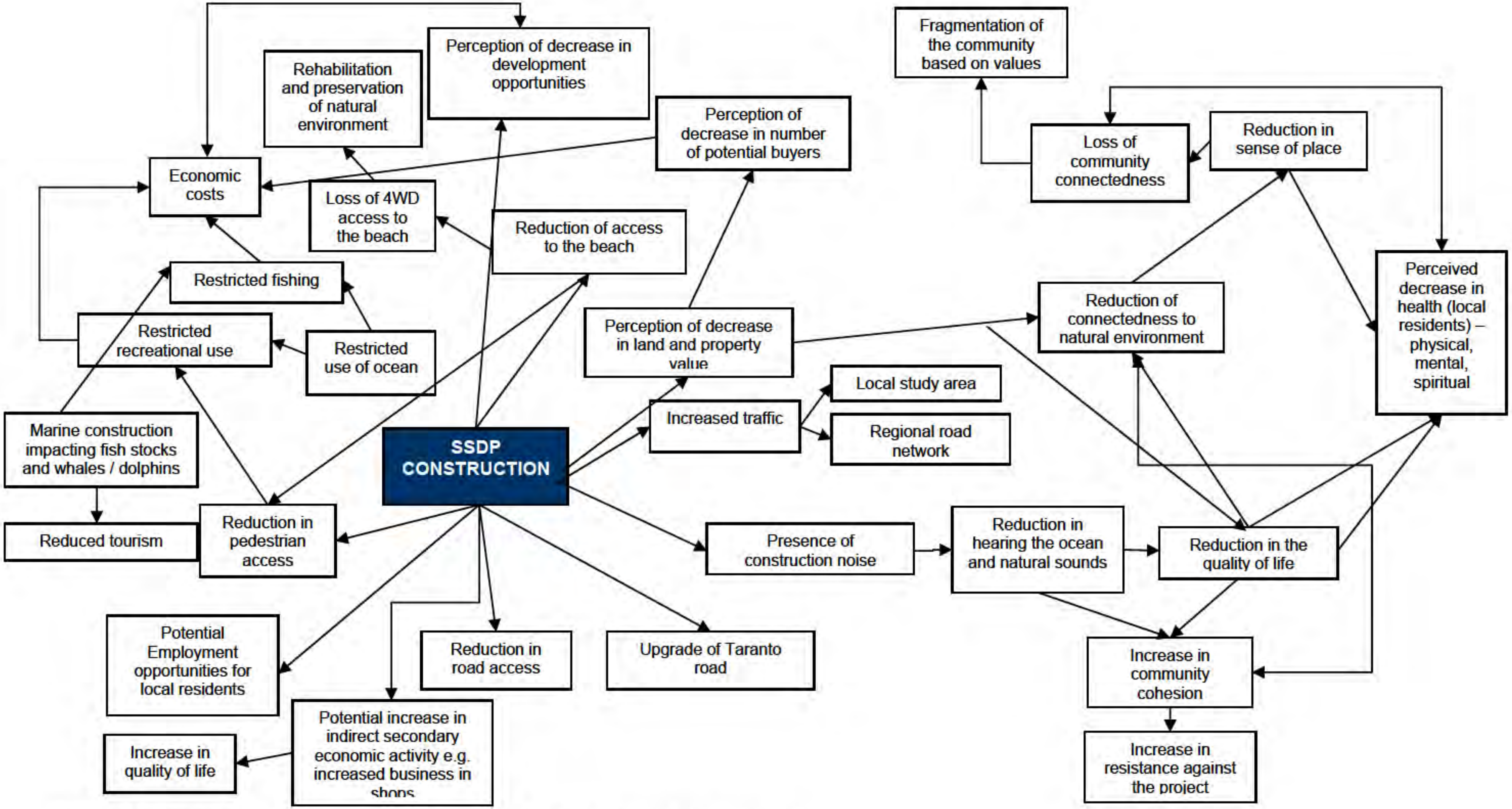

Figure A1 Webbing and Chaining for Potential SSDP Construction Impacts

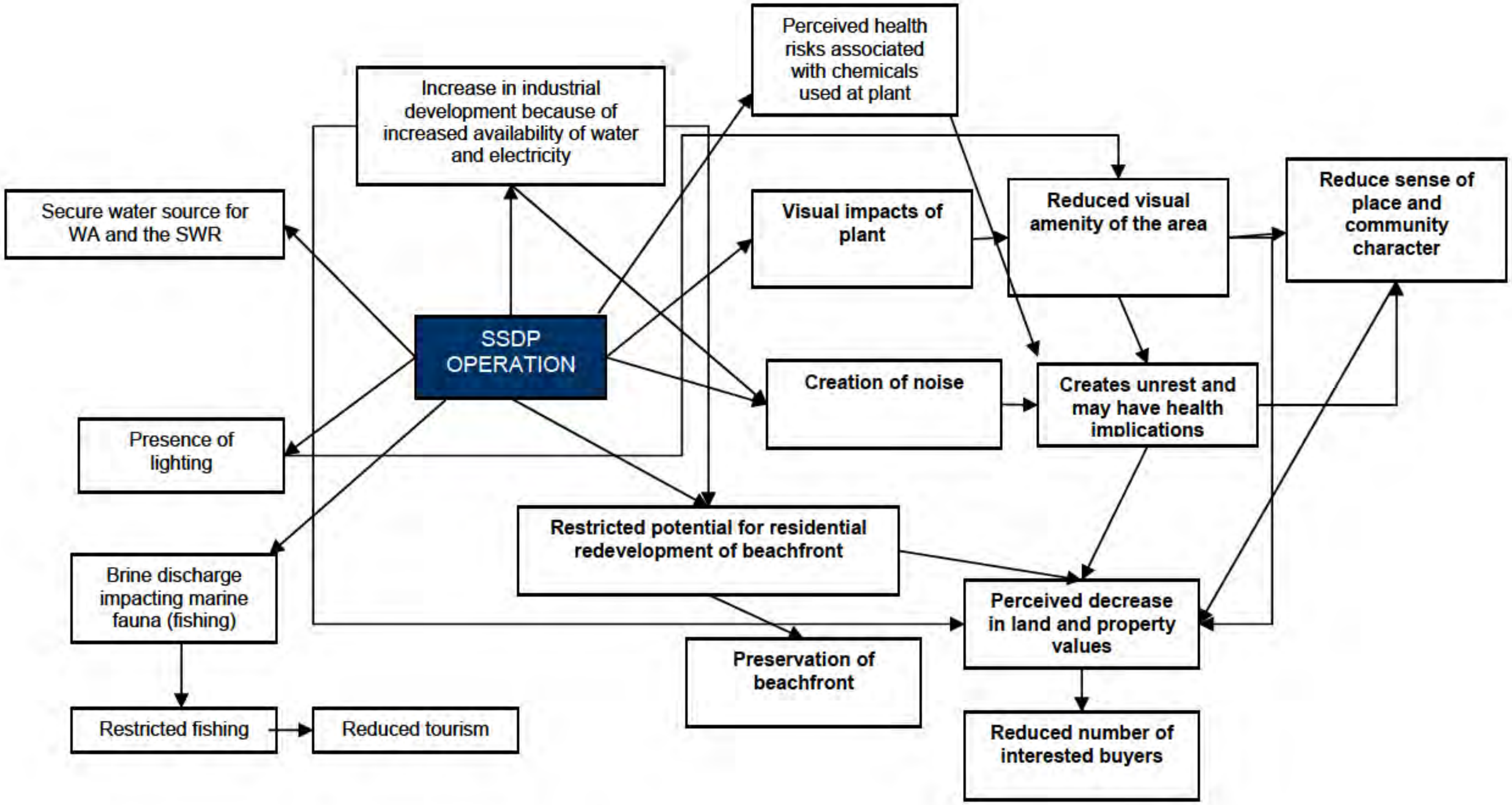

Figure A2 Webbing and Chaining for potential SSDP Operations Impacts

Stakeholders and Potential Social Impacts

The following community and key stakeholders were identified by GHD during the scoping stage as potential SIA stakeholders that may be consulted in the identification and ranking of positive and negative social impacts and mitigation, enhancement and monitoring measures.

Table A1 Potential social impact for stakeholder groups

Stakeholder Groups	Potential Social Impacts, Concerns and Issues identified by GHD during the Scoping Stage
The Water Corporation (Proponent)	• Loss of trust from communities due to the sudden announcement of the decision and the lack of perceived transparency in selecting the site. • Community concern about the project because of a lack of consultation and information about the project and the potential impacts.
Binningup Desalination Action Group	• Visual impact of the project and its effects on the amenity of the area and land values. • Increased population of the construction workforce and the: (a) increased traffic in the area, (b) increased population, (c) potential increases to crime and safety, (d) change in community identity and sense of place, and (e) competing demands on facilities and services including recreation. • Perceived costs to the community. • Health risks associated with the chemicals used at the plant. • Lack of consultation in selecting the site for the desalination plant and the lack of information about the potential impacts.
Myalup Residents Association	• Presence of a desalination plant close to environmentally sensitive areas. • Health risks associated with the chemicals used at the plant. • Lack of consultation in selecting the site for the desalination plant and the lack of information about the potential impacts.
Residents Association, Harvey	• Visual impact of tanks for residents within the immediate study area as well as visitors to the area.
Shire of Harvey	• Changes to potential for residential development in the area. • Changes to access to recreational activities during construction. • Costs associated with maintaining additional infrastructure in the area. • Community concern about the project.
Fire and Emergency Services	• Increased reliance on services due to additional people.
WA Police	• Increased crime rates due to increased population.

Stakeholder Groups	Potential Social Impacts, Concerns and Issues identified by GHD during the Scoping Stage
Senior Citizens	• Changes to the immediate study area with additional people migrating to the area during construction. • Increased crime rates due to temporary increased population. • Increased traffic in the area and changing traffic conditions.
Young People	• Potential for employment and training opportunities in the area. • Restricted access to the beach and recreational activities.
Tourism Operators	• Visual impact in the area, detracting from the natural landscape and the amenity of the area, potentially making it less attractive for tourists. • Restricted access to the beach and recreational activities.
Developers	• Potential for decrease buyer interest which may reduce land and property values, making it less attractive to developers. • Potential restrictions to residential development in the area.
Department of Environment and Conservation	• Environmental impacts of the construction of the desalination plant, pipeline or tanks on the land or marine environment. • Disruption of contaminated land during construction. • Impact of desalination process on the land or marine environment.
State and Local politicians	• Community concerns and issues with the desalination plant. • Potential for support / lack of support during an election.
Western Power	• Community concerns about the corridor for the transmission line for the desalination plant.
Health and Community Services	• Increased demand on services due to large influx of construction workers. • Reduced levels of service for existing customers.
Recreation centres	• Increased clients to recreational centres therefore increased revenue. • Potential for increased demand on facilities.
Country Clubs	• Increased memberships to country clubs in the area. • Potential for increased demand on facilities.
Businesses within the immediate study area	• Increased business in the area due to influx of construction workers.
Water Sports Clubs	• Increased clients to water sports clubs therefore increased revenue. • Increased demand on services which may lead to a reduction on the level of service

Stakeholder Groups	Potential Social Impacts, Concerns and Issues identified by GHD during the Scoping Stage
	to existing customers. • Competition for recreational activities and spaces. • Impact on water sports and recreation as a result of construction of the SSDP.
Education (schools, tertiary, P&C)	• Increased demand for education facilities. • Potential for additional users and therefore increased revenue.
Development Commissions	• Effects on development potential and changes to land uses in area. • Interaction with regional structure plans.
Fishing Industry	• Impact on fishing and crabbing in the area due to the construction of the SSDP.
Commuters	• Increased traffic in the area.
Farmers	• Impact of the construction of the pipeline on farming practices. • Increased traffic in the area. • Reduced land and property values due to pipeline easement.

Appendix D

Site Visit Schedule

Southern Seawater Desalination Plant

Social Impact Assessment Site Visit Schedule

Educational Facilities

	Binningup	Myalup	Wellesley	Wokalup	Harvey	Bunbury
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Notes:

Leisure and Recreational Facilities

	Binningup	Myalup	Wellesley	Wokalup	Harvey	Bunbury
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Notes:

Community Services and Facilities

	Binningup	Myalup	Wellesley	Wokalup	Harvey	Bunbury
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Notes:

Community Organisations

	Binningup	Myalup	Wellesley	Wokalup	Harvey	Bunbury
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Notes:

Transportation

	Binningup	Myalup	Wellesley	Wokalup	Harvey	Bunbury
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Notes:

Health and related Services/Facilities

	Binningup	Myalup	Wellesley	Wokalup	Harvey	Bunbury
1						
2						
3						
4						
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Notes:

Description of the Study Areas

Binningup

Myalup

Wellesley/Wokalup

Harvey

Bunbury

Appendix E

Terms of Reference (ToR)

SIA Terms of Reference

Description of the Existing Community

The following characteristics need to be researched to describe the existing communities. This will provide an overview of the existing communities to allow for the exploration of the changes that may occur as a result of constructing and operating the desalination plant. The draft list of variables within each profile item is an example of variables that could be included in the community profile. Variables will be included in the description of the community according to their relevance for the impact identification process. The resulting community profile will be up to seven pages long and should not be over detailed. Where appropriate, the profile will compare information for the local, regional and state study areas to facilitate understanding of magnitudes.

C 1	Demographics	For example: ◗ Age ◗ Sex ◗ Ethnicity ◗ Birthplace ◗ Cultural and language diversity ◗ Religion ◗ Marital status ◗ Family composition
C 2	Education	For example: ◗ Level of education ◗ List of education facilities in the community
C 3	Land and Housing	For example: ◗ Land and housing costs (sale and rental) ◗ Current affordable housing ◗ Housing stress in the local and regional study area (public and private housing available) ◗ Current levels of mortgage stress ◗ Current vacancy rates for properties for sale, rental, emergency and recreational / vacation accommodation ◗ Number and type of properties which will need to be used for the project to go ahead during construction and operation ◗ Identification of public and private housing within the study area ◗ Dwelling structures and tenure (home ownership) ◗ Living arrangements / household composition
C 4	Recreation and Leisure	For example: ◗ List of leisure and recreation facilities

C 5	Community Services and Facilities	For example: Describe the facilities and services that currently operate in the local study area including but not limited to: ◗ Community and cultural centres ◗ Community services and facilities ◗ Support services ◗ Community development services
C 6	Transport and Mobility	For example: ◗ Public transport ◗ Travel within area ◗ Travel to work
C 7	Tourism	For example: ◗ Number and seasonality of tourist and visitor to the local (primary zone of influence) and regional (secondary zone of influence) area ◗ List of attractions in the local study area
C 8	Community Identity and Cohesion	For example: Describe the community identify and their sense of place including: ◗ Identity – How the community view themselves, its local history and vision for the future; and ◗ Cohesion – The extent and strength of interrelationships (such as list of community organisations)
C 9	Description and Use of the Study Area	For example: ◗ Description and use of the study area – how the community currently value and use the study area
C 10	Health	For example: ◗ Describe the health of the community members in the study area including physical, mental, social, spiritual health ◗ Describe health and related services and facilities
C 11	Crime and Safety	For example: ◗ Describe the current levels and types of crime in the study area ◗ List of police and emergency services

C 12	Economic Environment	For example: ◗ Employment (industry and occupation) ◗ Family and household income ◗ Socio-economic status (level of disadvantage) ◗ Describe the employment, unemployment and local economic environment in the study area ◗ Number and type of businesses and industries
C13	Future Planning and Projects	For example: ◗ Describe other projects in the area ◗ Presence of planning and zoning activities ◗ Review local planning schemes

Identification of Social Impacts

The assessment should identify negative and positive social impacts. The assessment will also identify the stakeholders that could potentially be affected by the impacts. Social impacts also need to be identified for the construction and operation of the project and for the local and regional study areas.

SI 1	Demographics	Identify social impacts that relate to demographic and social change in the study areas.
	Considerations	◗ Is the project likely to produce demographic changes? ◗ Is the project likely to produce a change in the type of people living within the community (such as lower / higher socio economic status groups, professional groups, etc.)? ◗ Will the project advantage or disadvantage any groups in the community?
SI 2	Education	Identify social impacts that relate to education.
	Considerations	◗ Is the project likely to influence access to and use of education services and facilities (e.g. preschools, primary schools, high schools, TAFE, universities, skill share projects, community education programs)?
SI 3	Land and Housing	Identify social impacts that relate to land and housing.

	Considerations	◗ Will accommodation be necessary for any temporary workforce associated with the project? ◗ Will housing be increased or lessened as a result of the project? ◗ Is the project likely to impact on accommodation for specific groups in the community? ◗ Will the project result in individuals needing to relocate or become homeless? ◗ Are suitable options and housing choices available for any resulting relocation? ◗ Will there be any mandatory resumption? ◗ Will relocation (particularly if resulting in mandatory resumption) result in hardship for those affected? ◗ Is there a mechanism for compensation for those affected? ◗ Are there suitable arrangements in place to assist those affected to find and relocate to alternative accommodation?
SI 4	Community Services and Facilities	Identify social impacts on the existing social infrastructure.
	Considerations	◗ Is the project likely to influence access to and demand on support services (e.g. counselling, disability, child care centres and services, youth, aged care, Aboriginal and Torres Strait Islander Services, migrant services and refugee services, etc)? ◗ Is the project likely to influence access to and use of community services and facilities (e.g. community and neighbourhood centres, community services support centres, community halls and meeting places, advocacy services and employment services etc)? ◗ Is the project likely to result in an increased population that will collectively increase the need for the above services and facilities? ◗ Will the project alter or constrain the ability of any community facility to conduct its normal operations?
SI 5	Transport and Mobility	Identify social impacts that relate to transport and mobility.
	Considerations	◗ Is the project likely to alter pedestrian amenity? ◗ Is the project likely to affect accessibility and mobility in the area?
SI 6	Tourism	Identify social impacts that relate to tourism and visitors.
	Considerations	◗ Is the project likely to produce a change in the number, type or movements of tourist / visitors?
SI 7	Community Identity and Cohesion	Identify social impacts in relation to community identity and cohesion.

	Considerations	◗ Will the project enhance or detract from opportunities for individuals or groups to participate in the community? ◗ Will the project increase or decrease opportunities for social interaction in the community? ◗ How will the project change the sense of place and identity? ◗ Will the project affect areas of community significance? ◗ Will the project alter the way in which residents and workers can enjoy, socialise and recreate in the study areas? ◗ Will the structures associated with the project alter the study area's amenity (i.e. new fencing, landscaping or advertising devices etc.)?
SI 8	Description and Use of the Study Area	Identify social impacts that relate to the use of the study area.
	Considerations	◗ Will the project alter open space areas in the study areas? ◗ How is the project going to integrate with the existing neighbourhood (e.g. connectiveness, pathways and open space)? ◗ How will the Project change the use of the study area (number, type and movement)? ◗ How will the community's value of the study area change as a result of the Project?
SI 9	Recreation and Leisure	Identify social impacts on recreation and leisure.
	Considerations	◗ Will the project create or alter the need for cultural, recreation and information infrastructure and services (e.g. theatres, cinemas, art centres, community arts programs and services, museums, galleries, sporting facilities and activities, leisure facilities and services, libraries, communications facilities and services – including post offices, post boxes, mail delivery and telephone boxes)?
SI 10	Health	Identify social impacts in relation to health.
	Considerations	◗ Are there any specific health (physical and/or psychological due to disruption in social networks) impacts or risks associated with the project? ◗ Is there a perception in the community that the project may have health, environmental or social risks or benefits? ◗ Is the project likely to influence access to health and related facilities and services (e.g. hospitals, health clinics, nursing homes, alcohol and drug services, family planning services, hospice services, immunisation clinics, youth health services, women's health services, HIV/AIDS services, ATSI health services, occupational health and safety)?
SI 11	Crime and Safety	Identify social impacts related to crime and public safety.

	Considerations	◗ Will the Project change the level and type of crime in the area? ◗ Will the Project change the communities' perception of crime and safety in the area? ◗ Will the project consider CPTED principles?
SI 12	Economic Environment	Identify social impacts on the economic environment.
	Considerations	◗ Will the project result in a change in the number, type and access to jobs in the immediate and local study areas? ◗ Will the project create or enhance economic opportunities? ◗ Will the project have an increased demand on existing businesses in the area? ◗ Will there be a change in the industries and businesses in the area?
SI 13	Future Planning and Projects	Identify social impacts that relate to future planning and projects.
	Considerations	◗ Discuss impacts that can arise from the interaction with other projects or planning?
SI 14	Other	Describe any other social impacts.
	Considerations	◗ Consider the findings of other assessments including technical and Indigenous and European heritage assessments. ◗ Any other social impacts identified.

Ranking of Social Impacts

The social impacts identified will be ranked using levels of significance.

Mitigation, Enhancement and Monitoring Strategies

Recommendations will be identified for minimising the negative social impacts and maximising the positive social impacts of the desalination plant. The strategies will outline the social impacts identified, the mitigation recommendations and any monitoring and evaluation processes.

NOTE: The outcomes of the Indigenous and European heritage studies conducted by the Water Corporation will be considered in the Social Impacts Assessment.

Appendix F

Community Profile

Community Profile

The information contained in this profile has primarily been sourced from the Australian Bureau of Statistics Census of Population and Housing 2006. Information obtained from different sources is referenced in-text. Unless otherwise specified, the data reported in this section refers to the 2006 calendar year.

Demographics

The population usually[22] residing in the immediate study area is 1,093 people, which represents 2.2% of the population in the regional study area. The population in the local study area was 5,093 people, which represents 10.3% of the population in the regional study area (49,258 people) and 0.26% of the state's population (1,959,086 people).

It is forecasted that by 2016 the population of the regional study area will be 56,000 people. The state's population is projected to grow to 2,435,750 people by the same year (WAPC 2000). There was no available data on projected populations for the immediate and local study areas.

The South West Region[23], of which the immediate, local and regional study areas are part of, has the state's largest regional population with a 10-year average annual population growth rate of 2.5% in 2005 (DLGRD 2006). The DLGRD (2006) indicates that this growth rate was higher than that of the state and all regions. Moreover, the Shire of Harvey has a higher average annual growth rate of 3.0% (DLGRD 2006).

The four study areas have similar proportions of males and females. There are slightly more males than females in the immediate and local study areas with the proportion of males to females being 102/100 (i.e. 102 males for every 100 females) for these two study areas, compared with 100/100 in the regional study area and 99/100 in the state.

The median age in the immediate study area is 37.6 years and in the local study area is 38.3 years. These median ages are higher than those at the regional (36.6 years) and the state study areas (36.0 years). Figure D1 shows the population pyramids for the four study areas. This figure suggests that the populations in the four study areas are ageing with growth rates decreasing over time and a decline in young people. The

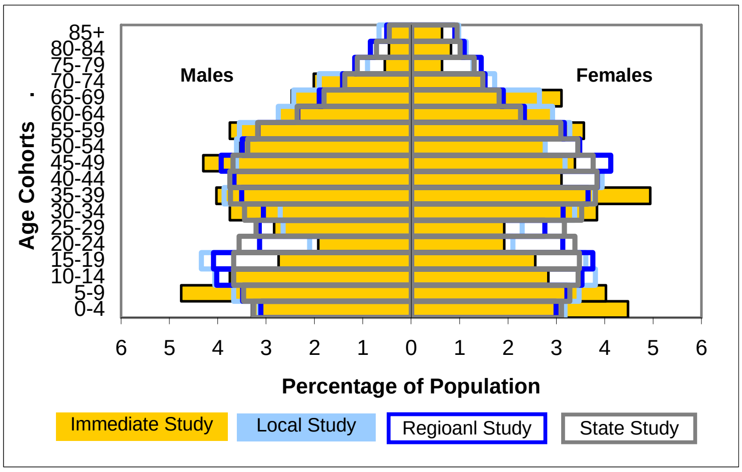


Figure D1: Population pyramids

[22] This is the place where a person usually lives. It may, or may not be the place where the person was counted on Census Night. (ABS Census Dictionary 2006).

[23] The South West Region is comprised of the City of Bunbury and the shires of Harvey, Collie, Dardanup, Capel, Busselton, Augusta-Margaret River, Nannup, Manjimup, Bridgetown-Greenbushes, Boyup Brook and Donnybrook-Balingup (DLGRD 2006).

population of the local study area shows a lower number of people aged 20 to 34 years and a higher number of people aged 55 to 74 years compared with the regional and state populations. The immediate study area has the highest proportions of people aged 0 to 9 years and 30 to 59 years.

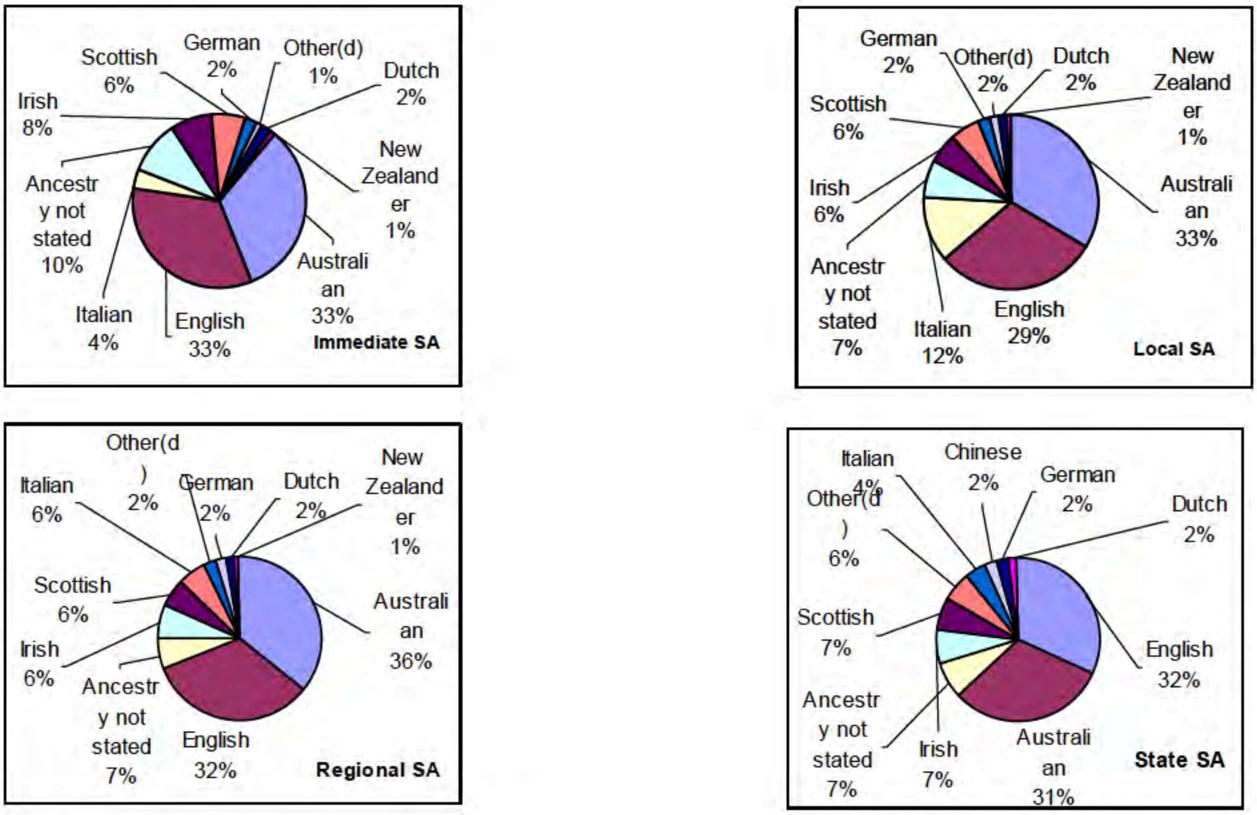


Figure D2: Ancestry

The majority of people in the four study areas identify themselves as having Australian and English ancestry (Figure D2). Irish and Scottish ancestry are also present but with smaller proportions. However, the local study area has a higher percentage of people with Italian ancestry than the immediate, regional and state study areas.

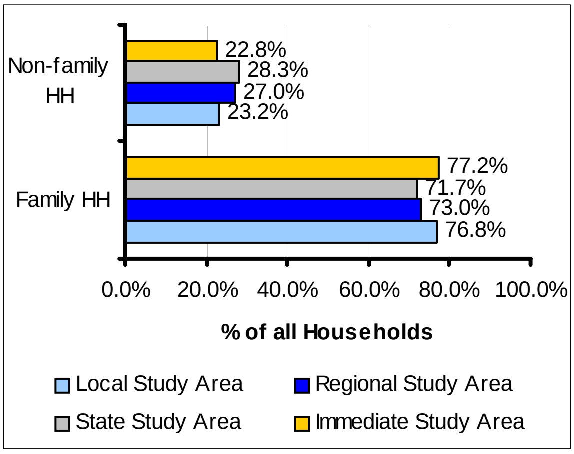


Figure D3: Household composition

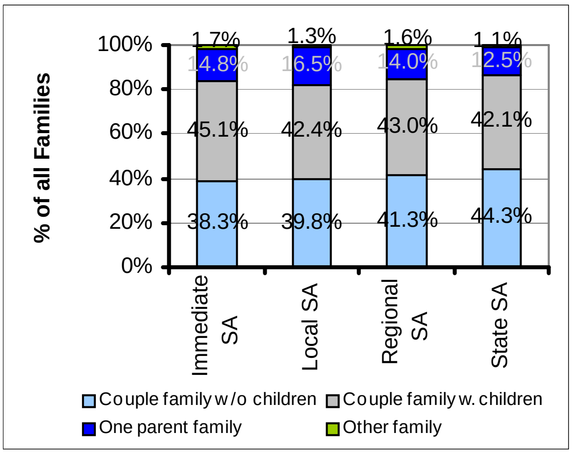


Figure D4: Composition of family households

In the four study areas, households have on average three people. As seen in Figure D3, the majority of households in the four study areas are composed of families[24]. However, the local and immediate study areas present higher proportions of family households compared to the regional and state study areas. A more detailed analysis of the types of family households (Figure D4) reveals that the immediate study area has a higher proportion (45.1%) of families consisting of couples with children compared to the local, regional and state study areas.

Education

The highest proportions of people in the regional, local and immediate study area have completed year 10 and year 12 (Figure D5). The state study area has a higher percentage of people whose completed highest year of school was year 12.

Compared with the state, the local study area has a higher proportion of people who completed Year 10 or below. Similarly, the percentage of people that did not go to school in the local study area is approximately double that of the regional and state study areas. The immediate study area has a higher proportion of people that have completed year 12 compared to the local and regional study areas.

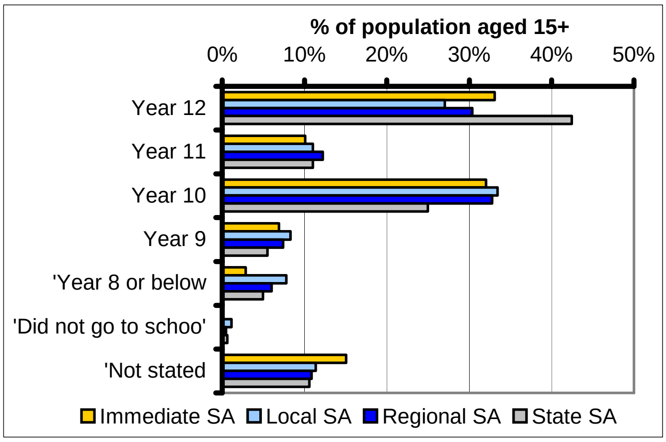


Figure D5: Highest year of school completed

[24] A family is defined by the ABS as two or more persons, one of whom is at least 15 years of age, who are related by blood, marriage (registered or de facto), adoption, step or fostering, and who are usually resident in the same household (ABS Census Dictionary 2006).

In terms of non-school educational attainment (Figure D6), the immediate, local and regional study areas tend to have more people that have finished a certificate. The most frequent non-school qualifications studied in the immediate, local and regional study areas are engineering and related technologies, management and commerce and education.

The Shire of Harvey is serviced by several school and education facilities (Table D1). There are three child care facilities: one in Australind and two in Harvey. The Shire is also serviced by 14 primary and pre-primary facilities of which five are located in Australind, two in Brunswick, two in Clifton Park, three at Harvey, one at Roelands and one at Yarloop. There are three high schools in the Shire: two at Harvey and one at Australind. The communities in the Shire of Harvey also have access to four further education facilities of which two are located at Bunbury, one at Harvey and one at Brunswick. The towns of Binningup and Myalup have no educational facilities in town.

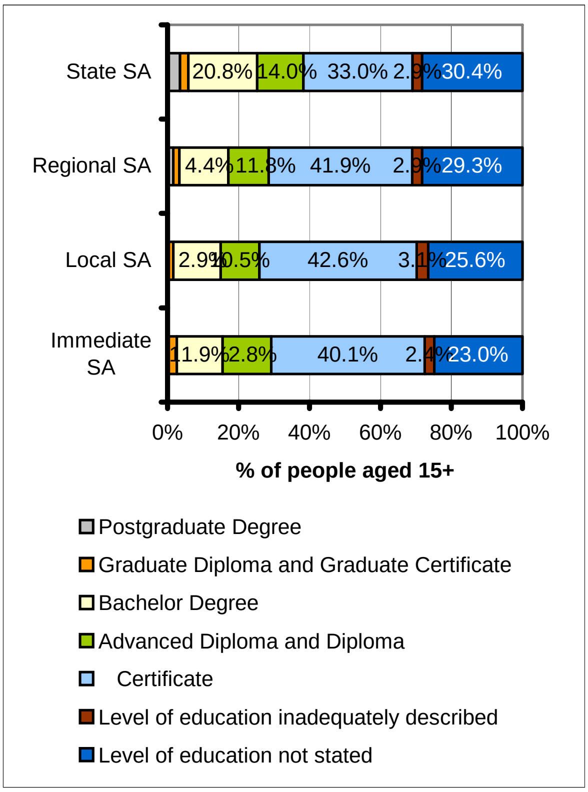


Figure D6: Level of non-school educational attainment

Table D1 Educational Facilities in the Shire of Harvey (Source: Harvey Shire Council 2006)

Child Care Facilities	Primary and Pre-Primary	High Schools	Further Education
Riverlinks Child Care & Community Centre, Australind	Australind Primary, Australind	Australind Senior High, Australind	Edith Cowan University, Bunbury
Harvey Occasional Child Care Centre, Harvey	Australind Pre-Primary, Australind	Harvey Senior High, Harvey	South West College of TAFE, Bunbury
Harvey Early Learning Centre, Harvey	Parkfield Primary, Australind	Harvey Agricultural College, Harvey	Harvey TAFE, Harvey
	Unity Christian School, Australind		Brunswick TAFE, Brunswick
	Leschenault Catholic, Australind		
	Brunswick Primary, Brunswick		
	St. Michael's Primary, Brunswick		

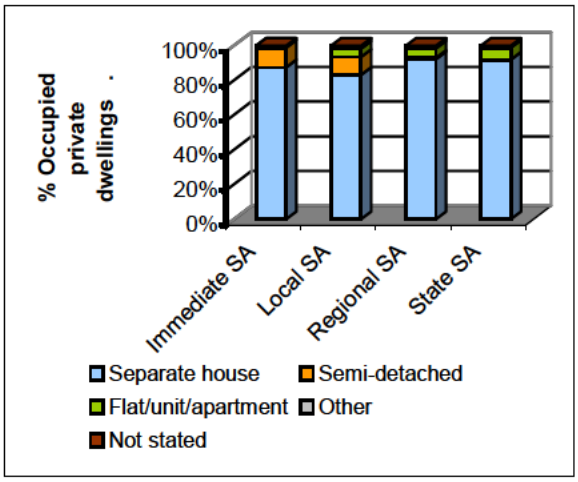
Child Care Facilities	Primary and Pre-Primary	High Schools	Further Education
	Clifton Park Primary, Clifton Park		
	Clifton Park Pre-Primary, Clifton Park		
	Hope Christian College, Roelands		
	Yarlooop Primary, Yarloop		
	Harvey Primary, Harvey		
	St. Anne's Primary, Harvey		
	St. Anne's Pre-Primary, Harvey		

Land and Housing

In 2006, there were 355 dwellings in the immediate study area with 98.9% of these being separate houses. The local study area had 1,739 dwellings of which 92.8% were separate houses, followed by 4.8% of flats, units and apartments (Figure D7). Separate houses are also predominant in the regional and state study areas but their proportion is significantly smaller in comparison to the local study area. The regional and state study areas also show a higher proportion of semi-detached dwellings and flats, units and apartments than the local study area.

In the immediate study area, the majority of dwellings are being purchased (36.7%), followed by rented dwellings (32.8%) and fully owned dwellings (29.7%) (Figure D8). In the local study area, the majority of dwellings are fully owned (36.5%), followed by lower percentages of dwellings being purchased (31.1%) and dwellings being rented (28.6%) (Figure D8). In the regional and state study areas, the majority of dwellings are being purchased (36.0% and 37.6%), followed by fully owned dwellings (30.2% and 31.4%) and rented dwellings (29.5% and 27.2%).

In the immediate study area, the median housing loan repayment ($1,184.3/month) is higher than that in the local ($1,078.7/month) and regional ($1,101.3/month) study areas and closer to that in the state ($1,213.0/month). The immediate, regional and state study areas have similar median weekly rent ($168.1/week, $167.2/week and $170.0/week) but the median weekly rent in the local study area is slightly lower $139.0/week.



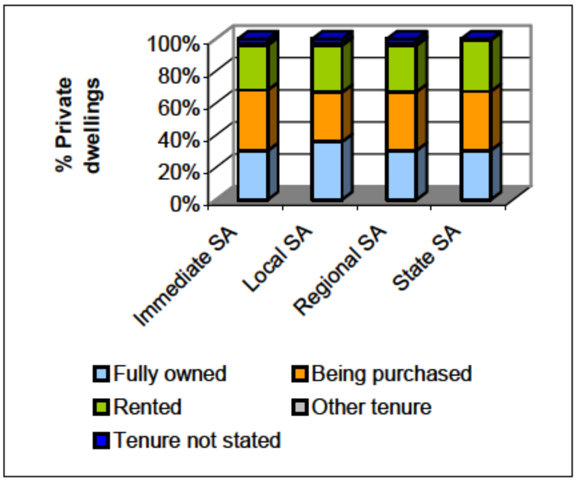


Figure D7: Dwelling structure

Figure D8: Dwelling tenure

Recreation and Tourism

There are 58 registered recreation organisations in the Shire of Harvey. Table D2 shows a summary of the number and type of recreation organisations registered in the Shire of Harvey 2006-07 Community Directory (2006). The majority of organisations are located in Harvey and Australind; and only three sport organisations from Table D2 were located in the towns of Binningup and Myalup.

Table D2 Recreation organisations in the Shire of Harvey

Service Area	Number of Organisations
Art	4
Sports	32
Pony clubs	1
Lodges	3
Youth groups	2
Craft groups	1
Interest groups (e.g. sewing)	6
Playgroups	5
Social clubs	2
Recreation & cultural centres/ground committees	2

Tourism Western Australia (2006b) recognises that tourism is a key driver of the Western Australian economy and is expected to continue growing. In 2005/06 the direct economic impact of tourism represented $3.0 billion or 2.7% of all economic activity (Gross Value Added) in the state. The indirect economic impact accounted for $1.9 billion or 1.7% of all economic activity (Gross Value Added) in the state. The direct and indirect contribution of tourism on employment meant that 63,000 Western Australians worked in the tourism industry, which represents 6.0% of the total state employment. This translates to 6 out of 100 people in the state being directly or indirectly employed as a result of tourism (Tourism Western Australia 2006b).

In 2004, the Shire of Harvey had 362 people employed in the tourism industry, which represents 7.9% of the employed population of the Shire, a proportion higher than the state average of 6% (Tourism Western Australia 2006a). It is estimated that the annual average expenditure of domestic and international tourists in the South West Region[25] of Western Australia in 2004 and 2005 was $628,509,290. Of all visitors to the region, 85% were intrastate visitors, 10% were interstate visitors and 5% were international visitors. The purpose of the majority of these visits was for holiday/leisure (64%) and visiting friends and family (25%). The top ten activities of domestic visitors included (in ranked order):

1. Eat out at restaurants
2. Visit friends and relatives
3. General sight seeing
4. Go to the beach (including swimming)
5. Go shopping (pleasure)
6. Visit wineries
7. Pubs, clubs, discos, etc
8. Bushwalking or rainforest walks
9. Visit national parks or State parks
10. Picnics or BBQs

Tourism attractions in the Shire of Harvey are summarised in Table D3 (Shire of Harvey Community Directory 2006 and site visit). The beaches and natural reserves at Binningup and Myalup are key natural resources of the Shire of Harvey providing several opportunities for recreational and sport activities.

Table D3 Tourism attractions

Community	**Attractions**
Binningup	Binningup Beach
	Country club
	Lakewood Shores Golf Course
	Lion’s park
Myalup	Lake Preston, Yalgorup National Park
	Myalup beach
	Paradise beach
	Whittaker’s mill
Harvey	Apex Park
	Blackboy Picnic Site
	Gibbs pool
	Harvey dam
	Harvey Historical Museum

[25] Detailed economic information was not available for small geographic areas. The data for the South West Region, of which the local and regional study areas are a part, was used to obtain an indication of the tourism trends in the areas. The South West region includes the local government areas of: Augusta-Margaret River, Boyup Brook, Bridgetown-Greenbushes, Bunbury, Busselton, Capel, Collie, Dardanup, Donnybrook-Balingup, Harvey, Manjimup, and Nannup (Tourism Western Australia 2006).

	Harvey River Diversion Snells Park Stirling dam Wineries
Australind	Featured wood gallery Heritage buildings and features of the Pioneers from the mid 1800s John Boyle O'Reilly memorial monument Leschenault Discovery Centre/Jetty walk Leschenault Estuary to the west (boating, sailing and windsurfing) Leschenault Peninsula Nature Reserve to the north Pioneer memorial
Brunswick Junction	Beela valley Brunswick cow Brunswick Pool Historic buildings White Rocks Museum & Dairy
Yarloop	Australind Pioneer cemetery Bushwalk trails and campsites Cathedral avenue Henton cottage Historic timber workers' cottages Hoffman Rd. Lookout Logue Brook dam & Lake Brockman Sotico historic engineering workshops St. Nicholas church Yarloop Heritage Trail Yarloop pool Yarloop Workshops Museum

Community Services and Facilities

A total of 86 community services, organisations and facilities are listed in the Shire of Harvey 2006-07 Community Directory (2006) servicing the Shire of Harvey. Of these, four were located in Binningup (Christian Youth Camp, Community Association, Volunteer Bushfire Brigade, and senior citizens Association) and two in Myalup (Volunteer Bush Fire Brigade and Community Group). Table D4 shows a summary of the type and number of community services, organisations and facilities available in the Shire. Communities in the local study area also have access to the services offered in Bunbury, which is the largest population centre in the South West Region and is located approximately 34 km from Binningup, 40 km from Myalup and 45 km from Harvey.

Table D4 Community facilities and services

Service Type	Harvey Shire
Family support (e.g. breastfeeding, drop-in centre)	3
Environment	1
Charities	1
Youth support	3
Community associations (e.g. RSPCA,)	6
Country Women's Association	3
Emergency services (SES and ambulance)	4
Fire brigade (bush)	6
Fire & rescue	1
Health groups	7
Seniors groups + RSL	9
Cultural groups	2
Political groups	2
Parents & citizens/friends	5
Radio	2
Respite	1
Restoration trust	1
Self-help	1
Telecentre	1
Libraries	5
Immunisation	4
Environment	3
Churches	15

Transport and Mobility

Access to the local study area is mainly by private vehicle through the South Western Highway and Old Coast Road. TransWA provides public transport services from Perth to Binningup, Bunbury and Harvey. Train services to Harvey are offered through the Australind line, which provides two daily return services between Perth and Bunbury. Towns in the local study area are also accessible by TransWA coaches along the Old Coast Road stopping at the turnoffs for Binningup, Myalup and Harvey.

Half of the dwellings in the immediate study area have two motor vehicles (Figure D9). Dwellings in the local study area generally have a higher number of motor vehicles compared to the regional and state study areas. The percentage of dwellings that have two or more motor vehicles is higher in the local study area than in the other three study areas.

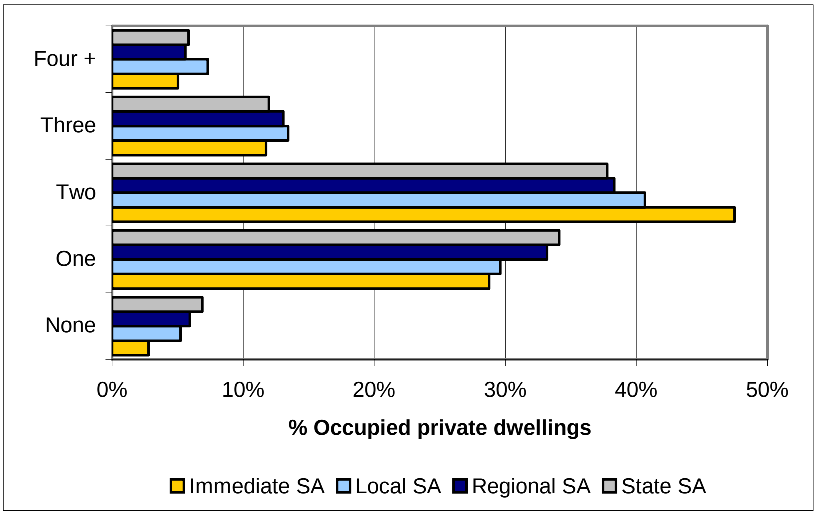


Figure D9: Number of motor vehicles per dwelling

When travelling to work people in the four study areas mostly travel by car as the driver. However, there is a slightly higher proportion of people in the immediate and regional study areas that travel to work by car as the driver (Figure D10). The immediate and local study areas have slightly higher proportions of people that did not go to work. This can be explained by the higher numbers of retirees in the towns of Binningup and Myalup. The local study area has a higher proportion of people that walked to work and that worked from home compared with the regional study area and the state.

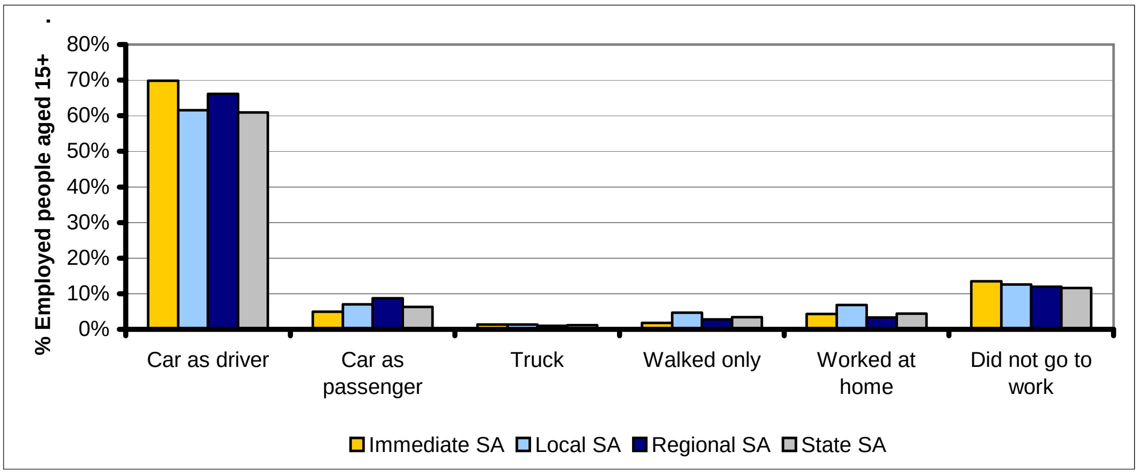


Figure D10: Most frequent methods of travelling to work

Community Identity and Cohesion

Initially Harvey was known as Korijekup based on the name given to the area by local Aboriginal communities, Korridge-e-cup, which means ‘the place of the red tailed black cockatoo’. The Harvey Districts history goes back to 1829 when the first governor of Western Australia, Governor Stirling, created the Harvey River Settlement. Early European settlement began in Australind in the 1840s and was greatly shaped by the farm settlement scheme brought by the London-based Western Australian Company. In the 1890s, the Australind hinterland was renowned for its farming and dairy while the Harvey river area was renowned for its orchards. Towns were further integrated through the construction of the Brunswick River Bridge in 1845. The construction of the Harvey River diversion enabled the use of a great amount of land resulting in Harvey outgrowing Brunswick. The Harvey Weir was constructed in 1916 and the Stirling Dam was completed in 1947. Later, the development of a major irrigation system enabled the growth of the diverse industries (see the Economic Environment section for a description of these industries) that characterise the Shire (Shire of Harvey undated, Harvey Tourism undated).

The beachside town of Binningup started as a lookout point in World War II and is now a fast growing residential town chosen by its residents because of the lifestyle if offers. Binningup is a relaxed, modern beachside town with few commercial and work opportunities in-town. Some community members[26] described Binningup as a tranquil environment in which houses are spaced enough as to have independence but the community feels like a highly integrated and cohesive one. The Binningup community is made of permanent residents, semi permanent residents (holiday homes) and tourists. The beach at this town is a key tourism destination in the local study area. Binningup is an Aboriginal name meaning ‘place of the mosquito’ (Harvey Tourism undated).

Myalup is a much smaller beachside town whose name means ‘place of the paperbark tree’. Myalup is a secluded town, highly integrated with its natural environment. Houses appear to be spaced further apart than Binningup and its beach is also a key tourism destination in the shire. The strong connection of the lifestyle with the natural environment is influenced by the proximity of the Yalgorup National Park and Myalup beach. Residents benefit from the presence of a diverse wildlife on their backyards. . The Myalup community is made of permanent residents, semi permanent residents (holiday homes) and tourists.

Community cohesion is difficult to measure but the Australian Census of Population and Housing indicator ‘level of voluntary work’ could provide some indication of cohesion. These indicators include voluntary work such as:

- Assisting at organised events and with sports organisations;
- Helping with organised school events and activities;
- Assisting in churches, hospitals, nursing homes and charities
- Other kinds of volunteer work (e.g. emergency services, etc.) (ABS).

Binningup and Myalup have a core stable population that expands temporarily on weekends and at holiday time. The permanent population seem to be highly cohesive because they have chosen to live in these towns because of the lifestyle they offer. Furthermore, the immediate and local study areas show significantly higher proportions (27.7% and 24.3% respectively) of people volunteering time to organisations or groups in their communities. This proportion is 18.3% in the regional study area and 16.8% in the state. However the fluctuating population due to the inflow of temporary residents could

[26] Feedback obtained during interview with local residents as part of the Social Impact Assessment.

affect the overall cohesiveness of these communities. A rapid increase in population brought about by the construction workforce could have an affect on cohesiveness.

Description and Use of the Study Area

In October 2007, GHD prepared an Environmental and Social Analysis of the pipeline options for the SSDP. This assessment identified the following six land uses crossed by the pipeline:

- **Coastal strip**: the Coastal Strip consists of the area between the SSDP site on Taranto Road and the eastern side of Old Coast Road. The area generally consists of sand dunes and native vegetation to the west, sand quarries further east, and farmland in the vicinity of Old Coast Road.

  Interviews with stakeholders and community members from the Binningup and Myalup communities and site visits to area, suggest that the beach and dunes near the proposed plant site are used for recreational activities. These activities include:

Boating	Surfing
Camping	Swimming
Fishing	Walking
Four wheel driving	General experience of the natural environment
Quad bike and motorbike riding	

- **Market Garden Strip**: the Market Garden Strip consists of the area just to the east of Old Coast Road and to the west of the Vegetated Strip. The eastern boundary of the Market Garden Strip is assumed to be West Break (running south off Forestry Road) and the Runnymede Rd road reserve (running south from Myalup Road). Land in this area generally consists of small farms and market gardens. Main features in this area where impacts are to be avoided or mitigated include houses, sheds, a roadside business (just south of the Old Coast/Rigg Road intersection) and a communications tower (adjacent the bend in Old Coast Road just north of the Myalup Road intersection).
- **Vegetated Strip**: the Vegetated Strip consists of the area just to the east of West Break/Runnymede Rd road reserve. The strip is bounded to the east by the unmade road reserve running south off Forestry Road just east of Richardson Road. Land in this area mainly consists of blocks of native vegetation and pine plantations.
- **Large Irrigated Paddock Strip**: the Large Irrigated Paddock Strip consists of the area between the road reserve marking the Vegetated Strip eastern boundary and Government Road. Land in this area generally consists of large farming blocks with some irrigated paddocks.
- **Town (& Surrounds) Strip**: the Town (& Surrounds) Strip consists of the area bounded by Government Road to the west and South Western Highway to the east. Land in this area generally consists of smaller irrigated paddocks, orchards, and vineyards as well as the town itself.
- **Scarp Strip**: the Scarp Strip consists of the area between South Western Highway and the proposed tank site (D). The Darling Scarp rises to the east of the highway and this land mainly consists of larger blocks of farmland used for dairies and native vegetation.

Health

There are no health services offered in the towns of Binningup and Myalup. However, communities in the Shire of Harvey have access to the following health services:

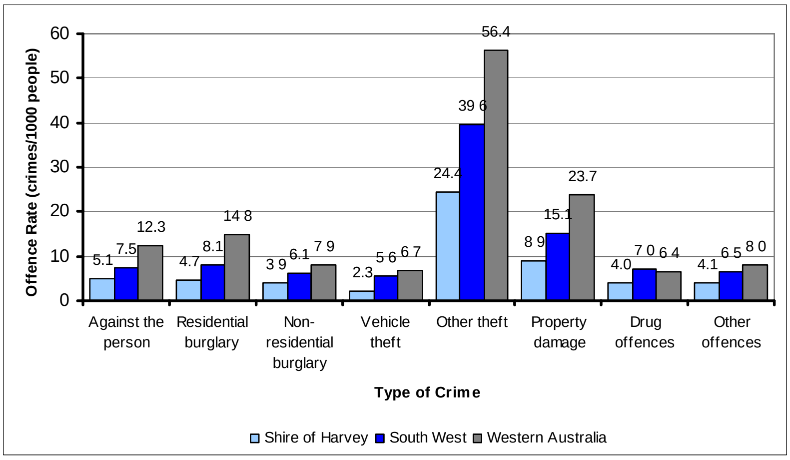
- Harvey Yarloop Health Service (including podiatrist, immunisation and disease control, child development, child health nurse, speech pathologist, school health, dietician, occupational therapist, physiotherapy, continence adviser);
- Ladies Harvey District Hospital Auxiliary;
- Harvey Districts Therapy Centre;
- Two Red Cross facilities;
- St. John Ambulance servicing Australind, Brunswick and Harvey Sub Centre;
- Australind Medical Centre;
- Harvey Medical Centre;
- Wellington Medical Centre;
- Community palliative care services (three HOPE Harvey services, three physiotherapists, two dental health services);
- Two counselling services; and
- Four veterinarians.

Additionally, communities in the Shire of Harvey are located close to the City of Bunbury, which offers a wider variety of health services. This section does not include community groups offering health support services, which are reported in the Community Services and Facilities section.

Crime and Safety

There are three police stations in the Shire of Harvey located at Yarloop, Harvey and Australind. Myalup is serviced by the Harvey Police Station and Binningup is serviced by the Australind Police Station. These towns are patrolled several times a week and the frequency of patrol depends on the level and nature of activities happening in town, generally these towns are patrolled every two to three days.

Comprehensive crime reports are not available for small areas and, therefore, crime statistics are reported for the Shire of Harvey, South West Region and Western Australia rather than the local, regional and state study areas. Offence rates show the number of crimes per 1000 people in the areas being described (Figure D11).



Offence rates were lower for the Shire of Harvey than those for the South West Region and state across all offence categories. Moreover, compared to 2003, the number of offences in 2004 in the Shire has decreased for most offence categories with the exception of offences against the person (+13%), property damaged (+13%) and other offences (+75%). Other offences

Figure D11: Offence rates in 2004 (Based on: Office of Crime Prevention 2004)

refers to government and justice procedures (mostly breach of restraining order), offences against good order (mostly trespassing), unlawful possession of weapons and any other offences. The long term trend between 1996 and 2004 reveals that for most years and offence categories the Shire of Harvey has experienced lower crime rates than those in the South West Region and in the state (Office of Crime Prevention 2004).

Preliminary statistics from the Western Australia Police (2007a) for the calendar year to September 2007 suggest that some towns in the regional study area have had increases in the offence rates of some types of crime (Figure D12). The offence rate of assaults in Harvey (9.6) and Bunbury (5.9) has already exceeded the 2004 offence rate for offences against the person (assaults is one of the types of offences in this category) for the Shire of Harvey (5.1). Similarly Binningup and Myalup have experienced higher offence rates for residential burglary (10.5 and 7.0 respectively) compared to the 2004 offence rates of the shire and South West Region (4.7 and 8.1 respectively). Myalup has also experienced an increase in the offence rate of non-residential burglary (14.0) compared to the 2004 offence rates of the shire (3.9), South West Region (6.1) and state (7.9). This is also the case for the offence rate of motor vehicle thefts in Myalup (14.0) and Wellesley (7.5), which are higher than the 2004 offence rates of the shire (2.3), South West Region (5.6) and state (6.7).

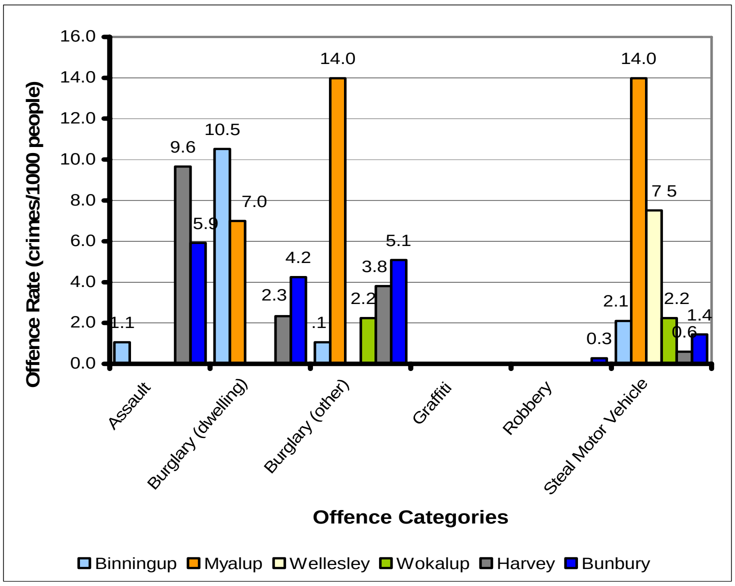


Figure D12: Preliminary offence rates for towns in the regional study area in 2007 (Source: WA Police 2007a)

Economic Environment

The immediate and local study areas have lower labour force participation[27] (55.1% and 57.5%) in comparison to the regional (61.5%) and the state (62.3%) study areas. This is also reflected by the percentage of the population not in the labour force, which in the immediate and local study areas is between 4.6% and 0.5% higher than in the other two study areas. However, the unemployment rate based on the total labour force is similar or slightly lower in the local study area (3.8%) in comparison to the regional (4.0%) and state (3.8%) study areas. In the immediate study area, the unemployment rate is 4.7%, which is slightly higher to that of the other three study areas.

[27] The potential labour force is considered to be the population aged 15 years and over. Labour force participation is the proportion of people aged 15 years and over that are employed or unemployed but looking for employment.

Figure D13 shows the labour force status for the four study areas. The percentages of people in full and part-time employment in the immediate and local study areas were between 1.8% and 3.8% lower than the regional and state study areas. This is accompanied by a higher proportion of people not in working age (i.e. 0-14 and 65+ years) to the population in working age (15-64 years), this is referred to as the dependency ratio. The dependency ratio in the immediate and local study areas was 56/100 (or 5.6 dependents per person in working age) compared to 49/100 and 48/100 in the regional and state study areas.

The four most frequent occupations in the immediate, local and regional study areas were labourers, managers, professionals and technicians and trades workers (Table D5).

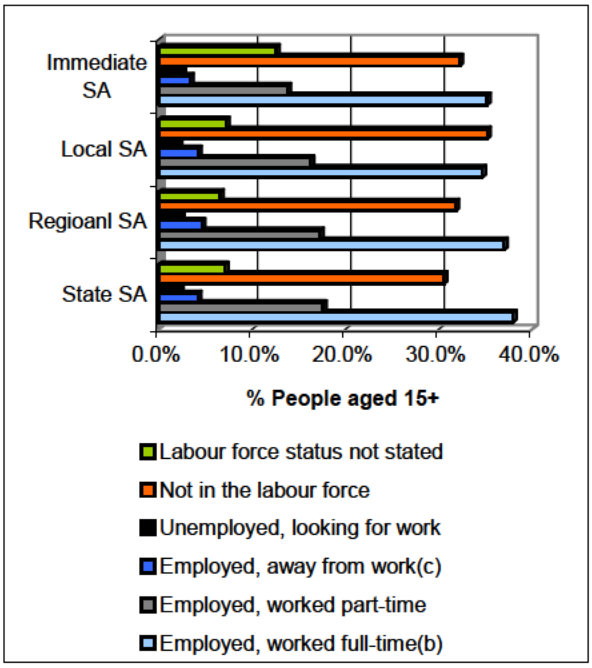


Figure D13: Labour force status

Table D5 Percentage of employed persons aged 15+ by occupation

Occupation	Immediate Study Area	Local Study Area	Regional Study Area	State Study Area
Managers	10.76%	17.3%	10.6%	12.5%
Professionals	14.80%	10.0%	13.5%	18.6%
Technicians & trades workers	22.42%	16.2%	19.5%	16.4%
Community & personal service workers	6.73%	7.0%	8.2%	8.9%
Clerical & administrative workers	9.64%	9.7%	12.5%	14.5%
Sales workers	9.42%	7.1%	9.8%	9.4%
Machinery operators & drivers	9.64%	9.6%	9.8%	7.3%
Labourers	15.92%	21.3%	14.4%	10.9%
Inadequately described / Not stated	0.67%	1.8%	1.7%	1.6%
Total Number of Employed People	**446**	**2,224**	**23,171**	**936,129**

The Gross Regional Product of the South West Region was $6.8 billion in 2004/05, which represents 6.7% of the Gross State Product (Department of Local Government and Regional Development 2006). The most active industries were manufacturing ($2,805 millions in 2001/02), retail trade ($1,205 millions in 2004/05), alumina ($972 millions in 2004/05), tourism ($609 millions in 2003/04), construction ($587 millions in 2004/05), agriculture ($557 millions in 2003/04), coal ($270 millions in 2004/05) mineral sand ($268 millions in 2004/05) and timber ($61 millions in 2004/05).

The industries that are the most labour intensive in the four study areas are manufacturing, agriculture, forestry & fishing, retail trade, construction, health care and social assistance and education and training (Table D6). The immediate and regional study areas show higher proportions of people employed in the construction industry in comparison to the local and state study areas. The local study area shows a significantly higher percentage of people employed in the manufacturing industry and in agriculture, forestry and fishing.

Table D6 Percentage of employed persons aged 15+ by labour intensive industries

Industry	Immediate Study Area	Local Study Area	Regional Study Area	State Study Area
Manufacturing	20.8%	25.0%	18.9%	9.4%
Agriculture, forestry & fishing	6.4%	14.7%	4.0%	3.3%
Retail trade	9.2%	8.8%	10.2%	11.1%
Construction	12.1%	7.5%	15.9%	9.1%
Health care & social assistance	6.1%	7.3%	5.9%	10.2%
Education & training	7.0%	7.1%	5.4%	7.7%

Median individual weekly income is lower in the local and regional study areas, whereas the immediate and state study areas have similar incomes (Figure D14). Median family income is higher in the state study area than in the other three study areas. In terms of median household income, the local study area has the lowest income compared to the other three study areas.

An estimate of the percentage of families living on incomes under the Henderson poverty line updated for Australia in 2006 (MIAESR 2007) clarifies the significance of income levels (Table D7). Overall, the immediate, local and regional study areas have higher percentages of families below the poverty line in comparison to the state averages.

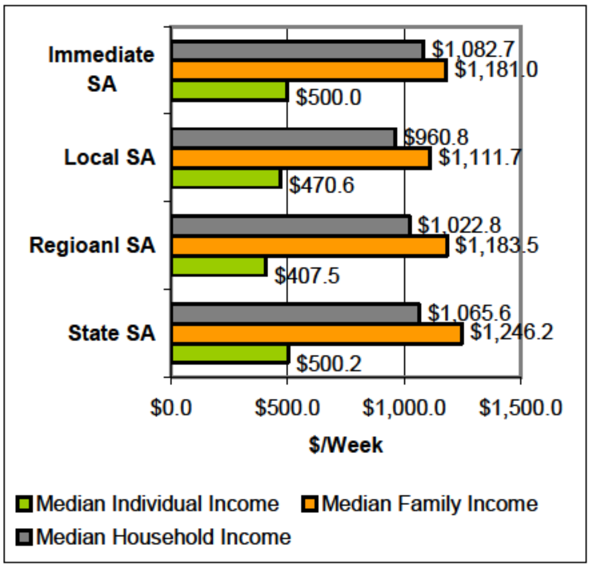


Figure D14: Median weekly income

The local study area has the highest percentages of families comprised of couples with and without children with incomes that place them in a situation of poverty. Similarly, a higher percentage of one-parent families in the regional study area are in a situation of poverty.

Table D7 Percentage of families below the updated Henderson Poverty Line for Australia

Family Type	Poverty Line (Sept. Qtr. 2006)	Immediate Study Area	Local Study Area	Regional Study Area	State Study Area
Couple family with children	$641.08	12.2%	14.1%	10.2%	11.6%
Couple family without children	$456.57	21.4%	26.8%	20.4%	17.3%
One-parent families	$530.36	50.0%	49.1%	53.1%	47.7%

The economic advantage/disadvantage of the study area can be further informed through an analysis of the Index of Relative Socio-Economic Advantage/Disadvantage[28] (IRSEAD) produced by the ABS (2001). The IRSEAD for the regional study area in 2001 was 961.7, which is lower than the state's 1,006.8 A lower score on the IRSEAD indicates that an area has a higher proportion of individuals with characteristics such as low incomes, more employees in unskilled occupations, greater labour disadvantage for females and lower use of internet at home (ABS 2001). However, the IRSEAD values for all the Local Government Areas in Western Australia has a minimum value of 703.4, a maximum value of 1209.0 and a median of 950.8 This means that although the regional study area has a lower IRSEAD, this value is higher than that of 50% of the state's Local Government Areas.

Future Planning

The Greater Bunbury Region Scheme[29] indicates that the future planning for the Binningup townsite is Urban Development with areas along the coast zoned Regional Open Space. The Myalup townsite has a small area zoned Urban Development surrounded by Regional Open Space which covers the Yalgorup National Park and Myalup Beach. The desalination plant site is zoned Public Purposes which includes Public Utilities. The remaining area in between Binningup and Myalup is zoned Rural.

[28] IRSEAD values should be interpreted with caution. The index does not have a zero value and values have been standardised to have an average of 1000. This means that a IRSEAD value of 1000 does not mean that that population is two times more economically advantaged than another population with an IRSEAD value of 500. Therefore, percentiles are given in order to facilitate understanding of IRSEAD values. Unfortunately, there were no IRSEAD values for state suburbs that make up the immediate and local study areas as in the ABS Census of Population and Housing of 2001, these suburbs were considered as 'unclassified' and bundled together with all other areas with low numbers of population in the state.

[29] Greater Bunbury Region Scheme. Department for Planning and Infrastructure, October, 2007

Appendix G

Stakeholder List

Stakeholder Groups	Stakeholders Invited to Participate	Interviewed	Study Area
Councils	City of Bunbury		Regional
	Shire of Harvey	✓	Local
Businesses / Tourism	Binningup Real Estate Agent	✓	Immediate
	Bunbury Regional Chamber of Commerce, President	✓	Regional
	Harvey Visitors Centre	✓	Local
	South West Chamber of Commerce and Industry		Regional
Industry	Harvey Agricultural Association		Local
	Kemerton Industrial Park	✓	Local
	Harvey Beef	✓	Local
	Coastal Green Turf Supplies	✓	Local
Resident Groups / Local Leaders	Binningup Senior Citizens Association	✓	Immediate
	Harvey Community Association		Local
	Harvey Country Women's Association	✓	Local
	Harvey Senior Citizens Centre		Local
	Myalup Community Association	✓	Immediate
	Binningup Desalination Action Group (BDAG)	✓	Immediate
Education	Harvey Primary School	✓	Local
	Harvey Senior High School	✓	Local
	St. Anne's Primary School		Local
	The Escape Youth Centre / Mulgara Family Centre	✓	Local
Environmental Groups	Harvey River Land Conservation District Committee		Local
	Wellesley Land Conservation District Committee	✓	Local
Beach Users / Recreation	Binningup Surf Lifesaving Club Inc.		Immediate
	Harvey District Water Sports Association	✓	Local
	South West Licensed Fisherman's Co-Operative		Regional
	Walking Group – Be Active	✓	Local
	Harvey Recreational Centre (Harvey Community Radio)	✓	Local
Total Interviews for Immediate Study Area			**4**
Total Interviews for Local Study Area			**12**
Total Interviews for Regional Study Area			**1**
Total Interviews			**18**

Appendix H

Stakeholder Interview Schedule

Social Impact Assessment

Stakeholder Consultation Discussion Guide

Interview format: Semi-structured interview

Specific topic areas need to be explored during the interview discussion however the discussion should remain flexible to allow for additional questions and unforseen issues to be explored.

Activity	Materials
Introduction	
Introduce project team members Provide background information about the Southern Seawater Desalination Project Provide description of the SIA process	Project description (blurb, diagram and map) SIA process description
Purpose	
◗ Outline purpose of the stakeholder interview and provide an overview of the questions to be asked	Interview schedule
Preliminary Questions	
◗ Provide opportunity for stakeholders to ask questions relating to the project, SIA or interview	Project Brochure(s)
SIA Questions	
◗ How do you think the Southern Seawater Desalination Plant could affect you, your household or your community? (Explore both positive and negative impacts) ○ Will this affect be a result of the construction and/ or operation of the project? ○ Will this affect be at a local, regional or state level?	
◗ What could be done to help reduce the negative affects of the project?	
◗ What could be done to help enhance the positive affects of the project?	
◗ What community groups are likely to be affected most by this project?	
◗ Do you have any other questions or suggestions you would like to make regarding the desalination project?	
Discussion Closing and Thank you	
◗ Provide contact details in case participant wants to see results of the assessment or can participate in the criteria weighting ◗ Consultation and SIA feedback ◗ Thank participant	Explanation of the criteria weighting process Contact Details of SIA team members

Relevant Information

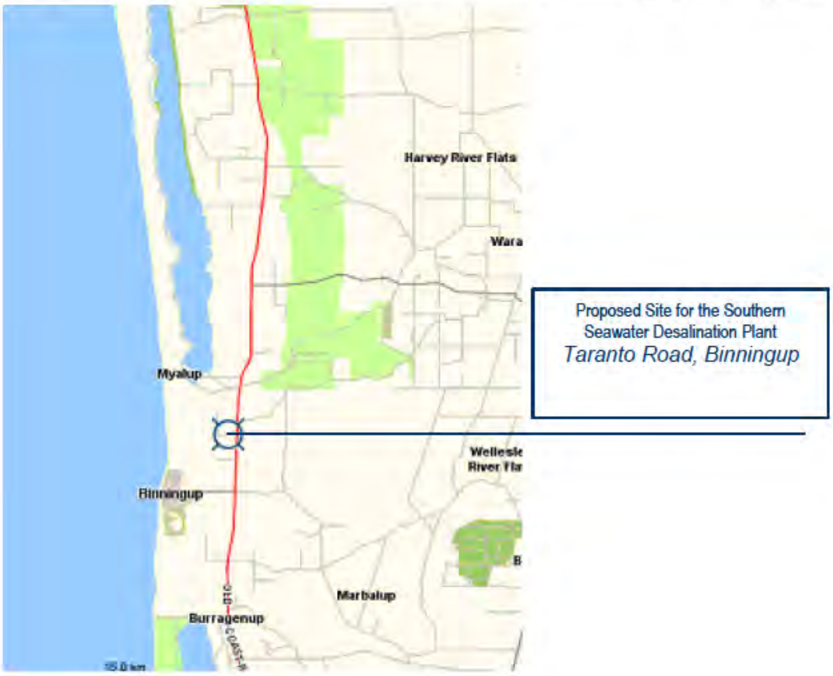
Project Description

Water Corporation is in the process of planning a second desalination plant: the Southern Seawater Desalination Plant (SSDP or the Project). The SSDP will supply water to the Perth metropolitan area and Mandurah by connecting to the Integrated Water Supply System (IWSS). Water Corporation has engaged consultants to undertake several studies to assist with project design. As part of these studies, Water Corporation has decided to undertake a voluntary (i.e. not required for Project approval) Social Impact Assessment (SIA).

The Southern Seawater Desalination Plant will initially provide 45 Giga litres (GL) of drinking water per annum from seawater, with a potential to upgrade to 100 GL per annum in the future. The SSDP will provide drinking water for the Perth metropolitan area and Mandurah by supplying water into the Integrated Water Supply System (IWSS) through a connection at Harvey. The SSDP will be powered by renewable energy[30].

Location:

The SSDP will be located approximately one kilometre from the ocean on a 44-hectare block on Taranto Road. The site is located between the towns of Binningup and Myalup as illustrated in the figure below).



Location of the SSDP

[30] Water Corporation (Undated) *Southern Seawater Desalination Plant* (website). Accessed 26 November 2007 < www.watercorporation.com.au/D/desalination_plant2.cfm>

Project components:

The Project is composed of four components:

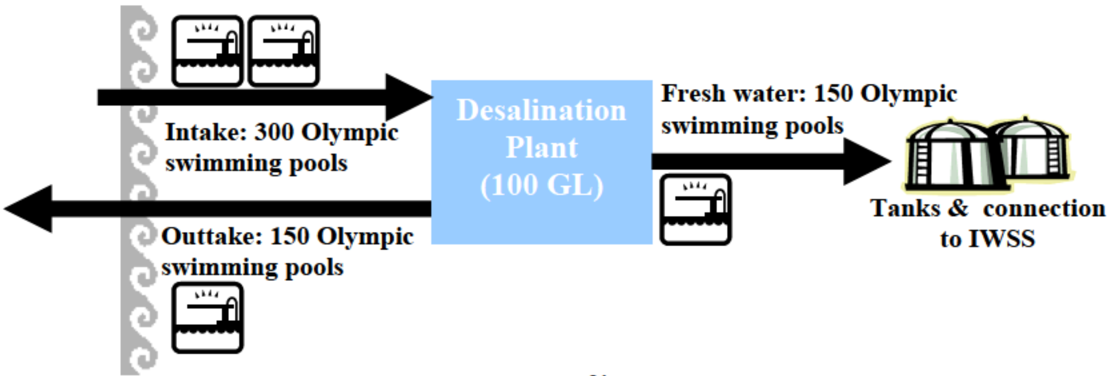
Desalination plant on Taranto Road;

Pipelines transporting seawater from the ocean to the desalination plant (approximately 400 m out in the ocean) and brine from the desalination plant back to the ocean (approximately 800 m out in the ocean);

Pipeline transporting drinking water from the desalination plant to tanks at Darling Scarp near Harvey (approximately 25 km); and

Four 25 ML tanks ('summit tanks') and a 20-50 ML sump located at Darling Scarp east of Harvey.

The key process in the SSDP is called reverse osmosis. This process uses pressure to push water through a semi-permeable membrane. Fresh water passes through the membrane while salts and other impurities are retained and discharged back into the ocean. The process for the SSDP is shown below.



Process for the SSDP at 100 GL capacity[31]

Project Timeframe and Stages

To meet project timelines dictated by increasing demand for water, the Project Environmental Review (PER) documentation for the Binningup Desalination project is to be submitted to the Environmental Protection Authority (EPA) by the end of 2007. Project stages and timeframes are summarised in the table below.

Project stages and timeframe

Project Name	Planning / Policy Development	Construction / Implementation	Operation / Maintenance	Decommission / Abandonment
Southern Seawater	Current	2009 - 2011	2011 - Unknown	Unknown

[31] Adapted from page 8, Water Corporation (2007) *Second Seawater Desalination Plant: Site alternatives and considerations* [on line]. Accessed on 20 November 2007 <www.watercorporation.com.au/_files/Site%20Alternatives%20Report,%20July%202007.pdf >

SIA Process Description

Social Impact Assessment is a systematic analysis in advance of impacts on the day-to-day quality of life of persons and communities whose environment is affected by a proposed plan, program, project or policy change. It also identifies opportunities for mitigating these impacts to minimise negative outcomes.

Social Impacts refers to changes in the day-to-day life including such things as the way people live, work, play, relate to one another, organise to meet their needs and generally cope as members of society.

The social impact assessment identifies impacts for the construction and operation of the project at the local and regional level.

The assessment will be finished in December and Water Corporation will make the report public at the beginning of 2008 together with other impact assessment such as environmental impact assessment.

Stage 1 ***The project*** – information about the project including its purpose, scope, history and construction and operation information.

Stage 2 ***Community Profile*** – description of the potentially affected communities including demographics, its history and background, the community services and facilities available and the community values and use of the study area.

Stage 3 ***SIA Stakeholder Input*** **–** contribution from key stakeholders in the process of identifying and ranking social impacts and identifying mitigation and enhancement measures.

Stage 4 ***Identifying, assessment and ranking the social impact assessment*** – analysis of the community profile and the project to identify social impacts, triangulation of findings from the various impact identification activities, analysis and ranking of social impacts.

Stage 5 ***Mitigation, enhancement and monitoring measures*** – strategies for mitigating impacts to enhance positive consequences and minimise negative consequences of the Project.

Stage 6 ***Production of SIA Report*** – production of draft SIA report, submission of draft SIA report for review by Water Corporation and academic reviewer, incorporation of Water Corporation and academic reviewer's suggestions in draft SIA report, draft SIA report is then made

Purpose of Stakeholder Interview

The SIA is an objective assessment undertaken by consultants GHD for Water Corporation. The purpose of the stakeholder interview is for the SIA team to gain an understanding of how different groups in the community could be affected by the proposed Southern Seawater Desalination Plant and measures that can be recommended to mitigate the negative and enhance the positive affects of the project. The information provided by stakeholders will be kept confidential and will be collated and analysed with that of other stakeholders. However, the report will mention the groups or organisations that have been consulted in the process. Participants will have access to the draft SIA report when Water Corporation makes public all draft impact assessment reports early in 2008.

Project Team Members Contact Details

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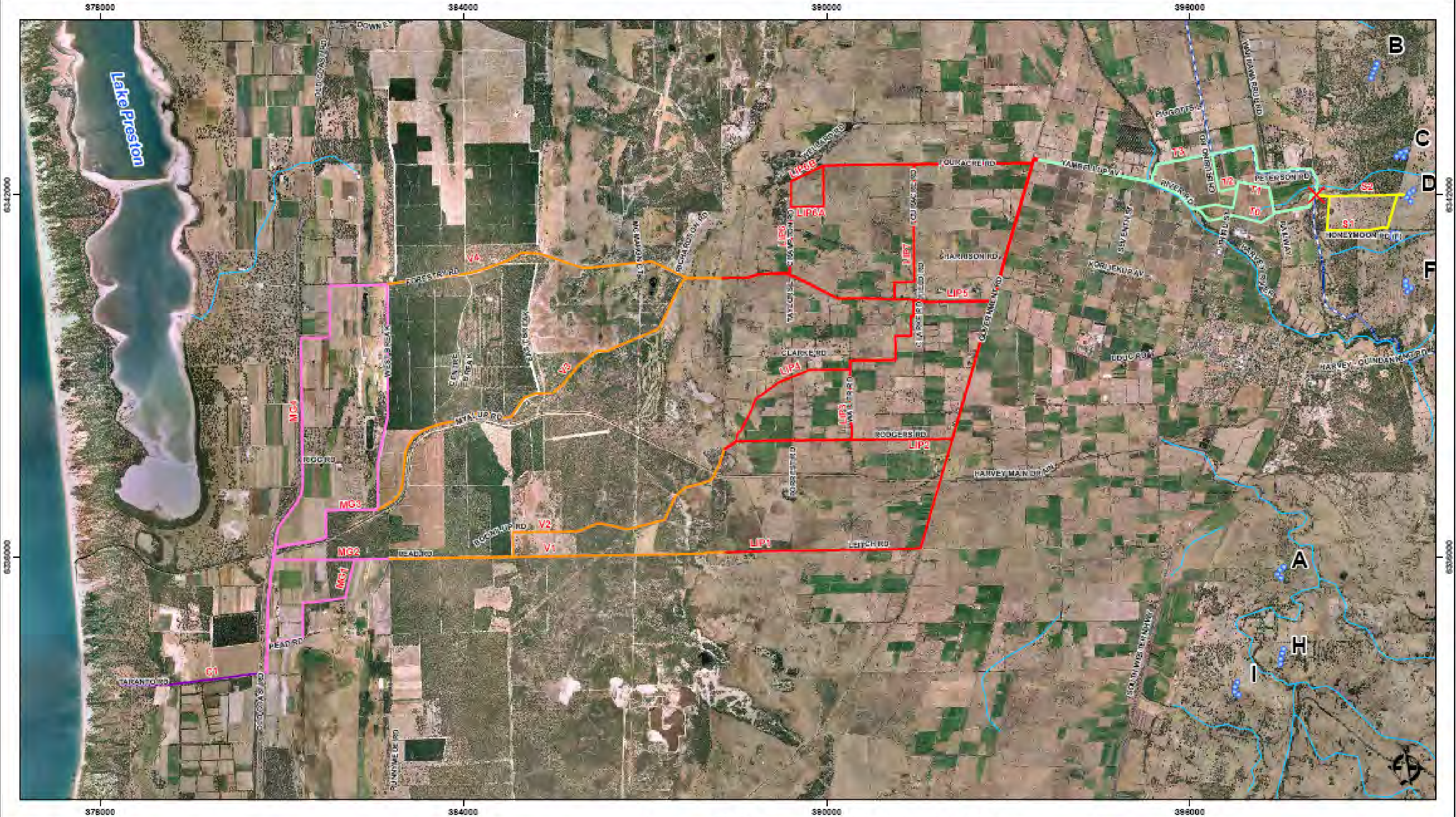
Carissa Buckland **Water Corporation**	**P** **E**	1800 810 075 Carissa.Buckland@watercorporation.com.au or desalination@watercorporation.com.au

Appendix I

Main Route Options and Land Use Strips

Source:

GHD (2007). *Water Corporation Southern Seawater Desalination Plant – Transfer Main: Environmental and Social Analysis.* October 2007. Perth, Western Australia.



LEGEND

- Cadastral Boundaries - Landgate - 200703
- Major Watercourses - Geoscience Australia - 2004
- Water Corporation DN1400 Trunk Main
- Potential Tank Sites
- Regulating Valve

Potential Pipeline Routes* - GHD - 2007

- Coastal Strip
- Market Garden Strip
- Vegetation Strip
- Large Irrigated Paddock Strip
- Town and Surrounds Strip
- Scarp Strip

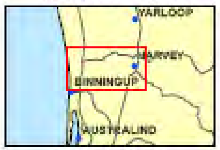
*Pipeline Routes sectioned by Land Zone Classes.
ALL DATA SOURCED FROM WATER CORPORATION UNLESS OTHERWISE STATED
MAP UNITS PROJECTED IN MGA ZONE 50
NOTE THAT POSITIONAL ERRORS CAN BE > 5M IN SOME AREAS
AERIAL PHOTOGRAPHY DATED MARCH 2006 SOURCED FROM WATER CORPORATION

SCALE

500 0 500 1,000 1,500 m

1:60,000 at A3

LOCALITY MAP



Harvey Region

CREATED BY	CHECKED	APPROVED
KINT	CR	

HORIZONTAL DATUM: GDA 94 PROJECTION: MGA ZONE 50

HEIGHT DATUM: NA METADATA RECORDED: 100%

DATE	FILE LOCATION
11.09.07	G:\61\21216\GIS\MXDS\6121216-G11.MXD
REVISION	**DRAWING NO**
0	6121216-G11

WATER CORPORATION

GHD CLIENTS PEOPLE PERFORMANCE

SOUTHERN SOURCES DESALINATION PLANT ENVIRONMENTAL AND SOCIAL ANALYSIS

Figure 1
Main Route Options and Land use Strips

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	M.De los Rios V. Garde	Bill Grace Leah O'Brien		Bill Grace Leah O'Brien		21/12/07
2	M.De los Rios V. Garde	WATERCORP Jo Madin Suzanne Brown	N/A	N/A	N/A	4/1/08
3	M.De los Rios V. Garde	Leah O'Brien		Leah O'Brien		8/1/08
4	M.De los Rios V. Garde	WATERCORP Jo Madin Suzanne Brown	N/A	N/A	N/A	10/1/08
5	M.De los Rios V. Garde	Peer Reviewer Jo Ann Beckwith	N/A	N/A	N/A	
6	M.De los Rios V. Garde	Leah O'Brien		Leah O'Brien		3/2/08

7	M. De los Rios V. Garde	Leah O'Brien				12/03/08
8	M. De los Rios V. Garde	Leah O'Brien		Leah O'Brien		18/03/08
9	M. De los Rios V. Garde	WATERCORP Jo Madin Suzanne Brown Peter Herkenhoff	N/A	Bill Grace		
10	M. De los Rios	Leah O'Brien		Leah O'Brien		06/05/08

1 Public Consultation

1.1 Background

Keeping the community involved in the preservation and enjoyment of our natural water resources is a vital consideration for the Water Corporation. Everyone in the community, from schools and businesses through to charities and government departments, is encouraged to learn more about the environment and its resources, and assist us in maintaining our precious water supply.

Community involvement is also vital to the success of many of our water infrastructure projects. The help of residents, community groups and stakeholders and their local knowledge is important in ensuring the sustainability of our water supply and the preservation of our world-class water resources.

However, with water resources under significant pressure from climate change and rapid population growth, the Corporation is required to act quickly to secure the next major water source for Western Australia.

When the decision to shelve the proposed South West Yarragadee groundwater proposal in favour of a second desalination plant north of Binningup was made, the local community was understandably surprised and angry, as no consultation on the site selection process had been undertaken. The Water Corporation acknowledged this at the time and has since then undertaken a large number of communications activities in order to increase the level of community involvement in the process.

Despite divergent views about seawater desalination and the project itself, there are some matters that the Corporation and the local community agree upon:

- Community consultation was lacking in the site selection process and that this has resulted in the community feeling disempowered, frustrated and angry;
- The Binningup and surrounding community identity and sense of place must be retained and supported during the construction and operation of the project;
- The natural environment (marine and terrestrial flora and fauna) should be protected and enhanced for future generations;
- The project's impacts on surrounding communities (such as visual amenity, noise and traffic) should be appropriately mitigated and managed to ensure minimal impact on residents' way of life;
- Public safety of both the community and our workforce are of utmost importance during the construction and operation of the plant; and
- The project will be enhanced through community consultation in its planning, construction and operational phases.

Agreement on these matters highlights that there is some common ground upon which the Water Corporation can work with the community in building and operating a plant that is environmentally socially acceptable.

1.2 Understanding the Community

1.2.1 Telephone research

The Water Corporation has engaged Synovate Research to undertake quarterly telephone surveys to better understand the issues of the local Binningup, Myalup and the wider communities of Harvey and Bunbury.

This research (Synovate 2007a, 2007b) tracks awareness, attitudes and perceptions of the desalination process and project and of the communication needs of the community. Information gathered in this research also allows us to incorporate social considerations into the development of the project. Reflecting our commitment to openness and transparency in this process, research findings are made publicly available on our website and sent to any member of the public who requests it.

The questions asked in the survey relate to the following:

- Community awareness of the desalination project;
- Level of community understanding regarding the project and its construction and operational impact;
- Predicted effects of the project on the local community;
- Level of community support for its construction;
- Extent to which residents are satisfied with consultation opportunities; and
- Communication – community preferences pertaining to communication methods and consultation undertaken by the corporation.

The first wave of research was undertaken in August 2007 (W1) and the second wave was undertaken in November 2008 (W2). The next round of research will occur in July 2008 (W3) and will continue to guide our consultation program. The survey sample was determined randomly (see Table 1.1).

Table 1.1 Social Survey Details

Area	W1 - Sample Size	W2 - Sample Size
Binningup	88	94
Myalup	38	40
Bunbury	203	100**
Pipeline route*	N/A	20
Total	329	254

* Landowners affected by the pipeline were not included in W1 as the pipeline route had not been determined at that stage.
** The sample size for Bunbury reduced during W2 as the sample was redistributed to factor in pipeline landowners.

Some of the key findings from W1 to W2 are:

Positive shift in community views

The most notable shifts in community views from W1 to W2 were:

- An increase in the extent to which Binningup residents feel informed about and support the desalination project;
- A slight increase in the extent to which Myalup and Bunbury residents support the desalination project;

- A decrease in community concern regarding the possible negative impacts of the desalination project; and

- A significant increase in satisfaction with project communication and the opportunities provided to deliver feedback on the desalination project.

Despite these improvements, the majority of residents would still like to receive more information regarding the site, the environmental assessment process and the social impact assessment process.

Regional differences

Compared with other south-west region residents, Binningup residents tend to be less supportive of the desalination project. They are more likely to perceive that the desalination project will have a negative impact on the local community.

Myalup residents tend to be the most satisfied in terms of the information and communications provided to local residents.

Bunbury residents are more likely than other regional residents to perceive that the desalination project will have either no effect or a positive effect on the local community.

Perceived impact

Perceived impacts of the desalination project raised by respondents included:

- Negative impacts on ocean / coastline;

- Noise pollution; and

- Negative environmental impacts.

1.2.2 Social Impact Assessment

Although mostly outside the scope of EPA's assessment, there is some overlap between the social and environmental impacts of this proposal. Accordingly, in addition to Synovate's quarterly telephone research, the Water Corporation commissioned GHD to undertake a Social Impact Assessment (SIA) in August 2007 (GHD 2008). The threefold purpose of the SIA was to:

- Identify and assess how construction and operation of the desalination project could potentially affect the community directly and indirectly;
- Identify likely social impacts their significance; and
- Identify mitigation, enhancement and monitoring measures to minimise the negative effects of the project and to maximise positive impacts.

The SIA methodology included:

- **Stage 1:** Gathering information about the project
- **Stage 2:** Developing a community profile
- **Stage 3:** Obtaining stakeholder input via interviews and focus groups
- **Stage 4:** Identifying, assessing and ranking the SIA
- **Stage 5:** Identifying mitigation, enhancement and monitoring measures
- **Stage 6:** Producing the SIA report

The SIA is broken up into two phases:

- **Phase 1:** Conducting the assessment.
- **Phase 2:** Further development of mitigation recommendations (from early 2008)

The SIA drew on information obtained through SIA-specific meetings, interviews with key community members and stakeholders and information from the community research undertaken by Synovate Research. The SIA also drew on data provided by the Corporation on the project.

The SIA-specific meetings were conducted with community members and stakeholders from Binningup, Myalup, Harvey and Australind in October and November 2007. Some of the key issues raised during these interviews were (GHD 2008):

Community consultation and information

> The community feel that there was a lack of consultation and information about the project, which has led to a lack of trust in the Corporation. They believe it was a political decision and not one based on the right site with least amount of impacts.

Community identity and sense of place

> The Binningup and Myalup communities worry that the desalination plant will compromise their community identity and sense of place. They are also concerned about perceived impacts of a large, transient workforce during plant construction.

Facilities and services

> The community is worried about the ability of existing services to cope with a large influx of construction workers.

Environment

> The community is concerned about environmental impacts of the plant, and the absence of information on health and environmental effects.

Future development and land values

> The community is concerned about the plant restricting future residential growth in the town and the reduction of property values.

Visual impact

> The community is concerned about how visible the plant will be from the surrounding communities and is not convinced that the plant will be effectively screened.

Noise

> The community is concerned that both the construction and operation of the plant will generate unacceptable levels of noise.

Dust

> Dust is not a major concern so long as it is managed appropriately to prevent any impacts on the local community.

Public safety and risk

> The community is concerned about the risks of transporting and storing chemicals and the impact of disturbing contaminated soils.

Closure between Binningup and Myalup Beach

> The community is concerned about the temporary closure of a portion of the beach during construction and the impact of this on recreational activities in the area.

Equity

The community feels they are bearing the costs of the project while they don't believe they benefit from it.

Traffic

The community is concerned about an increase in traffic and increased travel times as a result of the plant construction and operation.

Powerlines

The community is concerned about the impact of powerlines supplying power to the plant on the visual amenity of the area.

The Corporation's responses to concerns raised at community meetings, in submissions and during the SIA process are provided in Chapter 1.3 below.

1.3 The Consultation Program

The overarching goal of our consultation program is to understand community values and concerns and create opportunities for the community to provide input into the planning for the project.

The Corporation's consultation program will extend to all elements and phases of the project, including:

- The desalination plant;
- The water transfer pipeline route and Harvey Summit Tank;
- The environmental approvals process;
- The Alliance development phase;
- The future construction phase; and
- The future operational phase.

Our consultation program is diverse and includes:

1.3.1 Local advertising of community events and information on the project

Local advertising is an effective way of informing the community and stakeholders of the project. A monthly advertisement has been running in local newspapers and the Binningup Community Newsletter 'Waves' since August 2007. The topics covered to date include:

- Thanks for helping us (report on community research);
- Your environment, Your say (information on the voluntary release of the environmental scoping document);
- Desalination – an important piece of the drying climate puzzle (information on the Corporation's Security through Diversity strategy and the environmental process);
- Understanding the local environment (information on the environmental approval process, research at the Perth Seawater Desalination Plant and Peer Reviewers);
- Meet the new buoy in town – he's looking out for your ocean (information on the marine monitoring buoy);
- What is desalination and how does it work (information on the desalination process); and
- Whale expert joins team (information on the whale expert joining the desalination team).

An example of these advertisements is provided in Appendix E. Other forms of advertising have included local radio and at local venues, such as the Binningup and Harvey libraries and the Binningup General Store.

1.3.2 Participating in local events

The Corporation is keen to attend as many local events as possible during the planning and construction of the plant. Attending these events allows us to talk to people who may not normally attend a community meeting but may have an interest in the desalination project. The Corporation erected an information stand at the Binningup Spring Fair on Saturday 6 October 2007 and spoke to over 100 people about the project. We will continue to identify opportunities to attend local events to reach as many people as possible.

1.3.3 Holding community forums, workshops and open house / 'walk-ins'

The Corporation has been holding community forums, workshops and open house / 'walk ins' since the project was announced in May 2007. A schedule of these is provided in Table 1.2 below.

The two early meetings held in late May 2007 attracted a high number of attendees (over 300 in Binningup and 70 in Myalup). Since that time our forums have had lower attendance (from 15 to 45 people at each session). These sessions are invaluable as they provide us with the chance to hear community concerns and views first hand and factor these into our planning for the project.

1.3.4 Issuing regular community newsletters

The Corporation has issued community newsletters on a monthly basis since May 2007. This newsletter is letter-box-dropped to all Binningup community members, placed at local venues, emailed to over 100 people who are currently registered on our mailing list, and is placed on our website.

The newsletter provides up-to-date project information on the project, informing people of new documents that have become available and reminding people of how they can be involved in the project and seek more information. An example of our newsletter is provided in Appendix E.

1.3.5 Media relations

As with any high profile project, media interest in the desalination project has been high, particularly from the local media. The Corporation continues to proactively inform media of project developments to facilitate accurate and timely media coverage.

1.3.6 Community and stakeholder tours of the Perth Seawater Desalination Plant and Taranto Road site

The Corporation has extended an open offer to all south-west community members and stakeholders to tour the Perth Seawater Desalination Plant in Kwinana. To date many tours of the plant have been conducted for both the general public and specific stakeholders. An open day and barbecue was held on the Taranto Rd site on 2nd December and attended by 35 people.

1.3.7 Presentations and briefings to community groups and stakeholders

The project team continues to brief community groups and stakeholders. Key stakeholder such as the Shire of Harvey, the Binningup Desalination Action Group, Conservation Council, World Wildlife Fund for Nature and the South West Environment Centre will continue to be regularly briefed as the project moves forward.

During 2008 the project team will specifically provide presentations more specific to community groups and stakeholders to ensure a high level of engagement in the environmental assessment process, as well as providing updates on ongoing project activities.

1.3.8 Brochures, fact sheets and other visual aids

The project has a series of fact sheets and a brochure which contains information on the project, desalination and the environmental assessment program. These are available at our events, on our website and provided to interested parties on request. During the release of our Environmental Scoping Document, we produced two program-specific fact sheets to assist people in understanding the document. Refer to Appendix E for these fact sheets.

In addition, the Corporation is using advanced computer technology to visually communicate the aesthetic impacts of the plant, pipeline and the Harvey Summit Tank on the local environment (See Chapter **Error! Reference source not found.** Social Factors – Operational Impacts). Graphical depictions will continue to be enhanced as the design of the plant develops.

Our website www.watercorporation.com.au is regularly updated, providing online access to all relevant documents for community members and stakeholders. Our website is being used as repository for all reports and documents being produced as part of the project. It also outlines the community consultation opportunities, the environmental program and lists frequently asked questions and answers on the project. We store all community meeting presentations on the website for those with online access.

That being said, our research tells us that not everyone at Binningup uses the internet, so we regularly make documents available at local venues such as the Binningup and Harvey libraries and the Binningup General Store and extend an open offer to post any documents we list in our newsletter throughout the project.

Table 1.2 summarises communications activities to date.

Table 1.2 Communications Activities Undertaken

Activity	Dates
Community Events	
Community Meeting, Binningup	29 May 2007
Community Meeting, Myalup	30 May 2007
Perth Seawater Desalination Plant Tour for Binningup residents	2 July 2007
Perth Seawater Desalination Plant Tour for the Harvey Water - Sports Club	29 July 2007

Activity	Dates
Pipeline Landowners Workshop, Harvey	5 September 2007
Community Forums, Binningup (afternoon and evening)	25 September 2007
Binningup Spring Fair	6 October
Taranto Road Open Day (BBQ)	2 December 2007
Community Forums, Binningup (afternoon and evening)	3 December 2007
Community Forums, Binningup (afternoon and evening)	21 February 2008
Stakeholder Briefings	
Binningup Desalination Action Group	Ongoing
Shire of Harvey	Ongoing
South West Environment Centre	Ongoing
World Wide Fund for Nature	Ongoing
Conservation Council	Ongoing
Dolphin Discovery Centre	March 2007
Other stakeholder or community groups	On request
Landowners affected by preferred pipeline route, Harvey Summit Tank and near Taranto Road site	Regular one-on-one meetings
Other Activities	
Social Impact Assessment, GHD	2007
Social research (telephone)	Quarterly
Community newsletter	Monthly
Brochures, fact sheets and other materials	Ongoing
Local advertising	Ongoing
Website www.watercorporation.com.au	Ongoing
Dedicated community telephone line (free call)	Ongoing

1.3.9 Environmental communications

Activities already undertaken for the environmental impact assessment include:

- Voluntary release of the Environmental Scoping Document for public comment (28 November – 10 December 2007); and
- Response to 16 public submissions on 31 December 2007.

During the EPA 8-week Public Environmental Review public review and comment period, we plan to continue our comprehensive community consultation program, which will include:

- Community forums in Binningup and Harvey to further clarify information contained in the PER and associated scientific studies;
- Opportunities to access our environmental peer reviewers (QA information sessions);
- Media and newsletters;
- Key stakeholder briefings;
- A public tour of the proposed desalination plant site; and
- Static displays at local shopping centres, Council offices and libraries.

At the completion of the EPA's specified eight-week public review and comment period, the Corporation will prepare a *Response to Public Submissions* document, outlining our response (including how the proposal and/or the Water Corporation's environmental management commitments may change as a result of consultation) to all issues raised during the eight-week public comment period. This will be submitted to the EPA and made publicly available along with any additional information required to clarify/add to the PER.

1.4 Key Issues Raised and Responses

Table 1.3 outlines the main issues and concerns raised by the community to date and a summary of our response and/or the section of this Public Environmental Review document that addresses the issue.

Table 1.3 Key Issues and Responses

Social Issues Raised	Water Corporation Response / PER Section
Community consultation and information	It is recognised that the site selection process occurred without community consultation. Post-decision the site selection criteria were made publicly available, which ranked the Taranto Road site as the optimal site. A report that compared the cost of locating the plant at the Kemerton Industrial Park was also publicly released. The Corporation is committed to consulting and informing the community during the planning of the project and operation of the plant and to remaining open and transparent. The way in which we will continue to consult is outlined in this chapter of the PER.
Community identity and sense of place	Community identity and sense of place can be impacted upon by various factors. See the following PER chapters for more information: Chapter 11.0 Social Factors – Construction Impacts Chapter 12.0 Social Factors – Operational Impacts Chapter 14.0 Environmental Management
Facilities and services	In deciding on the location of the construction workforce, the Corporation will consider the potential impacts on local facilities and services. Recommendations from the Social Impact Assessment will also be considered, such as developing a needs assessment of the workforce.
Environment	The environmental issues raised by the community are addressed in the Water Corporation's Public Environmental Review.
Visual impact	The Corporation has undertaken preliminary sight line and view-shed modelling of the plant. As the design of the plant is not yet determined, this view-shed modelling is based on nominal building heights and revegetation principles. More extensive view-shed modelling of the plant will occur when the design is finalised, which is expected in the second half of 2008. This information will continue to be shared with the community and stakeholders. The Corporation has also undertaken view-shed modelling of the Harvey Summit Tank on surrounding areas. This modelling and a visual assessment is contained in Chapter 12.0 Social Factors – Operational Impacts.
Noise	Auditory amenity (noise) has been assessed for both the construction and operation of the plant. This assessment is contained within Chapters 11.0 Social Factors – Construction Impacts and 12.0 Social Factors – Operational Impacts.
Dust	The Corporation will manage dust suppression as part of its Construction Environmental Management Framework (see Appendix C).
Public safety and risk	The Corporation's approach to public safety and risk is outlined in Chapter 11.0 Social Factors – Construction Impacts. Public safety and risk will be managed in accordance with the management plans in the Construction Environmental Management Framework (see Appendix C).
Closure between Binningup and Myalup Beach	For public safety reasons, the 400 metre stretch of beach immediately adjacent to the site will be closed for up to 18 months during construction of the desalination plant. This beach closure will allow construction of the inlet and outlet pipes. The beach will reopen and be available as normal following construction.
Traffic	The Corporation will manage traffic as part of its Construction Environmental Management Plan (see Appendix C).

Social Issues Raised	Water Corporation Response / PER Section
Pipelines	The Construction Environmental Management Plan will address the way impacts on landowners will be managed.
Powerlines	The Corporation will work closely with Western Power to ensure that social impacts of the power line construction is mitigated and managed appropriately.

1.5 Future Opportunity for Public Involvement and Information

The Corporation will:

- Continue to organise community information sessions and forums at project milestones to ensure the community is kept informed and provided an opportunity to offer input into the planning of the project;
- Develop a social commitments register and be accountable for delivering on these commitments by making it an open document;
- Continue to develop clear and concise information materials including fact sheets, brochures, reports and visual technology;
- Continue to offer tours of the Perth Seawater Desalination Plant and the Taranto Road site;
- Continue utilising the website and freecall telephone line;
- Continue to issue a monthly newsletter with up-to-date information on the project;
- Continue with telephone research of the local community to track attitudes and perceptions, and make this information publicly available; and
- Continue to advertise information and events to ensure people are kept informed.
- In addition to these opportunities, the Corporation remains open to receiving ideas from the community on the ways they would like to get involved, with an open invitation to submit these ideas on the website, in our newsletters and at our community fora.

WATER CORPORATION

Southern Seawater Desalination Project

Project Implementation

PROJECT IMPLEMENTATION

Onshore Infrastructure

Description

An intermediate seawater pump station and brine outfall tank is located between the plant site and the shoreline. Its position and elevation facilitates gravity flows from the desalination plants as well as from the offshore intake and brine disposal pipelines. The pump station site selection considered minimisation of environmental impact on the dune system.

The pump station is located 400m from the shoreline and blended into the local topography with minimal protrusion above ground level. This location is as close to shore as possible without significantly impacting the dune system. It also gives good access to the seawater intake facility from all sides.

Seawater is then pumped to the pre-treatment facility and reverse osmosis facility located in the disused quarry area approximately 1000m further inland from the pumping station.

The overview of infrastructure is shown in Figure 1 which outlines the allowable construction area, and the planned rehabilitation and landscaped areas over the whole site. Figure 2 shows the total plant footprint with respect to the existing environment. The total area of the Project Area that would be revegetated would be as follows:

- Construction area: 5.2 ha
- Berm: 12.7 ha
- Offset areas: 10.5 ha

Additional landscape amenity plantings will be designed to allow for the secure and safe operations of the facility without impact on surrounding land or fauna.

The proposed microtunnelled construction of the offshore pipe lines from the seawater pump station to the offshore works under the dune system will ensure that the north south fauna corridors through the primary dune system will be maintained throughout all phases of the project.

In the area between the pumping station and the main infrastructure the long term north south fauna corridors will be reinstated as shown in Figure 1. The project specification will ensure stock fence only in the area between the sea water pump station location and the main desalination plant site. This type of fencing will allow for native fauna movements through the site.

To assure security in the construction of the pipeline trench, temporary fencing will be installed and protection of all open trenches outside the perimeter of the two main construction areas. In order to allow the fauna movement through these areas with open trenches, several open corridors without security fencing between mayor areas with security fencing installed will be available for the fauna crossing. The trenches in these crossing corridors will be covered with rigid materials able to keep both security and safety for people and native fauna crossing through these sections.

These corridors will be moved depending on the progress of the works, with at least one corridor always open between the pump station works and the main desalination plant site. Regular inspections are required as part of the fauna management actions developed in the Construction Environmental Management Framework.

A list of actions will be taken into account to avoid disturbance of fauna species and their habitat:

- During the construction stage, a fauna survey will be carried out prior to construction to determine the presence of endangered or protected fauna species in the construction area and surroundings.
- After this fauna survey, and considering the results, Fauna Management actions within the Construction Sustainability Management Plan and Operation Sustainability Management Plan within the Sustainability Management System will be refined and further developed. Within the Construction Sustainability Management Plan, Fauna Management will incorporate the followings aspects:
    - Specialist Advice on Threatened Fauna Species
    - Pre-Clearing Fauna Assessment
    - Clearing Methodology (considering a Two-Stage strategy)
    - Fauna Rescue Procedures
    - Reinstatement of Terrestrial Habitat
    - Hollow Management
- Fauna Management within the Operation Sustainability Management Plan will include a potential final Fauna Survey to assess the recuperation of communities and populations of fauna in line with the pre construction survey.
- The actions will specify construction procedures and clearing checklist to minimise clearing of native vegetation. The checklist will include hold points that require approval.
- Construction staff will be educated in relation to the risks of fauna deaths and how to manage animals which are injured or displaced
- At the beginning of the construction, the clearing of vegetation will be made from the centre to the edge, with the purpose of minimise the trapping and death of fauna species by machinery.
- The pipeline trench will be kept open for the minimal period required to undertake works.
- Every single trench opened during construction will be equipped with escape ramps at the end of the trenches, with a minimal slope of 1:3.
- The Environmental Scientist in place managing the Construction Sustainability Management Plan during construction will check the main places that are able to trap animals, at the end of the workday. If animals are discovered trapped, retrieval and management of the fauna will be conducted by a suitably approved consultant.
- If the trapping of fauna is continuous, temporary fencing or barriers to direct fauna will be placed along the trench in areas which are likely to be used as fauna corridors, e.g. possible linkages between bushland.
- One year after the construction, a replicate survey will be conducted utilising the same methodology and locations, to check if the fauna species are recovering to pre construction conditions.
- Rehabilitation of native vegetation will be undertaken between the security fences and the Pump station, using 20 artificial nests for possums to improve the recovery of this species.

Moreover, a number of actions in the landscaped areas will be implemented;

- Use of endemic flora to provide natural habitat, food and nesting facilities for fauna on site (only outside the security fences).
- Create vegetation links and corridors to encourage fauna movement through site (only outside the security fences).
- Retain hollowed branches from trees to be cleared, for use in habitat creation (only outside the security fences); and
- Rings to trees within close proximity to buildings to discourage possums entry to buildings (only inside the security fences);

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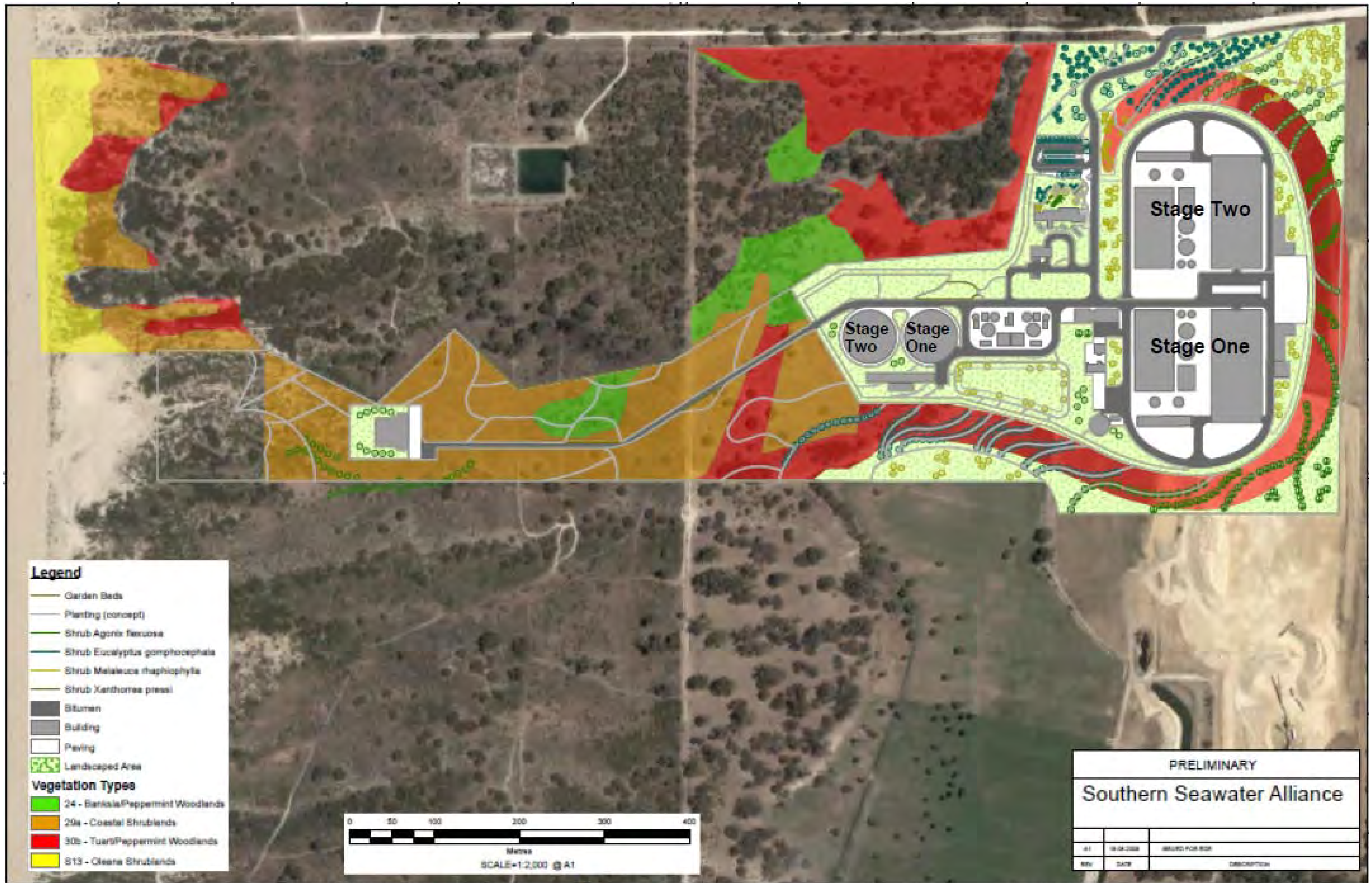


SSWA

WATER CORPORATION

INTEGRATED WATER SUPPLY SCHEME IWSS
SOUTHERN SEAWATER DESALINATION PLANT - TRV
REVEGETATION AREAS AND LANDSCAPE

JK43-96-100.6

A

A1

Offshore Infrastructure

Description

Seawater is extracted from the ocean through the screens incorporated in the offshore seawater intake structures. Seawater quality has a significant impact on the selection and operation of the pre-treatment system. It is important that the location of the intakes does not result in poor quality seawater flow into the plant.

The centre of the openings in the intake structure will be located 4.5m above the seabed so that high turbidity seawater associated with seabed activity is not entrained.

Typically the screens in the intake are installed at mid seawater level. To give good clearance from the more turbid conditions experienced near the seabed, the intake will be installed 500m offshore in a water depth of 9.5m to mean sea level.

The offshore pipeline infrastructure will be installed to handle the seawater intake and brine disposal system for two 50GL/yr desalination plants. The desalination plant is located approximately 1.4 km inland from the shoreline. The location of the marine works relative to the plant site is shown in Figure 3.

The Water Corporation has undertaken a background environmental assessment of the coastal area adjacent to the desalination plant site and identified a low ecological protection area (LEPA) that can extend 1,050m out from the shoreline.

To minimise the potential for brine recirculation the first diffuser is located 100m from the intakes. This effectively places the first brine diffuser port at an offshore distance of 600m. Brine dispersion has been modelled for the near field. The output of this work shows that 80 diffusers are required at a spacing of 4m. This places the end of the brine pipeline at a distance of approximately 950m offshore.

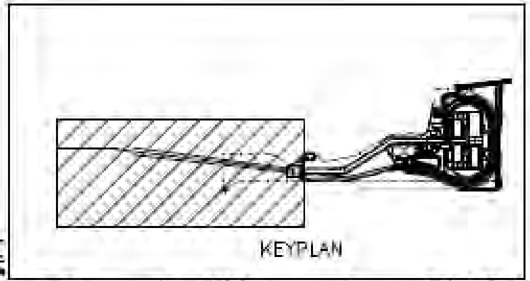
Given that the impact assessment of the construction of the offshore pipelines was conservatively based on dredging for the entire length, and that the selected option only requires dredging for approximately the last 400m, this effectively reduces the predicted impact (already not significant) even further.

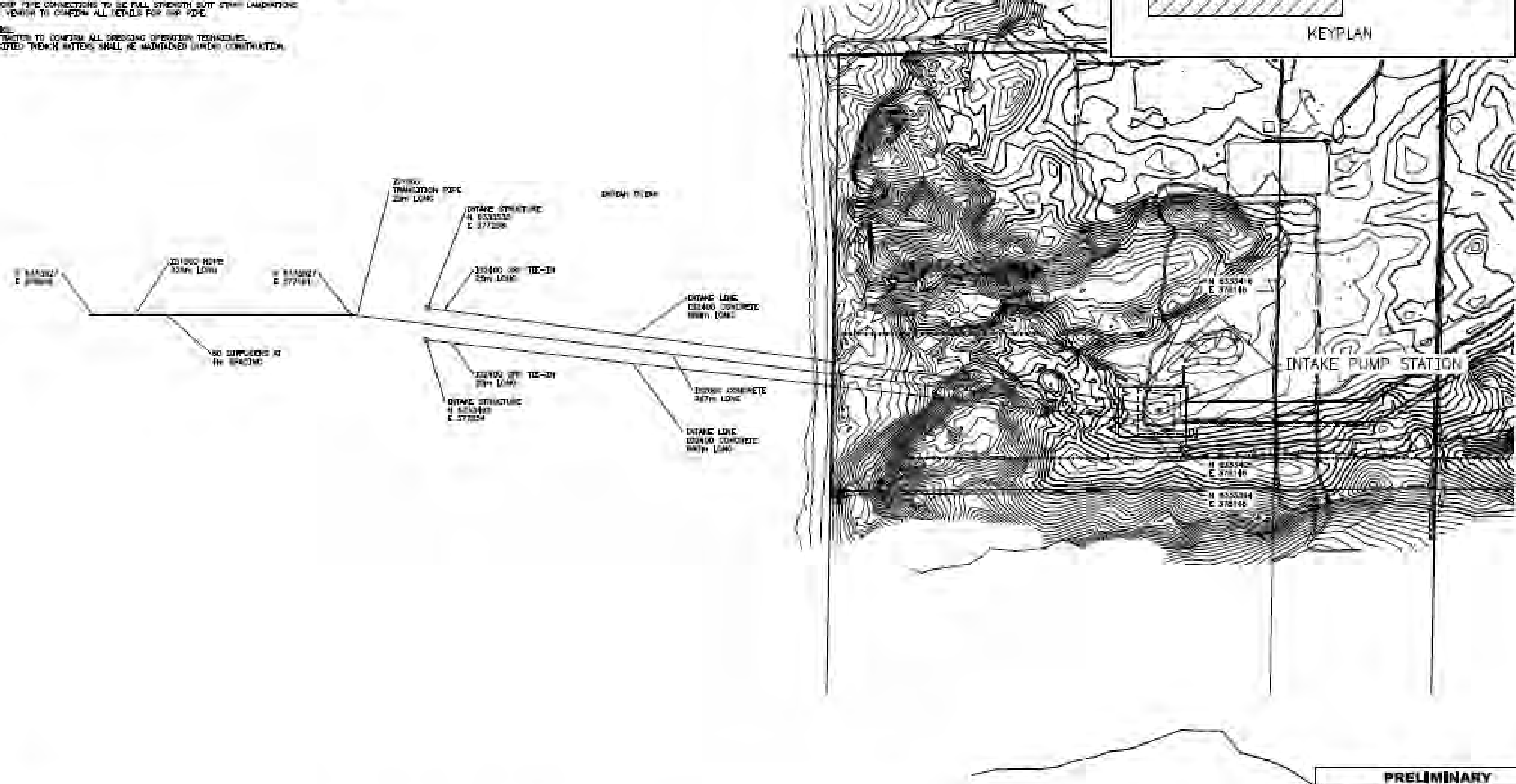
NOTES:

GENERAL:
1. ON THESE DRAWINGS ALL LEVELS ARE TO AUXILIARY CHART DATUM. CHART DATUM = -0.81m AHD.
2. ON THESE DRAWINGS ALL CHAINAGES ARE TAKEN FROM THE SHORELINE AT MEAN SEA LEVEL (MSL). MSL = 0.00m AHD.
3. DIMENSIONS SHOULD NOT BE OBTAINED BY SCALING.
4. DURING CONSTRUCTION THE STRUCTURES SHALL BE MAINTAINED IN A STABLE CONDITION AND NO PART SHALL BE OVERSTRESSED.
5. ANY DISCREPANCIES FOUND IN THESE DRAWINGS SHALL BE REFERRED TO THE SUPERINTENDENT FOR DECISION BEFORE PROCEEDING WITH ANY WORK.

PIPING:
1. POLYETHYLENE PIPES TO BE INSTALLED TO AS 2033 : 2008.
2. POLYETHYLENE PIPES TO BE PE100, SDR 26.
3. POLYETHYLENE PIPES ARE TO BE JOINED USING BUTT WELDING. REFER TO POPA PPP-001 FOR WELDING PARAMETERS.
4. BENDING RADIUS OF POLYETHYLENE PIPES SHALL NOT EXCEED 40m DURING INSTALLATION.
5. PRE-CAST CONCRETE JACKING PIPES SHALL BE IN ACCORDANCE WITH AS/NZS 4058 : 2007.
6. GRP PIPES SHALL BE IN ACCORDANCE WITH AS 3571 : 1989.
7. ALL GRP PIPE CONNECTIONS TO BE FULL STRENGTH BUTT STRAP LAMINATIONS.
8. PIPE VENDOR TO CONFIRM ALL DETAILS FOR GRP PIPE.

EARTHWORKS:
1. CONTRACTOR TO CONFIRM ALL DREDGING OPERATION TECHNIQUES.
2. SPECIFIED TRENCH BATTERS SHALL BE MAINTAINED DURING CONSTRUCTION.





PRELIMINARY

Southern SeaWater Alliance

REV	DATE	DESCRIPTION
A1	00.00.00	ISSUED FOR EDR

AUTHORISED: M. MARDAL, SSWA TECHNICAL DIRECTOR

ACCEPTED: SSWA ALLIANCE MANAGER

SSWA

WATER CORPORATION

INTEGRATED WATER SUPPLY SCHEME IWSS
SOUTHERN SEAWATER DESALINATION PLANT - TRV
INTAKE AND BRINE DISCHARGE
LAYOUT

PLAN: JK43-95-35.1 | ISSUE: A1 | ORIGINAL SHEET SIZE: A1

FOI 190429
Document 2q

Southern Seawater Desalination Project

Rehabilitation Plan

Southern Seawater Desalination Project

Terrestrial Impact – Vegetation associated with matters of National Environmental Significance (NES)

Post construction impact

Desalination Plant

After the construction stage of the desalination plant, the loss of existing vegetated areas (areas not degraded by the existing cleared quarry) will be 6.22 ha, distributed as follows:

Pump Station: 1.03 ha
Road to connect the Plant Site with the Pump Station: 0.42 ha

However the footprint of the seawater pump station and the connecting road do not impact on vegetation identified as habitat for matters of NES.

The footprint on areas identified as potentially supporting vegetation for matters of NES is 4.77 ha (this is both vegetated and unvegetated). Within this footprint, the actual currently vegetated area impacted containing vegetation associated with matters of NES (tuart/ peppermint feeding or habitat) will be less than 2.00 ha (individual trees impacted number approximately 40). This is shown on the yellow polygon on Figure 1.

Therefore, the proposed offset (at 4:1 ratio) is calculated at 2.00ha x 4 = 8ha.

Figure 2 is an artists impression of the final site showing post construction rehabilitation and amenity plantings.

Water Storage Facility

The location of the water storage facility has been sited in an area with minimal impact on a number of key sustainability factors including visual amenity and environmental factors.

Figure 3 shows the outcome of the design process for the water storage tanks (approximately 3.5kms from Harvey) located on agricultural land. Approximately 11 trees (Marri) will be removed to construct the tanks.

New Habitat Creation

Desalination Plant

Constructed berm: *12.7 ha* – Tuart/ Peppermint specifically selected for screening and Western Ringtail Possum feeding/habitat.
Landscape amenity plantings (using local species) outside security fencing (areas to be restored in the old quarry degraded areas): *7.7 ha*.

Total area of new vegetation = *20.40ha*

Figure 4 is a detailed view indicating rehabilitation of the section between the seawater pump station and the main infrastructure, the berm with new habitat plantings of Tuart and Peppermint, and areas for amenity landscaping utilising local species.

Water Storage Facility

The Water Corporation is in the process of purchasing this land, of which not all will be required for infrastructure. Figure 3 indicates the areas to be revegetated on site. Revegetation will be 3.5 ha of Marri and local native species.

Additional rehabilitation

Rehabilitation of all areas disturbed by construction but not required post-construction = 5.2 ha (including reestablishment of an additional Western Ringtail Possum north south movement corridor with Tuarts and Peppermints).

Additional Commitments not associated with proposed infrastructure

Rehabilitation of Lots 32, 33 and Part Lot 8

Offset areas: 10.5 ha rehabilitation of existing remnant vegetation outside of current proposal footprint.

Rehabilitation will seek to rehabilitate and significantly improve areas previously identified as supporting species of national and state importance, in particular the rehabilitation of degraded understorey to provide feeding trees and shelter for the Western Ringtail Possums between the existing Tuarts, and an increase in density of Banksias (as a feeding source for cockatoos).

Land Use Commitment

The Water Corporation currently owns freehold Lots 32, 33 and the part Lot 8 that contains a portion of the disused quarry. Lots 32 and 33 are currently zoned Public Utility (water). The current zoning of part Lot 8 will be amended to be consistent with the Lots 32 and 33.

The water storage facility on part Lot 554 Honeymoon Road will also be subdivided and rezoned to Public Utility (water).

Public Utility (water) zoning prevents any development not related to the Water Corporation, and with the current usage anticipated, the Water Corporation will commit not to sell or redevelop the land outside of the current plans for a wastewater treatment plant expansion.

Figure 4 also indicates the footprint of the expanded wastewater facility which currently exists on Lots 32 and 33. The Water Corporation will continue to operate a facility at this location but a maximum future footprint is indicated to provide clarity on the extent of future planning for the facility. All surrounding vegetation not already indicated as the post construction footprint will not be removed without referral to DEWHA. The potential expanded footprint of the wastewater facility will not extend into areas previously identified as having matters of NES.

Fig 1: The polygon indicates the footprint of approximately 4.77 ha containing both vegetated (less than 2 ha) and unvegetated areas.

Fig 2:Post Construction showing rehabilitated and created landscaping and vegetation.

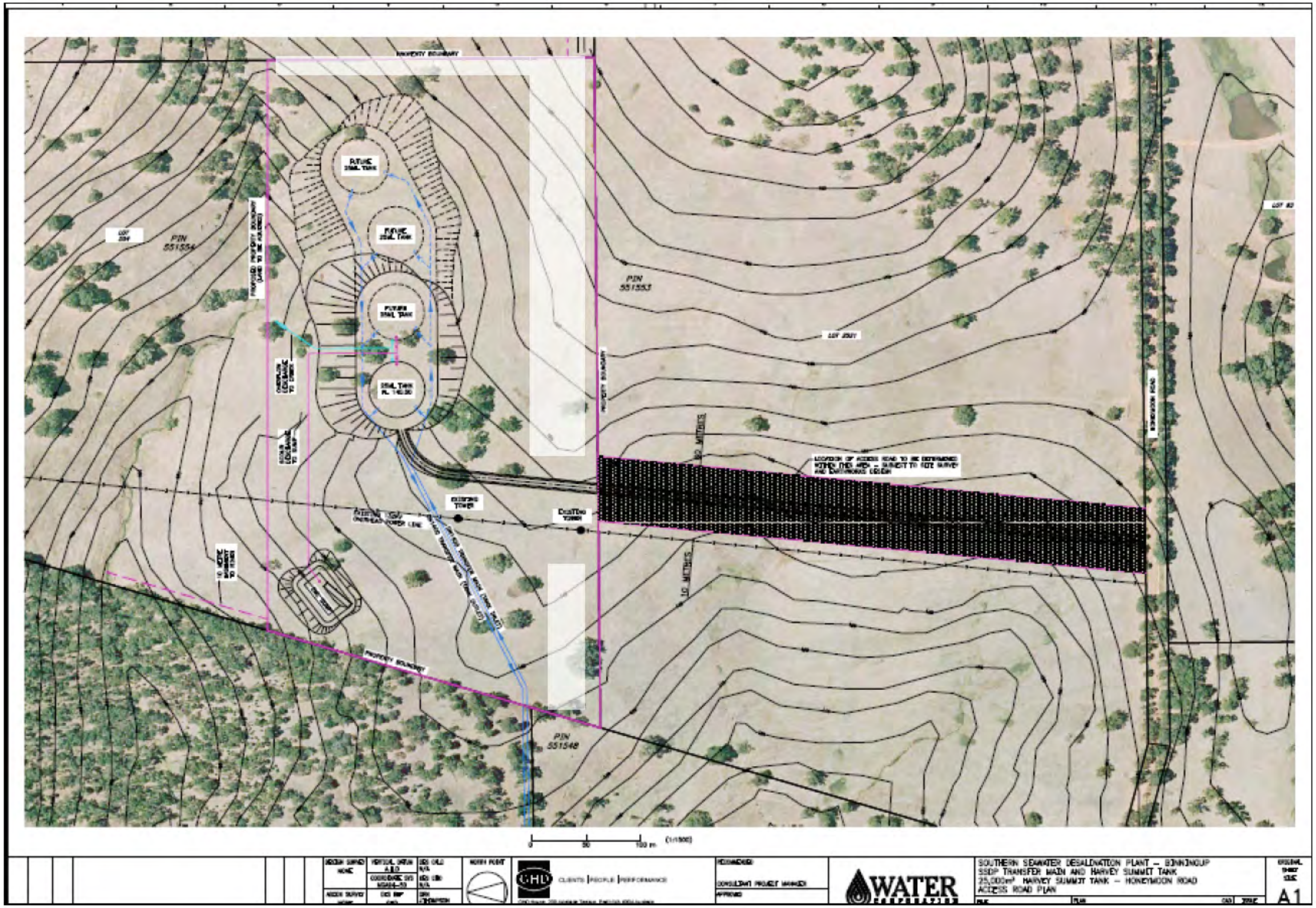


Figure 3 Layout of Water Storage Facility – including screening revegetation of 3.5ha

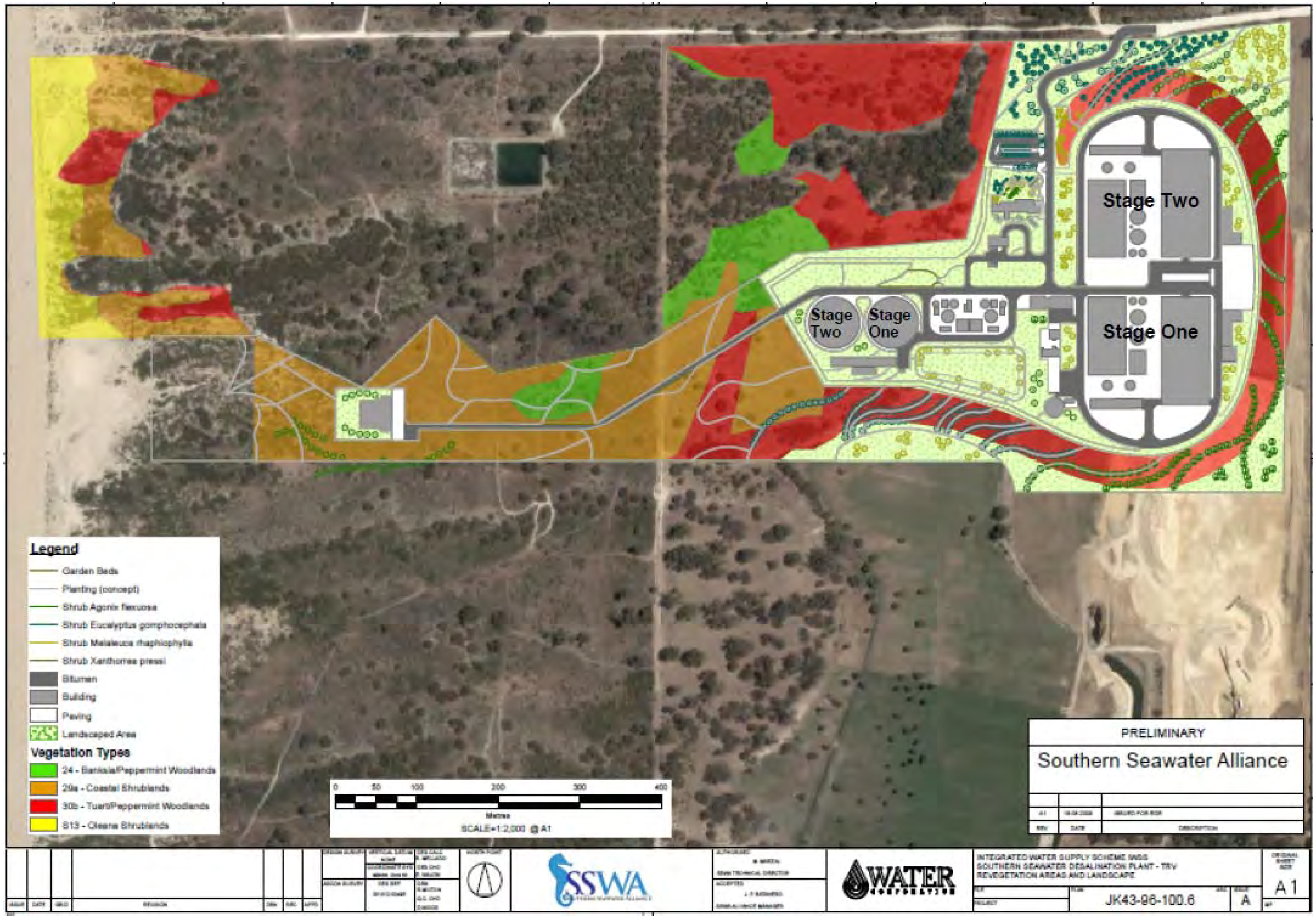
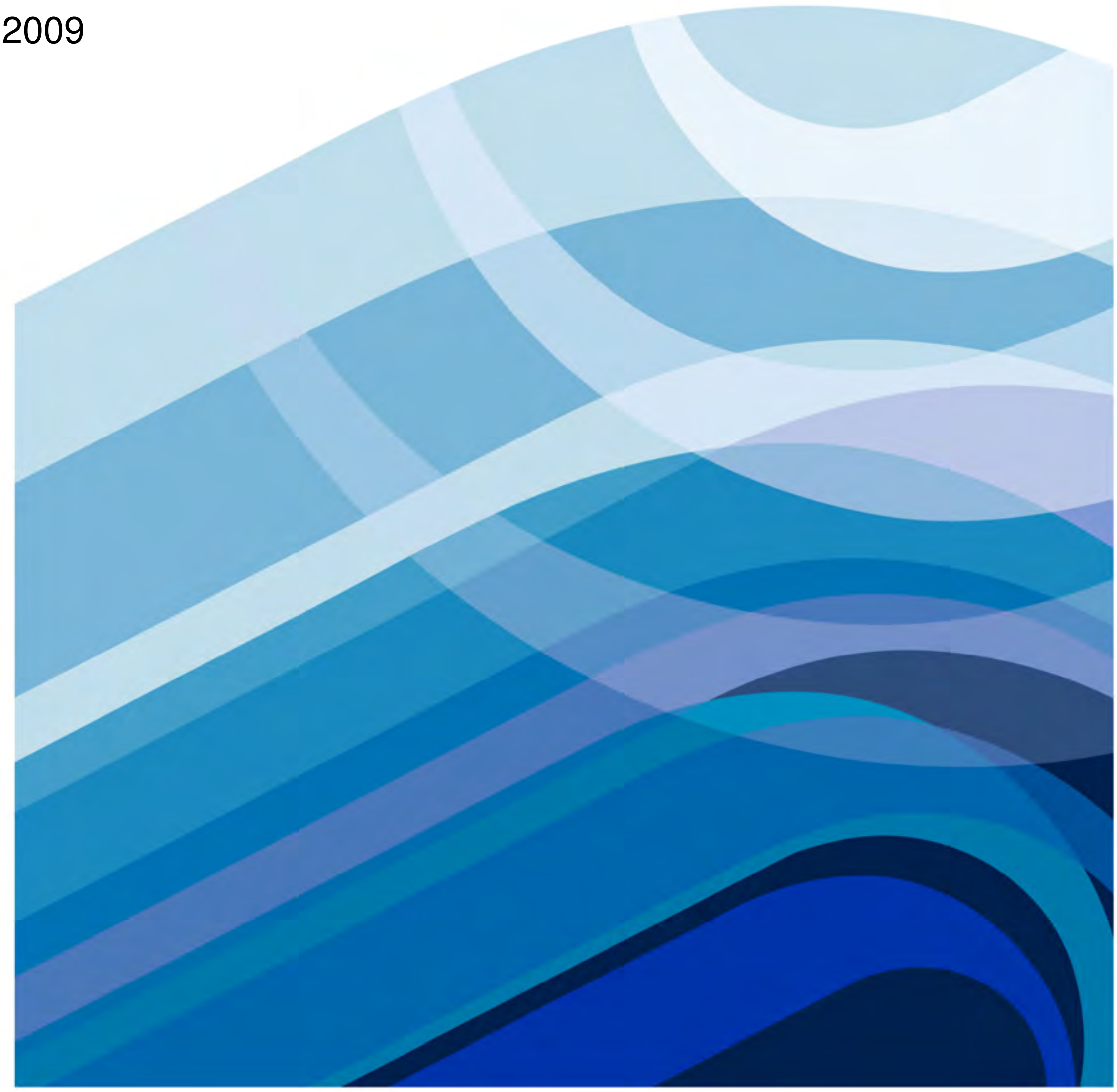


Figure 4 – Revegetation Plan – including additional offset rehabilitation outside of construction footprint

Southern Seawater Desalination Project

Response to Public Submissions for the Public Environmental Report Submitted to the Department of Environment, Water, Heritage and the Arts

May 2009



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Report	Version	Prepared by	Reviewed by
Southern Seawater Desalination Project: Response to Public Submissions for the Public Environmental Report Submitted to the Department of Environment, Water, Heritage and the Arts	140409 for review by DEWHA	K. Congdon	S.Brown
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1 Introduction

A Public Environmental Report (PER) was prepared by the Water Corporation according under the requirements of the *Environment Protection and Biodiversity Conservation Act* (1999) for the Southern Seawater Desalination Project (SSDP) at Lots 32, 33 and Part Lot 8 Taranto Road, Binningup in the Shire of Harvey. The PER was subject to a 30 day public review period from 3 February to 17 March 2009. This report is the Response to Public Submissions as required under the assessment framework, and outlines the response to issues raised during the 30 day public review period. It should be read in conjunction with the PER and associated appendices.

Once the Department of Environment, Water, Heritage and the Arts (DEWHA) considers this report has addressed the issues raised in the public submissions it will begin its assessment of the proposal and make recommendations to the Federal Minister for the Environment.

DEWHA issued guidelines requiring the evaluation in the PER of the significance of potential impacts upon but not limited to the following listed threatened and migratory species:

Fauna

Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*
Chuditch, Western Quoll	*Dasyurus geoffroii*
Western Ringtail Possum	*Pseudocheirus occidentalis*

Flora

Glossy-leaved Hammer-orchid	*Drakaea elastica*
Dwarf Hammer-orchid	*Drakaea micrantha* Hopper & A.P. Brown nom. inval.

Cetaceans

Blue Whale	*Balaenoptera musculus*
Humpback Whale	*Megaptera novaeangliae*
Pygmy Right Whale	*Caperea marginate*
Southern Right Whale	*Eubalaena australis*

Sharks

Grey Nurse Shark	*Caracharias Taurus*
Great White Shark	*Caracharodon carcharias*

Turtles

Leatherback Turtle	*Dermochelys coriacea*
Loggerhead Turtle	*Caretta caretta*

Birds

All migratory shorebirds listed under JAMBA, CAMBA and ROKAMBA.

The Commonwealth process is specific to the matters listed above and other matters that were listed in the guidelines set by DEWHA for the PER (DEWHA reference number 2008/4173). A much wider range of environmental matters and their management was considered under the state environmental assessment process. Material was provided to the state process through the Water Corporation's state Public Environmental Review and this response to public comments[1]. This same material was made available in the PER to inform the Commonwealth's deliberations. Some additional clarification has been provided in the PER to address the Commonwealth's specific requirements. In addition, DEWHA can require material to be added to the PER in response to public submissions.

[1] Information relevant to state public approval process including access to the state Public Environmental Report can be accessed via - http://www.watercorporation.com.au/D/desal2_per.cfm; the Statement of Conditions associated with State Government Approval for the Southern Seawater Desalination Project can be accessed via – http://www.watercorporation.com.au/D/desalination_plant2.cfm

2 Issues raised in public submissions and Water Corporation response

The Department required the Water Corporation's PER to assess impacts on Matters of National Significance (MNES), with particular regard to:

- Listed threatened species and ecological communities, notably the Western Ringtail Possum (*Pseudocherius occidentalis*, a transient visitor to the site), Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) and the Chuditch (*Dasyurus geoffroii*), due to vegetation clearing;
- Listed migratory species (Rainbow bee-eater (*Merops ornatus*)) due to disturbance of nesting sites; and
- Other threatened and listed migratory species likely to occur in the project area. These include the Humpback whale (*Megaptera novaeangliae*), Southern right whale (*Eubalaena australis*) and Blue whale (*Balaenoptera musculus*), the Australian sea-lion (*Neophoca cinerea*), Grey nurse shark (west coast population) (*Carcharias taurus*), great white shark (*Carcharodon carcharias*) and whale shark (*Rhincodon typus*), due to increased turbidity, blasting or seismic work.

Many public submissions on the PER discussed issues which were not related to MNES, such as:

- Indigenous heritage values;
- Social amenity, such as noise, views and lifestyle impacts (where not impacting on MNES);
- Alternative sources of water such as water trading, new dams and Wellington Dam desalination;
- Land zoning, planning strategies/policies and site selection;
- Energy use and greenhouse gas emissions;
- Health impacts of drinking desalinated water;
- Public health implications of co-locating the plant with an existing wastewater treatment plant;
- Pesticide use; and
- Nuisance mosquito breeding.

Many of these issues, where relevant to state environmental approvals process, have to a large extent already been addressed in the environmental impact assessment contained within the state Public Environmental Review (Water Corporation, 2008a) and the state Response to Public Submission for the Public Environmental Review submitted to the Environmental Protection Authority (Water Corporation 2008b). These documents were subsequently reviewed by the WA Environmental Protection Authority report on the proposal (EPA, 2008). The WA Minister for the Environment is currently considering the recommended conditions of approval for the proposal and a decision on the conditions is anticipated shortly. A summary of the Water Corporation's response to these non-MNES issues raised is also provided in this report for completeness.

2.1 MNES issues raised

The table below summarises each submission, the MNES issues raised within and the chapter of the PER which addresses the issue. The Water Corporation's response to these issues is discussed in detail.

Number	Name	Issues (MNES) raised	PER reference
1	W.A. Dept of Indigenous Affairs	The DIA has no issue or concern with the proposal.	N/A
2	Janet Nichols	Marine life. Shore life. Cetaceans.	6.3 6.3 6.3
3	P. A. Wellmans	Whales. Dolphins.	6.3 6.3
4	Elaine France	Migratory birds.	6.2.4
5	Bev Morton and Ruth Campbell-Hicks	Locality (and the environmental values). Marine mammals.	6.2 6.3

6	Binningup Desalination Action Group	Protected and endangered species. Flora and fauna studies. Duration of studies. Cetaceans. Toxicity impacts of process chemicals on marine life. Western ringtail possums. Carnaby's cockatoos. Ramsar wetland impacts. Threatened and migratory avifauna. Conservation values of site (non-specific to MNES).	6.2, 6.3 5 5 6.3 6.3 6.2.3 6.2.4 5.6.2 6.2.4 6.2
7	Lars Bejder	Marine fauna. Cetaceans.	6.3 6.3
8	South West Environment Centre	Western ringtail possums. Carnaby's and Baudin's cockatoos.	6.2.3 6.2.4
9	Dom Farnan	Conservation values of site (non-specific to MNES).	6.2
10	Ian and Lucy Harris	Duration of studies, particularly cetaceans. Western ringtail possums. Marine fauna.	5 6.2.3 6.3
11	Peter Reading	Western ringtail possums. Orchids. Marine fauna.	6.2.3 5.4.1 6.3
12	Donna Reading	Western ringtail possums. Orchids. Marine fauna.	6.2.3 5.4.1 6.3
13	Carolyn Bloye	Western ringtail possums. Red-tailed black cockatoos. White-tailed black cockatoos. Marine mammals. Waders and shorebirds.	6.2.3 6.2.4 6.2.4 6.3 6.2.4
14	Michael Derry	Western ringtail possums. Carnaby's black cockatoos. Baudin's black cockatoos. Forest red-tailed black cockatoos. Whales.	6.2.3 6.2.4 6.2.4 6.2.4 6.3
15	W.A. Dept of Health	No MNES discussed.	N/A

Duration and adequacy of baseline studies conducted

Submissions 6 and 10 were concerned that studies conducted for the PER were not over a long enough period of time. Studies were undertaken in consultation with the state EPA and DEWHA and the scope duration of these studies were deemed acceptable. It was identified during the state assessment that a further survey for the Glossy-leaved Hammer Orchid (*Drakaea elastica*) and the Dwarf Hammer Orchid (*Drakaea micrantha*) were required and these surveys were undertaken in late spring 2008. These targeted surveys did not record either species (Appendix A, section 5, p.9).

In addition, the approach taken to the proposal has been to constrain the design to meet particular environmental outcomes, such as meeting brine dilution requirements to allow for maximum protection of marine species (based on the recommendations of the Whole Effluent Toxicity test results) and selecting a terrestrial plant layout that protects the most valuable vegetation (habitat and feeding trees). This conservative approach to design and construction technique selection means it is not necessary to survey for every species, as the assumption has already been made that sensitive species (such as cetaceans) are in the project area and management measures to protect them will be implemented.

Conservation values of the site

Submissions 5, 6 and 9 raised the issue of the environmental conservation values of the site. It is agreed that there are areas on the site of high conservation value. These areas were identified early in the planning phase of the project and an "envelope" with lower values to MNES was marked out, within which all elements of the plant were required to fit.

In general, the impacts on the environmental values on the site (as they relate to MNES habitat and feeding trees) will be low. This is due to careful placement of the majority of infrastructure on the eastern cleared portion of Part Lot 8 (currently a cleared quarry). Underground pipelines connecting the plant to the seawater pumping station will require some vegetation removal, however this is not associated with vegetation supporting MNES. The footprint on areas of vegetation supporting MNES is estimated to be 4.7 ha (which is both vegetated and unvegetated). Within this footprint, the impacts on vegetation supporting MNES (tuarts/peppermints) is less than 2 ha.

Dewatering to lower the groundwater table in order to construct the seawater pumpstation has been minimised by the selection of diaphragm walls. This effectively reduces the volume of water to be removed to the volume contained in the pit, rather than continuously dewatering. The potential for acid sulphate soils to be created is therefore unlikely. However the Water Corporation has addressed the management of potential acid sulphate soils in the Construction Environmental Management Framework (Appendix C, p.50) which is consistent with the Water Corporation internal guideline, Water Corporation Acid Sulphate Soil and Dewatering Management Strategy 2007 (Appendix E). The approach has been reviewed by the state EPA as part of the assessment and approval under that process.

Potential impacts on marine life

Many submissions (2, 3, 5, 6, 7, 10, 11, 12, 13 and 14) were concerned with the impacts of the proposal on marine life, such as whales, dolphins, sharks, sea-lions, turtles and penguins.

The Water Corporation recognised the importance of the potential for impacts to marine life, particularly cetaceans, very early in the proposal and a large number of studies were commissioned in order to understand the risks involved and design the project to either eliminate or minimise those risks. The PER acknowledges the sources of risk to marine life (section 6.3, p.94) and discussed the potential impacts and their management, particularly during construction. It concluded that the proposal, with appropriate management actions, would be unlikely to have a significant effect on marine life or any marine species (section 6.3.3, p.100). Only one submission (7) raised new information that had not previously been noted in the PER (the potential presence based on anecdotal information of Little penguins (*Eudyptula minor*) has now been noted on p.54 in section 5.4.4). However the assessment of impacts and risks to marine life remains unchanged.

Specifically, the impacts of brine toxicity were raised by one submission (6). The Water Corporation, through conservative design of the marine diffusers to achieve low levels of salinity (and therefore other constituent concentrations) has demonstrated in its state and Commonwealth PERs that more than adequate dilution can be achieved to protect marine life. The impacts that the Water Corporation is aware of at other desalination plants around the world occur when sludge is not taken off-site (at this plant, sludge is planned to be taken to an appropriately licensed landfill facility), and when there is no diffuser to dilute the brine with surrounding seawater. Literature reviews have not yielded any credible evidence of significant impacts when an appropriately designed diffuser is used.

Detailed modelling was undertaken on several aspects of operation and brine disposal. This included consideration of currents (all locations and depths, measured by a fixed Acoustic Doppler Current Meter (ADCM)), weather patterns, actual bathymetry and salinity.

The marine programme and modelling was reviewed by Professor Jorg Imberger of the University of Western Australia's Centre for Water Research (Centre for Water Research, 2008). His review was made publicly available and Professor Imberger attended and presented his views and answered questions at two community meetings in Binningup. The review concluded that "the site and feasibility of the venture are sound".

Water Consultants International (2006) reviewed more than 70 papers and reports associated with reverse osmosis plants and could not find any credible evidence of significant marine impacts associated with operation when an appropriately designed diffuser is used and sludge is removed to landfill.

The brine mixing was modelled in two steps:

- The mixing that occurs due to the brine being discharged from the diffuser (this is within 100m of the diffuser and is known as the near field); and
- The mixing and movement that occurs beyond the near field.

The brine dilution in the near field was estimated assuming no currents and calm conditions (i.e. higher dilution will occur in the actual situation). This dilution was then applied to the oceanographic model. The mixing outside of the near field in the model was based upon a dye release undertaken in calm weather – actual mixing will be higher. Thus a conservative approach has been adopted.

The brine will be diluted at least 28 times (i.e. 28 litres of seawater will mix with every litre of brine discharge) due to the brine being ejected from the diffuser. This means that the maximum salinity increase 100 m from the diffuser (this being the Low Ecological Protection Area or LEPA) will be around 1 ppt and the diluted brine will not be hypersaline. Salinity toxicity is discussed in the state Public Environmental Review (section 8.2.7, p.198) where it is concluded "the operation of the SSDP plant is unlikely to increase salinity to a level that will affect flora and fauna residing outside of the LEPA". In addition, the state Ministerial Conditions of Approval require the Water Corporation to conduct Whole Effluent Toxicity (WET) testing according to protocols agreed to by the state Department of Environment and Conservation.

Cumulative impacts for salinity were considered by including all processes in the modelling that affect salinity (i.e. evaporation, freshwater input via the Harvey Diversion Drain and the brine discharge).

Whales have significant distributions and range or migrate over considerable distances. Given the small scale of the project and the large distances over which whales migrate, it is most unlikely that the whale population would be disrupted by the proposal. Therefore it is not considered necessary to study whale migratory patterns to ascertain environmental impact assessment.

Submission 7 was concerned that the PER implied that cetaceans did not use the area. The PER states that information is limited, so the Water Corporation's assumption has always been that cetaceans do use the area and appropriately conservative management actions will be adopted. The submission also refers to the PhD candidate studies provided by Murdoch University to the Water Corporation. The geographical extent of these visual representation studies is from Bunbury to Binningup, which is still almost 1 km south of the project site. The PER is still correct then in stating that information at the project site is limited.

For this reason, the Water Corporation has commissioned Western Whale Research and Murdoch University to undertake a monitoring program with strong community involvement and is investigating the use of hydrophones to directly determine the presence of cetaceans.

It should be also be noted that all marine construction activities will be managed conservatively based on the premise that whales could be present. Management actions already committed to include:

- If practicable, blasting will be conducted at times when marine mammals are least likely to be in the vicinity.

- Should any marine mammals be injured, specific advice will be sought from DEC. The Seawater Pipeline Installation Management Plan will be updated to reflect this.

- The Water Corporation has commissioned Western Whale Research to undertake a monitoring programme and is engaging Curtin University to deploy hydrophones to directly measure noise levels in the marine environment.

The expert report Western Whale Research (2008) advises that changes to whale migration routes will be temporary (i.e. whales will return). This is confirmed by the literature reviews of URS (2008a and b – see http://www.watercorporation.com.au/D/desal2_per.cfm).

Data is being collated on marine mammals with regard to when they are likely to be present. If practicable, blasting will be conducted at times when marine mammals are least likely to be in the vicinity. Blasting will be halted if mammals are sighted within the exclusion zone.

The extensive review of URS (2008a) provides confirmation that blasting, noise and vibration from construction are unlikely to cause significant harm to marine mammals with any impacts being temporary. This review, which has over 160 references, concludes that "*any noise that is generated would be minimal and inconsequential in comparison with the ambient noise of the near-surf zone where the pipelines will be located*". As such, it is not anticipated that whales and other marine mammals will avoid the area because of the operation of the desalination plant, as this will generate less noise than the marine construction (for the marine pipelines) and is located a minimum of 400m inland (the seawater pumping station is the closest operational noise generating infrastructure).

Threatened and migratory avifauna

Submissions 4, 6, 8, 13 and 14 were concerned about the potential impacts on birds, particularly in relation to the removal of habitat and feeding vegetation. It was recognised early in the planning of this proposal that there was a potential for impact on both feeding and habitat trees associated with birds that are considered MNES. Impact avoidance and minimisation was a high priority in the selection of the infrastructure envelope to be used by the project designers. Tunnelling will be used for a substantial portion (approximately 400m) of the terrestrial pipeline construction to avoid impacts on the plant. The majority of the 28km of water transfer pipeline to the storage tanks at Harvey will be either in cleared farmland or beneath roads. Therefore impact on this important habitat and feeding vegetation as assessed in the PER is not considered to be highly significant, due to the careful placement of the majority of infrastructure in the cleared quarry.

Impacts on coastal wading birds have been eliminated by locating the seawater pumpstation some 400m inland, and tunnelling the pipes from there westward to the seawater inlet structure (500m offshore).

The potential for impacts on migratory flyways was raised (submission 4) with particular reference to the powerlines proposed for the SSDP. The Water Corporation is securing the power transmission line supply from Western Power. They will be undertaking their own route selection (independent of the Water Corporation) and will be the proponent for this and will need to comply with the state *Environmental Protection Act 1986* and the Commonwealth EPBC Act (1999). Western Power addresses these issues in their referral.

The powerlines proposed for the SSDP do not constitute a significant risk to migratory birds for the following reasons:

Regional Context

There are several known wetland areas that are important to migratory birds in SW Western Australia and these are located in a wide ranging area between the Swan River and Rottnest to the Vasse-Wonnerup area (near Busselton) and across to Esperance in the south-east. The northern part of the Leschenault Inlet wetland system is known to be used by migratory birds.

While the movement of birds between these sites is not well understood there are significant structures (towns, transport infrastructure corridors, main roads, ports, industrial facilities, existing powerline corridors, etc) that occur between these sites that transect potential flight corridors. Some of these structures occur between the nearest known significant bird site to the SSDP project (the Peel-Yalgorup Ramsar wetland – which includes Lake Preston near Myalup) and the other important wetlands that birds may move to (e.g. Vasse-Wonnerup area, Leschenault Peninsula, Lake McLarty, Perth area wetlands), however, there is no evidence that significant bird mortality or impediment to bird movements have occurred in SW Western Australia as a result of these structures transecting potential flight corridors.

When consideration is given to the proposed SSDP powerlines in this regional context (i.e. the scale and location of these existing structures) it is difficult to see the proposed SSDP powerlines having any tangible affect on bird population or movement patterns between important sites in the south-west.

Local Context

The SSDP site itself will be built on predominantly degraded land. Some vegetation will be removed, but this lost vegetation will be replaced and biodiversity values enhanced. The loss of vegetation and construction activities may deter some birds involved in migration from landing at the site, but this is not likely to have any discernible effect on the utility of the flyway and its small physical size means that in no way would the SSDP site 'transect' any flyway.

Although the powerlines associated with the SSDP will extend over a longer linear distance than the SSDP site, these too will not be long enough to transect any flyway. Furthermore, the power lines will not present an impenetrable wall type barrier, only presenting any impedance to bird flight in the form of the transmission pylons or poles which will be used and the wire catenary. This suggests ample opportunity for birds flying through the area traversed by the transmission line to avoid actual impact by flying under or over the wires.

To place the actual extent of any supposed 'barrier' in context, for example, if a 70 mm diameter wire has spans are which are 50 m long and an average of 15 m above ground level, then the wire itself will present a cross-section acting as a barrier to bird flight of 3.5 m^2 within each 50 m span. If there are three wires in the transmission line, then the total area of wire in each 50 m span will be 10.5 m^2. This compares with a total area between pylons and underneath the wires of 750 m^2. Thus the wires would occupy only 1.4% of the available area for birds to fly underneath the wires (if the wires were 50 mm diameter and 20 m above ground-level, then this would fall to 0.75%). While bird strikes cannot be discounted on the powerlines servicing the SSDP, they would be infrequent and unlikely to have any population or species-level impacts.

Western ringtail possums

Submissions 6, 8, 10, 11, 12, 13 and 14 raised the issue of the impact on the habitat and feeding area for Western ringtail possums, particularly the maintenance of north-south linkages. The flora and fauna surveys undertaken (360 Environmental 2008) have stated that there were 4 individuals using the SSDP site. The potential for impact on this species was recognised by the Water Coporation early in the planning and design of the project and was the main driver for the purchase by the Water Corporation of extra land (another 40 ha to take the total site to approximately 80 ha) at Part Lot 8, an operating quarry with some degraded but potentially valuable remnant vegetation. The purchase of this site allowed for a large degree of flexibility in the placement of infrastructure, thereby reducing the amount of valuable vegetation being disturbed. Emphasis was placed on both maintaining habitat and linkage corridors across the site.

Additionally, reducing potential impact by using construction techniques such as tunnelling will be adopted, particularly in the coastal section from the seawater pumpstation (400m inland) out to the inlet structures (500m offshore). This will allow a large portion of the site to remain undisturbed, thus maintaining an undisturbed north-south linkage for fauna to use. For the portion being trenched between the seawater pumpstation and the plant, a section will remain open as a “corridor” to allow for movement of the possums during construction, in addition to the uncleared dune area 400m wide and to the west of the seawater pumpstation. These two corridors provide ample north-south linkages for fauna to travel across the site. Post-construction rehabilitation of the disturbed and undisturbed areas of the site will lead to a greater density and area of possum habitat and feeding trees than is currently present.

Management of potential impacts has been described in Section 6.2.3 of the PER (p.75). It was concluded that the proposal will not pose any significant risk to the populations of possums in the region (p.76). A mitigation strategy (Strategen 2009) to address the residual impacts has also been included in the PER (Appendix F). The strategy is also included (Appendix D) in this document.

A Rehabilitation Plan (Appendix M of the PER) addressed the areas on the site proposed for rehabilitation, including within the construction area and on other areas of the site. Rehabilitation of the disturbed and undisturbed areas of the site will lead to a greater density and area of possum habitat and feeding trees than is currently present.

Ramsar listed wetlands

One submission (6) questioned the validity of the assessment that the distance to the Peel-Yalgorup wetland (a Ramsar listed wetland) being some 2.5km from the project meant that no effects were anticipated at this wetland. While it is the case that approximately 1ha of a degraded grazed wetland will be impacted by the proposal (on Part Lot 8), the large distance to the Peel-Yalgorup system means it is highy improbable that any site works will impact on that wetland. Large dewatering impacts will not occur as the use of diaphragm walls in the construction of the seawater pumpstation effectively limits the drawdown to a highly localised area.

Orchids

The potential impacts on orchids were raised in two submissions (11 and 12). Specifically it was felt in these submissions that the research needed to assess the effects had not been conducted. However this is not supported, as the PER states (section 6.2.1, p.69) that in 2006 and 2007 surveys identified the likely presence of *Drakaea micranthra* in the survey area (prior to the pipeline route to Harvey being selected). The 28km pipeline route was carefully developed to avoid impacts on these rare orchids. A further targeted survey of the proposed route and plant site in 2008 did not locate any *Drakea* species (Appendix A, section 5, p.9).

2.2 Non-MNES issues raised

Alternative sites and pipeline routes considered

The submissions received identified a number of key issues related to the selection of the site for the desalination plant and the water transfer pipeline route. The issues and further information is provided in the following sections.

Desalination Plant Site – Land Zoning and appropriateness of siting the facility on this site

Submissions 5, 6 and 10 raised the appropriateness of the facility in a rural setting. Planning zones for Lots 32 and 33 is Public Purposes – Public Infrastructure, and Lot 8 is zoned Rural under both the Harvey Town Planning Scheme and the Greater Bunbury Regional Planning Scheme. The Water Corporation is required to obtain planning approval under both schemes, with a prohibition on a positive determination until the completion of the State environmental approval process. The Water Corporation will undertake all approvals required prior to construction being undertaken in accordance with the Greater Bunbury Planning Scheme and the Shire of Harvey Town Planning Scheme. The planning approval of the works is a requirement prior to Ministerial Works Authorisation under the *Water Agencies (Powers) Act 1984.*

Public Utility (water) zoning prevents any development not related to the Water Corporation, and with the current usage anticipated, the Water Corporation will commit not to sell or redevelop the land outside of the current plans for a wastewater treatment plant expansion.

Lack of sufficient community consultation, including on issues of noise and visual amenity, plus a perception of damage to the coastal area

Submissions 6, 10, 13 and 14 were concerned about the level of community consultation and the potential social impacts of the proposal. The Water Corporation has since May 2007 acknowledged that the community was understandably surprised by the announcement of the project and has worked closely with community members and stakeholders to understand their concerns about the desalination project. The Water Corporation's knowledge of the local community and its shared values continues to grow beyond that contained within the state and federal PER documents. The Water Corporation commissioned a Social Impact Assessment (SIA) on August 2007 to build on its understanding of the project's social impacts. A key recommendation of the SIA was to develop, in consultation with the affected communities, a Social Impact Management Plan. This process is already underway.

The SIA and numerous public meetings and stakeholder briefings gave us an insight into the potential social impacts of the project and made a number of recommendations to which the Water Corporation has committed:

- Community Reference Group (CRG). This has been convened and meetings have been held regularly since August 2008;
- Local Benefits Package;
- Social Impact Management Plan (SIMP); and
- Commitments Register.

The Water Corporation engaged with the community thoroughly before both state and federal PERs were released and held several workshop on the content during the consultation periods. All matters of national environmental significance have been discussed with stakeholders during the consultation process.

Consultation on noise management (construction and operational) occurred in the state PER assessment process and at public meetings. In the state PER Section 11.0, Social Factors – Construction Impacts (p.212), the EPA Objective for Noise (and Vibration) is identified in subsection 11.6.1 (p.218) as follows:

- Protect the amenity of nearby residents from noise and vibration by ensuring that noise levels meet statutory requirements and acceptable standards; and
- Avoid unacceptable adverse impacts on the natural environment, including native fauna.

State PER 11.6.9, Management of Impacts (p.222) describes the actions that will be taken to minimise noise impacts associated with SSDP construction activities, i.e.

- Monitoring construction noise weekly at all construction sites, compare against noise level objectives;
- Monitoring construction blasting noise, compare and record against noise level criteria;
- Scheduling noisy construction activities between 7am to 7pm with blasting to be undertaken only between the hours of 7am and 6pm (if changes to these hours are needed, Shire of Harvey approvals will be obtained and affected communities notified);
- Constructing an earth berm (bund) at the southern and eastern boundaries of the plant site prior to main construction activities commencing to minimise noise transfer to the nearest residential premises and the Binningup town site (berm will remain during operation of the plant);and
- Restricting materials transport vehicles to major transport routes and restricting their movements to between the hours of 6am to 8pm. This will include ungazetted roads. The use of reversing beepers for trucks and construction vehicles is a mandatory safety requirement. Specifically, the Code of Practice for Excavation (2005), states:

"Vehicles and mobile plant moving in and around workplaces, reversing, loading and unloading, are activities frequently linked with workplace injuries and fatalities … Mobile plant operating near ground personnel should be equipped with a reversing alarm and a revolving light" (p49)

The Code is available at http://www.docep.wa.gov.au/WorkSafe/PDF/Codes_of_Practice/index.htm

More generally, the OSH Regulations (1996) state:

3.2.2 Management of vehicles and moving plant at workplaces
A person who, at a workplace, is an employer, the main contractor or a person having control of the workplace must ensure that the movement and speed of vehicles and plant at the workplace are managed in a way that minimises the risk of injury to pedestrians and persons operating vehicles;

- CEMF Subsection 14.4, Management Actions (p.78) details, pertaining to General Construction Considerations, Noise Meter Calibration, Measuring Construction Noise and Measuring Blasting Noise, are described. In subsection 14.6, Contingency Actions of the CEMF (p.80), it is reiterated that "*noise monitoring will be undertaken to confirm that the noise criteria have been achieved by the directed actions*" and actions to be taken if the construction noise criteria or the blasting noise criteria are exceeded are identified as follow:
- Noise bunds or screens;
- Adjusting the work schedule for the offending work to be conducted in more appropriate time;
- Changing the technology or method of construction;
- Temporary relocation of the affected landowner (subject to agreement with the land owner).

The Water Corporation will also have in place a Community Complaints Management Plan.

Blasting is unlikely to be required, however, if this is the case, the works will be regulated under the Environmental Protection (Noise) Regulations 1987 (WA) with noise limits and blasting times assigned. The activity with the potential to generate the noisiest emissions is pile driving at and out from the beach. Section 11.6.5 of the state PER (p.220) describes the acoustic modelling undertaken to assess the potential impacts. The predicted noise levels were as high as 60dB(A) which would be clearly audible, however this is a similar level to that of a passing vehicle on a local road.

Consultation on visual amenity occurred via the state PER process and at several public meetings. In section 12.4, Visual Amenity, of the state PER, the Water Corporation acknowledges (in subsection 12.4.1, Background, p.237) that the SSDP "*could have some visual impact on the local area, given the nature and scale of the project*" and states that "*visual impacts can be mitigated by design and landscaping that compliments and, in some cases, enhances the local area*". Design, landscaping and revegetation plans will be implemented to minimise visual impact from Binningup and across the Leschenault Inlet wetland. The top of the lime silo (the tallest structure on the desalination plant site) may be marginally visible from some locations on the beach.

A man-made and vegetated berm (or bund) will be built along the southern and eastern boundary of Part Lot 8. The purpose of this berm is to act as a noise and visual screen between the site and existing and future southern/eastern properties and Binningup township.

The pump station will be located no closer to the beach than the eastern side of the primary dunes and the design criteria has been set for it to not be seen from the beach. Rehabilitation of the dune areas will further reduce any potential impact of the infrastructure on the visual amenity from the beach immediately in front of the seawater pumping station.

Lighting will be the minimum necessary to light the plant and will be designed to reduce overspill. It will be comparable to street lighting. It is expected that dispersed light pollution (i.e. light spill) from the plant will have less affect on Binningup and Myalup residents than their local street lighting.

Health issues

Submission 14 raised the issue of the generation of trihalomethanes (THMs) via the reverse osmosis process. The Water Corporation is regulated by the Department of Health in relation to the quality of all drinking water suplied to customers. In Australia, National Health and Medical Research Council define the acceptable health limits for THM in drinking water (0.25 mg/L). In Western Australia, THM health limits are set by the Department of Health. The Water Corporation is fully compliant with all the health requirements, including THM, defined by the Department of Health. As part of this commitment to transparency, we publish our water quality data (including THM) on our Corporation web site.

Pollutants arising from the plant and inadequate modelling to address these was an issue also raised by submission 14. The Corporation has a hazard and safety management system in place (which was established ten years before the regulations specifically required one) and standard designs that incorporate such things as building containment features, chlorine leak monitors, alarms, auto shutdown features etcetera which reduce the potential for release of chlorine to a rare event (the Water Corporation operates over 260 chlorine facilities around the state and has been using chlorine for over 80 years without suffering a release event that has impacted a member of the community). The Water Corporation is required to put in place a site specific management system which will be informed by the Fire and Emergency Services Agency resources, and the measures put in place within the plant such as fire systems and chlorine handling facilities.

Even in this event the positioning of the chlorination facility on site provides sufficient buffer within the Water Corporation owned land to protect public safety.

Onsite Ooccupationsal Safety and Health issues are addressed in the design.

Detailed responses to chemical issues have previously been provided to the public and posted at the following Water Corporation website links;

- http://www.watercorporation.com.au/_files/PublicationsRegister/15/ChemicalQuestions.pdf
- http://www.watercorporation.com.au/_files/PublicationsRegister/15/Chemicalsusedfortreatment.pdf

Submission 15 was concerned about the potential environmental health hazards posed by locating the plant close to an operating wastewater treatment plant and any potential cross-contamination. The submission was correct in noting that the lot is 80 hectares, and as such is sufficiently large to contain both operations independently. There is no possibility of any seepage from the wastewater treatment plant entering the desalination plant.

This submission also noted that there are general requirements for the Water Corporation to comply with the *Health (Pesticides) Regulations* 1956. It was recognised that the Water Corporation has developed a Pest Hygiene Management Plan and an Organochlorine Management Plan within the state PER Construction Environmental Management Framework (section 9.0, p.59 and Section 17.0, p100, respectively) in which these matters are thoroughly addressed and the potential risks posed. The Construction Environmental Management Framework is also included (Appendix C) of this report.

The risk of mosquito-borne diseases was also raised in submission 15. It was recommended that the Water Corporation liaise directly with the Shire of Harvey to identify natural mosquito breeding sites which may give rise to mosquitoes that will impact on the development. The Water Corporation is in the process now of discussing the development applications required by the Shire of Harvey. The Shire of Harvey will place appropriate conditions of approval as part of this process.

Recreation

Submission 13 raised the issue of the proposal's effects on beach access and potential tourism. This was originally predicted, due to the design process being run in parallel with the environmental impact assessment. This meant that impacts were in general over-predicted, such as the potential period for beach closure. The worst-case scenario was communicated to the community as being potentially 18 months of a section of beach immediately in front of the plant site being closed if open trenching methods were used to lay the marine pipes. The design of the project has since progressed to a point where a tunnelling method has been selected. This means the short section of beach immediately in front of the plant (not the section in front of the town of Binningup) may need to be closed for 2-3 weeks only, while the tunnelling machine is directly below.

The intake and outlet pipelines will be tunnelled underground from the seawater pump station to intake structures located approximately 500 m offshore. As a result the dunes and beach will not be disturbed from this work. Pipelines beyond the intake structure would be fabricated on the shore and towed into position. Shallow trenches would be excavated to provide a base for the pipes and to limit the protrusion of the pipes above the seafloor.

Current beach usage has been documented in the Coastal Management Plan (Shire of Harvey, 2006) which is available on http://www.harvey.wa.gov.au/Planning#coastal_management_plan. A key concern of the community is degradation of the environment, but also access by 4WD and motorbike usage within the beach environment. Access to lots 32, 33 and Lot 8 (Lot 8 is already restricted by fencing) must be restricted to ensure public safety during the construction of the plant. The impact of this restriction is not considered significant in the context of alternative available land used for these activities elsewhere in the region.

The facilities at Myalup and Binningup will not be impacted during the construction or operational phase of the project. Hence there are unlikely to be any impacts on tourism.

Air Quality – GHG Emissions

Concern was raised by submissions 8 and 14 on the carbon footprint and greenhouse gases associated with the plant. Production of potable water from seawater using reverse osmosis has made massive gains in efficiency since the early 1990's. In this time the energy intensity of the water produced has reduced from over 10kWh/KL to less than 4kWh/KL. These savings have been achieved through efficiency gains across the entire process, but particularly with the use and improved design of energy recovery devices on the "first pass" water flow, such as those used at the Perth Seawater Desalination Plant. This plant will use the most up-to-date proven energy efficiency technologies.

The Water Corporation is running a procurement process to secure the energy requirements. The Request for Proposal (RFP) documents were issued to 11 shortlisted proponents on 1 July 2008. Details of the proponents are available on our website at http://www.watercorporation.com.au/m/media_detail.cfm?id=3442.

The process allows for at least 80% of the requirements of the this plant to be provided by a renewable energy generator using commercially proven technologies. The other 20% is being offered to renewable energy generators that use technologies that have not previously been commercially proven. The Water Corporation hopes to give these technologies a chance to establish a commercial plant. However, if they are unable to provide the additional 20%, the Corporation will have an option from the main renewable generator to purchase the requirements so that the full needs of the plant will be supplied by renewable energy.

The RFP outlines the requirements for the electricity supply. The suppliers are required to generate sufficient electricity from an accredited renewable energy generator to satisfy the annual requirements of the plant. The amount generated will take into account all losses associated with transmitting the power to the plant from wherever the generators may be located.

The electricity supplier is required to pass on to the Water Corporation all environmental credits (e.g. Renewable Energy Certificates) associated with the generation of the renewable energy. These will be retained by the Water Corporation.

The plant energy figures do not include the energy used in pumping the water within the Integrated Water Supply System. The greenhouse gas emissions associated with the energy used to power these pumps is accounted for in the Water Corporation's overall greenhouse gas emissions. These emissions are reported annually to the Australian Greenhouse Office and in the Water Corporation's annual report. The Water Corporation has a program underway to reduce its overall greenhouse gas emissions and has an aspirational target of zero emissions by 2030.

3 Conclusions

From the interactions the Water Corporation has had with the community and the submissions received during both state and federal approvals processes it is clear that some community members have a strong interest in the proposal. Many of the community concerns that have been raised were able to be addressed during the design phase running in parallel with the impact assessment, such as the reduction in time for the beach closure in front of the plant from a maximum of 18 months to 2-3 weeks, by selection a tunnelling construction technique. It is believed that the substantive issues raised in the submissions period have been addressed in this report.

The Water Corporation will continue to strengthen its program of community engagement during the construction period in the following ways:

- A Water Corporation communications officer will work with the Alliance to maintain open communication with the community;

- The Community Reference Group (CRG) will play a major role in ensuring local concerns are communicated to the Water Corporation and in return, that the Water Corporation is transparent in it's dealings with the community;

- The Communications Officer will also maintain the Complaints Mechanism which ensures any concerns brought to the Water Corporation are resolved appropriately and in a timely manner;

- The desalination hotline (1800 810 075) and email address (desalination@watercorporation.com.au) will continue to operate during construction allowing easy access for the community to report problems or lodge enquiries; and

- Abide by the commitments made in the Construction Environmental Management Framework (contained in the PER and as C of this document).

Once the SSDP commences operation, the Water Corporation believes there will be minimal impact on the local community. To give the community confidence the Water Corporation will continue:

- The operation of the Community Reference Group, if they deem it necessary;

- To post signage at the plant site with the Water Corporation's contact details;

- To communicate any extraordinary circumstances or events with SSDP that might affect or interest the community; and

- To abide by the commitments made in the Operational Environmental Management Framework (contained in the PER and as Appendix B of this document.

4 References

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5 Appendices

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Appendix A Maunsell (2009)

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Southern Seawater Desalination Project Spring Survey
Targeted Significant Flora Survey

Binningup to Harvey Southern Seawater Desalination Project

Water Corporation

17 February 2009

Targeted Significant Flora Survey

Prepared for

Water Corporation

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17 February 2009

60047533

Quality Information

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Date	17 February 2009
Prepared by	Gaby Martinez and Lisa Chappell
Reviewed by	Kellie Gibbs

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	06/12/2008	Draft for Internal Review	Kellie Gibbs Senior Environmental Scientist - Botanist	K. Gibbs
B	10/12/2008	Draft for Submission	Kellie Gibbs Senior Environmental Scientist - Botanist	K. Gibbs
0	17/02/2009	Final Submission	Kellie Gibbs Senior Environmental Scientist - Botanist	K. Gibbs

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1.0 Introduction

1.1 Project Background

The Water Corporation is preparing to commence construction of the Southern Seawater Desalination Project (SSDP) at Binningup and associated infrastructure and pipelines to an infrastructure site at Harvey.

Previous surveys for the project and in the project area have determined the presence of Declared Rare Flora (DRF) populations. The DRF species concerned with this assessment are two species of Hammer Orchids, namely *Drakaea elastica* and *Drakaea micrantha.*

The Water Corporation is committed to conducting detailed spring surveys during optimum seasonal periods to accurately determine the location of any DRF orchids within or closely adjacent to the proposed project footprints. Maunsell | AECOM (Maunsell) was commissioned by the Water Corporation to conduct targeted DRF surveys of the proposed project area.

1.2 Scope of Works

The survey within the project area was carried out in order to locate and record populations of: the following significant flora;

- Declared Rare Flora:
  - Drakaea elastica
  - Drakaea micrantha)
- Priority Flora:
  - Acacia semitrullata (P3)
  - Caladenia speciosa subsp. speciosa (P4)
  - Eucalyptus rudis subsp cratyantha (P4)
  - Dillwynia dillwynioides (P3)
  - Lasiopetalum membranaceum (P3)

1.3 Location

The project area is located within the Shire of Harvey approximately 4.5 kilometres south of Forestry Road.

The project area is shown in Figure 1 and includes the site at Binningup which lies between the Binningup town site and Myalup Beach. The infrastructure corridor extends from the Binningup site in an easterly direction to Old Coast Road and follows this north until the Harvey River Diversion Drain. Here to corridor follows the drain to the east and traverses agricultural land in a north-easterly direction to join Rodgers Road. The project area then follows Rodgers Road in an easterly direction until to Eckersley Road and then follows north-easterly for approximately 4.8km. It then routes in an east south-easterly direction along Yambellup Avenue and crosses South Western Highway before terminating at the Harvey Infrastructure Site.

2.0 Declared Rare Flora and Priority Flora

The Department of Environment and Conservation (DEC) assigns conservation status to endemic plant species that are geographically restricted to few known populations or threatened by local processes. Allocating conservation status to plant species assists in protecting populations and conserving species from potential threats (DEC, 2008a and 2008b).

Rare Flora species are gazetted under subsection 2 of section 23F of the *Wildlife Conservation Act, 1950*. It is an offence to "take" or damage Rare Flora without Ministerial approval. Section 23F of the *Wildlife Conservation Act, 1950* defines "to take" as "… to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means."

Species designated as Priority Flora are under consideration for declaration as 'Rare Flora' and are in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four). Priority Flora lists is also administered by the DEC and while listed species do not have the same legal status as DRF, they are considered in approvals processes pursuant to the *Environmental Protection Act (1986).*

2.1 *Drakaea elastica* (DRF)

2.1.1 Conservation Significance

Drakaea elastica (Glossy-leaved Hammer Orchid or Praying Virgin) is classified by DEC as Declared Rare Flora (DRF) (and is afforded special protection under the *Wildlife Conservation Act 1950* and the Commonwealth *Environment Protection and Biodiversity Conservation Act (EPBC) 1999*, under which it is listed as Endangered.

2.1.2 Ecology, Habitat and Distribution

Temperate Australian terrestrial orchids have distinctive phases within the annual growth cycle. During cooler, wet months leaves emerge, flowering occurs either prior or immediately after replacement tubers are produced, after which orchids enter dormancy as a quiescent tuber during hot summer conditions.

Drakaea elastica is described as a tuberous perennial herb that grows to 0.12 - 0.3 metres high. Plants have a single flower to 4cm across and are distinguished from the related *Drakaea concolor* by its two-toned labellum with a more prominent glandular hairy upper lobe. Flowers are red and green or yellow. Typical flowering time is October to November (Brown *et al*., 2008).

Drakaea elastica is a species endemic to Western Australia. It has been found between Cataby and Ruabon on the Swan Coastal Plain. Typically populations occur in deep sandy soil in *Banksia* Woodland, often in association with tall *Kunzea* species.

This orchid has previously been known as *Drakaea lucida and Drakaea jeanensis* (Brown *et al*., 2008).

2.2 *Drakaea micrantha* (DRF)

2.2.1 Conservation Significance

Drakaea micrantha (Dwarf Hammer Orchid) is classified by DEC as Declared Rare Flora (DRF) and is afforded special protection under the *Wildlife Conservation Act 1950* and the Commonwealth *Environment Protection and Biodiversity Conservation Act (EPBC) 1999*, under which it is listed as Vulnerable.

2.2.2 Ecology, Habitat and Distribution

Drakaea micrantha is described as a tuberous, perennial herb that grows to 0.12 – 0.3m high. Flowers are red and yellow and generally flowers between September to early November. Plants have a single flower to 2.5cm across and are distinguished from the similar *Drakaea glyptodon* by its smaller size and less pouched labellum.

The species typically grows in white or grey sand. It often co-occurs with *Paracaleana nigrita* and other *Drakaea* species including *Drakaea glyptodon, D. thynniphila* and *D. livida*. *Drakaea micrantha* is so protected because very few individuals are known even though the species is widespread in many disjunct populations (Hopper and Brown, 2007).

Drakaea micrantha is a species endemic to Western Australia. It occurs in small disjunct populations between Perth, Augusta and the Porongurup Ranges. This species grows in bare sand patches in *Banksia* or Jarrah Woodland, often associated with *Kunzea glabrescens* thickets adjacent to winter-wet swamps.

2.3 *Acacia semitrullata* (P3)

2.3.1 Conservation Significance

Acacia semitrullata is classified by DEC as a Priority Three flora. The definition of a Priority Three flora under the *Wildlife Conservation Act, 1950* is as follows: *"Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey. "*

2.3.2 Ecology, Habitat and Distribution

Acacia semitrullata is described as a slender, erect, pungent shrub (0.1) 0.2 – 0.7 (-1.5) m high. Flowers are cream or white. Plants usually flower between May to October (DEC, 2008a).

This species grows in sand in Open Heath frequently fringing seasonally dry swamps and in sand over laterite in shallow depressions in Open Jarrah Forest. It is found from Yarloop to Collie and the Whicher ranges (DEC, 2008a).

2.4 Caladenia speciosa subsp. *speciosa* (P4)

2.4.1 Conservation Significance

Caladenia speciosa (Sandplain White Spider Orchid) is classified by DEC as a Priority Four flora. The definition of a Priority Four flora species rating under the *Wildlife Conservation Act, 1950* is as follows: "*Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.* "

2.4.2 Ecology, Habitat and Distribution

Caladenia speciosa is described as a tuberous, perennial, herb 0.35 – 0.8m high. Plants usually have one to three flowers to 15cm across. It is distinguished from *Caladenia longicauda* by its delicate pink tinged colouration and long, often split labellum fringe (Brown *et al.,* 2008).

This orchid is largely confined to sandy *Banksia*, Jarrah Woodland on the Swan Coastal Plain from near Mundijong to Boyanup where often it is found flowering in greater profusion following summer bushfires (Hoffman and Brown, 1992).

2.5 *Dillwynia dillwynioides* (P3)

2.5.1 Conservation Significance

Dillwynia dillwynioides is classified by DEC as a Priority Three flora. The definition of a Priority Three flora under the *Wildlife Conservation Act, 1950* is as follows: *"Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey. "*

2.5.2 Ecology, Habitat and Distribution

Dillwynia dillwynioides is described as a decumbent or erect, slender shrub, 0.3–1.2 m high. Flowers are red, yellow or orange, or a combination of all colors. Flowering takes place during August to December. This species usually occurs in sandy soils in winter-wet depressions (DEC 2008a).

Species distribution is on the Swan Coastal Plain from recorded locations north to Moore River National Park and south to the Pinjarra to Capel region.

2.6 *Eucalyptus rudis* subsp. *cratyantha* (P4)

2.6.1 Conservation Significance

Eucalyptus rudis subsp*. cratyantha* is classified by the DEC as a Priority Four. The definition of a Priority Four species rating under the *Wildlife Conservation Act, 1950* is as follows: "*Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.* "

2.6.2 Ecology, Habitat and Distribution

Eucalyptus rudis subsp*. cratyantha* is described as a tree growing up to 20m tall. It is endemic to Western Australia and occurs only in from Mandurah and Pinjarra south and south-west to Cape Naturaliste. It is confined to stream banks or floodplains on silty soils with clay subsoil (Centre for Plant Biodiversity Research, 2006).

The bark is rough in most trees but occasionally it is smooth. It differs from *Eucalyptus rudis* subsp. *rudis* in having slightly larger parts. The buds measure 1 - 1.5cm long whilst the fruit is 1.1 – 1.4cm wide and more pronouncedly campanulate (Centre for Plant Biodiversity Research, 2006).

2.7 *Lasiopetalum membranaceum* (P3)

2.7.1 Conservation Significance

Lasiopetalum membranaceum is classified by DEC as a Priority Three flora. The definition of a Priority Three flora under the *Wildlife Conservation Act, 1950* is as follows: *"Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey. "*

2.7.2 Ecology, Habitat and Distribution

Lasiopetalum membranaceum is a multi-stemmed shrub, 0.2–1m high. Flowers are pink, blue or purple. Flowering takes place from September to December. Populations occur on sand over limestone.

Distribution of the species is mostly on the Swan Coastal Plain but occasionally to the north-western Jarrah Forest and ranges from the Perth Region in the north to the Bunbury Region in the south.

3.0 Methodology

3.1.1 Desktop Assessment

Previous studies and literature relevant to this project were reviewed prior to undertaking the survey. Prior to field mobilisation, a desktop assessment of values associated with the DRF orchids, *Drakaea elastica* and *Drakaea micrantha,* was carried out. This included interrogation of the Department of Environment and Conservation's Declared Rare Flora spatial database results for the project area and surrounds. Specific habitat assessments were carried out during the desktop assessments in order to determine areas of suitable habitat for *Drakaea elastica* and *Drakaea micrantha*. These areas then became the focus of detailed ground surveys, however all areas were considered in foot searches. Additionally, relevant priority species, *Acacia semitrullata, Caladenia speciosa* subsp. *speciosa*, *Dillwynia dillwynioides* and *Eucalyptus rudis* subsp. *cratyantha* were also subject to desktop assessment, in order to maximise the efficiency and accuracy of the field surveys.

3.1.2 Field Assessment

Maunsell initially proposed to undertake field assessments during two separate site visits, in order to capture appropriate flowering times for both species of DRF orchid (*D. elastica* and *D. micrantha*). This multiple visit scenario would permit assessment of leaves only and then flowers as well for the *D.elastica* as per advice from Andrew Brown of DEC.

D. micrantha flowers from early September through to early November. Flowers are typically long lasting in comparison to most orchid species. Whilst, *D. elastica* requires identification at two separate intervals, these being at the time of leaf emergence and then again at the time of flowering. This is due to the fact that both the leaves and flowers resemble those of similar Hammer orchid species, however in combination are unique. Also, leaves are rarely in peak form at the same time, with leaves yellowing and shrivelling once flowers mature. Leaves emerge in late September and flowers follow in mid November (Brown, A., *pers.comm*).

One field survey was conducted within the Water Corporation project area, between 23rd to 26th September, 2008. During dates immediately prior to and following the assessments carried out in the Water Corporation project areas, a number of *D.elastica* and some *D.micrantha* populations were recorded in throughout adjacent areas as part of a survey conducted for Western Power, at the Kemerton Terminal and within adjacent corridors. During these surveys, DRF orchid plants located and recorded exhibited both intact leaves and flowers. Due to this, and based on knowledge and experience of Maunsell's Dr. Andrew batty, in consultation with Andrew Brown of DEC, it was determined that additional site assessments at later dates were not necessary. Additionally, the observation of both DRF species targeted in the wider project area confirms that the timing of the survey was accurately appropriate to capture both *D.elastica* and *D.micrantha*, which provides further confidence that subsequent surveys are not required.

For the purposes of locating DRF at the site, a gridding technique was used and all areas of native vegetation, or close to fringes of native vegetation, in the case of cleared or disturbed areas, were examined in detail by botanists on foot. All personnel conducting the search, including orchid specialist, Dr. Andrew Batty, were familiar with the appearance of the species surveyed and had experience in DRF recognition whilst recording the species subject to the search.

The grid sweeps utilised were between 3 to 12 metres each per sweep, depending on visibility of vegetation types in differing degrees of degradation. Navigation of the sweeps were carried out using a combination of handheld Global Positioning Systems (GPS) units, a GPS device associated with a Panasonic Toughbook (portable tablet PC) and magnetic compasses. Covered ground was indicated by tying pieces of coloured paper streamers (biodegradable) to vegetation at eye height. This "trail" was then sighted on the returning subsequent sweeps to ensure that no ground was missed or covered twice.

Where *D.elastica, D.micrantha, Caladenia speciosa, Acacia semitrullata* and *Eucalyptus rudis* subsp. *cratyantha* were located a GPS reading of the location were taken, individuals were counted and photographs were taken to confirm identifications.

4.0 Results

Maunsell recorded a total of 866 individual plants of the targeted Priority Flora species within the proposed water pipeline corridors. No individuals of any DRF species were recorded throughout the Water Corporation project area (Appendix A and Figures 2.1 – 2.10).

Previous studies conducted by 360 Environmental (2007) identified 33 plants of *Acacia semitrullata* (P3), two *Caladenia speciosa* (P4) and one *Eucalyptus rudis* subsp. *cratyantha* (P4) within the project area (Appendix B). Additionally, populations of *Dillwynia dillwynioides* (two locations) and *Lasiopetalum membranaceum* (one location) were recorded in areas near the project area, but not within current designated impact boundaries.

4.1 *Drakaea elastica* (DRF)

No flowering *D.elastica* (DRF) individuals or leaves were recorded during the survey.

4.2 *Drakaea micrantha* (DRF)

No flowering *D.micrantha* (DRF) individuals or leaves were recorded during the survey.

4.3 *Acacia semitrullata* (P3)

There were 843 *Acacia semitrullata* (P3) individuals recorded during the field survey (Figures 2.1 – 2.10). The specific locations of this species are presented in Appendix A.

4.4 *Caladenia speciosa* subsp. *speciosa* (P4)

There were 22 individuals of *Caladenia speciosa* subsp. *speciosa* (P4) recorded during the field survey (Figures 2.1 – 2.10). Specific locations of occurrences of this species area shown in Appendix A.

4.5 *Dillwyinia dillwynioides* (P3)

No flowering individuals of *Dillwynia dillwynioides* were recorded during the survey.

4.6 *Eucalyptus rudis* subsp. *cratyantha* (P4)

During the field assessment in September there was one individual of *Eucalyptus rudis* subsp. *cratyantha* (P4) found along the proposed water pipeline corridor (Figure 2.1). This species was located at 382422mE 6335994mN.

5.0 Discussion

Previous studies conducted by 360 Environmental (2007) located a total of 33 *Acacia semitrullata* (P3), two *Caladenia speciosa* subsp. *speciosa* (P4) and one *Eucalyptus rudis* subsp. *cratyantha* (P4) within the project area. Some populations of *Dillwynia dillwynioides* (P3) and *Lasiopetalum membranaceum* (P3) have also been recorded in areas near the project area and corridors.

A targeted and detailed flora survey of the project area was conducted in September 2008 by Maunsell. This survey did not record any populations of DRF species within the specified project area. The sites at Binningup (the proposed Desalination Plant site) and Harvey (infrastructure site) did not record any DRF or Priority flora populations.

A total of 866 individual plants of three species of Priority Flora were recorded within the proposed pipeline corridors. This included 843 plants of *Acacia semitrullata* (P3), 22 plants of *Caladenia speciosa* subsp. *speciosa* (P4) and one mature tree, *Eucalyptus rudis* subsp. *cratyantha* (P4). The *Eucalyptus rudis* subsp. *cratyantha* tree located by Maunsell in 2008 is the same specimen that 360 Environmental identified and vouchered during their 2007 field assessments (Appendix A and B).

Although no plants of known DRF species were recorded within the project area, it can not be ruled out that any individuals may appear in subsequent years, either arising from tuberoids that were dormant at the time of the survey or through seed dispersal from nearby populations, such as those recorded to occur within the Western Power Kemerton site.

Based on the results of the field assessment in September 2008, it is evident that the project area supports significant populations of the Priority Flora species *Acacia semitrullata* (P3). This species is classified by DEC as having a Priority Three conservation status. Maunsell recorded a total of 843 individual plants of this species and it was observed to be a dominant species in a number of vegetation types occurring in the project area. It is considered that based on the results of the survey, a review of the conservation status of this species is required. Data gathered during the survey in 2008 would provide valuable input into species reclassification. The Water Corporation is encouraged to liaise with DEC with regards to this matter.

It is a condition of DEC issued Flora Collection Permits that specimens of significant flora (i.e. DRF, Priority and range extensions) be submitted as voucher specimens for inclusion in the Western Australian Herbarium databases. Maunsell shall fulfil this requirement and proceed with submission of specimens collected during the survey.

6.0 References

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Brown, A., Dundas, P., Dixon, K. and Hopper, S. (2008) *Orchids of Western Australia*. University of Western Australia Press.

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Hopper, S.D., and Brown, A.P. (2007) *A revision of Australia's hammer orchids (Drakaea: Orchidaceae), with some field data on species-specific sexually deceived wasp pollinators.* Australian Systematic Botany 20: 252-285.

360 Environmental (2007) *Binningup Water Treatment Facility and Pipeline Corridor – Water Corporation – Due Diligence Flora and Fauna Investigation.* Report prepared for the Water Corporation.

DRF Flora Survey

December 2008

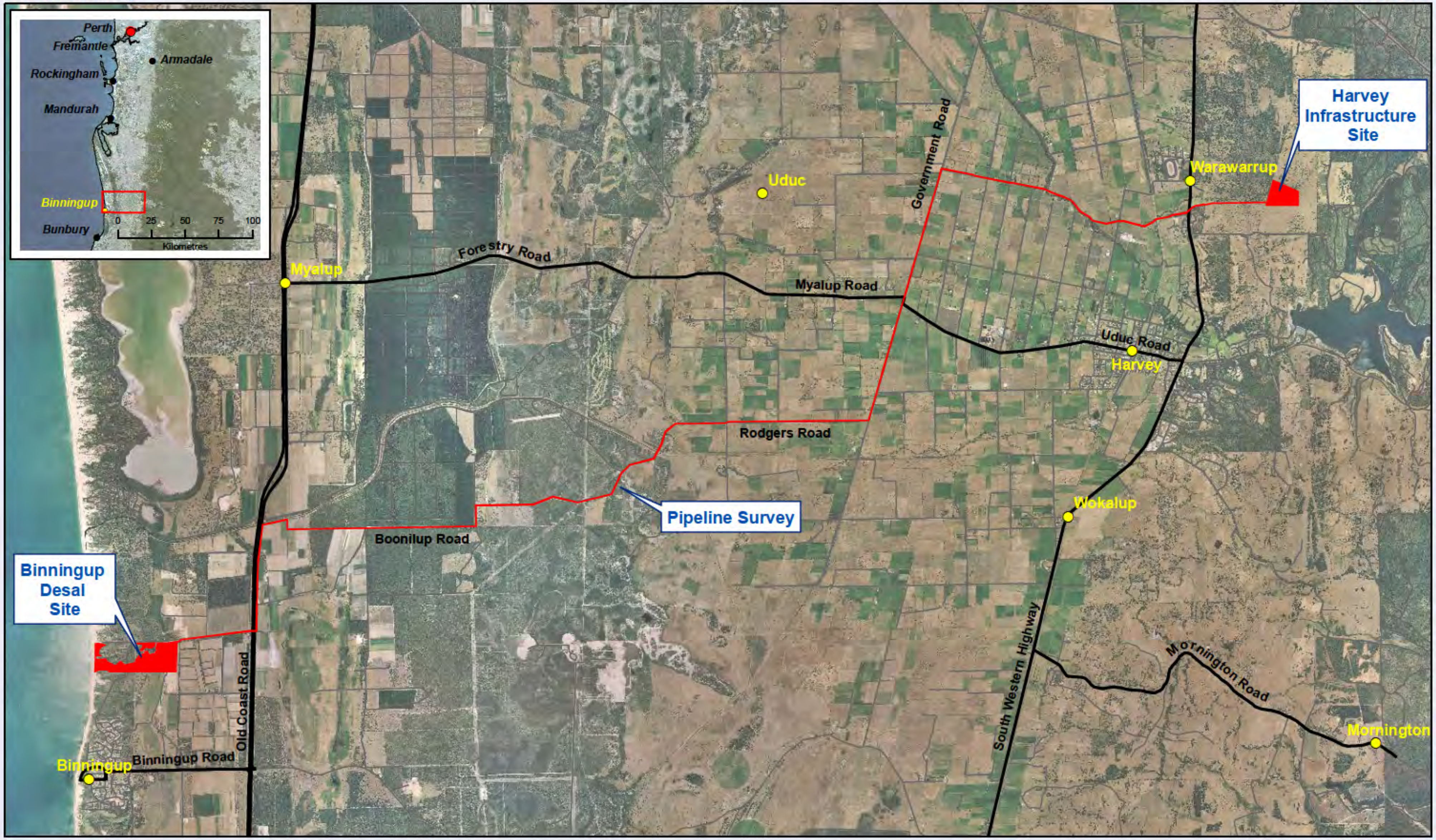


Figure 1

Locality Plan

0 1 2 3 4 5

Kilometres

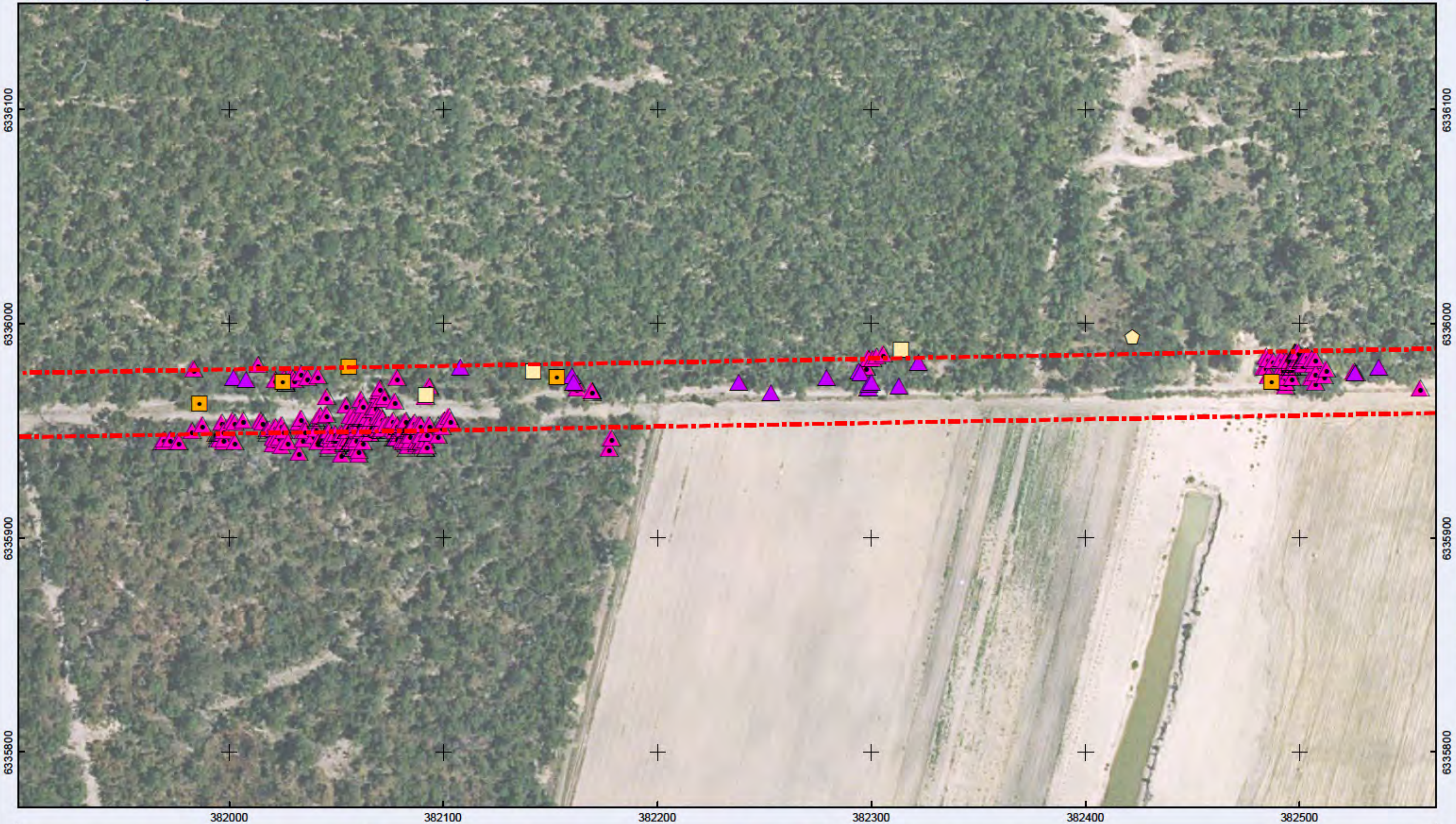
1:100,000

Pipeline Survey Area

MAUNSELL | AECOM

DRF Flora Survey

December 2008



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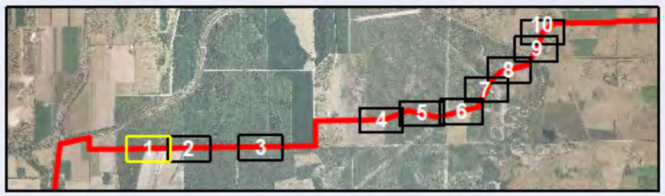

- Maunsell : Acacia semitrullata (P3)
- Maunsell : Caladenia speciosa (P4)
- 360 : Acacia semitrullata (P3)
- 360 : Caladenia speciosa (P4)
- Eucalyptus rudis subsp. cratyan ha (P4)

Figure 2.1

MAUNSELL | AECOM

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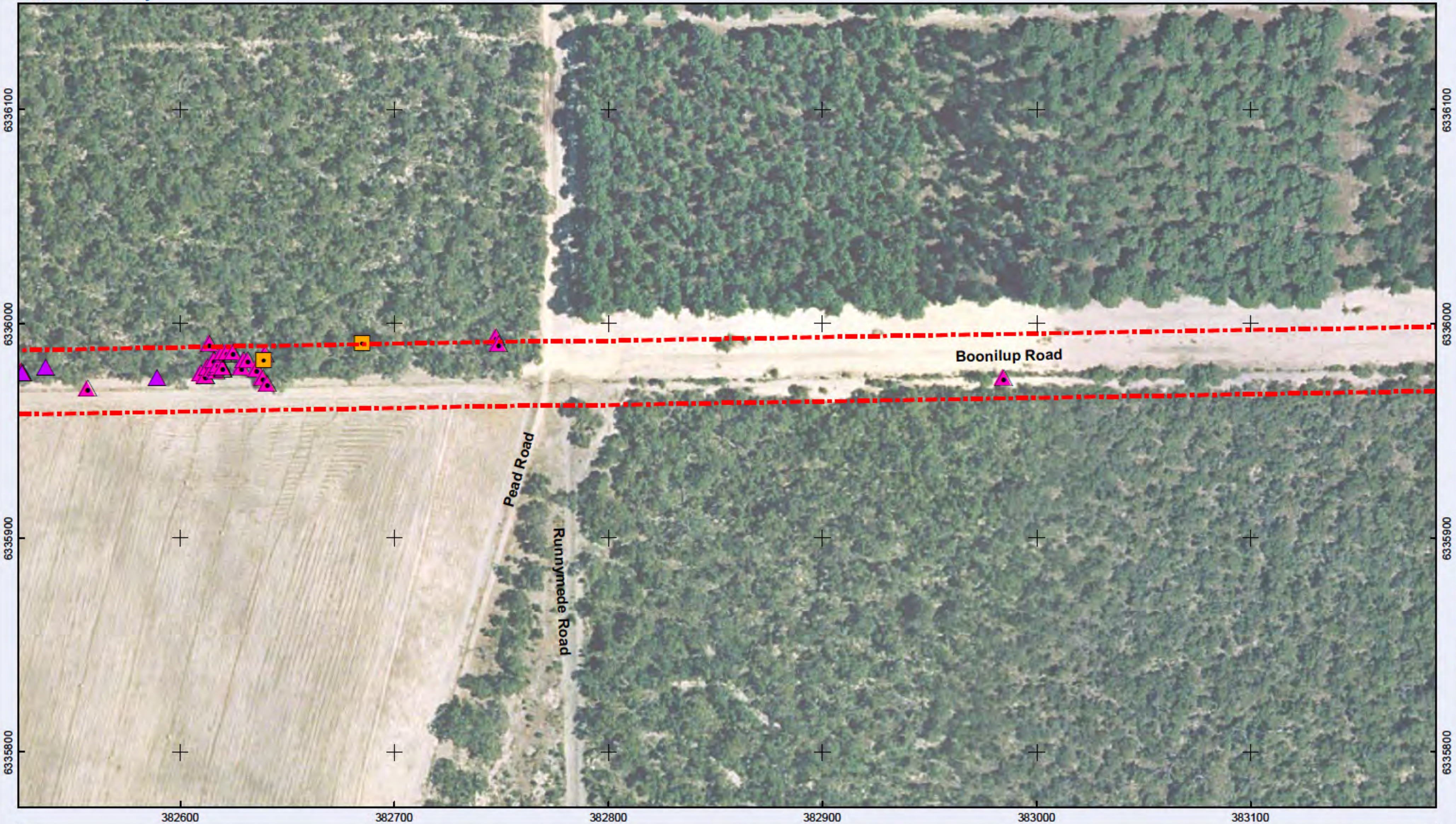

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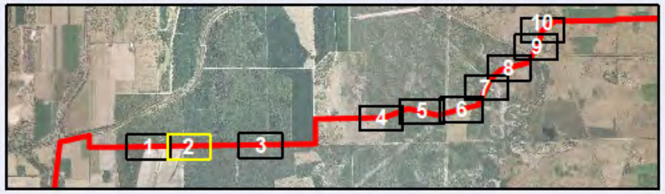
Metres
1:2,500



Maunsell : Acacia semitrullata (P3)
Maunsell : Caladenia speciosa (P4)
360 : Acacia semitrullata (P3)
360 : Caladenia speciosa (P4)
360 : Eucalyptus rudis subsp. cratyantha (P4)

Figure 2.2

MAUNSELL | AECOM

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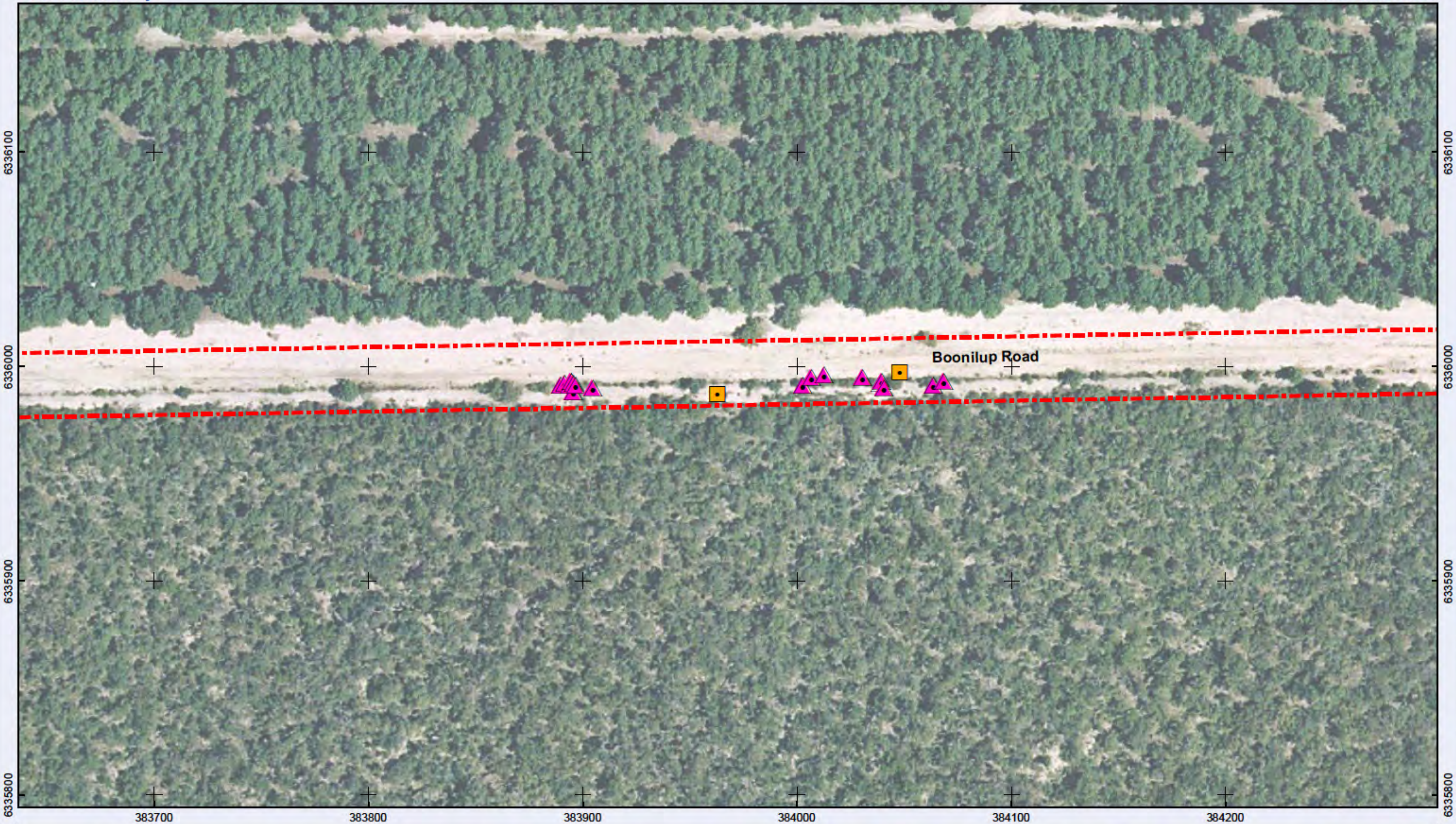

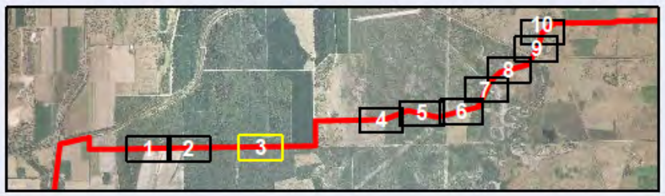

Figure 2.3

MAUNSELL | AECOM

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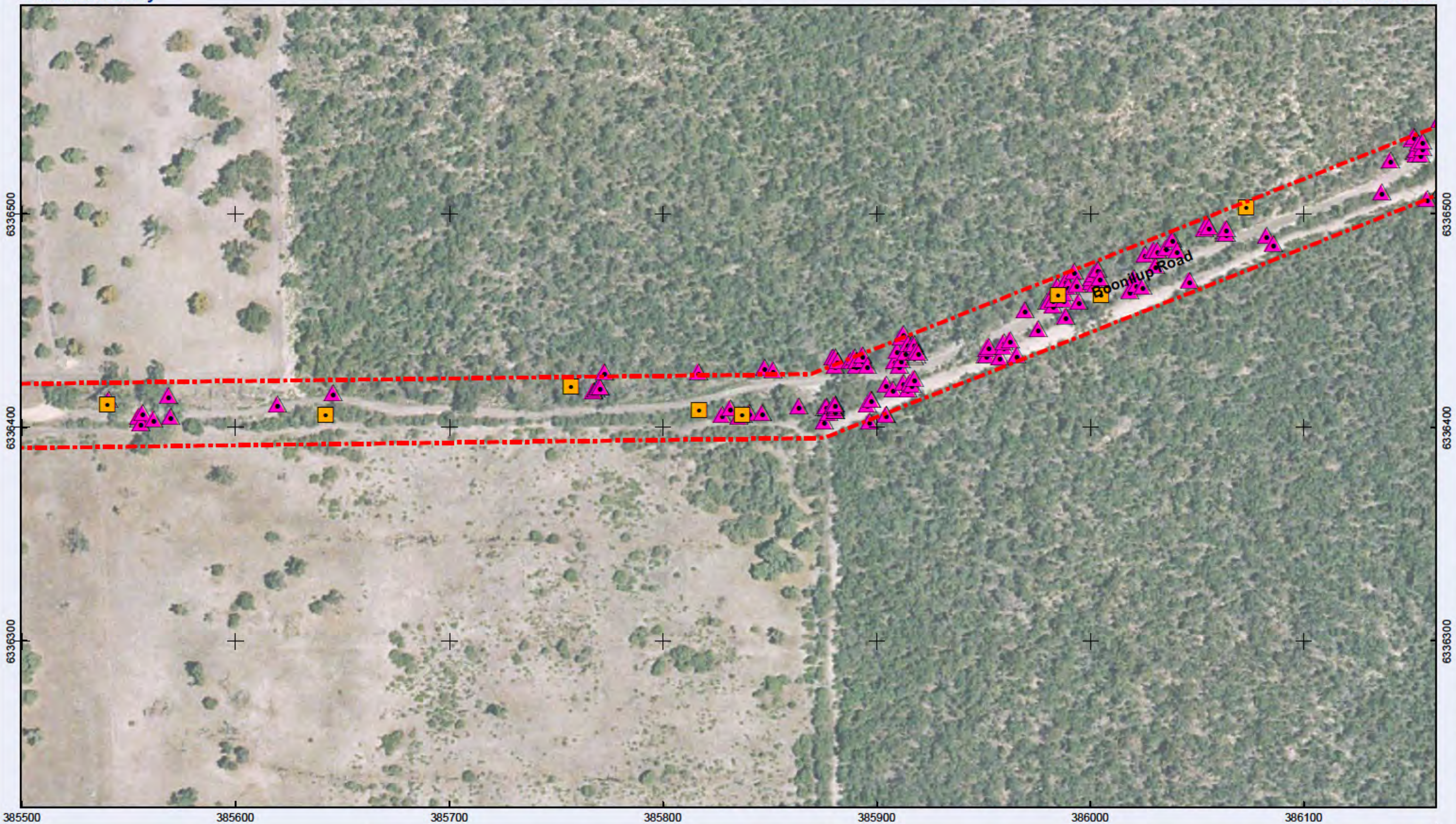

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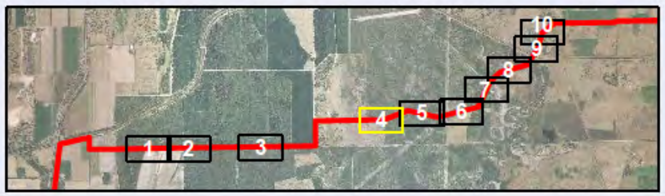
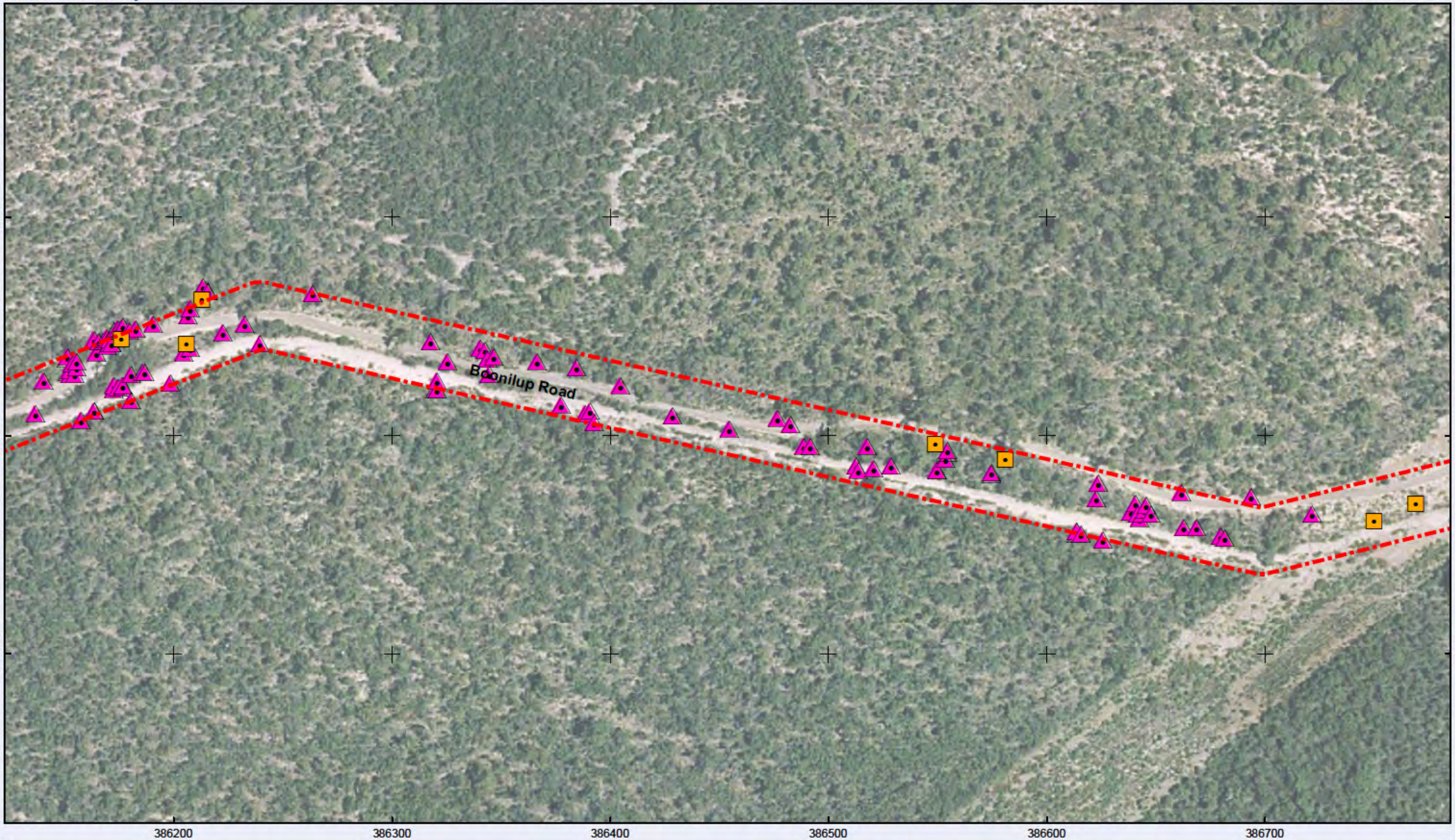


- Maunsell : Acacia semitrullata (P3)
- Maunsell : Caladenia speciosa (P4)
- 360 : Acacia semitrullata (P3)
- 360 : Caladenia speciosa (P4)
- 360 : Eucalyptus rudis subsp. cratyantha (P4)

Figure 2.4

MAUNSELL | AECOM



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Metres

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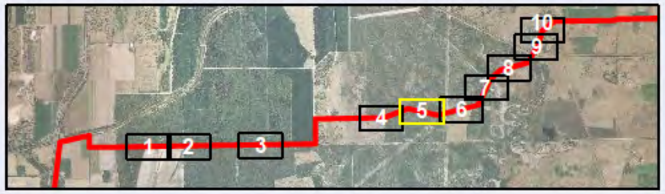

Maunsell : Acacia semitrullata (P3)

Maunsell : Caladenia speciosa (P4)

360 : Acacia semitrullata (P3)

360 : Caladenia speciosa (P4)

360 : Eucalyptus rudis subsp. cratyantha (P4)

Figure 2.5

MAUNSELL | AECOM

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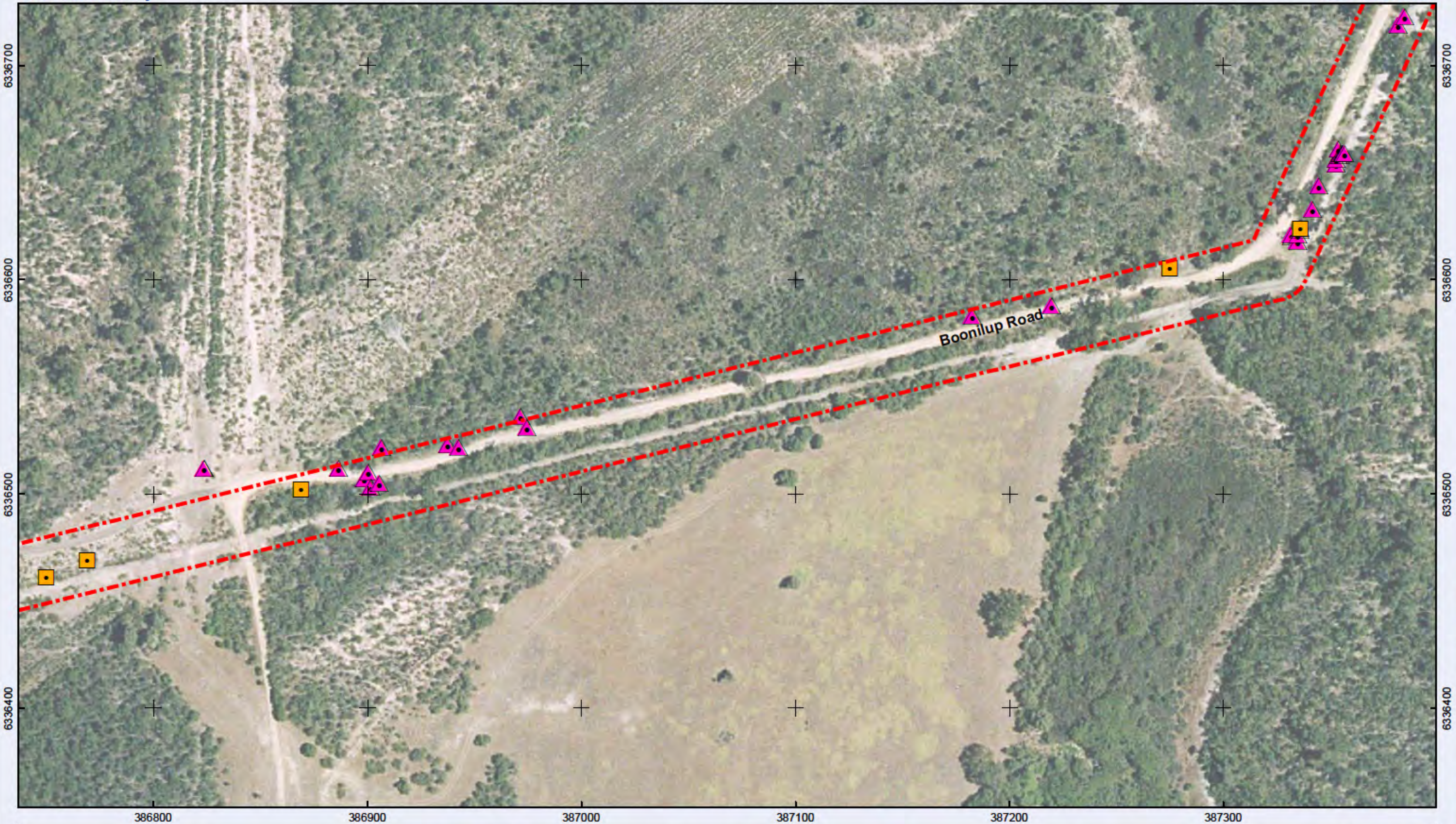
DRF Flora Survey *December 2008*



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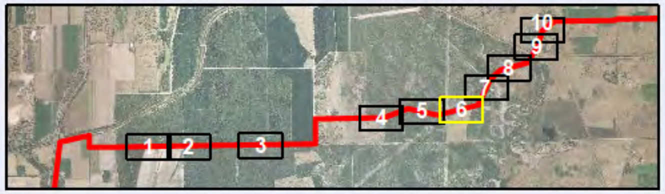
1:2,500



Maunsell : Acacia semitrullata (P3)
Maunsell : Caladenia speciosa (P4)
360 : Acacia semitrullata (P3)
360 : Caladenia speciosa (P4)
360 : Eucalyptus rudis subsp. cratyantha (P4)

Figure 2.6

MAUNSELL | AECOM

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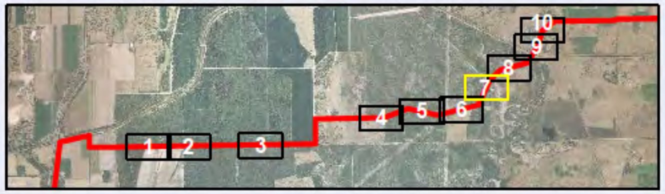

Maunsell : Acacia semitrullata (P3)
Maunsell : Caladenia speciosa (P4)
360 : Acacia semitrullata (P3)
360 : Caladenia speciosa (P4)
360 : Eucalyptus rudis subsp. cratyantha (P4)

Figure 2.7

MAUNSELL | AECOM

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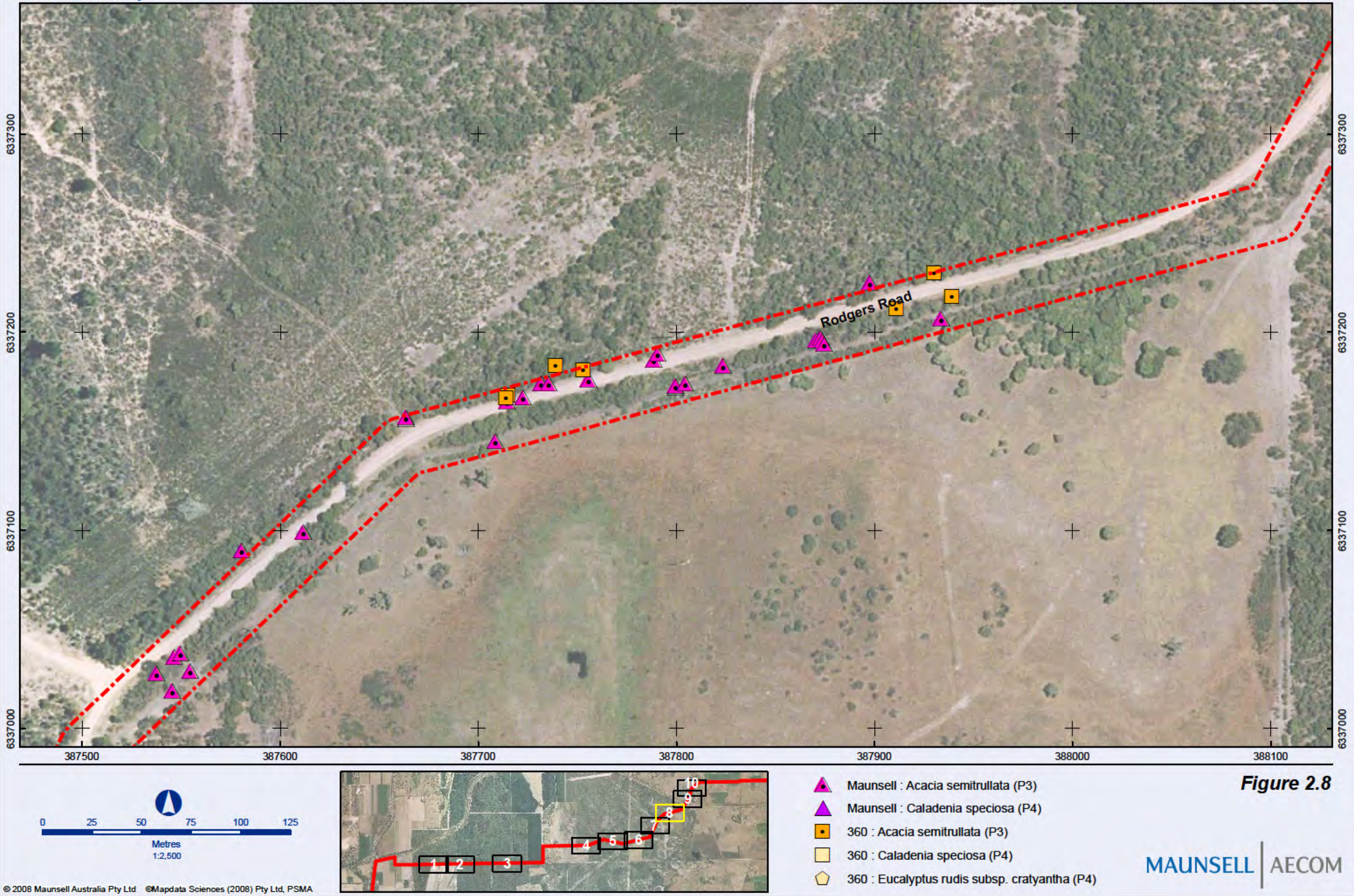
Rodgers Road
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6337100
6337200
6337300
387500
387600
387700
387800
387900
388000
388100
0 25 50 75 100 125
Metres
1:2,500
1
2
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7
8
9
10
Maunsell : Acacia semitrullata (P3)
Maunsell : Caladenia speciosa (P4)
360 : Acacia semitrullata (P3)
360 : Caladenia speciosa (P4)
360 : Eucalyptus rudis subsp. cratyantha (P4)
MAUNSELL | AECOM

Figure 2.8

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Metres
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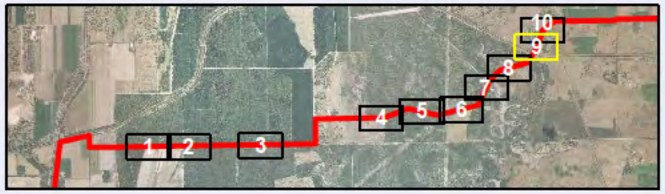

- Maunsell : Acacia semitrullata (P3)
- Maunsell : Caladenia speciosa (P4)
- 360 : Acacia semitrullata (P3)
- 360 : Caladenia speciosa (P4)
- 360 : Eucalyptus rudis subsp. cratyantha (P4)

Figure 2.9

MAUNSELL | AECOM

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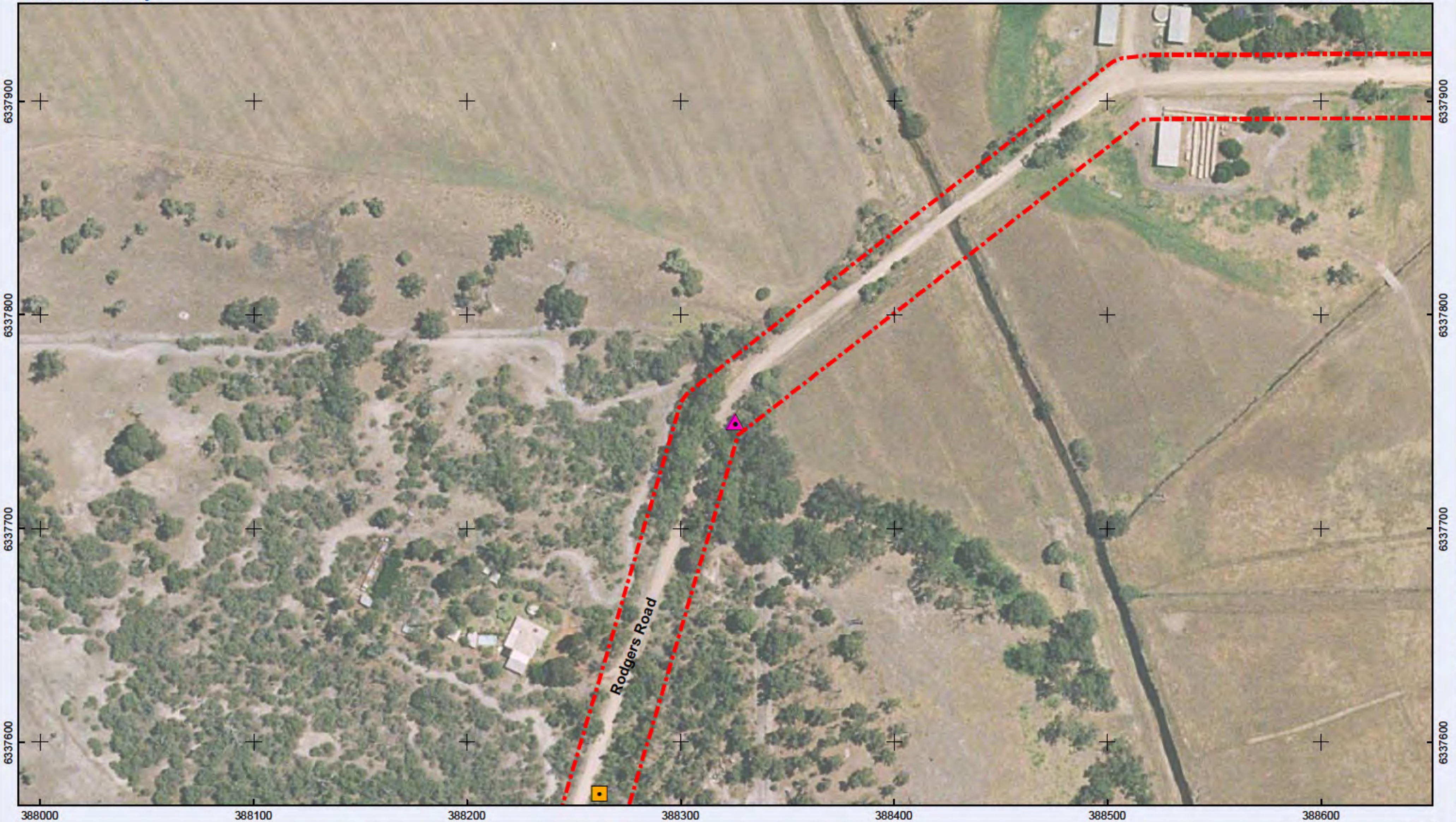

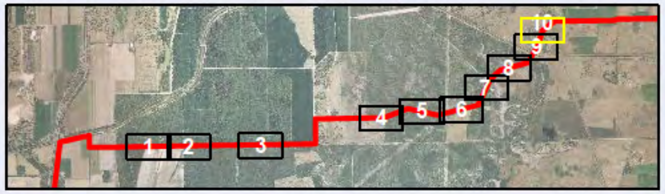

0 25 50 75 100 125

Metres

1:2,500

- Maunsell : Acacia semitrullata (P3)
- Maunsell : Caladenia speciosa (P4)
- 360 : Acacia semitrullata (P3)
- 360 : Caladenia speciosa (P4)
- 360 : Eucalyptus rudis subsp. cratyantha (P4)

Figure 2.10

MAUNSELL | AECOM

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Appendix A Recorded Locations of Significant Flora (Maunsell 2008)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
381968	6335945	*Acacia semitrullata* (P3)
381969	6335945	*Acacia semitrullata* (P3)
381969	6335946	*Acacia semitrullata* (P3)
381972	6335946	*Acacia semitrullata* (P3)
381975	6335945	*Acacia semitrullata* (P3)
381976	6335945	*Acacia semitrullata* (P3)
381982	6335950	*Acacia semitrullata* (P3)
381983	6335979	*Acacia semitrullata* (P3)
381987	6335953	*Acacia semitrullata* (P3)
381993	6335949	*Acacia semitrullata* (P3)
381994	6335946	*Acacia semitrullata* (P3)
381994	6335948	*Acacia semitrullata* (P3)
381994	6335949	*Acacia semitrullata* (P3)
381995	6335946	*Acacia semitrullata* (P3)
381995	6335946	*Acacia semitrullata* (P3)
381995	6335949	*Acacia semitrullata* (P3)
381996	6335949	*Acacia semitrullata* (P3)
381996	6335954	*Acacia semitrullata* (P3)
381997	6335945	*Acacia semitrullata* (P3)
381997	6335946	*Acacia semitrullata* (P3)
381997	6335950	*Acacia semitrullata* (P3)
382001	6335955	*Acacia semitrullata* (P3)
382002	6335945	*Acacia semitrullata* (P3)
382002	6335954	*Acacia semitrullata* (P3)
382006	6335955	*Acacia semitrullata* (P3)
382013	6335981	*Acacia semitrullata* (P3)
382014	6335955	*Acacia semitrullata* (P3)
382015	6335954	*Acacia semitrullata* (P3)
382017	6335949	*Acacia semitrullata* (P3)
382017	6335950	*Acacia semitrullata* (P3)
382017	6335951	*Acacia semitrullata* (P3)
382018	6335951	*Acacia semitrullata* (P3)
382020	6335944	*Acacia semitrullata* (P3)
382020	6335947	*Acacia semitrullata* (P3)
382020	6335951	*Acacia semitrullata* (P3)
382021	6335946	*Acacia semitrullata* (P3)
382021	6335952	*Acacia semitrullata* (P3)
382021	6335974	*Acacia semitrullata* (P3)
382023	6335947	*Acacia semitrullata* (P3)
382024	6335943	*Acacia semitrullata* (P3)
382024	6335953	*Acacia semitrullata* (P3)
382025	6335950	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
382025	6335974	*Acacia semitrullata* (P3)
382025	6335975	*Acacia semitrullata* (P3)
382026	6335972	*Acacia semitrullata* (P3)
382026	6335972	*Acacia semitrullata* (P3)
382026	6335973	*Acacia semitrullata* (P3)
382027	6335945	*Acacia semitrullata* (P3)
382028	6335975	*Acacia semitrullata* (P3)
382029	6335975	*Acacia semitrullata* (P3)
382030	6335974	*Acacia semitrullata* (P3)
382032	6335940	*Acacia semitrullata* (P3)
382032	6335954	*Acacia semitrullata* (P3)
382033	6335956	*Acacia semitrullata* (P3)
382033	6335977	*Acacia semitrullata* (P3)
382034	6335946	*Acacia semitrullata* (P3)
382034	6335950	*Acacia semitrullata* (P3)
382035	6335950	*Acacia semitrullata* (P3)
382036	6335975	*Acacia semitrullata* (P3)
382039	6335948	*Acacia semitrullata* (P3)
382040	6335951	*Acacia semitrullata* (P3)
382040	6335955	*Acacia semitrullata* (P3)
382041	6335945	*Acacia semitrullata* (P3)
382041	6335956	*Acacia semitrullata* (P3)
382041	6335976	*Acacia semitrullata* (P3)
382042	6335956	*Acacia semitrullata* (P3)
382042	6335957	*Acacia semitrullata* (P3)
382042	6335957	*Acacia semitrullata* (P3)
382044	6335947	*Acacia semitrullata* (P3)
382044	6335948	*Acacia semitrullata* (P3)
382044	6335948	*Acacia semitrullata* (P3)
382045	6335946	*Acacia semitrullata* (P3)
382045	6335947	*Acacia semitrullata* (P3)
382045	6335947	*Acacia semitrullata* (P3)
382045	6335947	*Acacia semitrullata* (P3)
382045	6335948	*Acacia semitrullata* (P3)
382045	6335949	*Acacia semitrullata* (P3)
382045	6335958	*Acacia semitrullata* (P3)
382045	6335966	*Acacia semitrullata* (P3)
382046	6335942	*Acacia semitrullata* (P3)
382046	6335943	*Acacia semitrullata* (P3)
382046	6335950	*Acacia semitrullata* (P3)
382047	6335945	*Acacia semitrullata* (P3)
382047	6335946	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
382047	6335948	*Acacia semitrullata* (P3)
382047	6335948	*Acacia semitrullata* (P3)
382047	6335948	*Acacia semitrullata* (P3)
382047	6335948	*Acacia semitrullata* (P3)
382049	6335946	*Acacia semitrullata* (P3)
382049	6335949	*Acacia semitrullata* (P3)
382051	6335948	*Acacia semitrullata* (P3)
382051	6335949	*Acacia semitrullata* (P3)
382052	6335939	*Acacia semitrullata* (P3)
382052	6335947	*Acacia semitrullata* (P3)
382052	6335948	*Acacia semitrullata* (P3)
382052	6335949	*Acacia semitrullata* (P3)
382053	6335944	*Acacia semitrullata* (P3)
382053	6335945	*Acacia semitrullata* (P3)
382054	6335950	*Acacia semitrullata* (P3)
382054	6335950	*Acacia semitrullata* (P3)
382054	6335962	*Acacia semitrullata* (P3)
382055	6335944	*Acacia semitrullata* (P3)
382055	6335947	*Acacia semitrullata* (P3)
382055	6335950	*Acacia semitrullata* (P3)
382055	6335952	*Acacia semitrullata* (P3)
382056	6335942	*Acacia semitrullata* (P3)
382056	6335943	*Acacia semitrullata* (P3)
382056	6335945	*Acacia semitrullata* (P3)
382056	6335945	*Acacia semitrullata* (P3)
382056	6335945	*Acacia semitrullata* (P3)
382056	6335957	*Acacia semitrullata* (P3)
382057	6335942	*Acacia semitrullata* (P3)
382057	6335942	*Acacia semitrullata* (P3)
382057	6335944	*Acacia semitrullata* (P3)
382057	6335944	*Acacia semitrullata* (P3)
382057	6335945	*Acacia semitrullata* (P3)
382057	6335945	*Acacia semitrullata* (P3)
382057	6335947	*Acacia semitrullata* (P3)
382058	6335942	*Acacia semitrullata* (P3)
382058	6335943	*Acacia semitrullata* (P3)
382058	6335945	*Acacia semitrullata* (P3)
382058	6335946	*Acacia semitrullata* (P3)
382058	6335946	*Acacia semitrullata* (P3)
382058	6335946	*Acacia semitrullata* (P3)
382058	6335948	*Acacia semitrullata* (P3)
382058	6335950	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
382058	6335952	*Acacia semitrullata* (P3)
382058	6335954	*Acacia semitrullata* (P3)
382058	6335954	*Acacia semitrullata* (P3)
382058	6335957	*Acacia semitrullata* (P3)
382059	6335942	*Acacia semitrullata* (P3)
382059	6335945	*Acacia semitrullata* (P3)
382059	6335946	*Acacia semitrullata* (P3)
382059	6335951	*Acacia semitrullata* (P3)
382059	6335953	*Acacia semitrullata* (P3)
382060	6335939	*Acacia semitrullata* (P3)
382060	6335941	*Acacia semitrullata* (P3)
382060	6335953	*Acacia semitrullata* (P3)
382060	6335956	*Acacia semitrullata* (P3)
382060	6335957	*Acacia semitrullata* (P3)
382061	6335950	*Acacia semitrullata* (P3)
382061	6335956	*Acacia semitrullata* (P3)
382061	6335956	*Acacia semitrullata* (P3)
382061	6335965	*Acacia semitrullata* (P3)
382062	6335945	*Acacia semitrullata* (P3)
382062	6335951	*Acacia semitrullata* (P3)
382062	6335957	*Acacia semitrullata* (P3)
382062	6335962	*Acacia semitrullata* (P3)
382064	6335956	*Acacia semitrullata* (P3)
382064	6335956	*Acacia semitrullata* (P3)
382064	6335957	*Acacia semitrullata* (P3)
382065	6335949	*Acacia semitrullata* (P3)
382065	6335949	*Acacia semitrullata* (P3)
382065	6335951	*Acacia semitrullata* (P3)
382065	6335954	*Acacia semitrullata* (P3)
382066	6335951	*Acacia semitrullata* (P3)
382066	6335951	*Acacia semitrullata* (P3)
382066	6335952	*Acacia semitrullata* (P3)
382066	6335956	*Acacia semitrullata* (P3)
382066	6335956	*Acacia semitrullata* (P3)
382066	6335960	*Acacia semitrullata* (P3)
382067	6335960	*Acacia semitrullata* (P3)
382067	6335961	*Acacia semitrullata* (P3)
382068	6335951	*Acacia semitrullata* (P3)
382068	6335961	*Acacia semitrullata* (P3)
382069	6335951	*Acacia semitrullata* (P3)
382069	6335953	*Acacia semitrullata* (P3)
382069	6335957	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
382069	6335967	*Acacia semitrullata* (P3)
382069	6335969	*Acacia semitrullata* (P3)
382070	6335949	*Acacia semitrullata* (P3)
382070	6335950	*Acacia semitrullata* (P3)
382070	6335950	*Acacia semitrullata* (P3)
382070	6335953	*Acacia semitrullata* (P3)
382070	6335956	*Acacia semitrullata* (P3)
382070	6335965	*Acacia semitrullata* (P3)
382070	6335969	*Acacia semitrullata* (P3)
382070	6335970	*Acacia semitrullata* (P3)
382071	6335951	*Acacia semitrullata* (P3)
382071	6335956	*Acacia semitrullata* (P3)
382071	6335956	*Acacia semitrullata* (P3)
382072	6335953	*Acacia semitrullata* (P3)
382072	6335965	*Acacia semitrullata* (P3)
382072	6335966	*Acacia semitrullata* (P3)
382074	6335953	*Acacia semitrullata* (P3)
382074	6335953	*Acacia semitrullata* (P3)
382075	6335950	*Acacia semitrullata* (P3)
382076	6335947	*Acacia semitrullata* (P3)
382076	6335950	*Acacia semitrullata* (P3)
382076	6335951	*Acacia semitrullata* (P3)
382076	6335951	*Acacia semitrullata* (P3)
382076	6335955	*Acacia semitrullata* (P3)
382077	6335947	*Acacia semitrullata* (P3)
382077	6335947	*Acacia semitrullata* (P3)
382077	6335949	*Acacia semitrullata* (P3)
382077	6335950	*Acacia semitrullata* (P3)
382077	6335950	*Acacia semitrullata* (P3)
382077	6335950	*Acacia semitrullata* (P3)
382077	6335964	*Acacia semitrullata* (P3)
382078	6335947	*Acacia semitrullata* (P3)
382078	6335949	*Acacia semitrullata* (P3)
382078	6335952	*Acacia semitrullata* (P3)
382078	6335952	*Acacia semitrullata* (P3)
382078	6335953	*Acacia semitrullata* (P3)
382078	6335975	*Acacia semitrullata* (P3)
382079	6335950	*Acacia semitrullata* (P3)
382079	6335951	*Acacia semitrullata* (P3)
382080	6335946	*Acacia semitrullata* (P3)
382080	6335952	*Acacia semitrullata* (P3)
382081	6335945	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
382081	6335945	*Acacia semitrullata* (P3)
382081	6335946	*Acacia semitrullata* (P3)
382081	6335951	*Acacia semitrullata* (P3)
382081	6335953	*Acacia semitrullata* (P3)
382081	6335953	*Acacia semitrullata* (P3)
382081	6335954	*Acacia semitrullata* (P3)
382082	6335942	*Acacia semitrullata* (P3)
382082	6335944	*Acacia semitrullata* (P3)
382082	6335946	*Acacia semitrullata* (P3)
382082	6335954	*Acacia semitrullata* (P3)
382082	6335955	*Acacia semitrullata* (P3)
382083	6335943	*Acacia semitrullata* (P3)
382083	6335945	*Acacia semitrullata* (P3)
382083	6335948	*Acacia semitrullata* (P3)
382083	6335950	*Acacia semitrullata* (P3)
382083	6335951	*Acacia semitrullata* (P3)
382084	6335946	*Acacia semitrullata* (P3)
382084	6335948	*Acacia semitrullata* (P3)
382084	6335952	*Acacia semitrullata* (P3)
382084	6335952	*Acacia semitrullata* (P3)
382085	6335953	*Acacia semitrullata* (P3)
382085	6335953	*Acacia semitrullata* (P3)
382086	6335954	*Acacia semitrullata* (P3)
382087	6335944	*Acacia semitrullata* (P3)
382087	6335946	*Acacia semitrullata* (P3)
382088	6335945	*Acacia semitrullata* (P3)
382088	6335952	*Acacia semitrullata* (P3)
382088	6335953	*Acacia semitrullata* (P3)
382089	6335943	*Acacia semitrullata* (P3)
382089	6335945	*Acacia semitrullata* (P3)
382089	6335945	*Acacia semitrullata* (P3)
382089	6335948	*Acacia semitrullata* (P3)
382089	6335953	*Acacia semitrullata* (P3)
382089	6335953	*Acacia semitrullata* (P3)
382090	6335943	*Acacia semitrullata* (P3)
382090	6335945	*Acacia semitrullata* (P3)
382091	6335942	*Acacia semitrullata* (P3)
382091	6335942	*Acacia semitrullata* (P3)
382091	6335946	*Acacia semitrullata* (P3)
382091	6335946	*Acacia semitrullata* (P3)
382091	6335966	*Acacia semitrullata* (P3)
382092	6335943	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
382092	6335949	*Acacia semitrullata* (P3)
382092	6335949	*Acacia semitrullata* (P3)
382093	6335953	*Acacia semitrullata* (P3)
382093	6335970	*Acacia semitrullata* (P3)
382093	6335971	*Acacia semitrullata* (P3)
382097	6335948	*Acacia semitrullata* (P3)
382097	6335953	*Acacia semitrullata* (P3)
382099	6335952	*Acacia semitrullata* (P3)
382099	6335954	*Acacia semitrullata* (P3)
382100	6335955	*Acacia semitrullata* (P3)
382100	6335955	*Acacia semitrullata* (P3)
382100	6335955	*Acacia semitrullata* (P3)
382102	6335957	*Acacia semitrullata* (P3)
382103	6335955	*Acacia semitrullata* (P3)
382161	6335973	*Acacia semitrullata* (P3)
382162	6335970	*Acacia semitrullata* (P3)
382162	6335972	*Acacia semitrullata* (P3)
382169	6335968	*Acacia semitrullata* (P3)
382169	6335969	*Acacia semitrullata* (P3)
382169	6335969	*Acacia semitrullata* (P3)
382169	6335969	*Acacia semitrullata* (P3)
382177	6335942	*Acacia semitrullata* (P3)
382178	6335947	*Acacia semitrullata* (P3)
382297	6335980	*Acacia semitrullata* (P3)
382297	6335980	*Acacia semitrullata* (P3)
382298	6335984	*Acacia semitrullata* (P3)
382298	6335984	*Acacia semitrullata* (P3)
382298	6335984	*Acacia semitrullata* (P3)
382300	6335984	*Acacia semitrullata* (P3)
382302	6335985	*Acacia semitrullata* (P3)
382305	6335986	*Acacia semitrullata* (P3)
382483	6335980	*Acacia semitrullata* (P3)
382484	6335980	*Acacia semitrullata* (P3)
382484	6335985	*Acacia semitrullata* (P3)
382485	6335976	*Acacia semitrullata* (P3)
382485	6335984	*Acacia semitrullata* (P3)
382485	6335984	*Acacia semitrullata* (P3)
382487	6335983	*Acacia semitrullata* (P3)
382488	6335975	*Acacia semitrullata* (P3)
382489	6335976	*Acacia semitrullata* (P3)
382489	6335976	*Acacia semitrullata* (P3)
382490	6335976	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
382490	6335978	*Acacia semitrullata* (P3)
382490	6335983	*Acacia semitrullata* (P3)
382491	6335974	*Acacia semitrullata* (P3)
382491	6335983	*Acacia semitrullata* (P3)
382491	6335983	*Acacia semitrullata* (P3)
382491	6335984	*Acacia semitrullata* (P3)
382491	6335984	*Acacia semitrullata* (P3)
382491	6335984	*Acacia semitrullata* (P3)
382492	6335979	*Acacia semitrullata* (P3)
382493	6335971	*Acacia semitrullata* (P3)
382493	6335973	*Acacia semitrullata* (P3)
382493	6335973	*Acacia semitrullata* (P3)
382493	6335975	*Acacia semitrullata* (P3)
382493	6335975	*Acacia semitrullata* (P3)
382493	6335983	*Acacia semitrullata* (P3)
382495	6335978	*Acacia semitrullata* (P3)
382495	6335980	*Acacia semitrullata* (P3)
382495	6335980	*Acacia semitrullata* (P3)
382495	6335981	*Acacia semitrullata* (P3)
382495	6335982	*Acacia semitrullata* (P3)
382495	6335983	*Acacia semitrullata* (P3)
382496	6335975	*Acacia semitrullata* (P3)
382496	6335980	*Acacia semitrullata* (P3)
382496	6335980	*Acacia semitrullata* (P3)
382496	6335980	*Acacia semitrullata* (P3)
382496	6335981	*Acacia semitrullata* (P3)
382497	6335981	*Acacia semitrullata* (P3)
382497	6335982	*Acacia semitrullata* (P3)
382497	6335982	*Acacia semitrullata* (P3)
382497	6335986	*Acacia semitrullata* (P3)
382497	6335987	*Acacia semitrullata* (P3)
382497	6335987	*Acacia semitrullata* (P3)
382498	6335982	*Acacia semitrullata* (P3)
382498	6335985	*Acacia semitrullata* (P3)
382498	6335986	*Acacia semitrullata* (P3)
382498	6335986	*Acacia semitrullata* (P3)
382498	6335986	*Acacia semitrullata* (P3)
382498	6335987	*Acacia semitrullata* (P3)
382499	6335984	*Acacia semitrullata* (P3)
382499	6335986	*Acacia semitrullata* (P3)
382499	6335987	*Acacia semitrullata* (P3)
382500	6335980	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
382500	6335983	*Acacia semitrullata* (P3)
382500	6335983	*Acacia semitrullata* (P3)
382500	6335983	*Acacia semitrullata* (P3)
382501	6335980	*Acacia semitrullata* (P3)
382501	6335981	*Acacia semitrullata* (P3)
382501	6335983	*Acacia semitrullata* (P3)
382502	6335983	*Acacia semitrullata* (P3)
382502	6335983	*Acacia semitrullata* (P3)
382502	6335983	*Acacia semitrullata* (P3)
382502	6335984	*Acacia semitrullata* (P3)
382502	6335985	*Acacia semitrullata* (P3)
382503	6335985	*Acacia semitrullata* (P3)
382505	6335975	*Acacia semitrullata* (P3)
382505	6335984	*Acacia semitrullata* (P3)
382505	6335984	*Acacia semitrullata* (P3)
382505	6335984	*Acacia semitrullata* (P3)
382506	6335977	*Acacia semitrullata* (P3)
382506	6335981	*Acacia semitrullata* (P3)
382506	6335981	*Acacia semitrullata* (P3)
382506	6335983	*Acacia semitrullata* (P3)
382507	6335973	*Acacia semitrullata* (P3)
382507	6335977	*Acacia semitrullata* (P3)
382507	6335984	*Acacia semitrullata* (P3)
382511	6335976	*Acacia semitrullata* (P3)
382512	6335979	*Acacia semitrullata* (P3)
382525	6335977	*Acacia semitrullata* (P3)
382525	6335977	*Acacia semitrullata* (P3)
382525	6335978	*Acacia semitrullata* (P3)
382526	6335977	*Acacia semitrullata* (P3)
382556	6335970	*Acacia semitrullata* (P3)
382609	6335977	*Acacia semitrullata* (P3)
382611	6335976	*Acacia semitrullata* (P3)
382611	6335976	*Acacia semitrullata* (P3)
382611	6335976	*Acacia semitrullata* (P3)
382612	6335980	*Acacia semitrullata* (P3)
382613	6335991	*Acacia semitrullata* (P3)
382614	6335979	*Acacia semitrullata* (P3)
382615	6335983	*Acacia semitrullata* (P3)
382615	6335983	*Acacia semitrullata* (P3)
382616	6335978	*Acacia semitrullata* (P3)
382616	6335980	*Acacia semitrullata* (P3)
382617	6335981	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
382617	6335981	*Acacia semitrullata* (P3)
382619	6335979	*Acacia semitrullata* (P3)
382619	6335979	*Acacia semitrullata* (P3)
382619	6335979	*Acacia semitrullata* (P3)
382619	6335980	*Acacia semitrullata* (P3)
382619	6335980	*Acacia semitrullata* (P3)
382619	6335986	*Acacia semitrullata* (P3)
382619	6335987	*Acacia semitrullata* (P3)
382621	6335987	*Acacia semitrullata* (P3)
382623	6335986	*Acacia semitrullata* (P3)
382624	6335986	*Acacia semitrullata* (P3)
382624	6335987	*Acacia semitrullata* (P3)
382628	6335980	*Acacia semitrullata* (P3)
382629	6335983	*Acacia semitrullata* (P3)
382631	6335983	*Acacia semitrullata* (P3)
382635	6335979	*Acacia semitrullata* (P3)
382638	6335975	*Acacia semitrullata* (P3)
382639	6335986	*Acacia semitrullata* (P3)
382640	6335972	*Acacia semitrullata* (P3)
382747	6335994	*Acacia semitrullata* (P3)
382748	6335991	*Acacia semitrullata* (P3)
382984	6335975	*Acacia semitrullata* (P3)
383889	6335991	*Acacia semitrullata* (P3)
383891	6335992	*Acacia semitrullata* (P3)
383893	6335991	*Acacia semitrullata* (P3)
383894	6335993	*Acacia semitrullata* (P3)
383894	6335993	*Acacia semitrullata* (P3)
383895	6335988	*Acacia semitrullata* (P3)
383895	6335992	*Acacia semitrullata* (P3)
383896	6335991	*Acacia semitrullata* (P3)
383904	6335990	*Acacia semitrullata* (P3)
384002	6335991	*Acacia semitrullata* (P3)
384006	6335995	*Acacia semitrullata* (P3)
384012	6335996	*Acacia semitrullata* (P3)
384030	6335995	*Acacia semitrullata* (P3)
384038	6335992	*Acacia semitrullata* (P3)
384039	6335993	*Acacia semitrullata* (P3)
384040	6335990	*Acacia semitrullata* (P3)
384063	6335991	*Acacia semitrullata* (P3)
384068	6335993	*Acacia semitrullata* (P3)
385540	6336413	*Acacia semitrullata* (P3)
385554	6336404	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
385554	6336405	*Acacia semitrullata* (P3)
385555	6336402	*Acacia semitrullata* (P3)
385556	6336407	*Acacia semitrullata* (P3)
385561	6336404	*Acacia semitrullata* (P3)
385568	6336415	*Acacia semitrullata* (P3)
385569	6336405	*Acacia semitrullata* (P3)
385619	6336411	*Acacia semitrullata* (P3)
385645	6336416	*Acacia semitrullata* (P3)
385767	6336417	*Acacia semitrullata* (P3)
385767	6336417	*Acacia semitrullata* (P3)
385768	6336418	*Acacia semitrullata* (P3)
385769	6336419	*Acacia semitrullata* (P3)
385770	6336419	*Acacia semitrullata* (P3)
385770	6336419	*Acacia semitrullata* (P3)
385772	6336426	*Acacia semitrullata* (P3)
385816	6336426	*Acacia semitrullata* (P3)
385827	6336406	*Acacia semitrullata* (P3)
385831	6336409	*Acacia semitrullata* (P3)
385835	6336405	*Acacia semitrullata* (P3)
385837	6336406	*Acacia semitrullata* (P3)
385840	6336407	*Acacia semitrullata* (P3)
385846	6336407	*Acacia semitrullata* (P3)
385847	6336428	*Acacia semitrullata* (P3)
385851	6336427	*Acacia semitrullata* (P3)
385863	6336410	*Acacia semitrullata* (P3)
385875	6336403	*Acacia semitrullata* (P3)
385875	6336409	*Acacia semitrullata* (P3)
385876	6336409	*Acacia semitrullata* (P3)
385876	6336410	*Acacia semitrullata* (P3)
385877	6336407	*Acacia semitrullata* (P3)
385879	6336410	*Acacia semitrullata* (P3)
385879	6336433	*Acacia semitrullata* (P3)
385880	6336408	*Acacia semitrullata* (P3)
385880	6336408	*Acacia semitrullata* (P3)
385880	6336408	*Acacia semitrullata* (P3)
385880	6336409	*Acacia semitrullata* (P3)
385880	6336410	*Acacia semitrullata* (P3)
385880	6336411	*Acacia semitrullata* (P3)
385880	6336411	*Acacia semitrullata* (P3)
385880	6336429	*Acacia semitrullata* (P3)
385880	6336433	*Acacia semitrullata* (P3)
385881	6336431	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
385881	6336431	*Acacia semitrullata* (P3)
385881	6336431	*Acacia semitrullata* (P3)
385887	6336431	*Acacia semitrullata* (P3)
385888	6336431	*Acacia semitrullata* (P3)
385889	6336433	*Acacia semitrullata* (P3)
385890	6336429	*Acacia semitrullata* (P3)
385890	6336431	*Acacia semitrullata* (P3)
385890	6336431	*Acacia semitrullata* (P3)
385890	6336431	*Acacia semitrullata* (P3)
385892	6336431	*Acacia semitrullata* (P3)
385892	6336431	*Acacia semitrullata* (P3)
385892	6336432	*Acacia semitrullata* (P3)
385893	6336432	*Acacia semitrullata* (P3)
385893	6336432	*Acacia semitrullata* (P3)
385893	6336432	*Acacia semitrullata* (P3)
385893	6336434	*Acacia semitrullata* (P3)
385895	6336411	*Acacia semitrullata* (P3)
385895	6336429	*Acacia semitrullata* (P3)
385896	6336403	*Acacia semitrullata* (P3)
385897	6336413	*Acacia semitrullata* (P3)
385897	6336413	*Acacia semitrullata* (P3)
385904	6336406	*Acacia semitrullata* (P3)
385904	6336406	*Acacia semitrullata* (P3)
385904	6336420	*Acacia semitrullata* (P3)
385907	6336418	*Acacia semitrullata* (P3)
385908	6336431	*Acacia semitrullata* (P3)
385909	6336436	*Acacia semitrullata* (P3)
385910	6336429	*Acacia semitrullata* (P3)
385911	6336432	*Acacia semitrullata* (P3)
385911	6336442	*Acacia semitrullata* (P3)
385912	6336421	*Acacia semitrullata* (P3)
385912	6336444	*Acacia semitrullata* (P3)
385913	6336435	*Acacia semitrullata* (P3)
385914	6336418	*Acacia semitrullata* (P3)
385914	6336439	*Acacia semitrullata* (P3)
385915	6336421	*Acacia semitrullata* (P3)
385916	6336420	*Acacia semitrullata* (P3)
385916	6336439	*Acacia semitrullata* (P3)
385917	6336423	*Acacia semitrullata* (P3)
385917	6336433	*Acacia semitrullata* (P3)
385917	6336435	*Acacia semitrullata* (P3)
385917	6336438	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
385917	6336439	*Acacia semitrullata* (P3)
385918	6336434	*Acacia semitrullata* (P3)
385918	6336436	*Acacia semitrullata* (P3)
385919	6336435	*Acacia semitrullata* (P3)
385950	6336434	*Acacia semitrullata* (P3)
385951	6336434	*Acacia semitrullata* (P3)
385951	6336437	*Acacia semitrullata* (P3)
385952	6336438	*Acacia semitrullata* (P3)
385957	6336433	*Acacia semitrullata* (P3)
385959	6336438	*Acacia semitrullata* (P3)
385959	6336440	*Acacia semitrullata* (P3)
385962	6336441	*Acacia semitrullata* (P3)
385965	6336434	*Acacia semitrullata* (P3)
385969	6336455	*Acacia semitrullata* (P3)
385975	6336446	*Acacia semitrullata* (P3)
385979	6336459	*Acacia semitrullata* (P3)
385980	6336459	*Acacia semitrullata* (P3)
385982	6336457	*Acacia semitrullata* (P3)
385982	6336460	*Acacia semitrullata* (P3)
385984	6336466	*Acacia semitrullata* (P3)
385984	6336466	*Acacia semitrullata* (P3)
385987	6336460	*Acacia semitrullata* (P3)
385987	6336463	*Acacia semitrullata* (P3)
385988	6336452	*Acacia semitrullata* (P3)
385988	6336469	*Acacia semitrullata* (P3)
385989	6336466	*Acacia semitrullata* (P3)
385992	6336473	*Acacia semitrullata* (P3)
385993	6336467	*Acacia semitrullata* (P3)
385994	6336459	*Acacia semitrullata* (P3)
386000	6336468	*Acacia semitrullata* (P3)
386000	6336470	*Acacia semitrullata* (P3)
386001	6336472	*Acacia semitrullata* (P3)
386002	6336467	*Acacia semitrullata* (P3)
386003	6336474	*Acacia semitrullata* (P3)
386004	6336470	*Acacia semitrullata* (P3)
386018	6336464	*Acacia semitrullata* (P3)
386020	6336470	*Acacia semitrullata* (P3)
386021	6336467	*Acacia semitrullata* (P3)
386024	6336466	*Acacia semitrullata* (P3)
386025	6336481	*Acacia semitrullata* (P3)
386029	6336483	*Acacia semitrullata* (P3)
386030	6336476	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
386031	6336483	*Acacia semitrullata* (P3)
386035	6336484	*Acacia semitrullata* (P3)
386038	6336487	*Acacia semitrullata* (P3)
386038	6336488	*Acacia semitrullata* (P3)
386040	6336483	*Acacia semitrullata* (P3)
386046	6336469	*Acacia semitrullata* (P3)
386053	6336493	*Acacia semitrullata* (P3)
386054	6336495	*Acacia semitrullata* (P3)
386055	6336494	*Acacia semitrullata* (P3)
386062	6336491	*Acacia semitrullata* (P3)
386062	6336492	*Acacia semitrullata* (P3)
386063	6336491	*Acacia semitrullata* (P3)
386063	6336493	*Acacia semitrullata* (P3)
386082	6336490	*Acacia semitrullata* (P3)
386085	6336486	*Acacia semitrullata* (P3)
386136	6336510	*Acacia semitrullata* (P3)
386140	6336525	*Acacia semitrullata* (P3)
386150	6336535	*Acacia semitrullata* (P3)
386151	6336529	*Acacia semitrullata* (P3)
386151	6336536	*Acacia semitrullata* (P3)
386152	6336528	*Acacia semitrullata* (P3)
386152	6336528	*Acacia semitrullata* (P3)
386152	6336530	*Acacia semitrullata* (P3)
386153	6336533	*Acacia semitrullata* (P3)
386154	6336528	*Acacia semitrullata* (P3)
386155	6336531	*Acacia semitrullata* (P3)
386155	6336534	*Acacia semitrullata* (P3)
386157	6336507	*Acacia semitrullata* (P3)
386163	6336511	*Acacia semitrullata* (P3)
386163	6336511	*Acacia semitrullata* (P3)
386163	6336544	*Acacia semitrullata* (P3)
386164	6336538	*Acacia semitrullata* (P3)
386165	6336543	*Acacia semitrullata* (P3)
386167	6336543	*Acacia semitrullata* (P3)
386168	6336544	*Acacia semitrullata* (P3)
386169	6336541	*Acacia semitrullata* (P3)
386169	6336545	*Acacia semitrullata* (P3)
386170	6336542	*Acacia semitrullata* (P3)
386170	6336544	*Acacia semitrullata* (P3)
386171	6336542	*Acacia semitrullata* (P3)
386171	6336542	*Acacia semitrullata* (P3)
386172	6336521	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
386172	6336523	*Acacia semitrullata* (P3)
386172	6336548	*Acacia semitrullata* (P3)
386173	6336548	*Acacia semitrullata* (P3)
386174	6336522	*Acacia semitrullata* (P3)
386174	6336548	*Acacia semitrullata* (P3)
386174	6336549	*Acacia semitrullata* (P3)
386175	6336549	*Acacia semitrullata* (P3)
386176	6336522	*Acacia semitrullata* (P3)
386176	6336523	*Acacia semitrullata* (P3)
386176	6336523	*Acacia semitrullata* (P3)
386176	6336550	*Acacia semitrullata* (P3)
386179	6336548	*Acacia semitrullata* (P3)
386180	6336516	*Acacia semitrullata* (P3)
386180	6336528	*Acacia semitrullata* (P3)
386182	6336549	*Acacia semitrullata* (P3)
386185	6336529	*Acacia semitrullata* (P3)
386186	6336529	*Acacia semitrullata* (P3)
386190	6336551	*Acacia semitrullata* (P3)
386198	6336524	*Acacia semitrullata* (P3)
386204	6336538	*Acacia semitrullata* (P3)
386206	6336555	*Acacia semitrullata* (P3)
386207	6336540	*Acacia semitrullata* (P3)
386207	6336558	*Acacia semitrullata* (P3)
386213	6336568	*Acacia semitrullata* (P3)
386215	6336566	*Acacia semitrullata* (P3)
386215	6336566	*Acacia semitrullata* (P3)
386222	6336547	*Acacia semitrullata* (P3)
386232	6336551	*Acacia semitrullata* (P3)
386239	6336542	*Acacia semitrullata* (P3)
386263	6336565	*Acacia semitrullata* (P3)
386317	6336543	*Acacia semitrullata* (P3)
386319	6336521	*Acacia semitrullata* (P3)
386320	6336521	*Acacia semitrullata* (P3)
386320	6336525	*Acacia semitrullata* (P3)
386325	6336534	*Acacia semitrullata* (P3)
386340	6336540	*Acacia semitrullata* (P3)
386342	6336539	*Acacia semitrullata* (P3)
386343	6336535	*Acacia semitrullata* (P3)
386344	6336528	*Acacia semitrullata* (P3)
386346	6336536	*Acacia semitrullata* (P3)
386366	6336533	*Acacia semitrullata* (P3)
386366	6336534	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
386377	6336514	*Acacia semitrullata* (P3)
386384	6336531	*Acacia semitrullata* (P3)
386388	6336510	*Acacia semitrullata* (P3)
386390	6336511	*Acacia semitrullata* (P3)
386392	6336506	*Acacia semitrullata* (P3)
386404	6336523	*Acacia semitrullata* (P3)
386428	6336509	*Acacia semitrullata* (P3)
386454	6336503	*Acacia semitrullata* (P3)
386476	6336508	*Acacia semitrullata* (P3)
386482	6336505	*Acacia semitrullata* (P3)
386488	6336495	*Acacia semitrullata* (P3)
386491	6336495	*Acacia semitrullata* (P3)
386512	6336486	*Acacia semitrullata* (P3)
386513	6336484	*Acacia semitrullata* (P3)
386517	6336495	*Acacia semitrullata* (P3)
386520	6336485	*Acacia semitrullata* (P3)
386528	6336486	*Acacia semitrullata* (P3)
386549	6336484	*Acacia semitrullata* (P3)
386549	6336484	*Acacia semitrullata* (P3)
386553	6336489	*Acacia semitrullata* (P3)
386554	6336492	*Acacia semitrullata* (P3)
386554	6336493	*Acacia semitrullata* (P3)
386574	6336482	*Acacia semitrullata* (P3)
386574	6336483	*Acacia semitrullata* (P3)
386613	6336455	*Acacia semitrullata* (P3)
386613	6336456	*Acacia semitrullata* (P3)
386613	6336456	*Acacia semitrullata* (P3)
386615	6336455	*Acacia semitrullata* (P3)
386622	6336471	*Acacia semitrullata* (P3)
386623	6336478	*Acacia semitrullata* (P3)
386625	6336452	*Acacia semitrullata* (P3)
386638	6336465	*Acacia semitrullata* (P3)
386640	6336469	*Acacia semitrullata* (P3)
386641	6336464	*Acacia semitrullata* (P3)
386642	6336462	*Acacia semitrullata* (P3)
386643	6336464	*Acacia semitrullata* (P3)
386644	6336466	*Acacia semitrullata* (P3)
386645	6336468	*Acacia semitrullata* (P3)
386647	6336464	*Acacia semitrullata* (P3)
386661	6336474	*Acacia semitrullata* (P3)
386662	6336458	*Acacia semitrullata* (P3)
386668	6336458	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
386679	6336454	*Acacia semitrullata* (P3)
386681	6336453	*Acacia semitrullata* (P3)
386693	6336472	*Acacia semitrullata* (P3)
386721	6336464	*Acacia semitrullata* (P3)
386823	6336512	*Acacia semitrullata* (P3)
386823	6336512	*Acacia semitrullata* (P3)
386886	6336512	*Acacia semitrullata* (P3)
386898	6336507	*Acacia semitrullata* (P3)
386900	6336510	*Acacia semitrullata* (P3)
386901	6336503	*Acacia semitrullata* (P3)
386905	6336505	*Acacia semitrullata* (P3)
386906	6336522	*Acacia semitrullata* (P3)
386937	6336523	*Acacia semitrullata* (P3)
386942	6336522	*Acacia semitrullata* (P3)
386971	6336536	*Acacia semitrullata* (P3)
386974	6336531	*Acacia semitrullata* (P3)
387182	6336583	*Acacia semitrullata* (P3)
387219	6336588	*Acacia semitrullata* (P3)
387331	6336620	*Acacia semitrullata* (P3)
387331	6336621	*Acacia semitrullata* (P3)
387334	6336618	*Acacia semitrullata* (P3)
387334	6336621	*Acacia semitrullata* (P3)
387335	6336623	*Acacia semitrullata* (P3)
387335	6336624	*Acacia semitrullata* (P3)
387341	6336633	*Acacia semitrullata* (P3)
387344	6336644	*Acacia semitrullata* (P3)
387352	6336654	*Acacia semitrullata* (P3)
387352	6336656	*Acacia semitrullata* (P3)
387353	6336658	*Acacia semitrullata* (P3)
387353	6336661	*Acacia semitrullata* (P3)
387354	6336658	*Acacia semitrullata* (P3)
387354	6336659	*Acacia semitrullata* (P3)
387355	6336659	*Acacia semitrullata* (P3)
387355	6336659	*Acacia semitrullata* (P3)
387356	6336659	*Acacia semitrullata* (P3)
387381	6336719	*Acacia semitrullata* (P3)
387381	6336754	*Acacia semitrullata* (P3)
387381	6336759	*Acacia semitrullata* (P3)
387381	6336760	*Acacia semitrullata* (P3)
387384	6336723	*Acacia semitrullata* (P3)
387385	6336759	*Acacia semitrullata* (P3)
387386	6336760	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
387389	6336769	*Acacia semitrullata* (P3)
387390	6336745	*Acacia semitrullata* (P3)
387391	6336739	*Acacia semitrullata* (P3)
387391	6336744	*Acacia semitrullata* (P3)
387391	6336770	*Acacia semitrullata* (P3)
387392	6336744	*Acacia semitrullata* (P3)
387394	6336747	*Acacia semitrullata* (P3)
387397	6336753	*Acacia semitrullata* (P3)
387400	6336765	*Acacia semitrullata* (P3)
387400	6336770	*Acacia semitrullata* (P3)
387400	6336770	*Acacia semitrullata* (P3)
387400	6336770	*Acacia semitrullata* (P3)
387401	6336770	*Acacia semitrullata* (P3)
387401	6336770	*Acacia semitrullata* (P3)
387401	6336770	*Acacia semitrullata* (P3)
387402	6336773	*Acacia semitrullata* (P3)
387404	6336770	*Acacia semitrullata* (P3)
387409	6336808	*Acacia semitrullata* (P3)
387409	6336813	*Acacia semitrullata* (P3)
387410	6336782	*Acacia semitrullata* (P3)
387410	6336820	*Acacia semitrullata* (P3)
387411	6336813	*Acacia semitrullata* (P3)
387412	6336790	*Acacia semitrullata* (P3)
387413	6336783	*Acacia semitrullata* (P3)
387413	6336790	*Acacia semitrullata* (P3)
387414	6336823	*Acacia semitrullata* (P3)
387415	6336794	*Acacia semitrullata* (P3)
387416	6336793	*Acacia semitrullata* (P3)
387416	6336799	*Acacia semitrullata* (P3)
387417	6336794	*Acacia semitrullata* (P3)
387418	6336794	*Acacia semitrullata* (P3)
387418	6336794	*Acacia semitrullata* (P3)
387418	6336795	*Acacia semitrullata* (P3)
387418	6336799	*Acacia semitrullata* (P3)
387418	6336803	*Acacia semitrullata* (P3)
387420	6336802	*Acacia semitrullata* (P3)
387420	6336802	*Acacia semitrullata* (P3)
387420	6336803	*Acacia semitrullata* (P3)
387420	6336806	*Acacia semitrullata* (P3)
387420	6336807	*Acacia semitrullata* (P3)
387421	6336808	*Acacia semitrullata* (P3)
387422	6336803	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
387422	6336804	*Acacia semitrullata* (P3)
387422	6336805	*Acacia semitrullata* (P3)
387423	6336805	*Acacia semitrullata* (P3)
387423	6336806	*Acacia semitrullata* (P3)
387423	6336812	*Acacia semitrullata* (P3)
387423	6336812	*Acacia semitrullata* (P3)
387423	6336822	*Acacia semitrullata* (P3)
387423	6336841	*Acacia semitrullata* (P3)
387424	6336808	*Acacia semitrullata* (P3)
387424	6336812	*Acacia semitrullata* (P3)
387424	6336820	*Acacia semitrullata* (P3)
387424	6336823	*Acacia semitrullata* (P3)
387425	6336808	*Acacia semitrullata* (P3)
387425	6336823	*Acacia semitrullata* (P3)
387425	6336845	*Acacia semitrullata* (P3)
387426	6336811	*Acacia semitrullata* (P3)
387426	6336822	*Acacia semitrullata* (P3)
387427	6336814	*Acacia semitrullata* (P3)
387427	6336815	*Acacia semitrullata* (P3)
387427	6336815	*Acacia semitrullata* (P3)
387428	6336828	*Acacia semitrullata* (P3)
387428	6336828	*Acacia semitrullata* (P3)
387428	6336830	*Acacia semitrullata* (P3)
387429	6336819	*Acacia semitrullata* (P3)
387429	6336832	*Acacia semitrullata* (P3)
387430	6336830	*Acacia semitrullata* (P3)
387430	6336834	*Acacia semitrullata* (P3)
387430	6336838	*Acacia semitrullata* (P3)
387431	6336819	*Acacia semitrullata* (P3)
387431	6336819	*Acacia semitrullata* (P3)
387431	6336822	*Acacia semitrullata* (P3)
387431	6336823	*Acacia semitrullata* (P3)
387431	6336836	*Acacia semitrullata* (P3)
387431	6336837	*Acacia semitrullata* (P3)
387432	6336825	*Acacia semitrullata* (P3)
387432	6336827	*Acacia semitrullata* (P3)
387432	6336827	*Acacia semitrullata* (P3)
387432	6336830	*Acacia semitrullata* (P3)
387432	6336837	*Acacia semitrullata* (P3)
387433	6336821	*Acacia semitrullata* (P3)
387433	6336829	*Acacia semitrullata* (P3)
387433	6336829	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
387433	6336830	*Acacia semitrullata* (P3)
387434	6336828	*Acacia semitrullata* (P3)
387434	6336829	*Acacia semitrullata* (P3)
387436	6336834	*Acacia semitrullata* (P3)
387436	6336835	*Acacia semitrullata* (P3)
387438	6336833	*Acacia semitrullata* (P3)
387446	6336903	*Acacia semitrullata* (P3)
387446	6336909	*Acacia semitrullata* (P3)
387447	6336847	*Acacia semitrullata* (P3)
387450	6336860	*Acacia semitrullata* (P3)
387468	6336885	*Acacia semitrullata* (P3)
387537	6337028	*Acacia semitrullata* (P3)
387545	6337019	*Acacia semitrullata* (P3)
387546	6337036	*Acacia semitrullata* (P3)
387549	6337038	*Acacia semitrullata* (P3)
387554	6337029	*Acacia semitrullata* (P3)
387580	6337090	*Acacia semitrullata* (P3)
387611	6337099	*Acacia semitrullata* (P3)
387663	6337156	*Acacia semitrullata* (P3)
387663	6337157	*Acacia semitrullata* (P3)
387708	6337145	*Acacia semitrullata* (P3)
387714	6337165	*Acacia semitrullata* (P3)
387722	6337167	*Acacia semitrullata* (P3)
387731	6337174	*Acacia semitrullata* (P3)
387735	6337174	*Acacia semitrullata* (P3)
387755	6337176	*Acacia semitrullata* (P3)
387788	6337186	*Acacia semitrullata* (P3)
387790	6337189	*Acacia semitrullata* (P3)
387799	6337172	*Acacia semitrullata* (P3)
387799	6337173	*Acacia semitrullata* (P3)
387804	6337174	*Acacia semitrullata* (P3)
387823	6337183	*Acacia semitrullata* (P3)
387870	6337196	*Acacia semitrullata* (P3)
387872	6337197	*Acacia semitrullata* (P3)
387873	6337196	*Acacia semitrullata* (P3)
387874	6337194	*Acacia semitrullata* (P3)
387897	6337225	*Acacia semitrullata* (P3)
387933	6337207	*Acacia semitrullata* (P3)
388143	6337346	*Acacia semitrullata* (P3)
388143	6337346	*Acacia semitrullata* (P3)
388143	6337346	*Acacia semitrullata* (P3)
388143	6337346	*Acacia semitrullata* (P3)

Appendix A : GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant, September 2008.

Easting (WGS84)	Northing (WGS84)	Species
388143	6337346	*Acacia semitrullata* (P3)
388143	6337346	*Acacia semitrullata* (P3)
388325	6337750	*Acacia semitrullata* (P3)
		TOTAL (*Acacia semitrullata*) 843
382002	6335975	*Caladenia speciosa* (P4)
382008	6335974	*Caladenia speciosa* (P4)
382108	6335980	*Caladenia speciosa* (P4)
382160	6335976	*Caladenia speciosa* (P4)
382161	6335973	*Caladenia speciosa* (P4)
382238	6335973	*Caladenia speciosa* (P4)
382253	6335968	*Caladenia speciosa* (P4)
382279	6335975	*Caladenia speciosa* (P4)
382294	6335978	*Caladenia speciosa* (P4)
382295	6335977	*Caladenia speciosa* (P4)
382298	6335970	*Caladenia speciosa* (P4)
382299	6335970	*Caladenia speciosa* (P4)
382299	6335972	*Caladenia speciosa* (P4)
382300	6335973	*Caladenia speciosa* (P4)
382313	6335971	*Caladenia speciosa* (P4)
382322	6335982	*Caladenia speciosa* (P4)
382526	6335977	*Caladenia speciosa* (P4)
382526	6335977	*Caladenia speciosa* (P4)
382537	6335980	*Caladenia speciosa* (P4)
382589	6335975	*Caladenia speciosa* (P4)
387450	6336861	*Caladenia speciosa* (P4)
387450	6336865	*Caladenia speciosa* (P4)
		TOTAL (*Caladenia speciosa*) 22
382422	6335994	*Eucalytus rudis* ssp. *cratyantha* (P4)
		TOTAL (*Eucalyptus rudis* ssp. *cratyantha*) 1

Appendix B Recorded Locations of Significant Flora (360 Environmental 2007)

Appendix B: GPS Locations for Priority Flora recorded within the Water Corporation and the Associated Pipeline Corridor for the Binningup Desalination Plant by 360 Environmental in 2007

Easting (WGS84)	Northing (WGS84)	Species
387715	6337168	*Acacia semitrullata* (P3)
387753	6337181	*Acacia semitrullata* (P3)
387739	6337183	*Acacia semitrullata* (P3)
387939	6337218	*Acacia semitrullata* (P3)
387911	6337212	*Acacia semitrullata* (P3)
387714	6337167	*Acacia semitrullata* (P3)
387930	6337230	*Acacia semitrullata* (P3)
386769	6336469	*Acacia semitrullata* (P3)
386176	6336544	*Acacia semitrullata* (P3)
386073	6336503	*Acacia semitrullata* (P3)
385985	6336462	*Acacia semitrullata* (P3)
386005	6336462	*Acacia semitrullata* (P3)
386206	6336542	*Acacia semitrullata* (P3)
386581	6336489	*Acacia semitrullata* (P3)
386750	6336461	*Acacia semitrullata* (P3)
387455	6336902	*Acacia semitrullata* (P3)
386869	6336502	*Acacia semitrullata* (P3)
387275	6336605	*Acacia semitrullata* (P3)
387336	6336624	*Acacia semitrullata* (P3)
387436	6336832	*Acacia semitrullata* (P3)
386549	6336496	*Acacia semitrullata* (P3)
388262	6337576	*Acacia semitrullata* (P3)
385642	6336406	*Acacia semitrullata* (P3)
385817	6336408	*Acacia semitrullata* (P3)
385837	6336406	*Acacia semitrullata* (P3)
386185	6336541	*Acacia semitrullata* (P3)
385540	6336411	*Acacia semitrullata* (P3)
386213	6336562	*Acacia semitrullata* (P3)
384048	6335997	*Acacia semitrullata* (P3)
382487	6335973	*Acacia semitrullata* (P3)
381986	6335963	*Acacia semitrullata* (P3)
382025	6335973	*Acacia semitrullata* (P3)
382056	6335980	*Acacia semitrullata* (P3)
382153	6335975	*Acacia semitrullata* (P3)
383963	6335987	*Acacia semitrullata* (P3)
382685	6335991	*Acacia semitrullata* (P3)
382639	6335983	*Acacia semitrullata* (P3)
385757	6336419	*Acacia semitrullata* (P3)
382142	6335978	*Caladenia speciosa* (P4)
382314	6335988	*Caladenia speciosa* (P4)
382092	6335967	*Caladenia speciosa* (P4)
382422	6335994	*Eucalyptus rudis* subsp. *cratyantha* (P4)

Appendix B Operational Environmental Management Framework

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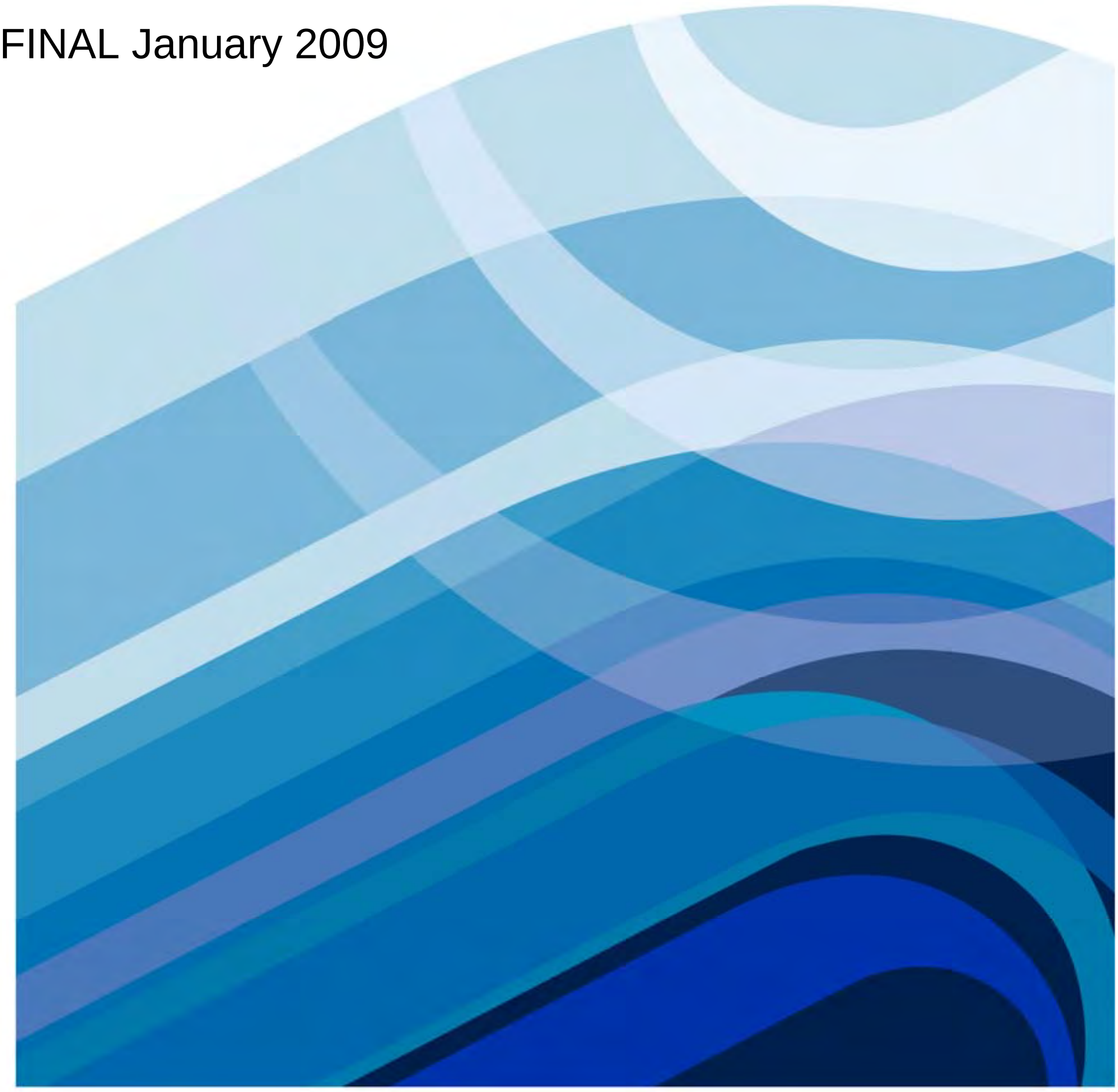
WATER CORPORATION

Southern Seawater Desalination Project

Operational Environmental Management Framework

FINAL January 2009



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Report	Version	Prepared by	Reviewed by
Southern Seawater Desalination Project – Operation Environmental Management Framework.	Draft for Internal Review February 2008.	E. Zajc, Environmental Scientist. D A. Luketina, Manager Environment - Water Corporation.	Stansfield J – Project Management Oliver M - Project Management Lee S – Infrastructure Design Groth G – Environment Branch (Operations) Watson G – Environment Branch (Operations) Baker A - Environment Branch (Approvals) Lord D – Expert Advisor/Reviewer Sibma S – Desalination Operations Christie S – Desalination Operations
Southern Seawater Desalination Project – Operation Environmental Management Framework.	Draft for Environmental Protection Authority February 2008.	D A. Luketina, Manager Environment - Water Corporation.	Environmental Protection Authority.
Southern Seawater Desalination Project – Operation Environmental Management Framework.	Public Environmental Review March 2008.	D A. Luketina, Manager Environment - Water Corporation.	Environmental Impact Assessment - Public Environmental Review.
Southern Seawater Desalination Project – Operation Environmental Management Framework.	**Final January 2009.**	**G Groth, Snr. Environmental Officer - Water Corporation.**	**Churchill N – Project Management**

Reference

This document should be cited as:

Water Corporation (2008) *Southern Seawater Desalination Project Operation Environmental Management Framework January 2009.*

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1.0 Overview

1.1 Project Outline

The Water Corporation is a public utility of the State Government of Western Australia responsible for public water supply in accordance with the *Water Corporation Act 1995* (WA) and associated legislation. The Water Corporation's Southern Seawater Desalination Project (SSDP) is considered critical infrastructure for public water supply to the Integrated Water Supply Scheme (IWSS) by the Government of Western Australia.

The Southern Seawater Desalination Project involves the construction and operation of:

- A reverse osmosis seawater desalination plant to produce Up to 100 GL/y, located at Lots 32 and 33 and Part Lot 8 on Taranto Road in the Shire of Harvey (approximately 140km south of Perth). The plant will include:
    - o up to four submerged seawater intake pipelines extending up to 600m offshore;
    - o a seawater pump station;
    - o storage facilities for chemicals;
    - o dual media filters (including backwash tanks) and drying beds;
    - o a reverse osmosis building;
    - o potabilisation and storage facilities for associated process chemicals;
    - o drinking water storage tank(s) and pump station(s);
    - o up to four seawater brine outlets with diffusers extending up to 1100m offshore; and
    - o site amenity buildings for purposes including administration, plant operations control, laboratory, workshop and general storage.
- 100ML water storage facility (in up to 4 storage tanks) with up to 5ML sump located north-east of the town settlement in the Shire of Harvey.
- Approximately 30km of 1400mm diameter cement-lined steel pipeline to connect the plant to the storage facility, and the storage facility to the existing Stirling Trunk Main of the Integrated Water Supply System (IWSS).

The Southern Seawater Desalination Project will be developed in stages. The initial construction and operation for a plant with the production capacity of 50 GL/y and with one water storage tank up to 32 ML capacity. All terrestrial and marine pipelines will be constructed for 100 GL/y capacity at the initial stage of construction including all earthworks. The capacity of the plant and water storage facility will be increased as water supply demand increases.

A map identifying showing the location of the plant, and associated infrastructure is shown in **Figure 1.1**.

The Southern Seawater Desalination Project will produce drinking quality water from seawater abstracted via the inlet pipe. The desalination process allows for the recovery of approximately 42% of the volume of the seawater as drinking water with the remaining water being discharged as a waste brine solution. This brine will be approximately twice as saline as the feed water (i.e. seawater).

The intake pipelines will extend from the shore up to 600m offshore and the outlet pipelines up to 1100m offshore. The outlet pipe discharge system will include multi-port diffuser(s) which will facilitate mixing in the Low Ecological Protection Area (LEPA) surrounding the outlet diffuser(s) (see Figure 1.2). The multi-port outfall is designed to reduce the salinity increase to 1 ppt or less above ambient conditions at the boundary of the LEPA. The LEPA is surrounded by a High Ecological Protection Area (HEPA). LEPAs and HEPAs are defined in the State Environmental (Cockburn Sound) Policy 2005 (Government of Western Australia, 2005).

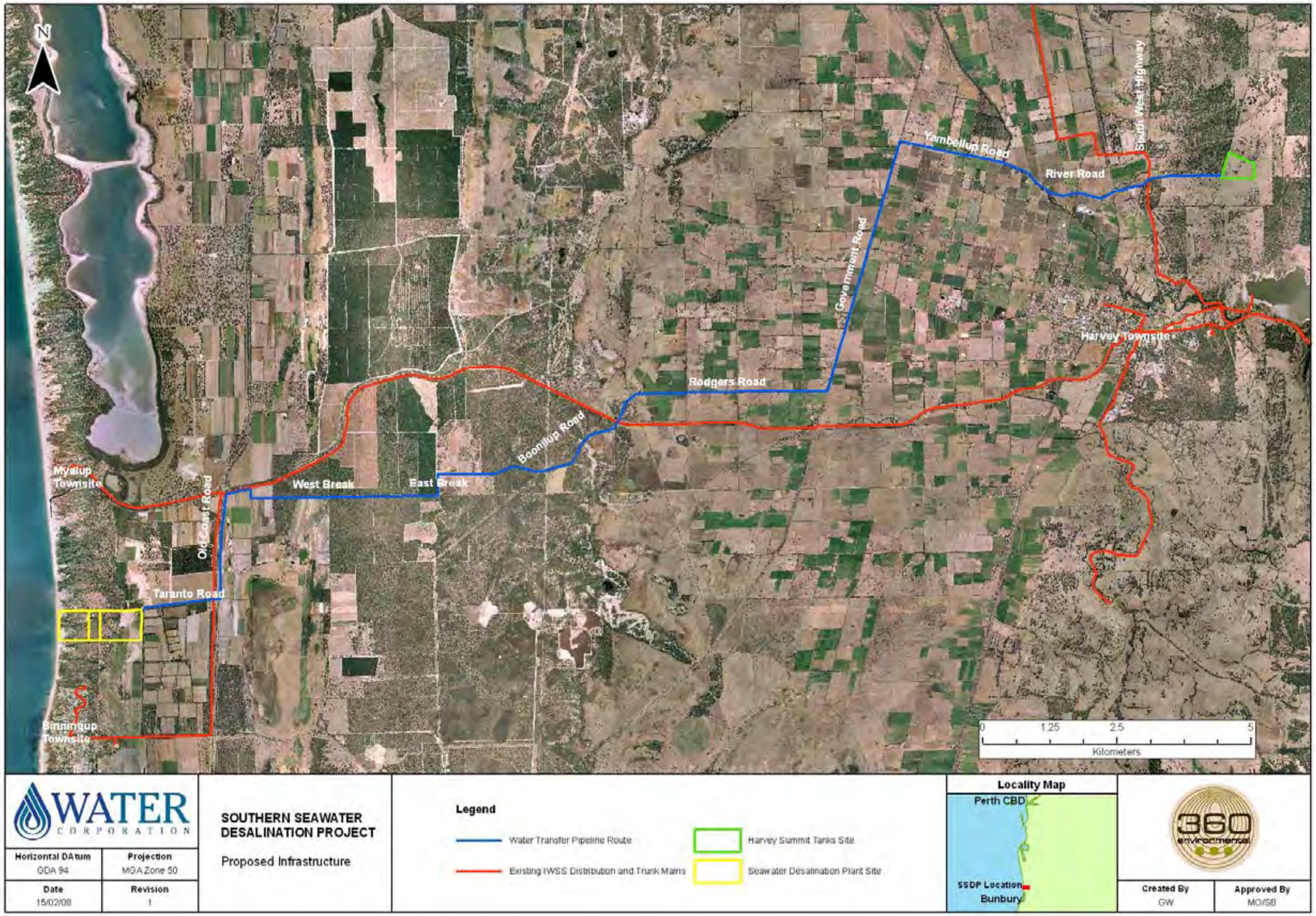

Figure 1.1 Overview map showing project infrastructure

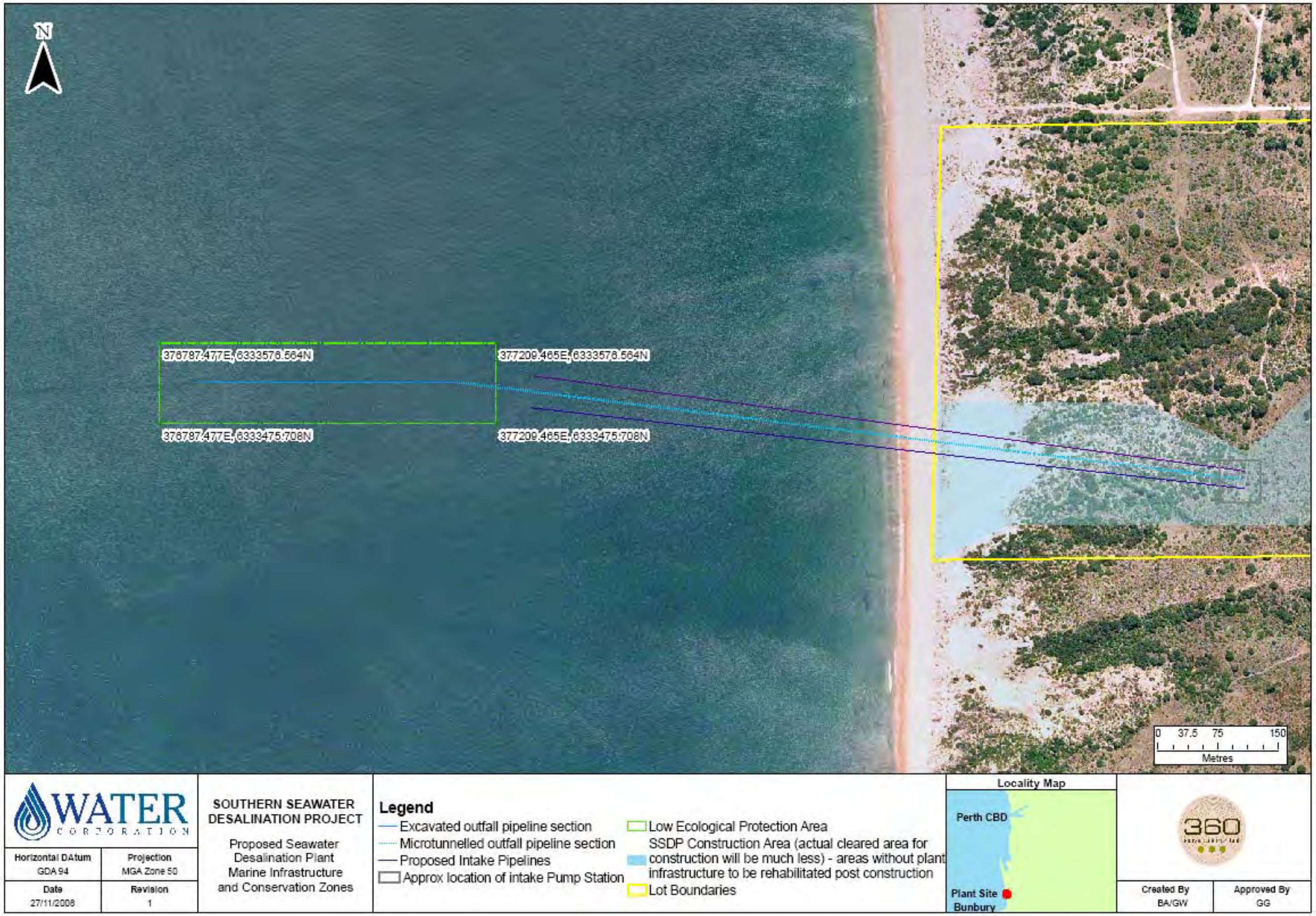

Figure 1.2 Schematic of the outlet and the Low Ecological Protection Area (LEPA) surrounding the diffuser(s)

1.2 Purpose of this OEMF

This Operation Environmental Management Framework (OEMF) contains the following management plans:

1. Whole Effluent Toxicity Testing Management (Section 4.0)
2. Diffuser Performance Monitoring (Section 5.0).
3. Discharge Water Quality Monitoring (Section 6.0).
4. Benthic Habitat Monitoring (Section 7.0)
5. Chemical and Dangerous Goods Management Plan (Section 8.0).
6. Waste Management Plan (Section 9.0).

These plans outline the actions that will be implemented to minimise any potential impacts on the environment associated with the operation of the Southern Seawater Desalination Plant. It is a primary objective that all environmental impacts during operation are avoided or minimised as far as practicable.

It is the purpose of this OEMF to:

1. meet statutory environmental requirements for the project;
2. identify actions to manage impacts on the environment that may occur as a result of operational activities; and
3. demonstrate transparency and accountability to community and government by identifying environmental management actions and making this OEMF publicly available.

1.2.1 Environmental Requirements of OEMF

This OEMF focuses on the management actions to be implemented during operation by operational staff. Supporting information is available upon request, or is contained in the Environmental Impact Assessment (Public Environmental Review) document available at www.watercorporation.com.au.

This OEMF will be further developed with the assistance of the relevant stakeholders for each component of the management plan. Stakeholders will be consulted during the Environmental Impact Assessment (Public Environmental Review) so that they have the opportunity to provide input into the project's environmental management actions.

1.3 Specifications

The materials and methodology stated in this plan are correct as of the publication date. The following changes to materials and methodologies will not invalidate this plan:

1. Changes to materials that do not result in additional or different environmental impacts.
2. Minor changes to methodologies that do not lessen environmental monitoring and/or additional or result in different environmental impact.

Changes to the materials or methodology that may result in reduced monitoring and/or cause a significant environmental impact will be referred to the relevant advisory agencies prior to implementation of the change.

This plan should be read in conjunction with the applicable Ministerial Conditions and other regulatory approvals (e.g. Works Approval, Licence).

1.4 Implementation of Contingency Actions

The OEMF outlines a number of contingency actions that may be used in the event that the management actions proposed do not achieve the purpose stated in each management plan.

1.5 OEMF Training

All staff involved in the operation of the SSDP Plant will receive training on relevant management plans within this OEMF. The names of the people trained on this OEMF will be recorded in an

OEMF Training Log along with the date and the specific plans for which that training was conducted.

1.6 Environment Policy

This OEMF is consistent with the Water Corporation's Environmental Policy (see Appendix 1). The policy can be found at the Water Corporation's website www.watercorporation.com.au.

1.7 Infrastructure Operation

This OEMF addresses matters related to operation. A separate Construction Environmental Management Framework (CEMF) contains management plans relating to construction.

1.8 Amendments arising from Public Environmental Review

This document may be amended following assessment of the Public Environmental Review. This document (as amended) will be made publicly available on the Water Corporation's website prior to operation.

2.0 Definitions

The terms used in this OEMF have the following meanings:

Brine or Brine Stream means the seawater concentrate from the reverse osmosis treatment process

Bund means an embankment of earth or a wall constructed of brick, stone or concrete to form the perimeter of a compound that will prevent lateral movement of the material contained within the embankment or wall.

CTD is the abbreviation for a conductivity/ temperature/ depth profiler.

Desalination Effluent means the effluent that is being discharged via the outlet pipeline and diffuser(s). Typically the desalination effluent will consist of the brine stream or a combination of the brine stream and injected seawater (the seawater being injected to increase dilution) plus any chemicals used in the treatment process.

EC10 is an estimate of the concentration causing an observable adverse effect on 10% of the population of a test organism.

EC50 is an estimate of the concentration that causes an observable adverse effect on 50% of the population of a test organism; Germination-concentration that results in 50% germination of zoospores; Larval development- concentration that results in 50% of larva deformed; Reproduction-concentration that results in 50% less fecundity when compared to controls.

High Ecological Protection Area is defined in the State Environmental (Cockburn Sound) Policy 2005 (Government of Western Australia, 2005) as an area afforded high protection in which small changes are allowed to the quality of water, sediment or biota (i.e. small changes in contaminant concentrations with no resultant detectable changes beyond natural variation in the diversity of species and biological communities, ecosystem processes and abundance/biomass of marine life).

IC10 is an acronym for “Inhibition Concentration 10%”, which is the concentration required to inhibit 10% of a parameter such as growth or luminescence in a test organism.

IC50 is an acronym for “Inhibition Concentration 50%”, which is the concentration required to inhibit 50% of a parameter such as growth or luminescence in a test organism. Typically a reduction in a biological response when compared with controls (e.g. Growth: Concentration that results in 50% less growth when compared to controls);

Limit of Reporting – the lowest concentration of an analyte that can be determined with an acceptable precision and accuracy.

LOEC - Lowest Observed Effect Concentration Function of concentration tested

Low Ecological Protection Area is defined in the State Environmental (Cockburn Sound) Policy 2005 (Government of Western Australia, 2005) as an area in which large changes are allowed to the quality of water, sediment or biota (i.e. large changes in contaminant concentrations that could cause large changes beyond natural variation in the natural diversity of species and biological communities, rates of ecosystem processes and abundance/biomass of marine life, but which do not result in bioaccumulation/biomagnification in near-by high ecological protection areas).

NOEC - No Observed Effect Concentration

Plant site means the site of the seawater desalination plant including Lots 32 & 33 Taranto Road Binningup, Part Lot 8 (to the southern boundary of Lots 32 and 33) Taranto Road Binningup, and includes the seawater pipelines located on part of Reserve 29628 (to the southern boundary of Lots 32 and 33) and the Indian Ocean (to the southern and northern boundaries of Lots 32 and 33) to a nominal distance of 1100m out to sea.

Pollution means the direct or indirect alteration of the environment to its detriment or degradation, to the detriment of an environmental value, or is of a prescribed kind from an emission (as defined by the *Environmental Protection Act 1986* (WA)).

Pycnocline is a region where decreasing temperature and salinity with depth results in corresponding increases in density.

3.0 Abbreviations

The following abbreviations used in this OEMF have the following meanings:

Terms

ANZECC	Australia and New Zealand Environment and Conservation Council
APHA	American Public Health Association
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASTM	American Society for Testing and Materials
AQIS	Australian Quarantine and Inspection Service
OEMF	Operational Environmental Management Framework
DAF	Department of Agriculture and Food (WA)
DEC	Department of Environment and Conservation (WA)
DEWHA	Department of Environment, Water, Heritage and the Arts (Commonwealth)
DIA	Department of Indigenous Affairs (WA)
DoCEP	Department of Consumer and Employment Protection (WA)
DoF	Department of Fisheries (WA)
DoH	Department of Health (WA)
DoW	Department of Water (WA)
DPI	Department for Planning and Infrastructure (WA)
FESA	Fire and Emergency Services Authority (WA)
FPC	Forest Products Commission (WA)
HEPA	High ecological protection area
IWSS	Integrated Water Supply Scheme
LEPA	Low ecological protection area
LOR	Limit of Reporting
MRWA	Main Roads Western Australia
MSDS	Materials Safety Data Sheet
NATA	National Association of Testing Authorities
OC	Organochlorine
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
WAPC	Western Australian Planning Commission
WET	Whole effluent toxicity

Measurement

cm	Centimetre
dB	Decibels of noise
GL/y	Gigalitres per year
ha	Hectare
kg	Kilograms
kg/ha	Kilograms per hectare
km	Kilometre
m	Metre
m^2	Square metre
mg/kg	Milligrams per kilogram
mg/L	Milligrams per litre
ML	Megalitre
ML/y	Megalitres per year
^oC	Temperature in degrees Celsius
ppt	Parts per thousand
psu	Practical salinity units (equivalent to ppt for practical purposes)

4.0 Whole Effluent Toxicity Testing Management

4.1 Context

A whole effluent toxicity (WET) testing methodology was developed for the Perth Seawater Desalination Plant to compare the discharge with the specifications in the Cockburn Sound Environmental Protection Policy (Government of Western Australia, 2005) and the supporting Manual of Standard Operating Procedures for monitoring against the Cockburn Sound Environmental Quality Criteria (2003-2004) (EPA, 2005). This methodology has been adopted (with some minor modifications based on accumulated learning from the testing of the Perth Seawater Desalination Plant desalination effluent) for the Southern Seawater Desalination Project.

The use of living test organisms (i.e. WET testing) is a reliable way to measure the potential biological impacts of the brine discharge on the surrounding environment. Indigenous organisms are chosen to maximise the relevance of the test results for the system under consideration.

4.2 Purpose

The purpose of this WET testing is to compare the discharge from the desalination plant with the ecosystem protection target at its boundary with the low ecological protection area (LEPA) surrounding the ocean outlet diffuser(s). WET testing methodology is based on the principles in USEPA (2003a, 2003b), APHA (1989) and ASTM (1998) protocols. Testing will be conducted at a NATA accredited laboratory in accordance with ANZECC/ARMCANZ (2000) whole effluent toxicity protocols.

4.3 Performance Indicators

1. Design/actual dilution compared to dilution determined using EC10 (the concentration that causes an effect on 10% of the population) and IC10 (inhibition concentration 10%) values obtained from each WET test.

4.4 Management Actions

4.4.1 Sampling Design

1. WET testing of the desalination plant discharge will occur twice[1] during operation using a sample obtained:
   a. Within three (3) months of establishment of a brine discharge, and
   b. Twelve (12) months after establishment of a brine discharge.
2. The following tests will comprise the WET testing:
   a. 15 minute Microtox test using the marine bacteria *Vibrio fischeri*;
   b. 48 hour macroalgal germination test using the marine brown kelp *Ecklonia radiata*;
   c. 48 hour mussel larval development test using the marine blue mussel *Mytilis edulis;*
   d. 72 hour algal growth test using the unicellular marine alga *Isochrysis galbana;*
   e. 24 Day copepod reproduction test using the estuarine copepod *Gladioferens imparipes;* and
   f. 7 day larval fish growth test using the marine fish pink snapper *Pagrus auratus.*
3. Testing will follow the WET methodology (section 4.5).
4. Reports will be submitted to the DEC for the WET tests conducted as per 1(a) and 1(b). These reports will contain:
   a. Explanation of methodology and approach.
   b. Presentation and discussion of results for the tests 2(a) to 2(f).

c. A discussion of any instances where WET testing indicates that the design dilution of the discharge at the boundary of the LEPA 80% species protection target and the HEPA 95% species protection target [2].

4.4.2 Microtox Test

5. The 15 minute Microtox test will be used as a range finding test to ensure that the concentrations selected for the chronic bioassays will bracket the EC50. The 15 minute acute toxicity test using the growth of the luminescent marine bacteria *Vibrio fischeri* will be based on the method listed in the Microtox Manual: A Toxicity Testing Handbook, Microbics, 1992[3].

4.4.3 Microalgae[4]

6. The 72 hour sub-chronic toxicity test using the growth of the marine alga *Isochrysis galbana* will be based on the method described by Stauber *et al.* (1994).
7. Tests will be performed in a temperature controlled laboratory using untreated microplates, which will be rinsed with dilution water prior to testing.
8. A filtered seawater control will be tested concurrently. A number of concentrations will be tested with four replicates each. The concentrations will be based on the results of the Microtox *Vibrio fischeri* test.
9. After 72 hours, the growth of the algae will be measured, and growth for each replicate will be calculated and compared with the control growth to obtain a percentage decrease in growth. The IC50 and IC10 will be determined using a probit analysis with the appropriate statistical program.

4.4.4 Macroalgae

10. A 48 hour sub-chronic toxicity test using the germination of the marine macroalga *Ecklonia radiata* will be undertaken based on the method described by Burridge *et al.* (1999).
11. Zoospores will be collected from adult specimens. The *E. radiata* specimens will be collected from sites that are unlikely to be affected by contamination.
12. Various concentrations of the water sample will be tested with three replicates each. The concentrations will be based on the results of the Microtox *Vibrio fischeri* test[5].
13. After 48 hours, the numbers of germinated gametes will be measured by counting a total of 40 of germinated and non-germinated gametes using a microscope. The EC50 and EC10 will be determined by using a probit analysis with the appropriate statistical program.

4.4.5 Copepods[6]

14. A modified 21-28 day acute toxicity test using the reproduction of the Swan River copepod *Gladioferens imparipes* will be undertaken based on the method described by the US EPA (2003a) Daphnid, Survival and Reproduction Test Method 1002.0.
15. Six concentrations will be tested based upon the results obtained from the Microtox *Vibrio fischeri* toxicity testing. Exposure to these concentrations will be for 24 hours. After this time, the Copepods will be placed in diluent water.
16. At day 15, after maturation, male and female copepods will be placed in the same well. Water changes and feeding will continue as previously.
17. Every second day the number of neonates produced by the female will be counted and recorded. These results will be used to calculate the EC50.
18. The concentration of sample resulting in a 50% decrease in the numbers of neonates produced compared with the control copepod (26 day EC50) will be determined using a probit analysis with the appropriate statistical program.

4.4.6 Mussels[7]

19. The 48 hour sub-chronic toxicity test using the larval development of the marine mollusc *Mytilis edulis* will be based on ASTM E724-98 (1998).
20. Collected male and female specimens will be induced to spawn using temperature shocks, and sperm and eggs will collected then added together to fertilise the eggs. Specimens will be collected from sites that that are unlikely to be affected by contamination.

21. The discharge will be tested at various concentrations (obtained from Microtox *Vibrio fischeri* testing) with three replicates each.

22. After 48 hours, the numbers of abnormal larvae will be measured by counting the number of normal and abnormal larvae using a microscope. The EC50 and EC10 will be determined by using a probit analysis with an appropriate statistical program.

4.4.7 Larval Fish[8]

23. The seven day sub-chronic toxicity test using growth of the larval pink snapper *Pagrus auratus* will be undertaken based on methods described by the USEPA (2003b) Test Method 1004.0 Sheepshead Minnow Larval Survival and Growth Test.

24. Various concentrations of collected water will be tested (based on the results obtained from the Microtox *Vibrio fischeri* toxicity tests) with three replicates.

25. Newly hatched larvae will be randomly allocated to each treatment.

26. Larvae will be monitored once per day at each water change and any mortality will be observed and recorded. The concentration of sample resulting in a 10% and 50% decrease in growth will be compared with the control fish to determine IC50 and IC10 values. The IC50 and IC10 will be determined by using a probit analysis with the appropriate statistical program.

4.5 Methodology

Grab samples downstream of all waste streams that enter the discharge pipe will be collected at the outlet during stable operation. Diluent will be collected from a site approximately 2km to the south of the diffuser(s) in the same water depth as the diffuser(s) (10-12m depth)[9]. The exact location will be recorded in accurate geographic coordinates. In the laboratory, test samples will be analysed for pH, salinity and temperature immediately prior to testing. The sample will be filtered (e.g. 0.45 microns) to remove all macroinvertebrates, microalgae and the majority of the bacteria that may confound toxicity test results.

Ecotoxicity testing will occur as soon as practicable after water sampling, and filtered seawater samples will be maintained at the appropriate temperature for each test throughout the testing period. Each toxicity test will use up to fifty dilutions of the seawater concentrate to represent the design dilution (within the LEPA) of the desalination effluent at high discharge rates.

Data (as shown in Table 4.1) will be placed in the BurrliOZ (Campbell et al., 2000) software to calculate a value designed to protect 95% (the target protection value for the HEPA) of the species from effects due to toxicants discharged from the proposed desalination plant with 50% confidence levels.

Table 4.1 Details of WET tests including the testing duration and applicable performance indicator

Test	Duration	Effect Concentration
Microalgae	72 hour	IC10
Macroalgae	48 hour	EC10
Copepod[6]	28 day test with 24 hour exposure	EC10=EC50/5
Mussel	48 hour	EC10
Larval Fish	7 day	IC10

The BurrliOZ software is designed to estimate the protecting concentrations of chemicals (and associated dilutions) such that a given percentage of species will not be affected. The estimations of the protecting concentrations will be computed by fitting the Burr III distribution to the toxicity data generated by the WET testing.

4.6 Additional Information

[1]Monitoring frequency

This monitoring frequency is considered sufficient because WET testing of the existing reverse osmosis Perth Seawater Desalination Plant (PSDP) (Geotechnical Services, 2008), shows that specifications in the Cockburn Sound Environmental Protection Policy (Government of Western Australia, 2005) and the supporting Manual of Standard Operating Procedures for monitoring against the Cockburn Sound Environmental Quality Criteria (2003-2004) (EPA, 2005) are met with a considerable margin of safety (the Southern Seawater Desalination Project plant will be similar in design to the PSDP). Further, Water Consultants International (2006), as part of a worldwide review of reverse osmosis desalination plants stated "detailed and quantified studies of the impact of desalination discharges on marine life surrounding Caribbean coral islands provides strong evidence of little or no impact, even when using unsophisticated discharge design".

[2]Trigger Criteria

A High Protection Zone (HEPA) is adjacent to the Low Ecological Protection Area (LEPA) surrounding the diffuser(s) discharging the desalination effluent. The Manual of Standard Operating Procedures – For Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (2003-2004) (EPA, 2005) states that for a High Protection Zone (HEPA):

If five species have been assessed and the statistical distribution method used, the dilution of the effluent (as % effluent) … should be protective of at least 95% of species

This means that the dilution at the LEPA/HEPA boundary should be higher than that which results in a measurable effect on 5% of species. In terms of concentrations, the concentration of brine at the LEPA/HEPA boundary should be lower than that which results in a measurable effect on 5% of species.

[3]Microtox Test

The marine bacteria *Vibrio fischeri* is a ubiquitous bacteria found in marine ecosystems throughout the world. *V. fischeri* displays a high sensitivity to a broad range of chemicals and is used throughout the world for determining toxicity of water, soil and sediment samples.

[4]Microtox Test

Unicellular algae form the base of the food chain in the marine system. These algae are primary producers in the marine system and provide food for larval, juvenile and adult crustaceans and molluscs. The microalgal species *Isochrysis galbana* was selected as the microalgal species to assess the toxicity of the discharge. This species was selected because it is widely distributed in Australian waters and the availability of temperate and tropical strains make it particularly suitable for site specific toxicity testing (Stauber *et al.* 1994). This species has been commonly used in toxicity tests throughout Australia for the past 15 years, and therefore, a large amount of information on this species is available.

[5]Macroalgae

The marine macroalga *Ecklonia radiata* provides both food and habitat for a range of other organisms in near-shore coastal areas. *E. radiata* is common along the temperate Western Australian coast (Wernberg et al. 2004). Therefore, *E. radiata* was selected as a suitable test organism for assessing the environmental impacts of the discharge. Toxicity tests using *E. radiata* have been performed on marine discharges throughout temperate Australia (e.g., Bidwell et al 1998, Burridge et al. 1999).

[6]Copepods

Copepods are a major part of the marine food chain as they represent a first order consumer, and they, in turn, provide food for larval fish and crustaceans. The Swan River copepod *Gladioferens imparipes* was selected to represent the copepod species in Cockburn Sound for the Perth Seawater Desalination Plant. Further, toxicity testing has been performed on this species for the last 10 years (Evans et al 2000).

Despite the theoretical suitability of the copepod *Gladioferens imparipes* for WET testing, data from WET testing of copepod reproduction using *Gladioferens imparipes* for the Perth Seawater Desalination Plant desalination effluent discharge shows that it is not possible to obtain consistent EC10 results (Geotechnical Services, 2008). However, reliable EC50 values can be obtained. For this reason, Warne (2008) recommended replacing the EC10 with the EC50 divided by 5.

Warne (2008) points out that the standard copepod test is an acute test while the other tests are sub-chronic and that acute and chronic toxicity test results should not be combined when using species sensitivity distribution methods. For this reason the standard copepod test has been modified, as was done for the Perth Seawater Desalination Plant (PSDP) tests (Geotechnical Services 2008), by reducing the time that the copepods are exposed to the desalination effluent to 24 hours. This is also closer to the duration that free drifting organisms such as copepods would be exposed to the desalination effluent (CWR, 2007c). Because of the energetic environment offshore of Binningup and subsequent high levels of dilution (KBR, 2008b), this exposure time is likely to be shorter than for the PSDP.

Consideration was given to substituting the copepod WET tests with the prawn *Penaeus monodon*. However, this prawn test is an acute test and would lead to acute and chronic toxicity test results being combined – contrary to the recommendations of Warne (2008). For this reason, the modified copepod test will be used.

[7]Mussels

The blue mussel, *Mytilis edulis*, is a first order consumer, filtering bacteria, microalgae and other small particles from the water column. *M. edulis* is found in temperate waters throughout the world, and in Western Australia it is found south of Geraldton. *M. edulis* has been used in toxicity tests throughout the world since 1980.

[8]Larval Fish

The pink snapper, *Pagrus auratus*, is a temperate marine fish commonly found associated with reefs. *P. auratus* is commonly found along the Western Australian coast where juveniles find appropriate habitat and food within seagrass beds.

[9]Site for Diluent

Modelling (KBR, 2008b) shows that the desalination effluent will be fully mixed within 2km of the discharge point and will therefore have little effect at this distance. Further, currents flow to the north the majority of the time, thus reducing the likelihood that the sample site to the south will be affected by the desalination effluent discharge. Finally, sites to the north can be affected by discharge from the Harvey Diversion Drain, so a southern site is preferred.

4.7 Contingency Actions

If the design dilution, which is a conservative estimate of the actual dilution (CWR, 2007b), is not protective of 95% of species i.e. the design dilution is less than the target dilution) then an additional set of tests will be undertaken. If these additional tests show that the design dilution is not protective of 95% of species, contingency actions could include:

1. Measuring the actual dilution at the LEPA/HEPA boundary using the methodology of CWR (2007b) and then comparing that dilution to the target dilution (actual dilution is likely to be higher than the design dilution).

2. Seeking the establishment of a Moderate Ecological Protection Area between the LEPA and the HEPA.

3. Identifying the chemicals contributing to the toxic effects and reducing the usage of those chemicals or substituting them.

4. Review operational procedures. For example, seawater injection could be increased at low flow rates to increase dilution.

5. Review the diffuser(s) design and modify the diffuser(s).

DEC will be advised if contingency actions are being investigated and the outcomes of those investigations.

4.8 Relevant Legislation

1. *Environmental Protection Act 1986* (WA).

5.0 Diffuser Performance Monitoring

5.1 Context

Water quality profile monitoring of the desalination discharge will be conducted to provide quantification of desalination effluent dilution at the boundary of the low ecological protection area (LEPA). The program's monitoring activities consist of profile sampling of salinity, temperature and dissolved oxygen at selected monitoring points. Salinity profiles will be used to calculate the increase in salinity and the dilution of the desalination effluent discharge. The dilution will be applied to the toxicant concentration data obtained from implementing the Discharge Water Quality Monitoring Plan to estimate toxicant concentration at the LEPA boundary. The estimated toxicant concentration will be compared with the ANZECC/ARMCANZ (2000) guidelines at the boundary of the LEPA and the high ecological protection area (HEPA).

Three types of monitoring locations have been chosen for the water quality profile monitoring:

1. *LEPA boundary*, 50m from the diffuser(s)
2. *Near LEPA*, 500m from the diffuser(s), directly north or south of the monitoring sites on the LEPA boundary.
3. *Reference*, 1250m from the diffuser(s)[1], directly north or south of the monitoring sites on LEPA boundary.

5.2 Purpose

The purpose of the water quality profile monitoring is to determine that the salinity increase at the boundary of the LEPA meets salinity criteria.

5.3 Performance Indicators

1. Salinity increase based on comparing the salinity at the LEPA boundary with the background salinity. The salinity increase is not to exceed 1 ppt more than 95% of the time and is not to exceed 1.3 ppt.

5.4 Management Actions

5.4.1 Water Quality Sampling Design

1. Two replicate vertical profiles measuring salinity, temperature and dissolved oxygen will be conducted at the following monitoring stations:
   a. 50m north of the mid-point of the diffuser(s)
   b. 50m south of the mid-point of the diffuser(s)
   c. 500m north of the mid-point of the diffuser(s)
   d. 500m south of the mid-point of the diffuser(s)
   e. 1250m north of the mid-point of the diffuser(s)
   f. 1250m south of the mid-point of the diffuser(s)
2. The data will be collected as prescribed in the 'Methodology' section below.
3. Testing will be conducted every two months to capture seasonal and operational variation with the first post-commissioning monitoring conducted after establishment of brine discharge. Monitoring will be conducted over a 12 month period with the first and final tests no closer together than 10 months.
4. The accuracy of the instruments will be sufficient to meet the Limit of Reporting (LOR) as per Table 5.1.
5. All instruments will be maintained and calibrated according to the manufacturers' specifications.

Table 5.1 Required Limit of Reporting

Parameter	LOR
Dissolved oxygen (DO)	± 0.1 $mg.L^{-1}$
Salinity	± 0.05 ppt
Temperature	± 0.1°C

5.4.2 Diffuser Inspection

6. The diffuser(s) and outlet pipeline will be visually inspected on a regular basis. Inspection methods may include divers, towed cameras/video or remotely operated vehicles. The frequency of inspection will be in accordance with the Ministerial Conditions/Commitments.

5.4.3 Reporting

7. A report will be submitted to the DEC within three months of the final sampling. The report will include calculations of the salinity increase and desalination effluent dilution at the boundary of the LEPA and at the stations 500m from the diffuser(s).

8. CTD (salinity is a function of Conductivity, Temperature and Depth) profile data will also be included in the report. The salinity increase will be compared to salinity requirements in the Ministerial Conditions.

5.5 Methodology

Salinity data collected at the sampling sites at the edge of the LEPA will be used to determine seawater salinity (temperature corrected) measured at no closer than 0.5m increments (with at least 30 seconds of data at each sampling depth) in the bottom 5m of the water column[2]. Pycnocline affect attributable to the diffuser(s) discharge will be identified and only those depths below the pycnocline averaged to assess diffuser(s) performance. However, if a pycnocline cannot be clearly identified, it shall be defined in accordance with the method of Roberts and Toms (1987) (also see Roberts *et al.* 1997).

At each station wind speed, wind direction, current speed and current direction will be estimated or measured manually for the period of 24 hrs before the time of measuring the seawater salinity. The background seawater salinity will be as measured by the on-line seawater intake meter in the desalination plant, averaged over the time of the diffuser monitoring sampling. This will then be used to calculate the background salinity of the seawater. Should the on-line instrument not be functioning at the time of sampling, an alternative calibrated instrument may be used. Failing this, the depth average salinity from the reference sites may be used to determine the background salinity ($S_{S)}$ of the seawater.

The seawater discharge will be as measured by the on-line wastewater outlet meter (from which salinity will be calculated) or a substitute instrument, averaged over the time of the diffuser monitoring sampling.

The increase in salinity (ΔS) at the monitoring sites on the LEPA boundary will be calculated as:

$$\Delta S = S_M - S_S$$

while the dilution or dilution factor at the monitoring sites on the LEPA boundary will be calculated using the following formula:

$$\text{Dilution Factor} = D = (S_B - S_S) / \Delta S$$

where:

S_B = salinity of the desalination effluent discharge
S_M = salinity at the monitoring station
S_S = background salinity of the seawater (at the inlet).

5.6 Additional Information

[1]Monitoring Sites

The reference sites coincide with sites used in the project's baseline water quality monitoring.

[2]Alternate salinity measurement method

If it is impractical to obtain measurements at 0.5 m increments in the vertical (for example, due to large waves moving the deploying vessel and instruments large distances vertically), then 5 vertical profiles obtained from a constantly descending instrument may be averaged to provide a representative profile.

5.7 Contingency Actions

If the diffuser inspection as per Section 5.4.2 shows the diffuser(s) and/or outlet pipe requires maintenance, then that maintenance will be scheduled and implemented.

Contingency actions will be triggered if the salinity increase at the edge of the LEPA (ΔS) is greater than 1ppt for more than 5% of the time or if ΔS exceeds 1.3ppt. Contingency actions may include the following:

1. The diffuser(s) will be inspected.
2. If the diffuser(s) needs maintenance, then that maintenance will be implemented and the salinity monitoring will be repeated.
3. Review operational procedures. For example, seawater injection could be increased at low flow rates to increase dilution.
4. Implement additional testing as per the Whole Effluent Toxicity Management Plan to determine if the higher levels of salinity are having an unacceptable ecological impact.
5. Review the diffuser design and modify the diffuser(s).

5.8 Related Plans

Discharge Water Quality Monitoring
Benthic Habitat Monitoring

5.9 Relevant Legislation

1. *Environmental Protection Act 1986* (WA).

6.0 Discharge Water Quality Monitoring

6.1 Context

The desalination effluent discharge stream will be monitored continuously for some parameters and at selected intervals for other parameters to provide information on operations, toxicants (metals), process additive chemicals and nutrient loading.

In general, substances that are in the intake seawater will be approximately doubled in concentration before being discharged in the brine stream. Dilutions of 25 to 50 within the Low Ecological Protection Area (LEPA) would result in these substances increasing in concentration by around 4% to 2% respectively compared to background seawater concentrations. Additional dilution beyond the LEPA will reduce this increase in concentration even further. Hence, it is only if a substance is added during the treatment process, as opposed to being present in the seawater intake stream, that there is the potential for any environmental impact.

Unlike thermal desalination plants, reverse osmosis desalination plants do not result in concentrations of metals increasing measurably beyond the approximate doubling discussed above. However, given the potential toxicity of some metals, monitoring of the desalination effluent stream for metals will be carried out as a safeguard.

Some of the additive chemicals used in pre-treatment processes can contain nitrogen. In turn, nitrogen can stimulate the growth of algae. For this reason, nitrogen and some of its compounds will be monitored and an annual nitrogen load estimated.

6.2 Purpose

The purpose of the discharge water quality monitoring is to quantify:

1. Flow volumes, flow rates and salinity of the discharge
2. Nutrient (nitrogen and phosphorus) load being discharged
3. The concentration of toxicants (metals) in the discharge
4. The concentration of process additive chemicals in the discharge.

6.3 Performance Indicators

1. Measurements are undertaken and reported
2. Detection of any toxicants (metals) added during the treatment process.

6.4 Management Actions

6.4.1 Operational Monitoring

1. Operational monitoring of the desalination plant will provide data for direct or indirect determinations of:
   a. Daily total volume and daily average flow rate of the desalination effluent discharged to marine waters.
   b. Daily total volume and daily average flow of the brine component of the desalination effluent discharged to marine waters.
   c. Daily average salinity of the inlet seawater and the desalination effluent discharged to marine waters.

6.4.2 Sampling Design for Desalination Effluent and Inlet Stream Sampling

1. Testing will be conducted twice a year with the first post-commissioning monitoring conducted within three months of establishment of brine discharge. Monitoring will continue for two years (four testing periods) after commissioning.
2. Three replicate grab samples will be taken of the seawater desalination effluent stream (i.e. downstream of where waste streams enter the discharge pipe) and of the inlet stream.
3. Samples will be analysed at a NATA accredited laboratory; to the detection limits where practicable, shown in Table 6.1, Table 6.2 and Table 6.3.
4. Sampling techniques will be consistent with those recommended in ANZECC/ARMCANZ (2000) and EPA (2005) including safe handing and sampling procedures[1].
5. All instruments will be calibrated and maintained according to manufacturers' specifications.

6.4.3 Data Analysis for Desalination Effluent and Inlet Stream Sampling

6. The net additional annual nitrogen load to marine waters due to the operation of the desalination plant will be calculated for the forms of nitrogen listed in Table 6.1.
7. The increase in concentration for each toxicant in Table 6.2 will be calculated as a concentration ratio (the ratio of desalination effluent concentration divided by inlet concentration).

6.4.4 Reporting

8. Results of the sampling will be reported annually and will include:
   a. Data as required by section 6.4.1 of this management plan
   b. Data as required by section 6.4.3 of this management plan for the duration of the desalination effluent and inlet stream sampling
   c. Any concentration ratio above 2 will be noted and discussed.

6.5 Additional Information

[1] Sampling Information

Water samples will be collected in accordance with Standard procedures consistent with AS. 5667. Analyte concentration will be measured to at least half the trigger level concentrations. The general approach to the sampling method will be pursuant to ANZECC/ARMCANZ (2000b). All samples will be appropriately labelled and tracked, and chain-of-custody documentation will be appropriately stored and maintained.

Sampling Compounds

The following list specifies the compounds (toxicants and nutrients) that will be measured during water quality sampling from the seawater concentrate discharge. The specific analysis for process chemicals will be determined prior to sampling of the desalination effluent stream.

Table 6.1 Water Quality Monitoring Parameters – General Water Quality and Nutrients

Analyte	Unit	LOR
Alkalinity (mg $CaCO_3$/L)	mg $CaCO_3.L^{-1}$	1
Total dissolved solids, TDS (mg/L)	$mg.L^{-1}$	5
Ammonium	µg $N.L^{-1}$	3
Nitrite and Nitrate	µg $N.L^{-1}$	2
Total Nitrogen	µg $N.L^{-1}$	50
Ortho-phosphorus	µg $P.L^{-1}$	2
Total Phosphorus	µg $P.L^{-1}$	5

Table 6.2 Water Quality Monitoring Parameters - Toxicants

Analyte	Unit	LOR
Filterable, Al	$mg.L^{-1}$	0.01
Total Al	$mg.L^{-1}$	0.01
Arsenic, As	$mg.L^{-1}$	0.002
Boron, B	$mg.L^{-1}$	0.003
Cadmium, Cd	$mg.L^{-1}$	0.002
Chromium, Cr[1]	$mg.L^{-1}$	0.001
Copper, Cu	$mg.L^{-1}$	0.001
Lead, Pb	$mg.L^{-1}$	0.002
Filterable Manganese, Mn	$mg.L^{-1}$	0.0002
Total Manganese, Mn	$mg.L^{-1}$	0.0002
Mercury, Hg	$mg.L^{-1}$	0.0005
Molybdenum, Mo	$mg.L^{-1}$	0.0005
Nickel, Ni	$mg.L^{-1}$	0.004
Selenium, Se	$mg.L^{-1}$	0.002
Silver, Ag	$mg.L^{-1}$	0.001
Vanadium, V	$mg.L^{-1}$	0.001
Zinc, Zn	$mg.L^{-1}$	0.002

Table 6.3 Water Quality Monitoring Parameters – Process Additive Chemicals

Analyte	Unit	LOR
Coagulating agent	$mg.L^{-1}$	TBD
Antiscalant	$mg.L^{-1}$	TBD
Filterable Iron, Fe	$mg.L^{-1}$	0.003
Total Fe	$mg.L^{-1}$	0.003

TBD = To BeDetermined

6.6 Contingency Actions

Contingency actions may include the following:

1. If the annual nitrogen load exceeds an allowed load then:
    a. The use of alternative process chemicals with a lower nitrogen content will be explored
    b. Chlorophyll-a data will be collected in the surrounding marine waters to determine the extent of any algal stimulation associated with nitrogen in the desalination effluent

c. Based on the algal stimulation in marine an increase in the allowed nitrogen load could be sought.

2. If a concentration ratio exceeds 2 for a toxicant then:

   a. Whole effluent toxicity testing may be conducted on the desalination effluent as per the Whole Effluent Toxicity Testing Management Plan.

   b. Additional samples may be analysed to determine the bio-available fraction.

   c. The estimated concentration (C) of the toxicant at the boundary of the Low Ecological Protection Area will be compared with ANZECC/AARMCANZ (2000) guideline trigger values for Low, Medium and High Ecological Protection Areas. The concentration (C) will be determined using:

$$C = (C_B + DC_S) / (1 + D)$$

where:

C_B = concentration of the toxicant in the desalination effluent discharge

C_S = concentration of the toxicant in the seawater (at the inlet)

D = the dilution in the LEPA (this can be obtained from implementing the Diffuser Performance Monitoring Plan or from theoretical or empirical relationships – also see Centre for Water Research, 2007).

6.7 Related Plans

Diffuser Performance Monitoring

6.8 Relevant Legislation

1. *Environmental Protection Act 1986*
2. *Occupational Safety and Health Act 1984*

7.0 Benthic Habitat Monitoring

7.1 Context

The marine benthic habitats in the vicinity of the Southern Seawater Desalination Plant were characterised using towed underwater video taken in December 2007 (UWA, 2008d). Habitats comprised (i) no biota (i.e. free of obvious fauna in video footage), (ii) vegetation and sessile invertebrates, (iii) sessile invertebrates and (iv) vegetation.

The area mapped was described by UWA (2008) as highly energetic (by natural wave energy), with large areas of reef pavement devoid of biota and where biota occurred they occupied a small proportion of the total reef surface. Megaripples and sediment sheets were observed midshore suggesting that sediment was highly mobile. The mosaic of seaweeds and benthic invertebrates was most developed on reefs 300-500m offshore with areas further inshore exhibiting an extensive pavement bare of invertebrates and seaweed due to the pavement being frequently covered and scoured by shifting sands.

Marine macroflora (including seaweeds and seagrasses) species occur at a distance from approximately 500m offshore to greater than 2500m offshore from the Seawater Desalination Plant site. More specifically, seagrass beds are more than 1200m from the shore along the pipe alignment. The seawater intake and outlet pipelines will be located along an alignment that generally contains bare sand and shell material. From 500m or so offshore the outlet pipelines and diffuser(s) are within a few hundreds of metres of marine flora and/or fauna.

Construction works may impact on the marine flora in close proximity to those works (Oceanica, 2008). The application of this Plan in relation to construction impacts is specified in the Seawater Pipeline Management Plan which is within the Construction Environmental Management Framework.

A worldwide review did not find any significant impacts on surrounding flora and fauna associated with the discharge of highly diluted brine from reverse osmosis desalination plants (Water Consultants International, 2006).

7.2 Purpose

The purpose of the Benthic Habitat Monitoring is to assess whether the construction and operation of the Southern Seawater Desalination Project may affect offshore benthic flora and fauna.

7.3 Performance Indicators

Performance will be demonstrated by:

1. Mean depth range that seagrass and sessile macroinvertebrates are found[1].

7.4 Management Actions

7.4.1 Prior to and Soon After Construction

1. The timing requirements are specified in the Seawater Pipeline Management Plan which is within the Construction Environmental Management Framework.

7.4.2 During Operation

2. Benthic habitat monitoring will be conducted between 18 and 30 months of brine discharge based on the methodology[2]. A report will be provided to the DEC within 6 months of the completion of the monitoring.

7.4.3 Method and Data Analysis

3. GIS referenced video footage from monitoring transects will be analysed using the same methodology as UWA (2008).
4. The transects will be the same as those used by UWA (2008) (see Figure 7.1) or a modification to provide greater detail in the vicinity of the outlet pipeline and diffuser(s).
5. All appropriate safety precautions for working in the field including collection and handling of samples, boat handling and diving (where applicable) will be followed by all sampling personnel.
6. Seagrass cover will be compared with previous surveys.
7. Sessile macroinvertebrate cover will be compared with previous surveys.

7.5 Additional Information

[1] Performance Indicators

EPA (2005) outlines two different approaches for monitoring seagrass. The first relates to seagrass shoot density while the second relates to the depth range that seagrass are found over.

The offshore environment in the vicinity of the desalination discharge and construction area is extremely dynamic (for this reason, the only seagrass species present - *Posidonia angustifolia* and *Posidonia coriacea* - are pioneer species). As such, there may be considerable changes in seagrass shoot density and presence/absence at any specific location from one year to the next. Broader mapping of seagrass which shows the depth range that seagrasses are found is considered to be more reliable. The same logic is applied to sessile macroinvertebrates.

[2] Timing of Surveys

The waters offshore of the desalination plant are turbid near the seabed for much of the year. This, means that the survey can only be conducted within a few months of the year is the highest possible quality video footage can be obtained.

[2] Habitat Transects and Categories

The baseline survey conducted by UWA (2008) consisted of a grided towed video design of the target area. This grid consisted of towed video transects every 500 m, equating to 10 transects running north-south and east-west as shown in Figure 7.1.

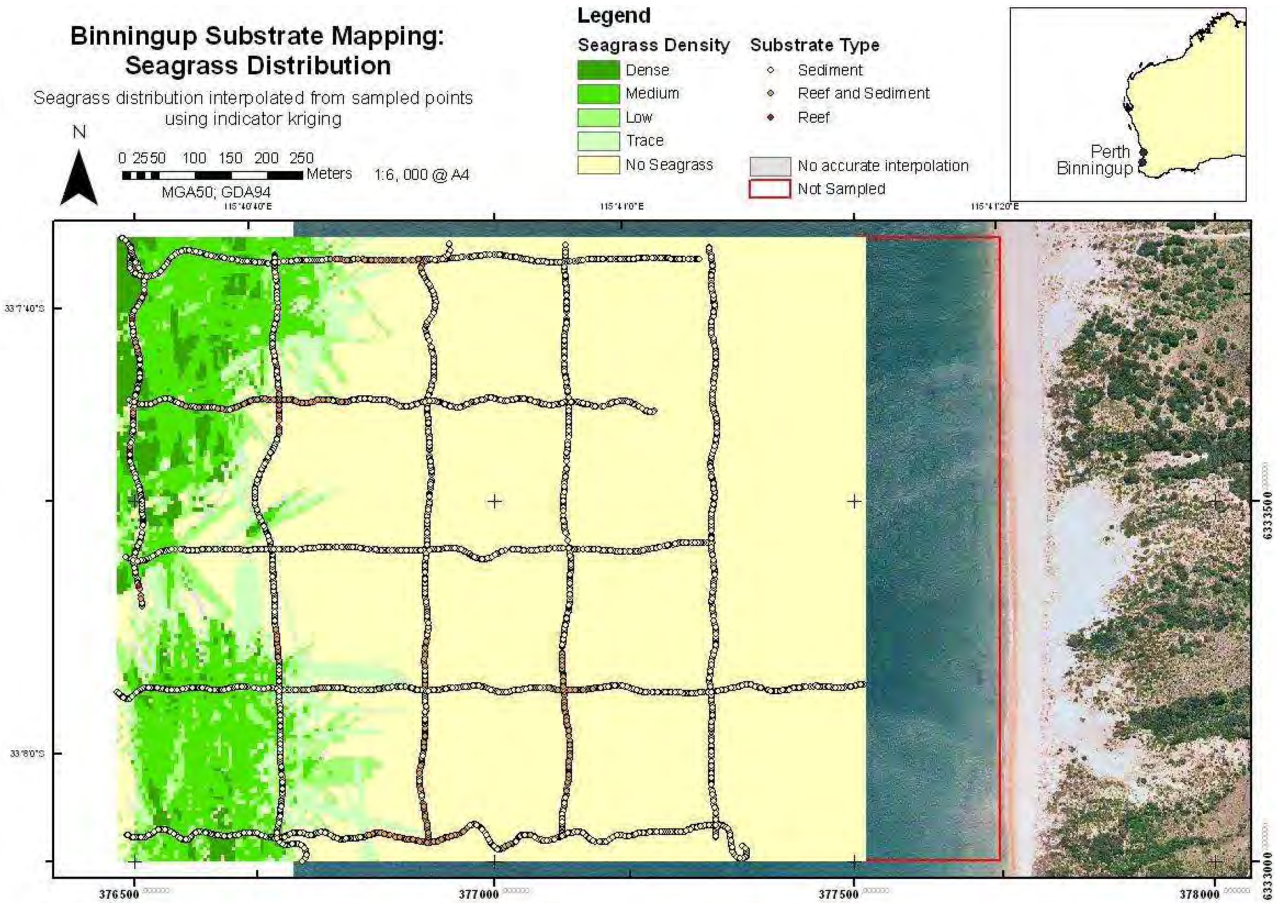

Figure 7.1 Location of transects used by UWA (2008d) and location of seagrass

Resulting underwater towed video imagery was observed and the following categories shown in Table 7.1 used to describe the habitat.

Table 7.1 Categories describing benthic communities for video interpretation.

Substrate	Macroalgae	Seagrass	Sessile invertebrates
Hard (reef/rock)	Undifferentiated	Undifferentiated	Undifferentiated
Can't discern	Mixed brown algae	*Amphibolis*	Sponges
Fractured/Fissured/Broken	Mixed red algae	*Zostera/ Heterozostera*	Ascidians
Unbroken	Mixed green algae	*Halophila*	Bryozoa
Cobbles	*Ecklonia*	*Posidonia*	Hydroids
Boulders/small outcrops	*Sargassum*	*Thalassodendron*	Soft corals, gorgonians
Soft (sediment)	*Caulerpa*		Hydroids
Can't discern	*Scytothalia*		Hard corals
Coarse gravel	Epiphytes		Sea whips
Fine gravel	*Codium*		*Tethya*
Sand			Black coral
Fine sand (silt/clay)			*Pyura*

7.6 Contingency Actions

Contingency actions will be largely dependent on the circumstances that result in changes and loss of seagrass and sessile macroinvertebrate cover. For example, loss of seagrass and/or sessile macroinvertebrates in the vicinity of the discharge area may be the result of winter storms and other inclement weather. Contingency actions in response to significant loss or change in seagrass and sessile macroinvertebrate cover may include:

1. investigation of the cause of seagrass or sessile macroinvertebrate changes

2. investigation of and/or collection of additional water quality monitoring data in order to determine if there are any correlations between the water quality data and the changes

3. re-examination of whole effluent toxicity analysis data and/or conducting additional whole effluent toxicity testing as per the Whole Effluent Toxicity Testing Management Plan to determine if toxicity effects may be responsible. If toxicity effects are present, the contingency actions in the Whole Effluent Toxicity Testing Management Plan may be implemented

4. implementing additional macrobenthic monitoring.

7.7 Related Plans

Whole Effluent Toxicity Testing Management
Discharge Water Quality Monitoring

7.8 Relevant Legislation

1. *Environmental Protection Act 1986*
2. *Wildlife Conservation Act 1950*
3. *Wildlife Conservation Regulations 1970*
4. *Occupational Safety and Health Act 1984*

8.0 Chemical and Dangerous Goods Management Plan

8.1 Context

A number of chemicals are used during the seawater desalination process and subsequent potibilisation process, including:

- Sulphuric acid
- Ferric sulphate
- Coagulating agent
- Antiscalant
- Calcium carbonate
- Carbon dioxide
- Chlorine
- Fluorosilicic acid
- Sodium hypochlorite
- Sodium bisulphite

These chemicals will be managed by Department of Consumer and Employment Protection (WA) (DoCEP) under the *Dangerous Goods Safety Act (2004).*

8.2 Purpose

The purpose of the chemical management plan is to ensure safe management of transport, storage and use of chemicals at the plant site to prevent any safety or environmental incidents.

8.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed key management actions.

8.4 Management Actions

8.4.1 Prior to Operation

1. All chemicals will be stored in areas designed to applicable Australian Standards and regulatory requirements.

8.4.2 Chemical Storage

2. All licenses required by the Chief Inspector of the DoCEP under the *Dangerous Goods Safety Act (2004)* will be obtained prior to any storage or use of any dangerous goods.
3. Liquid dangerous goods will be stored in a bunded area capable of containing 110% of the volume. For packaged liquid dangerous goods (goods in a number of smaller containers), the goods shall be stored in a covered bunded area capable of containing 110% of the volume of the largest container.
4. Where practicable, dangerous goods will be stored in minimum quantities to minimise the environmental impact if spillage occurs.
5. Incompatible dangerous goods will be segregated.

8.4.3 Record Keeping

6. Material Safety Data Sheets (MSDS) will be maintained for each dangerous good stored on site. The MSDS will be located outside of the compound in which the material is stored. The compound will be placarded in accordance with the DoCEP's *Guidance Note for Placarding*.
7. Deliveries of dangerous goods will only be accepted if they are accompanied by the relevant MSDS, or, if there is an existing and current MSDS for that dangerous good already held on the site.
8. A Dangerous Goods Log(s) will be maintained for all dangerous goods held on the site. The Log(s) will be stored in a secure location at the site entrance or in the main office. The Log(s) will identify the:

a. date on which the goods were received.
b. location(s) at which the goods are stored.
c. volume/quantity stored at each location.
d. date and volume/quantity removed whenever goods are removed from storage.
e. name of the person(s) receiving/removing goods to/from storage on each occasion.

A site plan that identifies the storage location of each dangerous good will accompany the Log.

8.4.4 Safety

9. Measures will be put in place to prevent unauthorised access to dangerous goods.
10. As standard practice, ignition sources (e.g. welding equipment, cigarettes, lighters) will be prohibited within any compound storing dangerous goods.

8.4.5 Training

11. All relevant operations staff will be trained on identification, storage and handling procedures for dangerous goods. Staff will also be trained on response procedures (including use of Spill Response Kits) for accidents and incidents and emergencies involving dangerous goods.

8.4.6 Accidents, Incidents and Emergencies

12. A Spill Response Kit will be installed and maintained for the clean-up and containment of spills to land or water. Each spill kit will contain as a minimum:
    a. universal absorbent pads or pillows or blankets.
    b. labelled plastic contaminated waste bags.
    c. safety gloves.

    Contaminated material from a spill will be disposed of in accordance with the Waste Management Plan.
13. The Chief Inspector of DoCEP will be notified of any accident involving dangerous goods.
14. FESA will be notified of any incident involving dangerous goods that has had, or has the potential to, have a significant impact on the environment or human safety.
15. DEC will be notified of any incident involving dangerous goods that has had, or has the potential to, have a significant impact on the environment.

8.5 Contingency Actions

No contingency actions are proposed.

8.6 Related Plans

Waste Management Plan

8.7 Relevant Legislation

1. *Environmental Protection Act 1986*
2. *Dangerous Goods Safety Act (2004)*
3. *Dangerous Goods (Transport) Act 1998*
4. *Occupational Safety and Health Act 1984*

9.0 Waste Management Plan

9.1 Context

Operational works will produce a range of liquid and solid wastes. These wastes include:

- site office paper, packaging and domestic wastes
- thickened sludge from media filter backwash
- desalination effluent discharge.

Inappropriate waste disposal has the potential to contaminate soil, surface water or groundwater and affect visual amenity.

Management of the desalination effluent is addressed in the Whole Effluent Toxicity Testing Management (section 4.0), Diffuser Performance Monitoring (section 5.0), Discharge Water Quality Monitoring(section 6.0) and Benthic Habitat Monitoring (section 7.0) plans.

9.2 Purpose

The purpose of the Waste Management Plan is to outline management actions to:

1. reuse waste materials where possible;
2. recycle wastes where practicable; and
3. dispose of waste streams in an acceptable manner.

9.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

9.4 Management Actions

9.4.1 General Office Waste

1. Separately marked waste bins will be provided for:

CATEGORY	DISPOSAL
General wastes.	Dispose on-site in a covered bin to prevent attraction of vermin. Bulk disposal offsite to landfill.
Recyclables (generally glass, paper and plastics).	Bulk dispose offsite to the nearest recycling facility. May be disposed of to landfill if a facility does not exist within 50km of the site[1].

9.4.2 Thickened Sludge from Media Filter Backwash

2. If alternative uses cannot be found for the thickened sludge, it will be disposed of to an appropriate Class III landfill pursuant to the Landfill Waste Classification and Waste Definition (DoE, 2005).

3. The composition of the thickened sludge will be tested prior to disposal to ensure that it meets Class III criteria.

9.5 Additional Information

[1] Waste Bins

General wastes and recyclables may be mixed (i.e. one bin used) if they are subsequently separated at a recycling facility.

9.6 Contingency Actions

The following actions will be undertaken if wastes are not appropriately disposed:

1. investigate the cause
2. alter management actions, if required.

9.7 Related Plans

Chemical and Dangerous Goods Management Plan

9.8 Relevant Legislation

1. *Environmental Protection Act 1986*
2. *Dangerous Goods Safety Act (2004) 1961*
3. *Dangerous Goods (Transport) Act 1998*
4. *Occupational Safety and Health Act 1984*
5. *Waste Avoidance and Resource Recovery Act 2007*

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Legislation referred to in the OEMF can be accessed via the State Law Publisher website at *http://www.slp.wa.gov.au.*

Appendix 1 – Water Corporation Environmental Policy

Introduction

The Water Corporation provides essential water, wastewater and drainage services to the people of Western Australia. We take water from the environment and return drainage water and treated wastewater and its by-products back into the environment.

In doing this, we aim to provide sustainable, safe and reliable water services to customers and the community.

This policy applies to the Statewide operations of the Water Corporation, which includes all activities, services and products provided by the Corporation to its customers, in accordance with its operating licence.

All employees, and where practicable, 'second parties' (Water Corporation agents, alliance participants, contractors and suppliers) will comply with and support implementation of this policy.

Commitment

The Corporation is committed to:

- playing a leading role in the sustainable future of Western Australia's water resources;
- compliance with applicable environmental legal requirements and with other environmental requirements to which the Corporation subscribes;
- preventing pollution and minimising the adverse effects of our activities; and
- excellence and continual improvement in environmental performance, including conserving natural resources and ecological systems and enhancing them where practicable.

How

Our commitments will be met by:

- providing appropriate services, resources and infrastructure to meet our stated objectives;
- identifying, assessing and managing our environmental risks;
- developing and implementing environmental improvement programmes with measurable targets;
- regularly reviewing and auditing our environmental systems and performance;
- developing and maintaining appropriate incident response plans and minimising the adverse environmental consequences of any accidents; and
- promoting efficient use of resources and minimisation of waste.

Our Environmental Management System provides the framework for developing, implementing, monitoring and reviewing our environmental objectives, targets and actions.

PCY230 Environmental Policy
31 October 2007
CDMS#: 375822

Peter D Moore
Chief Operating Officer

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Appendix C Construction Environmental Management Framework

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WATER CORPORATION

Southern Seawater Desalination Project

Construction Environmental Management Framework

FINAL January 2009

Project Number:

C-W01781
C-W01783

Document Number:

CDMS 558434
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Document History

Report	Version	Prepared by	Reviewed by
Southern Seawater Desalination Plant - Construction Environmental Management Plan.	Draft for Internal Review November 2007.	S A Hawkins, Snr. Environmental Scientist - Water Corporation.	Wallis J – Project Management Churchill N – Project Management Stansfield J – Project Management Oliver M - Project Management Goullee J – Project Management Smith R – Project Management Brown S – Project Management Faskel F - Project Management Congdon K - Project Management Herbert N – Infrastructure Design Lee S – Infrastructure Design Watson G – Environment Branch (Operations) Cole J - Environment Branch (Approvals) Baker A - Environment Branch (Approvals) Scott M – Sustainability Unit Robertson B – Capital Investment Doubikin R – Asset Management SW Lund L – Indigenous Resources Roffman T – OS&H Branch Basanovic G – Incident Management Madin J – Project Communications Wallis I (CEE) – Consulting Marine Engineer Bailey M (Oceanica) - Consulting Marine Scientist Lane K (ENV) – Consulting Terrestrial Scientist
Southern Seawater Desalination Project - Construction Environmental Management Plan.	Draft for Internal Review February 2008.	S A Hawkins, Snr. Environmental Scientist - Water Corporation.	D Lunetina - Environment Branch A Baker – Environment Branch D Thorpe - Environment Branch
Southern Seawater Desalination Project - Construction Environmental Management Framework.	Draft for Environmental Protection Authority February 2008.	D Luketina, Mgr Environment – Water Corporation. A Baker, Principal Environmental Scientist – Water Corporation. D Thorpe, Environmental Scientist – Water Corporation.	Environmental Protection Authority.
Southern Seawater Desalination Project - Construction Environmental Management Framework.	Public Environmental Review April 2008.		Environmental Impact Assessment - Public Environmental Review.
Southern Seawater Desalination Plant - Construction Environmental Management Framework.	Final January 2009.	G Groth, Snr. Environmental Officer - Water Corporation.	Churchill N – Project Management

Reference

This document should be cited as:

Water Corporation (2008) *Southern Seawater Desalination Project Construction Environmental Management Framework January 2009.*

Contents

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1.0 Overview

1.1 Project Outline

The Water Corporation is a public utility of the State Government of Western Australia responsible for public water supply in accordance with the *Water Corporation Act 1995* (WA) and associated legislation. The Water Corporation's Southern Seawater Desalination Project (SSDP) is critical Government infrastructure for public water supply to the Integrated Water Supply Scheme (IWSS).

The Southern Seawater Desalination Project involves the construction and operation of:

- A reverse osmosis seawater desalination plant to produce Up to 100 GL/y, located at Lots 32 and 33 and Part Lot 8 on Taranto Road in the Shire of Harvey (approximately 140km south of Perth).The plant will include:
    - Up to four submerged seawater intake pipelines extending up to 600m offshore.
    - Seawater pump station.
    - Chemical storage facility for chemicals including ferric sulphate, sulphuric acid and sodium hypochlorite.
    - Dual media filters (including backwash tanks) and drying beds.
    - Reverse osmosis building.
    - Potabilisation and storage facilities for chlorine, fluorosilicic acid, lime, carbon dioxide and minor process chemicals.
    - Drinking water storage tank(s) and pump station(s).
    - Up to four seawater brine outlets with diffusers extending to a distance of up to 1100m offshore.
    - Site amenity buildings for purposes including administration, plant operations control, laboratory, workshop and general storage.
- 100ML water storage facility (in up to 4 storage tanks) with up to 5ML sump located north-east of the town settlement in the Shire of Harvey.
- Approximately 30km of 1400mm diameter cement-lined steel pipeline to connect the plant to the storage facility, and the storage facility to the existing Stirling Trunk Main of the Integrated Water Supply System (IWSS).

Implementation of the Southern Seawater Desalination Project will be staged, with initial construction and operation for 50 GL/y water production capacity and with one water storage tank up to 32 ML capacity. All terrestrial and marine pipelines will be constructed for a 100 GL/y capacity at the initial stage of construction including all earthworks. The capacity of the plant site and water storage facility will be increased as water supply demand increases.

An overview map identifying the project infrastructure location is contained in Figure 1-1. Detailed maps of the infrastructure locations are contained in Appendices 1 to 3.

The Southern Seawater Desalination Project will produce drinking quality water from seawater abstracted via the inlet pipe(s). The desalination process allows for the recovery of approximately 42% of the volume of the seawater as drinking water with the remaining water being discharged as a waste brine solution. This brine will be approximately twice as saline as the feed water (i.e. seawater).

The intake pipelines will extend from the shore up to 600m offshore and the outlet pipelines up to 1100m offshore. The outlet pipe discharge system will include a multi-port diffuser which will facilitate mixing in the Low Ecosystem Protection Area (LEPA) surrounding the outlet diffuser (see Figure 1-2). The multi-port outfall is designed to constrain the salinity increase to 1 ppt or less above ambient conditions at the boundary of the LEPA. The LEPA is surrounded by a High Protection Ecosystem Area (HEPA).

Construction works will occur at several separate locations at the same time in order to meet the water supply demand timeframes. Construction works will generally be undertaken during daylight hours (0600hrs to 1900hrs), however construction works may be required 24-hours per day.

Figure 1-1 Locations of the Southern Seawater Desalination Project Infrastructure.

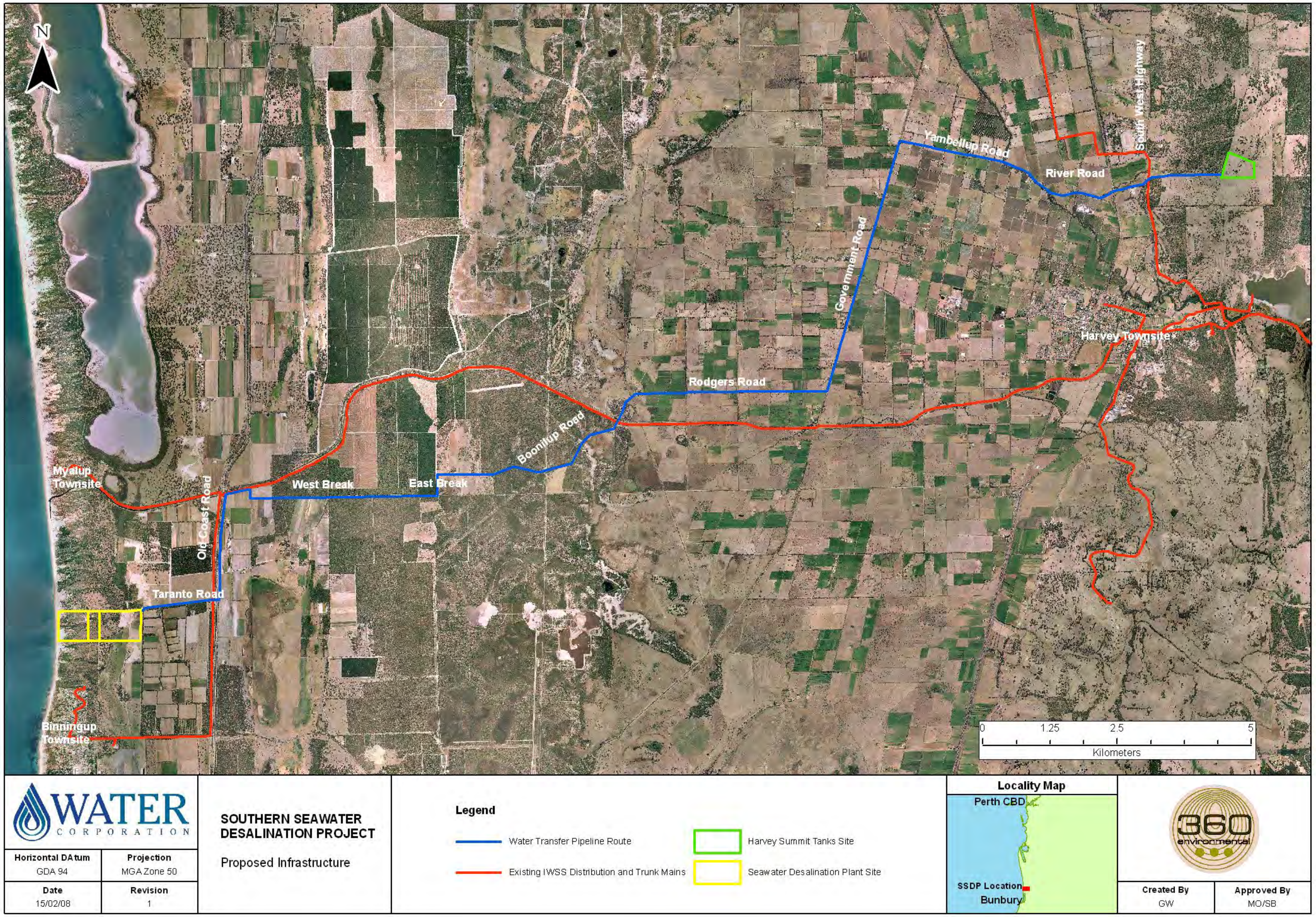
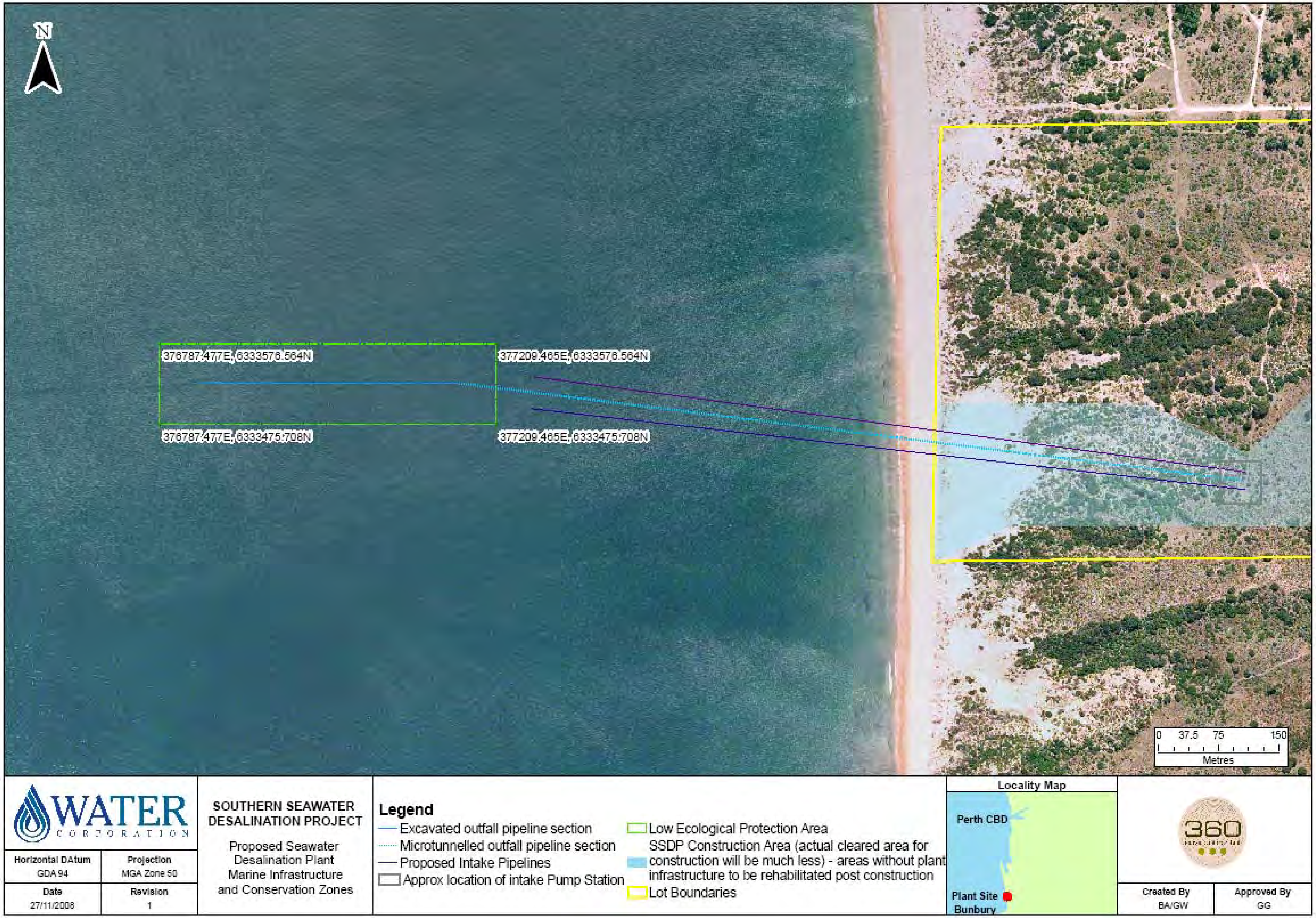


Figure 1-2 Schematic of the Outlet and the LEPA surrounding the diffuser



1.2 Purpose of this CEMF

This Construction Environmental Management Framework (CEMF) outlines the actions to be taken to minimise environmental impacts arising during construction. It is the primary objective that all environmental impacts during construction are avoided or minimised as far as practicable at all construction locations.

It is the purpose of this CEMF to:

1. address the statutory environmental requirements for the project (refer below).
2. identify the actions to be undertaken to manage the environmental impacts of the construction works.
3. address community and government expectations of transparency and accountability by identifying the management actions and making this CEMF publicly available.

1.2.1 Environmental Requirements of the CEMF

Construction of the project is regulated by Statement No. --- issued by the Minister for the Environment under s45(5) of the *Environmental Protection Act 1986* (WA). A copy of the Statement is contained in Appendix 6. The Western Australian Department of Environment and Conservation (DEC) is responsible for monitoring the implementation of conditions pursuant to s48(1) of the *Environmental Protection Act 1986* (WA).

This CEMF meets the requirements of the Water Corporation's Commitment 4 made in the Public Environmental Review, which states (Table 1-1):

Commitment No.	Commitment	Timing
4 Construction Environmental Management Framework – Implementation	The following management plans within the Construction Environmental Management Framework will be implemented: 1. Land Clearing and Trench Management. 2. Seawater Pipeline Installation Management 3. Watercourse Crossing Management 4. Dewatering and Acid Sulphate Soils Management 5. Hygiene (Plant Pathogen) Management 6. Fire Management 7. Waste Management 8. Noise Management 9. Vibration Management 10. Discharge of Pipeline Pressure Testing and Disinfection Waters Management 11. Rehabilitation Management 12. Environmental Incident Management 13. Compliance Management 14. Auditing Management	During construction and post-construction as defined by the plan.

Table 1-1 The Water Corporation's Commitment 2.1 of the Public Environmental Review.

The environmental issues listed above are addressed in a range of management plans in this CEMF. As this CEMF will be actively used during construction works, matters outside of the requirements of Commitment 4, including non-environmental matters and matters dealt with under requirements of other legislation, have also been included for operational completeness.

Furthermore, monitoring of the benthic habitat is not covered within this CEMF, although commencing prior to construction (to establish baseline data) and continuing throughout the operation of the SSDP Plant. Section 7.0 of the Operation Environmental Management Framework (OEMF) addresses this matter in detail.

This CEMF focuses on the management actions to be implemented during construction by construction staff. Consequently, background environmental information on the proposal has been intentionally limited. Background information is located in the Public Environmental Review (PER) document produced for the environmental impact assessment process, available at www.watercorporation.com.au.

It is the intention of the Water Corporation that this CEMF is developed with the assistance of the stakeholders listed for each management plan. Stakeholders will be consulted for specific matters within their spatial or statutory jurisdiction during the environmental impact assessment process to enable the stakeholders to have an opportunity to provide input into the management actions governing the project.

1.3 Specifications

This CEMF and the materials and methodologies therein are correct as of the publication date. The following changes to materials and methodologies will not invalidate this plan:

1. Changes to materials that do not result in additional or different environmental impacts.
2. Minor changes to methodologies that do not result in lessened environmental monitoring and/or additional or different environmental impact.

Changes to the materials or methodology that may result in reduced monitoring and/or cause a significant environmental impact will be referred to the relevant advisory agencies prior to implementation of the change.

This plan needs to be read in conjunction with the applicable Ministerial Conditions and other regulatory instruments.

1.4 Implementation of Contingency Actions

The CEMF outlines a number of contingency actions that may be used in the event that the management actions proposed do not achieve the purpose stated in each management plan

1.5 Environment Policy

This CEMF has been drafted to support The Water Corporation's Environmental Policy as contained in Appendix 4.

1.6 Training on the CEMF

All staff involved in the construction of the PSDP will receive training on relevant management plans within this CEMF. The names of the people trained on this CEMF will be recorded in a CEMF Training Log along with the date and the specific plans for which that training was conducted.

1.7 Infrastructure Construction

This CEMF addresses matters related to construction. A separate Operation Environmental Management Framework (OEMF) contains management plans relating to operation.

1.8 Amendments arising from Public Environmental Review

This document may be amended following submissions through the environmental impact assessment process. This document (as amended) will be made publicly available prior to construction.

1.9 Limitations

There are a number of minor limitations contained in this version of the CEMF. These matters are:

1. The Statement number and a copy of the Statement have not been inserted as the proposal is awaiting an implementation decision from the Minister for the Environment under s45(5) of the *Environmental Protection Act 1986* (WA). The Statement number and a copy of the Statement will be inserted following the implementation decision from the Minister. This matter will not affect review of this document.
2. The location of acid sulphate soils, plant diseases, habitat trees and weed infestations have not been included in the infrastructure maps. This information was not available

at the time of publication of the maps. This information is available in *Southern Seawater Desalination Project 2007 Terrestrial Flora and Fauna Survey* (360 Environmental, January 2008). These matters will be incorporated into the maps for the CEMF prior to construction. These matters will not affect review of this document as the management actions are explicit in how these matters will be mapped prior to construction.

3. The approvals referred to in Appendices 5, 6 and 7 have not been inserted as they have not been issued at the time of publication. These approvals will be obtained and inserted into this CEMF prior to construction. These approvals are:
    a. Statement of Environmental Conditions under the *Environmental Protection Act 1986* (WA).
    b. Permit to Interfere with Bed and Banks of Watercourses under the *Rights in Water and Irrigation Act 1914* (WA).
    c. Consent to Interfere with a Registered Aboriginal Heritage Site under the *Aboriginal Heritage Act 1972* (WA).

2.0 Definitions

The terms used in this CEMF have the following meanings:

Airblast Level means the noise level resulting from blasting with explosives.

Biofouling means the accumulation of marine organisms (flora or fauna) that attach to vessel hulls, ropes, anchors and other equipment.

Blast overpressure means the sharp instantaneous rise in ambient atmospheric pressure resulting from detonation of an explosive.

Bund means an embankment of earth or a wall constructed of brick, stone or concrete to form the perimeter of a compound that will prevent lateral movement of the material contained within the embankment or wall.

Declared Rare Flora means the flora protected under the *Wildlife Conservation Act 1950* (WA) due to it being rare, in danger of extinction, or otherwise in need of special protection.

Elder means a mature person of Aboriginal decent with experience and knowledge on matters related to aboriginal culture, customs, traditions and/or heritage, as determined by the Aboriginal community.

Environmental Harm means the direct or indirect alteration of the environment as defined by the *Environmental Protection Act 1986* (WA).

Environmental Incident means any event or impact on the environment involving the Water Corporation and/or its contractor's actions or assets that is capable of:

- causing harm to the environment or any person or property;
- causing pollution; and/or
- coming to the attention of an environmental regulatory agency.

Excavator means a machine used for excavating soil or sediment material and may include a backhoe excavator, bulldozer, dredge or other similar equipment.

Ground Disturbing Activities means the disturbance of earth or waters involving machinery including clearing, excavation, backfilling and compacting, but excludes geotechnical investigations, surveying, fencing and rehabilitation works.

Fauna means animals.

Flora means plants.

Habitat Tree means a mature native tree containing hollows that may be suitable for habitat of native fauna.

Harvey Summit Tanks means the water storage and balancing facility located approximately 3km north-east of the Harvey Townsite. The Harvey Summit tanks consist of up to 100ML of water storage (in up to 4 tanks) and a maintenance sump of up to 5ML capacity.

Initial Ground Disturbing Activities means the disturbance of earth or waters involving machinery including clearing and excavation to a depth of 0.5m, but excludes geotechnical investigations, surveying, excavation in excess of 0.5m, backfilling, compacting, fencing and rehabilitation works.

Integrated Water Supply Scheme (or IWSS) means the water transfer network supplying drinking quality water to 1.5 million West Australians in the Perth metropolitan area, south-west, central wheatbelt and the goldfields regions.

Landowner means the person(s) or management body that lawfully owns or lawfully manages a specific parcel of land.

pH_F means a field test of a water and soil paste to determine the presence of actual acid sulphate soils.

pH_{FOX} means a field test of a water and soil paste to determine the presence of potential acid sulphate soils (stored acidity).

Photosynthetically active radiation means the spectral range of light useful for plants for photosynthesis.

Seawater Desalination Plant Site means the site of the Seawater Desalination Plant including Lots 32 & 33 Taranto Road Binningup, Part Lot 8 (to the southern boundary of Lots 32 and 33) Taranto Road Binningup, and includes the seawater pipelines located on part of Reserve 29628 (to the southern boundary of Lots 32 and 33) and the Indian Ocean (to the southern and northern boundaries of Lots 32 and 33) to a nominal distance of 1250m from the high water mark.

Pollution means the direct or indirect alteration of the environment to its detriment or degradation, to the detriment of an environmental value, or is of a prescribed kind from an emission (as defined by the *Environmental Protection Act 1986* (WA)).

Priority Flora means flora that is recognised by the DEC as being under threat and in urgent need of further study; but is not yet declared rare flora under the *Wildlife Conservation Act 1950* (WA). Priority Flora is divided into Priority 1, Priority 2, Priority 3 and Priority 4 listings, with Priority 1 being the flora most under threat.

Registered Site means a defined spatial area registered as having significance to Aboriginal persons under the *Aboriginal Heritage Act 1972* (WA). The term excludes sites listed as "Stored Data" on the Department of Indigenous Affairs heritage database, which are not classified as sites under the *Aboriginal Heritage Act 1972* (WA).

Superintendent's Representative means the person nominated by the Superintendent from time to time in writing by and representing the Superintendent.

Sterile Hay Bales are hay bales that do not contain viable seeds and will therefore not introduce weed propagules when used for turbidity management.

Trunkmain and Water Transfer Pipeline means the pipeline that connects the Seawater Desalination Plant to the Harvey Summit Tanks, and the Harvey Summit Tanks to the existing Stirling Trunkmain of the IWSS, for the purpose of transferring drinking water.

Watercourse means a river, creek, gully, brook or irrigation channel that contains or has contained water, but excludes wetlands.

Water level indicator means a round steel post with a flat marked gauge plate of white background and black 1cm increment gauge markings each with a total nominal length of 2.0m (refer Water Corporation Plan B055-18-1 for example).

Wetland means land that is permanently, seasonally or intermittently waterlogged or inundated with water, but excludes watercourses.

Windrow means a line of stockpiled material, such as soil or vegetation.

3.0 Abbreviations

The following abbreviations used in this CEMF have the following meanings:

Terms

ALT	Alliance Lead Team - committee consisting senior management representatives from the project Alliance organisations.
AMT	Alliance Management Team - committee consisting on-site management personnel from Alliance organisations.
AQIS	Australian Quarantine and Inspection Service
CEMF	Construction Environmental Management Framework
DAF	Department of Agriculture and Food (WA)
DEC	Department of Environment and Conservation (WA)
DEWHA	Department of the Environment, Water, Heritage and Arts (C'th)
DIA	Department of Indigenous Affairs (WA)
DoCEP	Department of Consumer and Employment Protection (WA)
DoF	Department of Fisheries (WA)
DoH	Department of Health (WA)
DoW	Department of Water (WA)
DPI	Department for Planning and Infrastructure (WA)
FESA	Fire and Emergency Services Authority (WA)
FPC	Forest Products Commission (WA)
IWSS	Integrated Water Supply Scheme
MRWA	Main Roads Western Australia
MSDS	Materials Safety Data Sheet
NATA	National Association of Testing Authorities
OC	Organochlorine
SWALSC	South West Aboriginal Land and Sea Council (WA)
PAR	Photosynthetically active radiation
WAPC	Western Australian Planning Commission

Measurement

cm	Centimetre
m	Metre
m^2	Square metre
km	Kilometre
ha	Hectare
kg	Kilograms
kg/ha	Kilograms per hectare
mg/kg	Milligrams per kilogram
mg/L	Milligrams per litre
ML	Megalitre
GL/y	Gigalitres per year
ML/y	Megalitres per year
^oC	Temperature in degrees Celsius
dB	Decibels of noise
S%	Sulphur percentage

4.0 Responsibility Matrix

The matrix below provides guidance on the plans that are relevant to contractors involved in the project. Given that contracts have not been let, and the management structure and responsibilities of delivery of this project not finalised, this matrix are indicative of the division of responsibilities:

CEMF Reference	Contractor Seawater Desalination Plant (Alliance)	Contractor Water Transfer Pipeline	Contractor Supply	Water Corporation Supervisory Staff
Overview	✓	✓	✓	✓
Land Clearing and Trench Management	✓	✓		✓
Seawater Pipeline Installation	✓			✓
Watercourse Crossing Management		✓		✓
Dewatering and Acid Sulphate Soils	✓	✓		✓
Hygiene Management	✓	✓	✓	✓
Fire Management	✓	✓		✓
Waste Management	✓	✓		✓
Aboriginal Heritage Management	✓	✓		✓
Traffic and Public Safety Management	✓	✓	✓	✓
Noise Management	✓	✓	✓	✓
Vibration Management	✓	✓		✓
Dangerous Goods and Explosives Management	✓	✓	✓	✓
Organochlorine (Dieldrin) Management		✓		✓
Discharge of Pressure-Test Water and Disinfection	✓	✓		✓
Rehabilitation Management	✓	✓		✓
Environmental Incident Management	✓	✓		✓
Non-Compliance Management	✓	✓		✓
Community Complaints Management	✓	✓		✓
Auditing of CEMF	✓	✓		✓

Table 4-1 Responsibility Matrix

5.0 Land Clearing and Trench Management

5.1 Context

The construction works will require clearing of agricultural pasture and native vegetation at the Seawater Desalination Plant site, Water Transfer Pipeline route and the Harvey Summit Tanks site. The construction area supports locally and regionally significant flora and fauna, some of which are specifically protected under State and/or Commonwealth legislation. Clearing will be carried out within defined clearing widths to minimise construction impacts on flora and fauna and to reduce the area requiring rehabilitation.

Construction of the Water Transfer Pipeline will require the excavation of trenches for pipeline installation. Excavated trenches have the potential to trap fauna, which may present an undesirable risk to the health of the fauna and/or contractors working within the trench.

Separate management actions are required for land clearing in agricultural land and native vegetation, with specific actions on retaining topsoil for seed and nutrient retention for the rehabilitation works.

Dust can be generated from land clearing activities, and from cleared areas exposed to wind. Dust generation has the potential to be a physical and health hazard, and can adversely affect the amenity of the construction staff, the community and agricultural crops.

5.2 Purpose

The purpose of the Land Clearing and Trench Management Plan is to outline management actions to:

1. minimise construction impacts on flora and fauna, more specifically to:
    a. protect Declared Rare Flora, consistent with the provisions of the *Wildlife Conservation Act 1950* (WA).
    b. protect Critically Endangered, Endangered and Vulnerable flora, consistent with the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (C'th).
    c. minimise impacts on Priority Flora identified by the DEC.
    d. protect Specially Protected Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950* (WA).
    e. protect Critically Endangered, Endangered and Vulnerable fauna, consistent with the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (C'th).
    f. minimise impacts on Priority fauna identified by the DEC.
    g. minimise opportunities for fauna become trapped in the excavated trenches.
    h. response procedures for fauna that enter excavated trenches.
2. remove topsoil during clearing, and return it following installation of infrastructure.
3. minimise and control dust generation.

5.3 Performance Indicators

Performance will be demonstrated by:

5.3.1 Vegetation

1. Vegetation clearing is limited to within pre-determined clearing widths.
2. Habitat trees will be marked prior to construction and retained where possible.

3. Protected flora and fauna will not be disturbed without approval under the *Wildlife Conservation Act 1950* (WA) and/or the *Environment Protection and Biodiversity Conservation Act 1999* (C'th) (as appropriate).
4. Topsoil is managed to maximise germination of native vegetation contained in the topsoil.

5.3.2 Fauna

5. Trapped fauna are removed from the trench and released without harm.

5.3.3 Dust

6. No visible dust leaving the construction area.
7. No public complaints received regarding dust.

5.4 Management Actions

5.4.1 General

Prior to Construction

1. The Seawater Desalination Plant site, Water Transfer Pipeline route and the Harvey Summit Tanks site will be surveyed for the presence of Declared Rare Flora (as per the *Wildlife Conservation (Rare Flora) Notice 2008* and Priority Flora prior to construction. The survey will also identify the presence of Critically Endangered, Endangered and Vulnerable flora (as per the *Environment Protection and Biodiversity Conservation Act 1999* (C'th)).
2. If Declared Rare Flora are identified within the construction area a Licence to take Declared Rare Flora will be applied for, in accordance with the *Wildlife Conservation Act 1950* (WA) and the *Wildlife Conservation Regulations 1970* (WA).
3. The Seawater Desalination Plant site, Water Transfer Pipeline route and the Harvey Summit Tanks site will be surveyed for the presence of specially protected fauna (as per the *Wildlife Conservation (Specially Protected Fauna) Notice 2008* prior to construction.
4. If specially protected fauna are identified within the construction area a Licence to take specially protected fauna will be applied for in accordance with the *Wildlife Conservation Act 1950* (WA) and the *Wildlife Conservation Regulations 1970* (WA).
5. The Seawater Desalination Plant site, Water Transfer Pipeline route and the Harvey Summit Tanks site will be surveyed for the presence of potential habitat trees prior to construction.

Fauna Management

6. A barrier will be established at the end of each installed pipeline (excluding marine pipelines) at the end of each working day to prevent fauna entering the installed pipelines.
7. The end of each open excavation will be graded at the end of each day to provide a ramp for trapped fauna to escape the trench.
8. The Seawater Desalination Plant site and excavated trenches will be visually inspected prior to construction works commencing on each day to determine the presence of trapped fauna. The visual inspection will be conducted during daylight hours and will be completed by no later than 0900hrs.
9. Any fauna found within the Seawater Desalination Plant site or within any excavated trench will be removed and relocated to a minimum distance of 50m from the site or trench. The fauna removed will be recorded in the Fauna Removal Log, which shall be retained at the site office.
10. The types of fauna listed below will be treated by a qualified veterinary doctor (on-site or off-site) if found injured within the Seawater Desalination Plant site or the excavated trenches.
    - livestock (in consultation with the Landowner)
    - all birds
    - kangaroos

- large reptiles (includes snakes, monitor lizards and bobtails)
- Western Ringtail Possums or Brushtail Possums
- Chuditch (Western Quoll - native cat)
- Quokkas
- Southern Brown Bandicoot (Quenda)
- Woylie (Brush Tailed Bettong)
- Western Brush Wallabies

The injured fauna will not be harmed or killed unless a decision to euthanize (kill) any injured fauna is made by a veterinary doctor. A decision to euthanize livestock will only be made by the Landowner.

11. Dead fauna will be removed from the Seawater Desalination Plant site and excavated trenches to prevent additional fauna from entering the Seawater Desalination Plant site or excavated trenches to source food. They will be disposed of as putrescible waste (to landfill).
12. No dogs, cats or firearms will be allowed within any construction area.

Dust from Construction Works

13. Daily weather forecasts will be obtained for temperature and wind speed (South West Land Division - Bureau of Meteorology) and will make the forecast information available to persons involved in dust generating activities and dust suppression activities.
14. Water trucks and/or water cannons will be used to dampen areas identified as being potentially dust generating (sandy soils, soil stockpiles, unsealed access roads etc). The frequency of dampening will be determined based on weather conditions.
15. Dewatering water maybe used for dust suppression activities if the dewatering water meets the criteria for discharge to land contained in the Dewatering and Acid Sulphate Soils Management Plan.
16. Other dust control measures may be implemented (such as hydro-mulching, wind fencing, hardstanding or chemical dust supressants).
17. Vehicles transporting soils off-site will be covered to minimise dust generation during transport.

5.4.2 Seawater Desalination Plant

Clearing of Native Vegetation

18. Clearing of native vegetation will only commence once permission is obtained. It will be limited to those areas identified for clearing as contained in Appendix 1.
19. All timber trunks cleared will retained and stockpiled to a nominal height of no more than 3 metres. Vegetation crowns that have been cleared will be separately retained and stockpiled to a nominal height of no more than 5 metres. Vegetation crowns will be cut into sections of approximately 1m in length prior to stockpiling. The cleared and stockpiled vegetation trunks and crowns will be used during site rehabilitation[2].
20. Cleared vegetation will not be burned.
21. The Seawater Desalination Plant site will be surveyed at the completion of clearing works to determine the area (in ha or m^2) of native vegetation cleared. The area of clearing will be recorded.
22. Approximately 200mm of topsoil will be removed from the cleared areas and stockpiled in a windrow of no greater than 10 metres nominal height on the Seawater Desalination Plant site. The stockpiled topsoil will be used for rehabilitation works following construction.
23. A stock fence will be installed at the boundary of the defined Seawater Desalination Plant site clearing area (refer Appendix 1) to fence off the native vegetation that will be retained. The stock fence will be a 5 strand wire fence strained with posts with strand heights at 250mm, 500mm, 750mm, 1000mm and 1250mm above ground level prior to clearing. The fencing will aim to prevent unauthorised vehicle access and to discourage human traffic between the native vegetation and the construction areas, while still permitting fauna movement through the native vegetation and the construction areas.

24. Separate security fences will be installed of at least 1.8m height immediately around the Seawater Desalination Plant infrastructure and the Seawater Pump Station construction areas to prevent unauthorised human access.

Post-Construction

25. The Seawater Desalination Plant site will be contoured, including re-creation of the primary dune, establishment of earth screening bunds, and contouring of the whole site to achieve stable batters.
26. Areas compacted by construction works (excluding retained access and laydown areas) and that are to be rehabilitated, will be ripped. The areas will be ripped along the contour to a depth of approximately 300mm. Land will be graded following ripping to ensure that high or low points do not remain.
27. Stockpiled topsoil will be evenly spread over the ripped and graded areas as soon as reasonably practicable following the ripping and grading.
28. The retained large trunks and cut vegetation crowns will be randomly spread over the ripped, graded and topsoiled areas. Any other retained vegetation from dieback infected areas will be evenly spread within the dieback infected area (refer Hygiene Management Plan).
29. Excess overburden will be disposed of firstly within the Seawater Desalination Plant site, secondly to adjoining properties with agreement of adjoining Landowners, or thirdly the excess overburden will be disposed of to landfill.
30. If the overburden is from an area determined to be dieback infected, the overburden will be disposed of on-site (refer to Hygiene Management Plan).

5.4.3 Water Transfer Pipeline and Harvey Summit Tanks

Native Vegetation

Clearing - Pipeline

31. The clearing corridor for pipeline installation will be no greater than 20 metres width in native vegetation (excluding pipeline storage and vehicle turning points), excepting the pipeline section between the storage facility and the Stirling Trunkmain (where two pipelines will be installed – one to the Harvey Summit Tanks and one from the Harvey Summit Tanks) in which the clearing width will be no greater than 30 metres. The single pipeline clearing width maybe reduced to a minimum 15m width in sections less than 250m length to avoid sensitive environmental or social areas.
32. The clearing corridor will be marked in sections (up to 3km per section) with pegs and flagging tape (or other suitable marking method) prior to clearing.
33. Potential habitat trees will be marked with a different coloured flagging tape (or other suitable marking method) prior to clearing with a view to retaining the habitat trees. Potential habitat trees will only be cleared where retention is not practicably possible for pipeline installation.
34. Clearing of native vegetation will only commence once approval is received (hold point).
35. Only vegetation within the marked clearing areas (excepting the retainable habitat trees) will be cleared. During clearing, where existing fallen logs with a diameter larger than 300mm (950mm circumference) partially overlay the area to be cleared, the log will be cut at the clearing boundary to preserve the part of the log outside of the clearing corridor.
36. Each calendar week a survey of the area will be conducted to determine the area (in ha or m^2) of native vegetation cleared. The survey area will be recorded, and weekly updates will be provided along with the as-constructed drawings of the infrastructure.
37. Clearing in the State Forest will be conducted in consultation with the FPC (which retains rights to such timber). In consultation with the FPC, salvageable timber (trunks) that have been cleared will be removed to a location agreed with the FPC.
38. Any non-salvageable timber trunks will be retained and stockpiled to a nominal height of no more than 3 metres for later use in rehabilitation[1]. Retained tree crowns will be separately

stockpiled to a nominal height of no more than 5 metres after cutting the crowns into sections of approximately 1m length for later use in rehabilitation[1].

39. Cleared vegetation will not be burned.

40. Approximately 200mm of topsoil will be removed from 5m either side of the pipe centreline and stockpile it in a windrow of no greater than 5 metres nominal height. If access roads are constructed, topsoil will also be removed and stockpiled from these locations prior to construction of the access roads. Topsoil will be stockpiled for a period not exceeding two months for pipeline installation.

41. The trench will be excavated (to the required depth), with the excavated overburden stockpiled in a separate windrow of no greater than 5 metres nominal height.

42. The topsoil and overburden stockpiles maybe temporarily relocated to a point close to its place of origin where the clearing width is restricted to less than 20m. If the topsoil and overburden is dieback infected, the topsoil and overburden will only be relocated to with dieback infected areas (refer to the Hygiene (Plant Pathogen) Management Plan).

43. A temporary security fence will be installed of approximately 1.8m height around any open trench greater than 0.5m depth at the end of each construction day. The purpose of the fence will be to prevent access to the open trench by large terrestrial fauna (such as kangaroos). The fence base will have a continuous fabric shroud (such as shade cloth) pegged to the ground with a minimum height of 0.25m to prevent access to the construction site by small terrestrial fauna (such as snakes and lizards).

Fauna Management - Additional

44. The trench will be left open for the minimum time practicable to minimise the chance of fauna entering the trench and becoming trapped.

45. It will be ensured that at the end of each day, the length of open trench with a depth greater than 1.0m will not exceed 1000m for each separate construction area.

After Pipeline Installation

46. The overburden will be returned to the trench in layers, with each layer compacted in the trench at a thickness of no greater than 150mm to minimise soil consolidation in the trench following construction.

47. Clay cut-off walls[3] will be installed across the pipeline trench in agricultural land generally at a distance of no greater than 500m apart, as well as at the edge of wetland boundaries, irrigated paddocks, property boundaries and steeply sloping areas. The clay cut-off walls will be constructed of low to medium plasticity non-dispersive clay, sandy clay or silty clay with a nominal width of 1000mm and compacted in 150mm layers to minimise soil consolidation in the trench following construction.

48. Excess overburden will be disposed of to a suitable location agreed, firstly with the Landowner (the Landowner has first preference to retain excess overburden from their own property), secondly with adjoining Landowners, or thirdly the excess overburden will be disposed of to landfill.

49. If the overburden is from an area determined to be dieback infected, the overburden will be disposed of on-site (refer to Hygiene (Plant Pathogen) Management Plan).

50. The compacted areas (excluding retained access roads) will be ripped along the contour to a depth of approximately 300mm following backfilling and compaction of the trench. The land will be graded following ripping to ensure that high or low points do not remain.

51. The retained large trunks and cut vegetation crowns will be randomly spread over the ripped and graded areas. Any other retained vegetation from dieback infected areas will be evenly spread within the dieback infected area (refer Hygiene Management Plan)

52. The stockpiled topsoil will be evenly respread over the construction area as soon as reasonably practicable following ripping, grading and distribution of large trunks.

5.4.4 Agricultural Land

Prior to clearing

53. A land assessment survey will be undertaken (including photographs and/or video) of each land parcel (including road reserves) to determine pre-construction land condition.

54. Written notification will be provided to the landowner at least 14 days prior to the commencement of ground disturbing activities, including fencing, to enable the Landowner to prepare for construction (such as stock movement).

55. Prior to clearing on each lot, the construction corridor in agricultural land will be fenced where there is a risk of livestock (cattle or sheep) entering the open trench. The fence will be a 5 strand wire fence strained with posts and will be connected to the existing fences in each lot. The fence will be electrified where the existing fences in the lot are electrified, with strand heights at 200mm (earthed), 400mm (earthed), 600mm (electrified), 800mm (earthed) and 1000mm (electrified) above ground level.

Clearing

56. The clearing corridor for pipeline installation will be between 20 and 30 metres width in agricultural land (excluding pipeline storage and vehicle turning points).

57. The clearing corridor will be marked in sections (up to 3km per section) with pegs and flagging tape (or other suitable marking method) prior to clearing. Only then may the clearing be undertaken.

58. Cleared vegetation will not be burned.

59. approximately 200mm of topsoil will be removed from 5m either side of the pipe centreline and stockpile it in a windrow of no greater than 5 metres nominal height following vegetation clearing. If access roads are constructed, topsoil will also be removed and stockpiled from these locations prior to construction of the access roads.

60. The pipeline trenches will be excavated (to the required depth), with the excavated overburden stockpiled in a separate windrow of no greater than 5 metres nominal height.

61. Stockpiles of topsoil or overburden may be temporarily relocated to a location within 500m of its place of origin on occasions where the pipeline clearing corridor width is restricted to less than 30m width.

After Pipeline Installation

62. The overburden will be returned to the trench in layers, with each layer compacted at a thickness of no greater than 150mm to minimise soil consolidation in the trench following construction.

63. Clay cut-off walls[3] will be installed across the pipeline trench in agricultural land generally at a distance of no greater than 500m apart, as well as at the edge of wetland boundaries, irrigated paddocks, property boundaries and steeply sloping areas. The clay cut-off walls will be constructed of low to medium plasticity non-dispersive clay, sandy clay or silty clay with a nominal width of 1000mm and compacted in 150mm layers to minimise soil consolidation in the trench following construction.

64. Excess overburden will be disposed of to a suitable location agreed, firstly with the Landowner (the Landowner has first preference to retain excess overburden from their own property), secondly with adjoining Landowners, or thirdly the excess overburden will be disposed of to landfill.

65. The compacted areas (excluding retained access roads) will be ripped along the contour to a depth of approximately 300mm following backfilling and compaction of the trench. The Contractor will grade the land following ripping to ensure that high or low points do not remain.

66. The stockpiled topsoil will be evenly respread over the construction area as soon as reasonably practicable following ripping and grading.

5.5 Additional Information

[1] Fauna Removal

A Licence will be required under r17 of the *Wildlife Conservation Regulations 1970* (WA) issued by the DEC to take native fauna from the trench. A licence is not required for removal of livestock from the trench.

Guidance on fauna handling, fauna diseases and occupational safety matters in handling fauna can be sourced from the document *Minimising Disease Risk in Wildlife Management: Standard operating procedures for fauna translocation, monitoring and euthanasia in the field (*DEC, July 2005).

Photographs of native fauna that are likely to be encountered by the construction works are provided in the fauna Identification Chart (Figures 1-1 to 1-15). The Fauna Identification Chart will be displayed at the site offices to assist with field identification.

[2] Cleared Vegetation

The cutting of the vegetation crowns to a length of approximately 1m, then respreading over the cleared areas following construction, will help to create a microclimate suitable for seed germination. The cut and spread crowns will also assist with erosion control and minimise dust generation.

[3] Clay Cut-off Walls

Clay-cut-off walls will be installed to provide an impermeable seal (or plug) against preferential water movement through the pipeline bedding material along the length of the pipeline. The clay cut-off walls will be installed perpendicular to the trench.

5.6 Contingency Actions

Where the above actions do not achieve the purpose of this plan or are not complied with, the following contingency actions will be implemented as required:

Vegetation Clearing

1. The cause will be investigated and implementation of the management actions will be reinforced. If appropriate, the management actions will be amended.

2. Any environmental impacts will be mitigated.

Fauna

3. Fauna ladders and ramps will be installed within the open excavations to allow fauna to escape.

4. Shelters for fauna will be installed. Each shelter will consist of a damp hessian bag or an upturned ice-cream container (or other equivalent shade device). The shelters will be inspected for the presence of fauna as part of the inspection procedure.

Dust

5. Temporary wind fencing and/or hydro-mulching will be installed.

6. Dust generating construction work will temporarily cease during windy conditions until weather conditions become favourable.

5.7 Related Plans

1. Dewatering and Acid Sulphate Soils.
2. Hygiene Management.
3. Watercourse Crossing Management.
4. Incident Management.
5. Rehabilitation Management.

5.8 Relevant Legislation

1. *Wildlife Conservation Act 1950*, and *Regulations 1970* (WA).
2. *Environmental Protection Act 1986*, and *Regulations 1987* (WA).
3. *Conservation and Land Management Act 1984*, and *Regulations 2002* (WA).
4. *Environment Protection and Biodiversity Conservation Act 1999* (C'th).

5.9 Advisory Agencies

The following organisations will be consulted on this plan:

1. DEC
2. DAF
3. FPC
4. Conservation Commission
5. Shire of Harvey
6. DEWH

Table 5-1 Native Vegetation Clearing Log

Southern Seawater Desalination Project
Land Clearing and Trench Management

Native Vegetation Clearing Log

The purpose of the Native Vegetation Clearing Log is to record the area of native vegetation cleared. The area of native vegetation cleared will assist in determining the materials required for rehabilitation (tubestock, seed, staff). The Native Vegetation Clearing Log is to be completed by the Contractor on a weekly basis.

Name ……………………………………………………………………………………

Page ……… of ………

Date of Entry	Location and Property Reference	Area Cleared (m^2 or ha - specify)	Name and Position	Initial

Table 5-2 Fauna Removal Log

Southern Seawater Desalination Project
Land Clearing and Trench Management

Fauna Removal Log

The purpose of the Fauna Removal Log is to record the number, location and removal of fauna from within the trench. The Fauna Removal Log is to be completed by the Contractor on each day that fauna is removed from the trench.

Name ……………………………………………………………………………………

Page ……… of ………

Date of Entry	Location and Property Reference	Fauna Description (eg. snake, lizard)	No. Removed	Alive (Y/N)	Method of Removal	Name and Position	Initial

Figure 5-1 Fauna Identification Chart

Southern Seawater Desalination Project
Land Clearing and Trench Management

Fauna Identification Chart

This chart identifies fauna that may occur within the Southern Seawater Desalination Project area.

Western Grey Kangaroo

Tammar Wallaby

Woylie (Brushed Tailed Bettong)

Chuditch (Western Quoll). Specially Protected – Rare or likely to become extinct.

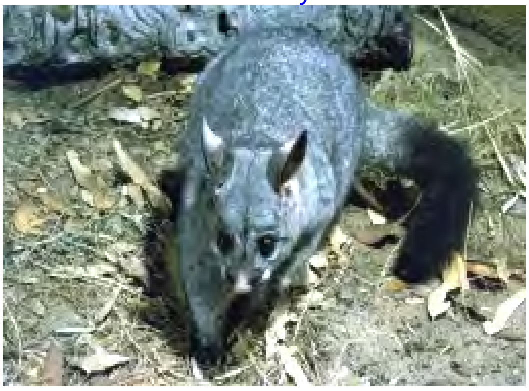
Quokka.
Specially Protected Rare or likely to become extinct.

Western Pygmy Possum

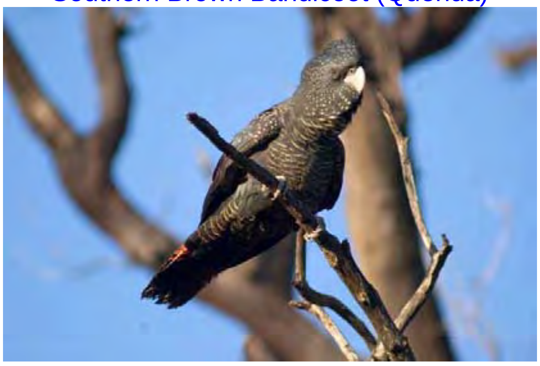
Western Ringtail Possum. Specially Protected – Rare or likely to become extinct.

Brushed Tailed Phascogale. Specially Protected – Rare or likely to become extinct.

Southern Brown Bandicoot (Quenda)



Brushed Tailed Possum



Forest Red-Tailed Black Cockatoo. Specially Protected – Rare or likely to become extinct

White Tailed Black Cockatoo. Specially Protected – Rare or likely to become extinct (Baudin's and Carnaby's Cockatoo)

Dugite Snake

Carpet Python

Monitor Lizard

Photos: DEC WA (Wells & Wells) – www.environment.wa.gov.au
Australian Wildlife Conservancy – www.australianwildlife.org
Fourth Crossing Wildlife (Chris McGregor) – www.fourthcrossingwildlife.com

6.0 Seawater Pipeline Installation Management

6.1 Context

The Southern Seawater Desalination Project will require the installation of ocean pipelines for seawater intake and brine discharge. The intake pipelines will extend from the shore to approximately 600m offshore and the outlet pipelines to up to 1100m offshore. This management Plan covers installation of these pipelines, intake structures and the diffuser.

Maps produced from previous surveys show the presence and distribution of marine habitats, including flora and fauna. The marine pipelines and infrastructure have been located where they will have minimal impact on the marine ecology of the area.

Marine macroflora (including seaweeds and seagrasses) species occur at a distance from approximately 500m offshore to greater than 2500m offshore from the Seawater Desalination Plant site. More specifically, seagrasses are more than 1200m from the shore along the pipe alignment. The seawater intake and outlet pipelines will be located along an alignment that generally contains bare sand and shell material, however from 500m offshore the marine works are within 100m of marine flora to the south, west and north. The construction works may impact on the marine flora in close proximity. Environmental monitoring will be undertaken to ensure that the impacts of marine construction works are within a defined area.

The specific construction methods for seawater pipeline installation have yet to be selected. Initial investigations indicate open trenching is likely to be the most appropriate construction method and that blasting will not be required. The different construction alternatives under consideration are listed within this plan with the management actions for each construction method identified. Apart from the area of excavation, the environmental impacts of each construction method predominantly relate to the suspension of sediments, which can both reduce light available to marine flora for photosynthesis and settle onto marine flora.

Underwater blasting is unlikely, however may be required to remove rock where excavation is not practicable or possible. Blasting has the potential to affect marine mammals (including whales and dolphins) if they are within the immediate vicinity of blasts. Management actions are specified based upon Western Whale Research (2008) to minimise the impacts of underwater blasting on whales and dolphins.

6.2 Purpose

The purpose of the Seawater Pipeline Installation Management Plan is to outline management actions to:

1. minimise impacts on ocean water quality and marine flora during marine construction works.
2. minimise impacts of blasting on marine mammals.
3. inform the community of the location and timing of the works.
4. to quantify the final area of disturbance.

6.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

6.4 Management Actions

Prior to Construction

1. Vessels reaching the construction site by sea from international waters will discharge all ballast waters at least 12 nautical miles from the Western Australian coastline in accordance with Australian Quarantine and Inspection Service (AQIS) requirements for ballast water discharge.

2. All marine vessels will be visually inspected prior to entry to Australian Waters to confirm they are free from biofouling and sediments in accordance with AQIS requirements.

3. AQIS Bunbury (Phone 08 9791 4787) will be contacted to confirm any need for a quarantine inspection of marine vessels entering Australian Waters prior to their entry to Australian Waters.

4. A temporary Marine Exclusion Area will be established with marine warning buoys installed in the ocean at nominally 300m, 550m, 800m, 1050m and 1300m from the beach at nominally 500m north and 500m south of the marine pipeline alignment. Additional buoys will be installed at nominally 250m intervals between the two 1300m warning buoys in a north-south direction (refer Figure 6-1). The marine warning buoys will demarcate the marine construction zone where public marine access will be restricted during construction. The marine warning buoys will be marked identifying that the buoys mark a marine exclusion zone, and will be fitted with a flashing warning light to be visible at night.

5. Approval for installation of the marine warning buoys will be obtained from the DPI under the *Marine Navigational Aids Act 1973* (WA) prior to installing the warning buoys.

6. A Beach Exclusion Area will be established at nominally 200m north and 200m south of the marine pipelines' alignment to prevent public access to the construction area. The beach exclusion area will remain until beach construction works are completed and it is safe for the public to access the beach area.

7. The Marine Exclusion Area and the Beach Exclusion Area will be made known to the public by:

    a. Installation of signage at the Binningup and Myalup beach car parks that contain a map identifying the beach and marine exclusion areas, and the dates during which the access restrictions will apply.

    b. Installation of signage on each exclusion fence. The signage will contain a map identifying the Marine Exclusion Area and the Beach Exclusion Area, and the dates during which the access restrictions will apply.

    c. Placing a *Notice to Mariners* in public notices section of *The West Australian* newspaper and the *Harvey Reporter* newspaper identifying the Marine Exclusion Area and the marine warning buoys, in consultation with the DPI.

8. A marine biological survey with special emphasis on the distribution of seagrasses and macroalgae will be undertaken in the area shown in Figure 6-1 within the 12 months prior to the commencement of marine works to determine the species distribution and density of marine macroflora. The results of this survey will be used to compare the marine macroflora distribution and density post construction to determine impacts due to marine construction works.

9. The beach profile will be monitored during and post -marine construction activities. Profiles will be collected in the same locations as used by UWA (2008b).

Construction – Construction Works

10. Offshore construction works will be contained within the Marine Exclusion Zone and will not extend further offshore than that necessary to place infrastructure in accordance with the nominal distances given in the approved Characteristics Table.

11. To avoid damaging seagrass areas, where practicable barge anchors and other large anchors will not be placed more than 1300m offshore, and in areas free of marine flora and fauna.

12. All marine construction works will temporarily cease if whales or dolphins (cetaceans) are sighted within the Marine Exclusion Area. Marine construction works may resume when the cetaceans are outside of the Marine Exclusion Area.

13. Construction will consist of some or all of the methods outlined in the following section:

Excavation and Backfilling

a. The maximum width of the excavated trench offshore will be 50m.

b. Excavated material from the trench may be sidecast to either side of the trench, where sidecasting is part of the construction method[1].

c. Where excavated material is sidecast, the vertical drop distance will be minimised as far as is practicable to minimise potential sediment suspension.

d. The total number of days on which excavation occurs offshore of the nominal 6m depth contour or where rock is encountered, whichever is further offshore, shall not exceed 122 days[1].

e. The trench containing the installed pipeline will be backfilled. Backfill may include material different from that excavated. Rock armouring, concrete and other anchoring materials may be used.

f. Any rock, concrete or pipelines within the beach or surf zone will be covered with sand to nominally level with the surrounding beach.

Jetty and Sheet Piling

g. A temporary construction jetty and/or sheet piling may be constructed from the beach and into the ocean for pipeline installation.

h. Visual monitoring will be conducted for the presence of whales and dolphins during pile driving from the pile driving machinery. Pile driving will temporarily cease if whales or dolphins are sighted within the Marine Exclusion Area.

i. The beach profile will be restored if jetty and/or sheet piling causes greater than 50m length and/or 5m width accretion or erosion on either side of the works, or if erosion is likely to extend to the primary dune. The source of the fill will be accreted sand or the excavated trench material.

Thrust Boring / Sub-Sea Tunnelling / Directional Drilling

j. Thrust boring or sub-sea tunnelling or directional drilling may be used for pipeline installation, with the launch pit to be land based and the receival pits to be ocean based.

k. Water-based drilling fluid will be used for boring or tunnelling or drilling. An oil-based drilling fluid will not be used for boring or tunnelling or drilling.

l. Sheet piles, rock or concrete may be used in the construction of the receival pit. (see sheet Piling, above)

m. Excavated material from the trench may be sidecast to either side of the trench, where sidecasting is part of the construction method.

Pipeline Burial/Partial Burial/Non-Burial

n. Seawater pipelines will be buried under the beach and offshore until a nominal 6m seawater depth contour. The depth of sand cover in the beach and surf zone over pipelines (and rock and concrete placed over the pipelines) shall be designed to prevent exposure during a 1 in 100 year storm.

o. The seawater pipelines may be rock armoured, anchored with metal and/or concrete weights and/or anchored with piles grouted into the sea floor.

p. Offshore of the nominal 6m depth contour, seawater pipelines may be placed on the sea floor, in a partially buried position, or in a completely buried position. Pipelines will be installed so that the pipelines, any rock or concrete armouring or anchoring do not project more than 10% of the water depth (based upon mean sea level) or 1.0m above the general level of the surrounding sea floor, whichever is lesser.

Construction – Marine Monitoring

14. Monitoring will be conducted for marine turbidity and photosynthetically active radiation (PAR) during excavation and backfilling, construction of receival pits, construction of the jetty and sheet piling, and correction of erosion and accretion of the beach profile.

15. Monitoring for the turbidity and PAR of the marine waters will be at 500m north (Site A) and 500m south (Site B) of the marine construction works at a distance of 1300m from the beach. Turbidity will also be monitored at 1250m south (Control Site A) and 1250m north (Control Site B)[2] (Refer Table 6-1 and Figure 6-1).

Table 6-1 Marine Monitoring Locations –Coordinates

Site	Northings (m N)	Eastings (m E)
A	6334027	376410
B	6333027	376410
Control Site A	6332277	376999
Control Site B	6334777	376999

16. Any visible turbidity plume from the marine construction works will be tracked and turbidity measured within the plume at 500m from the marine pipelines if the plume is visible at between 250m and 1300m from the shoreline.

17. Turbidity and PAR will be measured twice on each day of marine construction works. One set of measurements will be in the morning and one in the afternoon with at least 4 hours between measurements. PAR will be measured 1 m below the water surface and turbidity and PAR will be measured at 1m from the sea floor using a field probe. The turbidity and PAR results will be recorded in the Marine Monitoring Log.

18. Subject to safety considerations (i.e. in accordance with the *Occupational Safety and Health Act 1984* (WA)), based upon the judgement of the monitoring vessel master/skipper or marine works supervisor, monitoring for PAR and turbidity may temporarily cease. The master/skipper or marine works supervisor shall make a note in the Marine Monitoring Log as to the sea state and weather conditions in such circumstances. Where marine conditions do not allow marine monitoring to be undertaken, the marine works may continue in the absence of marine monitoring if it is safe to do so.

19. Monitoring equipment for PAR and Turbidity measurements will be maintained and serviced in accordance with the manufacturer's specifications to minimise the probability of equipment malfunctions. All equipment malfunctions will be recorded in the Marine Monitoring Log. All equipment malfunctions will be rectified as soon as is reasonably practicable.

20. The Marine Monitoring Log will be submitted to the Department of Environment and Conservation on a monthly basis during the offshore construction period.

Construction – Underwater Blasting

21. The Shire of Harvey will be informed prior to any underwater blasting.

22. Public notice signage will be installed on the Beach Exclusion Area fencing (500m north and south) and at the entrance to the main public beach at both Binningup and Myalup on each day of blasting. The public notice signage will indicate the proposed time(s) of the day in which underwater blasting will be undertaken.

23. An Ocean Watch Vessel[3] will survey the ocean for a 1 hour period immediately prior to blasting within a 2km radius of the blast site to confirm the presence or absence of whales and dolphins. Sighting for whales and dolphins will also be undertaken from elevated land near the blast site for a 1 hour period immediately prior to blasting.

24. Blasting will not be undertaken if whales or dolphins are located within a 1km radius of the blast area (as advised by Western Whale Research, 2008).

25. The Ocean Watch Vessel will ensure other vessels do not come within 500m of the blast site.

26. A Blast Supervisor will be responsible for the safe conduct of blasting. The Blast Supervisor will ensure that the minimum weight of explosives suitable to undertake the work is used (i.e. the weight of explosives does not exceed the weight of explosives required).
27. The Blast Supervisor will ensure that the explosive charges are placed in closely staggered drill holes (i.e. not surface blasting). The Blast Supervisor will determine the exact separation distances between drill holes. The Blast Supervisor will consider the suitability of delayed blasts to minimise blast energy.
28. The Underwater Blasting Log will be completed for each blast.
29. Visible fish mortalities[4] from within 500m of the blast site will be removed immediately following blasting to minimise attraction of scavenging fish and birds to the area.
30. Any surplus charges not detonated immediately following each blast will be removed.

Post Construction

31. The beach profile will be restored consistent with the surrounding natural beach profile.
32. The beach profile will be monitored over a 12 month period following marine works. The profiling will commence within 6 months of the marine works being completed. Profiles will be collected in the same locations as used by UWA (2008b). Should the profiles show greater erosion in the vicinity of the marine works than elsewhere, an additional 12 months of profiling will be undertaken.
33. The exclusion fence, ocean warning buoys[5], signage at the Binningup and Myalup beach car parks, and all other infrastructure and materials will be removed from all beach areas.
34. Disturbed beach areas will be rehabilitated in accordance with the Rehabilitation Management Plan.
35. A marine biological survey with special emphasis on the distribution of seagrasses and macroalgae will be undertaken in the area shown in Figure 2-1 within 12 months following the completion of marine works to determine the species distribution and density of marine macroflora. The survey will include a comparison of marine macroflora distribution and density with the pre-construction marine macroflora survey to determine impacts due to marine construction works.

6.5 Additional Information

[1] Excavation impacts

Suspended sediments from excavation can reduce light levels and thereby impact seagrasses. The area of greatest impact on turbidity and PAR is within 100-200m from the marine works, where the majority of suspended sediments settle (Oceanica, 2008b). The impacts on the seagrass species that occur around 1300m and further offshore will be temporary if excavation of areas containing rock (which can result in more turbid suspensions) is limited to 4 months (122 days) (Oceanica, 2008b). Further, the variable nature of the currents (UWA, 2008a) means that light attenuation due to suspended sediments from excavation on any particular seagrass area would be considerably less than 122 days.

[2] Marine Monitoring Sites

Control Sites A and B at 1250m north and south of the marine construction works were selected to provide background water quality data that is not affected by the construction activities nor unduly influenced by other human sources.

The monitoring sites 1300m offshore (Sites A and B) have been selected to coincide with the closest seagrass areas.

Turbidity is a measure of the cloudiness or amount of light scattered in the water. Light required for photosynthesis is measured by *Photosynthetically Active Radiation* (PAR). There is no standard direct correlation between turbidity and PAR – rather it tends to be site specific. For this reason, both parameters are measured.

[3] Warning Blasts

A small charge warning blast was considered to warn off dolphins, whales and fish from the blast site prior to the full charge blast. Advice obtained for the blasting for construction of the Bunbury Wastewater Treatment Plant Ocean Outfall was that a warning blast can attract inquisitive animals (such as dolphins) and the suspended sediment plume created can attract fish. Consequently, a small charge warning blast could result in higher marine mortalities during the full charge blast. Accordingly, ocean surveys (Ocean Watch Vessel) and land surveys for dolphins and whales are considered more appropriate than a small charge warning blast.

[4] Fish Mortalities

There are no practicable measures to reduce fish mortality that could be implemented. Consequently, no measures are proposed to reduce fish mortalities other than the removal of visible fish mortalities to minimise scavenging fish from entering the blasting area for future blasts.

[5] Permanent Markers

Note that some permanent buoys/markers are possibly needed to mark permanent Marine Exclusion Zones around the seawater intake structures and the diffuser structures. These exclusion zones will be much smaller than the temporary Marine Exclusion Zone used during construction. The location of the permanent markers will be specified in the Operational Environment Management Plan

Monitoring of other Water Quality Parameters

The marine water quality monitoring focuses on turbidity and PAR monitoring as it is known that sediment particles can become suspended in the water column from seabed disturbing construction works. Other water quality parameters (such as dissolved oxygen) are considered unlikely to be impacted by construction due to rapid mixing in the high energy marine environment. Consequently, the monitoring of water quality parameters during construction has been restricted to turbidity and PAR.

Silt Curtains

The use of silt curtains extending from the sea floor to the water surface was considered for containment of turbid waters resulting from marine construction works. Experience from the Perth Seawater Desalination Project located in Cockburn Sound found that during inclement weather the silt curtains were destroyed. As the marine waters at the Southern Seawater Desalination Project are higher energy than Cockburn Sound, it is considered improbable the silt curtains could be effectively deployed and maintained during construction. The decision not to use silt curtains is consistent with the marine construction works used for the Bunbury Wastewater Treatment Plant Ocean Outfall, located approximately 25km to the south and constructed in 2002. Accordingly, silt curtains are not proposed as part of the marine construction works.

Disposal of Excavated Material

Advice obtained from the Australian Government Department of the Environment, Water, Heritage and the Arts (formerly the Department of Environment and Water Resources; formerly the Department of Environment and Heritage) for the Perth Seawater Desalination Plant (letter dated 14 April 2005) confirmed that a Permit was not required under the *Environment Protection (Sea Dumping) Act 1981* (C'th) as (1) the backfilling is for a purpose other than the mere disposal of the matter, and (2) procedures were in place for ensuring the backfilling did not cause marine pollution. Accordingly, a Permit is not required under the *Environment Protection (Sea Dumping) Act 1981* (C'th) for the Southern Seawater Desalination Project. Similar circumstances apply for the *Western Australian Marine (Sea Dumping) Act 1981* (WA), and accordingly, a Permit is not required under that Act.

6.6 Contingency Actions

No contingency actions are proposed.

6.7 Related Plans

1. Dangerous Goods and Explosives Management
2. Environmental Incident Management
3. Community Complaints Management
4. Rehabilitation Management Plan

6.8 Relevant Legislation

1. *Environmental Protection Act 1986* (WA).
2. *Marine Navigational Aids Act 1973* (WA)
3. *Quarantine Act 1908* (C'th)
4. *Wildlife Conservation Act 1950* (WA)
5. *Wildlife Conservation Regulations 1970* (WA)
6. *Occupational Safety and Health Act 1984* (WA)

6.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. AQIS
2. DEC
3. DoF
4. DoCEP (Worksafe WA)
5. DPI
6. Shire of Harvey
7. DEWHA

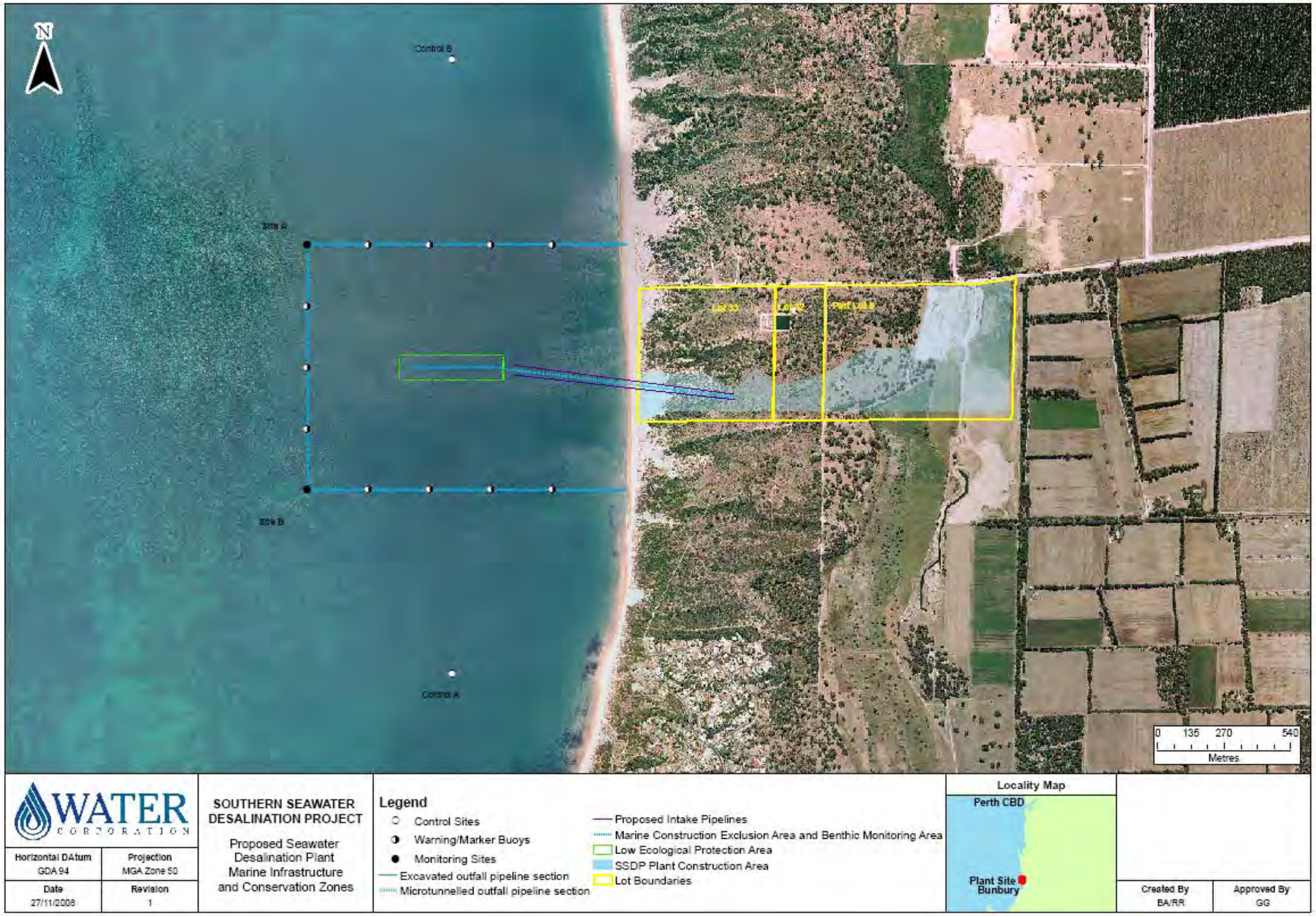


Figure 6-1 Marine Exclusion Area, Marine Pipelines and Monitoring Sites

Table 6-2 Marine Monitoring Log

Southern Seawater Desalination Project
Seawater Pipeline Installation Management

Marine Monitoring Log

The purpose of the Marine Monitoring Log is to record the marine turbidity and PAR during seawater pipeline installation.

Date: ________________________

Name: ________________________

Position: ________________________

Monitoring comments (optional):

____

____

____

MONITORING TIME: Morning / Afternoon (please circle)

SAFE TO SAMPLE?: Yes / No (please circle)

COORDINATES:

Site	Northings (m N)	Eastings (m E)
A	6334027	376410
B	6333027	376410
Control Site A	6332277	376999
Control Site B	6334777	376999

FIELD SAMPLING RESULTS:

	Turbidity (NTU)				
	Site A	Site B	Control A	Control B	Mean of Control A & B
Time					
Recording at 2m from sea floor					

	Photosynthetically Active Radiation (PAR) (µmol/m/s)				
	Site A	Site B	Control A	Control B	Mean of Control A & B
Time					
Recording at 2m from sea floor					

Table 6-3 Underwater Blasting Log

Southern Seawater Desalination Project
Seawater Pipeline Installation Management

Underwater Blasting Log

The purpose of the Underwater Blasting Log is to record the key aspects of each underwater blast.

Date of Blast	Location of Blast	Weight of Charge (kg)	Time whale and dolphin surveys completed	Time of Blast	Mortalities (total number and species)	Comments	Name and Position

Page ……… of …

7.0 Watercourse Crossing Management

7.1 Context

The Water Transfer Pipeline from the Seawater Desalination Plant site to the Harvey Summit Tanks will cross a number of watercourses (drains, rivers and streams). Construction activities at the watercourses have the potential to disrupt natural water flows and add suspended sediment material (particulates) to the water column.

The watercourses may provide habitat for flora and fauna. Some of the watercourses may also have heritage significance to persons of Aboriginal descent (refer Aboriginal Heritage Management).

All watercourse crossings will be constructed using an open trench as identified in Figure 7-1. The pipeline will be buried below the watercourse so that watercourse flows are not interrupted following construction.

7.2 Purpose

The purpose of the Watercourse Crossing Management Plan is to outline management actions to minimise:

1. impacts on water quality and watercourse flow.
2. impacts on beds and banks of watercourses.

7.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

7.4 Management Actions

Prior to Construction

1. A permit to interfere with the beds and banks of watercourses will be obtained from the DoW in accordance with s17 of the *Rights in Water and Irrigation Act 1914* (WA).

Construction

2. Liaison with Harvey Water will occur at least 14 days prior to any works carried out in irrigation watercourses operated by Harvey Water.

3. Vegetation clearing will be undertaken at watercourses, if required, in accordance with the Land Clearing and Trench Management Plan.

4. The flow of the watercourse will be diverted by channel or by diversion pipeline. If a watercourse contains water that is not flowing or flowing slowly, it will be temporarily dammed with any minor water flow to be transferred by pump and pipeline.

5. A continuous row of sterile hay bales will be installed and maintained approximately 10m downstream of the construction works for sediment filtration and flow velocity reduction if the watercourse is visually turbid from construction works at a distance of approximately 100 metres downstream of the construction works. The bales will be fixed using stakes to the base of the watercourse during construction.

Post Construction

6. Any installed bales and stakes will be removed within 7 days following the completion of construction works at the watercourse.
7. The banks of the watercourse will be re-contoured using construction equipment so that the banks are returned to the original profile with equivalent pre-construction stability.
8. The banks of the watercourse will be rehabilitated as documented in the Rehabilitation Management Plan, with cleared and cut vegetation placed on the banks to minimise erosion and encourage microclimates for seed germination.

7.5 Contingency Actions

If the watercourse is visually turbid at a distance of 100m downstream of the construction works after the installation of sterile hay bales, the following actions will be undertaken:

1. installation of additional continuous row(s) of sterile hay bales or a geofabric barrier downstream of the construction works for sediment filtration and flow velocity reduction;

2. addition of Alum (aluminium sulphate $Al_2(SO_4)^{3-}$) to remove sediments from suspension between the construction works and the bales/geofabric. The concentration of alum required will be dependent on the level of sedimentation of the water. Soda Ash (sodium carbonate Na_2CO_3) will also be applied for pH correction during Alum dosing at a rate of 2 parts Alum: 1 part Soda Ash.

7.6 Related Plans

1. Land Clearing and Trench Management
2. Dewatering and Acid Sulphate Soils Management
3. Aboriginal Heritage Management
4. Rehabilitation Management

7.7 Relevant Legislation

1. *Rights in Water and Irrigation Act 1914*, and *Regulations 2000* (WA).

7.8 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DEC
2. DoW
3. Conservation Commission
4. Harvey Water

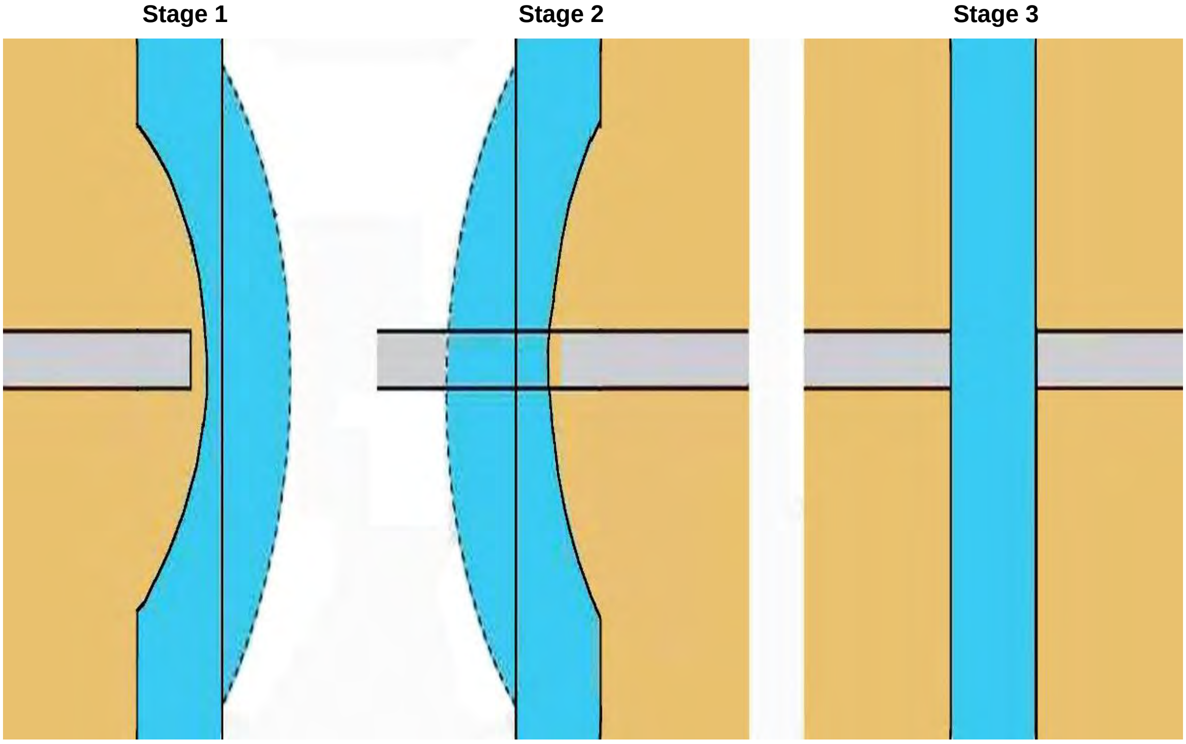


Figure 7-1 Watercourse Crossing by Open Trenching.

For 'Stage 1' the watercourse is diverted to one side, making one side dry for pipeline installation. At 'Stage 2' the watercourse is diverted in the opposite direction, making the other side dry for pipeline construction and to connect to the pipeline installed during 'Stage 1'. 'Stage 3' involves the re-alignment of the watercourse banks to the original alignment and profile. The pipeline is buried below the land and the watercourse.

8.0 Dewatering and Acid Sulphate Soils Management

Management of dewatering and acid sulphate soils will be undertaken in a manner consistent with the risk based approach outlined in the Water Corporation Acid Sulphate Soil and Dewatering Management Strategy (Water Corporation 2007)

8.1 Context

Dewatering by spears and pumps will be required for excavations and installation of infrastructure in areas where the watertable is above the installation depth. Pipeline installation will occur during dry periods to reduce the need for dewatering, with the temporal extent of dewatering limited by the pipeline installation rate (at approximately 100m per day), with dewatering in any one area being completed within approximately 7 days.

The construction areas may also contain Acid Sulphate Soils (ASS), which are naturally occurring soils and sediments containing sulphide minerals. When ASS is dewatered, excavated or otherwise exposed to air, the sulphides react with oxygen in the air to form sulphuric acid. Sulphuric acid can contaminate the groundwater and cause the release of metals bound in the soil (such as arsenic, aluminium and iron).

Mapping completed by the WAPC (May 2007) identifies that the infrastructure has the following ASS risks:

	ASS RISK (for excavations up to 3m depth)
Seawater Desalination Plant:	2 ha of “high to moderate risk” (degraded remnant wetland) 19 ha of “moderate to low risk” 63 ha of “no known risk” (Note: marine areas have not been mapped by WAPC, however ASS are not expected due to the limestone marine environment).
Water Transfer Pipeline:	5.5 km of “no known risk”
	23 km of “moderate to low risk”
	0.5 km of “high to moderate risk” 0.5 km of no data recorded (Note: ASS is not expected due to the high elevation of the land (approximately 80m AHD to 130m AHD))
Harvey Summit Tanks:	No data recorded (Note: ASS are not expected due to the high elevation of the land (approximately 130m AHD to 170m AHD)).

Table 8-1 ASS Risk mapping for the Southern Seawater Desalination Project areas.

The ASS identified at the Seawater Desalination Plant site is not anticipated to be of concern as those areas will be filled to achieve the necessary height for infrastructure installation. Exposure of ASS in stockpiles and within the excavated trench for the Water Transfer Pipeline will be limited due to the rate of pipeline installation (at approximately 100 metres per day).

8.2 Purpose

The purpose of the Dewatering and Acid Sulphate Soils Management Plan is to outline management actions to:

1. minimise the environmental impacts of dewatering.
2. identify and manage areas of ASS.

8.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

8.4 Management Actions

Prior to Construction

1. The presence of ASS and the depth to groundwater will be determined as described below:
    a. Sample sites will be located at 500m[1] intervals along the pipeline routes, except for the Boonilup Road section where the sampling distance will be 100m[1]. At the Seawater Desalination Plant site the degraded remnant wetland will be sampled (minimum 2 sample sites).
    b. At each sample site, one 500 gram sample will be taken from the centre of each soil layer (horizon)[2] to a depth of approximately 4.0 metres[3]. The sample will be collected and placed in a sealed plastic bag, excluding air. Shell material, if present, will be removed from the sample in the field. Samples will be placed in a field freezer or esky containing ice, then frozen within 24 hours of collection (i.e. on return from field sampling).
    c. Each soil sample will be tested by the Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS)[4] suite method by a laboratory accredited by NATA for analysis by SPOCAS.
    d. For each soil profile, the following will be recorded:
        i. Location (geo-referenced to eastings and northings) of the sample site.
        ii. Depth from which the soil sample was taken.
        iii. Description of thickness, soil texture and grain size for each layer.
        iv. Description of colour using a Munsell colour chart for each layer.
        v. Description of soil mottling, organic matter, moisture content, and presence of shell material for each layer.
        vi. Estimation of the water table depth below ground level.
        vii. Photograph of the soil profile with a field marking indicating the sample collection points.
    e. Reporting of the results will include:
        i. Description of the equipment and methods used for sample collection.
        ii. Maps with geo-referenced coordinates of each sampling site.
        iii. Results of SPOCAS tests (includes Titratable Actual Acidity, Titratable Peroxide Acidity, Acid Neutralising Capacity, Titratable Sulfidic Acidity).
        iv. Recorded matters listed in part '1d' (above).
        v. NATA endorsed laboratory report for the laboratory results.
        vi. Description of Chain of Custody for samples collected for laboratory analysis.
        vii. Discussion of laboratory analysis.

Construction

Dewatering General

2. Excessive dewatering will be avoided. The rate of dewatering will be limited to the minimum rate required for the infrastructure to be installed within the trench.

Dewatering to Ocean

3. Dewatering water maybe discharged to the ocean from the Seawater Desalination Plant site. It will be ensured that the dewatering water is discharged within the surf zone (nominally within 0m to 25m of the shoreline) where the dewatering water will be rapidly mixed by wave action.
4. Dewatering discharge will not create a visible plume greater than 100m from the discharge location.

Dewatering to Land

5. Dewatering water will be infiltrated on-site within cleared or agricultural areas. Infiltration of dewatering water will be within a defined area (may require earth bunding).

6. Dewatering to native vegetation will only occur where no other practicable disposal option exists.

7. Dewatering water maybe used for dust suppression if monitoring confirms that the discharge water meets the following water quality criteria for discharge to land (below).

Dewatering to a Watercourse

8. Dewatering water may be discharged to a watercourse if monitoring confirms that the water meets the water quality criteria for discharge to a watercourse (Table 8-2).

9. Dewatering water will be discharged to a watercourse via a settling tank/bund to remove suspended sediments. The size of the settling tank/bund will be designed (subject to land availability) to allow for sufficient retention time to remove visible suspended solids.

10. The dewatering water will be discharged from the settling tank/bund onto a hard surface (such as a rocky ledge), or via a diffuser, to minimise flow velocity that could erode the watercourse bed, banks or vegetation of the watercourse, and to aerate the discharge.

11. A continuous row(s) of sterile hay bales or geofabric will be installed, through which the discharge will pass prior to entering the watercourse if the settling tank/bund does not sufficiently remove suspended sediments (i.e. the watercourse is visibly turbid). The bales/geofabric will be fixed using stakes to the base of the watercourse. The bales/geofabric and stakes will be removed following the completion of discharge.

12. If required, the dewatering discharge will be dosed with Alum (aluminium sulphate - $Al_2(SO_4)^{3-}$) to remove sediments from suspension within the settling tank/bund or on the discharge side of the bales/geofabric. The concentration of alum required will be dependent on the level of sedimentation of the water. Soda Ash will also be applied (sodium carbonate - Na_2CO_3) during Alum dosing at a rate of 2 parts Alum: 1 part Soda Ash for pH correction.

Monitoring of Dewatering Discharge to a Watercourse or Land

13. The discharge water will be monitored at the discharge point once per day for pH and temperature using a calibrated multimeter probe(s).

14. The water within a watercourse to which dewatering water is discharged will be monitored at 100m upstream and 100m downstream of the discharge point for pH and temperature using a calibrated multimeter probe(s). The results of discharge will be compared to the upstream water quality.

15. The discharge will be managed such that the following water quality objectives are achieved:

	Temperature	pH
Discharge to Watercourse[5]	Within ± 2 degrees Celsius in watercourse (100m downstream v. 100m upstream)	6.0-8.5 for discharge water *or* within ± 2 pH units in watercourse (100m downstream v. 100m upstream)
Discharge to Land	Not applicable	4-10 for discharge water[6]
Discharge to Ocean	Not applicable	4-10 for discharge water[6]

Table 8-2 Dewatering Discharge Objectives.

16. A visual turbidity assessment will be taken of the discharge and of the watercourse at 100m upstream and downstream of the discharge.

17. Sterile hay bales and/or a geofabric will be installed within the watercourse downstream of the discharge to reduce turbidity if the watercourse is identified as visibly turbid.

18. The watercourse will be dosed on the discharge side of the bales/geofabric with Alum (aluminium sulphate - $Al_2(SO_4)^{3-}$) to reduce turbidity if the installation of bales/geofabric does not sufficiently reduce turbidity. The concentration of alum required will be dependent

on the level of turbidity of the water. Soda Ash (sodium carbonate - Na_2CO_3) will also be applied during Alum dosing at a rate of 2 parts Alum: 1 part Soda Ash for pH correction.

19. The results of monitoring for pH, temperature and turbidity will be recorded on the Water Discharge Monitoring Log.

20. The pH of the dewatering waters will be neutralised with liquid lime if the dewatering discharge water quality does not meet the discharge objectives for pH. The rate of neutralisation will be based on achieving a neutralised discharge quality to within the pH discharge water objective of pH 6.0-8.5 for a watercourse or pH 4.0-10.0 for discharge to land or ocean.

21. The rate of dewatering will be adjusted, or location of dewatering changed, if the dewatering discharge to a watercourse does not meet the temperature discharge objectives.

Dewatering on Boonilup Road Wetland (Watercourse) Area

22. A fixed water level indicator will be installed with 1cm increments into the open water area of each wetland containing open water within 100m of the Water Transfer Pipeline on Boonilup Road (excluding the Harvey-Myalup Drain).

23. The wetland water levels will be monitored and recorded on the Wetland Water Level Monitoring Log to 1cm accuracy in all wetlands within 100m of the Water Transfer Pipeline on Boonilup Road on each day during construction.

24. Dewatering water may be temporarily discharged to any wetland that records a reduction in water level greater than 10cm (and accounting for any natural reduction in water levels recorded in wetlands beyond the immediate construction area). Discharge will continue until the natural water level is restored to within 1cm. Discharge will be monitored and recorded on the Water Discharge Monitoring Log.

ASS Soil Management

25. The ASS risk (based on preconstruction investigations) will be marked on the infrastructure maps for the Water Transfer Pipeline (Appendix 2). The maps will identify a 500m/100m buffer on pipeline areas identified as having ASS given the investigation confidence (sampling) interval was 500m/100m for preconstruction investigations.

26. Field sampling and field analysis will be conducted for pH_F and pH_{FOX} at 50m intervals within the 500m/100m buffer during construction to determine the starting location of ASS where present. The field sampling and analysis will be conducted in accordance with Appendix 1 of *Performing and Interpreting Soil Field pH* of *Draft Identification and Investigation of Acid Sulfate Soils* (DoE, May 2006).

27. ASS material will be stockpiled separately from non-ASS material. Stockpiles of ASS material will be placed on a pad of Aglime (pulverised limestone) of no less than 100mm depth.

28. Stockpiles of ASS material will be neutralised by thorough mixing with the following ratios of aglime (pulverised limestone) based on the ASS risk supplied in Appendix 2:

	ASS Assessment			
	Nil	**Low** *(S% 0.03-0.4)*	**Medium** *(S% 0.5 -1.9)*	**High** *(S% 2.0-5.0)*
Rate of Aglime dosing[7] (tonne of lime : tonne soil excavated)	No treatment required	2:100	8:100	19:100

Notes:
1. Ratios are based on tonnage, not volume. Estimation of the bu k density of the ASS material is required prior to neutralisation.
2. Aglime dosing rates are for pure fine Aglime (100% $CaCO_3$) using a safety factor of 1.5. If commercial grade lime is used the rates must be proportionally emended to account for change in purity.
3. Aglime dosing rate includes the weight of Aglime pad on which ASS material is placed.
4. Limestone has not been recommended given low surface (reaction) area and high volume requirements for neutralisation.

Table 8-3 Aglime Dosing Rates for ASS Soils.

29. Neutralised ASS material maybe disposed of to:
    a. the excavated trench.
    b. a suitable location agreed with the Landowner (the Landowner has first preference to retain excess overburden from their own property).
    c. a suitable location agreed with adjacent Landowners (with preference to Landowners on the pipeline route) or other nearby Landowners.
    d. a local landfill as inert waste.
    e.

Reporting

30. The following details will be recorded and reported weekly:
    a. volume of dewatering.
    b. locations of dewatering discharge.
    c. volume of ASS material excavated and neutralised.
    d. disposal locations of neutralised ASS material.

8.5 Additional Information

ASS Sampling

[1] It is noted that *Draft Identification and Investigation of Acid Sulfate Soils* (DoE, May 2006) recommends an ASS linear sampling interval of 50m. The preconstruction sampling interval to be undertaken for the pipeline will be at 500m intervals (which is predominantly "moderate to low risk"), with 100m intervals for the Boonilup Road section (which is mostly "moderate to low risk" with sections of "high to moderate risk"). The recommended interval of 50 metres for investigative sampling is not practicable (would equate to approximately 800 sites), consequently, a conservative linear interval buffer of 500m/100m will be added to the results of investigation sampling from the ASS delineation mapping, with field testing at 50m intervals conducted during construction for field delineation.

[2] It is noted that *Draft Identification and Investigation of Acid Sulfate Soils* (DoE, May 2006) recommends an ASS vertical sampling interval of 0.25 metres, or greater where soil layers are less. The recommended interval for investigative sampling is not considered necessary as the material will not be returned in layers (excepting topsoil). One sample from each soil layer will be sufficient to determine the overall ASS risk and allow ASS, if present, to be quantified by volume and concentration for effective management during construction.

[3] 4 metres is the approximate maximum reach of the machinery which will be used for geotechnical excavations and construction. Sampling beyond this depth is not practicable.

[4] SPOCAS tests are being conducted on all soil samples collected. Tests for pH_F and pH_{FOX} will not be conducted for pre-construction delineation of ASS as the DEC (formerly as the WA Department of Environment, May 2006) identifies that tests for pH_F and pH_{FOX} have a 20-40% error (false positives and false negatives). Consequently, tests for pH_F and pH_{FOX} (as a precursor for determining the need for SPOCAS testing) are not considered by the Principal to be reliable for pre-construction delineation of ASS.

Dewatering Discharge

[5] pH 6.5 is the lower guideline value for South-western freshwater river ecosystems by ANZECC (2000). pH 6.0 is the guideline action trigger level recommended by DoW (2006).

[6] pH range of 4-10 is consistent with the *Environmental Protection (Unauthorised Discharges) Regulations 2004* (WA).

[7] the aglime dosing rate is based on Appendix 1 of *Acid Sulfate Soils Guideline Series – Treatment and Management of disturbed acid sulfate soils* (DEC, October 2004).

Dewatering Licence

A licence from the DoW to conduct dewatering activities is not required as a result of powers contained in s83(2)(b)(i) of the *Water Agencies (Powers) Act 1984* (WA).

8.6 Contingency Actions

No contingency actions are considered necessary.

8.7 Related Plans

1. Land Clearing and Trench Management Plan
2. Watercourse Crossing Management Plan

8.8 Relevant Legislation

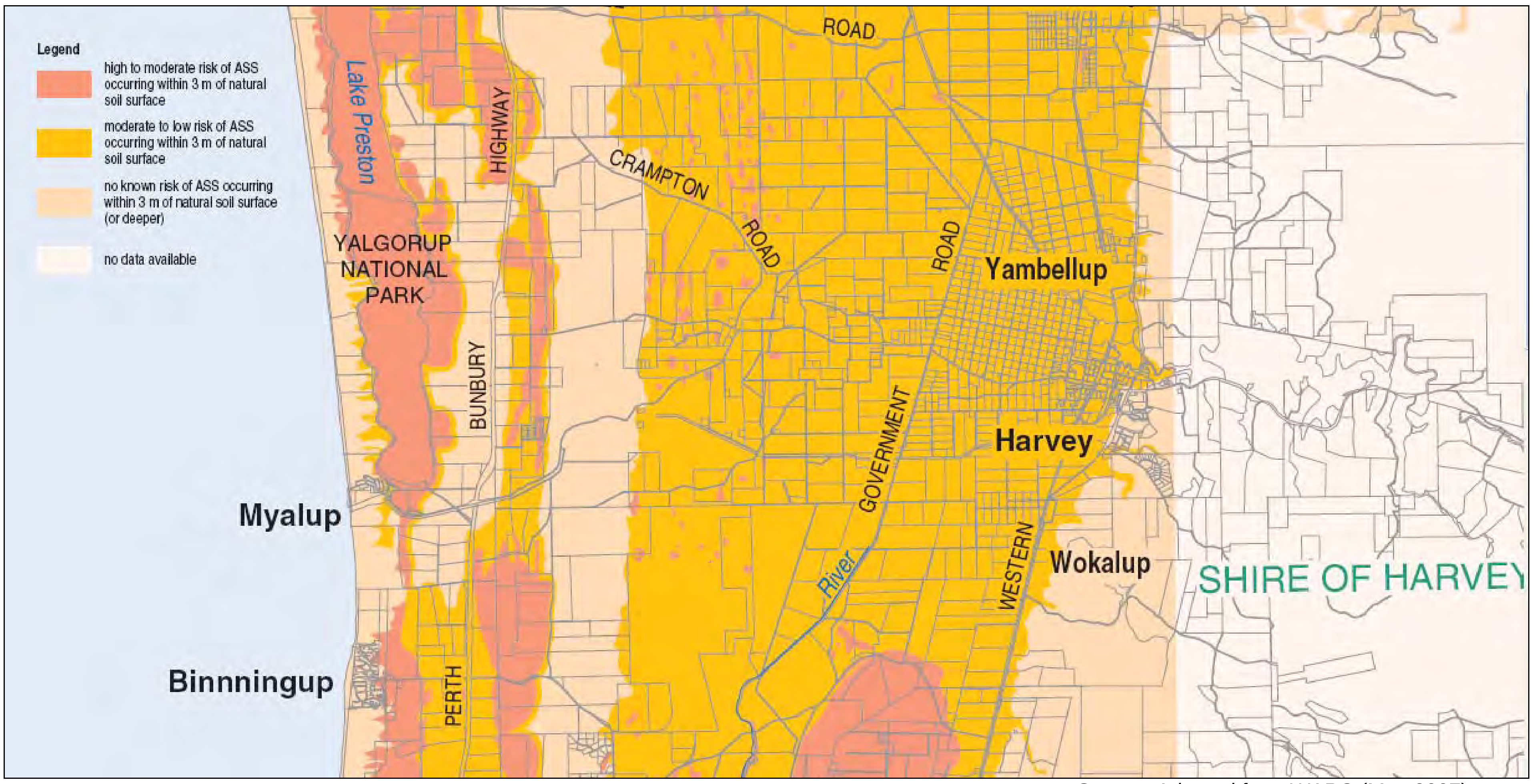
1. *Environmental Protection Act 1986*, and *Regulations 1987* (WA).
2. *Environmental Protection (Unauthorised Discharges) Regulations 2004* (WA)
3. *Contaminated Sites Act 2003*, and *Regulations 2006* (WA).
4. *Water Agencies (Powers) Act 1984* (WA).

8.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DEC
2. DoW

Figure 8-1 ASS Risk Mapping for the Construction Area.



. Source: Adapted from WAPC (May 2007).

Table 8-4 Water Discharge Monitoring Log

Southern Seawater Desalination Project
Dewatering and Acid Sulphate Soils Management

Water Discharge Monitoring Log

The purpose of the Water Discharge Monitoring Log is to record the water quality of water discharge to land/water. The Water Discharge Monitoring Log is to be completed by the Site Environmental Scientist on each day of water discharge.

Name ………………………………………………………………………………………

Page ……… of ………

Date of Entry	Property Description and Sample Site (e.g. discharge, watercourse upstream or downstream)	Discharge Rate (L/min)	Temp. (^oC)	pH	Turbidity (visible)	Name and Position	Initial

Table 8-5 Wetland water Level

Southern Seawater Desalination Project
Dewatering and Acid Sulphate Soils Management

Wetland Water Level Monitoring Log

The purpose of the Wetland Water Level Monitoring Log is to record the water level in the open water of wetlands within 100m of the Boonilup Road Section of the Water Transfer Pipeline. The Wetland Water Level Monitoring Log is to be completed by the Site Environmental Scientist on each day of construction of the Water Transfer Pipeline on Boonilup Road.

Name ……………………………………………………………………………………

Page ……… of ………

Date of Entry	Wetland No / Description	Water Level at Construction Start (cm)	Current Water Level (cm)	Is Level Change greater than 10cm?	Dewatering to wetland required (accounting for natural reductions in water level)?	Name and Position	Initial

9.0 Hygiene (Plant Pathogen) Management

9.1 Context

The construction areas may contain infestations of the plant pathogens that cause Phytophthora Dieback (*Phytophthora cinnamomi*) and Armillaria Root Disease (*Armillaria luteobubalina*). The symptoms of plant pathogens include the dieback of limbs and branches, yellowing of foliage, and vegetation death.

The construction areas also contain a range of weed species, which have the potential to compete with native flora and can affect agricultural productivity. Dormant weed seeds can be contained in topsoil, which when disturbed by construction activities can cause the weed seeds to germinate. Weed species are often opportunistic and can quickly colonise cleared land.

Plant pathogens and weeds are spread through the movement of soil from infected areas to uninfected areas. The construction areas will be surveyed prior to construction for evidence of plant pathogens and significant weed infestations. These areas will be marked on the infrastructure maps contained in Appendix 2.

9.2 Purpose

The purpose of the Hygiene Management Plan is to outline management actions to minimise:

1. the spread of the plant pathogens (*Phytophthora cinnamomi* and *Armillaria luteobubalina*) and weeds from infested to uninfested land.

9.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the management actions (hygiene procedures) to minimise the spread of plant pathogen and weeds.
2. Weed distribution and density post-construction compared to pre-construction records.

9.4 Management Actions

Prior to Construction

1. Identified infestations of declared weeds and Watsonia (*Watsonia bulbillifera*) will be sprayed to minimise weed spread during construction.

2. It will be ensured that vehicles and machinery (including wheels, racks, undercarriage and inside cabins) and footwear are to be inspected and cleaned of sods of dirt and slurry prior to entry to the construction areas.

Construction

3. Construction materials (e.g. soil, revegetation material) will not be sourced from areas known to contain forest diseases or high weed infestations.

4. Hygiene Inspection Points (with signage, refer Figure 20) will be established at the sites to be marked on the infrastructure maps contained in Appendix 2 (based on a pre-construction dieback survey to prevent soil transfer from infected areas to uninfected 'protectable' areas).

5. It will be ensured that all vehicles, footwear and equipment entering the Hygiene Inspection Points will be cleaned to remove attached sods of dirt (including the tyres, undercarriage and inside cabin of the vehicle). Vehicles, footwear and equipment will be cleaned by:

a. air hosing and brushing during dry conditions.
b. low volume, high pressure water hosing during wet/boggy conditions.

6. Construction vehicles will be kept within the clearing corridor (nominally 20 metres in native vegetation and 30m in agricultural land – refer to Land Clearing and Trench Management Plan).

7. Topsoil, overburden or vegetation will not be transported from dieback infected areas to uninfected 'protectable' areas.

8. Excess overburden will be disposed of from dieback infected areas on-site within the dieback infected construction corridor by evenly spreading over the construction area prior to spreading the infected topsoil. This may result in a raised land level. Where disposal of overburden by this manner is not practicable due to excessive mounding, an alternative disposal location will be sought.

9. Cleared vegetation will not be removed from determined dieback infected areas. All cleared vegetation from dieback infected areas will be retained within the dieback infected areas.

10. Topsoil will not be respread from agricultural areas in areas of native vegetation in order to minimise the spread of pasture species.

Post-Construction

11. The construction area will be monitored for weed infestations in spring (September to November) for a period of 12 months following completion of the construction works. The monitoring will include:
    a. the species of weeds identified.
    b. an estimation of the distribution and densities of weeds.
    c. a comparison with pre-construction weed distribution and densities to identify areas requiring spraying, based on photographs from the land condition survey (refer to Land Clearing and Trench Management Plan).

12. The construction areas will be sprayed where weed infestations exist at densities or distributions at more than 50% above pre-construction levels during the 12 month weed monitoring period. The spraying of agricultural land will be conducted in consultation with the Landowner using a herbicide listed in the 2006/2007 DAF Canola, Pulse and Legume Pasture Spraying Charts (Bulletin 4674, 2006) (refer Figure 21). The spraying within native vegetation will be conducted using Fusilade® herbicide. Weed infestations immediately adjacent to watercourses will be sprayed in a manner which prevents overspray to the watercourse, or alternatively the weeds will be removed by hand.

13. The construction area will be monitored for weed infestations annually in spring (September to November) for a further period of 2 years following completion of the construction works. The monitoring will include:
    a. the species of weeds identified.
    b. an estimation of the distribution and densities of weeds.
    c. a comparison with pre-construction weed distribution and densities to identify areas requiring spraying, based on photographs from the land condition survey (refer to Land Clearing and Trench Management Plan).

14. The construction areas will be annually sprayed where weed infestations exist at densities or distributions at more than 50% above pre-construction levels during the 3 year weed monitoring period. The spraying of agricultural land will be conducted in consultation with the Landowner using a herbicide listed in the 2006/2007 DAF Canola, Pulse and Legume Pasture Spraying Charts (Bulletin 4674, 2006) (refer Figure 21). The spraying within native vegetation will be conducted using Fusilade® herbicide. Weed infestations immediately adjacent to watercourses will be sprayed in a manner which prevents overspray to the watercourse, or alternatively the weeds will be removed by hand.

9.5 Additional Information

Hygiene Inspection Points

Hygiene Inspection Points will be designed such that:

1. there is physical separation between object being cleaned and effluent produced (i.e. grate over a sump).
2. cleaning wastewater is infiltrated on-site within infested areas.
3. the object being cleaned does not become re-contaminated by the wastewater.

Figure 9-1 Hygiene Inspection Point Signage.

(600 x 350mm – Black lettering on white background. Corporate logos are in colour)

Herbicides

A range of herbicides suitable for use is contained in spray charts produced by the DAF (refer Figure 21). As different herbicides may use the same active ingredient, but with varying concentrations, the application rate must be adjusted according to the directions supplied by the manufacturer of each individual herbicide.

9.6 Contingency Actions

No contingencies are considered necessary.

9.7 Related Plans

1. Land Clearing and Trench Management
2. Watercourse Crossing Management

9.8 Relevant Legislation

1. *Conservation and Land Management Act 1984*, and *Regulations 2002* (WA)
2. *Agriculture and Related Resources Protection Act 1976* (WA)

9.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DEC
2. DAF
3. Conservation Commission

Figure 9-2 DAF Spray Charts. Page 1 of 7.

Grains Research & Development Corporation

2006/2007
CANOLA, PULSE AND LEGUME PASTURE SPRAYING CHARTS
BULLETIN 4674

ISSN 1448-0352
Replaces Bulletin 4618

Government of Western Australia
Department of Agriculture

These charts list herbicides registered in Western Australia for the control of weeds in pulse and canola crops and legume pastures.

Compiled by Vanessa Stewart, John Moore and Julie Roche

USERS OF ANY CHEMICAL PRODUCT SHOULD ALWAYS READ THE PRODUCT LABEL BEFORE USE AND FOLLOW THE DIRECTIONS SPECIFIED ON THAT LABEL

REGISTRATIONS

These charts summarise registered broad acre herbicide uses and rates per hectare for common weeds and should be used as a guide only.

PRODUCTS CONTAINING THE SAME ACTIVE INGREDIENT

For many herbicides there may be a large number of alternative products containing the same or different concentrations of the same active ingredient.

In these charts a representative active ingredient concentration has been specified and the herbicide rate stated is for products with that concentration.

Where it is known that there are alternative products available that have a different active ingredient concentration/s the following statement has been included with the product details (in red text):

'Alternative concentration/s available'

Where this alert appears users should check their product label to determine active ingredient concentration and use the rates specified on that label.

ALTERNATIVE PRODUCTS

There may be variation in registered uses, withholding periods and rates between alternative products containing the same active ingredient at the same and/or different concentrations of that active ingredient. Follow the directions on the label of the product to be used.

CODE

The chart should be read with reference to the code present.

WEED IDENTIFICATION

To identify weeds mentioned in this chart consult:

- *Weeds: The Ute Guide (Southern Edition Version 2)*
Available GRDC Ground Cover Direct - 1800 11 00 44
- *Western Weeds (A guide to the weeds of Western Australia)*
Available Department of Agriculture Western Australia (South Perth) - (08) 9368 3333

IMPORTANT DISCLAIMER

1. The information in this chart has been written for Western Australian conditions and may not be applicable or suitable for use in States other than Western Australia.
2. The State of Western Australia, the Minister for Agriculture, the Chief Executive Officer of the Department of Agriculture, the Grains Research and Development Corporation and their respective officers, employees and agents:

a) do not make any representation or warranty as to the accuracy, reliability, completeness or currency of the information in the chart (including but not limited to information which has been provided by third parties);

b) make no representation or warranty that any of the active ingredients or products specified in this chart are registered pursuant to the Agricultural and Veterinary Chemicals Code Act 1994 (WA);

c) have relied on the information contained in the Australian Pesticides and Veterinary Medicines Authority database and herbicide labels in preparing this chart and accept no liability for any errors in this chart that arise from such reliance; and

d) will not be liable, in negligence or otherwise, to any person for any loss, liability or damage arising out of an act or failure to act by any person in using or relying on any information, representation or statements contained in this publication.

Notes

Restricted herbicides

The following herbicides have restricted use in areas where grapes and tomatoes are grown commercially:

MCPA, MCPB, 2,4-D, 2,4-DB, dicamba and picloram.

Consult the Department of Agriculture for information concerning the storage and application of these herbicides near these areas.

2,4-D Additional label instructions for application

Additional instructions to strengthen the current label warnings in relation to minimising chemical spray drift.

"This is a PHENOXY HERBICIDE that can cause severe damage to susceptible crops such as cotton, grapes, tomatoes, oilseed crops and ornamentals.

- DO NOT use unless wind speed is more than 3 kilometres per hour and less than 15 kilometres per hour as measured at the application site.

- DO NOT apply with smaller than coarse to very coarse spray droplets according to the ASAE S572 definition for standard nozzles."

Herbicide compatibility - Tank mixing

Before tank mixing pesticides you should ask the following questions;

- Is the mixture proven and registered?

- Is the proposed mixture the best approach to the problem?

Before making a mixture the physical compatibility of the components should be checked. This can be done in a glass jar or similar transparent container. It requires accurate measurement of the component chemicals and mixing in the correct volume of water so as to achieve the same concentrations as the proposed tank mix. Use the same water as that which will be used in the paddock.

Allow test jar to sit for several hours or longer following agitation.

If gelling, precipitation or separation occurs after standing then the tank mix should not be used unless after re-agitation the gel or precipitate goes back into solution or suspension.

Mixing Order

Fill the tank with water to at least one third to half full then mixing should be in the order of:

- wettable powders,
- flowables,
- emulsifiable concentrates,
- water solubles
- followed by surfactants.

Physical compatibility does not imply biological compatibility. Unproven tank mixes may have poorer weed control and/or cause crop damage. Compatibilities should be checked annually as formulations may vary between seasons and between companies.

Check the label for information on product compatibilities and recommendations on suggested intervals between application of various products.

Check label for information on tank mixes and the addition of crop oils and other surfactants/adjuvants. The addition of adjuvants to some herbicides or mixtures can result in severe crop damage.

Herbicide resistance

Continuous use of the same herbicide or herbicides with the same mode of action may lead to the development of herbicide resistance to that group of chemicals. Selection of resistant populations can occur in as little as 3-4 years.

Research indicates that once a weed population is resistant to herbicides from MOA groups A and B it will not become susceptible to those herbicides again.

Herbicide Mode of Action

Herbicides act by interfering with specific processes occurring in plants. This interference is described as the herbicide's Mode of Action. In Australia, the group to which a herbicide product belongs is identified by a letter code, A, B, C... This code is found on all product labels and herbicide drums.

Avoiding herbicide resistance

The adoption of Integrated Weed Management (IWM) is likely to prevent or at least delay herbicide resistance.

IWM involves the use of many different approaches to weed control including techniques that are chemical, mechanical, agronomic and biological.

Examples of weed management techniques include cultivation, burning, grazing, hay cutting, spray topping, crop topping, seed collection, seeding rates, crop competition and crop choice/rotation.

Resistance risk of herbicides

The risk of developing resistance to herbicides is different for each of the mode of action groups. A low risk rating does not mean that resistance will not develop.

High Risk – Group A and Group B herbicides

Moderate Risk – Groups C, D, E, F, G

Low risk – Groups I, J, K, L, M, N

Herbicide use guidelines

1. Read the label.
2. Apply only one application of any herbicide from any herbicide MOA group in a single season.
3. Where a herbicide from a specific group has been used on a particular paddock, avoid using a herbicide from the same group in the following season for control of that weed in that paddock.
4. Consider using tank mixes of products with different modes of actions that also control the target weed species.

Herbicide Mode of Action Groups

MOA	MOA Sub-group	Example Herbicides
A	Fops - Aryloxyphenoxy-propionates	Diclofop-methyl, fenoxaprop haloxyfop, propaquizafop, quizalofop
	Dims - Cyclohexanediones	Butroxydim, clethodim, sethoxydim, tepraloxydim, tralkoxydim
B	Sulfonyl ureas	Chlorsulfuron, iodosulfuron-methyl, mesosulfuron-methyl, metsulfuron, triasulfuron
	Sulfonamides	Flumetsulam, metosulam
	Imidazolinones	Imazamox, imazapic, imazapyr, imazethapyr
C	Ureas	Diuron, linuron
	Triazines	Atrazine, cyanazine, simazine, terbutryn
	Triazinones	Metribuzin
	Nitriles	Bromoxynil
D	Dinitro-anilines	Oryzalin, pendimethalin, trifluralin
E	Thiocarbamates	Tri-allate
F	Nicotinanilides	Diflufenican, picolinafen
	Isoxazolidinones	Isoxaflutole
G	Diphenyl ethers	Oxyfluorfen
	Pyrimidinones	Butafenacil
	Triazolinones	Carfentrazone-ethyl
I	Benzoic acids	Dicamba
	Phenoxyalkanoic acids	2,4-D, 2,4-DB, MCPA
	Pyridine carboxylic acids	Clopyralid
K	Amides	Metolachlor
	Amino propionates	Flamprop-methyl
	Benzamides	Propyzamide
L	Bipyridyliums	Diquat, paraquat
M	Glycines	Glyphosate
N	Glycines	Glufosinate

Known resistant weeds in Australia

Weed species	MOA groups to which resistance has developed
Annual ryegrass	A, B, C, D, E*, K*, M
Barley grass	A, B, L
Brome grass	A
Capeweed	L
Fumitory (Dense Flower)	D
Indian hedge mustard	B
Paterson's curse	B
Prickly lettuce	B
Silvergrass	L
Sowthistle	B
Wild oat	A, B, K
Wild radish	B, C, F, I
Wild turnip	B

* Resistance to these MOA groups has been detected in cross resistance testing - not in populations where field selection of resistance has occurred.

Figure 9-2. DAF Spray Charts. Page 2 of 7. Print A3 for best results.

Pasture topping options - label registrations

Herbicide	Trade name	Operation	Rate/ha	Withholding period	Notes - See label for additional critical comments
Diquat/paraquat 115/135 g/L	e.g. Spray.Seed®	Spray topping for control of grass seed set	**800 mL/ha**	GSF - 1 day (7 days horses) - remove stock from treated areas 3 days before slaughter	- Apply in a minimum of 50 L/ha water by boom spray. - Apply at end of growing season. Heavily graze paddocks during spring flush period to prevent early seed heads emerging. - Remove all stock about 3 weeks before end of growing season to allow seed heads to emerge evenly. - Set boom spray at a height to give double overlap spray pattern at the top of the pasture being sprayed.
		Hay freezing	**1.5 L/ha**	As above	- Hay freezing for maximum retention of protein for summer grazing.
Paraquat 250 g/L	e.g. Gramoxone® (alternative paraquat products are available which have this registration)	Spray topping Grasses generally (particularly Annual ryegrass)	**400 mL/ha**	GSF - 1 day (7 days horses) - remove stock from treated areas 3 days before slaughter	- Heavily graze paddocks during spring flush to encourage even head emergence. - Remove stock 2-3 weeks before anticipated maturity of target. - Delay spraying until last heads at the bottom of the plant have emerged and initial signs of haying off appear. - Set boom spray at a height to give double overlap spray pattern at the level of the seed heads.
		Spray topping Barley grass	**400 mL/ha**	As above	- Manage paddocks as above. Spray after head emergence when all seed heads are green and no sign of haying off.
		Spraytop - graze to destroy seed heads (Prevention of Annual ryegrass Toxicity (ARGT))	**400 mL/ha**	As above	- Grazing management as for spray topping. Remove stock 3-4 weeks before anticipated maturity date. - Spray must be applied within 10 days of first annual ryegrass seed heads emerging. - To ensure adequate control of toxin development, heavy continuous grazing is essential from 1 day after spraying until the pasture has completely hayed off. Regrowth after spraying must be eaten off to prevent new seed heads which could become toxic.
		Hay freezing	**800 mL/ha**	As above	- Graze paddocks as for spray topping. Remove stock 3-4 weeks before anticipated maturity. Apply prior to start of haying off regardless of grass species.
Glyphosate 450 g/L (isopropylamine salt) **	Numerous	Pasture topping for annual grass and Capeweed seed set reduction	Barley grass, Brome grass, Capeweed, Silvergrass: **240-360 mL/ha**; Annual ryegrass: **360 mL/ha**	Not required when used as directed	- Remove stock prior to treatment to allow even regrowth. - Apply to capeweed and annual ryegrass at flowering. For other grasses apply from head - milky dough stage. - Use high rate for dense infestations or where annual ryegrass is present. - Apply before signs of plants haying off. - Reduction in pasture legume population may occur. - DO NOT apply to clover or medic crops intended for seed or hay.

** NOTE: Glyphosate products come in many different concentrations of active ingredient and in different formulations. Follow directions and use rates specified on the label of the product being used.

Figure 9-2. DAF Spray Charts. Page 3 of 7. Print A3 for best results.

Pulse and canola crop-topping, pre-harvest desiccation and pre-harvest weed control registrations

Herbicide	Trade name	Operation	Crop	Rate/ha	Withholding period	Notes - See label for additional critical comments
Diquat 200 g/L	Reglone®	Pre-harvest crop desiccation	Chickpeas, Faba beans, Dry peas Lentils, Lupins	2 to 3 L/ha	GSF: 1 day Harvest: Lupins - NS Chickpeas, Lentils, Faba beans, - 2 days Dry peas - NRD	- Spray as soon as crop reaches full maturity. - Helps overcome slow and uneven ripening and harvest weed problems - Add Agral® at 200 mL/100 L or BS 1000® at 160 mL/100 L prepared spray.
		Pre-harvest crop desiccation	Canola	1.5 to 3.0 L/ha	GSF: 1 day Harvest: 4 days	- Spray when 70% of the pods are yellow and the seeds are browny/bluish and pliable. - Canola ripens unevenly and is prone to pod shatter and seed loss. - Direct harvest 4-7 days after spraying. - Add Agral® at 200 mL/100 L or BS 1000® at 160 mL/100 L.
Paraquat 250 g/L	e.g. Gramoxone® (Alternative paraquat products are available which also have this registration)	Crop topping to reduce Annual ryegrass seed set	Chickpeas, Faba beans, Field peas, Lentils, Lupins, Vetch	400 or 800 mL/ha	GSF: 1 day (7 days horses) - remove stock from treated areas 3 days before slaughter Harvest: 14 days	- Spray when the ryegrass is at the optimum stage, that is when the last ryegrass seed heads at the bottom of the plant have emerged and the majority are at or just past flowering (with anthers present or glumes open) but before haying off is evident. - Use of the higher rate in these crops is usually more reliable and gives a greater reduction in seed set. - Reduction in crop yield may occur especially if the crop is less advanced relative to the ryegrass, that is if crops have a majority of green immature pods. The higher rate may also result in higher yield losses. In practice crop yield losses in excess of 25% may occur. - Apply by ground boom only in 50-100 L/ha. - Spray with a calibrated boom spray designed to give double overlap at the level of the ryegrass seed heads. Pressures of 250-350 kPa and use of 110015 or 02 nozzles or equivalent will aid coverage.
Glyphosate **540 g/L**	Roundup PowerMAX®[1]	Crop topping to reduce viable seed set (Annual ryegrass)	Faba beans, Field peas	320-680 mL/ha	GSF: 7 days Harvest: 7 days	- Use lower rate if ryegrass is flowering and higher rate if ryegrass is at milky dough stage. - Application should be made at or after crop maturity. Application before this time may significantly reduce yields (in practice losses in excess of 25% can occur). - Apply when the average seed moisture content is below 30%. For Faba beans this is indicated by the pods going black, for Field peas by the pods going yellow. - DO NOT USE ON CROPS INTENDED FOR SEED OR SPROUTING
		To desiccate crop as a harvest aid and weed control (may reduce germination % of seed to unacceptable levels of crops intended for production)	Chickpeas, Faba beans, Field peas, Lentils	680 mL - 1.8 L/ha	GSF: 7 days Harvest: 7 days	- Apply by boom or by air. Use higher rates where crops or weeds are dense and where faster desiccation is required. Application should be made at or after crop maturity. - Chickpeas and Lentils - apply when physiologically mature and less than 15% green pods. - Field peas - apply when seeds turn yellow and average seed moisture content is below 30%. - Faba beans - apply when the pods turn black and average seed moisture content is below 30%.
Metsulfuron + Glyphosate **540 g/L**	Ally® +Roundup PowerMAX®[2]	Crop desiccant and knockdown weed control	Chickpeas	5 g + 0.5-1.1 L	GSF: 7 days Harvest: 7 days	- Apply when chickpeas physiologically mature with < 15% green pods - Use higher glyphosate rate when crops or weeds are dense and faster desiccation required.

[1,2] While there are alternative glyphosate and metsulfuron products available as far as we can determine they do not currently have these registrations on their labels for WA and as such cannot be used for this use. Registration changes occur frequently. Check the label of your specific product to see if a registration is in place for Western Australia.

Figure 9-2. DAF Spray Charts. Page 4 of 7. Print A3 for best results.

HERBICIDE OPTIONS FOR USE IN LEGUME PASTURES

Weeds	PRE-EMERGENCE			POST-EMERGENCE											
	IMAZETHAPYR 700 g/kg (Spinnaker®)	S-METOLACHLOR 960 g/L (Dual® Gold) Alternative concentration/s available	TRIFLURALIN 480 g/L Alternative concentration/s available	2,4-D AMINE 500 g/L (Spray/Graze) Alternative concentration/s available	2,4-DB 500 g/L (e.g. Buttress®) Alternative concentration/s available	ATRAZINE 500 g/L Alternative concentration/s available	BROMOXYNIL 200 g/L (e.g. Bromicide®)	BROMOXYNIL/DIFLUFENICAN 250/25 g/L (e.g. Jaguar®) Alternative concentration/s available See notes regarding rates	BUTROXYDIM/FLUAZIFOP 250/212 g/kg (Fusion®Super)	DICLOFOP-METHYL 375 g/L	DIFLUFENICAN 500 g/L (e.g. Brodal® Options)	DIFLUFENICAN/MCPA 25/250 g/L (e.g. Tigrex®) Alternative concentration/s available	DIQUAT 200 g/L (Reglone®)	DIURON 900 g/kg Alternative concentration/s available	FLUAZIFOP-P-BUTYL 128 g/L (Fusilade® Forte) Alternative concentration/s available
Herbicide Group	B	K	D	I	I	C	C	C/F	A/A	A	F	F/I	L	C	A
Annual ryegrass	70-140 g S	NRW	1.2-1.7 L			NRW			230-320 g	1.0 L				1.0-2.0 kg	820 mL Luc 0.82-1.24 L
Barley grass	70-140 g S		NRW						230-320 g				see label	1.0-2.0 kg	820 mL Luc 0.82-1.24 L
• Brome grass			NRW S						285-320 g				see label	NRW S	820 mL Luc 0.82-1.24 L
• Cape tulip				NRWA	see label										
Capeweed	NRWA S			0.75-1.0 L	2.1-3.2 L	NRW	1.4-2.0 L	500 mL-1.0 L			200 mL S	0.5-1.0 L	see notes	1.0-2.0 kg	
• Chickweed	NRWA							1.0 L S			NRWA S	1.0 L S		2.0 kg	
Corn gromwell (Ironweed, Sheepweed)							1.4-2.0 L	500-750 mL			200 mL S	1.0 L		NRW S	
•Cotula							NRWA	NRWA							
• Crassula								500 mL S			200 mL S	500-750 mL		NRW	
Dock (seedlings)				0.75-1.0 L	1.0-2.0 L			1.0 L S				1.0 L S		2.0 kg	
Doublegee (Spiny emex)	70-140 g S			0.75-1.0 L	2.1-3.2 L	NRW	2.0 L	500-750 mL				1.0 L S		1.0-2.0 kg	
• Erodium (Storksbill)	70-140 g			NRWA				500 mL S				1.0 L S	see notes	NRW	
• Fumitory			1.2-1.7 L	see label	see label		2.0 L S	0.75-1.0 L S				see label			
• Iceplant						Permit						1.0 L S		NRW	
• Lesser Canary grass			1.2-1.7 L						230-320 g						820 mL Luc NRW
• Mallows					Not common WA species			NRWA S			200 mL S	1.0 L S			
Mintweed (*Salvia reflexa*)	NRWA					1.1 kg		NRWA S							
• Mustards	70-140 g			0.75-1.0 L	1.0-2.0 L	NRW	2.0 L	0.5-1.0 L			100-200 mL	0.5-1.0 L		NRW	
Paterson's curse	70-140 g S			0.75-1.0 L	2.1-3.2 L		2.0 L S	500-750 mL			NRWA S	1.0 L S			
Peppercress							1.4-2.0 L	1.1 L				1.0 L S			
Prickly lettuce	NRWA S			NRW	2.1-3.2 L			1.0 L S			NRWA	0.5-1.0 L			
Saffron thistle				1.5 L	2.1-3.2 L		1.4-2.0 L	1.0 L				1.0 L S		1.0-2.0 kg	
Silvergrass (Vulpia)													see label		
Slender thistle				0.75-1.0 L	2.1-3.2 L									1.0-2.0 kg	
Sorrel (seedlings)				NRWA				1.0 L S			NRWA S	NRWA			
Sowthistle				0.75-1.0 L	2.1-3.2 L			1.0 L S				1.0 L S		1.0-2.0 kg	
Toad rush	70-140 g	200-250 mL						1.0 L S			NRWA S	1.0 L		NRW	
Volunteer canola	NRW not IT			NRW				500-750 mL				500 mL			
Volunteer cereals									230-320 g						820 mL Luc NRW
Volunteer field peas								750 mL S							
Volunteer lupins	NRW			NRWA				0.5-1.0 L S				1.0 L S			
Wild oat	70-140 g S		1.2-1.7 L S						230-320 g	1.5-2.0 L				NRWA	820 mL Luc 0.82-1.24 L
Wild radish	70-140 g S			0.75-1.0 L	NRWA S	NRW	2.0 L	350 mL-1.0 L			100-200 mL	0.25-1.0 L		NRWA	
Wild turnip				0.75-1.0 L	1.0-2.0 L	NRW	2.0 L	500-750 mL			100-200 mL	0.5-1.0 L		NRWA	
Wireweed	70-140 g S		1.2-1.7 L	NRW	2.1-3.2 L	NRW	2.0 L S	1.0 L			NRWA S	750 mL S		2.0 kg	
Yellow burrweed	NRWA S		NRW				1.4-2.0 L	750 mL			NRWA S			NRW	
Lucerne 1st Year	X	NRC	IBS SCO	NRC	see label	X	1 leaf +	3-8 leaf	PO	SCO	NRC	NRC	NRC	X	> 2-3 leaf
Lucerne Established	after C/G	NRC	IBS SCO	NRC	see label	PO	< 150 mm regrowth	PO	PO	SCO	NRC	NRC	see label	see notes	PO
Medic	NRC	NRC	IBS SCO	NRC	3-8 leaf	NRC	see label	see label	PO	SCO	NRC	NRC	NRC	NRC	PO
Sub Clover	NRC	IPP	IBS SCO	see label	3-8 leaf	NRC	1 leaf +	3-8 leaf	PO	SCO	> 3 leaf	3-8 leaf	NRC	NRC	PO
Serradella	see label	NRC	NRC	NRC	NRC	NRC	NRC	NRC	NRC	SCO	NRC	NRC	NRC	NRC	NRC
Weed Stage	PE	PE	PE	see label	2-6 leaf	5-8 cm	to 6 leaf	see label cot-8 leaf	2 leaf-ET	2-4 leaf	2-6 leaf see label	2-6 leaf see label	see label	PE - seedling	5 leaf - ET
Wetting agent (WA)/Oil	NN	NN	NN	NN	see label	NN	NN	NR	Oil required	WA	NR	NR	WA	NN	NN
Formulation	WG	EC	EC	AC	AC	tank mix	EC	EC	EC	EC	SC	EC	AC	WG	EC
Rainfastness	2 hours	NS	NS	6 hours	4 hours	NS	3 hours	4 hours	1 hour	2 hours	4 hours	4 hours	NS	NS	1 hour
Aerial application	Yes	No	No	Yes	No	No	Yes	NR	Yes	Yes	NS	Not WA	Yes	No	Yes
Withholding Period- GSF	14 days	13 weeks	NRD	7 days	7 days	NRD	14 days	14 days	21 days	7 weeks	14 days	7 days	1 day	NRD	21 days

Weeds	POST-EMERGENCE														
	FLUMETSULAM 800 g/kg (Broadstrike®) Alternative concentration/s available	HALOXYFOP 520 g/L (e.g. Verdict® 520) Alternative concentration/s available	IMAZAMOX 700 g/kg (Raptor®)	IMAZETHAPYR 700 g/kg (Spinnaker®)	MCPA AMINE 500 g/L (Spray/graze)	PARAQUAT (e.g. Gramoxone®) 250 g/L (Autumn/early winter)	PARAQUAT (e.g. Gramoxone®) 250 g/L (Late winter/early spring)	PARAQUAT/DIQUAT 135/115 g/L (e.g. Spray.Seed®)	PROPAQUIZAFOP 100 g/L (e.g. Correct®)	PROPYZAMIDE 500 g/L (e.g. Kerb®)	QUIZALOFOP-P-ETHYL 99.5 g/L (e.g. Targa®) Alternative concentration/s available	SETHOXYDIM 186 g/L (Sertin®)	SIMAZINE 500 g/L Alternative concentration/s available	TEPRALOXYDIM 200 g/L (Aramo®)	TERBUTRYN/MCPA 275/160 g/L (e.g. Agtryne® MA)
Herbicide Group	B	A	B	B	I	L	L	L/L	A	K	A	A	C	A	C/I
Annual ryegrass		75-100 mL + oil 100 mL + WA				Sub 0.6-1.6 L Luc 1.2-1.6 L	Luc 1.6-2.4 L	1.6-2.4 L	300-450 mL	1.0-1.5 L	300 or 375 mL	0.5-1.0 L		175-300 mL	
Barley grass		50-75 mL + oil 75-100 mL + WA	45 g			Sub 0.6-1.6 L Luc 1.2-1.6 L	Luc 1.6-2.4 L	1.6-2.4 L	200 mL	1.0-1.5 L	250 mL	see label		175-250 mL	
• Brome grass		50-75 mL + oil 75-100 mL + WA	45 g			Sub 0.6-1.6 L Luc 1.2-1.6 L	Luc 1.6-2.4 L	1.6-2.4 L	300 mL	1.0-1.5 L	300 or 375 mL	see label		175-250 mL	
• Cape tulip					see label										
Capeweed	25 g + D see label				0.35-1.4 L	see label	see label	1.6-2.4 L							1.0-1.5 L
• Chickweed	NRWA S		NRW					1.6-2.4 L		1.5-2.0 L					
Corn gromwell (Ironweed, Sheepweed)								1.6-2.4 L							NRW
•Cotula	25 g					**	**								
• Crassula						**	**								1.0-1.5 L
Dock (seedlings)					0.35-1.4 L										
Doublegee (Spiny emex)	25 g + D		45 g S	see notes		**	**	1.6-2.4 L							NRW
• Erodium (Storksbill)		50-100 mL + oil	45 g		NRWA	see label	see label	1.6-2.4 L							1.0-1.5 L
• Fumitory	NRWA S				see label	**	**	1.6-2.4 L							
• Iceplant															
• Lesser Canary grass						Sub 0.6-1.6 L Luc 1.2-1.6 L	Luc 1.6-2.4 L	1.6-2.4 L		1.0-1.5 L		1.0 L			
• Mallows	25 g see label					**	**	1.6-2.4 L							
Mintweed (*Salvia reflexa*)															
• Mustards	25 g		45 g	70-140 g	0.35-1.4 L	**	**	1.6-2.4 L							NRW
Paterson's curse	25 g S				0.35-1.4 L			1.6-2.4 L		1.5-2.0 L					300-500 mL or 1.0-1.5 L
Peppercress	25 g														
Prickly lettuce															
Saffron thistle					NRWA										NRW
Silvergrass (Vulpia)			50 g see label			Sub 0.6-1.6 L Luc 1.2-1.6 L	Luc 1.6-2.4 L	1.6-2.4 L		1.0-1.5 L			0.75-1.0 L		
Slender thistle					NRWA										
Sorrel (seedlings)										1.5-2.0 L					
Sowthistle					NRWA										
Toad rush				70-140 g		**	**	1.6-2.4 L							1.0-1.5 L
Volunteer canola	25 g (Not IT)				NRWA	**	**	1.6-2.4 L							
Volunteer cereals		50-75 mL + oil 75-100 mL + WA	45 g			Sub 0.6-1.6 L Luc 1.2-1.6 L	Luc 1.6-2.4 L	1.6-2.4 L	200 mL B, O, W 250 mL Tr	NRW	250 mL B, W	1.0 L W, O		175-250 mL	
Volunteer field peas								1.6-2.4 L							
Volunteer lupins	10-25 g		45 g		see label	**	**	1.6-2.4 L							
Wild oat		37.5-50 mL + oil 50-75 mL + WA	45 g			Sub 0.6-1.6 L Luc 1.2-1.6 L	Luc 1.6-2.4 L	1.6-2.4 L	250 mL	1.5-2.0 L	125 or 250 mL	1.0 L		175-250 mL	
Wild radish	25 g S		45 g S		0.35-1.4 L			1.6-2.4 L							
Wild turnip	25 g		45 g		0.35-1.4 L			1.6-2.4 L							NRW
Wireweed	see label		45 g S	70-140 g S				1.6-2.4 L		1.5-2.0 L					NRW
Yellow burrweed	25 g														NRW
Lucerne 1st Year	> 2-3 leaf	> 2 leaf	3 leaf - pre fl	2 leaf +	NRC	X	X	X	PO	3 leaf +	PO	PO	NRC	NRC	NRC
Lucerne Established	PO	> 2 leaf	pre fl	after C/G	NRC	> 12 month	> 12 month	2-4 cm see notes	PO	pre July 31	PO	PO	see label	NRC	NRC
Medic	> 2-3 leaf	> 2 leaf	3 leaf - pre fl see notes	NRC	NRC	NRC	NRC	NRC	PO	3 leaf +	PO	PO	NRC	NRC	NRC
Sub Clover	> 2-3 leaf	> 2 leaf	3 leaf - pre fl	see label	4 leaf - pre fl	> 6 leaf	NRWA	> 6 leaf see notes	PO	3 leaf +	PO	PO	3 leaf < 8 wks post sow	SCO	3 leaf +
Serradella	> 3 leaf	NRC	3 leaf - pre fl	2 leaf +	NRC	NRC	NRC	NRC	PO	see label	NRC	NRC	NRC	NRC	NRC
Weed Stage	< 10 cm see label	2 leaf-ET	Gr < 2 T Bl cot-3 leaf	cot-3 leaf	cot-5 cm see label	young	young	< 10 cm	3 leaf-MT	PE-PO see label	3 leaf-ET/MT	2-6 leaf/T	2 leaf-T Gr	2 leaf-FT	see label
Wetting agent (WA)/Oil	see label	see label	WA see label	WA	NN	see label	see label	see label	WA or veg oil	see label	WA &/or Oil	Oil required	NR	Oil	NN
Formulation	WG	EC	WG	WG	AC	AC	AC	AC	EC	SC	EC	EC	SC	EC	SC
Rainfastness	4 hours	1 hour	2 hours	2 hours	6 hours	1 hour	1 hour	1 hour	1 hour	NS	3 hours	2 hours	NS	1 hour	6 hours
Aerial application	Yes	Yes	No	No	Yes	No	No	No	Yes	NS	NS	Yes	No	No	Yes
Withholding Period- GSF	3 days	Luc 21 days Sub/Med 7 days	7 days	14 days	7 days	1 day (horses 7 days)	1 day (horses 7 days)	1 day (horses 7 days)	3 days	25 days	Luc 28 days Sub/Med 14 days	14 days	grazing 14 days cutting 21 days	4 weeks	7 days

Code	Definition
•	Check label for species controlled
**	Label states 'will provide control of some small broad-leaved weeds'
AC	Aqueous concentrate
After C/G	After cutting and/or grazing
B	Barley
Bl	Broad-leaved weeds
cot	Cotyledon
D	Diuron
DNG	Do not graze
EC	Emulsifiable concentrate
ET	Early tillering
fl	Flowering
FT	Full tillering
Gr	Grass weeds
GSF	Withholding period for grazing or cutting for stock food
IBS	Incorporated by sowing
IPP	Immediately post planting
Luc	Lucerne
Med	Medics
MT	Mid tillering
NN	Not necessary
Not IT	Inadequate control of imidazolinone tolerant canola
NR	Not recommended
NRC	Not registered for use in this crop (pasture)
NRD	Withholding period not required when used as directed
NRW	Not registered for this weed in these crops (pastures)
NRWA	No registration for this pattern of use in WA
NS	Not stated
O	Oat
Oil	Spray oil
PE	Pre-emergence
Per/Permit	Use permitted under APVMA permit
PO	Post-emergence
Pre fl	Pre flowering
Pre S	Pre sowing
PSPE	Post sowing pre-emergence
S	Suppression only of this weed
SC	Suspension concentrate
SCO	Seed crops only
see label	Refer to label for clarification on tank mixes, growth stages, adjuvants etc.
Sub	Sub. clover
Tr	Triticale
T	Tiller/s, tillering
veg oil	Vegetable based spray oil
W	Wheat
WA	Wetting agent
WG	Water dispersible granule
WP	Wettable powder
X	DO NOT USE on first year lucerne

Note: The use of brand, trade and proprietary names has been done solely for the purpose of assisting users in identifying products.
It does not imply a preferred recommendation. Alternative products with the same active ingredient as products specified on this chart may perform as well or better than those specified products.

Pasture tolerances
Exact values for species/variety tolerance are difficult to determine as variations can occur due to stage of pasture growth, variety or environmental conditions. Follow label directions. Seek advice from your chemical manufacturer, Department of Agriculture or local agronomist on individual species/variety tolerance.

POISON'S EMERGENCY INFORMATION CENTRE
13 11 26

Herbicide resistance to this mode of action sub group is confirmed in Australian populations of this weed.

Herbicide resistance has been confirmed in Australian populations of this weed species to one or more MOA components of this herbicide mixture.

Herbicide resistance is expected based on other data.

STOP

ALWAYS READ THE LABEL OF THE PRODUCT YOU ARE ABOUT TO USE

- **Product registrations may vary between seasons.**
- There may be variation in rates, registered uses and/or withholding periods between labels of individual products containing the same active ingredient
- **Always check the label to ensure compliance with the registrations of the specific product being used.**

Figure 9-2. DAF Spray Charts. Page 5 of 7. Print A3 for best results.

HERBICIDE OPTIONS FOR WEED CONTROL IN PULSE CROPS

PRE CROP EMERGENCE HERBICIDE OPTIONS

Weeds	ATRAZINE + SIMAZINE 500+500 g/L (Alternative concentration/s available)	CARFENTRAZONE-EHTYL 240 g/L (Hammer®)	CYANAZINE 900 g/kg (Bladex®) (Alternative concentration/s available)	DIURON 900 g/kg (Alternative concentration/s available)	DIURON + TRIFLURALIN 500 g/L + 480 g/L respectively (Alternative concentration/s available)	IMAZETHAPYR 700 g/kg (Spinnaker®)	ISOXAFLUTOLE 750 g/kg (Balance®)	METRIBUZIN 750 g/kg (e.g. Lexone®) (Alternative concentration/s available)	PENDIMETHALIN 330 g/L (Alternative concentration/s available)	SIMAZINE 500 g/L (Alternative concentration/s available)	SIMAZINE + TRIFLURALIN 500 g/L + 480 g/L respectively (Alternative concentration/s available)	TRI-ALLATE 500 g/L (e.g. Avadex® Xtra) (Alternative concentration/s available)	TRIFLURALIN 480 g/L (Alternative concentration/s available)
Herbicide Group	C+C	G	C	C	C+D	B	F	C	D	C	C+D	E	D
Annual ryegrass	0.5-1.0 L + 0.5-1.0 L Sim S		1.1 kg	Lu 1.1 kg S Fp 835 g-1.2 kg	2.0 L + 1.25 L trif S	70 g S		180-380 g S see label	2.0-3.0 L see label	see notes	see notes	see notes	1.2-1.7 L
Barley grass	0.5-1.0 L + 0.5-1.0 L Sim S		1.1 kg S	Fp 835 g-1.2 kg		70 g S		see label		see notes	see notes		
• Brome grass	0.5-1.0 L + 0.5-1.0 L Sim S		1.1 kg S	Lu 1.1 kg S Fp 835 g-1.2 kg				180-380 g		see notes	see notes		1.7 L S
Capeweed	0.5-1.0 L + 0.5-1.0 L Sim	25-75 mL + kdown	1.1 kg	Lu 1.1 kg Fp 835 g-1.2 kg		NRWA S	100 g	180-380 g S see label		see notes	see notes		
• Clovers	0.5-1.0 L + 0.5-1.0 L Sim	25-75 mL + kdown		Lu 1.1 kg				180-380 g S		see notes	see notes		
Dock (seedling)	NRW			Lu 1.1 kg S				180-380 g		see notes	see notes		
Doublegee (Spiny emex)	0.5-1.0 L + 0.5-1.0 L Sim	25-75 mL + kdown	1.1 kg	Lu 1.1 kg Fp 835 g-1.2 kg	2.0 L + 1.25 L trif	70 g S	see label	180-380 g		see notes	see notes		
• Erodium	NRW	25-75 mL + kdown	NRWA			70 g		180-380 g		NRW	see notes		
• Fumitory	25-75 mL + kdown		1.1 kg S					180-380 g		see notes	see notes		1.2-1.7 L
• Lesser canary grass												see notes	1.2-1.7 L
Mallows		25-75 mL + kdown											
• Mustards	0.5-1.0 L + 0.5-1.0 L Sim		1.1 kg	Fp 835 g-1.2 kg		70 g	100 g	180-380 g		see notes	see notes		
Silver grass (Vulpia)	0.5-1.0 L + 0.5-1.0 L Sim						see label	NRW	2.0-3.0 L S see label	see notes	see notes		
Sorrel (seedling)				Lu 1.1 kg S						see label			
Soursob				NRW						see label	see notes		
Volunteer canola	NRW not TT					NRW not IT				see notes not TT			
Volunteer cereals	0.5-1.0 L + 0.5-1.0 L Sim S									see notes			
Volunteer lupins						NRW							
Wild oat	0.5-1.0 L + 0.5-1.0 L Sim S			Lu 1.1 kg S Fp 835 g-1.2 kg	2.0 L + 1.25 L trif S	70 g S		NRWA	2.0-3.0 L S	see notes	see notes	1.6 L	1.2-1.7 L S
Wild radish	0.5-1.0 L + 0.5-1.0 L Sim	25-75 mL + kdown	1.1 kg S	Lu 1.1 kg Fp 835 g-1.2 kg	2.0 L + 1.25 L trif	70 g S	100 g	180-380 g		see notes	see notes		
Wild turnip (Mediterranean turnip)	0.5-1.0 L + 0.5-1.0 L Sim		1.1 kg	Lu 1.1 kg Fp 835 g-1.2 kg	2.0 L + 1.25 L trif	NRW		180-380 g		see notes	see notes		
Wireweed	0.5-1.0 L + 0.5-1.0 L Sim		1.1 kg S	Lu 1.1 kg S		70 g S	see label	180-380 g S	2.0-3.0 L see label	see notes	see notes	see notes	1.2-1.7 L
Narrow leaved lupins	Pre S; PSPE	Pre S	NRC	Pre S; PSPE	IBS	NRC	NRC	NRC	IBS	Pre S; PSPE	IBS	IBS	IBS
Field peas	NRC	Pre S	Pre S; 3-5 node	Pre S; PSPE see notes	NRC	PSPE	NRC	PSPE; 3 node Permit	IBS	NRC	NRC	IBS	IBS
Chickpeas	NRC	Pre S	Pre S	NRC	NRC	NRWA	PSPE	PSPE	IBS	Pre S; PSPE	IBS	IBS	see label
Faba beans	NRC	Pre S	Pre S	NRC	NRC	PSPE	NRC	PSPE	IBS	Pre S; PSPE	IBS	IBS	see label
Lentils	NRC	Pre S	Pre S	NRC	NRC	NRC	NRC	PSPE	NRC	NRC	NRC	NRC	NRWA
Vetches	NRC	Pre S	NRWA	NRC	NRC	NRC	NRC	PSPE	NRC	NRC	NRC	NRC	IBS
Weed Stage	PE	< 6-8 leaf	PE-3 cm	PE-seedling	PE	PE	PE	PE-4 leaf	PE	PE	PE	PE	PE
Wetter(WA)/Oil	NN	see label	NR	NN	NN	NN	NR	NR	NN	NN	NN	NN	NN
Formulation	tank mix	EC	WG	WG	tank mix	WG	WG	DF/WG	EC	SC	tank mix	EC	EC
Rainfastness	NS	1 hour see notes	NS	NS	NS	2 hours	NS	NS	NS	NS	NS	NS	NS
Aerial application	No	No	No	No	No	Yes	No	see label	No	No	No	NS	No
Withholding period	H & GSF see labels	H NRD GSF 14 days	H & GSF NRD	H & GSF NRD	H & GSF NRD	H NRD GSF 14 days	H NRD GSF 4 wks	H NRD GSF-0 or 14 days see label	H & GSF NRD	H NRD GSF Ck 9 wks GSF Fb 8 wks	H NRD GSF Ck 9 wks GSF Fb 8 wks	NRD	H & GSF NRD
Notes	Do not use on whitish or grey sands. Apply maximum of 750 mL/ha atrazine + 750 mL/ha simazine on yellow sands. **DO NOT** apply atrazine post emergence to lupins - it will kill them. Sufficient rainfall to wet the soil through to the root zone necessary within 2-3 weeks of application.	CAUTION: Emerged grain legumes are extremely sensitive to Hammer®. Ensure boom cleaned thoroughly as per label instructions prior to post-emergent spraying. Addition to knockdown improves speed at which visual symptoms develop. Do not sow for one hour after application. Use low rates for small weeds in good growing conditions. Use high rates for older weeds that may have grown in less than optimal conditions.	Temporary crop damage (yellowing) may occur where applied to crops grown on sand over clay (duplex soils). Do not apply to soils with high sand or gravel content. For peas, pre-sowing applications preferred to post emergent application, check label. If mixing with glyphosate add ammonium sulphate 2% w/v.	**Peas:** Do not use on sandy soils. Use lower rate pre-sowing in low rainfall wheatbelt and use higher rate immediately after sowing in Great Southern area. Weak on grasses. Tank mix with trifluralin where annual ryegrass is expected. [Apply to lupins on light soils only]. Do not use on white or grey sands. Apply in minimum 50 L water/ha.	Will provide better control of annual ryegrass than diuron alone.	Spinnaker® may not kill weeds, however severe weed stunting will eliminate competition. Do not apply after end of June in low rainfall areas.	Ensure applied after furrow closure, direct contact of herbicide with seed may cause crop injury. A minimum spray volume 50 L/ha recommended. Refer to label for plant back periods for other crops and minimum post application rainfall requirements.	Use lower rates on sands and highest rates on very heavy soils. Plant crop at least 5 cm deep. Best results when rain follows within a few days of spraying. Note: Use in peas permitted under permit. Note: Can be applied as an early post-emergent option in field peas only when the crop is at the 3 node stage. Post emergent application to other pulse crops will result in crop damage.	Incorporate by sowing within 24 hours of application. Attempting to incorporate when soils are very wet or very dry may result in insufficient mixing and therefore poor weed control.	Rates - Chickpeas 1.0-2.0 L/ha; Faba beans 2.0-2.5 L/ha; Lupins 1.0-2.0 L/ha on light soils; 2.0-3.0 L/ha on gravelly loam soils. Add trifluralin if annual ryegrass or wild oats are expected.	Rates - Chickpeas 2.0 L/ha Sim + 1.25-1.7 L/ha trifluralin; Faba beans 1.0-1.5 L/ha Sim + 800 mL/ha of trifluralin; Lupins 1.0-2.0 L/ha Sim + 1.25 L/ha of trifluralin. For lupins maximum 1.5 L/ha simazine on yellow sands. Application should not be made to ridged or excessively cloddy soil.	Apply up to 3 weeks before to immediately before sowing. Incorporate immediately on wet soil, on dry soil, may be left for up to 24 hours. Plant 5 cm deep. Tank mix with trifluralin if annual ryegrass, annual phalaris or wireweed present or for enhanced control of wild oats emerging from top 1 cm.	Incorporate by seeding within 4 hours of application. Use lower rates on sandy soils. Use higher rate for heavy stubble cover. Stubble cover above 40-50% can reduce weed control achieved. Check rate for each crop species.

POST CROP EMERGENCE HERBICIDE OPTIONS

Weeds	BUTROXYDIM/FLUAZIFOP-P 250/212 g/L (Fusion® Super)	CLETHODIM 240 g/L (Select®)	CLETHODIM/HALOXYFOP 200/48 g/L (Motsa®)	CYANAZINE 900 g/kg (Bladex®) (Alternative concentration/s available)	DICLOFOP-METHYL 375 g/L (Alternative concentration/s available)	DIFLUFENICAN 500 g/L (e.g. Brodal® Options)	DIFLUFENICAN + METRIBUZIN 500 g/L + 750 g/kg respectively (Alternative concentration/s available)	FLUAZIFOP-P 128 g/L (Fusilade® Forte) (Alternative concentration/s available)	FLUMETSULAM 800 g/kg (Broadstrike®)	HALOXYFOP 520 g/L (e.g. Verdict® 520) (Alternative concentration/s available)
Herbicide Group	A/A	A	A/A	C	A	F	F+C	A	B	A
Annual ryegrass	230-320 g	150-250 mL	200-300 mL	0.55-1.1 kg	1.0 L			410-820 mL see label		75-100 mL Oil 100 mL WA
Barley grass	230-320 g	175-250 mL	150-200 mL	0.55-1.1 kg S				410-820 mL see label		50-75 mL Oil 75-100 mL WA
• Brome grass	285-320 g	175-250 mL	150-200 mL	0.55-1.1 kg S				410-820 mL see label		50-75 mL Oil 75-100 mL WA
Capeweed				0.55-1.1 kg		200 mL S	100 mL + 100-150 g Mbz S		25 g S	
• Clovers										
Dock (seedling)										
Doublegee (Spiny emex)				0.55-1.1 kg			100 mL + 100-150 g Mbz S		25 g S	
• Erodium				NRWA						NRW
• Fumitory				0.55-1.1 kg S						
• Lesser canary grass	230-320 g	150-250 mL	150-200 mL					410-820 mL		NRW
Mallows						200 mL S	NRW		NRW S	
• Mustards				0.55-1.1 kg		100-200 mL	NRW		NRWA	
Silver grass (Vulpia)										
Sorrel (seedling)						NRWA S				
Soursob										
Volunteer canola									NRW not IT	
Volunteer cereals	230-320 g	175-250 mL W,O 250 mL B	150-200 mL					410-820 mL see label		50-75 mL Oil 75-100 mL WA
Volunteer lupins									25 g	
Wild oat	230-320 g	175-250 mL	150-200 mL		1.5-2.0 L			410-820 mL see label		37.5-50 mL Oil 50-75 mL WA
Wild radish				0.55-1.1 kg S		100-200 mL	100 mL + 100-150 g Mbz		25 g S	
Wild turnip (Mediterranean turnip)				0.55-1.1 kg		100-200 mL	NRW		25 g	
Wireweed				0.55-1.1 kg S		NRWA S				
Narrow leaved lupins	PO	PO-80% flower	PO-flower	NRC	PO	2-6 leaf see notes	> 3 leaf see label	PO	NRC	2 leaf-pre fl
Field peas	PO	PO-full flower	PO-flower	Pre S; 3-5 node	PO	3 node-pre fl	NRC	PO	2-6 nodes	2 node-pre fl
Chickpeas	PO	PO-full flower	PO-flower	NRC	NRC	NRC	NRC	PO	4-6 branch	2 leaf-pre fl
Faba beans	PO	PO-full flower	PO-flower	NRC	NRC	NRC	NRC	PO	NRC	2 leaf +
Lentils	PO	PO-2 node	PO-7 node	NRC	NRC	3 leaf-pre fl	NRC	NRC	4-8 leaf	2 node-pre fl
Vetches	PO	NRC	NRC	NRC	NRC	NRC	NRC	PO	NRC	2 node-pre fl
Weed Stage	2 leaf-ET	2 leaf-FT	2 leaf-ET	PE-3 cm	2-4 leaf	2-6 leaf	to 25 cm	2 leaf-ET	< 5 cm	2 leaf-ET
Wetter(WA)/Oil	Oil required	Oil see notes	Oil see notes	NR	WA	NR see notes	NR	NN	NR	see notes
Formulation	EW	EC	EC	WG	EC	SC	Tank mix	EC	WG	EC
Rainfastness	1 hour	1 hour	1 hour	8 hours	2 hours	4 hours	4 hours	1 hour	4 hours	1 hour
Aerial application	Yes	Yes	Yes	No	Yes	NS	No	Yes	Yes	Yes
Withholding period	see notes	H NRD GSF 21 days	H NRD GSF 8 wks	GSF & H NRD	H NRD GSF 7 wks	H NRD GSF 14 days	H NRD GSF 14 days	see label GSF 3-7 wks H 5-17 wks	H NRD GSF 4 wks	H NRD GSF 28 days
Notes	Always apply with Supercharge® at 1 L/100 L, or D-C-Trate® at 2 L/100 L of spray solution. Do not apply in less than 50 L/ha water. Use lower rates for young weeds growing in ideal conditions, higher rates for weeds that are predominantly at early tillering, in dense populations or growing in less than ideal conditions. Fb GSF&H 5 wks; Ck/Fp GSF&H 7 wks; Lu GSF 3 wks H 4 wks.	See label for specific details on crop growth stage. Use lower rates for small weeds in good growing conditions. Always apply with D-C-Trate® at 2 L/100 L; Hasten® or Kwickin® at 1 L/100 L volume; Uptake® at 500 mL/100 L spray volume. The addition of Liase® at 2% may improve control if application conditions are not ideal.	The lower doses will provide effective control if applied under ideal conditions to weeds that are smaller, actively growing and free from stress. Always apply with Hasten®, Kwickin® or Uptake® at 1 L/100 L of spray volume.	Use the higher rate where large weeds are present. Post emergence application to chickpeas, faba beans and lentils will result in crop damage.	Wetter essential unless not recommended for tank mixes. Check label for tank mix recommendations. 500 g/L formulations not registered in pulses.	150 mL/ha is the preferred rate when the first weeds are at the 4 leaf stage. Increase rates for older and larger weeds or for dense weed infestations. Do not add oil. Apply when weeds are actively growing. Best 4-6 weeks after sowing. Brodal® Options lupin growth stage 2 leaf - before start of primary flowering (Big Bud)	Crop damage (leaf burn) may occur if crop is stressed, e.g. by brown leaf spot or is still adversely affected by simazine. Not recommended where more than 2.5 L of simazine used before seeding. Do not apply with wetting agents, crop oils or grass selectives. Crop damage more common south of Great Eastern Highway. Do not apply to Myallie lupins if atrazine has been applied pre-emergence.	See label for maximum rate information for different pulse crops. Apply at lowest rate only if weeds not tillering and before 5 leaves present. Use higher rate once tillering started.	Do not apply to crops suffering from any other herbicide treatment. Lupins controlled at 25 g. Do not add oils and wetters.	**Note:** Latest crop growth stage for application varies between products - check label. Check label for tank mixing with post emergence broadleaf herbicides. Use non-ionic wetting agent where tank mixing. Increase rates when grasses more than 4 leaf stage. See label for specific adjuvant recommendations. Broadleaf herbicides should not be mixed with this product. Spray at least one week apart.

Weeds	IMAZAMOX 700 g/kg (Raptor®)	METOSULAM 714 g/L (Eclipse®)	PICOLINAFEN 750 g/kg (Sniper®)	PROPAQUIZAFOP 100 g/L (e.g. Correct®)	QUIZALOFOP-P-ETHYL 99.5 g/L (e.g. Targa®) (Alternative concentration/s available)	SETHOXYDIM 186 g/L (Sertin®)	SIMAZINE "top up" 500 g/L (Alternative concentration/s available)	TEPRALOXYDIM 200 g/L (Aramo®)
Herbicide Group	B	B	F	A	A	A	C	A
Annual ryegrass				300-450 mL see label	300 or 375 mL	0.5-1.0 L	0.75-2.0 L S	175-300 mL
Barley grass	45 g			200 mL see label	250 mL	see label	0.75-2.0 L S	175-250 mL
• Brome grass	45 g			300 mL see label	300 or 375 mL	see label	0.75-2.0 L S	175-250 mL
Capeweed		NRW	50 g S				0.75-2.0 L	
• Clovers		NRW						
Dock (seedling)							0.75-2.0 L	
Doublegee (Spiny emex)	45 g S	NRW					0.75-2.0 L	
• Erodium	45 g							
• Fumitory								
• Lesser canary grass						1.0 L		
Mallows								
• Mustards	45 g	NRW					0.75-2.0 L	
Silver grass (Vulpia)	NRW						0.75-2.0 L	
Sorrel (seedling)								
Soursob								
Volunteer canola	NRW not IT	NRW not IT						
Volunteer cereals	45 g			200 mL W,O,B 250 mL Tr	250 mL W, B	1.0 L W, O see label	0.75-2.0 L	175-250 mL
Volunteer lupins	45 g							
Wild oat	45 g			250 mL see label	125 or 250 mL see label	1.0 L	0.75-2.0 L S	175-250 mL
Wild radish	45 g S	7-10 g	33-50 g				0.75-2.0 L	
Wild turnip (Mediterranean turnip)	45 g	NRW					0.75-2.0 L	
Wireweed	45 g S							
Narrow leaved lupins	NRC	8 leaf-flower bud	2-6 leaf	PO	PO	PO-pre fl	PO see notes	PO
Field peas	PO-4 node	NRC	3 node-pre fl	PO	PO	PO-pre fl	NRC	PO
Chickpeas	NRC	NRC	NRC	PO	PO	PO-pre fl	NRC	PO
Faba beans	3-6 node Per	NRC	NRC	PO	PO	PO-pre fl	NRC	PO
Lentils	NRC	NRC	NRC	PO	PO	PO-pre fl	NRC	PO
Vetches	NRC	NRC	NRC	PO	PO	NRC	NRC	PO
Weed Stage	Gr < 2 T Bl cot-3 leaf	< 8 leaf; < 20 cm	2-8 leaf	3 leaf-MT	3 leaf-ET/MT	2-6 leaf/T	2 leaf-T Gr < 10 cm Bl	2 leaf-FT
Wetter(WA)/Oil	WA	NR	NR	WA see label	WA & or Oil	Oil required	NN	Oil
Formulation	WG	WG	WG	EC	EC	EC	SC	EC
Rainfastness	2 hours	2 hours	4 hours	1 hour	3 hours	2 hours	NS	1 hour
Aerial application	No	see label	No	Yes	NS	Yes	No	No
Withholding period	H NRD GSF 6 wks	H NRD GSF 4 wks	H NRD GSF Lu 6 wks GSF Fp 4 wks	see label H 7-15 wks	see label H 6-12 wks GSF 28 days	H NRD GSF 21 days	H NRD GSF see label	H 12 wks GSF 4 wks
Notes	Do not use adjuvants other than BS 1000® or equivalent at 200 mL per 100 L water. Do not roll field peas after germination if use of Raptor® is planned. Controls lupins at 45 g. Faba bean registration on permit. Do not apply if frost is forecast.	Use only on healthy crops. A slight yellowing often accompanied by height reduction may be noticeable from 1-4 weeks after application. Do not use oils or wetters. Use higher rate when large wild radish populations or crop competition is poor.	Use lower rate on 2-4 leaf radish. Use higher rate at 4-6 leaf radish. To achieve effective control of 6-8 leaf radish good spray coverage of weeds is essential, majority of plants must be 2-6 leaf. Peas grown on high pH soils in the presence of free lime may be less tolerant.	Do not use crop oils. For best control wait until 75% of annual ryegrass have begun tillering. Can be tank mixed for broad spectrum of grass weeds. See label for details.	Use higher rate under high weed burden and/or when weeds are tillering. See label for specific adjuvant details.	See label for adjuvant requirements. Use 500 mL rate for annual ryegrass prior to tillering. See label for grass selective mixtures to improve control of brome, barley grass, wild oats and self sown cereals. Do not allow spray mix to sit overnight. See label for clarification of latest crop growth stages	Apply within 4 weeks of sowing. To be used in conjunction with pre-emergent application of simazine. Do not apply to lupins showing signs of damage from pre-emergent application.	Always apply Hasten® or Kwickin® at 1 L/100 L spray volume or similar adjuvant see label compatibility section. The lower doses will only provide effective control if applied under ideal conditions to susceptible weeds that are smaller, actively growing and free from temperature or moisture stress.

• Check label for species controlled

STOP ALWAYS READ THE LABEL OF THE PRODUCT YOU ARE ABOUT TO USE AND FOLLOW THE DIRECTIONS ON THE LABEL

Figure 9-2. DAF Spray Charts. Page 6 of 7. Print A3 for best results.

HERBICIDE OPTIONS FOR WEED CONTROL IN CANOLA CROPS

Weeds	ATRAZINE 500 g/L Only for TT varieties. Alternative concentration/s available	SIMAZINE 500 g/L Only for TT varieties. Alternative concentration/s available	CARFENTRAZONE-EHTYL 240 g/L (Hammer®)	s-METOLACHLOR 960 g/L (Dual®Gold) Alternative concentration/s available	ORYZALIN/TRIFLURALIN 125/125 g/L (e.g. Duet®/Yield®)	PENDIMETHALIN 330 g/L Alternative concentration/s available	TRI-ALLATE 500 g/L (e.g. Avadex®Xtra) Alternative concentration/s available	TRIFLURALIN 480 g/L Alternative concentration/s available	ATRAZINE 500 g/L Only for TT varieties. Alternative concentration/s available	BUTROXYDIM/FLUAZIFOP-P 250/212 g/L (Fusion®) Super	CLETHODIM 240 g/L (Select®)	CLETHODIM/HALOXYFOP 200/48 g/L(Motsa®)	CLOPYRALID 300 g/L (e.g. Lontrel®) Alternative concentration/s available	DICLOFOP-METHYL 375 g/L	FLUAZIFOP-P 128 g/L (Fusilade® Forte) Alternative concentration/s available	HALOXYFOP 520 g/L (e.g. Verdict® 520) Alternative concentration/s available	PROPAQUIZAFOP 100 g/L (e.g. Correct®)	QUIZALOFOP-P-ETHYL 99.5 g/L (e.g. Targa®) Alternative concentration/s available	SETHOXYDIM 186 g/L (Sertin®)	TEPRALOXYDIM 200 g/L (Aramo®)	IMAZAPIC/IMAZAPYR 525/175 g/kg (OnDuty®) (Clearfield) varieties Only for imidazolinone tolerant (IT)
	PRE CROP EMERGENCE HERBICIDE OPTIONS								POST CROP EMERGENCE HERBICIDE OPTIONS												
Herbicide Group	C	C	G	K	D/D	D	E	D	C	A/A	A	A/A	I	A	A	A	A	A	A	A	B/B
Annual ryegrass	2.0-4.0 L S	2.0-4.0 L S		NRW	1.6 or 2.3 L	1.8-3.0 L	NRW see notes	1.2-1.7 L	1.0-2.0 L	210 g	150-250 mL	200-300 mL		1.0 L	410 mL see label	75-100 mL Oil 100 mL WA	300-450 mL see label	300 or 375 mL	0.5-1.0 L see label	175-300 mL	40 or 55 g
Barley grass	2.0-4.0 L S	2.0-4.0 L S							NRW	210 g	175-250 mL	150-200 mL			410 mL see label	50-75 mL Oil 75-100 mL WA	200 mL see label	250 mL	see label	175-250 mL	40 g
• Brome grass	2.0-4.0 L S	2.0-4.0 L S							NRW	250-280 g	175-250 mL	150-200 mL			NRW	50-75 mL Oil 75-100 mL WA	300 mL see label	300 or 375 mL	see label	175-250 mL	40 g
Capeweed	2.0-4.0 L	2.0-4.0 L	25-75 mL + kdown						NRW				300 mL								see notes
• Clovers	2.0-4.0 L	2.0-4.0 L	25-75 mL + kdown										150 mL								40 g
Doublegee (Spiny emex)	2.0-4.0 L	2.0-4.0 L	25-75 mL + kdown						NRW												40 g
• Erodium (Storksbill)	2.0-4.0 L	2.0-4.0 L	25-75 mL + kdown													NRW					40 g S
• Fumitory	2.0-4.0 L	2.0-4.0 L			1.6 or 2.3 L S			1.2-1.7 L													40 g
Medics	NRW												150 mL								40 g S
• Mustards	2.0-4.0 L	2.0-4.0 L							1.0-2.0 L												20-40 g
Silver grass (Vulpia)	2.0-4.0 L	2.0-4.0 L			1.6 L S	2.0-3.0 L S			NRW												40 g S see label
Toadrush				150-250 mL																	40 g
Volunteer cereals	NRW	NRW							NRW	210 g	175-250 mL W,O 250 mL B	150-200 mL			410 mL see label	50-75 mL Oil 75-100 mL WA	200 mL W,B,O 250 mL Tr	250 mL B,W	1.0 L W, O see label	175-250 mL	20 g O 40 g W, B
Volunteer legumes			NRW										100-250 mL see label								40 g S vetch only
Wild oat	2.0-4.0 L S	2.0-4.0 L S			1.6 or 2.3 L S	1.8-3.0 L S	1.6 L	1.2-1.7 L		210 g	175-250 mL	150-200 mL		1.5-2.0 L	410 mL see label	37.5-50 mL Oil 50-75 mL WA	250 mL see label	125 or 250 mL	1.0 L see label	175-250 mL	20-40 g
Wild radish	2.0-4.0 L S	2.0-4.0 L S	25-75 mL + kdown						1.0-2.0 L												20-40 g
Wild turnip (Mediterranean turnip)	2.0-4.0 L	2.0-4.0 L							1.0-2.0 L												20-40 g
Wireweed	NRW S	NRW			1.6-2.3 L	1.8-3.0 L	see notes	1.2-1.7 L	NRW												40 g
Canola Stage	Pre S; PSPE	Pre S; PSPE	Pre S	see notes	IBS	IBS	IBS	IBS	PO	4 leaf +	PO-BFB	BSE; BFB	2-8 leaf	PO	PO-6 leaf	2 leaf-BSE	PO	PO	PO-BFB	PO-BSE	2-6 leaf
Weed Stage	PE-2 leaf	PE	< 6-8 leaf	PE	PE	PE	PE	PE	PE-2 leaf	2 leaf-ET	2 leaf-FT	2 leaf-ET	< 10 cm	2-4 leaf	2-5 leaf	2 leaf-ET	3 leaf-MT	3 leaf-ET/MT	2-6 leaf	2 leaf-FT	see label
Wetting agent (WA)/Oil	see label	NN	see label	NN	NN	NN	NN	NN	Oil required	Oil required	Oil see notes	Oil see notes	NN	WA	NN	see notes	WA see label	WA &/or Oil	Oil required	Oil required	Oil
Formulation	SC	SC	EC	EC	EC	EC	EC	EC	SC	WG	EC	EC	AC	EC	EC	EC	EC	EC	EC	EC	WG
Rainfastness	NS	NS	1 hour	NS	NS	NS	NS	NS	NS	1 hour	1 hour	1 hour	3 hours	2 hours	1 hour	1 hour	1 hour	3 hours	2 hours	1 hour	2 hours
Aerial Application	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NS	Yes	No	No
Withholding Period - Harvest	NRD	NRD	NRD	NRD	NRD	NRD	NRD	NRD	NRD	17 weeks	NRD	8 weeks	12 weeks	NRD	17 weeks	NRD	16 weeks	11 weeks	NRD	NRD	NRD
Withholding Period - GSF	15 weeks	15 weeks	14 days	10 weeks	NRD	NRD	NRD	NRD	6 weeks	21 days	21 days	8 weeks	12 weeks	7 weeks	21 days	28 days	see label	28 days	21 days	4 weeks	6 weeks
	Only for Triazine Tolerant (TT) Canola! For best results apply to bare moist soil, either immediately before seeding or as a PSPE treatment at or within 7 days of sowing. The use of atrazine in canola is subject to adherence to the Integrated Weed Management strategy for TT Canola. See label for details.	**Only for Triazine Tolerant (TT) Canola!** For best results apply to bare moist soil, either immediately before seeding or as a PSPE treatment at or within 7 days of sowing. The use of simazine in canola is subject to adherence to the Integrated Weed Management strategy for TT Canola. See label for details.	CAUTION: Emerged canola is extremely sensitive to Hammer®. Ensure boom cleaned thoroughly as per label instructions prior to post-emergent spraying. Apply with knockdown herbicides at label rates to increase visual speed at which broadleaf weeds develop visual symptoms and improve final control. Do not sow for one hour after application. Use low rates for small weeds in good growing conditions. Use high rates for older weeds that may have grown in less than optimal conditions.	Apply to moist soil. Use rates toward higher end of range where longer residual control is required. Apply at or immediately after planting before crops and weeds emerge. When sowing using knife points and zero tillage and leaving a seeding slot do not apply post seeding unless harrows or similar have filled-in the seeding slot before application. Alternatively apply immediately before seeding.	Incorporation within 4 hours of application recommended. If tank mixing with knockdown herbicides the mixture should be kept thoroughly agitated and sprayed within 1 hour of mixing. Low rate for use with conventional cultivation, high rate for use with direct seeding.	Incorporate by sowing within 24 hours of application. Use higher rates on medium to heavy textured soils and lower rates on light textured soils. Heavy soil which are cloddy or have surface crust or surface seal should be avoided. Waterlogged conditions after application may retard emergence.	Apply up to 3 weeks before to immediately before sowing. Incorporate immediately on wet soil, on dry soil, may be left for up to 24 hours. Plant 5 cm deep. Tank mix with trifluralin, if annual ryegrass, annual phalaris or wireweed are present and for enhanced control of wild oats emerging from top 1 cm of seed bed.	Apply 4 weeks before or just before sowing. Incorporate within 4 hours. Water logging immediately post seeding and or sowing deeper than approx. 1-2 cm can severely reduce emergence.	**Only for Triazine Tolerant (TT) Canola!** Apply to moist soil when weeds are actively growing. The addition of 0.5-1% v/v of crop oil will enhance post emergence activity. The use of atrazine in canola is subject to adherence to the Integrated Weed Management strategy for TT Canola. See label for details.	Always apply with Supercharge® at 1 L/100 L, or D-C-Trate® at 2 L/100 L. Canola can be sensitive. To minimise leaf symptoms do not apply to any variety before majority (80%) of plants are at the true 4 leaf stage (4th leaf expanded 5th leaf emerging).	Use lower rates for small weeds in good growing conditions. Always apply with D-C-Trate® at 2 L/100 L; Hasten® or Kwickin® at 1 L/100 L volume; Uptake® at 500 mL/100 L spray volume. The addition of Liase® at 2% may improve control if application conditions are not ideal.	The lower doses will provide effective control if applied under ideal conditions to weeds that are smaller, actively growing and free from stress. Always apply with Hasten®, Kwickin® or Uptake® at 1 L/100 L of spray volume.	Effective treatment for transplant capeweed control. Can be tank mixed with most other herbicides. Also available in 750 g/kg formulation, adjust rates accordingly. Volunteer faba beans and lupins will only be suppressed.	Wetter essential unless not recommended for tank mixes. Check label for tank mixture recommendations. 500 g/L formulation not registered for use in canola.	Do not apply at flowering stage of weeds. Do not allow weeds to reach late tillering stage before applying. Apply in no less than 50 L/ha water. See label for rates for larger weeds.	Increase rates when grasses more than 4 leaf stage. Use Uptake® at 0.5 L/100 L or if using other oils 1.0 L/100 L and add a non-ionic wetter at 200 mL/100L. Note: Withholding periods vary between individual products - check label.	Use with either a non ionic surfactant such as BS 1000® at 0.2% v/v or Hasten® or Kwickin® at 0.5% v/v. Do not use with Synertrol® or Codacide® oil. For best control wait until 75% of annual ryegrass have begun tillering. Can be tank mixed for broad spectrum of grass control. See label for details.	Use higher rate under high weed burden and/or when weeds are tillering. See label for surfactant/wetting agent details.	See label for adjuvant details. See label for grass selective mixtures to improve control brome, barley grass, wild oats and self sown cereals. Do not allow spray mix to sit overnight.	For adjuvant requirements see label compatibility section. The lower doses will only provide effective control if applied under ideal conditions to susceptible weeds that are smaller, actively growing and free from temperature or moisture stress. Do not apply after the commencement of stem elongation or after 8 leaf stage, whichever is earliest.	**For use with Clearfield production system (Imidazolinone tolerant) canola only.** Always apply with Hasten® or Kwickin® at 0.5 L/100 L. Tank mixture with 150 mL clopyralid 300 g/L improves capeweed control if applied at cotyledon - 4 leaf stage of capeweed. Use 55 g rate where annual ryegrass significant weed. Do not use at 40 to 55 g on shallow, strongly duplex soils in WA.

Herbicide resistance to this mode of action sub group has been confirmed in Australian populations of this weed species.

Herbicide resistance has been confirmed in Australian populations of this weed species to one or more MOA components of this herbicide mixture.

Herbicide resistance is expected based on other data.

STOP

ALWAYS READ THE PRODUCT LABEL

- Product registrations may vary between seasons.
- There may be variation in rates, registered uses and/or withholding periods between labels of individual products containing the same active ingredient, of the same or a different concentration and of the same or different formulation.
- Always check the label to ensure compliance with the registrations of the specific product being used.

CODES FOR PULSE AND CANOLA SPRAY CHARTS

Code	Definition
•	Check label for species controlled
AC	Aqueous concentrate
B	Barley
BFB	Before flower bud
BI	Broad-leaved weeds
BSE	Before stem elongation
Ck	Chickpeas
cot	Cotyledon
DF	Dry flowable
EC	Emulsifiable concentrate
ET	Early tillering
Fb	Faba beans
Fp	Field peas
FT	Fully tillered
Gr	Grass weeds
GSF	Withholding period for grazing or cutting for stock food
H	Harvest withholding period
IBS	Incorporated by sowing
IPP	Immediately post planting
IT	Imidazolinone tolerant (Clearfield®)
kdown	Knockdown herbicide (glyphosate or paraquat/diquat)
Le	Lentils
Lu	Lupins
Mbz	Metribuzin
MT	Mid tillering
NN	Not necessary
Not IT	Will not provide adequate control of IT Canola
Not TT	Will not provide adequate control of TT Canola
NR	Not recommended
NRC	Not registered for use in this crop
NRD	Withholding period not required when used as directed
NRW	Not registered for this weed in these crops
NRWA	No registration for this pattern of use in WA
NS	Not stated
O	Oats
Oil	Spray oil
PE	Pre-emergence
Per/Permit	Use permitted under APVMA permit
PO	Post-emergence
Pre fl	Pre flowering
Pre S	Pre sowing
PSPE	Post sowing pre-emergence
S	Suppression only of this weed
SC	Suspension concentrate
see label	Refer to label for clarification on tank mixes, growth stages, adjuvants etc.
Sim	Simazine
T	Tiller/s or Tillering
Tr	Triticale
trif	Trifluralin
TT	Triazine tolerant
Ve	Vetch
W	Wheat
WA	Wetting agent
WG	Water dispersible granule
wks	Weeks
WP	Wettable powder

Note: The use of brand, trade and proprietary names has been done solely for the purpose of assisting users in identifying products.

It does not imply a preferred recommendation. Alternative products containing the same active ingredient may perform similarly to those products specified.

Crop tolerances
Exact values for species/variety tolerance are difficult to determine as variations can occur due to stage of crop growth, variety or environmental conditions. Follow label directions. Seek advice from your chemical manufacturer, Department of Agriculture or local agronomist on species/variety tolerance.

POISON'S EMERGENCY INFORMATION CENTRE
13 11 26

For further weed management informatiion:
Department of Agriculture, Western Australia
South Perth (08) 9368 3333
www.agric.wa.gov.au

Figure 9-2. DAF Spray Charts. Page 7 of 7. Print A3 for best results.

10.0 Fire Management

10.1 Context

The construction works include activities that may represent a fire risk. Such risks may arise from welding and grinding, vehicle movements over dry vegetation, and disposal of matches or cigarettes. Fires have the potential to cause irreversible damage to the environment, property and human heath or life.

10.2 Purpose

The purpose of the Fire Management Plan is to outline management actions to:

1. minimise the risk of preventable fires.
2. respond to fires in an appropriate manner.

10.3 Performance Indicators

Performance will be demonstrated by:

1. absence of fires generated during construction.
2. response to fires in accordance with the management actions.

10.4 Management Actions

Fire Prevention - General

1. A Site Fire Officer will be designated for each construction area to identify and rectify potential fire hazards. Construction staff will report potential fire hazards to the Site Fire Officer.
2. The daily 'fire danger' ratings will be obtained from the Bureau of Meteorology and will display the ratings daily at the site office for the awareness of construction personnel.
3. The lighting and smoking of cigarettes will be prohibited except in designated cleared areas and immediately outside of site buildings.
4. Cleared vegetation from the construction area will not be burned.
5. Dry chemical or carbon dioxide fire extinguishers[1] will be located in close proximity to all cutting, grinding or welding (or any other spark generating activity).
6. A shroud will be installed if cutting, grinding or welding (or any other spark generating activity) occurs within 5m of vegetation/dry grasses. The shroud will be installed between the activity and the vegetation to capture sparks.
7. Flammable liquids and materials (including explosives) will only be stored in designated areas fitted with a dry chemical or carbon dioxide fire extinguisher.
8. On the advice of FESA or relevant Local Government Authority, construction work that may present a high risk of ignition (e.g. cutting, grinding or welding) may be temporarily terminated on days declared to have a "high", "very high" or "extreme" fire danger and if there are a number of fires in close proximity in order to avoid the potential for further depletion of fire fighting resources.

Fire Prevention - Vehicles

9. It will be ensured that all construction vehicles will be fitted with a dry chemical or carbon dioxide fire extinguisher[1].

10. There will be daily inspections of all construction vehicles to remove combustible material from radiators, tracks, guards and undercarriages.

11. It will be ensured that construction vehicles are inspected and serviced to prevent or repair oil and fuel leaks prior to the start of construction works, and then inspected monthly.

12. It will be ensured that tractors, bulldozers and road graders will not be used during prohibited burning times, unless they are fitted with a vertical exhaust pipe that is maintained in a sound and efficient condition and fitted with a spark arrestor (r37A *Bush Fires Act 1954* (WA)).

Fire Response

13. Training will be provided to construction staff on the proper use of fire extinguishers.

14. A mobile water tanker will be located within 10km of any construction area for fire response. Each water tanker will be equipped with a connectable hose that can be used for fire fighting.

15. Dewatering water maybe used for fire response (irrelevant of water quality).

16. Fires will be managed by:
    a. Small fires – fire extinguishers and/or on-site water tankers will be used by the field personnel to extinguish the fire.
    b. Large fires – FESA will be called to attend and extinguish fires that cannot be managed by the field personnel. Phone 000.

17. The relevant Local Government Authority and FESA will be notified of any fire in which fire fighting equipment is used. Notification will be made as soon as reasonably practicable following the detection of the fire.

18. The DEC, FPC and the Conservation Commission will also be notified of any fire in which fire fighting equipment is used in land vested with the Conservation Commission (State Forest). Notification will be made as soon as reasonably practicable following the detection of the fire.

10.5 Additional Information

[1] Fire extinguishers

Carbon dioxide fire extinguishers and dry chemical powder fire extinguishers are both suitable for ordinary combustibles, flammable liquids, flammable gasses and live electricity.

Dry chemical powder fire extinguishers are suitable for ordinary combustibles, flammable liquids, flammable gasses, live electricity and cooking oils.

10.6 Contingency Actions

No contingency actions are considered necessary.

10.7 Related Plans

1. Land Clearing and Trench Management Plan.
2. Dangerous Goods and Explosives Management Plan

10.8 Relevant Legislation

1. *Bush Fires Act 1954* (WA).

10.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. FESA
2. DEC
3. FPC
4. Conservation Commission
5. Relevant Local Government Authority

11.0 Waste Management

11.1 Context

The construction works will produce a range of liquid and solid wastes. These wastes include:

- site office rubbish, paper, packaging and domestic wastes.
- spent welding rods, grinding wheels, visors and shot blast from welding operations.
- spoil and surplus rock from boring activities or backfilling.
- sewage from temporary toilets.
- used lubricating oils from machinery maintenance.

Inappropriate waste disposal has the potential to contaminate soil, surface water or groundwater and affect visual amenity. Wastes from construction must be disposed of in a lawful and environmentally acceptable manner.

11.2 Purpose

The purpose of the Waste Management Plan is to outline management actions to:

1. reuse waste materials where possible
2. recycle wastes where practicable
3. dispose of construction wastes in an acceptable manner.

11.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

11.4 Management Actions

Construction

1. Separate and marked waste bins will be established for:

CATEGORY	DISPOSAL
General wastes.	Dispose on-site in a covered bin to prevent attraction of vermin. Bulk disposal offsite to the nearest landfill.
Recyclables (generally glass, paper and plastics).	Bulk dispose offsite to the nearest recycling facility. May be disposed of to landfill if a facility does not exist within 50km of the construction area.
Steel Recycling (generally steel pipe and other steel wastes).	Bulk dispose offsite to the nearest steel recycling facility. May be disposed of to landfill if a facility does not exist within 50km of the construction area.
Hydrocarbons (generally drums/containers containing oil, grease, petrol, diesel or hydrocarbon contaminated soil).	Dispose on-site to plastic lined or bunded bins. Bulk dispose offsite to: 1. a Controlled Waste Contractor licensed under the *Environmental Protection (Controlled Waste) Regulations 2004* (WA); or 2. a hydrocarbon recycler (Note: if hydrocarbons are recycled they are not a controlled waste for transport purposes).

Table 11-1 Waste Bins for General Wastes, Recyclables, Steel Recycling and Hydrocarbons.

2. Periodic disposal of wastes from the construction area to the identified disposal locations will be arranged.
3. Wastes, other than excess overburden (excluding spoil) will not be buried on any construction site.
4. All wastes will be removed from all construction sites following the completion of construction works.
5. Excess overburden produced from trench excavation will be disposed of to:
    a. the excavated trench or the Seawater Desalination Plant site.
    b. a suitable location agreed with the Landowner (the Landowner has first preference to retain excess overburden from their own property),
    c. a suitable location agreed with adjacent Landowners (with preference to Landowners on the pipeline route).
    d. a local landfill as inert waste.

    Other suitable sites for disposal of excess overburden may be identified. Disposal of soils affected by ASS will be treated as per the Dewatering and Acid Sulphate Soils Management Plan prior to disposal.

Post-Construction

6. Any waste that is identified post-construction will be removed.

11.5 Contingency Actions

1. The following actions will be undertaken if wastes are not appropriately disposed of:
    a. investigate the cause.
    b. alter management actions, if required.
    c. inform all field personnel of revised management actions.
    d. mitigation of any environmental and visual impacts.

11.6 Related Plans

1. Dewatering and Acid Sulphate Soils Management Plan.

11.7 Relevant Legislation

1. *Environmental Protection Act 1986*, and *Regulations 1987* (WA).
2. *Environmental Protection (Controlled Waste) Regulations 2004* (WA).

11.8 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DEC
2. Shire of Harvey

12.0 Aboriginal Heritage Management

12.1 Context

The *Aboriginal Heritage Act 1972* (WA) registers and protects sites of importance to Aboriginal persons. It is an offence to interfere with a registered site[1] without the consent of the Western Australian Minister for Indigenous Affairs. The construction works avoid all existing registered sites on the Department of Indigenous Affairs database.

The construction area is also subject to a native title claim by the Gnaala Karla Boojah Native Title Claimant Group (NTCG) under the *Native Title Act 1993* (C'th). The South West Aboriginal Land and Sea Council is the representative body for the Gnaala Karla Booja NTCG. Native title has yet to be determined by the National Native Title Tribunal.

Prior to construction, an Aboriginal heritage survey of the Seawater Desalination Plant site, Water Transfer Pipeline and the Harvey Summit Tanks site will be conducted with the Gnaala Karla Booja NTCG to identify the presence of any unidentified Aboriginal heritage sites. If new sites are identified by the preconstruction survey, consent will be obtained from the Minister for Indigenous Affairs to interfere with those sites prior to construction. Initial ground disturbing activities at registered sites will be conducted in the presence of a Cultural Monitor from the Gnaala Karla Booja NTCG.

Despite preconstruction surveys, additional heritage materials or artefacts may also be identified during construction.

12.2 Purpose

The purpose of the Aboriginal Heritage Management Plan is to outline management actions to:

1. identify the presence of Aboriginal heritage sites
2. manage disturbance of registered Aboriginal heritage sites, if required.
3. identify procedures in the event that a new potential site is identified during construction.

12.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

12.4 Management Actions

Prior to Construction

1. An Aboriginal heritage survey of the Seawater Desalination Plant site, Water Transfer Pipeline and the Harvey Summit Tanks site will be conducted with the Gnaala Karla Booja NTCG.

During Construction

2. A Cultural Monitor will be employed in consultation with the Gnaala Karla Booja NTCG to monitor initial ground disturbing activities at any registered Aboriginal heritage site identified. The Cultural Monitor will be paid at a rate in accordance with The Water Corporations policies for Cultural Monitors.

3. Shade, water and personal protective equipment (hard hat, safety glasses, noise (ear) protection and high visibility vest) will be provided to the Cultural Monitor. The Cultural Monitor will be responsible for personal transport to the construction areas.

4. The Cultural Monitor will monitor initial ground disturbing activities to:
   a. detect the presence of archaeological material of heritage significance.
   b. detect human skeletal material.
   c. advise on minimisation of construction impacts on heritage values.

5. The Cultural Monitor will advise during the construction works if archaeological material or human skeletal material is identified, as well as any matters of heritage concern.

6. Construction works will be undertaken in the absence of the Cultural Monitor if for any reason the arranged Cultural Monitor does not attend the site. A replacement Cultural Monitor will be sort as soon as reasonably practicable following the absence if future attendance at the construction works by the Cultural Monitor is unlikely.

7. Construction works will cease as soon as practicable within a nominal 20 metres of any archaeological material (artefacts including hunting tools, scatters, scar trees) identified within the construction area. An archaeologist will be engaged to record the identified material and to advise the DIA if the identified material is likely to be of Aboriginal heritage significance. Construction activities within 20 metres of the identified material will only recommence based on advice of the archaeologist or the DIA.

8. Construction works will cease as soon as practicable within a nominal 20 metres of any skeletal material identified within the construction area. The Harvey Police Station (Phone 9729 1001, located at 17A Hayward St in Harvey) will be contacted to attend and determine a resolution of the matter. Construction activities will only recommence within 20 metres of the identified material on the direction of the Superintendent based on advice of the Police.

9. Any dispute between the Cultural Monitor and site construction personnel will be resolved on advice from the Water Corporation's Manager, Indigenous Resources Section (Phone 9420 3864)

12.5 Additional Information

[1] The construction works avoid all locations identified by the DIA site register. A number of locations on the DIA site register occur within the greater Harvey area:

DIA SITE ID	LOCATION NAME	TYPE	REGISTER	SITE?
5614	Lake Preston	Artefacts / Scatter	Stored data	No
5843	Harvey	Artefacts / Scatter	Stored data	No
5797	Harvey 45	Artefacts / Scatter	Stored data	No
5798	Harvey 46	Artefacts / Scatter	Stored data	No
5799	Harvey 47	Artefacts / Scatter	Stored data	No
5800	Harvey 48	Artefacts / Scatter	Stored data	No
5801	Harvey 49/Myalup Beach Road	Artefacts / Scatter	Stored data	No
5802	Harvey 50/Myalup Beach Road	Artefacts / Scatter	Stored data	No
5811	Harvey 60	Artefacts / Scatter	Stored data	No
17778	Kellys Camp	Man-Made Structure, Historical	Stored data	No
17779	Wallams Camps 1 & 2	Man-Made Structure, Historical	Stored data	No
17783	Mornington Mill Corroboree Ground	Ceremonial	Permanent	YES

Table 12-1 Locations listed the DIA site register.

Only the Mornington Mill Corroboree Ground is classified as an Aboriginal heritage site under the *Aboriginal Heritage Act 1972* (WA).

Sites that are classified on the 'Permanent' register are classified as sites under the *Aboriginal Heritage Act 1972* (WA) and are protected. Sites classified as 'Stored data' are not sites under the

Aboriginal Heritage Act 1972 (WA) due to unreliable information, however are maintained on the DIA database as a record of having been previously reported and for future reference.

12.6 Contingency Actions

No contingency actions are considered necessary.

12.7 Related Plans

1. Land Clearing and Trench Management Plan
2. Watercourse Crossing Management Plan

12.8 Relevant Legislation

1. *Aboriginal Heritage Act 1972* (WA), and *Regulations 1974* (WA).
2. *Native Title Act 1993* (C'th)

12.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. SWALSC
2. DIA

13.0 Traffic and Public Safety Management

13.1 Context

There will be in excess of 5000 vehicle movements for the cartage of pipelines and other equipment (excludes support vehicle movements) for the Southern Seawater Desalination Project. Some partial road closures will be required, and increased traffic volumes from construction vehicles will result in short-term impacts on local traffic movement.

Construction will occur within publicly accessible roads and road reserves, private farmland and State Forest. The construction works involve deep earthworks, materials storage and handling, and heavy machinery and equipment that could pose a risk to members of the public if accessing the site.

13.2 Purpose

The purpose of the Traffic and Public Safety Management Plan is to outline management actions to:

1. manage construction vehicle traffic and local traffic.
2. minimise construction impacts on local traffic movements.
3. reduce the risk to public accessing the construction site.

13.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

13.4 Management Actions

Traffic

1. Traffic management activities on public roads will be coordinated with MRWA and the Shire of Harvey prior to construction.
2. It will be ensured that construction vehicles will typically use the following major roads for the transport of construction materials and equipment to minimise disturbance on local traffic and the community:
    a. South Western Highway
    b. Perth-Bunbury Highway (Old Coast Road)
    c. Government Road
    d. Forestry Road

    Local roads will be used for accessing the construction sites where major roads do not allow access to the construction works.
3. The use of local roads by semi-trailers and road trains will be limited for the transport of construction materials and equipment to daylight hours (nominally 6am-8pm) to minimise noise impacts on residences positioned on local roads.
4. Road signage will be displayed within all construction areas in accordance with Australian Standard 1742.3-2002 *Manual of Uniform Traffic Control Devices - Part 3: Traffic control devices for works on roads*.
5. Road access in the construction area will be maintained by the use of signed detours and/or a single lane. Advisory signs will be installed sufficiently in advance of the construction works to allow road users to take alternative routes.
6. A temporary crossover(s) will be installed to maintain access by Landowners to their properties if the existing crossover is disturbed by the construction works. All disturbed

crossovers will be repaired or replaced as soon as practicable following construction works affecting that property.

7. It will be ensured that construction vehicles do not exceed 50km/h on non-bituminised roads or access tracks outside of the active construction area.
8. A 15km/h speed limit will be imposed within the active construction area. Signage of the speed limit will be displayed within construction areas.

Safety

9. The public will be excluded from accessing all construction areas where practicable. Open excavations (such as trenches and dewatering pits) will be fenced or otherwise demarcated where there is a risk of public access.
10. Advisory warning boards identifying hazards, risks, safety requirements and emergency phone numbers will be installed at each entry to all construction areas.
11. Machinery and plant that is located in publicly accessible locations will be secured (in a locked compound where practicable) when the construction site is not occupied.

13.5 Additional Information

The statutory requirements and guidelines that apply to the *Local Government Act 1995* (WA), *Main Roads Act 1930* (WA) and the *Road Traffic Act 1974* (WA), will be aware of and complied with.

13.6 Contingency Actions

No contingency actions are considered necessary.

13.7 Related Plans

1. Land Clearing and Trench Management
2. Noise Management

13.8 Relevant Legislation

1. *Local Government Act 1995* (WA)
2. *Main Roads Act 1930* (WA)
3. *Road Traffic Act 1974* (WA)

13.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. MRWA
2. Shire of Harvey

14.0 Noise Management

14.1 Context

Construction works will generate noise that may interfere with the amenity of occupants of near residential properties. Noise from the construction works will be monitored to determine and manage the impacts of noise.

Noise in Western Australia is regulated under the *Environmental Protection (Noise) Regulations 1997* (WA). Construction works (excluding blasting) are generally exempt from compliance with the assigned noise levels between the hours of 7.00 am and 7.00 pm, subject to a number of provisions (the provisions are contained within the plan). Despite this exemption, construction noise should still be managed and noise level objectives set to minimise noise impacts.

Noise from blasting activities during construction is regulated under the *Environmental Protection (Noise) Regulations 1997* (WA). Blasting noise limits apply.

The nearest noise sensitive premises for the Seawater Desalination Plant site is approximately 600m to the south east. The nearest noise sensitive premises for the Harvey Summit Tanks site is approximately 650m to the north east. A number of noise sensitive premises occur within 50m of the Water Transfer Pipeline.

14.2 Purpose

The purpose of the Noise Management Plan is to outline management actions to:

1. identify noise objectives and blasting noise limits.
2. undertake noise monitoring.
3. outline corrective actions to variances of noise objectives and limits.

14.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

14.4 Management Actions

General Construction Considerations

1. Plant and practices that have the lowest possible noise emissions, will be used where practicable.
2. Portable noise generating equipment (e.g. generators) will be located as far away from noise sensitive premises as practicable. Noise screening will be installed where particularly noisy construction works are conducted adjacent to residential premises.
3. Known noisy activities (e.g. rock breaking) will be scheduled during daylight hours (nominally 7am to 7pm) where they occur within 100m of residential premises. Notice to the Landowner of the residential premises will be provided prior to the commencement of such works.

Noise Meter Calibration

4. Noise will be measured using a portable sound level meter. It will be ensured that the meter is calibrated at least every 2 years by a laboratory accredited by NATA to undertake calibration of sound level measuring instruments.

5. The portable sound level meter will be tested in the field (using a standard sound source) prior to, and after, any series of measurements to be taken. The tests will be undertaken to confirm if the meter is accurate within ±0.5 dB.

Measuring Construction Noise

6. Noise levels will be measured at least once every 7 days during construction, or in response to any complaint that may arise. Noise monitoring will be undertaken for a period of no less than 15 minutes, and no greater than 4 hours.
7. The frequency of noise monitoring maybe increased (up to a maximum daily monitoring frequency) if complaints of unacceptable noise are received.
8. Noise measurements will be undertaken at the boundary of the construction sites and at least 1.2m above ground level. For the Seawater Desalination Plant site and the Harvey Summit Tanks site, the boundary is the cadastral (land) boundary of the site. For the Water Transfer Pipeline, the boundary will be the edge of the pipeline working width (30m for agricultural land and 20m for native vegetation).
9. Noise measurements will be undertaken on the Water Transfer Pipeline route at least 3 metres from any noise reflecting surface (building wall, vehicles, etc).
10. All noise measurements will be recorded in the Noise and Vibration Monitoring Log.
11. The occupiers of each premises will be given written notice at which noise emissions will be likely to exceed the specified noise levels at least 24 hours prior to such works for Sunday and Night Construction Works (7.00pm to 7.00 am).
12. It will seek to meet the following noise level objectives:

Location of measurement	**Time of day**	**Assigned level (dB)**		
		L_{A10} (not to be exceeded more than 10% of the time)	L_{A1} (not to be exceeded more than 1% of the time)	L_{Amax} (must not be exceeded at any time)
Boundary of Water Transfer Pipeline working width when less than 15m from a Residential of Rural Building	0700 to 1900 hrs Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hrs Sunday and Public Holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hrs all days	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hrs on any day to 0700 hrs Monday to Saturday and to 0900 hrs Sunday and Public Holidays	35 + influencing factor	45 + influencing factor	55 + influencing factor
Boundary of Seawater Desalination Plant site or Boundary of Harvey Summit Tanks site. Boundary of Water Transfer Pipeline working width when greater than 15m from Residential of Rural Building	All Hours	60	75	80
Note: (1) An influencing factor of 2 dB will be added to the Assigned Level where there is a major road within 100 metres of the construction works (6000-15000 vehicles per day; e.g. Old Coast Road and South Western Highway). (2) 10 db will be added to the noise measurement where impulsiveness is present (banging, thumping).				

Table 14-1 Noise Level Objectives for Construction.

Measuring Blasting Noise

13. Blasting will only be undertaken between 7.00 am and 6.00pm on any day.

14. Blasting noise (airblast level) will be measured if blasting occurs within 100 metres of any residential premises. Airblast level will be measured at the nearest noise sensitive premises (where access is possible) at between 1.2 and 1.6 metres in height above ground level, and at least 5 metres from any noise reflecting surface (building wall, vehicles, etc).
15. The following blasting noise criteria will be complied with:

Day/Time	Airblast assigned level (dB)
0700 to 1800hrs Monday to Saturday	125 dB $L_{linear, peak}$ for any blast
	120 dB $L_{linear, peak}$ for nine in any 10 consecutive blasts, regardless of interval.
0700 to 1800hrs Sundays	120 dB $L_{linear, peak}$ for any blast
	115 dB $L_{linear, peak}$ for nine in any 10 consecutive blasts, regardless of interval.

Table 14-2 Blasting Noise Criteria.

14.5 Additional Information

Regulation 7 of the *Environmental Protection (Noise) Regulations 1997* (WA) prohibits the exceeding of assigned levels of noise defined by Regulation 8. Table 14-1 (above) identifies the assigned levels contained in Regulation 8. Regulation 13 exempts construction works at construction sites from compliance with the assigned levels between 7.00am and 7.00pm, subject to a number of provisions (the provisions are contained within the plan). Consequently, Table 14-1 lists the assigned levels as “objectives” and not as defined limits for construction works for the project.

The blasting noise criteria have been stated as limits as there are no exemptions in the *Environmental Protection (Noise) Regulations 1997* (WA) that allow for variation from the assigned levels.

14.6 Contingency Actions

1. Actions maybe taken to reduce noise impacts on residential premises if the construction noise criteria or the blasting noise criteria are exceeded. Such actions may include:
    a. noise bunds or screens.
    b. adjusting the work schedule for the offending work to be conducted in more appropriate time.
    c. changing the technology or method of construction.
    d. temporary relocation of the affected Landowner (subject to agreement with the Landowner).
2. Noise monitoring will be undertaken to confirm that the noise criteria have been achieved by the directed actions.

14.7 Related Plans

1. Land Clearing and Trench Management.
2. Explosives and Dangerous Goods Management Plan
3. Vibration Management Plan

14.8 Relevant Legislation

1. *Environmental Protection Act 1986* (WA)
2. *Environmental Protection (Noise) Regulations 1997* (WA)

14.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DEC
2. Shire of Harvey

Table 14-3 Noise and Vibration Log

Southern Seawater Desalination Project
Noise Management Plan & Vibration Management Plan

Noise and Vibration Monitoring Log

The purpose of the Noise and Vibration Monitoring Log is to record the levels of noise and vibration against the criteria. The Noise and Vibration Monitoring Log is to be completed by the Site Environmental Scientist.

Name ……………………………………………………………………………………….

Page ……… of ………

Date of Entry	Location of monitoring location (Lot number and location description)	Construction activity description (general construction, blasting, etc)	Noise (dB)	Applicable Noise Criteria Limit (dB)	Vibration (mm/s)	Applicable Vibration Criteria Limit (mm/s)	Name and Position	Initial

15.0 Vibration Management

15.1 Context

Vibration caused by construction works (including earthmoving, rock breaking and blasting) has the potential to affect the integrity of buildings and their fittings. The areas of impact may include walls (internal and external), architraves and skirtings, glass and mirrors, tiled flooring, and external fixtures such as concrete pools and brick fences.

The nearest vibration sensitive premises for the Seawater Desalination Plant site is approximately 600m to the south east. The nearest vibration sensitive premises for the Harvey Summit Tanks site is approximately 650m to the north east. A number of vibration sensitive premises occur within 50m of the Water Transfer Pipeline.

A Building Inspector will be engaged to undertake property condition assessments of properties within 100m of all construction works, and within 1000m of any blasting, to determine any structural impacts caused by vibration.

15.2 Purpose

The purpose of the Vibration Management Plan is to outline management actions to:

1. undertake vibration monitoring.
2. identify the pre-construction condition of properties.
3. identify the post-construction condition of properties.

15.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

15.4 Management Actions

Vibration Monitoring

1. Vibration will be monitored using a portable vibration monitor at least once every 7 days if construction works are within 100 metres of residential premises. The frequency of monitoring maybe increased (up to a maximum daily monitoring frequency) for residences within 20m of the construction works.

2. The vibration monitoring will be undertaken at a distance of 5 metres from any residential premises, at a location between the construction works and the residential premises.

3. All noise measurements will be recorded on the Noise and Vibration Monitoring Log (refer to Noise Management Plan).

4. The following vibration standard (the safe limit applied for blasting affecting residential buildings) will be complied with:

Frequency	Vibration Standard
Not to be exceeded for 9 in 10 blasts.	5 mm/s
Not to be exceeded at any time	10 mm/s

Table 15-1 Vibration Standards.

Property Assessment

5. Landowners located within 100mof all construction works, and within 1000m of any blasting, will be offered a pre-construction property condition assessment prior to construction. The assessment will be conducted by a Building Inspector. The assessment will be conducted in consultation with the Landowner to identify any existing building defects (e.g. cracking). The assessment will include use of a video and/or photographs to document any existing building defects. A Property Condition Report will be prepared by the Building Inspector and provided to the Landowner.
6. The Building Inspector will undertake a second property condition assessment in consultation with the Landowner following the completion of construction works near the property for comparison to the pre-construction property condition report.
7. Any new building defects, or worsened existing defects, that are caused by the construction works will be repaired. The repairs will be conducted in consultation with the Landowner and to a standard equivalent or better than the pre-construction condition.
8. No fee will be charged to the Landowner to undertake the property condition assessments, reports or any required repair works.

15.5 Additional Information

Vibration Standard

[1] The German Standard DIN 4150-3 (1999) has been used as the vibration standard.

Noise and Vibration Monitoring Log

The Noise and Vibration Monitoring Log is contained in the Noise Management Plan.

Property Condition Report

An example Property Condition Report is attached to this plan. The Building Inspector may use a separate report that meets the same minimum requirements identified in the example Report.

15.6 Contingency Actions

Vibration Monitoring

1. The construction technology or method will be modified or the work schedule adjusted, to reduce the cumulative impacts of construction works if the vibration standard for blasting is exceeded.

Property Assessment

2. A resolution will be facilitated between the Landowner if agreement cannot be reached as to the nature and scale of impacts, or the nature and quality of remediation, of any vibration impacts.

15.7 Related Plans

1. Land Clearing and Trench Management
2. Explosives and Dangerous Goods Management Plan
3. Vibration Management Plan

15.8 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DoCEP
2. Shire of Harvey

Table 15-2 Property Condition Report

PROPERTY CONDITION REPORT	
Property Owner:	________________________
Property Address:	________________________ ________________________
Date Pre-construction assessment:	____/____/ 20____
Pre-construction Building Inspector:	________________________
Date Post-construction assessment:	____/____/ 20____
Post-construction Building Inspector:	________________________

The Building Inspector will inspect each area of the property, paying particular attention to the condition of walls (internal and external), architraves and skirtings, glass and mirrors, tiled flooring, and external fixtures such as concrete pools and brick fences.

Pre-construction Condition		Post-construction Condition	
Entry/Hallway			
Notes:		Change?:	Yes ☐ No ☐
		Action Required?:	Yes ☐ No ☐
		If action required, list:	
Photographs: Yes ☐	Video: Yes ☐	Photographs: Yes ☐	Video: Yes ☐
Lounge Room			
Notes:		Change?:	Yes ☐ No ☐
		Action Required?:	Yes ☐ No ☐
		If action required, list:	
Photographs: Yes ☐	Video: Yes ☐	Photographs: Yes ☐	Video: Yes ☐

Family Room	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Dining Room	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Kitchen	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Bedroom 1	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐

Bedroom 2	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Bedroom 3	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Bedroom 4 / Study	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Bathroom 1	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐

Bathroom 2	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Toilet	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Laundry	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Garage	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐

House Exterior	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Other (eg Pool, Brick Fencing)	
Notes: Photographs: Yes ☐ Video: Yes ☐	Change?: Yes ☐ No ☐ Action Required?: Yes ☐ No ☐ If action required, list: Photographs: Yes ☐ Video: Yes ☐
Additional Comments (optional):	Additional Comments (optional):
Agreement	
Building Inspector: ____________________ Landowner: ____________________	Building Inspector: ____________________ Landowner: ____________________

The Building Inspector and the Landowner are to sign this Property Condition Report to indicate agreement to the above information.

16.0 Dangerous Goods and Explosives Management

16.1 Context

Dangerous goods used and stored during construction works will include hydrocarbons (fuels & oils), and chemicals for water treatment (chlorine, acids). Spillages of dangerous goods have the potential to:

- contaminate soil, surface water and groundwater.
- impact personnel and public safety.
- create an ignition source.

Dangerous goods must be contained (bunded) to prevent spillages and ensure compliance with regulatory requirements.

Explosives may also be stored and used for blasting of rock for pipeline installation. Explosives need to be contained to prevent unauthorised access and ignition.

16.2 Purpose

The purpose of the Dangerous Goods and Explosives Management Plan is to outline management actions for:

1. the storage and containment of dangerous goods and explosives.
2. responding to a spill of a dangerous good.
3. the reporting of incidents involving dangerous goods and explosives.

16.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

16.4 Management Actions

Dangerous Goods

1. A Licence issued by the Chief Inspector of the DoCEP under s45A(1) of the *Explosives and Dangerous Goods Act 1961* (WA) will be obtained prior to any storage of dangerous goods.

2. Liquid dangerous goods will be stored in a bund or compound capable of containing 110% of the volume of the dangerous goods stored. For packaged liquid dangerous goods (goods in a number of smaller containers), the goods shall be stored in a bund or compound capable of containing 110% of the volume of the largest container.

3. Dangerous goods will be stored in minimum quantities (where possible) to minimise the environmental impact if spillage occurs.

4. Dangerous goods will be segregated to ensure incompatible dangerous goods are not co-located (refer Figure 16-1).

5. Dangerous goods will not be stored within 25m of any watercourse or wetland.

Explosives

6. A Permit issued by the Chief Inspector of the DoCEP under s34 of the *Explosives and Dangerous Goods Act 1961* (WA) will be obtained prior to any storage or use of explosives at construction sites.

7. A Shotfirer's Permit under r116A of the *Explosives and Dangerous Goods (Explosives) Regulations 1963* (WA) will be obtained for use of explosives.

8. FESA will be notified where any unexploded ordnances are located or stored within the construction area. Construction within 20m of identified unexploded ordnance will cease until FESA has attended and confirmed the area safe to continue work.

Record Keeping

9. Material Safety Data Sheets will be maintained for each dangerous good and each explosive stored. The MSDS will be located outside of the compound in which the material is stored. The compound will be placarded in accordance with the DoCEP's *Guidance Note for Placarding*.

10. Deliveries of dangerous goods and explosives will only be accepted if they are accompanied by a Materials Safety Data Sheet (MSDS) for that dangerous good or explosive, or, if there is an existing and current MSDS for that dangerous good or explosive already held on the site.

11. A Dangerous Goods and Explosives Log (Manifest) will be maintained of all dangerous goods and explosives held on the construction sites. The Log will be stored in a secure location at the site entrance. The Log will identify the:
    a. date on which the goods were received.
    b. location(s) at which the goods are stored.
    c. volume/quantity stored at each location.
    d. date and volume/quantity removed from storage when used.
    e. name of the person(s) receiving/removing goods to/from storage on each occasion.

    A site plan that identifies the storage location of each dangerous good will accompany the Log.

Safety

12. Dangerous goods and explosives will be stored in a locked compound to prevent unauthorised access.

13. Ignition sources (e.g. welding equipment, cigarettes, lighters) will be prohibited within any compound used for the storage of dangerous goods or explosives.

Training

14. All construction staff will be trained on identification, storage and handling procedures for dangerous goods and explosives. Construction staff will also be trained on response procedures (including use of Spill Response Kits) for accidents and incidents and emergencies involving dangerous goods or explosives.

Accidents, Incidents and Emergencies

15. A Spill Response Kit will be installed and maintained at each construction site for the clean-up and containment of spills to land or water. Each spill kit will contain:
    a. universal absorbent pads or pillows or blankets.
    b. a containment boom (for containing discharges to water).
    c. labelled plastic contaminated waste bags.
    d. safety gloves.

    Contaminated material will be disposed of from a spill in accordance with the Waste Management Plan.

16. The Chief Inspector of the DoCEP will be notified of any accident involving explosives or dangerous goods (s55(1) of the *Explosives and Dangerous Goods Act 1961* (WA)).

17. FESA will be notified of any incident involving dangerous goods or an explosive that has had, or has the potential to, have a significant impact on the environment or human safety.

18. The DEC will be notified of any incident involving dangerous goods or an explosive that has had, or has the potential to, have a significant impact on the environment.

16.5 Additional Information

An example Dangerous Goods and Explosives Log is attached to this plan.

16.6 Contingency Actions

No contingency actions are considered necessary.0

16.7 Related Plans

1. Incident Management
2. Waste Management

16.8 Relevant Legislation

1. *Explosives and Dangerous Goods Act 1961* (WA)
2. *Explosives and Dangerous Goods (Dangerous Goods Handling and Storage) Regulations 1992* (WA)
3. *Explosives and Dangerous Goods (Explosives) Regulations 1963* (WA)
4. *Environmental Protection Act 1986* (WA)
5. *Occupational Safety and Health Regulations 1996* (WA)

16.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DoCEP
2. FESA
3. DEC

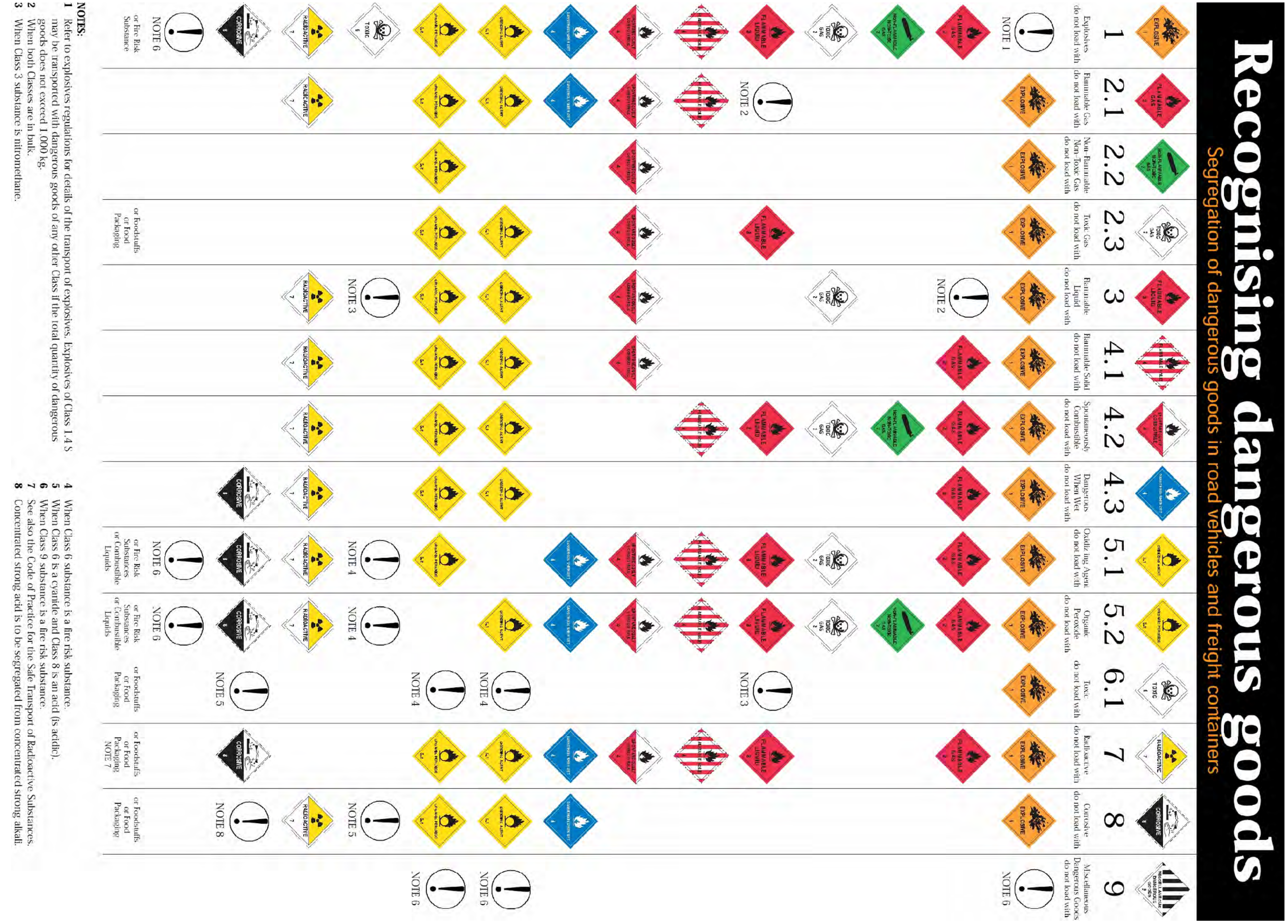


Figure 16-1 Guidance on Segregation of Dangerous Goods.

This guidance has been designed for road vehicles and freight containers, however is also applicable to storage on construction sites. Print A3 for best results

Table 16-1 Dangerous and Explosive Goods Manifest (6 pages)

Southern Seawater Desalination Project
Page 1 of 6

Dangerous Goods and Explosives Log

The principal purpose of the manifest is to provide contractors and emergency service authorities with information about the quantity, type and location of dangerous goods and explosives stored.

Licensee ………………………………………………………………………………………

Address of Premises ………………………………………………………………………………………

Date of Preparation ………………………………………………………………………………………

Site Plan No. ………………………………………………………………………………………

Emergency Contacts

Name	Position	Telephone	
		B/H: A/H/Mobile:	
		B/H: A/H/Mobile:	
		B/H: A/H/Mobile:	
		B/H: A/H/Mobile:	
		B/H: A/H/Mobile:	
		B/H: A/H/Mobile:	

Dangerous Goods and Explosives Emergency Contacts

Water Corporation's Emergency Contacts

Name	Position	Organisation	Telephone	
George Basanovic	Corporate Incident Management Coordinator	Water Corporation	B/H: A/H/Mobile:	9420 3247 [redacted]
Ciaran MacCarron	Manager Occupational Health and Safety	Water Corporation	B/H: A/H/Mobile:	9420 3690 [redacted]
Mark Oliver	Senior Project Manager – Seawater Desalination Plant	Water Corporation	B/H: A/H/Mobile:	9420 3752 [redacted]
John Stansfield	Project Manager – Seawater Desalination Plant	Water Corporation	B/H: A/H/Mobile:	9420 3406 [redacted]
John Goullee	Principal Project Manager – Water Transfer Pipeline and Harvey Summit Tanks	Water Corporation	B/H: A/H/Mobile:	9420 2149 [redacted]
Gordon Groth	Senior Environmental Officer	Water Corporation	B/H: A/H/Mobile:	9420 2796 [redacted]
Trevor Roffman	OSH Coordinator, Project Management Group	Water Corporation	B/H: A/H/Mobile:	9420 2413 [redacted]
Guy Watson	Environmental Operations Manager	Water Corporation	B/H: A/H/Mobile:	9420 3832 [redacted]

External Emergency Contacts

Position	Telephone	
Fire and Emergency Services Authority (Bunbury)	B/H: A/H/Mobile:	9780 1900 000 all hours
Police (Harvey)	B/H: A/H/Mobile:	9729 1001 - 17A Hayward St Harvey 000 all hours
Department of Consumer and Employment Protection Resources Safety Division	B/H:	9222 3595
Department of Environment and Conservation (Perth)	B/H: A/H/Mobile:	9726 4111 1300 784 782

Dangerous Goods - Maximum Permissable Quantities

Summary of Maximum Permissible Quantities - Licence under s45A of the *Explosives and Dangerous Goods Act 1961* (WA)

Bulk Storage

Tank Id No.	Dangerous Goods					Tank	
	Name	Class	Sub Risk(s)	UN No.	PG	Type	Capacity (L)

Package Storage Areas

Storage area			Dangerous Goods			Quantity (kg)	
	Name	Class	Sub Risk(s)	UN No.	PG	Average	Maximum

Other Packaged

Storage Area	Class	Sub Risk(s)	Packaging Group	Average Quantity (kg or L)	Maximum Quantity (kg or L)

Dangerous Goods - Receipt/Removal Log

Date Received/ Removed	Storage Location	Type of Dangerous Good	Maximum Permissible Quantity (kg)	Quantity Received (kg)	Quantity Removed (kg)	Quantity Remaining in Storage (kg)	Name of Person Receiving/ Removing

Explosives - Maximum Permissable Quantities

Summary of Maximum Permissible Quantities – Permit under s34 of the *Explosives and Dangerous Goods Act 1961* (WA)

Bulk Storage

Tank Id No.	Dangerous Goods					Tank	
	Name	Class	Sub Risk(s)	UN No.	PG	Type	Capacity (L)

Explosives - Receipt/Removal Log

Receipt/Removal

Date Received/ Removed	Storage Location	Type of Explosives	Maximum Permissible Quantity (kg)	Quantity Received (kg)	Quantity Removed (kg)	Quantity Remaining in Storage (kg)	Name of Person Receiving/ Removing

17.0 Organochlorine (Dieldrin) Management

17.1 Context

The Water Transfer Pipeline crosses land in which dieldrin pesticide, an organochlorine (OC), was historically applied to the soil surface for the control of the African black beetle in potato crops and to control weevils in fruit trees. Residual OC contamination exists in the top 10cm to 15cm of soil in the OC contaminated land. The residual OC contamination will require management during construction.

The WA Department of Agriculture and Food (DAF) (circa 2004) has determined the known dieldrin concentrations in the affected land:

Land on Water Transfer Pipeline route	Dieldrin Concentration (mg/kg)	Length of water transfer main affected
[redacted], Shire of Harvey	0.21	200m
[redacted], Shire of Harvey	0.07-0.09	150m
[redacted], Shire of Harvey	0.06-0.3	125m

Table 17-1. Land Affected by Residual OC Contamination on the Water Transfer Pipeline Route. The location of the OC contaminated lands have been suppressed and will remain strictly confidential as requested by the DAF (refer to Additional Information below).

Aerial imagery of the affected lands is depicted in Figure 23. Construction works are expected to impact approximately 1425m^3 of OC contaminated soil (475m length x 20m width x 15cm depth).

The residual OC contamination does not represent a health risk to construction staff and no personal protective equipment is required (the health investigation level for dieldrin is 10.00mg/kg for occupation of residential dwellings and 50.00mg/kg for occupation of commercial and industrial sites).

The risk is that construction works will remobilise dieldrin in the soil to the surface, with cattle consuming the remobilised dieldrin through ingestion of pasture and soil. Dieldrin consumed by cattle can bio-accumulate in the meat and milk; making it unsuitable for human consumption.

17.2 Purpose

The Purpose of the Organochlorine (Dieldrin) Management Plan is to outline management actions to:

1. manage remobilisation of residual OC contaminated soil during construction.
2. ensure that livestock do not access exposed OC contaminated soil during construction and immediately following post-construction.

17.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

17.4 Management Actions

Hygiene

1. It will be ensured that all vehicles and equipment will be brushed and/or air jetted to remove sods of dirt attached to the vehicle (including tyres, undercarriage and inside cabin) prior to exiting OC affected land to minimise contamination of adjacent lands (note there is no requirement for cleaning procedures prior to entering the affected land)

Construction

2. It will be ensured that livestock do not access OC affected land under construction or stockpiles of OC affected material.
3. A maximum 20m construction width will be used through OC contaminated land. The construction width maybe further reduced in the OC contaminated land to further minimise the area and volume of OC contaminated soil disturbed that would require management.
4. OC contaminated topsoil (top 15cm) will be stockpiled separately from soil stockpiles from other land. OC contaminated topsoil will not be placed on non- OC contaminated land.
5. An agreement with the Landowner will be reached on the management of OC contaminated topsoil by one of the following methods:
   a. **Remediation**[1]: Removal of OC contaminated topsoil to a depth of 15cm, replaced with 15cm of clean fill.
   b. **Partial Remediation**[2]: Removal of OC contaminated topsoil to a depth of 15cm, replaced with 50% clean fill and 50% OC contaminated topsoil to a depth of 15cm.
   c. **No Remediation**[3]: Removal of OC contaminated topsoil to a depth of 15cm during construction, which will be replaced following construction to a depth of 15cm.

   Where an agreement cannot be reached on the method, the 'No Remediation' method will be undertaken.
6. Surplus OC contaminated topsoil from the construction works maybe disposed of within the excavated trench of the affected agricultural land, with a minimum cover of 750mm of uncontaminated soil.
7. Surplus OC contaminated topsoil maybe disposed of to landfill or any other location not used for agriculture.
8. Surplus overburden (soil beneath 15cm depth) maybe disposed of to any land as this soil will not be OC contaminated.

Post-Construction

9. Liaisons will occur with the Landowner to ensure that livestock are excluded from land on which no remediation[3] has occurred until that area has been rehabilitated with pasture grass (refer to Rehabilitation Management Plan for agricultural lands).

17.5 Additional Information

Confidentiality

The location of the OC contaminated lands will remain strictly confidential as requested by the DAF. The locations of the OC contaminated lands will only be provided to the construction staff on the Water Transfer Pipeline. The locations of the OC contaminated lands will not be made available in the publicly available copy of the CEMF to maintain this confidentiality.

Pre-construction testing

Preconstruction testing of the affected lands will not be undertaken. The previous testing results from the DAF (circa 2004) are considered sufficient for construction management given that all OC contaminated land will be managed by the same management actions listed in this plan (i.e. the concentration is irrelevant to management). The DAF have provided verbal confirmation that pre-construction testing is not required (pers. com. 22 October 2007 A.Drage (DAF) to S.Hawkins (Water Corporation)).

Remediation

[1] Where the Landowner agrees to 'Remediation' of the OC contaminated land, topsoil will not be returned. The area will be fertilised and seeded as defined by the Remediation Management Plan. The DAF will then be able to assess the land to determine if it can be regarded as remediated.

[2] Where the Landowner agrees to 'Partial Remediation' of the OC contaminated land, the OC contaminated topsoil will be returned. Partial Remediation is considered an option as the Landowner may wish to retain the seed bank and nutrients contained in the topsoil. The area will be fertilised and seeded as defined by the Remediation Management Plan. The affected land may remain determined as OC contaminated by the DAF.

[3] Where the Landowner agrees to 'No Remediation' of the OC contaminated land, the OC contaminated topsoil will be returned in full. No Remediation is considered an option as the Landowner may wish to retain the seed bank and nutrients contained in the topsoil. The area will be fertilised and seeded as defined by the Remediation Management Plan. The affected land will likely remain determined as OC contaminated by the DAF.

17.6 Contingency Actions

No contingency actions are considered necessary.

17.7 Related Plans

1. Land Clearing and Trench Management
2. Dewatering and Acid Sulphate Soils Management

17.8 Relevant Legislation

1. *Agricultural Produce (Chemical Residues) Act 1983* (WA)

Note: The *Contaminated Sites Act 2003* (WA) and *Regulations 2006* (WA) do not apply as the residual OC contamination is a result of correct application of a pesticide (refer s5(2) and s4 of the *Contaminated Sites Regulations 2006* (WA)).

17.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DAF
2. DoH
3. DoCEP (Worksafe WA)

[redacted]

Figure 17-1 Organochlorine Contaminated Land

at [redacted], [redacted] and [redacted] The location of the OC contaminated lands has been intentionally 'blacked-out' in this publicly available version of this plan to comply with the confidentiality requirements of the DAF.

18.0 Discharge of Pipeline Pressure Testing and Disinfection Waters Management

18.1 Context

Following the construction of sections of the Water Transfer Pipeline, each section will be pressure tested to confirm its structural integrity. Each section tested will be approximately 5km in length. The pressure testing will be conducted using groundwater, scheme water, or a disinfection water containing 12.5% sodium hypochlorite.

Immediately prior to operation, the entire 30km Water Transfer Pipeline will be disinfected with 12.5% sodium hypochlorite. Disinfection is required in order to reduce bacterial contamination within the pipeline. This process will produce a disinfection water at approximately 5mg/L to 20mg/L chlorine.

Both the pressure test water and disinfection water will have a pH of between 8 to 12 pH units resulting from interaction with the lime in the cement lining of the pipeline.

The pressure test and disinfection waters will be unsuitable for domestic supply, and consequently must be discharged to the environment in an appropriate manner.

Residual chlorine contained in disinfection waters can be consumed by material with a high carbon content (such as soil and vegetation), or can be neutralised with 10% Sodium Thiosulphate using a de-chlorination unit. The impacts of pH can be controlled by management of flow rates for discharge to a watercourse, or can be neutralised by acid dosing (using a non-chlorinated acid).

The estimated total volume of controlled discharge to the environment will be approximately 100 ML (50 ML each from the pressure test water and the disinfection water).

The waters will be discharged from section valves to land, watercourses along the pipeline route, or to the ocean. The quality of the discharge waters will be monitored prior to, and during, discharge to the environment.

18.2 Purpose

The purpose of the Discharge of Pipeline Pressure Testing and Disinfection Waters Management Plan is to outline the management actions to:

1. Define the method and management of discharge of pressure test water and disinfection water to the environment.

18.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.
2. Results of pH and chlorine monitoring in compliance with the discharge criteria.

18.4 Management Actions

General

1. Sections of pipeline between section valves (approximately 5km each) of the Water Transfer Pipeline will be pressure tested following construction of that section. The pressure testing will be conducted using groundwater, scheme water, or disinfection water containing 12.5% sodium hypochlorite.
2. The entire Water Transfer Pipeline will be disinfected with 12.5% sodium hypochlorite prior to operation.
3. Pressure test and disinfection waters will be preferentially discharged to the following major watercourses via scour valves:
   a. Harvey River
   b. Myalup/Harvey Main Drain
   c. Harvey Irrigation Channels
4. Disinfection water maybe preferentially discharged to agricultural land where approval of the Landowner has been obtained, or secondly to minor watercourses or drains, where discharge to the major watercourses is not practicable.
5. Pressure test and disinfection waters maybe discharged to the ocean at the Seawater Desalination Plant site. The discharge will occur through the outlet pipeline constructed for the Seawater Desalination Plant, or alternatively through a separate pipeline located in the surf zone (nominally 10m to 25m from the shoreline).

Chlorine and pH Discharge Criteria

6. The following discharge criteria apply:

	Chlorine (mg/L)	pH
Discharge to Watercourse	1.0[1] for discharge water	6.0 to 8.5 for the discharge water ***or*** ± 2 pH units downstream v. upstream measured at 100m from the discharge [2]
Discharge to Agricultural Land	1.0[1] for discharge water	4.0 to 10.0 for the discharge water [3]
Discharge to Ocean	Not applicable[4]	4.0 to 10.0 for the discharge water [3]

Table 18-1 Chlorine and pH Discharge Criteria

Management and Monitoring of Chlorine

7. Disinfection water will be tested for total chlorine prior to discharge to confirm that the total residual chlorine meets the discharge objectives. Testing may be conducted by water samples taken to a laboratory, or by field test equipment capable of accuracy to 1.0mg/L.
8. A mobile de-chlorination unit will be used to neutralise the residual chlorine with 10% Sodium Thiosulphate if the disinfection water has residual chlorine greater than 1.0mg/L.
9. Disinfection water will be discharged to a watercourse through a series of sterile hay bales. The bales will assist to aerate the discharge, reduce flow velocity, and reduce any suspended solids and turbidity. The bales will also assist in the neutralisation of residual chlorine (by acting as a carbon source).

Management and Monitoring of pH

10. The pH of the pressure test water and disinfection water will be field tested for (by multimeter) at the discharge point prior to discharge to confirm that the pH meets the discharge criteria on each day of discharge.
11. The pH of the pressure test water and disinfection water will be field tested for (by multimeter) at 100m upstream and 100m downstream of the discharge point on each day of discharge if the discharge does not meet the pH criteria for the discharge water for

discharges to a watercourse. The rate of discharge will be adjusted so that the pH in the watercourse downstream of the discharge is within ± 2 pH units of the upstream water quality.

12. The pH of the discharge water will be neutralised with sulphuric acid if the pH of the discharge does not meet the pH discharge criteria (with flow adjustment).

18.5 Additional Information

Discharge Criteria for Chlorine and pH

[1] Chlorine at 1.0mg/L is consistent with chlorine residual in potable water supply and is in accordance with the Water Corporation's guideline for disposal of disinfection water. Chlorine will be diluted by mixing within the watercourse, and consumed through biological uptake by bacteria, sediments and flora.

[2] Discharge pH is consistent with ANZECC/ARMCANZ and DoW guidelines for freshwater. Watercourse pH is consistent with the Water Corporation's guideline for disposal of disinfection water.

[3] pH limits defined by the *Environmental Protection (Unauthorised Discharges) Regulations 2004* (WA).

[4] Chlorine concentration for discharge to the ocean is not of concern given the concentration of chlorine present in the ocean as chloride (being part of sodium chloride (salt)).

De-chlorination

The Water Corporation's Water Technologies Division has two mobile de-chlorination units that may be made available upon request. The rate of de-chlorination capability is approximately 4ML/day. The discharge water may be pH corrected using an acid prior to de-chlorination.

Reuse

Consideration may be given to the reuse of the pressure test water and/or the disinfection water by a transfer of the water from one section of the pipeline to the next, with disinfection reoccurring in the next section. This will reduce the volume of water to be disposed of to the environment.

Consideration may also be given to reuse of the pressure test water and/or the disinfection water by discharge to a Harvey Summit Tanks such as the Harvey Dam.

18.6 Contingency Actions

1. Pressure testing of the pipeline may be repeated if the pressure test identifies that there are defects in the pipelines. The same procedure for monitoring the discharge of pressure test water to the environment will apply.

2. The same procedure for monitoring the discharge of the disinfection water to the environment will apply if disinfection is repeated.

18.7 Relevant Legislation

1. Environmental Protection Act 1986 (WA).
2. *Environmental Protection (Unauthorised Discharges) Regulations 2004* (WA).

18.8 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DoW
2. DEC
3. Harvey Water

19.0 Rehabilitation Management

19.1 Context

Construction of the Seawater Desalination Plant, Water Transfer Pipeline and the Harvey Summit Tanks will involve clearing of agricultural land and native vegetation (located in agricultural land, road reserves and State Forest). Rehabilitation of areas cleared will be undertaken as soon as reasonably practicable following the completion of construction works.

Following the implementation of rehabilitation actions, the success of the rehabilitation works will be monitored for a period of one year for agricultural lands, and for 5 years for native vegetation.

19.2 Purpose

The purpose of the Rehabilitation Management Plan is to outline management actions for:

1. rehabilitation of agricultural land disturbed during construction to a condition that is equal to the pre-construction condition and that is acceptable to the Landowner.
2. rehabilitation of native vegetation (including dune vegetation) to a condition that supports a self-sustaining plant community with comparable density and diversity to the pre-existing vegetation.

19.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

19.4 Management Actions

19.4.1 Seawater Desalination Plant

Native Vegetation

1. The proponent's completion objective for rehabilitation of Seawater Desalination Plant site for native vegetation is:

Native Vegetation	*Rehabilitation will achieve a post-construction condition of native vegetation that will, in the future[1], likely support a self-sustaining plant community with comparable species density and species diversity to the pre-existing vegetation.*

2. The Seawater Desalination Plant site will be re-contoured, including re-creation of the primary dune, establishment of earth screening bunds, and contouring of the whole site to achieve stable batters.
3. Seed for rehabilitation will be collected from within nominally 50km of the construction site between (nominally) December to March of the year prior to seeding. A Licence will be obtained from the CEO of the DEC under s88(1) of the *Conservation and Land Management Act 1984* (WA) for collection of seed within DEC managed land (Note: Licence application to be made in accordance with r83 of the *Conservation and Land Management Regulations 2004* (WA)).
4. Seed will be collected based upon the species list identified in Table 19-2. The mass of each species collected will be determined based on seed availability (including consideration of recalcitrant species).
5. Following ripping of the compacted areas (refer to Land Clearing and Trench Management), the land will be seeded[2] with native vegetation seed at a rate of 5kg/ha. The 5kg/ha seed

base will be mixed with a 10kg/ha bulking agent (such as white sand) to achieve a more even spread of seed.

6. A slow release fertiliser having a low phosphorus content (such as Osmocote® PLUS Native Gardens (ratio Nitrogen 17: Phosphorus 1.6: Potassium 8.7)) will be applied at a nominal rate of 200kg/ha (by total weight, or at a rate as directed by the manufacturer) at the time of seeding.
7. Areas seeded and fertilised will be irrigated once per week for a period of 4 weeks following seeding and fertilising to encourage seed germination at a nominal irrigation rate of 50kL/ha (being equivalent to 5mm rainfall). Irrigation will be undertaken using a diffuse spray to prevent erosion during irrigation. Where seeding is undertaken in the months of December, January, February or March, there will be additional irrigation of the seeded area once per week for those months.
8. The revegetation works will be monitored for growth cover and vigour for a period of five springs following seeding and fertilising. The monitoring will assess the density and diversity of the rehabilitated areas compared to pre-construction photographs and any relevant pre-construction reports (including flora surveys).
9. Supplementary seeding, direct planting, fertilising and/or irrigation will be undertaken if the monitoring identifies poor growth in any revegetation area following the completion of spring monitoring,
10. Growth of large tree species (such as Jarrah and Marri) will be removed from within 7.5m of buried pipelines during the monitoring period[3]. Removal of these species will occur by cutting at the base of the plant and applying a Glyphosate herbicide to the cut surface.

19.4.2 Pipeline and Harvey Summit Tanks

Agricultural Land

11. The completion objective for rehabilitation of construction areas of agricultural land is:

Agricultural Land	*Rehabilitation will achieve a post-construction agricultural condition that is equal or better than the pre-construction agricultural condition, and is acceptable to the Landowner.*

12. Irrigation paddocks (that were laser levelled prior to construction) will be re-laser levelled as soon as practicable following construction on each lot.
13. Following ripping of the compacted areas (refer to Land Clearing and Trench Management), land disturbed by construction works will be seeded in consultation with the Landowner. Generally, three types of seed mixes containing a combination of rye grass and clover will be used, being separate proportions for irrigated agriculture, dry land agriculture, or agriculture on winter waterlogged land.
14. The following rates of seed and fertiliser will be applied on agricultural land under rehabilitation:

Seed (kg/ha)	Phosphorus (kg/ha)	Nitrogen (kg/ha)	Potassium (kg/ha)	Sulphur (kg/ha)
25	40	35	20	20

Table 19-1 Seed and Fertiliser Application rates

Seed and fertiliser applications rates maybe varied by agreement with the Landowner.

15. The seed and fertiliser will be supplied to the Landowner at the above rate if the Landowner wishes to undertake the seeding and fertilising on their own land.
16. The Landowners of laser levelled irrigation paddocks will be requested to commence irrigation following seeding and fertilising to encourage seed germination. All non-irrigated paddocks will be irrigated with a nominal depth of 10mm of water (equivalent to 100kL/ha) following seeding and fertilising to encourage seed germination. Irrigation will be undertaken using a diffuse spray to prevent erosion during irrigation.

17. The growth success of rehabilitation works on agricultural land will be monitored for a period of one full spring following seeding and fertilising. The growth success will be measured by vegetation cover and vigour compared to pre-construction photographs.

18. Soil consolidation of the construction areas will be monitored on all laser levelled irrigation paddocks and measure any soil consolidation.

19. A report will be provided detailing the monitoring undertaken and the results of growth success and soil consolidation.

20. In consultation with the Landowner (and at no cost to the Landowner), seeding, fertilising and irrigation will be repeated in any areas that do not have vegetation cover or vigour that is equal to or better than the preconstruction condition within the first 12 months following the completion of all construction works on the land.

21. In consultation with the Landowner (at no cost to the Landowner), remedial works will be undertaken to correct soil consolidation if the trench settles or consolidates greater than 3cm in laser levelled irrigation paddocks, or greater than 10cm in non-irrigated paddocks, within the first 12 months following the completion of all construction works. The remedial works to be undertaken will involve (as per the Land Clearing and Trench Management Plan):
    a. removal of topsoil.
    b. replacement and compaction with clean fill of equivalent soil type.
    c. replacement of topsoil.
    d. seeding and fertilising as stated above.
    e. Any other actions as agreed on with the Landowner (which may or may not include other actions to account for consequential loss or future soil consolidation).

Native Vegetation

22. The completion objective for rehabilitation of construction areas with native vegetation is:

Native Vegetation	*Rehabilitation will achieve a post-construction condition of native vegetation that will, in the future[1], likely support a self-sustaining plant community with comparable species density and species diversity to the pre-existing vegetation.*

23. Following ripping of the compacted areas (refer to Land Clearing and Trench Management), the land will be seeded[2] with native vegetation seed at a rate of 5kg/ha. The 5kg/ha seed base will be mixed with a 10kg/ha bulking agent (such as white sand) to achieve a more even spread of seed.

24. Seed for rehabilitation will be collected from within 50km of the construction site between (nominally) December to March of the year prior to seeding. A Licence will be obtained from the CEO of the DEC under s88(1) of the *Conservation and Land Management Act 1984* (WA) for collection of seed within State Forest (Note: Licence application to be made in accordance with r83 of the *Conservation and Land Management Regulations 2004* (WA)).

    The species of seed to be collected will be based upon the species list identified in Table 15-2. The mass of each species collected will be determined based on seed availability (including consideration of recalcitrant species).

25. A slow release fertiliser having a low phosphorus content (such as Osmocote® PLUS Native Gardens (ratio Nitrogen 17: Phosphorus 1.6: Potassium 8.7)) will be applied at a nominal rate of 200kg/ha (by total weight, or at a rate as directed by the manufacturer) at the time of seeding.

26. Areas seeded and fertilised will be irrigated once per week for a period of 4 weeks following seeding and fertilising to encourage seed germination at a nominal irrigation rate of 50kL/ha (being equivalent to 5mm rainfall). Irrigation will be undertaken using a diffuse spray to prevent erosion during irrigation. Where seeding is undertaken in the months of December, January, February or March, the seeded area will be additionally irrigated once per week for those months.

27. The revegetation works will be monitored for growth cover and vigour for the period of one full spring following seeding and fertilising. A report on the monitoring undertaken will be prepared.

28. If the monitoring identifies poor growth in any revegetation area following the completion of spring monitoring, supplementary seeding, direct planting, fertilising and/or irrigation will be undertaken.
29. Following the spring monitoring and any supplementary works, there will be annual monitoring of the rehabilitation works for a further 4 spring periods (i.e. a total of 5 spring monitoring years). The monitoring will assess the density and diversity of the rehabilitated areas compared to pre-construction photographs and any relevant pre-construction reports (including flora surveys).
30. Direct planting by seedlings maybe undertaken if supplementary works within the monitoring period are required to improve vegetation density or diversity.
31. Growth of large tree species (such as Jarrah and Marri) will be removed from within 7.5m of the Water Transfer Pipeline centreline within the Water Corporation's monitoring period[3]. Removal of these species will occur by cutting at the base of the plant and applying a Glyphosate herbicide to the cut surface.

19.5 Additional Information

Native Vegetation Rehabilitation

[1] The density and diversity of rehabilitated native revegetation will change over time. Such changes over time include:

1. increase in overstorey height.
2. development of understorey with increased overstorey height.
3. leaf litter drop from overstorey to suppress weed species.
4. species recruitment from adjacent vegetation.

As the changes listed above can only be developed over time, it would be unlikely that rehabilitation of native vegetation could be deemed to support a self-sustaining plant community with comparable species density and species diversity to the pre-existing vegetation within a period of 20 to 30 years.

A 20 to 30 year timeframe for implementing rehabilitation of native vegetation is considered inappropriate given that:

1. native revegetation requires limited active management once established.
2. the area of native vegetation to be cleared is small (<15ha).
3. large trees cannot be planted within 7.5m of the pipeline (due to root damage of rubber ring joints), so the vegetation structure will be different for a large proportion of the rehabilitation.
4. the *likelihood* of the vegetation to meet the completion objectives into the future can be assessed after a lesser time period (5 years after establishment)

Consequently, the likelihood of the vegetation achieving the completion objectives in the future will be assessed after a period of 5 years. The 5-year assessment will include:

1. calculation of the current species density and species diversity in comparison to the pre-construction species density and species diversity
2. the likelihood of recruitment of species from adjacent vegetation.
3. a determination if the native vegetation will, within a period of 30 years, likely achieve the completion objectives. The determination will be made in consultation with the Landowner with a view to hand over management of the rehabilitated areas to the Landowner
4. the determination will include any requirement to fund minor active management (such as weed control) to the Landowner.

[2] Timing of seeding for native vegetation will be dependant on seed availability.

Infrastructure Maintenance

[3] It is required by this plan to remove large trees species from within 7.5m of buried pipelines to prevent tree roots from interfering with the rubber ring joints that connect the pipe lengths. This operational maintenance work will need to be undertaken throughout the life of the project in consultation with the relevant Landowner(s) beyond the timeframe covered by this CEMF.

Weed Management

The 3 year monitoring and management period for weeds in agricultural land and native vegetation specified in the Hygiene Management Plan is separate to the monitoring and management periods for rehabilitation. These actions will be undertaken concurrently.

19.6 Contingency Actions

Native Vegetation

1. Additional or alternative actions required will be considered to meet the completion objectives if the rehabilitation works in native vegetation do not meet the completion objectives within 5 years.

Agricultural Land

2. A resolution will be facilitated with the Landowner if agreement cannot be reached as to the success of rehabilitation works on agricultural land.

19.7 Related Plans

1. Land Clearing and Trench Management
2. Well Construction Management
3. Hygiene Management

19.8 Relevant Legislation

1. *Conservation and Land Management Act 1984* (WA) and *Regulations 2004* (WA).

19.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DEC
2. DAF
3. Conservation Commission
4. Shire of Harvey

Table 19-2 Native Flora to be Considered for Rehabilitation of Native Vegetation

(from 360 Environmental 2008).

Notes:

1. The *WAH No.* is the plant family number used by the Western Australian Herbarium.
2. *Declared weed* means the species has been declared under the *Agriculture and Related Resources Protection Act 1976* (WA).
3. Priority flora species are as defined by the Department of Environment and Conservation, but have no specific legal protection.
4. *NS* indicates a weed of national significance as defined by Thorp & Lynch (2000).

WAH No.	FAMILY / TAXA	COMMON NAMES	NOTES
3	**Selaginellaceae**		
	Selaginella gracillima		
011C	**Dennstaedtiaceae**		
	Pteridium esculentum	bracken	
016A	**Zamiaceae**		
	Macrozamia riedlei	zamia	
017A	**Pinaceae**		
	Pinus pinaster	maritime pine	weed
20	**Typhaceae**		
	Typha orientalis	bullrush	weed
23	**Potamogetonaceae**		
	Potamogeton drummondii	pond weed	
26	**Juncaginaceae**		
	Triglochin sp. B Flora of Australia (P.G. Wilson 4294)		
	Triglochin trichophora		
	Triglochin huegelii		
	Triglochin nana		
27	**Alismataceae**		
	Alisma lanceolatum	water plantain	weed
31	**Poaceae (grasses)**		
	Aira caryophyllea	silvery hairgrass	weed
	Aira cupaniana	early hairgrass	weed
	Aira praecox	early hairgrass	weed
	Ammophila arenaria	marram grass	weed
	Amphipogon laguroides subsp. laguroides		
	Amphibromus nervosus		
	Amphipogon turbinatus		
	Amphipogon amphipogonoides		
	Amphipogon laguroides subsp. laguroides		
	Austrodanthonia occidentalis		
	Arundo donax	'bamboo'	weed
	Austrostipa campylachne		
	Austrostipa compressa		
	Austrostipa flavescens		
	Austrostipa sp.		
	Avena barbata	wild oats	weed
	Briza maxima	blowfly grass	weed
	Briza minor	shivery grass	weed
	Bromus diandrus	great brome	weed
	Bromus hordeaceus	soft brome	weed
	Bromus rubens	red brome	weed
	Cynodon dactylon	couch	weed
	Dactylis glomerata	cocksfoot	weed
	Deyeuxia quadriseta	reed bentgrass	weed
	Dichelachne crinita	longhair plumegrass	
	Ehrharta brevifolia	annual veldt grass	weed
	Ehrharta calycina	perennial veldt grass	weed
	Ehrharta longiflora	annual veldt grass	weed
	Elymus scaber		
	Eragrostis curvula	African love grass	weed
	Glyceria declinata		weed
	Holcus lanatus	Yorkshire fog	weed
	Holcus setiger	annual fog	weed
	Hordeum geniculatum	barley grass	weed
	Hordeum leporinum	barley grass	weed
	Lagurus ovatus	hair's tail grass	weed
	Lolium multiflorum	talian rye grass	weed
	Lolium perenne	perennial ryegrass	
	Lolium rigidum	annual rye grass	weed
	Medicargo polymorpha		weed
	Microlaena stipoides var. stipoides		
	Paspalum sp.		weed
	Pennisetum clandestinum	kikuyu	weed
	Poa annua	winter grass	weed
	Poa drummondiana	knotted poa	weed
	Poa poiformis	coastal poa	
	Poa porphyroclados		

	Poa porphyroclados		
	Polypogon monspeliensis	annual beardgrass	weed
	Sorghum halepense	Johnson grass	weed
	Spinifex hirsutus	hairy spinifex	
	Stenotaphrum secundatum buffalo grass	buffalo grass	weed
	Vulpia bromoides	squirrel tail fescue	weed
	Vulpia muralis		weed
32	**Cyperaceae (sedges)**		
	Baumea articulata	jointed rush	
	Baumea preissii subsp. laxa		
	Bolboschoenus caldwellii	marsh club-rush	
	Carex appressa	tall sedge	
	Carex preissii		
	Cyathochaeta ?avenacea		
	Cyperus sp.		
	Cyperus tenellus	tiny flatsedge	weed
	Eleocharis acuta	common spike-sedge	
	Ficinia nodosa	knotted club-rush	
	Gahnia trifida	coastal saw-sedge	
	Isolepis cernua var. setiformis		
	Isolepis hystrix		weed
	Isolepis marginata	coarse club-rush	weed
	Isolepis stellata	star club-rush	
	Lepidosperma gladiatum	coastal sword-sedge	
	Lepidosperma longitudinale	pithy sword-sedge	
	Lepidosperma pubisquameum		
	Lepidosperma scabrum		
	Lepidosperma squamatum		
	Lepidosperma tetraquetrum		
	Mesomelaena graciliceps		
	Schoenus caespititius		
	Schoenus curvifolius		
	Schoenus efoliatus		
	Schoenus grandiflorus	large flowered bogrush	
	Schoenus subfascicularis		
	Schoenus sublateralis		
	Tetraria capillaris	hair sedge	
	Tetraria octandra		
35	***Araceae***		
	Zantedeschia aethiopica	Arum lilly	Declared weed
39	***Restionaceae (rushes)***		
	Anarthria laevis		
	Desmocladus asper		
	Desmocladus flexuosus		
	Hypolaena exsulca		
	Lepyrodia glauca		
	Lepyrodia muirii		
	Lyginia barbata		
	Lyginia imberbis		
	Meeboldina roycei		
	Meeboldina scariosa		
40	***Centrolepidaceae***		
	Aphelia cyperoides		
	Centrolepis aristata	pointed centrolepis	
	Centrolepis drummondiana		
	Centrolepis mutica		
47	**Commelinaceae**		
	Cartonema philydroides		
50	**Philydraceae**		
	Philydrella pygmaea subsp. pygmaea		
52	**Juncaceae**		
	Juncus articulatus	jointed rush	
	Juncus bufonius	toad rush	weed
	Juncus kraussii	sea rush	
	Juncus microcephalus		weed
	Juncus pallidus	pale rush	
	Juncus pauciflorus	loose flower rush	
	Juncus subsecundus	finger rush	
	Juncus usitatus	common rush	weed
	Luzula meridionalis	field woodrush	
054B	**Asparagaceae**		
	Asparagus asparagoides	bridal creeper	Declared weed & NS
054C	**Dasypogonaceae**		
	Acanthocarpus preissii		
	Dasypogon bromeliifolius	pineapple bush	
	Lomandra hermaphrodita		
	Lomandra maritima		
	Lomandra micrantha subsp. micrantha		
	Lomandra nigricans		
	Lomandra odora	tiered matrush	
	Lomandra preissii		
	Lomandra purpurea	purple matrush	
	Lomandra sericea	silky matrush	

	Lomandra sonderi		
054D	**Xanthorrhoeaceae**		
	Xanthorrhoea brunonis		
	Xanthorrhoea preissii	grass tree or blackboy	
054E	**Phormiaceae**		
	Dianella revoluta var. divaricata		
054F	**Anthericaceae**		
	Agrostocrinum hirsutum		
	Agrostocrinum scabrum subsp. scabrum		
	Caesia micrantha	pale grass-lily	
	Chamaescilla corymbosa var. corymbosa		
	Corynotheca micrantha var. micrantha		
	Dichopogon capillipes		
	Johnsonia acaulis		
	Laxmannia squarrosa		
	Sowerbaea laxiflora	purple tassels	
	Thysanotus arbuscula		
	Thysanotus arenarius		
	Thysanotus manglesianus	fringed lily	
	Thysanotus multiflorus	many-flowered fringe lily	
	Thysanotus thyrsoideus		
	Tricoryne elatior	yellow Autumn lily	
054G	**Asphodelaceae**		
	Trachyandra divaricata	onion weed	weed
054J	**Colchicaceae**		
	Burchardia congesta		
	Wurmbea monantha		
55	**Haemodoraceae**		
	Anigozanthos manglesii subsp. manglesii	kangaroo paw	
	Conostylis aculeata subsp. aculeata	prickley conostylis	
	Conostylis aculeata subsp. preissii		
	Conostylis juncea		
	Haemodorum ?sparsiflorum		
	Phlebocarya ciliata		
60	**Iridaceae**		
	Gladiolus undulatus	wild gladiolus	weed
	Patersonia occidentalis	purple flag	
	Romulea obscura		weed
	Romulea rosea var. rosea	Guilford grass	weed
	Romulea sp.		
	Watsonia sp.		weed
66	**Orchidaceae**		
	Caladenia discoidea	dancing orchid	
	Caladenia flava subsp. flava		
	Caladenia latifolia	pink fairy orchid	
	Caladenia longicauda subsp. calcigena		
	Caladenia marginata	white fairy orchid	
	Caladenia paludosa		
	Caladenia speciosa		DEC Priority 4 species
	Cryptostylis ovata		
	Disa bracteata		weed
	Diuris corymbosa		
	Drakaea glyptodon	king-in-his-carrage	
	Drakaea micrantha		Declared Rare Flora
	Elythranthera brunonis	purple enamel orchid	
	Elythranthera emarginata	pink enamel orchid	
	Eriochilus dilatatus subsp. dilatatus		
	Eriochilus dilatatus subsp. multiflorus		
	Leporella fimbriata	hare orchid	
	Lyperanthus serratus	rattle beak orchid	
	Microtis media subsp. media		
	Microtis media subsp. quadrata		
	Paracaleana nigrita	flying duck orchid	
	Prasophyllum parvifolium	Autumn leek orchid	
	Pterostylis aff. nana		
	Pterostylis brevisepala		
	Pterostylis crenulata		
	Pterostylis recurva	jug orchid	
	Pterostylis sanguinea		
	Pterostylis vittata	banded greenhorn	
	Pyrorchis nigricans	red beaks	
	Thelymitra benthamiana	cinnamon sun orchid	
	Thelymitra crinita	blue lady orchid	
	Thelymitra flexuosa	twisted sun orchid	
	Thelymitra graminea		
	Thelymitra macrophylla		
	Thelymitra paludosa		
	Thelymitra vulgaris		
70	**Casuarinaceae**		
	Allocasuarina sp.		Introduced horticultural species
88	**Urticaceae**		
	Parietaria ?cardiostegia		
	Parietaria debilis	pelitory	

90	**Proteaceae**		
	Adenanthos meisneri		
	Adenanthos obovatus	basket flower	
	Banksia attenuata	slender banksia	
	Banksia grandis	bull banksia	
	Banksia ilicifolia	holy-leaved banksia	
	Banksia littoralis	swamp banksia	
	Grevillea diversifolia subsp. diversifolia		
	Hakea lissocarpha	honey bush	
	Hakea prostrata	harsh hakea	
	Hakea ruscifolia	candle hakea	
	Hakea varia	variable-leaved hakea	
	Persoonia longifolia	snottygobble	
	Persoonia saccata	snottygobble	
	Petrophile linearis	pixie mops	
	Stirlingia latifolia	blueboy	
92	**Santalaceae**		
	Exocarpos sparteus	broom ballart	
	Leptomeria cunninghamii		
	Leptomeria pauciflora	sparse-flowered currant bush	
	Santalum acuminatum	quondong	
97	**Loranthaceae**		
	Nuytsia floribunda	Christmas tree	
103	**Polygonaceae**		
	Persicaria ?prostrata		weed
	Polygonum aviculare	wireweed	
	Rumex crispus	curled dock	weed
105	**Chenopodiaceae**		
	Rhagodia baccata subsp. baccata		
	Threlkeldia diffusa	coast bonefruit	
109	**Phytolaccaceae**		
	Phytolacca octandra	red ink plant	weed
110	**Aizoaceae**		
	Carpobrotus edulis	hottentot fig	weed
	Carpobrotus virescens	coastal pigface	
111	**Portulacaceae**		
	Calandrinia brevipedata	short-stalked purselane	
	Calandrinia granulifera	pygmy purselane	
	Calandrinia liniflora	parakeelya	
	Calandrinia sp. SW coastal (J. Dodd 753)		
113	**Caryophyllaceae**		
	Cerastium glomeratum	mouse ear chickweed	weed
	Cerastium pumilum		weed
	Petrorhagia dubia	velvet pink	weed
	Silene gallica	French catchfly	weed
	Stellaria pallida		
119	**Ranunculaceae**		
	Clematis linearifolia		
	Ranunculus sessiliflorus	smallflower buttercup	
131	**Lauraceae**		
	Cassytha racemosa forma racemosa		
	Cinnamomum camphora	camphor laural	weed
136	**Fumariaceae**		
	Fumaria muralis	wall fumitory	weed
138	**Brassicaceae**		
	Cakile maritima	sea rocket	weed
	Heliophila pusilla		weed
	Stenopetalum gracile		
143	**Droseraceae**		
	Drosera erythrorhiza subsp. squamosa		
	Drosera gigantea subsp. geniculata		
	Drosera menziesii subsp. penicillaris		
	Drosera macrantha	bridal rainbow	
	Drosera minutiflora		
	Drosera neesii	jewel rainbow	
	Drosera pallida	pale rainbow	
	Drosera porrecta		
149	**Crassulaceae**		
	Crassula colorata var. acuminata		
	Crassula colorata var. colorata		
152	**Pittosporaceae**		
	Marianthus tenuis		
161	**Rosaceae**		
	Rubus sp.	blackberry	Declared weed & NS
163	**Mimosaceae (acacias)**		
	Acacia applanata		
	Acacia cochlearis	rigid wattle	
	Acacia cyclops	coastal wattle	
	Acacia dentifera		
	Acacia extensa	wiry wattle	
	Acacia huegelii		
	Acacia lasiocarpa var. lasiocarpa		
	Acacia paradoxa	kangaroo thorn	weed

	Acacia pulchella var. glaberrima		
	Acacia pycnantha	golden wattle	weed
	Acacia saligna	orange wattle	
	Acacia semitrullata		DEC Priority 3 species
	Acacia stenoptera	narrow winged wattle	
	Acacia truncata (Sand dune variant)		
	Acacia urophylla		Introduced horticultural species
	Acacia willdenowiana	grass wattle	
	Paraserianthes lophantha subsp. lophantha	formerly Albizia	Introduced horticultural species
164	**Caesalpiniaceae**		
	Labichea punctata	lance-leaved cassia	
165	**Papilionaceae (peas)**		
	Aotus gracillima		
	Aotus procumbens		
	Aotus sp.		
	Bossiaea eriocarpa	common brown pea	
	Callistachys lanceolata	connich	
	Chamaecytisus palmensis	tagasaste	weed
	Daviesia divaricata subsp. divaricata		
	Daviesia physodes		
	Dillwynia dillwynioides		DEC Priority 3 species
	Dipogon lignosus	dolichos Pea	weed
	Euchilopsis linearis	swamp pea	
	Gastrolobium ebracteolatum		
	Gompholobium capitatum		
	Gompholobium confertum		
	Gompholobium polymorphum		
	Gompholobium tomentosum	hairy yellow pea	
	Hardenbergia comptoniana	native wisteria	
	Hovea pungens	Devil's pins	
	Hovea trisperma	common hovea	
	Isotropis cuneifolia subsp. cuneifolia		
	Jacksonia furcellata	grey stinkwood	
	Jacksonia gracillima		
	Jacksonia sternbergiana	stinkwood	
	Kennedia prostrata	scarlet runner	
	Latrobea tenella		
	Lotus angustissimus	narrow leaf trefoil	weed
	Lotus subbiflorus		weed
	Lotus uliginosus	greater lotus	weed
	Lupinus cosentinii	lupins	weed
	Melilotus indicus		weed
	Melilotus siculus		weed
	Ornithopus compressus	yellow serradella	weed
	Pisum sativum		weed
	Pultenaea ochreata		
	Pultenaea reticulata		
	Templetonia retusa	cockies tongues	
	Trifolium angustifolium var. angustifolium	narrow leaf clover	weed
	Trifolium campestre var. campestre	hop clover	weed
	Trifolium cernuum	drooping flower clover	weed
	Trifolium hybridum var. hybridum	alsike clover	weed
	Vicia sativa subsp. nigra	common vetch	weed
	Viminaria juncea	swishbush	
167	**Geraniaceae**		
	Erodium cicutarium	common stalksbill	weed
	Geranium molle	dove's foot cranesbill	weed
	Geranium retrorsum		
	Pelargonium capitatum	rose pelargonium	weed
	Pelargonium littorale subsp. littorale		
168	**Oxalidaceae**		
	Oxalis corniculata	yewllow wood sorrel	weed
	Oxalis perennans		
	Oxalis pes-caprae	soursob	weed
173	**Zygophyllaceae**		
	Zygophyllum fruticulosum	shrubby twinleaf	
	Zygophyllum simile		
175	**Rutaceae**		
	Boronia dichotoma		
	Diplolaena dampieri	southern Diplolaena	
	Philotheca spicata	pepper and salt	
182	**Tremandraceae**		
	Platytheca galioides		
	Tetratheca hirsuta	black eyed Susan	
183	**Polygalaceae**		
	Comesperma calymega	blue-spike milkwort	
	Comesperma flavum		
	Comesperma virgatum	milkwort	
185	**Euphorbiaceae**		
	Euphorbia paralias	sea spurge	weed
	Euphorbia terracina	Geraldton carnation weed	weed
	Monotaxis occidentalis		
	Phyllanthus calycinus	false Boronia	

	Poranthera drummondii		
	Poranthera microphylla	small Poranthera	
215	**Rhamnaceae**		
	Spyridium globulosum	basket bush	
223	**Sterculiaceae**		
	Lasiopetalum membranaceum		DEC Priority 3 species
	Thomasia cognata		
226	**Dilleniaceae**		
	Hibbertia cuneiformis	cutleaf Hibbertia	
	Hibbertia hypericoidesi		
	Hibbertia racemosa	stalked guinea flower	
	Hibbertia stellaris	orange stars	
	Hibbertia vaginata		
263	**Thymelaeaceae**		
	Pimelea lanata		
265	**Lythraceae**		
	Lythrum hyssopifolia	lesser loosestrife	weed
273	**Myrtaceae**		
	Agonis flexuosa var. flexuosa	peppermint	
	Astartea scoparia		
	Calothamnus quadrifidus	one-sided bottlebrush	Introduced horticultural species
	Calytrix angulata	yellow starflower	
	Calytrix flavescens	summer starflower	
	Calytrix fraseri	pink summer calytrix	
	Corymbia calophylla	marri	
	Darwinia citriodora	lemon-scented Darwinia	
	Eucalyptus gomphocephala	tuart	
	Eucalyptus gomphocephala (mallee form)		
	Eucalyptus marginata subsp. marginata	jarrah	
	Eucalyptus platypus	moort	Introduced horticultural species
	Eucalyptus rudis subsp. cratyantha		DEC Priority 4 species
	Eucalyptus rudis subsp. rudis	flooded gum	
	Eucalyptus wandoo	wandoo	
	Hypocalymma angustifolium	white myrtle	
	Kunzea glabrescens	spearwood	
	Leptospermum laevigatum	Victorian tea tree	weed
	Melaleuca incana subsp. incana	grey honeymyrtle	
	Melaleuca lanceolata	rottnest teatree	Introduced horticultural species
	Melaleuca lateritia	robin redbreast bush	
	Melaleuca preissiana	Moonah	
	Melaleuca preissiana	Moonah	
	Melaleuca rhaphiophylla	swamp paperbark	
	Melaleuca teretifolia	banbar	
	Melaleuca thymoides		
	Melaleuca trichophylla (glabrous form)		
	Melaleuca viminea subsp. viminea		
	Pericalymma ellipticum	swamp teatree	
275	**Onagraceae**		
	Oenothera mollissima		weed
	Oenothera stricta	common Evening Primrose	weed
276	**Haloragaceae**		
	Gonocarpus pithyoides		
281	**Apiaceae**		
	Actinotus glomeratus		
	Centella asiatica		
	Daucus glochidiatus	Australian carrot	
	Eryngium pinnatifidum subsp. pinnatifidum		
	Homalosciadium homalocarpum		
	Hydrocotyle callicarpa	small pennywort	
	Hydrocotyle pilifera var. glabrata		
	Hydrocotyle pilifera var. pilifera		
	Hydrocotyle tetragonocarpa		
	Platysace filiformis		
	Trachymene coerulea subsp. coerulea		
	Trachymene pilosa	native parsnip	
	Xanthosia huegelii		
288	**Epacridaceae**		
	Astroloma ciliatum	candle cranberry	
	Astroloma sp.		
	Brachyloma preissii subsp. obtusifolium		
	Conostephium pendulum	pearl flower	
	Leucopogon australis	spiked beard-heath	
	Leucopogon conostephioides		
	Leucopogon cordatus		
	Leucopogon parviflorus	coast beard-heath	
	Leucopogon propinquus		
	Leucopogon racemulosus		
	Leucopogon sprengelioides		
	Lysinema ciliatum	curry flower	
293	**Primulaceae**		
	Anagallis arvensis var. arvensis	pimpernel	weed
	Anagallis arvensis var. caerulea	pimpernel	weed
	Samolus junceus		

301	**Oleaceae**		
	Olea europaea	olive	weed
302	**Loganiaceae**		
	Logania serpyllifolia subsp. angustifolia		
	Logania vaginalis	white spray	
	Phyllangium divergens		
	Phyllangium paradoxum		
303A	**Menyanthaceae**		
	Villarsia albiflora		
304	**Apocynaceae**		
	Alyxia buxifolia	dysentery bush	
	Vinca major	blue periwinkle	weed
305	**Asclepiadaceae**		
	Gomphocarpus fruticosus	cotton bush	Declared weed
307	**Convolvulaceae**		
	Dichondra repens	kidney weed	
307A	**Cuscutaceae**		
	Cuscuta epithymum	lesser dodder	weed
310	**Boraginaceae**		
	Heliotropium curassavicum	smooth heliotrope	
	Echium plantagineum	Paterson's curse	weed
313	**Lamiaceae**		
	Hemiandra glabra subsp. glabra		
	Hemiandra pungens	snakebush	
	Mentha x piperita	eau de Cologne mint	weed
315	**Solanaceae**		
	Anthocercis littorea	yellow tailflower	
	Solanum linnaeanum	apple of sodon	Declared weed
	Solanum nigrum	black berry nightshade	weed
	Solanum symonii		
	Cuscuta epithymum	lesser dodder	
316	**Scrophulariaceae**		
	Bacopa ?monnieri		
	Dischisma arenarium		
	Parentucellia viscosa	sticky bartsia	
	Veronica distans		
	Dischisma arenarium		weed
320	**Orobanchaceae**		
	Orobanche australiana	Australian broomrape	
	Orobanche minor	lesser broomrape	weed
326	***Myoporaceae***		
	Myoporum insulare	blueberry tree	
329	**Plantaginaceae**		
	Plantago lanceolata	ribwort plaintain	weed
331	**Rubiaceae**		
	Opercularia hispidula	hispid stinkweed	
	Opercularia vaginata	dog weed	
339	**Campanulaceae**		
	Wahlenbergia capensis	cape bluebell	weed
	Wahlenbergia gracilenta	annual bluebell	
340	**Lobeliaceae**		
	Isotoma hypocrateriformis	woodbridge poison	
	Lobelia alata	angled Lobelia	
	Lobelia rhytidosperma	wrinked-seeded Lobelia	
	Lobelia tenuior	slender Lobelia	
341	**Goodeniaceae**		
	Dampiera linearis	common Dampiera	
	Lechenaultia biloba	blue Leschenaultia	
	Lechenaultia floribunda	free-flowering Leschenaultia	
	Scaevola calliptera		
	Scaevola crassifolia	thick-leaved fan-flower	
343	**Stylidiaceae**		
	Levenhookia pusilla	midget stylewort	
	Levenhookia stipitata	common stylewort	
	Stylidium aff. junceum		
	Stylidium brunonianum	pink fountain triggerplant	
	Stylidium calcaratum	book trigger plant	
	Stylidium carnosum	fleshy-leaved triggerplant	
	Stylidium guttatum	dotted triggerplant	
	Stylidium junceum	reed triggerplant	
	Stylidium piliferum	common butterfly triggerplant	
	Stylidium repens	matted triggerplant	
	Stylidium schoenoides	cow kicks	
345	**Asteraceae**		
	Arctotheca calendula	capeweed	weed
	Arctotheca populifolia	dune Arctotheca	weed
	Asteridea pulverulenta	common bristle daisy	
	Carduus tenuiflorus	sheep thistle	
	Cirsium vulgare	spear thistle	weed
	Conyza bonariensis	flaxleaf fleabane	weed
	Cotula coronopifolia	waterbuttons	weed
	Craspedia variabilis		
	Euchiton sphaericus		weed

Hyalosperma cotula		
Hyalosperma pusillum		
Hypochaeris glabra	smooth catsear	weed
Lactuca serriola	prickley lettuce	weed
Lagenophora huegelii		
Millotia myosotidifolia		
Millotia tenuifolia var. tenuifolia	soft Millotia	
Olearia axillaris	coastal daisybush	
Olearia paucidentata	Autumn scrub daisy	
Ozothamnus cordatus		
Podotheca angustifolia	sticky longheads	
Quinetia urvillei		
Rhodanthe citrina		
Senecio diaschides		weed
Senecio pinnatifolius var. latilobus		
Siloxerus humifusus	procumbent Siloxerus	
Sonchus oleraceus	common sowthistle	weed
Trichocline spathulata	native gerbera	
Ursinia anthemoides	Ursinia	weed

20.0 Environmental Incident Management

20.1 Context

Environmental incidents have the potential to occur on construction sites due to the scale and type of works being undertaken. For the purposes of this CEMF, an Environmental Incident is:

> *any event or impact on the environment involving actions or assets associated with the project that is capable of:*
> 1. *causing harm to the environment or any person;*
> 2. *causing pollution; and/or*
> 3. *coming to the attention of the public or an environmental regulatory agency.*

Environmental incidents include matters such as:

1. chemical spills (including hydrocarbons).
2. fires.
3. discharges of contaminated waters to the environment.
4. environmental monitoring results indicating an impact to the environment or any person (water quality, noise, etc).
5. death or injury of a marine mammal (such as whales or dolphins) or terrestrial fauna.

Environmental incidents do not include matters where there is no impact on the environment or do not cause concern for external groups, for example, a routine variance to compliance with this CEMF (routine variances will be dealt with under the Non-compliance Management Plan).

The Water Corporations Standard *SG110 Incident Management Corporate Planning Model* defines the manner in which the Principal responds to incidents. Environmental incidents relating to construction of the Southern Seawater Desalination Project shall be conducted as per Standard SG110.

20.2 Purpose

The purpose of the Environmental Incident Management Plan is to outline management actions to:

1. identify, manage and report on environmental incidents.
2. identify management actions required for prevention of future environmental incidents.

20.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions.

20.4 Management Actions

Determining an Environmental Incident

1. Suspected environmental incidents will be reported to an on-site environmental scientist. The environmental scientist will assess the impact site and make a determination (based upon professional experience) on whether the suspected environmental incident is confirmed.

2. If a confirmed environmental incident occurs, the incident will be repored as soon as reasonably practicable to:

Name	Position	Organisation	Telephone	
George Basanovic	Corporate Incident Management Coordinator	Water Corporation	B/H: A/H/Mobile:	9420 3247 [redacted]
Mark Oliver	Senior Project Manager – Seawater Desalination Plant	Water Corporation	B/H: A/H/Mobile:	9420 3752 [redacted]
John Stansfield	Project Manager – Seawater Desalination Plant	Water Corporation	B/H: A/H/Mobile:	9420 3406 [redacted]
John Goullee	Principal Project Manager – Water Transfer Pipeline and Harvey Summit Tanks	Water Corporation	B/H: A/H/Mobile:	9420 2149 [redacted]
Gordon Groth	Senior Environmental Officer	Water Corporation	B/H: A/H/Mobile:	9420 2796 [redacted]
Guy Watson	Environmental Operations Manager	Water Corporation	B/H: A/H/Mobile:	9420 3832 [redacted]

Table 20-1 The Water Corporations Environmental Incident Contact List.

During an Environmental Incident

3. The on-site environmental scientist will determine if the incident is likely to have a continued environmental impact if construction work continues.
4. Based on that advice, construction work that would continue to have an environmental impact will temporarily cease. Other construction works not related to the environmental incident and environmental impact will continue.
5. Construction works at the affected area will only recommence on the approval of the on-site environmental scientist.
6. The incident will be investigated and an Incident Report (refer Figure 24) will be completed as soon as reasonably practicable (generally within 24 hours). The Incident Report will be provided to the persons listed above.
7. All Incident Reports will be logged on a file retained at the construction site office.

Reporting an Environmental Incident

8. Environmental incidents will be reported to the DEC by phone as soon as reasonably practicable following the environmental incident if the environmental incident has caused or is likely to cause pollution, or material or serious environmental harm (in accordance with s72(1) of the *Environmental Protection Act 1986* (WA)). Contact both:
   a. DEC Bunbury Office
      Phone: 9726 4300
   b. DEC Pollution Response (Perth)
      Phone: 1300 784 782

   Written confirmation of the environmental incident will be provided to the CEO of the DEC, based on the Incident Report.
9. Environmental incidents will be reported to the Local Government Authority, FESA and the Police as appropriate (as per Standard SG110).
10. All environmental incidents will be reported to the DEC as part of annual compliance reporting required under the Minister for the Environment's Statement of Conditions imposed under the *Environmental Protection Act 1986* (WA), irrespective of whether the environmental incidents have caused or is likely to cause pollution, or material or serious

environmental harm (in accordance with s72(1) of the *Environmental Protection Act 1986* (WA)).

Remediation of an Environmental Incident

11. The on-site environmental scientist, will determine any requirement to undertake remediation works, and the manner in which remediation works will be undertaken. Additional advice maybe sought from The Water Corporation, the other on-site personnel or the DEC in making that determination.

Post Environmental Incident Training

12. There will be a briefing following the investigation of a confirmed environmental incident. The briefing will include any identified construction process improvements that could prevent reoccurrence of the same environmental incident.
13. The CEMF will be updated (as appropriate) to reflect process improvements.

20.5 Contingency Actions

No contingency actions are considered necessary.

20.6 Related Plans

1. Fire Management
2. Dewatering and Acid Sulphate Soils Management
3. Land Clearing and Trench Management
4. Dangerous Goods and Explosives Management

20.7 Relevant Legislation

1. *Environmental Protection Act 1986* (WA)

20.8 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DEC
2. FESA

WATER CORPORATION

INCIDENT REPORT

From: ____________ Branch/Region: ____________

Description: ____________

REPORT

WHAT HAPPENED: ____________

WHY: ____________

WHEN: ____________

WHERE: ____________

EXTENT OF IMPACT - Actual ____________

Potential - *(Consider; Secondary Effects, Environment, Customer, Community, Corporation's System)* ____________

THOSE INFORMED OF THE INCIDENT (*Internal & External*) (*When*?) ____________

PROGNOSIS - (*Consider; Action Taken, Action Planned, Time to Resolution*) ____________

DECISION and NOTIFICATION by BRANCH/REGION

IS THE INCIDENT REPORTABLE? ☐ NO ☐ YES (provide details) ☛

IS IT? ☐ MINOR ☐ SIGNIFICANT ☐ MAJOR

(Seek advice from senior management or the CIMC if unsure)

Decisions made by (Name): (*print*) ____________

Designation: ____________

Notified Control Centre/CIMC
Customer Contact & Scheduling/Manager

Report to (Name): ____________

Date: ..../..../.... Time: ____________

Agreed report back (*who & when*) ____________

Report By: ____________

Signed: ____________ Date: ____________ Contact Phone (24 *hr*) ____________

Branch/Region: ____________ Time: ____________ Contact Fax (24 *hr*) ____________

Contact Callsign (24 *hr*) ____________

A copy of this form must be faxed/phoned to the
Corporate Incident Management Coordinator Fax (09) 420 2656 Mobile 0417 180 677

Figure 20-1 Water Corporation's Incident Report Form

21.0 Compliance Management

21.1 Context

This CEMF outlines the actions, criteria and objectives to be implemented or achieved during construction. If for any reason the actions, criteria or objectives are not implemented or achieved, a response process is required to correct those matters within an appropriate timeframe and with notification to appropriate personnel.

21.2 Purpose

The purpose of the Compliance Management Plan is to outline the management actions to:

1. identify, communicate and correct non-conformity with the management actions contained in this CEMF.

21.3 Performance Indicators

Performance will be demonstrated by:

1. Resolution of non-conformity with the management actions contained CEMF in accordance with the actions contained in this plan.

21.4 Management Actions

1. The site personnel, Water Corporation, or third parties (such as regulators, local government authorities and the public) may identify potential non-conformity with the actions, criteria or objectives identified in this CEMF. All potential non-coconformities will be reported to the an appropriately qualified environmental scientist on site.
2. The report will be investigated within 48 hours notification to confirm its validity.
3. An Improvement Notice will be issued if the report is confirmed as valid (i.e. there is a non-conformity with the CEMF). The Improvement Notice details:
    a. the nature of the non-conformity;
    b. an assessment of the environmental impact;
    c. a decision on the corrective action(s) required. This may include revision of the actions, criteria or objectives identified in the CEMF;
    d. the timeframes allowed to implement the corrective actions;
    e. any requirements to inform contracting staff of the corrective actions to prevent reoccurrence; and
    f. close-out of corrective actions.

    The Improvement Notice is shown at Figure 21-1.
4. The corrective actions contained in the Improvement Notice will be implemented.
5. The actions required by the Improvement Notice will be completed and notification that the corrective actions have been completed will be provided to the environmental scientist..
6. The environmental scientist will review the actions taken, will be confirm that the corrective actions have been implemented and the complete the close-out section of the Improvement Notice.
7. A copy of all completed Improvement Notices will be maintained at the Site Office.

21.5 Additional Information

An Improvement Notice is a written communication tool that is used to improve environmental performance. An Improvement Notice should not be regarded as a sanction.

The process flowchart for management of CEMF non-compliances is contained in Figure 21-2.

21.6 Contingency Actions

If there is a dispute between the on-site environmental scientist and construction personnel, regarding the requirements contained in an Improvement Notice, the Water Corporation will resolve the dispute.

21.7 Related Plans

All plans are considered relevant

21.8 Relevant Legislation

1. *Environmental Protection Act 1986* (WA)

21.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DEC

Southern Seawater Desalination Project
Compliance Management

Improvement Notice

Report - On-site environmental scientist and responsible construction personnel to complete	
Date:	___________________________
Location:	___________________________
Contractor:	___________________________
Nature of Non-Compliance Reported:	___________________________ ___________________________ ___________________________
Is the Reported Non-Compliance Valid?	Yes / No (please circle)
Assessment of Environmental Impact:	___________________________ ___________________________ ___________________________
Corrective Actions to be Implemented:	___________________________ ___________________________ ___________________________
Timeframe for completion:	Immediately 24hrs 48hrs 7 days (please circle)
Contractor to Inform Staff:	Yes/No (please circle)
Issue Date and Time:	___________________________
Issued to (Name and Position):	

Close-out - Responsible construction personnel to complete		
Describe the corrective actions implemented:		___________________________
___________________________ ___________________________ ___________________________		
Name:	Signature:	Date:

Close-out - On-site environmental scientist to complete		
Corrective actions have been implemented?:	Yes / No (please circle)	
Are additional corrective actions required?	Yes / No (please circle) If Yes – complete a new Improvement Notice with the new corrective actions	
Name:	Signature:	Date:

A copy of the completed Improvement Notice is to be forwarded to the Site Management Team

Figure 21-1 Improvement Notice

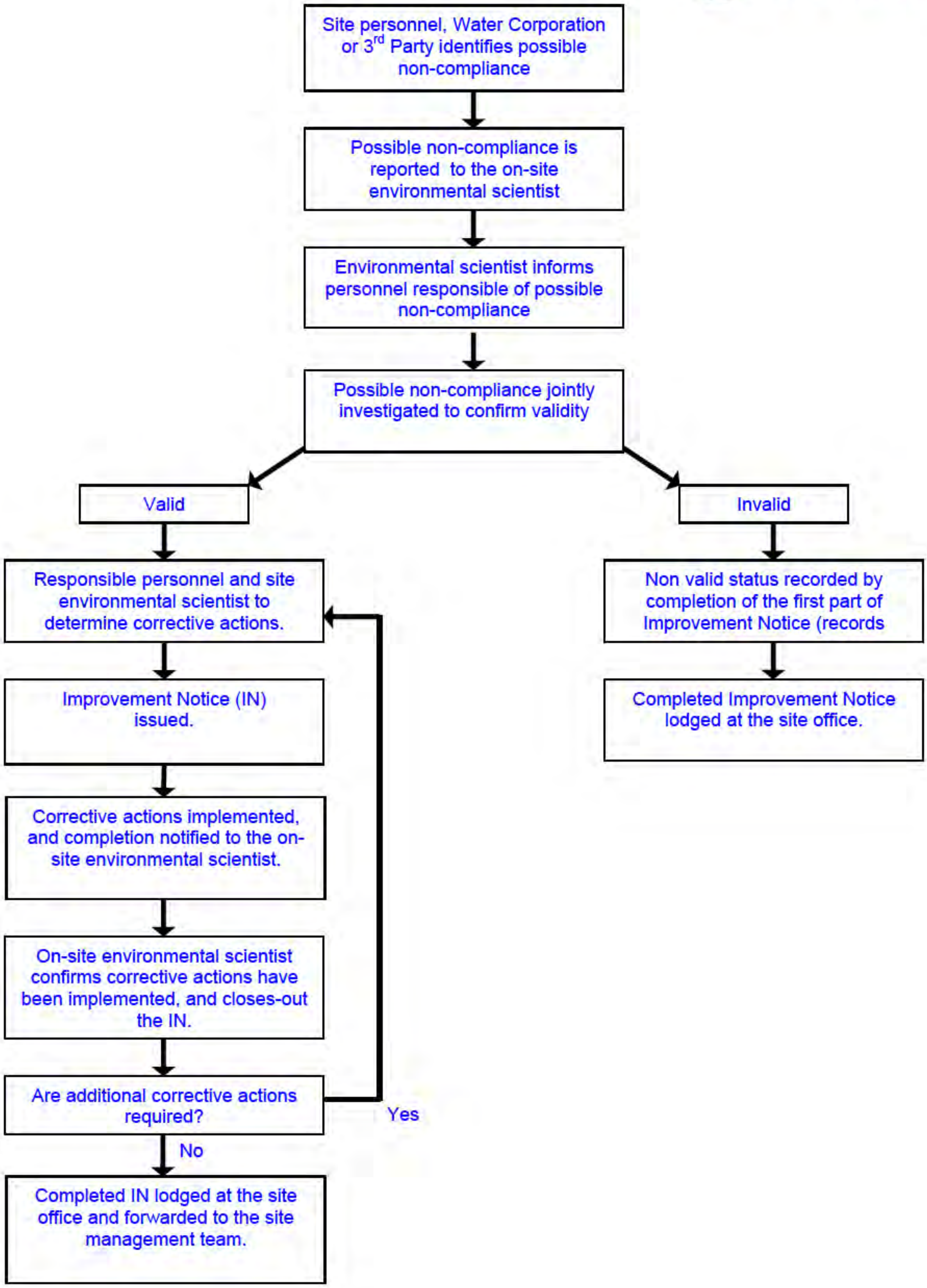


Figure 21-2 Compliance Assessment Process Flowchart

22.0 Community Complaints Management

22.1 Context

Construction works will occur in public and private lands and in close proximity to private residences. Impacts on the community during construction works are expected. A community complaints process will be established to ensure that community complaints are managed effectively.

22.2 Purpose

The purpose of the Community Complaints Management Plan is to outline management actions to:

1. record complaints received from the community.
2. record the response to community complaints received.

22.3 Performance Indicators

Performance will be demonstrated by compliance with the prescribed management actions.

22.4 Management Actions

1. There will be a designated Communications Officer to coordinate the receipt, investigation and resolution of community complaints.
2. There will be a free-call telephone number and an email address through which the community can telephone/email and have their complaints recorded.
3. The Communications Officer will acknowledge receipt of emailed complaints within nominally 48 hours of receipt.
4. The free-call telephone number and email contact details will be displayed at the external fence to each construction site.
5. The Communications Officer (or delegate) will record all complaints received on a Community Complaint Record (Figure 22-1). All Community Complaint Records will be maintained at the site office.
6. The Communications Officer will commence investigations into the nature and cause for the complaint within nominally 48 hours of receipt of the complaint. The investigation will include consultation with the on-site environmental scientist to determine if the cause for the complaint was in conformity with the management actions contained within this CEMF.
7. The Communications Officer will seek to provide a response to the complainant within 7 days of receipt of the complaint. The Communications Officer will complete the Community Complaint Record with details of how the complaint was addressed and the close-out discussions with the Complainant.
8. The Communications Officer will retain all Community Complaint Records at the site office during construction.
9. The Communications Officer will provide a copy of all Community Complaint Records at the end of each month during construction.

22.5 Contingency Actions

No contingency actions are considered necessary.

22.6 Related Plans

All plans are considered relevant.

22.7 Relevant Legislation

1. *Environmental Protection Act 1986* (WA)

22.8 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. Shire of Harvey
2. DEC

Southern Seawater Desalination Project
Community Complaints Management

Community Complaint Record

Complaint Receipt – Communications Officer to Complete

Date:

Time:

Complainant Details: Name:

Telephone Number(s):

Email address:

Residential Address:

Postal Address:

Nature of Complaint:

Does the complaint require further investigation? Yes / No (please circle)

Estimated timeframe for completion: 24hrs 48hrs 7 days (please circle)

Relevant on-site personnel:

Construction location relevant to complaint:

Details of investigations undertaken:

Assessment of complaint:

Are corrective actions to be implemented? (if yes, describe)

Close-out with Complainant - Communications Officer to Complete

Date of response to Complainant:

Time of response to Complainant:

Method of response: Telephone Email (please circle)

Describe the actions implemented:

Is the complaint resolvable? Yes / No (please circle)

Inform staff? Yes / No (please circle)

Does the Complainant wish to be added to the project mailing list? Yes / No (please circle)

Officer Name: Signature:

A copy of all completed Community Complaint Records is to be forwarded to the Superintendent at the end of each month of construction.

Figure 22-1 Community Complaint Record

23.0 Auditing of the CEMF

23.1 Context

This CEMF for the Southern Seawater Desalination Project outlines a large number of management actions to be implemented during construction. These management actions will be audited to confirm that the management actions have been implemented. Auditing will be undertaken by the Alliance Lead Team (ALT) or their assigned representatives and an External Auditor, and may also be undertaken by local and state regulatory agencies.

Where auditing identifies that the management actions contained in the CEMF have not been implemented or do not achieve a satisfactory environmental performance, the specified contingency actions will be undertaken. Where contingency actions are not specified or are considered unsuitable, the auditor will seek to identify alternative actions to achieve the intended environmental objective.

23.2 Purpose

The purpose of Auditing of the CEMF is to outline management actions to:

3. identify the schedule and context of audits against the management actions contained within this CEMF.
4. confirm compliance with the management actions.
5. identify potential improvements in environmental performance.

23.3 Performance Indicators

Performance will be demonstrated by:

1. Compliance with the prescribed management actions contained in this CEMF.

23.4 Management Actions

1st Party Audits - Alliance Management Team (AMT)

10. The AMT or its delegates (including the on-site environmental scientist) will undertake daily informal observations of compliance with the management actions contained in this CEMF. These audits need not be recorded.

2nd Party Audits – Water Corporation

11. The Water Corporation will undertake assessments of compliance with the management actions contained in this CEMF each 3 consecutive months of construction. Reports generated from the audits will be provided to the AMT.

3rd Party Audits – Water Corporation's External Auditor

12. The Water Corporation will employ an External Auditor to undertake audits each 12 consecutive months of construction. The External Auditor will be a Certified Environmental Practitioner or Auditor, preferably with experience in the water industry.

3rd Party Audits – DEC

13. The DEC may undertake compliance audits of construction works at any time pursuant to the provisions of s48(1) and Part VI of the *Environmental Protection Act 1986* (WA).

3rd Party Audits – Shire of Harvey or other State Government Agency

14. The Contractor and the Principal will welcome inspections and audits by the Shire of Harvey and other State Government agencies interested in the project. The Principal will arrange the timing of such audits and inspections following requests from the Shire of Harvey and other State Government agencies.

23.5 Additional Information

1. All audits by all parties should seek to indicate if the project has:
   a. complied with the requirements as stipulated in the CEMF; and
   b. achieved satisfactory environmental performance.

   Non-conformity will be deemed to have occurred if the requirements of this CEMF have not implemented and there is unsatisfactory environmental performance.

   Both criteria are relevant, because although the CEMF may not have been strictly followed, alternative (and more appropriate) actions to achieve the intended environmental outcome may have been implemented. Alternatively, compliance with the actions specified in the CEMF may not have achieved satisfactory environmental performance and require modification/corrective action.

2. It is expected that any audit by a 3rd party (other than the Water Corporation's External Auditor) will be limited to within the statutory jurisdiction of that party.

23.6 Contingency Actions

No contingency actions are considered necessary.

23.7 Related Plans

All plans are considered relevant.

23.8 Relevant Legislation

1. *Environmental Protection Act 1986 (WA)*

23.9 Advisory Agencies

The following organisations have been consulted on development of this plan:

1. DEC

24.0 References

The following documents were reviewed and/or cited in preparation of the CEMF:

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Legislation referred to in this CEMF can be accessed via the Western Australian State Law Publisher website at *http://www.slp.wa.gov.au* or via the Australasian Legal Information Institute website at *http://www.austlii.edu.au*.

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Appendix 1 - Seawater Desalination Plant Site Structure Map

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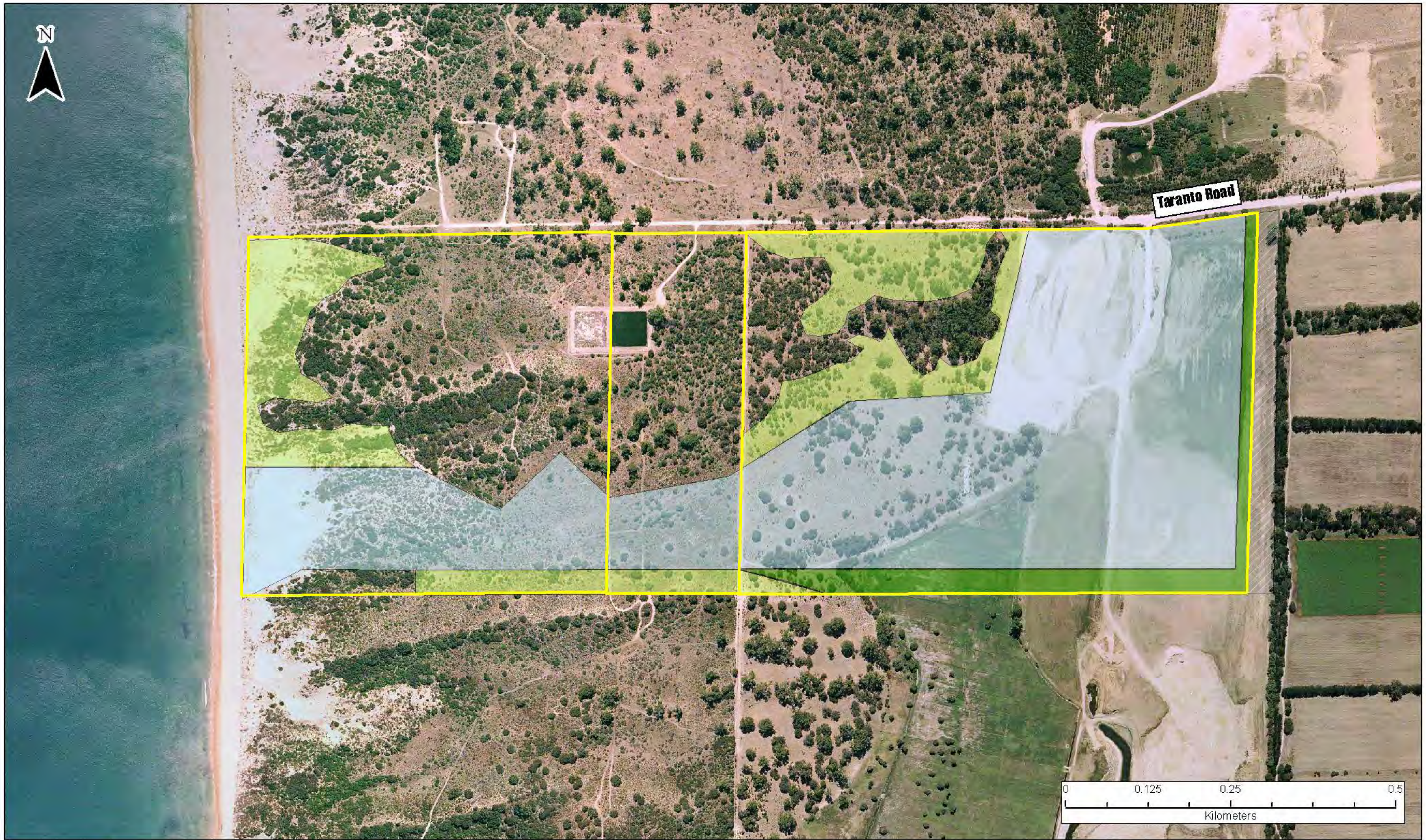

WATER CORPORATION	
Horizontal DAtum	Projection
GDA 94	MGA Zone 50
Date	Revision
15/02/08	1

SOUTHERN SEAWATER DESALINATION PROJECT

Proposed Seawater Desalination Plant Terrestrial Construction and Revegetation Areas

Legend

- SSDP construction area (actual cleared area for construction will be much less) - areas without plant infrastructure to be rehabilitated post construction
- Visual and noise berm with revegetation
- Lot 8 access road
- Lot boundaries
- Potential areas for rehabilitation (refer to biodiversity offset commitments)

Locality Map

360 environmental

Created By	Approved By
GW	MO/SB

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Appendix 2 - Water Transfer Pipeline Maps

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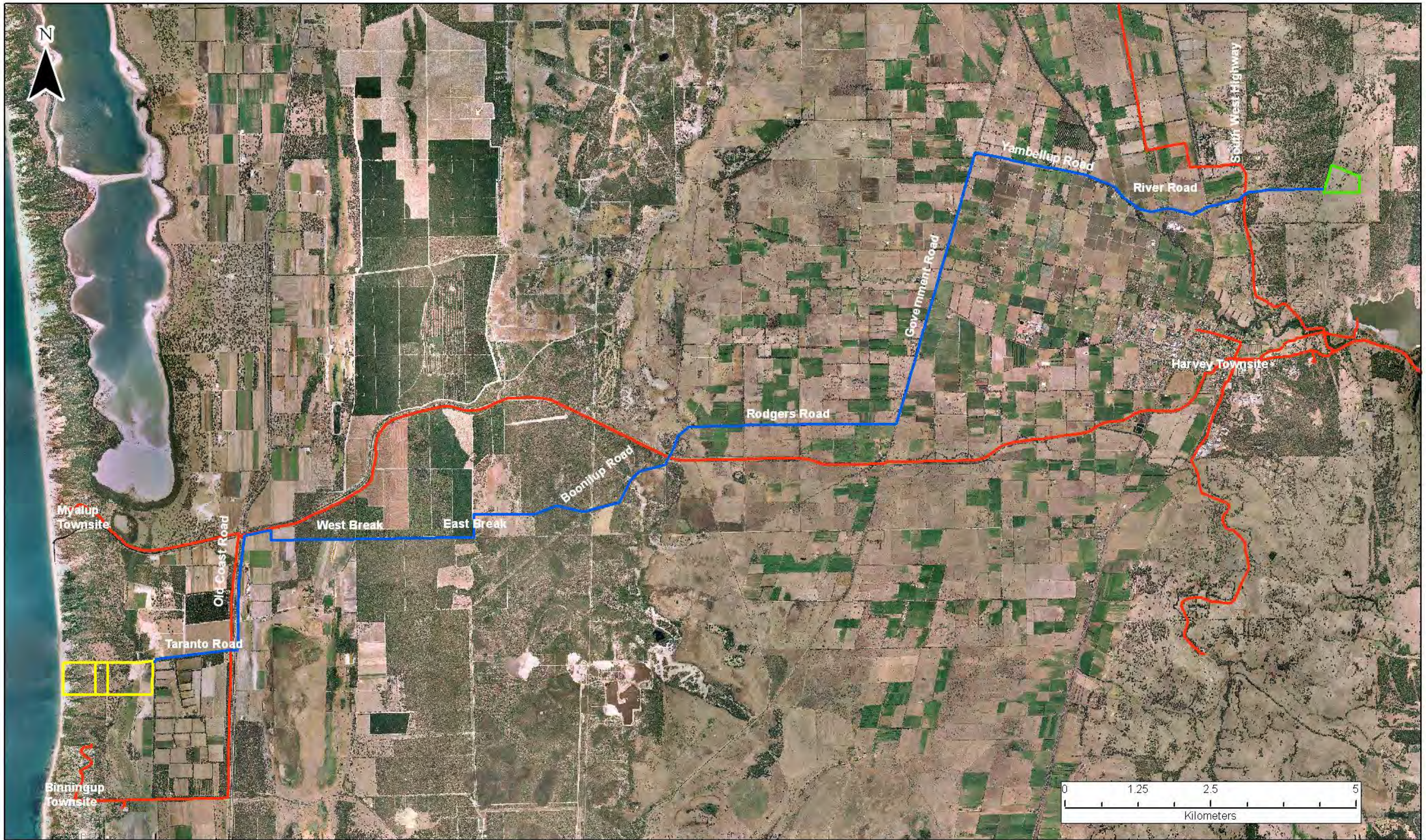


WATER CORPORATION

Horizontal DAtum	Projection
GDA 94	MGA Zone 50
Date	**Revision**
15/02/08	1

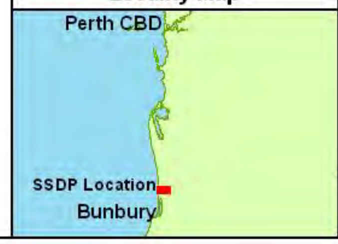
SOUTHERN SEAWATER DESALINATION PROJECT

Proposed Infrastructure

Legend

- Water Transfer Pipeline Route
- Existing IWSS Distribution and Trunk Mains
- Harvey Summit Tanks Site
- Seawater Desalination Plant Site

Locality Map



360 environmental

Created By	Approved By
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Appendix 3 - Harvey Summit Tanks Structure Maps

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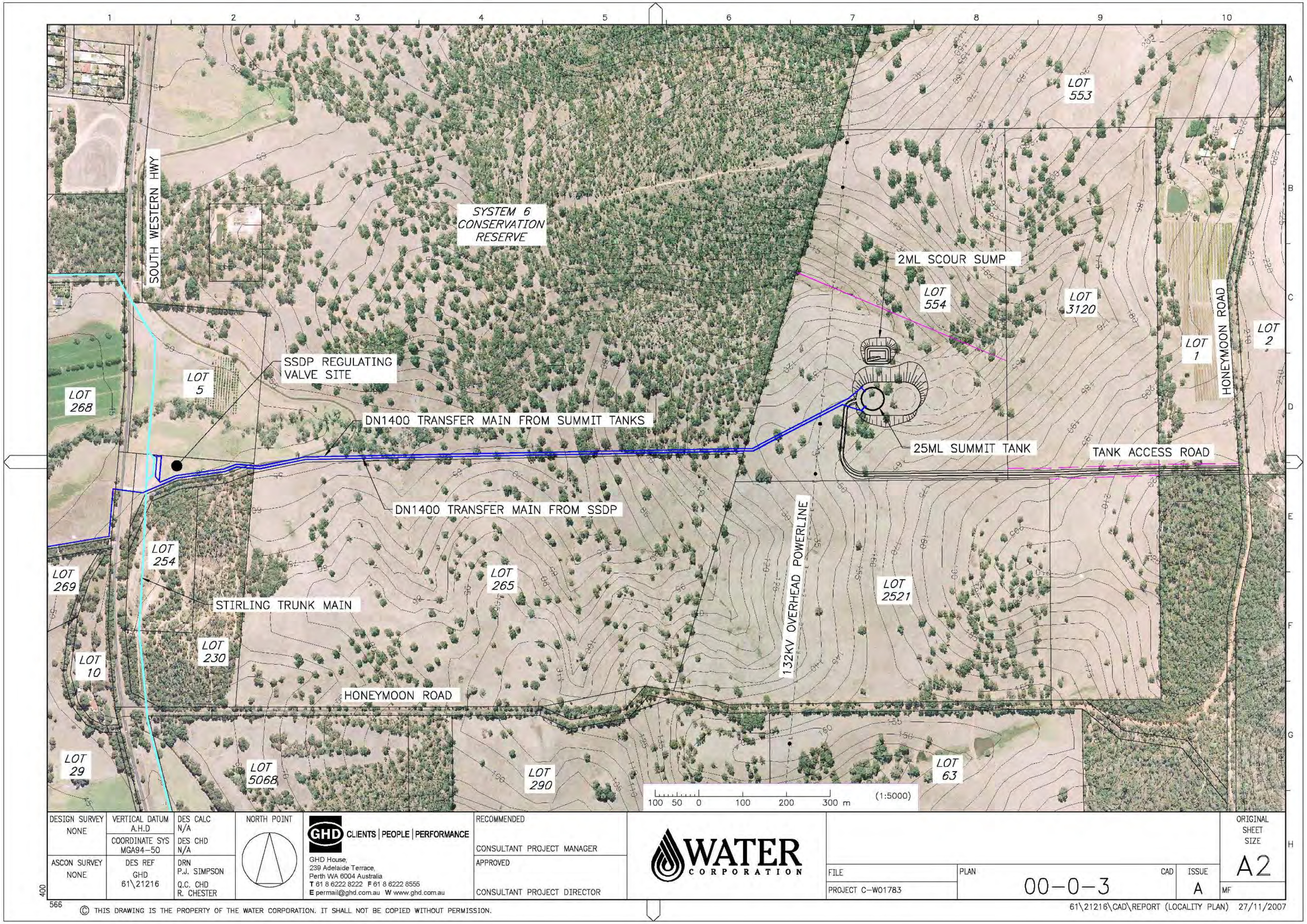

SYSTEM 6 CONSERVATION RESERVE
SOUTH WESTERN HWY
2ML SCOUR SUMP
LOT 553
LOT 554
LOT 3120
LOT 1
LOT 2
HONEYMOON ROAD
SSDP REGULATING VALVE SITE
LOT 5
LOT 268
DN1400 TRANSFER MAIN FROM SUMMIT TANKS
25ML SUMMIT TANK
TANK ACCESS ROAD
DN1400 TRANSFER MAIN FROM SSDP
132KV OVERHEAD POWERLINE
LOT 254
LOT 269
LOT 265
LOT 2521
STIRLING TRUNK MAIN
LOT 230
LOT 10
HONEYMOON ROAD
LOT 29
LOT 5068
LOT 290
LOT 63
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DESIGN SURVEY NONE
VERTICAL DATUM A.H.D
COORDINATE SYS MGA94-50
DES CALC N/A
DES CHD N/A
NORTH POINT
ASCON SURVEY NONE
DES REF GHD 61\21216
DRN P.J. SIMPSON
Q.C. CHD R. CHESTER
GHD CLIENTS | PEOPLE | PERFORMANCE
GHD House, 239 Adelaide Terrace, Perth WA 6004 Australia
T 61 8 6222 8222 F 61 8 6222 8555
E permail@ghd.com.au W www.ghd.com.au
RECOMMENDED
CONSULTANT PROJECT MANAGER
APPROVED
CONSULTANT PROJECT DIRECTOR
WATER CORPORATION
FILE
PROJECT C-W01783
PLAN 00-0-3
CAD
ISSUE A
ORIGINAL SHEET SIZE A2
MF
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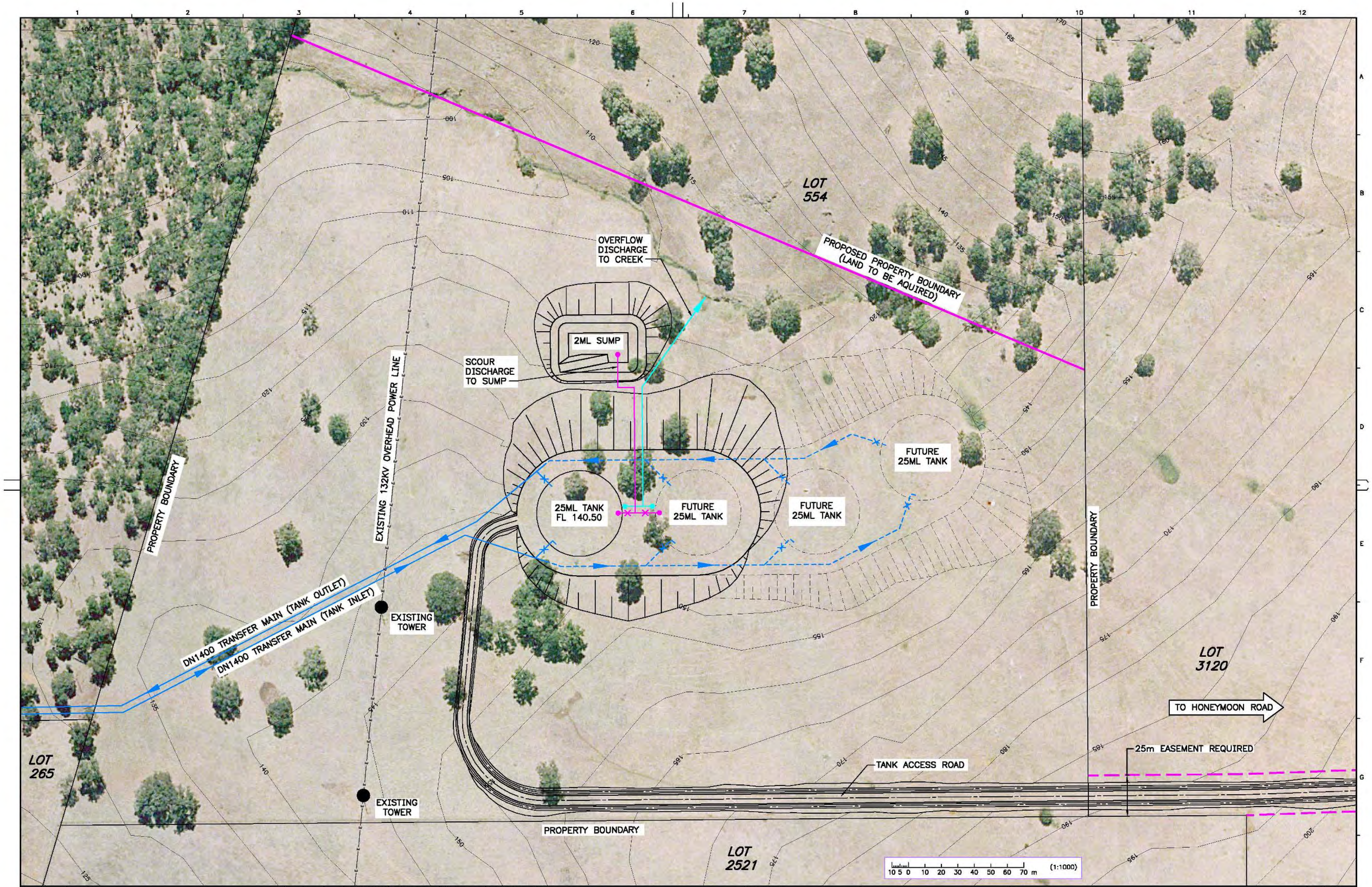
61\21216\CAD\REPORT (LOCALITY PLAN) 27/11/2007



ISSUE	DATE	GRID	REVISION	DRN	REC	APPD

DESIGN SURVEY NONE	VERTICAL DATUM A.H.D	DES CALC N/A
	COORDINATE SYS MGA94-50	DES CHD N/A
ASCON SURVEY NONE	DES REF GHD 61\21216	DRN P.J. SIMPSON
		Q.C. CHD R. CHESTER

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CONSULTANT PROJECT MANAGER
APPROVED
CONSULTANT PROJECT DIRECTOR

WATER CORPORATION

FILE
PROJECT C-W01783
PLAN 00-0-1
CAD ISSUE A
ORIGINAL SHEET SIZE A1
61\21216\CAD\REPORT (TANK SITE) 27/11/2007

Appendix 4 - Water Corporation Environmental Policy

Introduction

The Water Corporation provides essential water, wastewater and drainage services to the people of Western Australia. We take water from the environment and return drainage water and treated wastewater and its by-products back into the environment.

In doing this, we aim to provide sustainable, safe and reliable water services to customers and the community.

This policy applies to the Statewide operations of the Water Corporation, which includes all activities, services and products provided by the Corporation to its customers, in accordance with its operating licence.

All employees, and where practicable, 'second parties' (Water Corporation agents, alliance participants, contractors and suppliers) will comply with and support implementation of this policy.

Commitment

The Corporation is committed to:

- playing a leading role in the sustainable future of Western Australia's water resources;
- compliance with applicable environmental legal requirements and with other environmental requirements to which the Corporation subscribes;
- preventing pollution and minimising the adverse effects of our activities; and
- excellence and continual improvement in environmental performance, including conserving natural resources and ecological systems and enhancing them where practicable.

How

Our commitments will be met by:

- providing appropriate services, resources and infrastructure to meet our stated objectives;
- identifying, assessing and managing our environmental risks;
- developing and implementing environmental improvement programmes with measurable targets;
- regularly reviewing and auditing our environmental systems and performance;
- developing and maintaining appropriate incident response plans and minimising the adverse environmental consequences of any accidents; and
- promoting efficient use of resources and minimisation of waste.

Our Environmental Management System provides the framework for developing, implementing, monitoring and reviewing our environmental objectives, targets and actions.

PCY230 Environmental Policy
31 October 2007
CDMS#: 375822

Peter D Moore
Chief Operating Officer

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Appendix 5 - Water Corporation's Statement of Environmental Conditions under the Environmental Protection Act 1986 (WA)

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OFFICE OF THE APPEALS CONVENOR
ENVIRONMENTAL PROTECTION ACT 1986

Ms Sue Murphy
Chief Executive Officer
Water Corporation
PO Box 100
LEEDERVILLE WA 6902

Our ref: Report 1302
Enquiries: (08) 9221 8711
Date: 22 April 2009

Dear Ms Murphy

SOUTHERN SEAWATER DESALINATION PLANT PROPOSAL, BINNINGUP (Assessment No. 1687)

Thank you for your letter to the Minister for Environment advising that you accept the conditions contained in the statement that was issued for the above proposal and that you waive your right of appeal.

At the request of the Minister, I have advised the decision-making authorities that they may now exercise their powers with respect to the proposal.

It should be noted that subsequent to publishing the statement, minor clerical changes were made to the implementation conditions under the provisions of section 46C(1)(b)(i) of the *Environmental Protection Act 1986*. The notice of the changes made is provided as Attachment 1 to the enclosed statement.

Please address future correspondence relating to the implementation of this proposal to:

Manager
Proposal Implementation Monitoring Section,
Department of Environment and Conservation
Locked Bag 104
Bentley Delivery Centre WA 6983

Yours faithfully

A. Sutton

Anthony Sutton
A/APPEALS CONVENOR

cc: Proposal Implementation Monitoring Section

Minister for Environment; Youth

Statement No. 792

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED
(PURSUANT TO THE PROVISIONS OF THE
ENVIRONMENTAL PROTECTION ACT 1986)

SOUTHERN SEAWATER DESALINATION PROJECT
LOTS 32 & 33, AND PART LOT 8 TARANTO ROAD, BINNINGUP
SHIRE OF HARVEY

Proposal:	The proposal is to construct and operate a minimum 50 GL/annum and up to 100 Gigalitre per annum desalination plant on Lots 32 and 33, and Part Lot 8 Taranto Road, Binningup; marine inlet/outlet pipes; and a water supply pipeline to transport potable water to the Integrated Water Supply Scheme via a storage facility near Harvey.
Proponent:	Water Corporation
Proponent Address:	PO Box 100, LEEDERVILLE WA 6902
Assessment Number:	1687

Report of the Environmental Protection Authority: Report 1302

The proposal referred to in the above report of the Environmental Protection Authority may be implemented. The implementation of that proposal is subject to the following conditions and procedures:

1 Proposal Implementation

1-1 The proponent shall implement the proposal as assessed by the Environmental Protection Authority and described in schedule 1 and 2 of this statement subject to the conditions and procedures of this statement.

2 Proponent Nomination and Contact Details

2-1 The proponent for the time being nominated by the Minister for the Environment under sections 38(6) or 38(7) of the *Environmental Protection Act 1986* is responsible for the implementation of the proposal.

Published on:

14 APR 2009

10th Floor, Dumas House, 2 Havelock Street, West Perth Western Australia 6005
Telephone: +61 8 9213 7250 Facsimile: +61 8 9213 7255 Email: Minister.Faragher@dpc.wa.gov.au

2-2 The proponent shall notify the Chief Executive Officer (CEO) of the Department of Environment and Conservation of any change of the name and address of the proponent for the serving of notices or other correspondence within 30 days of such change.

3 Time Limit of Authorisation

3-1 The authorisation to implement the proposal provided for in this statement shall lapse and be void within five years after the date of this statement if the proposal to which this statement relates is not substantially commenced.

3-2 The proponent shall provide the CEO of the Department of Environment and Conservation with written evidence which demonstrates that the proposal has substantially commenced on or before the expiration of five years from the date of this statement.

4 Compliance Reporting

4-1 The proponent shall prepare and maintain a compliance assessment plan to the satisfaction of the CEO of the Department of Environment and Conservation.

4-2 The proponent shall submit to the CEO of the Department of Environment and Conservation, the compliance assessment plan required by condition 1 at least 6 months prior to the first compliance report required by condition 6. The compliance assessment plan shall indicate:

1. frequency of compliance reporting;
2. approach and timing of compliance assessments;
3. retention of compliance assessments;
4. reporting of potential non-compliances and corrective actions taken;
5. table of contents of compliance reports; and
6. public availability of compliance reports.

4-3 The proponent shall assess compliance with conditions in accordance with the compliance assessment plan required by condition 1.

4-4 The proponent shall retain reports of all compliance assessments described in the compliance assessment plan required by condition 1 and shall make those reports available when requested by the CEO of the Department of Environment and Conservation.

4-5 The proponent shall advise the CEO of the Department of Environment and Conservation of any potential non-compliance as soon as practicable.

4-6 The proponent shall submit a compliance assessment report annually from the date of issue of the Implementation Statement No. 792 addressing the previous twelve month period or as agreed by the CEO of the Department of Environment and Conservation. The compliance assessment report shall:

1. be endorsed by the proponent's Managing Director or a person, approved in writing by the Department of Environment and Conservation, delegated to sign on the Managing Director's behalf;

2. include a statement as to whether the proponent has complied with the conditions Review;

3. identify all potential non-compliances and describe corrective and preventative actions taken;

4. be made publicly available in accordance with the approved compliance assessment plan; and

5. indicate any proposed changes to the compliance assessment plan required by condition 1.

5 Performance Review and Reporting

5-1 The proponent shall submit to the CEO of the Department of Environment and Conservation Performance Review Reports at the conclusion of the second, fourth and sixth years after the commencement of operation and then, at such intervals as the CEO of the Department of Environment and Conservation may regard as reasonable, which address:

1 the major environmental risks and impacts; the performance objectives, standards and criteria related to these; the success of risk reduction/impact mitigation measures and results of monitoring related to the management of the major risks and impacts;

2 the level of progress in the achievement of best practice environmental performance, including industry benchmarking, and the use of best available technology where practicable; and

3 improvements gained in environmental management which could be applied to this and other similar projects.

6 Water Quality and Marine Biota

6-1 The proponent shall ensure the Low Ecological Protection Area does not exceed 100 metres by 600 metres (50 metres either side of the diffuser array) as shown in Figure 1, schedule 2.

6-2 To achieve the Environmental Quality Objectives (EQOs) established by the Environmental Protection Authority (schedule 2) for the surrounding marine environment, including the Low Ecological Protection Area/discharge zone, the proponent shall prepare and implement a Marine Environment Monitoring Program to the satisfaction of the Chairman of the Environmental Protection Authority on the advice of the CEO of the Department of Environment and Conservation.

The Marine Environment Monitoring Program shall:

1 prior to discharges to the marine environment, identify the chemicals and pH present in the pressure test and disinfection water to be discharged during construction and operation, and establish its toxicity to freshwater and marine environments consistent with the recommended approaches in ANZECC/ARMCANZ 2000*;

2 prior to discharges to the marine environment, identify the discharge point and rate of discharge for the pressure test and disinfection water and, based on the levels of ecological protection to be achieved in the marine environment (see schedule 2) and a 95% species protection in the Harvey Main Drain, the predicted zones of mortality, effect (but not mortality) and influence (i.e. above background), as well as the rate of recovery;

3. establish existing benthic community composition and health prior to marine construction and then monitor benthic community composition and health annually after construction to determine impact and recovery;

4. prior to discharges to the marine environment, identify environmental quality indicators and associated "trigger" levels, based on the guidelines and recommended approaches in ANZECC/ARMCANZ 2000* and its updates, for assessing the performance of the discharges (with the exception of salinity where the agreed trigger levels are 1 parts per thousand (ppt) salinity increase above background 95% of the time and not exceeding an increase of 1.3 ppt above background at the boundary of the Low Ecological Protection Area) in meeting the EQOs, (see schedule 2);

5. prior to discharges to the marine environment, design and employ protocols and schedules for reporting performance against the EQOs using the environmental quality "trigger" levels for discharges identified in condition 6-2-4 and the salinity trigger level of not exceeding 1 ppt salinity increase 95% of the time and never exceeding 1.3 ppt at the boundary of the Low Ecological Protection Area; and

6. specify that monitoring shall be conducted for twelve months following completion of commissioning (commissioning shall not exceed six months) and twelve months following the initiation of full production (according to design specifications).

* - *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* ANZECC/ARMCANZ, 2000.

6-3 The proponent shall submit the results of the Marine Environment Monitoring Program, required by condition 6-2, to the CEO of the Department of Environment and Conservation within three months following of the finalisation of each element.

6-4 If the Marine Environment Monitoring Program required in condition 6-2 demonstrates that the environmental quality "trigger" levels (as determined through condition 6-2) are not met, the proponent shall immediately report to the CEO of the Department of Environment and Conservation with the remedial management and/or preventative actions to be implemented.

6-5 The proponent shall monitor dissolved oxygen levels at least weekly, either by deploying data loggers or by hand, at sites agreed by the CEO of the Department of Environment and Conservation to determine whether the "trigger" values are being achieved, for a period of 12 months immediately following:

- Completion of commissioning phase or six months from commencement of the commissioning phase, whichever is sooner; and
- The initiation of full production (according to design specifications).

6-6 The proponent shall report the results of the dissolved oxygen monitoring required in condition 6-5 to the CEO of the Department of Environment and Conservation within three months following the finalisation of each twelve month monitoring period as outlined in condition 6-5.

6-7 If the dissolved oxygen concentrations as measured according to condition 6-5 fall below 60% saturation at the boundary of the Low Ecological Protection Area, the proponent shall, within twenty-four hours, report to the CEO of the Department of Environment and Conservation and provide management measures which will be implemented to minimise any potential effects of the discharge.

6-8 The proponent shall verify diffuser performance in terms of achieving the required number of initial dilutions under a range of flow rates, low energy/calm meteorological and sea-state conditions to achieve a high level of ecosystem protection (99% species protection as defined by ANZECC/ARMCANZ 2000* for toxicants and 1 ppt 95% of the time for salinity) at the edge of the Low Ecological Protection Area (i.e. 50 metres either side of the diffuser array) for a period of 12 months immediately following:

- Completion of commissioning phase or six months from commencement of the commissioning phase, whichever is sooner; and
- The initiation of full production (according to design specifications).

* Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC/ARMCANZ, 2000

6-9 Prior to commissioning, the proponent shall conduct Whole Effluent Toxicity testing of wastewater, consistent with a Toxicity and Testing protocol based on Section 4 of the Southern Seawater Desalination Project Operational Environmental Management Framework, to the satisfaction of the CEO of the Department of Environment and Conservation.

The proponent shall conduct Whole Effluent Toxicity testing of wastewater consistent with the toxicity and testing protocol at the following intervals:

- One month following the initiation of the commissioning phase;
- 12 or 18 months following the initiation of commissioning (whichever comes first); and
- 12 months following the commencement of full production.

6-10 Prior to operation, the proponent shall identify management measures that will be implemented in the event that the Whole Effluent Toxicity testing results show that the original wastewater diffuser is not achieving sufficient dilutions to meet a high level of ecological protection at the edge of the Low Ecological Protection Area under all wastewater flow and oceanographic conditions.

6-11 The proponent shall submit the results of the Whole Effluent Toxicity testing required in condition 6-9 to the CEO of the Department of Environment and Conservation within six months of the initiation of each test.

6-12 Subject to the outcome of the Marine Environment Monitoring Program required by condition 6-2, the outcome of the dissolved oxygen monitoring required by condition 6-5, the verification of diffuser performance as determined in accordance with condition 6-8 and the Whole Effluent Toxicity testing required by condition 6-9, the monitoring and reporting requirements shall be reviewed and potentially amended by the CEO of the Department of Environment and Conservation on advice of the Environmental Protection Authority.

7 Marine Mammals

7-1 At least one week prior to the commencement of the construction of the seawater pipelines, the proponent shall implement a temporary cetacean exclusion zone covering the marine area at least 1 kilometre from any point of the pipeline alignment as defined in schedule 2. The temporary exclusion zone shall be demarcated with marker buoys placed at a minimum of 500 metre intervals along the boundary of the temporary exclusion zone. Additional buoys shall be placed 1.5 kilometres from any point of the pipeline alignment as defined in Figure 1, Schedule 2 to assist marine mammal observers* determine the proximity of any cetaceans or pinnipeds observed.

7-2 Visual monitoring for the presence of marine mammals within 2 kilometre radius of the active blasting area shall be undertaken by a qualified marine mammal observer*. Visual monitoring shall commence at least 60 minutes prior to each blast using binoculars and the naked eye from a survey vessel positioned within 500 metres of the drill and blast area. Visual monitoring shall continue until the blast has been detonated.

* A marine mammal observer means a person qualified and experienced in identifying marine fauna, estimated distances and interpreting fauna behaviour. It is suggested that approximately five years relevant experience would be adequate.

7-3 If cetaceans or pinnipeds are observed within a 2 kilometre radius of the blast areas their movements shall be closely observed by one support vessel. If a marine mammal enters within a 1 kilometre radius of the blast area blasting shall cease. Blasting shall only resume when all marine mammals are outside a 1 kilometre radius from the blast area, or not less than thirty minutes have passed since the last sighting.

7-4 At least one week prior to the commencement of the construction of the seawater pipelines, the proponent shall implement and demarcate a temporary marine animal beach exclusion zone nominally 200 metres north and 200 metres south of the pipeline alignment on the beach. If marine animals are sighted in this zone, the proponent shall implement measures to prevent construction activities from causing any distress or physical harm, or cease construction activities if necessary.

7-5 The proponent shall investigate and report within 14 days, any marine animal observed to be in distress as a result of construction activities to the Chief Executive Officer of the Department of Environment and Conservation (Wildcare Hotline and DEC Duty Officer) and the actions taken, including any modifications to the implementation of the proposal.

7-6 Within three months following the completion of construction of the seawater pipeline, the proponent shall provide a report on all recorded sightings required by conditions 7-2, 7-3, 7-4 and 7-5, to the CEO of the Department of Environment and Conservation.

8 Terrestrial Fauna

8-1 During the construction of the desalination project the proponent shall, every six months, provide a report on the management measures taken to prevent the death of native fauna within the pipeline corridor (including fauna trench inspections) and the plant site, to the CEO of the Department of Environment and Conservation.

8-2 Within one month following the completion of construction of the desalination plant, the proponent shall re-instate the north-south possum movement linkage across the plant site to permit the free movement of possums.

9 Terrestrial Flora and Vegetation

9-1 Based on the results of the existing declared rare flora (DRF), priority flora, and threatened and priority ecological community surveys* and the proposed survey in Spring 2008, the proponent shall provide evidence to the CEO of the Department of Environment and Conservation that the pipeline construction corridor has been located to avoid and/or minimise the identified populations of DRF prior to commencing construction.

* - *Southern Seawater Desalination Plant: 2007 Terrestrial Flora and Fauna Survey*, 360 Environmental, January 2008.

9-2 At lease three months prior to commencement of construction, the proponent shall prepare a map with GIS coordinates which demonstrates the avoidance and minimisation of impacts upon Declared Rare Flora, Priority flora, Threatened Ecological Communities and Priority Ecological Communities which identifies a final construction corridor based on avoidance and minimisation of impacts, see condition 9-1.

9-3 In implementing the proposal, the proponent shall minimise the loss of identified declared rare and priority flora, and priority and threatened ecological communities and may only take Declared Rare Flora within the identified pipeline construction corridor which shall not exceed 20 metres in width.

9-4 The proponent shall monitor the number of declared rare and priority flora, and the area of priority and threatened ecological communities referred to in conditions 9-1 and 9-2 to demonstrate that the number lost has been minimised. This monitoring is to be carried out to the satisfaction of the CEO of the Department of Environment and Conservation.

9-5 Within two months following the completion of construction, the proponent shall submit the results of monitoring required by condition 9-4 and a report demonstrating that the number of declared rare and priority flora, and the area of priority and threatened ecological communities lost has been minimised, to the CEO of the Department of Environment and Conservation.

9-6 Within two months following completion of construction of the Water Transfer Pipeline, the proponent shall commence rehabilitation of the pipeline corridor to habitat similar to that which occurred prior to clearing in accordance with the criteria included in condition 9-7.

9-7 Within two months following completion of construction of the desalination plant, the proponent shall commence rehabilitation of the site in accordance with the following:

1 Re-establishment of vegetation in the rehabilitation area to be comparable with that of the pre-clearing vegetation such that the following criteria are met within three years:

(1) Species diversity is not less than 70 percent of the known original species diversity;

(2) Declared rare flora and priority flora are re-established with not less than 50 percent of the pre-disturbance baseline density after three years and 65 percent success after five years; and

(3) Weed coverage less than 10 percent.

2 A schedule of rate of rehabilitation acceptable to the CEO of the Department of Environment and Conservation.

9-8 In liaison with the Department of Environment and Conservation, the proponent shall monitor progressively the performance of rehabilitation against the criteria in condition 9-7 based on annual monitoring in Spring.

9-9 The proponent shall submit annually a report of the rehabilitation performance monitoring required by condition 9-8 to the CEO of the Department of Environment and Conservation and shall address in the report the following:

1 Progress towards meeting the criteria required by condition 9-7 and milestone criteria; and

2 Contingency management measures in the event that criteria are unlikely to be met.

10 Wetlands

10-1 The proponent shall only clear native vegetation on Part Lot 8 Taranto Road, Binningup and the Boonilup Road section of the Water Transfer Pipeline subject to the satisfactory demonstration that an 'Offset Implementation Strategy' has been prepared and is able to be implemented in accordance with condition 10-2.

10-2 The 'Offset Implementation Strategy' referred to in condition 10-1 shall detail an offset which will provide an adequate restoration of an agreed wetland in accordance with Environmental Protection Authority *Guidance Statement No.19: Environmental Offsets – Biodiversity* (September 2008) and to the satisfaction of the CEO of the Department of Environment and Conservation.

10-3 During construction of the Water Transfer Pipeline, the proponent shall not dewater along the length of the pipeline within the area of Boonilup Road section of the Water Transfer Pipeline (see Figure 4, Schedule 1) unless otherwise authorised by the CEO of the Department of Environment and Conservation.

11 Greenhouse Gas Emissions

11-1 The proponent shall ensure that all electricity used by the plant is purchased from renewable sources, and the associated Renewable Energy Certificates are surrendered.

11-2 In the event that condition 11-1 cannot be met, the proponent shall offset the quantity of greenhouse gas emissions produced by the amount of electricity which is sourced from non-renewable sources by purchasing carbon offset credits from accredited third parties, or otherwise, in a manner approved by the CEO of the Department of Environment and Conservation.

12 Closure and Final Rehabilitation (Plant Site and Harvey Summit Tank)

12-1 Prior to commencement of construction, the proponent shall conduct surveys of the proposal area to collect baseline information on the following:

1 Soil profiles;

2 Groundwater levels;

3 Surface water flows;

4 Vegetation complexes; and

5 Landscape and landforms.

12-2 In the event of closure of the desalination plant, the proponent may leave the pipeline underground, wherever it is below ground level.

12-3 In the event of closure of the desalination plant, the proponent shall commence rehabilitation of the site in accordance with the following:

1 Re-establishment of vegetation in the rehabilitation area to be comparable with that of the pre-clearing vegetation such that the following criteria are met within three years following the cessation of the use of the site for the desalination plant:

(1) Species diversity is not less than 70 percent of the known original species diversity;

(2) Declared Rare Flora and Priority flora are re-established with not less than 50 percent of the pre-disturbance baseline density after three years and 65 percent success after five years; and

(3) Weed coverage less than 10 percent.

2 A schedule of rate of rehabilitation acceptable to the CEO of the Department of Environment and Conservation.

12-4 In liaison with the Department of Environment and Conservation, the proponent shall monitor progressively the performance of rehabilitation against the criteria in condition 12-3 based on annual monitoring in Spring.

12-5 The proponent shall submit annually a report of the rehabilitation performance monitoring required by condition 12-4 to the CEO of the Department of Environment and Conservation and shall address in the report the following:

1 Progress towards meeting the criteria required by condition 12-3 and milestone criteria; and

2 Contingency management measures, and their implementation, in the event that criteria are unlikely to be met.

Procedures

1. Where a condition states "on advice of the Environmental Protection Authority", the Environmental Protection Authority will provide that advice to the Department of Environment and Conservation for the preparation of written notice to the proponent.

2. The Environmental Protection Authority may seek advice from other agencies or organisations, as required, in order to provide its advice to the Department of Environment and Conservation.

3. The Minister for Environment will determine any dispute between the proponent and the Environmental Protection Authority or the Department of Environment and Conservation over the fulfilment of the requirements of the conditions.

4. Where a condition lists advisory bodies, it is expected that the proponent will obtain the advice of those listed as part of its compliance reporting to the Department of Environment and Conservation.

5. The proponent is required to apply for a Works Approval and Licence for this project under the provisions of Part V of the *Environmental Protection Act 1986*.

Hon Donna Faragher JP MLC
MINISTER FOR ENVIRONMENT; YOUTH

14 APR 2009

Schedule 1

Southern Seawater Desalination Plant, Lots 32 and 33, and Part Lot 8 Taranto Road, Binningup (Assessment No. 1687)

The proposal is to construct and operate a 100 Gigalitre desalination plant on Lots 32 and 33, and Part Lot 8 Taranto Road, Binningup, in the Shire of Harvey; marine inlet/outlet pipes; and a water supply pipeline to transport potable water to the South West Integrated System via a storage facility near Harvey.

General Description

The proposal is described in the following document – *Southern Seawater Desalination Project,* Water Corporation, Public Environmental Review (April 2008).

Summary Description

A summary of the key proposal characteristics is presented in Table 1.

Table 1 – Summary of Key Proposal Characteristics

Element	Description
General	
Capacity	50 Gigalitres per year initial capacity 100 Gigalitres per year ultimate capacity *
Power requirement	50 Megawatts annual average
Power Source	100% renewable energy from Western Power Grid
Clearing of vegetation required	Not more than 15 hectares (at plant site)
Rehabilitation	7 hectares minimum
Offset (rehabilitation)	13 hectares minimum
Seawater intake	
Intake volume	Average 722 Megalitres per day
Length (indicative)	Extending approximately 500 metres offshore
Number	2 pipes
Diameter	2.4 metres
Concentrated seawater discharge	
Discharge Volume	418 Megalitres per day (average)
Salinity	Up to 65,000 milligrams per litre
Temperature	Not more than 2°C above or below ambient seawater
pH	6-8
Length (indicative)	Extending not more than 950 metres offshore
Number	1 pipe
Diameter	2 metres
Diffuser	Located between 600 and 950 metres offshore and up to approximately 350 metres in total length

Element	Description
Sludge	
Sludge production	30 tonnes per day (approximately)
Water Transfer Pipeline	
Length	30 kilometres (approximately)
Diameter	1400 millimetres
Destination	Harvey Summit Tank Site
Clearing of native vegetation	Not more than 7 hectares (in pipeline corridor)
Rehabilitation	7 hectares minimum
Harvey Summit Tank Site	
Number of tanks	Up to 4
Capacity of each tank	32 Megalitres
Sump size	2 Megalitres (upgradeable to 5 Megalitres)
Clearing of native vegetation	Not more than 0.1 hectares

* Actual production can be up to 15% greater than the design production.

Figures

Figure 4: Boonilup Road section of the water transfer pipeline (attached).

The Boonilup Road section of the water transfer pipeline referred to in condition 10-3 is defined in Figure 4.

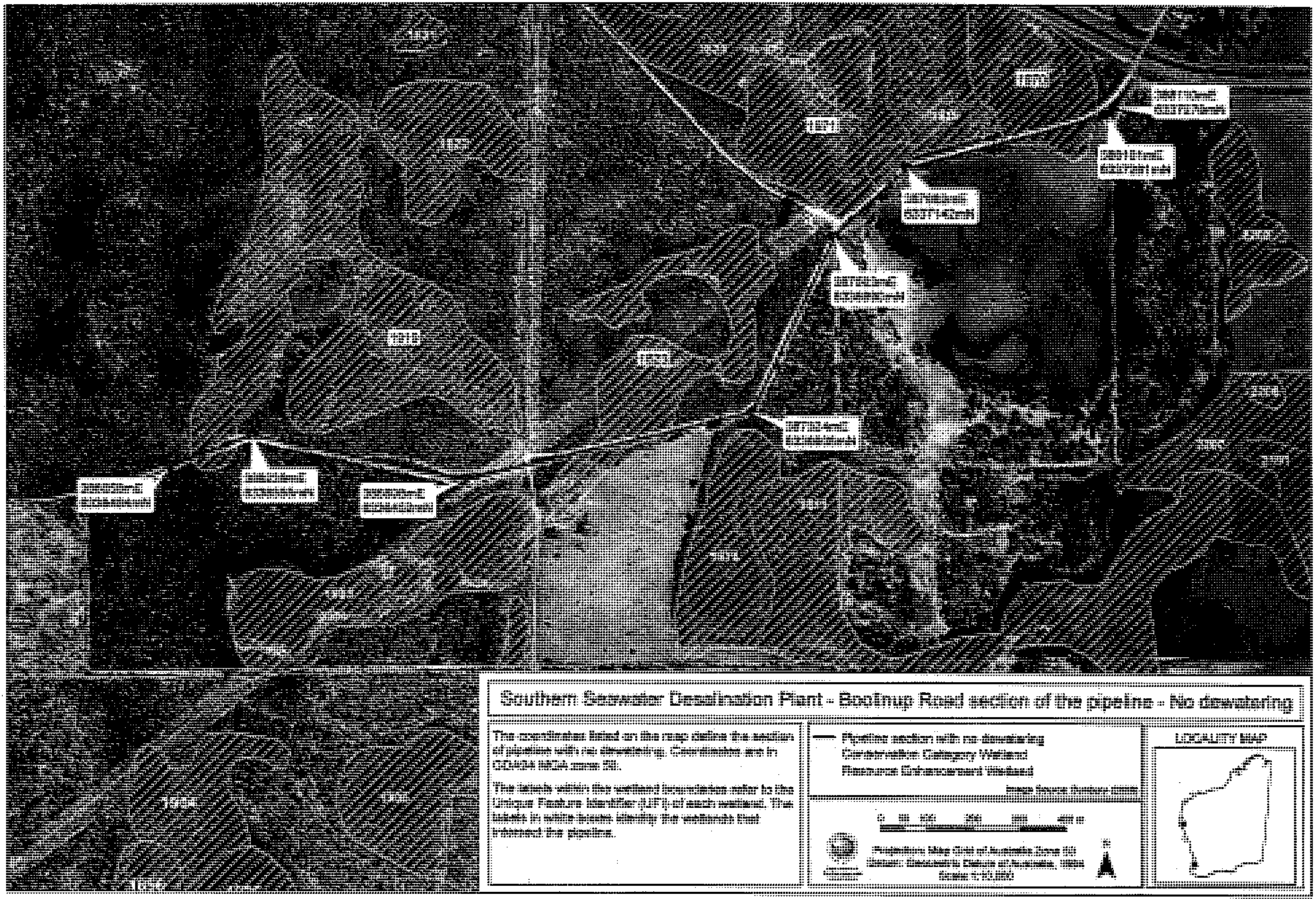


Figure 4: ***Boonilup road section of the water transfer pipeline (refer to condition 10-3).***

Schedule 2

Southern Seawater Desalination Plant, Lots 32 and 33, and Part Lot 8 Taranto Road, Binningup (Assessment No. 1687)

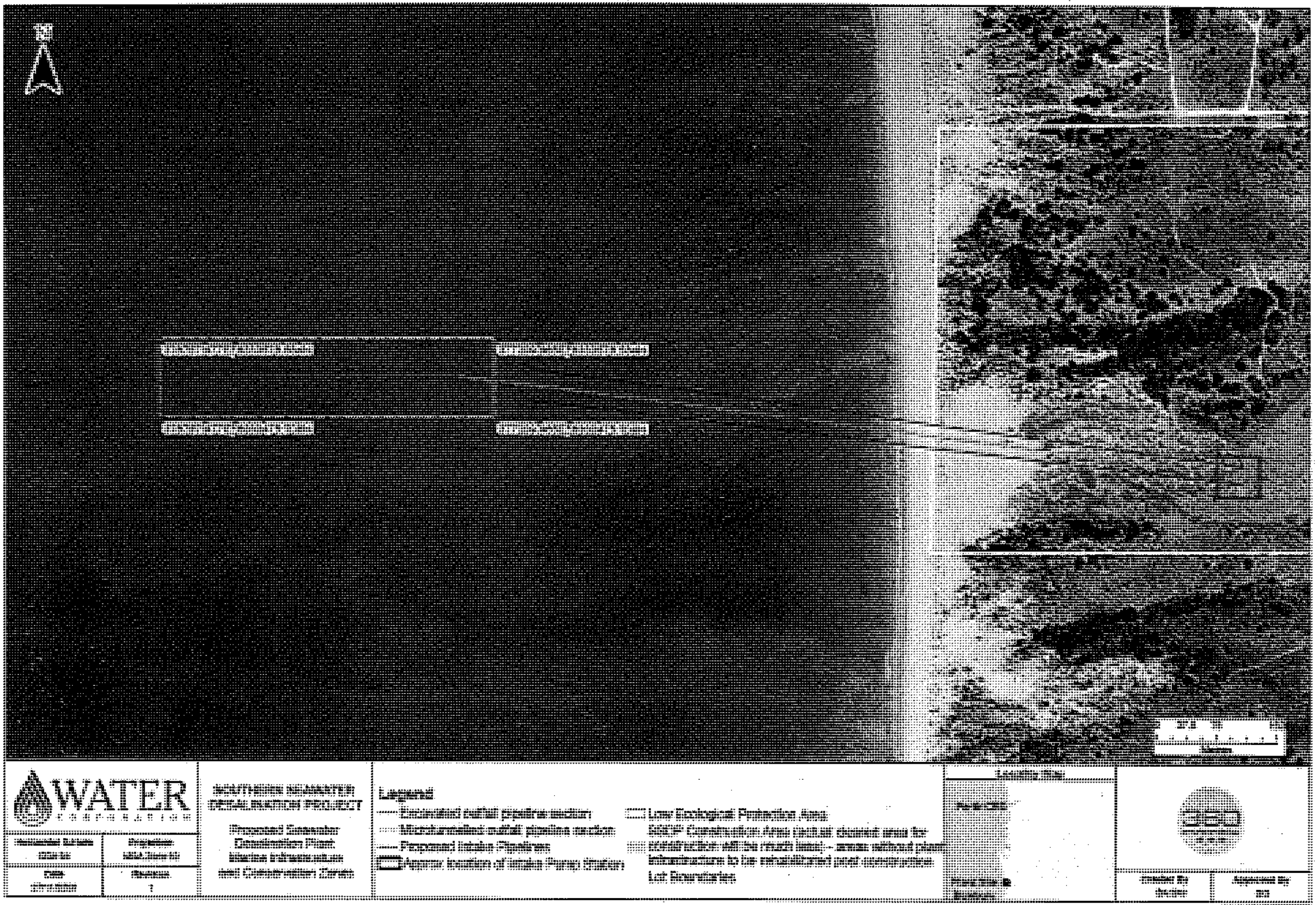
Environmental Quality Objectives for the surrounding marine environment including the Low Ecological Protection Area:

- Maintenance of ecosystem integrity at a low level of ecological protection within the Low Ecological Protection Area (LEPA) and at a high level of ecological protection at the designated LEPA boundary;
- Maintenance of aquatic life for human consumption assigned to all parts of the marine environment surrounding the ocean outlet;
- Maintenance of primary contact recreation values assigned to all parts of the marine environment surrounding the ocean outlet;
- Maintenance of secondary contact recreation values assigned to all parts of the marine environment surrounding the ocean outlet;
- Maintenance of aesthetic values assigned to all parts of the marine environment surrounding the ocean outlet;
- Maintenance of cultural and spiritual values assigned to all parts of the marine environment surrounding the ocean outlet; and
- Maintenance of Industrial Water Supply.

The Low Ecological Protection Area is 100 by 600 metres (50 metres either side of the diffuser array) as show in Figure 1.

The Marine Exclusion Zone required under condition 7-1 is defined spatially in Figure 2.

Figure 1: Size and location of the Southern Seawater Desalination Plant LEPA



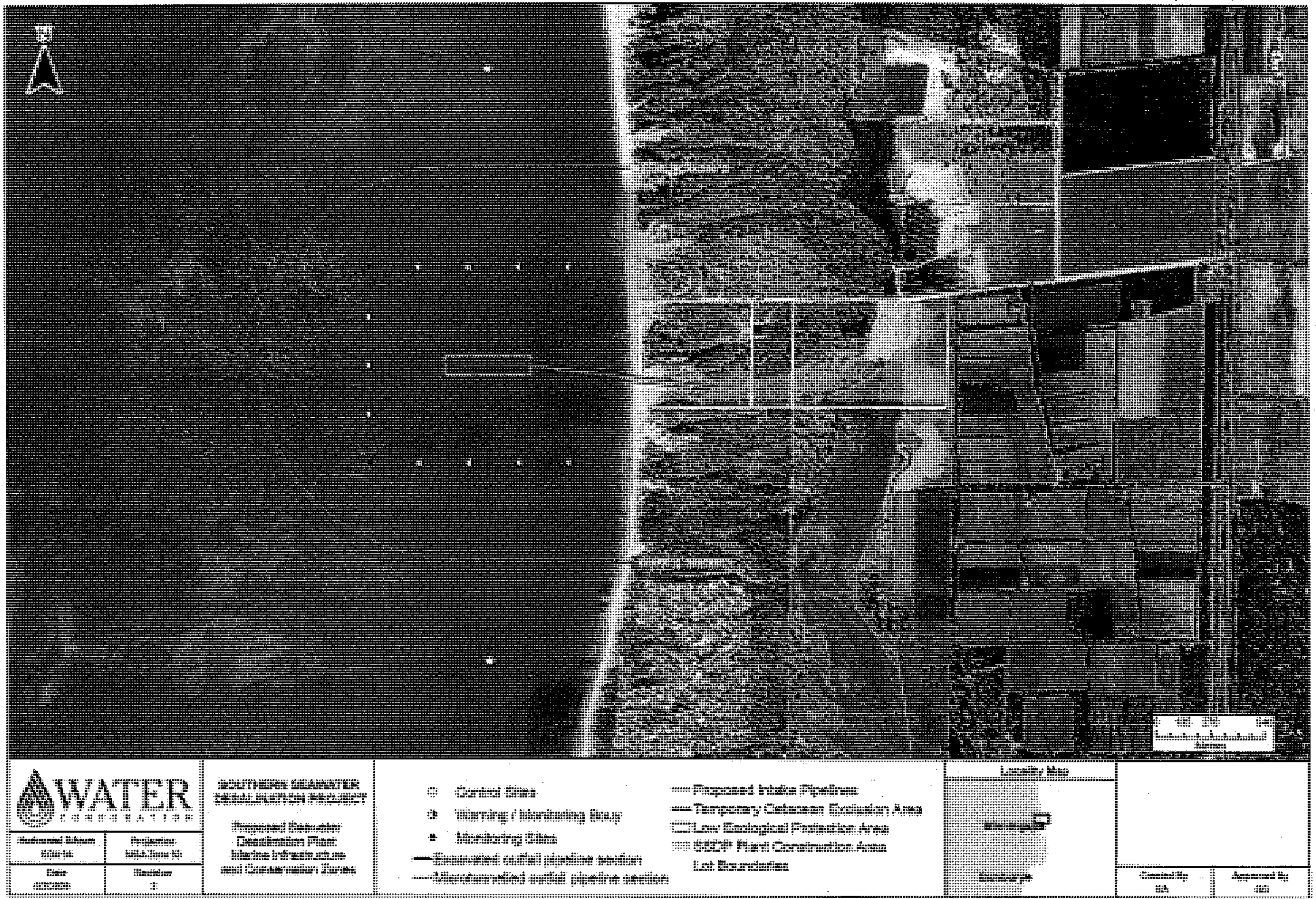


Figure 2: Seawater pipeline construction – Marine Exclusion Zone

ATTACHMENT 1

Minister for Environment; Youth

Section 46C
Environmental Protection Act 1986

NOTICE OF CHANGES TO IMPLEMENTATION CONDITIONS
MINISTERIAL STATEMENT 792

SOUTHERN SEAWATER DESALINATION PROJECT
LOTS 32 & 33 AND PART LOT 8 TARANTO ROAD, BINNINGUP, SHIRE OF HARVEY
WATER CORPORATION

Pursuant to section 46C(1)(b)(i) of the *Environmental Protection Act 1986,* the implementation conditions applying to the above proposal are changed in accordance with the Schedule to this Notice. I consider these changes to be of a minor nature which are necessary or desirable to correct a clerical mistake or unintentional error.

Donna Faragher

Hon Donna Faragher JP MLC
MINISTER FOR ENVIRONMENT; YOUTH

22 APR 2009

Schedule

1 Condition 4 amended

Condition 4 of Ministerial Statement 792 is amended as follows:

(a) In condition 4-2, deleting "condition 1" and "condition 6" and replacing with "condition 4-1" and "condition 4-6" respectively.

(b) In condition 4-3, 4-4 and 4-6, delete "condition 1" and replace with "condition 4-1".

2 Condition 6-9 amended

Condition 6-9 of Ministerial Statement 792 is amended by replacing the second dot point paragraph with the following:

"12 months following the completion of commissioning or 18 months following the initiation of commissioning (whichever occurs first);".

10th Floor, Dumas House, 2 Havelock Street, West Perth Western Australia 6005
Telephone: +61 8 9213 7250 Facsimile: +61 8 9213 7255 Email: Minister.Faragher@dpc.wa.gov.au

Appendix 6 - Water Corporation's Permit to Interfere with Bed and Banks of Watercourses under the Rights in Water and Irrigation Act 1914 (WA)

Government of **Western Australia**
Department of **Water**

looking after all our water needs

Our ref: WT2640
Enquiries: Steven O'Brien

Mr David Burton
Water Corporation
PO Box 100
Leederville WA 6902

Dear Sir

Re: ***Southern Seawater Desalination Plant, Issue of a Permit to Obstruct or Interfere***
Property: ***Crown Reserve 22977 Warawarrup & Unallocated Crown Land at Corner of Yambellup and River Road, Harvey***

Please find enclosed your *Permit to Obstruct or Interfere*, authorising you to modify the watercourse, under *the Rights in Water and Irrigation Act 1914*, subject to certain terms, conditions or restrictions.

It is important that you read the conditions of your permit carefully. If you do not understand your permit, please contact the Department as soon as possible, as there are penalties for failing to comply with all of your licence conditions.

The approved modifications must be completed while the permit is current. Should the works be expected to continue past the expiry date of the permit, you must apply for an extension. It is suggested that an application to vary the duration of the permit be made at least one month in advance.

Should your authorised modification cause a detrimental effect on another person or damage the water resource or associated environment, the Department may amend, suspend or cancel your permit.

The Department of Water emphasises that it is the responsibility of the permit holder to ensure the safety and adequacy of the design, method of construction and operation of the works or action the subject of the permit.

The Department focuses upon water resource related issues. It does not assess, and indeed is precluded by the *Rights in Water and Irrigation Regulations 2000* from assessing, the works or action in respect of which the permit has been issued.

Compliance with the terms, conditions or restrictions of this permit does not absolve the permit holder from responsibility for compliance with the requirements of all Commonwealth and State legislation.

If you have any queries relating to the above matter, please contact Steven O'Brien at the Department of Water on telephone 08 6364 6865.

Yours faithfully

R. G. Caunce

Ron Caunce
Program Manager, Licensing
April 22, 2009

168 St Georges Terrace Perth Western Australia 6000
PO Box K822 Perth Western Australia 6842
Telephone (08) 6364 7600 Facsimile (08) 6364 7601
www.water.wa.gov.au
wa.gov.au

PERMIT TO OBSTRUCT OR INTERFERE (S17)

Granted by the Minister under section 17 of the Rights in Water and Irrigation Act 1914

Permit Holder(s)	Water Corporation	
Description of Water Resource	Harvey River Harvey River	
Location of Water Source	Unallocated Crown Land at Corner Yambellup and River Road, Harvey Lot 3000 On Plan 49937 - Volume/Folio Lr3138/140 - Lot 3000 Warawarrup - Crown Reserve 22977	
Authorised Activities	**Activity**	**Location of Activity**
	Installation of Water Transfer Pipeline for the Southern Seawater Desalination Project by the Water Corporation	Lot 3000 On Plan 49937 - Volume/Folio Lr3138/140 - Lot 3000 Warawarrup - Crown Reserve 22977
	Installation of Water Transfer Pipeline for the Southern Seawater Desalination Project by the Water Corporation	Unallocated Crown Land at Corner Yambellup and River Road, Harvey
Duration of Permit	From 24 April 2009 to 31 December 2010	

This Permit is subject to the following terms, conditions and restrictions:

1 The permit holder shall not construct the pipeline in a manner that may obstruct the free flow of the river.

2 The Water Corporation shall comply with the recommendations contained in the following Water Quality Protection Note(s): Infrastructure Corridors Near Sensitive Water Resources.

3 The permit holder shall not interfere with the bed of the watercourse on any location, except as approved by the Department of Water

End of terms, conditions and restrictions

This Permit is granted subject to the Rights in Water and Irrigation Regulations 2000

Appendix 7 - Water Corporation's Consent to Interfere with Registered Heritage Sites under the Aboriginal Heritage Act 1972 (WA)

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WATER CORPORATION

MEMORANDUM

DATE: Tuesday 19 August 2008

TO: Andrew Baker, Principal Environmental Scientist

FROM: Vanessa Ugle Manager Aboriginal Heritage Approvals

SUBJECT: **Binningup Desalination Plant No2**

RE: Aboriginal Heritage Survey - Recommendations

The Indigenous Resources Section with the assistance of a qualified Anthropologist and Archaeologist carried out an Aboriginal Heritage Survey of the proposed new Desalination Plant in Binningup.

The survey consists of two parts an Ethnography and Archaeology component. The Archaeology component was carried out on the 20-23 May 2008 and the Ethnography component was carried out with members of the Gnaala Karla Boodja Native Title Claim Group on the 17-18th June 2008.

As a result of the survey being carried out, the following recommendations were made;

1) **It is recommended** that as no sites as defined by Section 5 of the Western Australian Aboriginal Heritage Act (1972) were identified within the project area, that the Water Corporation should proceed with the project as planned.

2) **It is recommended** that the Water Corporation take into consideration the request of the Aboriginal community to engage two Aboriginal Monitors chosen from the group who participated in the survey to inspect ground disturbing works that affect the construction of the seawater pump station (Lot 33), inlet and outlet pipelines to the sea (Lot 33 and beach), pipelines from the treatment plant site to the seawater pump station (Lots 8, 32 and 33) and the construction of service roads (lots 8,32 and 33 boundaries are not fenced in order to exclude Nyungars and wildlife access through the area.

3) **It is further recommended** that the Water Corporation give due consideration to Aboriginal community requests that all water courses crossed for the pipeline are crossed by directional drilling rather than open trenching which is considered culturally inappropriate.

4) No archaeological site was located within or in close proximity to the project area in the course of the survey. No archaeological sites were previously registered within this project area. There are no archaeological barriers present to effect the proposed development.

5) If the ground is excavated to install inlet and outlet pipes to transect the coastal sand dunes for 1.2km **it is recommended** that monitoring occur by Aboriginal Traditional Owners to ensure that any skeletal or artefactual material that may be present is avoided, conserves, documented and /or collected.

6) The most likely areas where archaeological sites, in particular, artefact scatters or burials may occur are banks of rivers, lakes, creeks and exposed sandy deposits. The removal or excavation of large quantities of sediment increases the risk of disturbing archaeological sites that may lie beneath the ground surface. **It is recommended** that Water Corporation inform any project personnel of their obligation to report any archaeological material, should this be encountered during earthmoving, as outlined under Section 15 of the Western Australian Aboriginal Heritage Act (1972).

7) If Water Corporation locate an archaeological site in the process of survey or ground excavation, **It is recommended** that work cease in the immediate area. Any skeletal material should be reported to Department of Indigenous Affairs and the Western Australian Police Service. Any artefactual material should be reported to Heritage and Culture Division, Department of Indigenous Affairs.

Please find attached a copy of the Aboriginal Heritage Survey Report " by Brad Good and Associates Consulting Anthropologists and Archaeologists".

If you have any further queries regarding this project, please contact me on 9420 3679.

For your information,

Vanessa Ugle
Manager Heritage Approvals, Indigenous Resources

Department of Indigenous Affairs
Government of Western Australia

ENQUIRIES : Ms Pam Thorley - Ph 9235 8135

OUR REF: 08/0260 V3

YOUR REF:

Mr Gordon Groth
Senior Environmental Officer, Environment Branch
Water Corporation
PO Box 100
LEEDERVILLE WA 6902

Dear Mr Groth

PROPOSED SOUTHERN SEAWATER DESALINATION PROJECT - COMMONWEALTH PUBLIC ENVIRONMENTAL REPORT (CPER)

I refer to your letter of 3 February 2009 seeking a comment or submission on the Draft CPER. Thank you for the opportunity.

Examination of the Register of Aboriginal Sites reveals that there are no recorded sites in or near the proposed plant site. Heritage surveys conducted indicate there are no sites or heritage values known in the project area.

The Water Corporation intends to avoid any impact to indigenous heritage values through register searches, plant design, consultation, heritage survey, monitoring during construction and to comply with the Aboriginal Heritage Act 1972. The proponent has prepared an adequate Aboriginal heritage management Plan for the management of subsurface finds during construction and the operating life of the plant.

This set of actions and intents demonstrates due diligence with regard to the provisions of the legislation. Accordingly, the Department of Indigenous Affairs has no issue or concern with the proposal as set out in the Draft CPER for the Binningup Desalination Plant.

Please contact Mr Denis Callaghan on 9235 8135 for more information.

Yours sincerely

Pam Thorley

Ms Pam Thorley
Registrar of Aboriginal Sites
10 February 2009

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Appendix D Targeted Significant Flora Survey (Strategen, 2009)

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strategen

Southern Seawater Desalination Project

Mitigation and Offset Strategy

Prepared for
Water Corporation
by Strategen

April 2009

Southern Seawater Desalination Project

Mitigation and Offset Strategy

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Suite 7, 643 Newcastle Street Leederville WA
ACN: 056 190 419

April 2009

Disclaimer and Limitation

This report has been prepared for the exclusive use of the Client, in accordance with the agreement between the Client and Strategen ("Agreement").

Strategen accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any person who is not a party to the Agreement.

In particular, it should be noted that this report is a qualitative assessment only, based on the scope of services defined by the Client, budgetary and time constraints imposed by the Client, the information supplied by the Client (and its agents), and the method consistent with the preceding.

Strategen has not attempted to verify the accuracy or completeness of the information supplied by the Client.

Client: Water Corporation

Report	Version	Prepared by	Reviewed by	Submitted to Client	
				Copies	Date
Preliminary Draft Report	V1	CM/WM	WM	Electronic	28/9/08
Draft Report	V2	CM/WM	WM	Electronic	20/10/08
2nd Draft Report	V3	CM/WM	WM	Electronic	22/10/08
Final Draft Report	V5	CM/WM	WM	Electronic	19/11/08
Final Report	FINAL	CM/WM	WM	Electronic	24/04/09

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1. INTRODUCTION

1.1 BACKGROUND

The Water Corporation, a corporatised government body charged with supplying drinking water to Western Australian residents, is proposing to establish a Reverse Osmosis (RO) seawater desalination plant at Binningup 130 km south of Perth on the south-west coast of Western Australia (WA). The plant will have an initial production capacity of 50 Gigalitres (GL)/year with potential to extend to 100 GL/year. Its primary components are the RO plant and associated seawater intake/outfall pipes within and into the ocean from Lots 32, 33 and part Lot 8 Taranto Road, Binningup, a 28.5 km long water transfer pipeline to Harvey, and a new water storage facility 3.5 km north-east of the Harvey town site.

In July 2007 the Water Corporation referred the proposal to the WA Environmental Protection Authority (EPA) for assessment under Section 38 of the *Environmental Protection Act* 1986, to construct and operate the Southern Seawater Desalination Project (SSDP). It was formally assessed at the level of Public Environmental Review (PER) under the State process. The Proposal was approved by the Minister of Environment with Ministerial Statement 792 released on 22 April 2009.

The SSDP Proposal was subsequently referred to the Department of Environment, Water, Heritage and Arts (DEWHA) for consideration of whether it constituted a Controlled Action and therefore required assessment under the *Environmental Protection and Biodiversity Act* (EPBC Act). DEWHA has since deemed that the SSDP has the potential to significantly impact on Matters of National Environmental Significance (NES) protected under the EPBC Act, in particular threatened species and listed migratory species (Section 1.4). A Commonwealth Public Environmental Review (cPER) has been determined as the appropriate assessment approach by the DEWHA to allow a full assessment of the Proposal.

1.2 DESCRIPTION OF PROPOSED ACTION

The proposed action is made up of the following components:

1. RO plant and infrastructure, including:
   - a seawater intake structure (for an ultimate plant capacity of 100 GL/year)
   - seawater supply pipeline(s), which feeds into a seawater pump station (both for an ultimate plant capacity of 100 GL/year)
   - a minimum 50 GL/year, maximum 100 GL/year potable water production reverse osmosis desalination plant (including pre-treatment and post-treatment facilities) located at Lots 32,33 and Part Lot 8, Taranto Road Binningup (in the Shire of Harvey)
   - brine discharge pipeline(s) and diffuser array in the ocean (for an ultimate plant capacity of 100 GL/year)
2. Water transfer pipeline, being:
   - approximately 28.5 km of 1400 mm diameter buried water transfer pipeline from the plant to a water storage facility 3.5 km north east of Harvey

- approximately 1.5 km of 1400 mm diameter buried pipeline to deliver water from the storage tank in Harvey into the existing Stirling-Harvey Trunk main
- a regulating valve on the delivery main at a site already containing existing valve infrastructure.

3. Water Storage Facility, 3.5 km north east of Harvey, compromising:
    - initially one 32 Megalitre (ML) tank with provision for three additional 32 ML water storage tanks (ultimately being of a combined volume of 130 ML)
    - maintenance sump (initially 2ML with provision for expansion to 5 ML storage)

1.3 PURPOSE AND SCOPE OF DOCUMENT

This Mitigation and Offsets Strategy has been developed to outline:

- the nature and extent of impacts to species listed under the EPBC Act that are likely to be affected by the Proposal
- proposed on-site avoidance and mitigation to be implemented in design and during and following construction to reduce the local impact on these species
- proposed on-site and off-site strategies to offset residual impacts and ensure no net significant impact to these species.

This document is intended to be read in conjunction with the EPBC Referral and cPER documentation for this project.

1.4 EPBC LISTED SPECIES POTENTIALLY IMPACTED ON BY PROPOSAL

Following on from the findings of the cPER, the following species of National Environmental Significance will be subject to specific mitigation strategies to reduce the extent and significance of potential impacts:

- Western Ringtail Possum (*Pseudocheirus occidentalis*)
- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*)
- migratory bird species
- cetaceans
- Leatherback Turtle (*Dermochelys coriacea)*
- Loggerhead Turtle (*Caretta caretta*)
- Grey Nurse Shark (*Carcharias taurus)*
- Great White Shark (*Carcharodon carcharias*)
- Dwarf Hammer-orchid (*Drakaea micrantha*)
- Glossy-leaved Hammer-orchid (*Drakaea elastica*)

2. DEVELOPMENT OF MITIGATION STRATEGY

This Mitigation and Offset Strategy is based on the framework outlined in *Draft Policy Statement: Use of Environmental Offsets under the Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment and Water Resources (DEWR) 2007), EPA Bulletin No. 1 *Environmental Offsets – Biodiversity* (EPA 2008), EPA Position Statement No. 9 *Environmental Offsets* (EPA 2006) and EPA Guidance Statement No. 19 *Environmental Offsets – Biodiversity* (EPA 2008).

For the purpose of this strategy and consistent with DEWR (2007), 'mitigation' refers to the range of actions that can be undertaken on-site in design and construction to reduce the level of impacts of the development undertaken on-site. Environmental offsets provide compensation for those impacts, which cannot be adequately reduced through avoidance and mitigation.

Mitigation approach

Consistent with this terminology, the management of on-site environmental impacts to habitats of species of NES have firstly been addressed using the mitigation hierarchy outlined in EPA (2006) (Figure 1):

1. Avoid (i.e. exclude potential habitat of species altogether)
2. Minimise (limit magnitude) (i.e. reduce clearing of habitat to as low as possible)
3. Rectify (restore, repair) (e.g. rehabilitation of temporary disturbance areas
4. Reduce (over time) (e.g. reducing the permanent footprint over time)
5. Offset (initiative outside of footprint to reduce net impact on species)

Mitigation

This strategy therefore firstly outlines management actions that have or will be employed by Water Corporation to avoid impact on EPBC Act listed species wherever practicable. Where avoidance is not possible, Water Corporation will be implementing measures to minimise the extent of impact and/or rectify/reduce the significance of that impact over time, with the intention of ensuring the net impact is not significant. Such measures include rectifying impacts of clearing for construction in areas disturbed but not required for permanent plant or operation.

Where it has been deemed that a risk of a significant residual impact on an EPBC listed species still exists after mitigation, the offsetting of these impacts has been considered. An offset strategy has been outlined in the document for each species where such a risk may be inferred.

Offset definition EPA position versus DEWHA

There are many definitions of environmental offsets. The Australian Government defines environmental offsets as 'actions taken outside a development site that compensate for the impacts of that development - including direct, indirect or consequential impacts'. Based on this definition, some proposed initiatives to be implemented on-site, such as the rehabilitation of habitat outside of the development footprint, would be considered mitigation not offsets. Under the EPA Position Statement No. 9, on-site measures that are outside of the development footprint, once avoidance and minimisation measures are exhausted, would be considered offsets.

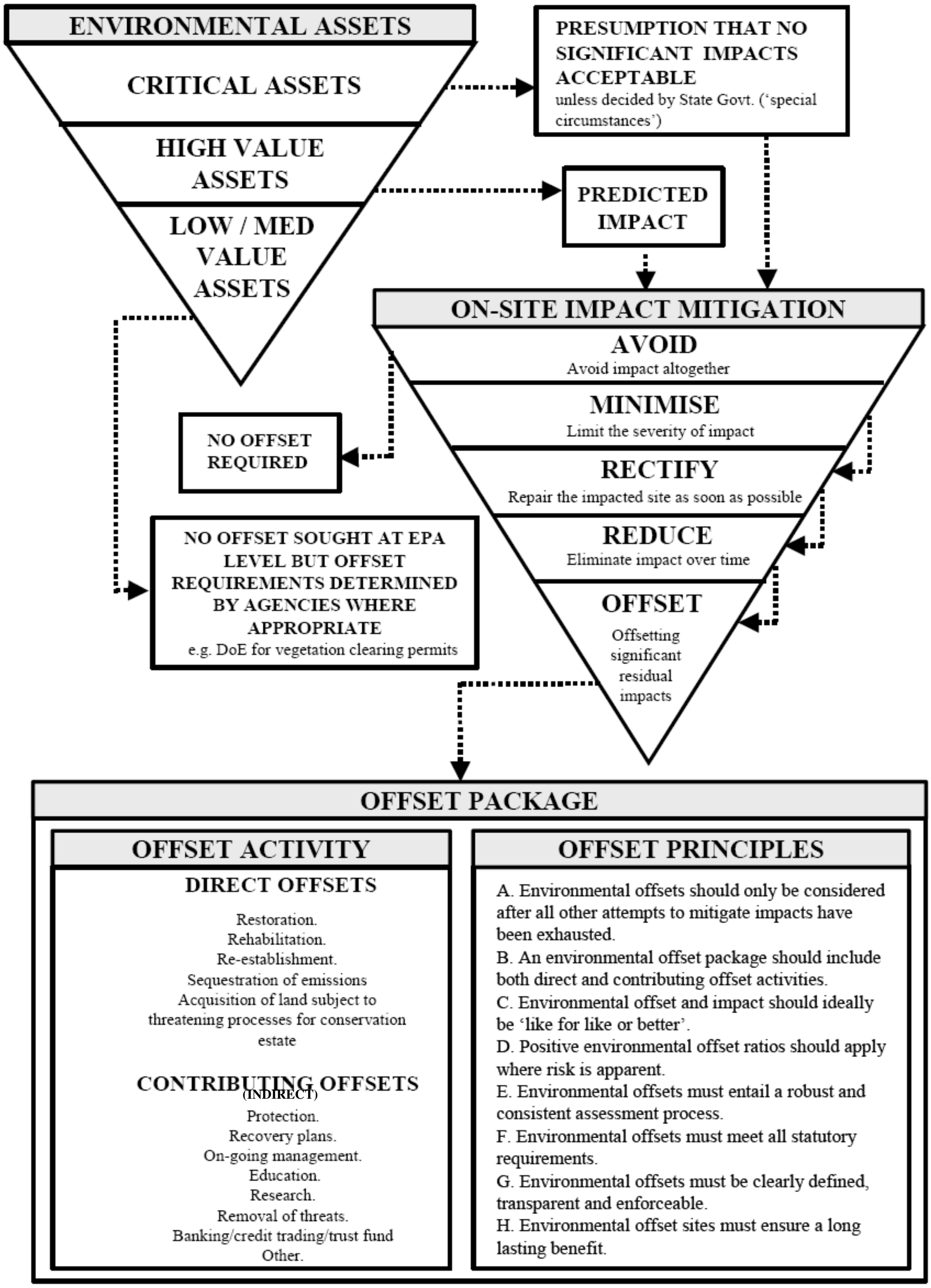


Figure 1 Decision framework for the use of environmental offsets (Source: EPA 2006). Note, contributing offsets are termed 'indirect' offsets in DEWR (2007)

Offsets (on-site and off-site)

To address this inconsistency, for the purpose of this strategy, any initiative to decrease the net impact on a species (other than minimisation) that is outside of the development footprint is referred to as an offset. Such offsets may be both on-site (e.g. rehabilitation of habitat in Lots 32, 33 and part Lot 8) and off-site (e.g. research, acquisition of land for conservation).

Approach to determining offsets

The offset strategies have been proposed based on position outlined in DEWR (2007):

1. Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted.
2. A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes which are cost effective for proponents.
3. Environmental offsets should deliver a real conservation outcome.
4. Environmental offsets should be developed as a package of actions - which may include both direct and indirect offsets.
5. Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'.
6. Environmental offsets should be located within the same general area as the development activity.
7. Environmental offsets should be delivered in a timely manner and be long lasting.
8. Environmental offsets should be enforceable, monitored and audited.

Types of offsets

This strategy adopts the Commonwealth terminology for 'types' of offsets, being that environmental offsets are generally categorised into direct and indirect offsets. Generally, the EPA equivalent to an indirect offset is a 'contributing' offset (Figure 1)

Direct offsets

Direct offsets are aimed at on-ground maintenance and improvement of habitat or landscape values. They may include:

- long-term protection of existing habitat – including through the acquisition and inclusion of land in the conservation estate, and covenanting arrangements on private land
- restoration or rehabilitation of existing degraded habitat
- re-establishing habitat.

Indirect offsets

Indirect offsets are the range of other actions that improve knowledge, understanding and management leading to improved conservation outcomes. They may include:

- implementation of recovery plan actions – including surveys
- contributions to relevant research or education programs
- removal of threatening processes
- contributions to appropriate trust funds or banking schemes that can deliver direct offsets through a consolidation of funds and investment in priority areas
- on-going management activities such as monitoring, maintenance, preparation and implementation of management plans etc.

3. DEFINITIONS

For the purposes of this report, the terms revegetation and rehabilitation have been defined as follows:

1. **Revegetation:** establishment of new plantings to create natural vegetation for National Environmental Significant species habitat and corridor linkage.
2. **Rehabilitation:** the botanical enhancement of degraded native vegetation National Environmental Significant species habitat and corridor linkage.

4. WESTERN RINGTAIL POSSUM

4.1 NATURE, EXTENT AND SIGNIFICANCE OF IMPACTS

A previous survey (360 Environmental 2007) identified the occurrence of a small population of Western Ringtail Possum (WRP) within the Tuart and peppermint vegetation associations, and the Banksia and peppermint vegetation associations on the SSDP Plant site. Potential WRP movement corridors from north to south and east to west were also identified within the SSDP site that may allow movement through the site to other habitat areas.

The east-west corridor, which represents the most favourable vegetation for WRP has been able to be avoided during construction, however the narrow north-south peppermint corridor will be temporarily removed during construction for the installation of the buried seawater pipelines. It is not expected that this removal will have a long-term impact on the population as a whole, however the roaming range of a number of individuals will be affected until the corridor can be restored, as north-south movement of animals along the coastal fringe will be restricted.

4.2 ON-SITE AVOIDANCE AND MITIGATION

The primary approach to managing the impact on WRP was to avoid most of their potential habitat areas within the SSDP site that were in a good condition and minimise impact to those areas that cannot be avoided (Table 1, Table 2). To achieve this, the Water Corporation acquired additional land adjacent to the original site (Lots 32 and 33) designated for the plant to provide more space for the project. The purchase of Part Lot 8 to the immediate east of the original site, which contained an area of land previously cleared for grazing quarrying, has allowed Water Corporation to retain more native vegetation suitable for WRP in Lots 32 and 33 (Figure 2).

The main plant site has been shifted out of Lots 32 and 33 and into Part Lot 8, where it is mostly already cleared. Disturbance in Lots 32 and 33 is now restricted to that required for the seawater intake and desalination discharge pipelines between the plant and the ocean. The width of disturbance for this infrastructure has been minimised and is positioned on the southern side of the lots to avoid the denser stands of peppermint trees (Figure 2). The vegetation that will be cleared in Lots 32 and 33 is of lower value for WRP compared to that retained due to its poor condition and sparseness. In addition to the vegetation being retained in Lots 32 and 33, the purchase of Part Lot 8 enables Water Corporation to ensure the conservation of suitable WRP habitat within Part Lot 8, which was otherwise rural land (Figure 2). In total, approximately 15 ha of vegetation is required to be cleared on the plant site, however approximately only 2 ha of this clearing is vegetation of value to WRP or Carnaby's Black Cockatoo.

Management will also focus on the retention of movement corridors for the WRP (Table 2). With the majority of construction occurring in Part Lot 8, the east-west corridor will not be affected, thereby allowing WRP to move south and then east through the SSDP site or vice versa (west and then north) throughout construction and operation. However, the north-south corridor will be affected by the need to install the seawater intake and outfall pipelines. A narrow section of sparse peppermint vegetation that makes up part of the north-south corridor between the pump station and the plant site will need to be removed for the installation of the pipelines (Figure 2). Water Corporation is investigating options to allow WRP to continue to move in a north-south direction while the pipelines are being installed including possum bridges or placement of hessian material and brush cover over the foredune to increase cover and enhance its function as a north-south corridor. The latter will be made possible by installing the pipelines by tunnelling underground instead of open trenching between the pumping station and the intake structures 500 m offshore. As a result the dune vegetation will not be disturbed from this work and an approximately 450 m vegetated corridor will remain during construction. In addition, Water Corporation will allow fauna movement throughout areas within open trenches by always keeping at least one corridor open between the pump station and the plant.

Following construction, the Water Corporation will revegetate the sections of the movement corridor disturbed (approximately 2.8 ha) using acacias (fast growing species' for rapid return of cover), peppermint trees (for foraging and shelter) and tuarts (for shelter). The net result will be a more intact north-south corridor. The current condition of the vegetation in this section is poor to very poor. This rehabilitation will have regional benefits as it will enhance the Yalgorup/Myalup/Leschenault Coastal North-South Linkage, a significant regional link.

A Revegetation Management Plan has been developed and is included as Appendix G of the cPER. The plan describes the methodology for on-site rehabilitation and includes:

- clearing protocol
- topsoil and mulch management
- weed management
- seeding and planting protocol
- monitoring

A Construction Environmental Management Framework has been prepared to ensure that remnant habitat is retained, and injury and mortality of WRP is avoided, during the construction of the plant and associated pipelines (Table 2).

These management measures will greatly reduce potential for long term impact on the WRP as their habitat within the SSDP site shall be retained and movement in all directions through the site will continue to be possible in the long term.

Table 1 Environmental objectives and targets for protection and management of WRP and its habitat during and after construction

Objective	Target
To minimise the disturbance to WRP and their habitat during construction and operation	No additional clearing outside of approved development footprint during construction
	Stock fences are erected around the retained WRP habitat prior to construction to ensure no access during construction
	No WRP death or injury attributable to the Project during construction and operation of the SSDP
Maintain and/or enhance the habitat linkages across site	Underground tunnelling used for installation of seawater intake and outfall pipelines through the foredunes.
	Retention of WRP movement corridors throughout construction and operation of SSDP
Revegetate and rehabilitate cleared or degraded WRP habitat respectively	Acceptable survival of tube stock plantings within rehabilitated and revegetated areas within three years of commencement of rehabilitation activities.
	Minimal weed infestation within revegetated and rehabilitated areas.

Table 2 On-site management actions for protection and management of WRP and its habitat during and after construction

Topic	Action	Timing	Responsibility
Habitat retention	1. Part lot 8, which has been previously disturbed by grazing and quarrying, acquired to construct plant and thereby reduce the extent of clearing of WRP habitat required on Lots 32 and 33.	Implemented during planning phase	Water Corporation
	2. At least 31 ha of remnant vegetation shall be retained in SSDP site (Figure 2). The vegetation to be retained has been identified as supporting a possum population. The vegetation to be retained also forms part of the east-west movement corridor.	Planning phase and construction Ongoing	Water Corporation
	3. Clearing of vegetation within lots 32 and 33 shall be restricted to degraded vegetation not suitable for WRP habitat with the exception of a narrow north-south corridor of degraded peppermint trees (Area 2 in Figure 2)	Planning phase and construction	Water Corporation
Maintenance of movement corridors	4. Underground tunnelling shall be used to install the seawater intake and outfall pipelines for approximately 450 m through the foredunes to reduce clearing of dune vegetation.	During Construction	Construction Contractor
	5. Water Corporation shall examine options, and implement if deemed feasible, to maintain and/or temporally a shelter corridor or other means to allow WRPs to move in a north-south direction across the SSDP site during the construction of the seawater intake and outfall pipelines. The use of possum bridges and artificial shelter belts will be examined.	Prior to and during construction	Water Corporation
	6. A corridor for the movement of WRP shall be maintained by restricting security fencing to around the seawater pump station and desalination plant construction sites. A connecting pipeline must be installed between the two sites, therefore a stock fence shall be placed between these two areas to discourage human traffic but not limit the movement of possums.	During Construction	Construction contractor
Construction Management	7. A Construction Environmental Management Framework to be developed prior to construction shall include the following management actions for WRP : • installation of fencing around remnant native vegetation and movement corridors • installation of fencing with ground level shrouding around open trenches • retention of potential habitat trees where possible • relocation of WRP prior to construction • protocols for clearing • protocol for vehicle usage and site management • actions to ensure injury/mortality to WRP is minimised during construction works • actions for dealing with injured fauna • protocol for WRP encounters during construction • environmental induction training • protocol for minimising construction at night.	Prior to construction	Water Corporation
Rehabilitation	8. Areas of the north-south WRP habitat corridor disturbed during construction shall be revegetated with peppermint and tuart trees following construction with the intention of improving its present condition from poor/very poor.	After construction	Water Corporation
	9. Approximately 10.7 ha of the SSDP site cleared for construction and not part of the permanent footprint of the plant shall be revegetated after construction, including the planting of peppermints and tuarts in spacing of 4 m.	After construction	Water Corporation

Topic	Action	Timing	Responsibility
	10. Rehabilitation shall be managed in accordance with the Revegetation Management Plan, which includes protocol on the following: • clearing • topsoil • mulching • weed management • seeding and planting • watering • monitoring.	After construction	Water Corporation

4.3 OFFSETS (ON-SITE)

In addition to 10.7 ha[1] of revegetation of areas disturbed during construction, another 10.5 ha of degraded native vegetation on the SSDP site, not associated with any construction activities, will be rehabilitated to improve flora linkages across the SSDP site and the quality of fauna habitat (Figure 3).

Species to be used in the rehabilitation of WRP habitat include:

- *Agonis flexuosa* (Peppermint)
- *Eucalyptus gomphocephala* (Tuart)
- typical understorey species relevant to the area being rehabilitated.

Seed will be collected within a nominal 50 km radius of the SSDP site to ensure that the seed collected is provenance correct. Use of local provenance seed can increase the success of revegetation as seedlings are already genetically adapted to the existing physical climate. Seed collection will be undertaken by an experienced and suitably qualified contractor. Further details on rehabilitation methodologies and species to be utilised are described in the Revegetation Management Plan (Appendix N of cPER).

The constructed berms built for screening purposes, will also be replanted using the above species. This includes an additional 7.7 ha of revegetation to that already proposed above. This includes planting a section directly adjacent to remnant vegetation, Taranto Road and the proposed access road in the north of Lot 8 of with juvenile plants rather than seedlings to enhance the north-south and east-west movement corridors at a faster rate.

The end result will be an increase in habitat available for WRP in Lots 32, 33 and Part Lot 8 and the protection of all habitat not required for the plant in the long term. These offsets which total over 17 ha (including the berm) are considered more than adequate to offset the approximate 2 ha of WRP habitat affected by the Proposal.

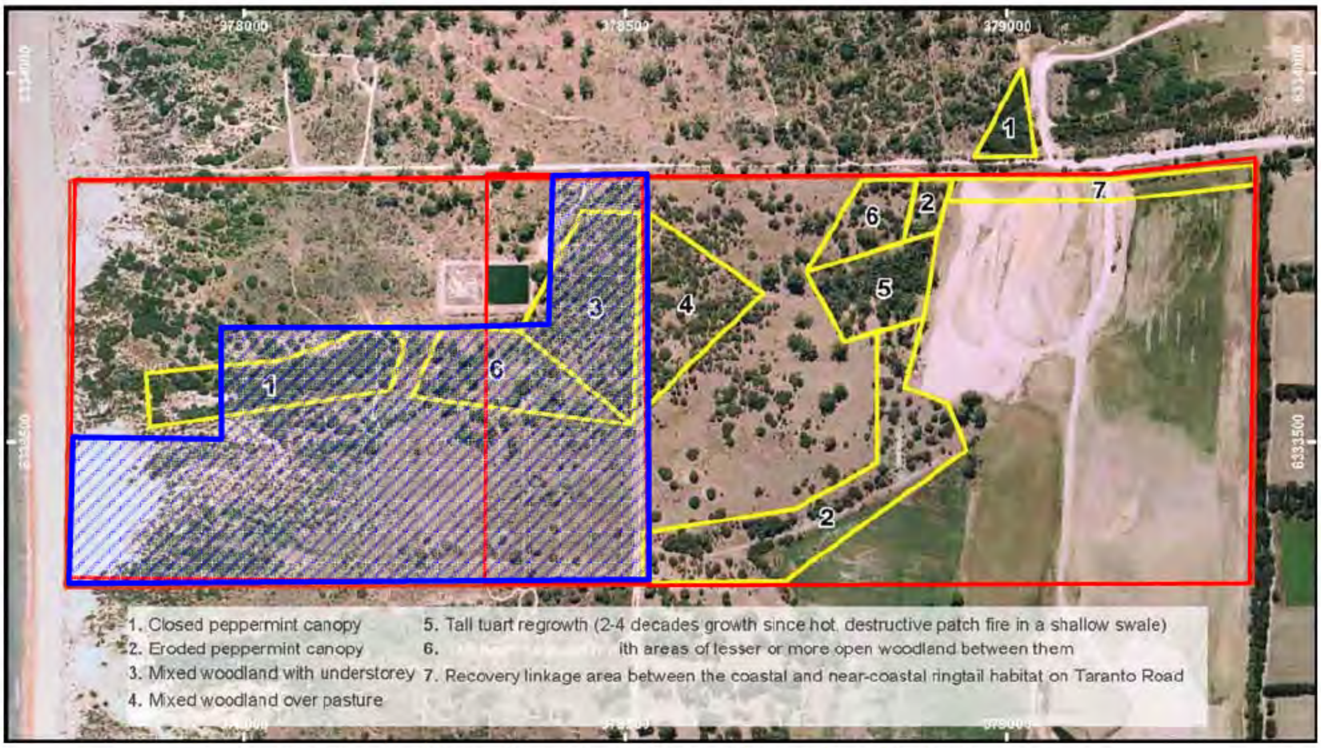
[1] 10.7 ha of revegetation includes 4.35 ha of native vegetation cleared for construction and 6.35 ha of land classed as agricultural land disturbed during construction

Supporting these on-site direct offsets will be a Site Habitat and Fauna Management Plan, which will provide the framework for Water Corporation to protect habitat on site (retained and restored) and ensure operational activities do not interfere with the use of the site by WRP. The plan will include a tree health as well as a WRP population monitoring program. It will include provision for Water Corporation to investigate any decline in health of habitat or WRP population and implement remedial actions if feasible.

4.4 OFFSETS (OFF-SITE)

The Water Corporation is actively seeking opportunities to partner with the Department of Environment and Conservation (DEC) on existing research programs and priorities by enabling them to extend the geographical range of their knowledge.

The numbers of individuals in the Western Ringtail Possum population utilising the SSDP site and land north and south of the site is not known, nor its relationship to the larger population known to exist in the Leschenault Peninsula Conservation Park to the south. A long term population study, spanning approximately five years and encompassing pre-construction, construction and post-construction phases of the SSDP, examining presence and numbers of WRP between Leschenault Peninsula and Yalgorup National Park would have benefits for future planning decisions for coastal development in the region. Such a study would involve funding of technical officers to conduct spotlighting (walking and in vehicles), arboreal cage traps and tagging, and surveys for dreys and faecal pellet counts to develop a population count and range extent for the WRP in this part of WA.



Likely impact on Western Ringtail Possum habitat without purchase of Part Lot 8

Proposed impact on Western Ringtail Possum utilising Part Lot 8

Legend

Subject Site

1 Habitat Patches (see caption for codes)

N

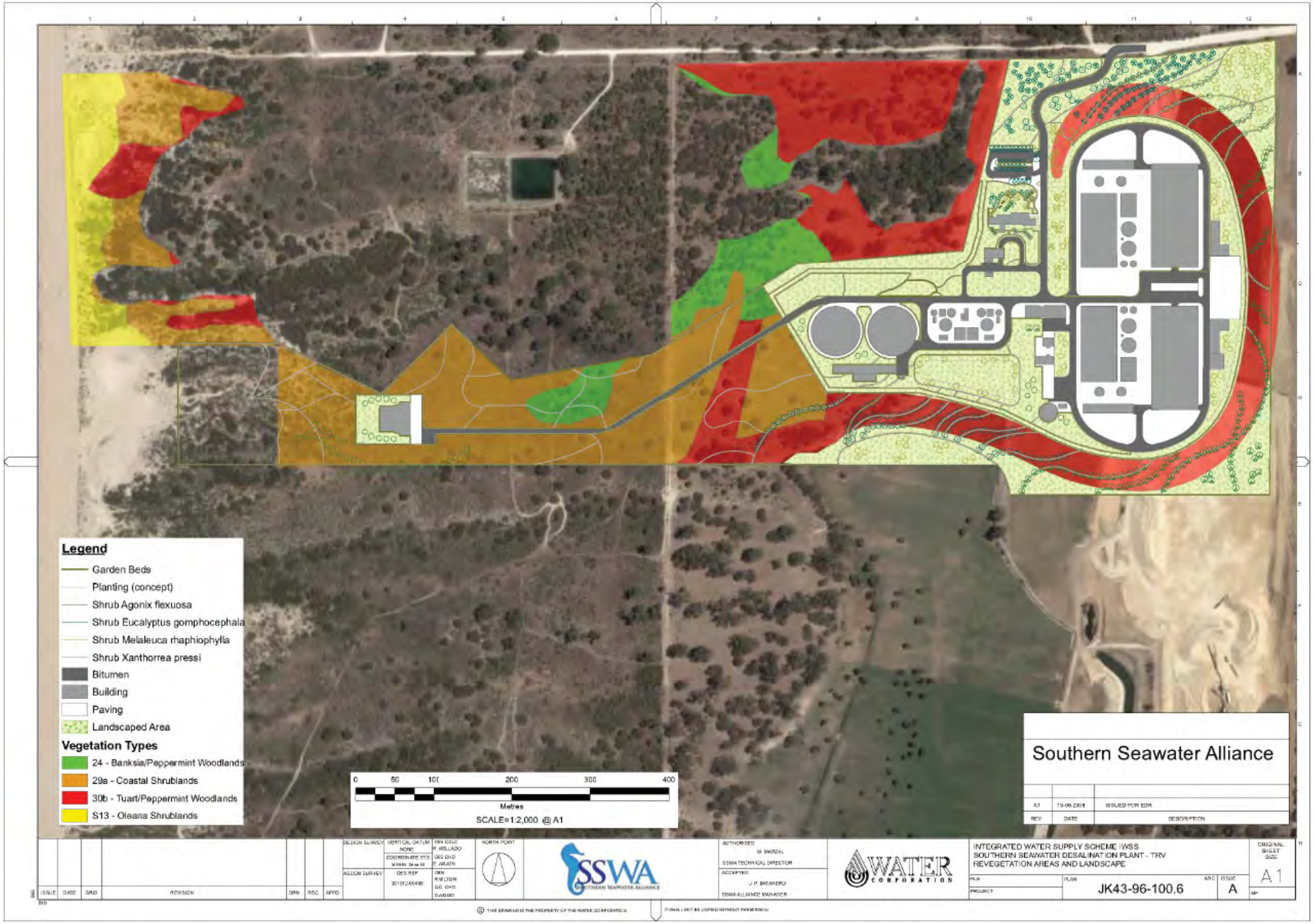
0 125 250 375 500

Metres

Plant footprint

Scale approximate only

Figure 2 Predicted impact to Western Ringtail Possum habitat with and without use of Lot 8.



Southern Seawater Desalination Project

PROPOSED CONSTRUCTION AND REVEGETATION AREAS FOR THE PLANT SITE

FIGURE 3

strategen

Figure 3 Revegetation Plan Apr-2009

5. CARNABY'S BLACK COCKATOO

5.1 NATURE, EXTENT AND SIGNIFICANCE OF IMPACTS

The 2007 survey by 360 Environmental identified flocks of Carnaby's Black Cockatoo feeding in areas adjacent to the SSDP site and a small flock feeding on *Hakea prostrata* vegetation within the SSDP site.

Within the SSDP site, two potential nests/hollows were identified; however these will not be affected by construction works. 14 potential feeding trees were identified in the SSDP site, of which, up to four are likely to be removed during construction.

Three potential hollows/nests and 74 potential feeding trees were identified on or adjacent to the Water Transfer Pipeline. The three trees containing hollows will be retained as construction width can be restricted adjacent to these trees, however, up to an estimated 17 feeding trees are likely to be cleared for the construction of the pipeline.

No potential feeding or nesting trees will be affected by the construction works for the Harvey Summit Tanks.

The numbers of feeding trees that will be removed during construction suggest a limited impact on potential food sources for Carnaby's Black Cockatoo given the known reduction in foraging habitat for this species. However, relatively, this part of the coastal plain still supports large tracts of foraging habitat for this species, unlike the Perth metropolitan area. The loss of 21 feeding trees appears of low local-regional significance given approximately 10,000 ha of native vegetation, which contains large tracts of foraging habitat, exist in the surrounding region.

5.2 ON-SITE AVOIDANCE AND MITIGATION

On-site management for Carnaby's Black Cockatoo will focus on habitat retention (Table 4). The acquisition of Part Lot 8 for construction of the majority of the plant has allowed Water Corporation to retain more native vegetation suitable for Carnaby's Black Cockatoo. Without the purchase of Part Lot 8, the vast majority of feeding trees would have to be removed (Figure 4). With the shifting of most infrastructure to cleared areas in Part Lot 8 and the location of pipeline infrastructure towards the south of Lots 32 and 33, it has allowed Water Corporation to retain almost all of the feeding trees in Lots 32 and 33, most of the feeding trees in Part Lot 8 and both potential nesting trees on the SSDP site (Figure 4). In total, approximately 15 ha of vegetation is required to be cleared on the plant site, however approximately only 2 ha of this clearing is vegetation of value to WRP or Carnaby's Black Cockatoo.

The route and site selection process for the Water Transfer Pipeline and the tank site respectively, also took into account the objective of avoiding or minimising impact to Cockatoo foraging habitat. The majority of pipeline traverses road reserves and agricultural land, with only 7 ha of the 30 km corridor requiring clearing of vegetation. The tank facility is situated entirely on agricultural land.

Table 3 Environmental objectives and targets for protection and management of Carnaby's Black Cockatoo and its habitat during and after construction

Objective	Target
To minimise the disturbance to Carnaby's Black Cockatoo and their habitat during construction and operation	No additional clearing outside of approved development footprint during construction
	No Carnaby's Black Cockatoo death or injury attributable to the Project during construction and operation of the SSDP
Maximise the potential for the Project area to continue to be utilised by Carnaby's Black Cockatoo	All potential nesting trees avoided during construction and retained
	Restrict removal of feeding trees on SSDP site to four feeding trees identified in development footprint (as indicated on Figure 4)
Revegetate and rehabilitate cleared or degraded Carnaby's Black Cockatoo habitat respectively	Acceptable survival of tube stock plantings within revegetated and rehabilitated areas within three years of commencement of rehabilitation activities.
	Minimal weed infestation within revegetated and rehabilitated areas.

Table 4 On-site management actions for protection and management of Carnaby's Black Cockatoo and its habitat during and after construction

Topic	Action	Timing	Responsibility
Habitat retention	1. Part lot 8, which has been previously disturbed by grazing and quarrying, acquired to construct plant and thereby avoid removing habitat trees and reducing the number of feeding trees on Lots 32 and 33.	Implemented during planning phase	Water Corporation
	2. At least 31 ha of remnant vegetation shall be retained in SSDP site (Figure 4). The vegetation to be retained includes potential feeding trees and nests/hollows.	Planning phase and construction Ongoing	Water Corporation
	3. All potential nesting trees identified shall be retained within the SSDP site and the Water Transfer Pipeline	During Construction	Water Corporation Construction contractor
	4. The removal of identified feeding trees shall be restricted to the four recorded in the plant development footprint on the SSDP site and 17 in the Water Transfer Pipeline disturbance corridor.	During construction	Water Corporation Construction contractor
Construction management	5. A Construction Environmental Management Framework to be developed prior to construction shall include the following management actions for Carnaby's Black Cockatoo: • installation of fencing around remnant native vegetation and movement corridors • retention of potential habitat trees where possible • protocols for clearing • protocol for vehicle usage and site management • protocol for Black Cockatoos encounters during construction • environmental induction training.	Prior to construction	
Rehabilitation	6. Approximately 10.7 ha of the SSDP site cleared for construction and not part of the permanent footprint of the plant shall be revegetated after construction, including the planting of banksias, hakeas and tuarts in spacing of 4 m.	After construction	Water Corporation

Topic	Action	Timing	Responsibility
	7. Rehabilitation shall be managed in accordance with the Revegetation Management Plan which includes protocol on the following: • clearing • topsoil • mulching • weed management • seeding and planting • watering • monitoring	After construction	Water Corporation

5.3 OFFSETS

Although a significant impact to this species is unlikely as a result of the proposed action, the 10.5 ha of additional rehabilitation of degraded vegetation that will occur on the SSDP site in areas not associated with construction will aim to enhance and expand the suitable feeding habitat for Carnaby's Cockatoo within the Proposal site (Figure 3). The rehabilitation program will serve as a direct offset to impacts.

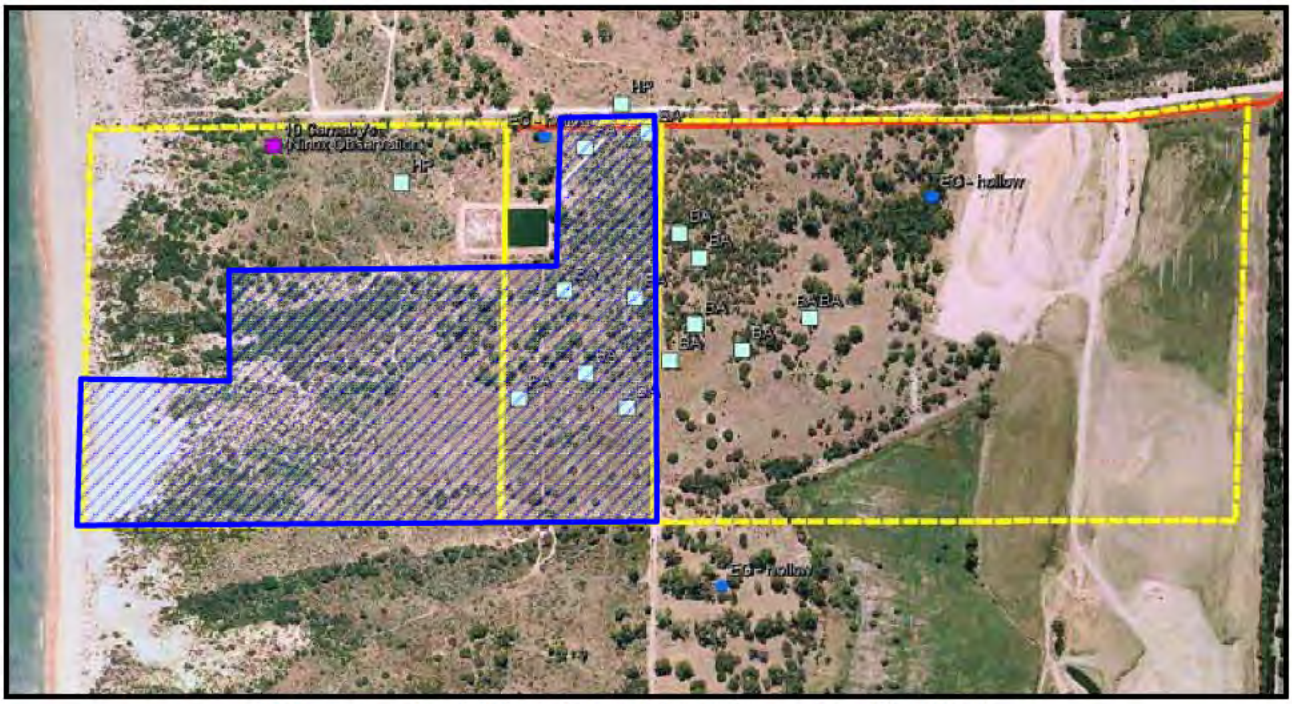
Species to be planted to ensure a greater abundance of feeding habitat in the future include:

- *Banksia attenuata*
- *Hakea prostrata*
- *Eucalyptus gomphocephala*
- typical understorey species relevant to the area being rehabilitated.

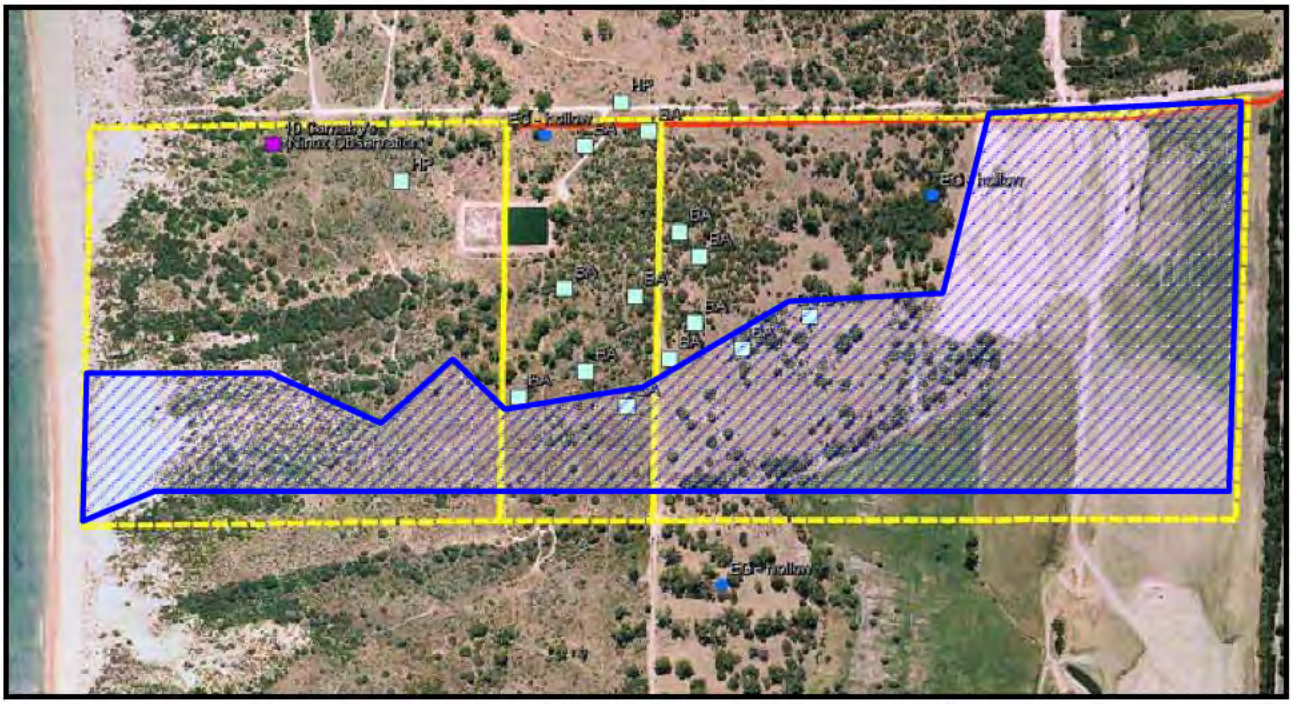
Section 4.3 describes the local provenance seed collection philosophy that will be adopted to maximise likely success of plant survival. Further details on rehabilitation methodologies and species to be utilised are described in the Revegetation Management Plan (Appendix G of cPER).

Screening planting of 3.5 ha of around the Harvey Summit water storage facility, which is currently cleared agricultural land, will also be undertaken. Species used will include Marri (*Corymbia calophylla*) and other local and other local endemic species suitable for Carnaby's Black Cockatoo foraging habitat.

Supporting these offsets will be a Site Habitat and Fauna Management Plan, which will provide the framework for Water Corporation to protect habitat on site (retained and restored) and ensure operational activities do not interfere use of the site by Carnaby's Black Cockatoos.



Likely impact on Carnaby's Black Cockatoo habitat without purchase of Part of Lot 8



Proposed impact on Carnaby's Black Cockatoo habitat utilising Part of Lot 8

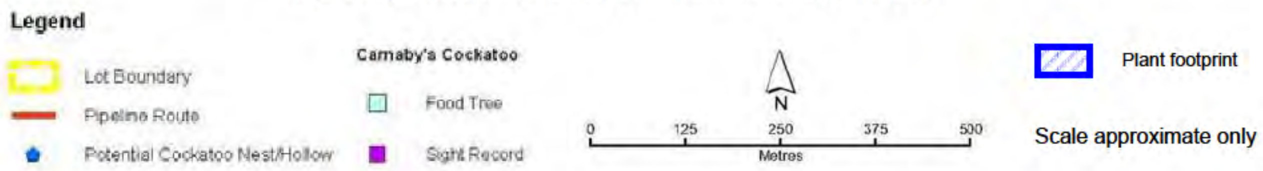


Figure 4 Predicted impact to Carnaby's Black Cockatoo habitat with and without use of Lot 8

6. BAUDIN'S BLACK COCKATOO

Baudin's Black Cockatoo was not sighted during surveys in the SSDP site, however the nesting sites identified could be utilised by this species. They could also conceivably frequent habitat along the pipeline route, however it is highly unlikely that the clearing proposed would significantly affect this species.

Management and mitigation measures to be implemented for Carnaby's Black Cockatoo will however have some similar benefits for Baudin's Black Cockatoo in regards to roosting trees and foraging habitat.

7. MIGRATORY BIRDS

7.1 NATURE, EXTENT AND SIGNIFICANCE OF IMPACTS

Lot 8 contains a peripheral estuarine wetland area that is the northern and supra tidal extent of the Leschenault Inlet. The northern part of the Leschenault Inlet wetland system is known to be used by migratory birds. Birds such as the Great Egret, Cattle Egret and Glossy Ibis, listed on JAMBA and/or CAMBA, which have a possibility of occurring in nearby wetlands (URS 2008), may also occur in this wetland. The predicted maximum development footprint includes a portion of the degraded wetland area. Given the degraded nature of the wetland it is unlikely the site contains important habitat for these species or supports breeding sites. These species are also highly mobile, that, if disturbed, are capable of finding other sites unassisted. Final plant design may exclude further portions of the wetland area from disturbance.

The Rainbow Bee-eater, also listed under JAMBA, is likely to occur during September to April within the Proposal area (URS 2008) and was recorded within the Banksia and tuart vegetation types on the SSDP site. Sufficient suitable habitat for this species is available outside of the Proposal area, hence it is unlikely the proposed development will significantly impact this species.

7.2 ON-SITE AVOIDANCE AND MITIGATION

Final design of the plant layout will aim to minimise the impact to the partly modified Leschenault Inlet Conservation Category Wetland and fringing vegetation within Lot 8. The design of the plant has yet to be finalised due to the two different tenders for construction.

A Wetland Management Plan will be prepared as part of the Site Habitat and Fauna Management Plan and submitted to DEC prior to Part V Works Approval being issued. On-site management measures outlined for Carnaby's Black Cockatoo (Table 4) will have similar benefits for the Rainbow Bee-eater as it utilises similar habitats. A primary focus of the selection of infrastructure sites was to avoid and minimise the clearing of terrestrial native flora during construction (GHD 2007a), thereby minimising the loss of avifauna habitat.

Table 5 Environmental objectives and targets for protection and management of Migratory bird habitat during and after construction

Objective	Target
To minimise the disturbance to Migratory avifauna and their habitat during construction and operation.	No Migratory avifauna death or injury attributable to the Project during construction and operation of the SSDP
	No additional clearing within remnant vegetation identified for retention

Table 6 On-site management actions for protection and management of Migratory bird habitat during and after construction

Topic	Action	Timing	Responsibility
Habitat retention	1. Clearing procedures will ensure disturbance to the Conservation Category wetland at the RO plant site associated with the partly modified Leschenault Inlet will not exceed 1 ha.	Planning phase and during construction	Water Corporation
Wetland Management	1. A Wetland Management Plan shall be prepared as part of the Site Habitat and Fauna Management Plan and submitted to DEC prior to Part V Works Approval being issued.	Prior to construction	Water Corporation

7.3 OFFSETS

As it is unlikely the Proposal will have a significant impact on migratory bird species, offsets are not considered necessary. However, offsets for conservation significant wetlands described in Section 10.3 will result in benefits for migratory waterbird species.

8. MARINE FAUNA

8.1 NATURE, EXTENT AND SIGNIFICANCE OF IMPACTS

Cetaceans

Cetaceans that are listed under the EPBC Act that may potentially frequent the coastal area in proximity to the seawater intake and outfall include:

- Southern Right Whale (*Eubalaena australis*) - Endangered
- Blue Whale (*Balaenoptera musculus*) - Endangered
- Humpback Whale (*Megaptera novaeangliae*) - Vulnerable
- Bryde's Whale (*Balaenoptera brydei*) - Migratory
- Pygmy Right Whale (*Caperea marginate*) - Migratory
- Dusky Dolphin (*Lagenorhynchus obscurus*) - Migratory
- Orca (*Orcinus orca*) - Migratory.

Other cetaceans that could conceivably occur in the Proposal area include: minke whale, common dolphin, Risso's dolphin, pan-tropical spotted dolphin, Indian Ocean bottlenose dolphin and bottlenose dolphin. The only confirmed sightings of cetaceans around Binningup are predominantly dolphins, most likely the bottlenose dolphin (URS 2008).

The use of the coastal areas off Binningup by cetaceans and therefore the potential to affect them during construction is difficult to judge as there have been no direct studies of marine mammals in this region (Western Whale Research 2008). Impacts associated with noise generated from the Proposal and shock effect in the event of any explosives use during construction are intrinsically low and will be further attenuated through the management measures described in Section 8.2. It is possible that the proposed activities may illicit some short-term behavioural changes, but these will be temporary (the duration of the activity) and only in the immediate area.

It is considered unlikely that the hypersaline brine discharge will impact on cetaceans as these animals are presumably able to sense changes in water salinity and avoid if necessary (Western Whale Research 2008).

Leatherback and Loggerhead turtles

The Loggerhead Turtle may utilise habitat within the vicinity of the SSDP for foraging and has been infrequently sighted in the area. The Leatherback Turtle has been occasionally seen in waters near Binningup, although this species is generally a non-nesting migrant visitor to Western Australia.

Literature reviews and an assessment on marine turtle risks generally concluded that the SSDP site presents minimal risks to turtles and the risks that do exist can be reduced via the management actions proposed in Section 8.2.

Similar to cetaceans, it is unlikely the brine discharge will impact on the Leatherback and Loggerhead turtles.

Grey Nurse and Great White Shark

Information available on the occurrence, species diversity, abundance, distribution and movements of marine mammals and sharks at or near the Proposed SSDP site is extremely limited, however the west coast Grey Nurse Shark and the Great White Shark may potentially occur near the Proposal area.

Grey Nurse and Great White Sharks that enter the Proposal area will able to detect the low frequency noises generated by the construction activities, however, no critical habitat or aggregation areas for either species are known to occur in the vicinity of the SSDP site, hence impact from construction noise is likely to be short-term and non-persistent.

Similar to cetaceans, it is unlikely the brine discharge will impact on the Grey Nurse and Great White Shark.

8.2 ON-SITE MITIGATION

The primary focus for management of large marine mammals and turtles during construction is to ensure their absence from the zone of active works (Table 8). The site for the intake and outfall pipes was selected because it was mostly devoid of habitat features that could attract large numbers of marine fauna to the area, hence the risk of impact is inherently low.

To further reduce the risk of impact to marine fauna, a 1 km marine exclusion area shall be established around the site during construction. This zone will be monitored and surveyed for the presence of marine fauna immediately prior to and during construction activities (Table 8). During blasting activities, if any fauna are sighted within 2 km of the activity, construction will not proceed or will cease until the individuals move out of the exclusion zone. Construction activities will only be conducted in daylight hours and benign sea conditions to enhance the effectiveness of the surveillance.

Table 7 Environmental objective and targets for protection and management of marine fauna and its habitat during and after construction

Objective	Target
To minimise the disturbance to protected marine fauna within the Project area.	No long term change in protected marine fauna movement and behaviour in the vicinity of SSDP
	No protected marine fauna fatalities or injuries within the SSDP site attributable to the Project

Table 8 On-site management actions for protection and management of marine fauna during construction and operation of the SSDP

Topic	Action	Timing	Responsibility
Design	1. Site for intake and outfall pipelines and diffuser selected in an area generally devoid of habitat features such as reefs, sponge gardens or algal beds with limited seagrass coverage which does not commence until about 1000 m offshore.	Implemented during planning phase	Water Corporation
Marine construction activities	2. If necessary to use explosives, only small charges shall be used.	During construction	Construction contractor

Topic	Action	Timing	Responsibility
	3. A 1 km marine exclusion and safety zone shall be established around the site during construction. The exclusion zone shall be monitored during noise intensive activities such as pile-driving and blasting to ensure they are clear of any conservation significant marine fauna.	During construction	Construction contractor
	4. An ocean watch vessel with a suitably qualified observer onboard shall survey the ocean for a 1 hour period prior to blasting within a 2 km radius of the blast site to confirm the presence or absence of marine fauna. Sighting will be undertaken from an elevated land position at the same time. If any are observed to be within the zone then detonation shall be delayed until such time as the observed fauna are outside the zone.	During construction	Construction contractor
	5. To enhance the effectiveness of surveillance, detonations shall only be conducted in daylight conditions and with benign sea conditions (e.g. sea state 3 or below) so that boat (and land-based observers if used) have a reasonable probability of sighting any marine fauna incursion into the safety zone.	During construction	Construction contractor
	6. All marine construction works shall cease if marine fauna are sighted within the marine exclusion zone	During construction	Construction contractor
	7. As far as practicable, any underwater blasting shall be conducted outside of the recognised migration periods in that area for southern right whales (May to October) and humpback whales (May to November)	During construction	Construction contractor

8.3 OFFSETS

Direct offsets for impacts on marine fauna are not considered necessary at this stage in consideration of the low likelihood of impacts to large marine fauna from the construction and operation of the SSDP.

In regard to indirect offsets, Water Corporation has commissioned Western Whale Research (WWR) to undertake a monitoring programme and is investigating the use of hydrophones to directly determine the presence of whales. The incorporation of an acoustic logger placed appropriately offshore of Binningup will provide the first recorded data of whale species that use or inhabit the on-shelf waters. In addition, a series of aerial surveys will provide data on the wider distribution and seasonal timing of species, small vessel surveys will enable identification of individuals, while land based surveys shall be used to provide an accurate baseline dataset that will provide data for the immediate area over time. The land based surveys will allow community members to have the opportunity to contribute sightings of whales to a study of whale migration routes.

A collaborative approach is envisaged between WWR and the Dolphin Discovery Centre in Bunbury who will be involved with the provision of volunteers, some training for local residents and the development of specific sighting forms and data entry.

This fieldwork will provide baseline information that integrates into the broader strategic research framework on the West coast.

9. DWARF HAMMER-ORCHID (*DRAKAEA MICRANTHA*) AND GLOSSY-LEAVED HAMMER-ORCHID (*DRAKAEA ELASTICA*)

9.1 NATURE, EXTENT AND SIGNIFICANCE OF IMPACTS

Drakaea micrantha (Dwarf Hammer orchid) has been recorded from around the south coast, between Perth and Albany. It is usually found in open sandy patches in *Banksia* and Jarrah woodland where it grows under thickets of *Kunzea glabrescens* with the Flying Duck orchid (*Paracaleana nigrita*) and other *Drakaea* species (Hoffman and Brown 1998).

While there was a lot of apparently suitable habitat for *Drakaea micrantha* in the wetlands part of the Water Transfer Pipeline route (Boonilup Road area), only one plant was recorded. It was recorded in state forest approximately 45 m north of the Water Transfer Pipeline route on Boonilup Road in a seasonally dampland area (360 Environmental 2008). Given that one *Drakaea micrantha* plant was found, other *Drakaea micrantha* plants may be present at the same location (360 Environmental 2008).

Indirect impacts on *D. micrantha* from temporary dewatering within the pipeline corridor is unlikely due to the dewatering cone of depression being less than 30 m and limited to approximately seven days duration.

D. elastica (Glossy-leaved Hammer-orchid) is found between Cataby and Ruabon on the Swan Coastal Plain and occurs in white or grey deep sandy soil in Banksia woodland, often in association with *Kunzea* spp. (Hopper and Brown 2007). The species has been previously recorded in the Binningup Region but was not recorded in 360 Environmental 2007 survey or the 2008 survey (360 Environmental 2008, K. Gibbs, pers. Comm. 2008).

9.2 ON-SITE AVOIDANCE AND MITIGATION

The first option for management of *D. micrantha* and *D. elastica* shall be avoidance and minimising the clearing of suitable habitat for these species (Table 10). Currently only one *D. micrantha* individual has been recorded within the Proposal area, and this shall be avoided and vegetation clearing minimised by reducing the construction working width of the Water Transfer Pipeline from 50 m to 20 m in the area.

For any populations of *D. micrantha* or *D. elastica* found prior to construction and not able to be avoided, a Management Plan shall be prepared in consultation with DEWHA that shall describe a translocation program for the specimens. They shall be tagged in Spring at the time of survey and translocated in March/April, being the appropriate driest time of year at which to undertake such a program.

Revegetation of the pipeline route with low growing shrub species after construction should rectify some of the impact by restoring suitable habitat for both species.

Table 9 Environmental objective and targets for protection and management of *D. micrantha* and *D. elastica* during and after construction

Objective	Target
Ensure impacts on *D. micrantha* and *D. elastica* are adequately identified and minimised during construction	Occurrences of *D. micrantha* and *D. elastica* (as identified in the flora surveys) to be clearly identified on detailed design plans and in the field for the duration of the construction works.
	Areas containing *D. micrantha* and *D. elastica* (as identified in the flora surveys) not to be disturbed are clearly delineated in the field for the duration of the construction works.

Table 10 On-site management actions for protection and management of *D. micrantha* and *D. elastica* during construction the SSDP and associated infrastructure

Topic	Action	Timing	Responsibility
Baseline information	1. A spring flora survey shall be undertaken in October 2008 within and adjacent to the length of Water Transfer Pipeline alignment to identify the presence and location of *D. micrantha* and *D. elastica* plants.	Early October 2008	Water Corporation
Avoidance	2. Existing areas of cleared land shall be used preferentially over vegetated areas for pipeline and remnant vegetation avoided.	Already implemented in planning	Construction contractor
	3. Construction working width to be minimised and within the State Forest, approximately 50 m north of the Water Transfer Pipeline on Boonilup Road, where *D. micrantha* was identified, shall be reduced to 20 m to minimise vegetation clearing in this area.	During construction	Construction contractor
	4. If any populations of *D. micrantha* or *D. elastica* not previously recorded, are found within the road reserve (in the 2008 spring flora survey), opportunities to avoid or reduce the impact to these populations to the minimum practicable shall be investigated.	Prior to construction	Water Corporation
Translocation	5. For any populations of *D. micrantha* or *D. elastica* not able to be avoided, a Management Plan shall be prepared in consultation with DEWHA that shall addresses: • local translocation program, including description of proposed methodology, locations to be translocated to, and timing and responsibilities • monitoring program • contingency actions, including further research into propagation.	Prior to construction	Water Corporation
Rehabilitation	6. Areas cleared for buried pipeline installation shall be revegetated with low growing shrubs following construction. Seed used shall be local provenance collected within a 50 km radius of the pipeline route.	After construction	Water Corporation

9.3 OFFSETS

Due to the fact that only one individual of *D. micrantha* has been identified in the Proposal area and that it will be avoided by reducing the working width of the pipeline corridor, offsets do not appear warranted at this stage.

10. CONSERVATION SIGNIFICANT WETLANDS

10.1 NATURE, EXTENT AND SIGNIFICANCE OF IMPACTS

Lot 8 contains a peripheral estuarine wetland area that is the northern and supra tidal extent of the Leschenault Inlet. This wetland has been classified by the DEC in 1996 as a Conservation Category wetland. The wetland has a total area of 481.5 ha, of which approximately 2 ha occurs within the SSDP site. The portion of the wetland within the SSDP site is currently in a 'completely degraded' state, and as such the Water Corporation originally intended to use the wetland for parts of the infrastructure for the project, including additional filling, the construction of a visual/noise berm along the southern boundary and the placement of infrastructure such as buildings. No wetland vegetation was to be cleared as part of this Proposal as all such vegetation on the SSDP site has been previously cleared. It was considered that the remaining portion of wetland to the south of the SSDP site would not have been affected by this action. .

The proposed Water Transfer Pipeline will intersect or run adjacent to eight conservation significant wetlands (six Conservation Category wetlands and two Resource Enhancement wetlands) and their associated buffers, along Boonilup Road. Construction works for the pipeline will require the clearing of native vegetation within the Boonilup Road Reserve. The flora and fauna values within the road reserve have already been compromised by construction of the road, therefore it is expected that further impact on the wetlands from clearing of vegetation for pipeline construction will not reduce the value of the wetlands.

Dewatering of the groundwater will be required along the Water Transfer Pipeline route to allow dry installation of the pipeline within a 3 m deep pipeline excavation. For construction, dewatering to a depth of approximately 3.5 m will be required to allow for safe installation of the pipeline. Based on experience of similar installations by Water Corporation in the area, ground water levels are expected to naturally recover with seven days following the cessation of dewatering.

The Water Transfer Pipeline will be buried with the surrounding fill being coarse bedding sand for pipeline protection. This has the potential to alter groundwater flows by acting as a preferential pathway for water flow. The risk of preferential flow is greatest in areas that have heavy soils such as loam or peat. Creating preferential water flows has the potential to cause long-term environmental impact on wetlands such as draining or flooding.

10.2 ON-SITE AVOIDANCE AND MITIGATION

Avoidance

Due to the 'completely degraded' state of the portion of wetland in Part Lot 8, it shall not be completely avoided during the construction of the SSDP.

A criterion for the selection of an appropriate Water Transfer Pipeline route was the protection of wetlands. The total avoidance of wetland vegetation was not possible due to the geographical extent of the large chain of wetlands that extend north to south between Binningup and Harvey, however the alignment of the pipeline was chosen to avoid the clearing of large amounts of wetland vegetation as described below. The total length of pipe within Conservation Category wetlands along the chosen route of Boonilup Road will be approximately 150 m.

Minimisation

The final plant layout has been designed to minimise the impact to the partly modified Conservation Category wetland and fringing vegetation within Lot 8. The only part of the project that will be located within the DEC geomorphic boundary of the wetland will be the visual/noise berm of tuart/peppermint woodland and additional landscaping areas of native vegetation. The placement of infrastructure outside of the wetland boundary has reduced the area of disturbance of the wetland from the originally proposed 3 ha to 1 ha. In addition, as the wetland is presently cleared, it is considered that the planting of native vegetation for the berm and landscaping will result in improvement of wetland function on the SSDP site and will function as an upland habitat area adjacent to the wetland.

Wetland management of the wetland on part Lot 8 will be addressed in the Site Fauna and Habitat Management Plan and refer to procedures for ensuring the extent of disturbance to wetland areas is kept to the absolute minimum required (Table 11), controlling surface drainage to prevent siltation during construction, and spill prevention and response procedure.

Clearing of wetland vegetation along Boonilup Road shall be minimised during the construction of the Water Transfer Pipeline by utilising existing disturbed areas within the Boonilup Road Reserve as much as practicable. The construction working width will be restricted to 15 m (rather than the required 20 m) in areas where wetlands are affected to further reduce the amount of clearing of wetland vegetation. Total clearing along the Boonilup Road section is estimated to be less than 1 ha following application of these measures (Table 11). The maximum estimated impact on each wetland affected along Boonilup Road, as a percentage of its total area, is described in Table 11. Wetland No. 1970 is the most affected with 4.2% of its total area to be cleared. In total, the clearing in the five wetlands amounts to 1.93 ha, or 0.3% of their combined area of 627.6 ha (Table 11).

Table 11 Predicted impacts to conservation significant wetlands from construction of the Water Transfer Pipeline

Wetland No.	Wetland Type	Classification	Total area of wetland (ha)	Approximate impact to wetland (% of wetland affected)
13239	Conservation Category	Estuary peripheral	481.5	1 ha (0.2%)
1655	Conservation Category	Dampland	33.6	Impact to buffer only
1819	Conservation Category	Dampland	40.2	Impact to buffer only
1903	Conservation Category	Dampland	11.6	Impact to buffer only
1919	Conservation Category	Dampland	25.5	0.16 ha (0.6%)
1971	Conservation Category	Sumpland	10.8	0.17 ha (1.6%)
1974	Conservation Category	Sumpland	7.3	Impact to buffer only
1823	Resource Enhancement	Dampland	10.0	0.3 ha (3.0%)
1970	Resource Enhancement	Sumpland	7.1	0.3 ha (4.2%)
Total			627.6	1.93 ha (0.3%)

Source: EPA 2008

In regards to potential dewatering impacts, construction works for the Boonilup Road section shall only be undertaken in the dry (Summer) months, where groundwater is naturally at its lowest, to minimise the impact of groundwater drawdown on the wetland. A Dewatering and ASS Management Plan shall be developed if dewatering is required along the Boonilup Road section of the Water Transfer Pipeline, although this is unlikely in Summer. If required, dewatering could consist of an approximately 500 m set, progressively following the construction front. Construction works will be completed at a rate of 100 m/day, meaning dewatering in any one area will be limited to approximately five to seven days duration. No measurable effect is anticipated from such dewatering on the wetlands along the pipeline route (if required) because of the temporary nature of the operation and the staged method described. The Management Plan will include the monitoring of water levels in adjacent wetlands.

In wetlands areas intercepted by the pipeline where the in-situ material is impermeable or semi-impermeable, and therefore creating natural perched conditions in the wetlands, there is a potential for creating preferential water flows along the pipeline following infill of the pipeline trench with coarse sand with higher porosity. This will be managed by the installation of 1 m clay cut-off walls placed perpendicular to the pipeline within the trench to replace the intercepted impermeable strata layer. The clay cut-off walls will be a barrier to flow along the pipeline, effectively causing the groundwater to flow through the original pre-construction pathway. The clay cut-off walls will also be installed at the boundaries of the wetlands along Boonilup Road, at the edge of irrigated agricultural paddocks, property boundaries and in steeply sloping areas. In pervious soils, the course soil used for backfill will be similar in porosity to the sand surrounds and hence not create preferential water flows and no mitigation is deemed necessary.

Rectification

The proponent will mitigate impacts to wetlands through revegetation of cleared areas along the pipeline corridor after construction.

Table 12 Environmental objectives and targets for protection and management of conservation significant wetlands during and after construction

Objective	Target
To minimise the disturbance to 'conservation category' wetlands	No additional clearing within remnant vegetation identified for retention
	No long term effect on groundwater levels in vicinity of wetlands.

Table 13 On-site management actions for protection and management of conservation significant wetlands during and after construction

Topic	Action	Timing	Responsibility
Wetland vegetation	2. Clearing procedures will ensure disturbance to the Conservation Category wetland at the RO plant site associated with the partly modified Leschenault Inlet will not exceed 1 ha.	Planning phase and during construction	Water Corporation
	3. Clearing procedures will ensure disturbance to the wetlands and their fringing vegetation along Boonilup Road will not exceed the areas as described in Table 11	Planning phase and during construction	Water Corporation
	4. The construction width for the Water Transfer Pipeline corridor shall be reduced from 20 m to 15 m in areas through affected wetlands along Boonilup Road (Table 11)	Planning phase and during construction	Water Corporation
	5. Wetland management will be addressed in the Site Fauna and Habitat Management Plan and refer to procedures for: • ensuring the extent of clearing to wetland areas is kept to the absolute minimum required • controlling of surface drainage and erosion to prevent siltation of adjacent wetland areas during construction • spill prevention and response • dewatering control; and • rehabilitating areas disturbed within the Conservation Category wetland area but not required to be kept clear following construction.	Prior to construction	Water Corporation
	6. The pipeline corridor shall be revegetated following construction with suitable wetland native species in wetland areas and upland species in wetland buffer areas affected to rectify impact on wetlands in the medium to long term.	After construction	Water Corporation
Dewatering management	7. If dewatering is required along the Boonilup Road section of the Water Transfer Pipeline, a Dewatering and ASS and Management Plan shall be developed.	Prior to construction	Water Corporation
	8. Construction works for the pipeline shall be undertaken in the dry (summer) months to reduce the potential for dewatering to be required.	During construction	Water Corporation
Groundwater flows	9. Clay cut-off walls with a width of 1 m shall be installed within the trench perpendicular to the pipeline at the boundaries of the wetlands along Boonilup Road, at the edge of irrigated agricultural paddocks, property boundaries and in steeply sloping areas.	During construction	Water Corporation

10.3 OFFSETS (OFF-SITE)

Water Corporation is investigating an off-site wetland restoration project nearby to offset the impacts of the project on wetland areas. This is being done to meet the requirements of condition 10 of Ministerial Statement 792 which states:

"10-1 The proponent shall only clear native vegetation on Part Lot 8 Taranto Road, Binningup and the Boonilup Road section of the Water Transfer Pipeline subject to the satisfactory demonstration that an 'Offset Implementation Strategy' has been prepared and is able to be implemented in accordance with condition 10-2.

10-2 The 'Offset Implementation Strategy' referred to in condition 10-1 shall detail an offset which will provide an adequate restoration of an agreed wetland in accordance with Environmental Protection Authority *Guidance Statement No.19: Environmental Offsets – Biodiversity* (September 2008) and to the satisfaction of the CEO of the DEC".

After discussions with DEC Bunbury, Benger Swamp has been recommended as a potential site for this project as its protection and enhancement is a DEC priority. A separate Offsets Implementation Strategy containing further details of this offset is being prepared and will be submitted for approval to the DEC. A brief summary is included below.

10.3.1 Benger Swamp

Benger Swamp is situated on the Swan Coastal Plain between the Darling Scarp and Wellesley River, approximately 12 km south west of Harvey. Originally it covered an area of approximately 1000 ha, but over the last 100 years, this has been reduced to approximately 580 ha by the construction of a series of drains and levees (DEWHA 2008).

The Swamp supports a diverse array of waterbirds with some of the largest populations in WA, and is a breeding site for many of these species. Fourteen of these species are listed on international migratory treaties, thirteen are listed on the Japan Australia Migratory Bird Agreement (JAMBA) and thirteen are listed on the China Australia Migratory Bird Agreement (CAMBA). It supports two internationally rare species of waterbird, including a remnant population of the Australasian Bittern (*Botaurus poiciloptilus*), declared threatened under the WA Wildlife Conservation Act 1950, Schedule 1. Benger Swamp also supports a range of wildlife in addition to birds, including the long necked tortoise (*Chelodina Oblonga*), water rat (*Hydromys chrysogaster*) and three frogs: brown tree frog (*Litoria adelaidensis*); golden bell frog (*L. moorei*); and a species of *Crinia* (DEWHA 2008).

Benger Swamp is an example of a seasonal, freshwater marsh which has been detrimentally affected by various agricultural practices and other threatening processes such as weed invasion and feral animals. It is reliant on active management to maintain its biological/ecological value (DEWHA 2008).

10.3.2 Direct offsets

The Water Corporation is working with DEC in developing the restoration project for Benger Swamp to improve its wetland values through planting of native vegetation in degraded areas of the Swamp to re-establish habitat.

10.3.3 Indirect offsets

In addition to revegetation works at Benger Swamp, the Water Corporation will ensure strategies for weed control, feral animal control, fencing and monitoring will be included as part of the Restoration Project to further enhance the conservation value of Benger Swamp. Additional research activities such as an Australasian Bittern Survey are also being investigated.

11. CONCLUSION

The major mitigation measures for the SSDP to avoid, minimise or rectify impacts on species of National Environmental Significance include:

- acquisition of Part Lot 8 for the location of the SSDP plant to avoid or reduce the clearing of significant habitat areas on Lots 32 and 33
- avoiding significant habitat and/or flora species within the Project area through changes in project design
- maintaining WRP movement corridors within the SSDP site throughout construction and operation of SSDP
- revegetating 10.7 ha of the site not required for the operation of the SSDP with local provenance species after construction
- developing a Site Habitat and Fauna Management Plan for EPBC listed species and wetland management detailing actions to be implemented to ensure impacts to are minimised during construction and operation of the SSDP
- establishing a marine exclusion zone around the construction area to ensure the absence of large marine fauna during marine construction activities

Offsets for any residual impact after implementation of the above management measures include:

- rehabilitating 10.5 ha of degraded vegetation in Lots 32 and 33 (in addition to the rehabilitation of areas cleared for construction) and revegetating 7.7 ha of berms around south-east boundary of site to improve quality of fauna habitat and ecological linkages. The revegetation will be dominated by flora species used by WRP and Carnaby's Black Cockatoo for sheltering, foraging and roosting.
- investigating opportunities to fund research programs to enhance knowledge of the WRP in the region
- commissioning Western Whale Research to conduct further research and monitoring of whale presence and movement in the region
- investigating opportunities for a Wetland Restoration Project for Benger Swamp and supporting site management.

Taking into account these measures to be implemented, the proposed SSDP is not likely to have a significant impact upon specific Matters of NES afforded protection by the EPBC Act.

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Appendix E Water Corporation Acid Sulphate Soil and Dewatering Management Strategy 2007

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Water Corporation Acid Sulfate Soil and Dewatering Management Strategy

July, 2007

Water Corporation

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Executive summary

The maintenance and installation of water supply, wastewater and drainage, and irrigation assets by the Water Corporation, by necessity, results in the disturbance of soils with the potential requirement for dewatering of the superficial aquifer water table to facilitate site works. During maintenance and development of these assets, there is a need for the Water Corporation to demonstrate the best practice acid sulfate soil and dewatering management that achieves sound environmental outcomes. This *Acid Sulfate Soil and Dewatering Management Strategy* has been prepared by Parsons Brinckerhoff, on behalf of the Water Corporation, to address the environmental management commitments that will be made by the Water Corporation to ensure that management and development of these assets do not cause any long-term environmental harm.

Water Corporation will adopt a risk-based management approach to acid sulfate soils and dewatering. The risk assessment process is depicted diagrammatically in Figure E.1. Several risk factors have been considered with regards to deriving appropriate risk-based management strategies. These include:

- PROJECT RISK - The project risk assessment considered the scope of work of the project including project duration, volume of soil disturbing activities, depth to groundwater, type and proximity of environmental receptors, and beneficial use of groundwater.

- RISK OF ACID SULFATE SOIL OCCURRENCE - The risk of acid sulfate soil occurrence considers indicative parameters including geology, site elevation, depth to groundwater, wetlands and vegetation sensitivity and WAPC ASS risk rankings, to assess the likelihood of acid sulfate soils being present in a given environment.

- RISK OF ACID GENERATION – The acid generation risk assessment is undertaken post field work to determine the likelihood of given soil types to generate acidity if disturbed. The risk assessment considers parameters such as depth of soil in the profile, soil type, pH_F and pH_{FOX} results, sulfide content, and metals concentrations.

- DEWATERING RISK – The dewatering risk assessment considers factors such as duration of dewatering, depth of drawdown and proximity to nearest receptors to determine the relative risk of dewatering activities.

The aforementioned risk assessments are used collectively to derive a MANAGEMENT LEVEL for acid sulfate soil handling and dewatering activities. The management levels adopt the following principles:

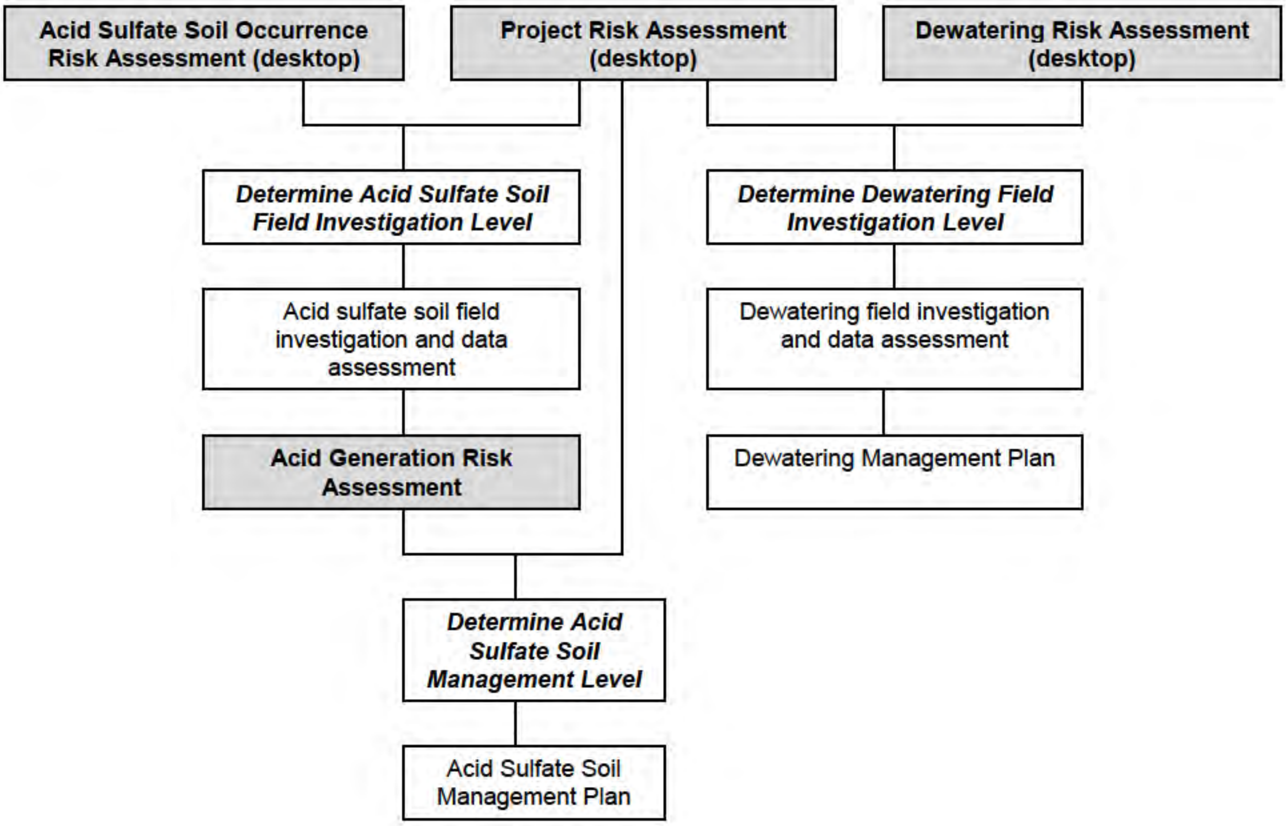
- Level 1 –- represents a low risk to the environment whereby measurable environmental impacts are unlikely. No active management practices will be adopted.

- Level 2 – represents a moderate risk to the environment in that impacts may occur but are not certain to occur. Management practices will focus on routine monitoring to identify change, and adopt active management strategies as a contingency.

- Level 3 – represents a high risk to the environment whereby impact to the environment is likely without management. Active management practices will be undertaken to ensure protection of environmental values.

This risk-based management strategy is considerate of the spirit and intent of relevant guidelines while considering the risk/cost benefit of investigation and management activities at each level of site development.

Figure E.1: Risk assessment process



1. Introduction

The maintenance and installation of assets by the Water Corporation, by necessity, results in the disturbance of soils with the potential requirement for dewatering of the superficial aquifer water table to facilitate site works. There is a need for the Water Corporation to demonstrate the best practice acid sulfate soil and dewatering management that achieves sound environmental outcomes. The Water Corporation is committed to conducting works in an environmentally responsible manner.

This document details the Water Corporation's commitments for the preparation and implementation of acid sulfate soil and/or dewatering management plans. All management plans will be prepared in accordance with the spirit and intent of relevant guidelines, with a focus on not causing any long-term, serious environmental harm.

1.1 Asset management undertaken by Water Corporation

The Water Corporation manages a variety of assets to achieve its core business of water supply and waste water disposal, namely:

- Water – collect, treat, transfer and deliver drinking quality and non-drinking-quality water.
- Wastewater and Drainage – collect, transport, treat, dispose and return wastewater and drainage water to the water cycle.
- Irrigation – bulk supplier of water for irrigation.

The following summarises the different infrastructure components that must be developed and maintained to successfully operate these systems.

1.1.1 Linear infrastructure

The water and wastewater systems that service Perth comprise thousands of kilometres of pipelines that link supply reservoirs, bores, water treatment plants and wastewater treatment plants, with approximately 600,000 connected properties. There are over 9,000 km of wastewater pipe alone.

The pipelines range in size from small drinking water delivery pipes to major sewers. They include 'normal' and pressure mains and are located at all depths from "above ground" to 10 metres below ground, and in all environments including soils adjacent to wetland systems and adjacent to Perth's river systems. Some pipes also cross river systems (or are buried below them).

1.1.2 Non-linear infrastructure

The Water Corporation has some $10 billion of infrastructure that controls the collection, treatment and transfer of water.

Non-linear infrastructure includes water treatment plants (including chlorine dosing facilities), reservoirs, dams, weirs, tanks, valve pits, dosing plants, overflow systems and ocean outfalls associated with the water supply systems.

In the wastewater treatment system, non-linear infrastructure includes:

- wastewater treatment plants, of which there are currently 3 in the metropolitan area and 92 in regional Western Australia;
- pumping stations, of which there are 550 in the metropolitan area (112 are located near rivers). Pumping stations are typically located in low-lying areas; and
- overflow storage tanks, that are typically located adjacent to pumping stations.

Perth's reticulated systems are located at topographical peaks and designed for gravity-feed where possible. In some cases reticulated systems are supported by pump stations that, by necessity, are generally located in low-lying areas.

Depending on the capacity of the system, non-linear infrastructure installations can range in size from 400 m^2 to 5,000 m^2, with earthwork activities ranging from a few weeks, on smaller projects, up to several months for larger projects. Due to the low-lying locations of many of the infrastructure components, dewatering is often required. Further, construction works are commonly undertaken in close proximity to sensitive receptors including residential water supplies, wetlands and rivers.

2. Regulatory requirements

The management of acid sulfate soils and dewatering discharge by the Water Corporation must be compliant in principle with guidelines and licencing requirements of various state regulatory organisations, as listed in the following sections.

2.1 Licences

Dewatering licences – general

Advice from the Department of Water (DoW) has indicated that the Water Corporation is not required to obtain either a Section 5C or Section 26D licence under the *Rights in Water and Irrigation Act (1914)* in regards to dewatering. The power given to the Water Corporation by Section 83(2)(b) of the *Water Agencies (Powers) Act 1984* overrides the generic requirements of Sections 5C and 26D of the *Rights in Water and Irrigation Act* and therefore the Water Corporation **is exempt** from the requirement to obtain a dewatering licence.

Swan River Trust development applications

Under Part 5 of the *Swan River Trust Act (1988)*, where dewatering associated with works is required within the Swan River Trust Act management area, the works (including dewatering) require the approval of the Swan River Trust. However, by agreement, the Water Corporation **is exempt** from submitting development applications for dewatering.

Local authority development applications

Local government authorities can require a dewatering and/or acid sulfate soil management plan as a part of their environmental management. This is more often a requirement when discharging excess dewater into the local authority controlled drainage system. The local government should be contacted prior to site works to confirm requirements.

Dewatering discharge disposal

A disposal licence is required under the *Waterways Conservation Act 1936*, if any dewatering discharge is proposed to be disposed of within any waterway covered under this Act (e.g. Peel-Harvey Estuary).

2.2 Relevant guidelines

The Water Corporation will comply with the following guidelines, or updated versions thereof, where appropriate:

- Water Quality Protection Note 13 – *Dewatering of soils at construction sites* (DoW, April 2006)
- Policy SRT/DE6 – *Dewatering* (Swan River Trust, August 2001)
- WAPC Bulletin #64 – *Acid Sulfate Soils* (WAPC, 2003)
- *Acid Sulfate Soil Guidelines Series* (DEC, 2004 – 2006)
- *Dewatering Effluent and Groundwater Monitoring Guidance for Acid Sulfate Soil Areas* (DEC, June 2006).

2.3 Agreed management approach

Notifying consultants of exemptions

The Water Corporation will ensure that relevant consultants and contractors are made aware of its exemption from requiring dewatering licences.

Management plans

Regardless of the fact that a dewatering licence is not required, there is a need for the Water Corporation to prepare and implement an acid sulfate soil and dewatering management plan for all sites that require dewatering to ensure that the environment is managed responsibly.

Management plans will be held on file at the Water Corporation for a period not less than 5 years and will be available for audit by the DEC upon request.

Notifying the Department of Environment and Conservation

Communication between the Water Corporation and DEC will be maintained to ensure the regional offices are aware of Water Corporation activities in their area:

- On high-impact projects, this will be undertaken through the formal assessment process;
- On low-impact projects, communication will be in the form of a notification letter to the relevant DEC regional manager. The letter shall include details of any proposed significant deviations from the guidelines listed in Section 2.2.

The DEC shall provide response where required within 10 working days of correspondence where they require further information. Water Corporation will assume that if a response is not received from the DEC in this timeframe that the DEC consents to the management approach.

3. Methodology for assessment

The Water Corporation will adopt a risk-based approach that is consistent with the intent of the guidelines presented in Section 2.2 to determine the level of assessment necessary prior to construction with regards to acid sulfate soils and dewatering.

All projects undertaken by the Water Corporation will document the outcomes of the project risk assessment on the *Project Acid Sulfate Soil and Dewatering Risk Assessment Form* provided in Appendix A.

3.1 Scope of project

Determination of the level of assessment to be undertaken to define acid sulfate soils and dewatering management requires a clear understanding of the scope of the project and the environmental setting in which it is located. The following aspects of project scope will need to be defined prior to site investigation:

- Proposed duration of project;
- Volume, area and depth of soil disturbance activities;
- Anticipated depth to groundwater;
- Type and proximity of sensitive environmental receptors; and
- Beneficial use of groundwater in the project area.

Once project scope factors have been defined, each factor will be assigned a risk ranking based on the likelihood for the activity to result in a measurable risk to the environment. Table 3.1 defines risk levels for each of the aforementioned project scope factors.

Table 3.1: Project scope risk assignment

Project Factors	Project Risk Level		
	LOW	**MEDIUM**	**HIGH**
Duration of Project	Less than 1 month	1-3 months	Greater than 3 months
Volume of excavation	Less than 100 m^3	100 m^3 – 1000 m^3	Greater than 1000 m^3
Depth of excavation	Less than 3 mBGL	3 – 10 mBGL	Greater than 10 mBGL
Depth to groundwater	Depth to groundwater > depth of excavation	Depth of excavation < 3 m below depth to groundwater	Depth of excavation > 3 m below depth to groundwater
Distance to Sensitive Receptors	Greater than 500 m	200 – 500 m	Less than 200 m
Sensitivity of Environmental Receptors	Unclassified water body	Multiple Use	Environmental Protection Policy or Conservation Category
Beneficial Use of Groundwater Resource	Irrigation or lower quality	Priority 3 resource	Priority 1/2 resource

The overall project scope risk will be defined by the highest factor risk assuming that two or more risk factors have been allocated that risk. Where only one risk factor defines the risk category, the project risk will be downgraded by one risk level.

For example:

- A project will be designated HIGH risk if the “duration of project” and “distance to sensitive receptors” are identified as HIGH, but all other project factors have a MEDIUM or LOW risk.
- A project will be designated MEDIUM risk if the “depth of excavation” is designated HIGH but all other project factors have a MEDIUM or LOW risk.

It is noted that in accordance with the requirements of the DEC (2006), sites where the total excavation volume is less than 100 m^3 will be considered to have NO RISK with regards to acid sulfate soils and therefore further assessment for acid sulfate soils does not need to be undertaken. However, a dewatering risk assessment will still need to be undertaken to determine the field investigation level and appropriate management strategies.

3.2 Acid sulfate soils

3.2.1 Desktop data review

Despite knowledge on the general areas characteristic of acid sulfate soils, detailed risk maps in Western Australia have not been produced for the whole state. Risk maps exist predominantly for costal areas (DEC, 2006). These risk maps provide information on the potential depth of occurrence of acid sulfate soils but do not provide information on the magnitude of the risk of acidification of soils due to their disturbance.

For sites outside the defined risk map areas, desktop assessment of regionally available information will be undertaken using key indicators of acid sulfate soils to identify the likelihood of occurrence outside the regionally mapped areas, and to confirm the risk of specific activities disturbing acid sulfate soils and shallow groundwater.

3.2.2 Data sources

Perth region

The Perth area encompasses land extending from Gingin to Dunsborough where regional acid sulfate soil mapping has been undertaken. The following data sources may be used to complete a desktop review for the Perth area:

- WAPC Bulletin 64 - South Metropolitan Region Scheme Acid Sulfate Soil Map
- Perth Metropolitan Region 1:50,000 Environmental Geology Series Maps.
- Geological Maps of Australia Series, 1: 250,000
- WRC, Perth Groundwater Atlas

Regional areas with ASS risk map

Regional areas that have had a detailed acid sulfate soil risk map produced are:

Wyndham, Dampier, Peedamulla and Mardie, Onslow, Exmouth, Coral Bay and Carnarvon, Denham, Geraldton, Gingin, Estuaries Kimberley, Mandurah, Peel, Greater Bunbury, Busselton, Dunsborough, Augusta, Walpole and Denmark, Albany – Torbay, Derby, Broome, Goldsworthy, Port Headland, Sherlock / Balla Balla / Mundabullangana, Point Samson, Wickham, Roebourne, and Karratha.

The following data sources may be used to complete a desktop review for sites that fall into the regions listed above:

- WAPC Bulletin 64 - Acid Sulfate Soil Risk Maps
- Geological Maps of Australia Series, 1: 250,000
- Department of Environment WIN Database for depth to groundwater

Regional areas without an ASS risk map

The following data sources may be used to complete a desktop review for regional areas:

- Department of Environment WIN Database for depth to groundwater
- Department of Environment Statewide River Water Quality Assessment (2004) for surface water quality.
- Shuttle Radar Topography Mission (SRTM) for Digital Elevation Model (DEM) and water bodies
- AGSO National Geoscience Dataset for regional regolith mapping
- Integrated dataset of Agricultural Land Cover Change (ALCC95), Forests of Australia 2003, 1996/97 Land Use of Australia, and the National Vegetation Information System 2000 (NVIS00) for regional vegetation cover.
- Geological Maps of Australia Series, 1: 250,000

3.2.3 Determination of risk of acid sulfate soil presence

Data from each of the aforementioned sources will be collated for each site where proposed excavation or dewatering works are planned. The potential for occurrence of acid sulfate soils at the site will be assessed through the use of key indicators such as topography, geology, wetlands, depth to groundwater, and vegetation and classified as HIGH (almost certain), MEDIUM (likely), MEDIUM-LOW (possible in isolated circumstances), and LOW (unlikely).

The following general principles (DEC, 2006) regarding the occurrence of acid sulfate soil have been used to determine a risk ranking of the key indicators, namely that acid sulfate soils can be found in:

- Areas depicted on geology and/or geomorphological maps as geologically recent (e.g. shallow tidal flats or tidal lakes, coastal alluvial valleys, wetlands, floodplains, waterlogged areas, swamps);
- Areas identified in geological descriptions or maps as bearing acid sulfide minerals, former marine or estuarine shales and sediments, recent quartz sand units, iron cemented organic rich sands (coffee rock), coal deposits, or mineral sand deposits;
- Areas known to contain peat or a build-up of organic material;
- Areas of known acidic soils with pH values ≤4.5 particularly in areas where organic matter and carbonaceous materials have depleted over time;
- Areas where the highest known watertable level is within 3 m of the surface; and
- Areas depicted in vegetation mapping as mangroves, wetland dependent vegetation (e.g. Melaleuca spp.), or salt/acid dependent vegetation (e.g. Casuarina spp.)

Table 3.2 summarises the acid sulfate soil risk classification used for the Perth region.

Table 3.3 summarises the acid sulfate soil risk classification used for the Albany-Torbay region.

Table 3.4 summarises the acid sulfate soil risk classification used for other regional areas.

It is noted that in regional areas of high surface elevation (>100m AHD), due to their geomorphological setting, risk classifications of MEDIUM or HIGH based on geological information requires supporting information from a secondary source (wetland, vegetation, water table) to be characterised as having a MEDIUM or HIGH risk of containing acid sulfate soils.

Table 3.2: Acid sulfate soil risk classification criteria – Perth region

Site Elevation	Geology	Wetland Classification	Depth to Groundwater	WAPC ASS Risk Map Ranking	Acid Sulfate Soil Risk Classification
>20 mAHD	LIMESTONE GRANITES and GNEISSES LATERITE DOLERITE CALCAREOUS SAND SAND of colluvial origin SAND derived from limestone	None	>10 mBGL	Low to No Risk	LOW
5 – 20 mAHD	SAND of eolian origin SILT of colluvium origin	Multiple Use	5-10 mBGL	Moderate to Low Risk	MEDIUM-LOW
5 – 20 mAHD	SAND of eolian origin SILT or CLAY of alluvium origin	Multiple Use	<5 mBGL	Moderate to Low Risk	MEDIUM
<5 mAHD	PEAT and PEATY SAND SILT of lacustrine origin	Resource Enhanced or Conservation Category	<5 mBGL	High Risk	HIGH

1. Based on the GSWA 1:50,000 Environmental Geology Series metropolitan maps

Table 3.3: Acid sulfate soil risk classification criteria – Albany-Torbay region

Topography	Geology[1]	Wetland Classification	Depth to Groundwater	WAPC ASS Risk Map Ranking	Acid Sulfate Soil Risk Classification
>40 mAHD	LIMESTONE GRANITES, MIGMATITES and GNEISSES SANDS and GRAVELLY SANDS of granitic origin LATERITE and LATERITIC GRAVELS SAND of alluvium origin (tertiary) SILTSTONE and SPONGOLITE Beach and dune SAND	None	>10 mBGL	Low to No Risk	LOW
5 – 40 mAHD	SAND of alluvium origin (quaternary)	Multiple Use	5-10 mBGL	Moderate to Low Risk	MEDIUM-LOW
5 – 40 mAHD	SAND of alluvium origin (quaternary)	Multiple Use	<5 mBGL	Moderate to Low Risk	MEDIUM
<5 mAHD	PEATY SAND of lake and swamp origin SANDY SILT and SILTY SAND, and CLAYEY SILT of lacustrine origin	Resource Enhanced or Conservation Category	<5 mBGL	High Risk	HIGH

1. Based on the GSWA 1:50,000 Environmental Geology Series ALBANY and TORBAY maps

Table 3.4: Acid sulfate soil risk classification criteria – Regional areas

Topography	Geology/Lithology			Vegetation, Wetlands and Water Bodies		Depth to Groundwater	Acid Sulfate Soil Risk Classification
	Regolith	Geology	Soil Types	Vegetation	Water Bodies		
>100 mAHD	MODERATELY WEATHERED BEDROCK	DURICRUST (CALCRETE/ SILICRETE/ UNDIFFERENTIATED) SEDIMENTARY ROCKS (MESOZOIC) SEDIMENTARY ROCKS (PALEOZOIC) GRANITIC ROCKS (ARCHEAN-PROTEROZOIC)	DUPLEX SOILS RED AND YELLOW EARTHS HARD SETTING LOAMY SANDS WITH RED CLAYEY SUB SOILS	NATIVE GRASSLANDS NATIVE SHRUBS AND HEATHS CROPS NATIVE FORESTS AND WOODLANDS	NONE CREEKS – fresh to brackish RIVERS – fresh to brackish WATER BODIES – fresh to brackish	>10 mBGL	LOW
20 – 50 mAHD	TERRESTRIAL SEDIMENTS ALLUVIAL SEDIMENTS AEOLIAN SANDS	QUATERNARY DEPOSITS DURICRUST (FERRUGINOUS)	EARTHY SANDS LEACHED SANDS	NATIVE GRASSLANDS NATIVE SHRUBS AND HEATHS CROPS NATIVE FORESTS AND WOODLANDS	RIVERS –saline WATER BODIES – saline	5 – 10 mBGL	MEDIUM-LOW
5 – 20 mAHD	TERRESTRIAL SEDIMENTS ALLUVIAL SEDIMENTS AEOLIAN SANDS	QUATERNARY DEPOSITS DURICRUST (FERRUGINOUS)	EARTHY SANDS LEACHED SANDS	MALALEUCAS, EUCALYTUS	SEASONAL WETLANDS	<5 mBGL	MEDIUM
<5 mAHD	LACUSTRINE SEDIMENTS	QUATERNARY DEPOSITS in low-lying, wetland areas	LEACHED SANDS in low lying areas. CRACKING CLAYS, UNDERLAIN IN AREAS BY HARD PAN AREAS	MALALEUCAS, EUCALYTUS	WETLANDS	<5 mBGL	HIGH

3.2.4 Field investigation

Field investigations will be undertaken prior to the commencement of earthworks with sufficient time to enable laboratory results to be provided and assessment of suitable management strategies to be made.

The intensity of the field investigation undertaken will be commensurate with the risk of the project to cause environmental harm (as determined in Table 3.1) and the likelihood of acid sulfate soils occurrence (as determined in Tables 3.2 – 3.4). The field investigation level can be determined by completing the *Project Acid Sulfate Soil and Dewatering Assessment Form* provided in Appendix A. The field approach detailed below will be adopted as a minimum but higher order action will be considered if there is insufficient information to fully characterise potential acid generating soils. Table 3.5 presents the risk matrix for determining the acid sulfate soil field investigation level.

Table 3.5: Field investigation level risk matrix

Acid Sulfate Soil Risk	Project Scope Risk		
	LOW	MEDIUM	HIGH
LOW	Level 1	Level 1	Level 2
MEDIUM-LOW	Level 1	Level 2	Level 3
MEDIUM	Level 2	Level 3	Level 4
HIGH	Level 3	Level 4	Level 4

Level 1 investigation

The Level 1 investigation level relates to those scenarios where acid sulfate soils are not expected to be present, and if present their disturbance is unlikely to pose a risk to the environment due to the low volume of material to be excavated, short exposure times, and/or a lack of interaction of the soils with groundwater.

Standard geotechnical investigation and site walkover will be undertaken prior to site development. If the results of the geotechnical investigation indicate a deviation to the preliminary project risk assessment, the desktop risk assessment will be amended based on the new information and the need for acid sulfate soil investigation will be reassessed.

Level 2 investigation

The Level 2 investigation level relates to those scenarios where acid sulfate soils may be present but if present are unlikely to pose a risk to the environment due to the low volume of material to be excavated, short exposure times, and/or a lack of interaction of the soils with groundwater. These scenarios may also relate to sites proximal to environmental receptors where a degree of caution is warranted to ensure environmental values are protected.

Standard geotechnical investigation and site walkover will be undertaken prior to site development. In addition the follow acid sulfate soils screening investigation will be undertaken:

- Field analysis of pH_F and pH_{FOX} (pH after oxidation) will be undertaken in each bore from each lithology, or at 1 m intervals, whichever is greater.
- For those samples where pH_F is less than 3.5 or pH_{FOX} less than 3, laboratory analysis using Chromium Reducible Sulfur Suite (S_{CR}) or SPOCAS will be undertaken.

Level 3 investigation

The Level 3 investigation level relates to those scenarios where acid sulfate soils are likely to be present and may be present below the water table. Due to the nature of the acid sulfate soils (e.g. high risk in environmentally sensitive areas) and/or potential for occurrence below the water table, responsible management of acid sulfate soils will be required. Acid sulfate soils likely to be encountered in these scenarios are strongly lithologically controlled and dependent on groundwater levels. Consequently therefore development of a suitable management strategy is reliant on lithological and hydrologically considerate soil delineation.

In addition to the standard geotechnical investigation, the following acid sulfate soil investigation will be undertaken:

Linear infrastructure

- Soil boreholes will be drilled at a frequency of 1 per 200 m to 1 per 500 m, or a minimum of 2 boreholes per excavation length for excavations less than 500 m.

Non-linear infrastructure

- Soil boreholes will be installed at a frequency of 4 soil boreholes per excavation or at a frequency of 4 boreholes for the first hectare and 2 boreholes per hectare for each subsequent hectare (for developments less than 10 Ha). Boreholes will be installed to a depth of 2 m below the depth of the excavation (to account for potential dewatering drawdowns).

Field analysis

Field analysis of pH_F and pH_{FOX} (pH after oxidation) will be undertaken in each borehole:

- from each lithology above the water table, or at 1 m intervals, whichever is greater;
- at 0.5 m intervals though the zone of water table fluctuation (nominally 1 m above and below the current water table); and
- from each lithology below the water table, or at 1 m intervals, whichever is greater.

Laboratory analysis

Laboratory analysis using Chromium Reducible Sulfur Suite (S_{CR}) or SPOCAS will be undertaken for:

- the highest risk soil sample from each soil bore based on pH_F/pH_{FOX} results;
- 1 in every 10 bores, or one bore per site, whichever is greater at 0.5 m intervals through the soil profile; and
- at least two samples from each lithology, for continuous soil lithologies greater than 0.5 m thick.

In addition, select samples will be analysed for metals (Al, As, Cd, Cr, Fe, Pb, Mo, Ni, Se, and Zn) to assist in determining risk of metals mobilisation to groundwater and suitable options for material disposal if required.

Level 4 investigation

The Level 4 investigation level relates to those scenarios where acid sulfate soils are likely to be present both above and below the water table and occurs in environments recognised as having a high acid generating potential. Due to the tendency for these environments to occur in close proximity of sensitive environmental receptors, close management of acid sulfate soils will be necessary to ensure that harm to the environment does not occur. To facilitate the development of appropriate management strategies, a detailed acid sulfate soil investigation will be undertaken.

In addition to the standard geotechnical investigation, the following acid sulfate soil investigation will be undertaken:

Linear infrastructure

- Soil boreholes will be drilled at a frequency of 1 per 100 m or a minimum of 2 per excavation length for excavations less than 200 m.
- This grid may be tightened where warranted (e.g. – proximal to sensitive receptors, in areas of variable acid generating potential or complex geology) to ensure complete characterisation of the soil profile is achieved.

Non-linear infrastructure

- Soil boreholes will be installed at a frequency of 4 per excavation to a depth of at least 2 m below the depth of the excavation (to account for potential dewatering drawdowns).

Field analysis

Field analysis of pH_F and pH_{FOX} (pH after oxidation) will be undertaken in each bore:

- at 0.5 m intervals through the soil profile; and
- from each lithology in the soil bores.

Laboratory analysis

Laboratory analysis using Chromium Reducible Sulfur Suite (S_{CR}) or SPOCAS will be undertaken for:

- the highest risk soil sample from each bore and 1 in every 5 bores at 0.5 m intervals through the bore profile for linear infrastructure greater than 500 m;
- at 0.5 m intervals through the soil profile for non-linear excavations and linear excavations less than 500 m;
- from each lithology in the soil profile.

In addition, select samples will be analysed for metals (Al, As, Cd, Cr, Fe, Pb, Mo, Ni, Se, and Zn) to assist in determining risk of metals mobilisation to groundwater and suitable options for material disposal if required.

3.2.5 Determination of risk of acid generation

The determination of risk for acid generation for soil types present at the site can be determined after the field investigation (including field and/or laboratory analysis) has been completed. The actual risk for acid generation to occur as a result of soil disturbance, regardless of the nature of the project, is dependent on several factors including:

- soil type
- depth of soil in the profile;
- volume of soil to be excavated;
- pH_F and pH_{FOX};
- sulfide content in the soil; and
- metals content in the soil.

Table 3.6 summarises the risks of acid generation associated with each of these soil parameters. The acid generation risk assessment will be considered for each soil type in conjunction with the project risk to define a suitable management strategy as discussed in Section 4.1.

Table 3.6 applies to soils that exceed the DEC action criteria for sulfide content (0.03%S or 18 mol H^+/tonne) only (DEC, 2006). Those soils with sulfide content less than the action criteria will be considered NO risk, regardless of their other soil parameters, and will therefore not require any special management during the construction stage.

Table 3.6: Acid generation risk assessment

Soil parameter	Acid generation risk		
	LOW	MEDIUM	HIGH
Depth in the soil profile	Upper 3 m of the soil profile	3 mBGL to the water table	Soils collected from below the water table
Volume of soil to be excavated	Less than 100 m^3	100 – 1000 m^3	Greater than 1000 m^3
Field pH indicators[1]	$pH_F>5$ $pH_{FOX}>4$	$4<pH_F<5$ $3<pH_{FOX}<4$	$pH_F<4$ $pH_{FOX}<3$
Soil type and sulfide content[2]	Medium to heavy clays and silty clays with <0.1%S OR Sandy loams/peat to light clays and cemented gravels < 0.07%S	Medium to heavy clays and silty clays with >0.1%S OR Sandy loams/peat to light clays and cemented gravels 0.07%S – 0.1%S OR Sands to loamy sands <0.07%S	Sandy loams/peat to light clays and cemented gravels >0.1%S OR Sands to loamy sands >0.07%S
Metals concentrations	[Metals] < EILs[3] [Fe] approx < 100 mg/kg [Al] approx < 100 mg/kg	HIL[4]>[Metals] > EILs 1000 >[Fe] < 100 mg/kg 1000 >[Al] < 100 mg/kg	[Metals] > HIL [Fe] approx > 1000 mg/kg [Al] approx > 1000 mg/kg

1. Based on the mean of all pH_F and pH_{FOX} values taken for the soil type.
2. Sulfide content will be defined by the maximum sulfide content measured for that soil type.
3. EIL – ecological investigation levels (DEC, 2003)
4. HIL – health investigation level for applicable landuse (DEC, 2003)

The risk of acid generation for all soils that exceed the action criteria will be defined by:

- The highest criteria in each of the soil parameter categories will define the risk level for that category;
- The acid sulfate soil risk will be defined by the highest soil parameter risk assuming that two or more risk factors have been allocated that risk. Where only one risk factor defines the risk category, the project risk will be downgraded by one risk level. For example:
  - The soil type will be designated HIGH risk if the “soil type/sulfide content” and “volume of soil to be excavated” are identified as HIGH, but all other soil parameters have a MEDIUM or LOW risk.
  - The soil type will be designated MEDIUM risk if the “soil type/sulfide content” is designated HIGH but all other soil parameters have a MEDIUM or LOW risk.
- Metals concentrations will only be considered for MEDIUM and HIGH field pH indicators and soil type/sulfide content categories. In this case, the higher of the risk rankings will apply. For example:
  - if a soil is ranked as having a MEDIUM risk of Field pH indicators or Soiltype/sulfide content but metals concentrations are ranked as HIGH, the acid generating potential of the soil will be considered HIGH).

3.3 Dewatering

To ensure suitable risk assessment and management of dewatering activities, pre-construction dewatering investigations and predictions of drawdown impacts should be undertaken. The aims of the dewatering investigations are to:

- Determine the likely quality of dewatering discharge
- Determine the appropriate dewatering and disposal method
- Enable prediction of dewatering quantities
- Enable predictions of the extent of drawdown (cone of depression)

3.3.1 Field investigation

The complexity of the field investigation for dewatering purposes will be related to the risk of the dewatering activities to cause environmental harm. Risk will be characterised on the following factors:

- Duration of dewatering;
- Proximity of dewatering to sensitive receptors; and
- Potential for oxidation of acid sulfate soils.

Table 3.7 summarises the risk ranking for each of these environments.

Table 3.7: Dewatering risk matrix

Dewatering Factor	Dewatering Risk Ranking		
	LOW	**MEDIUM**	**HIGH**
Duration	Less than 1 month	1 – 3 months	> 3 months
Proximity to sensitive receptors	Greater than 500 m	200 – 500 m	<200 m
Acid sulfate soil environment[1]	LOW or MEDIUM-LOW ASS risk	MEDIUM ASS risk	HIGH ASS risk

1. Based on the acid sulfate soil risk defined by Tables 3.2 – 3.4.

The level of field investigation for dewatering will be based on the highest risk component as determined in Table 3.7. Table 3.8 defines the minimum dewatering field investigation for each risk level.

Table 3.8: Dewatering investigation program matrix

Risk Level	Dewatering investigation program
LOW	▪ Determination of soil types during geotechnical investigation ▪ Determination of water table level from soil bore installations ▪ Collection of a groundwater sample from soil bores (no dedicated groundwater monitor bore) and analysis for a suitable suite of analytes ▪ Estimation of hydraulic parameters of the aquifer through review of published information
MEDIUM	▪ Determination of soil types during geotechnical investigation ▪ Installation of 1-2 temporary groundwater monitor wells down-hydraulic gradient of the excavation and/or between the excavation and the receptor where the risk ranking has been defined due to receptor proximity ▪ Determination of water table level from the soil bore and monitor well installation ▪ Collection of a groundwater sample from the monitor well and analysis for the acid sulfate soil groundwater suite[1] and other relevant water quality parameters ▪ Estimation of hydraulic parameters of the aquifer through review of published information
HIGH	▪ Determination of soil types during geotechnical investigation ▪ Installation of a suitable number of groundwater monitor wells around the excavation ▪ Determination of hydraulic parameters (permeability, storage, transmissivity) of the soils through pump testing ▪ Monitoring of groundwater levels from the groundwater monitor bores (seasonal levels if lead time permits) ▪ Collection of groundwater samples from the monitor wells and analysis for the acid sulfate soil groundwater suite[1] and other relevant parameters ▪ Collection of water quality samples from nearby sensitive receptors if relevant.

1. pH, EC, TDS, TDS, DO, redox, total acidity, total a kalinity, sulfate, chloride, total Al and Fe, dissolved Al, As, Cr, Cd, Fe, Mn, Ni, Se, Zn, ammoniacal nitrogen, hydrogen sulfide, total N, total P, filterable reactive P (FRP)

3.3.2 Modelling of dewatering requirements

In all dewatering cases modelling of the impacts of dewatering will be undertaken by a qualified hydrogeologist to predict the volume of water to be extracted and the groundwater drawdown radius.

The complexity of the model, and parameters modelled, will be considerate of the risk associated with dewatering activities, as summarised in Table 3.9.

Table 3.9: Modelling requirements

Dewatering Risk Level	Model requirements
LOW	▪ Maximum drawdown cone estimated using published tables for common soil types ▪ Calculation of dewatering volumes and rates
MEDIUM	▪ Maximum drawdown cone estimated using recognised methods (Theis, Sichardt, etc) ▪ Calculation of dewatering volumes and rates ▪ Calculation of aquifer recharge rates
HIGH	▪ Modelling of drawdown cone over time based on site-specific aquifer properties ▪ Calculation of dewatering volumes and rates ▪ Modelling of aquifer recharge rates and impacts over time ▪ Prediction of settlement impacts due to dewatering

4. Acid sulfate soil and dewatering management

Appropriate management of acid sulfate soils and dewatering activities will be undertaken to ensure that there are no long-term adverse impact to the environment. The degree of management undertaken by the Water Corporation and their contractors during construction works will be commensurate with the potential for immediate risk to the environment.

4.1 Acid sulfate soils

The management principles adopted by Water Corporation in their handling of acid sulfate soils will be considerate of the risk of acid sulfate soils causing harm to the environment based on the risk of acid generation as determined through field and laboratory testing (as determined in Table 3.6) and project risk (as determined in Table 3.1). Table 4.1 summarises the risk management levels that will be adopted.

Table 4.1: Management level – risk matrix

Acid Generation Risk Level	Project Risk Level		
	LOW	MEDIUM	HIGH
LOW	Level 1	Level 1	Level 2
MEDIUM	Level 1	Level 2	Level 3
HIGH	Level 2	Level 3	Level 3

A **LEVEL 1** management ranking represents those earthworks scenarios where acid sulfate soils are absent or are present in low concentrations above the water table or where earthworks activities are sufficiently short term to minimise the opportunity for oxidation of acid sulfate soils. As a result, disturbance of these materials is unlikely to result in any environmental impacts that would not naturally occur in the environment. Due to the low level of risk, no active acid sulfate soil management will be undertaken for those sites with a Level 1 management ranking.

A **LEVEL 2** management ranking represents those earthworks scenarios where acid sulfate soils are likely to be present in with a moderate acid generating potential or with a high acid generating potential but in low volumes. Management of these soils will adopt a monitor and react strategy if signs of oxidation occur.

A **LEVEL 3** management ranking represents those earthwork scenarios where acid sulfate soils are likely to be present in abundance and have a high likelihood of generating acidity during the period of earthworks. Active management of these soils will be undertaken based on the assumption that oxidation of the soils will occur during the course of the earthworks.

The following sections describe the minimum management strategies, and the management principles that will be adopted by the Water Corporation for the management of acid sulfate soils.

4.1.1 Excavation management

Table 4.2 summarises the excavation management practices that will be followed for each of the management levels to minimise the risk of oxidation of acid sulfate soils due to construction activities.

Table 4.2: Excavation management practices

Management Level	Linear Infrastructure	Non-linear Infrastructure
Level 1	▪ Standard construction management practices to be adopted. No specific acid sulfate soil considerations required.	▪ Standard construction management practices to be adopted. No specific acid sulfate soil considerations required.
Level 2	▪ Where possible, trench segments will be excavated in lengths that permit the opening and closing of the trench within 48 hours. ▪ Where in-situ PASS is exposed for a period exceeding 5 days, neutralisation of the sides and base of the excavation will be undertaken prior to backfilling.	▪ Where in-situ PASS is exposed for a period exceeding 5 days, neutralisation of the sides and base of the excavation will be undertaken prior to backfilling.
Level 3	▪ Implementation of alternate construction methods (e.g. horizontal directional drilling (HDD)) will be considered. ▪ Where soils must be disturbed, trench segments will be excavated in the shortest practicable lengths. ▪ Where in-situ PASS is left exposed, neutralisation of the sides and base of the excavation (e.g. barriers of high grade aglime, spraying with liquid neutralising agents) will be undertaken routinely as appropriate throughout the duration of the exposure.	▪ Implementation of construction methods that exclude the availability of oxygen (e.g. sheet-piling) will be considered. ▪ Where in-situ PASS is left exposed, neutralisation of the sides and base of the excavation (e.g. barriers of high grade aglime, spraying with liquid neutralising agents) will be undertaken routinely as appropriate throughout the duration of the exposure.

4.1.2 Soil stockpiling and neutralisation

Soil neutralisation may be required for soils identified as potentially acid generating during the pre-construction field investigations (i.e. those soil types identified in Table 3.6 as having a MEDIUM or HIGH sulfide content). Table 4.3 summarises the practices that will be adopted for stockpiling and treatment (neutralisation) of soils for each of the management levels. The requirement for stockpiling and neutralisation will be dependent on the risk management level for the soil type and the duration of stockpiling.

Table 4.3: Management of soil stockpiles

Management Level	Short-term stockpiles (less than 5 days)	Medium-term stockpiles (5 days to 1 month)	Long-term stockpiles (greater than 1 month)
Level 1	Untreated soils will be stockpiled direct to ground	Untreated soils will be stockpiled direct to ground	Untreated soils will be stockpiled direct to ground
Level 2	Untreated soils will be stockpiled direct to ground	Untreated soils will be stockpiled on a containment pad	Untreated soils will be stockpiled on a containment pad
Level 3	Untreated soils will be stockpiled on a containment pad	Treated soils will be stockpiled on a containment pad	Treated soils will be stockpiled on a containment pad

Stockpile construction

Stockpile construction will adhere to the following principles:

- Where practicable (i.e. – adequate space is available) soil types with different acid generating capacities will be stockpiled separately and managed according to their individual risk level.
- Soils will be stockpiled as far away from environmental receptors and drains as practicable to minimise potential for mobilisation of the soils, and impacts from the soils into these waterways.
- The amount of neutralising agent will be based on 0.2 times the maximum acidity for every metre depth of the soil to be treated. The amount of neutralising agent required for the containment pad will be calculated using the *Containment Pad Calculation Worksheet* provided in Appendix B.
- Where the acid generating potential of the soils is not known, the containment pad will be constructed of a guard layer of crushed, compacted limestone or equivalent neutralising agent to a minimum thickness of 300 mm.
- The stockpile containment will be constructed so that all leachate and run-off is collected and the ingress of surface water is prevented. This may necessitate the construction of containment bunds and diversion banks. The containment bunds/diversion banks will be constructed on non-acid-generating, low-permeability soils.
- The stockpile containment unit will be constructed so that all leachate and run-off can infiltrate through the neutralising guard layer. Where infiltration to ground is impracticable, leachate and run-off will be diverted to a containment pond and tested for water quality and need for treatment prior to disposal to the environment.
- The surface area of the stockpile will be minimised to reduce the extent of material exposed to atmospheric oxygen. This may involve:
  - Shaping the stockpile and/or capping or lining it with a material that will minimise drying by wind and sun and prevent the ingress of rainfall. This management practice will apply to soils collected from above the water table;
  - Spraying the surface of the stockpile to keep it moist using iron-free water or neutralising solution. The spray will need to be carefully managed to prevent over-wetting of the stockpile material and should comprise a fine mist to prevent desegregation of the soil from the stockpile surface. This management practice will be suitable for soils collected from below the water table.

Neutralisation agent

Aglime or lime sands are the preferred neutralising materials for the treatment of acid sulfate soils. Neutralising materials obtained for use by the site will be accompanied by information pertaining to its effective neutralising value (ENV), which is a measure of the soils neutralising capacity in consideration of particle size distribution of the neutralising material.

Where ENV information is not provided by the supplier, Calcium Carbonate Equivalence by a NATA accredited laboratory to determine the neutralising value (NV) of the material and particle size distribution (PSD) will be determined. (The calcium carbonate equivalence method is applicable for calcium carbonate only and cannot be used for determination of NV for calcium oxides or calcium hydroxides). The number of samples to be laboratory tested will be consistent with the DoE *Guidelines for Acceptance of Solid Waste to Landfill* (2001). The NV used for calculating the neutralisation material dosing ratio for the treatment of soils is based on the average NV value obtained from the laboratory analysis. The calculation for ENV will be determined using the *ENV Calculation Worksheet* provided in Appendix C.

Other neutralising agent such as magnesite, dolomite, sodium bicarbonate, soda ash, hydrated lime/slaked lime, or quicklime may be considered. Use of alternative neutralising agents will need to be justified based on consideration of NV and ENV, solubility, pH, chemical constituents and impurities, moisture content and method of application.

Methods of neutralisation

The method of neutralisation will adhere to the following principles:

- **Where untreated soils have been stockpiled** on a containment pad, soil neutralisation will occur at the time of backfilling by backfilling the excavation with both the untreated soils and the neutralising agent present in the pad. Approximate mixing of the acid generating soils and the neutralising agent during backfilling will occur by vertically “cutting back” the stockpile and “raking in” the neutralising agent within the excavation.
- **Where treated soils are to be stockpiled** on a containment pad, the excavated material will be neutralised using a suitable neutralising agent. The amount of neutralising agent required will be based on the highest percent sulfur concentration for that soil type and will be calculated using the *Neutralising Agent Calculation Worksheet* provided in Appendix D.
- Neutralisation will be undertaken by mechanical application on the containment pad to achieve uniform blending of the neutralising material and the acid generating soils.
- Where excavation works are undertaken in areas of limited space, alternative neutralisation options, such as treatment of soil within a neutralisation unit, off-site neutralisation, in-situ injection of the neutralising agent prior to excavation, or injection of neutralising agent into stockpiles will be considered.

The method of neutralisation will need to be considerate of the soil type to be neutralised. In particular:

- Uniform blending of sands and sandy silts can typically be accomplished using mechanical tilling or “bucket blending” methods;
- Uniform blending of peats, silts and clays is usually difficult to achieve using standard earthworking equipment. These materials are generally more suitable for off-site disposal. If treated on-site the treatment method will need to include crushing or fragmenting of the soil (whilst minimising oxygen exposure) prior to treatment.

4.1.3 Disposal

Soils that are unsuitable for reuse at the site for geotechnical purposes will be disposed off-site to a suitable facility, as is appropriate for the project. The options for disposal in order of preference are:

- Untreated to a treatment facility capable of undertaking the required soil treatment and disposal;
- Untreated to a Class 2 landfill facility, in accordance with the specific requirements of the designated facility;
- Treated and validated in accordance with the requirements of Section 3.1.3 after which soil will be considered inert and may be disposed as day cover to a Class 1 landfill or reused for alternative purposes (e.g. landscaping).

4.1.4 Validation and performance criteria

The following validation and monitoring will be undertaken:

Linear infrastructure

- **Untreated soils** will be checked daily for visual signs of acid generation (e.g. – formation of jarosite or iron oxides). Representative soil samples will be collected daily from the surface of the stockpile (minimum 2 samples per stockpile face) and tested for pH_F.
- **Treated soils** will be sampled at a rate of 1 sample/50 m^3 soil and tested for pH_F and pH_{FOX} following treatment to validate the effectiveness of the neutralisation process. When pH_F and pH_{FOX} is found to be within the performance criteria (Table 4.4), soils will be considered suitable for backfill into the trench.
- **Leachate and run-off** from the stockpiles will be field tested for pH, EC, temperature and total acidity prior to release to the environment, to determine if neutralisation is necessary.

Non-linear infrastructure

- **Untreated soils** that are identified as potentially acid generating will be checked daily for visual signs of acid generation (e.g. – formation of jarosite or iron oxides). Representative soil samples will be collected twice weekly from the surface of the stockpile (minimum 2 samples per stockpile face) and tested for pH_F.
- **Treated soils** will be sampled at a rate of 1 sample/50 m^3 soil and tested for pH_F and pH_{FOX} following treatment to validate the effectiveness of the neutralisation process. When pH_F and pH_{FOX} are found to be within the performance criteria, and soils are expected to be stockpiled for longer than two weeks, 1:10 field samples will be sent to the laboratory for confirmatory analysis by SPOCAS or the S_{CR} Suite, prior to use as backfill. When the soil will be reused within two weeks, field results will be used as the basis for confirming neutralisation.

Performance criteria

Table 4.4 summarises the performance criteria to be adopted for the stockpiles during the monitoring programme.

Table 4.4: Stockpile performance criteria

Medium	Acceptable Threshold
Untreated soils	$pH_F > 4$
Treated soil	$pH_F > 6.5$ $pH_{FOX} > 6.5$ TPA[1]+TAA[2] <18 mol H^+/tonne
Leachate and run-off	8.5>pH>6.5 TTA[3] < 40 mg/L

1. TPA – Titratable Peroxide Acidity
2. TAA – Titratable Actual Acidity
3. TTA – Total Titratable Acidity

4.1.5 Contingency plans

Contingency plans will be developed on a site-specific basis to address actions to be undertaken where performance criteria are not met. Contingency plans will consider, but not be limited to, implementation of the following:

- If due to unforseen circumstances, the duration of the earthworks activities is extended, a reassessment of the management strategies will be undertaken and implementation of a higher level of soil management will be adopted if warranted.
- If any soils are encountered during excavation works that are not representative of the soils previously identified, these soils will be treated in accordance with the procedures adopted for the highest risk soil previously identified at the site.
- If the aforementioned stockpile performance criteria are exceeded, the following points will be implemented:
    - If pH_F results of the untreated soils are outside the acceptable thresholds, the soil stockpile will be covered with a guard layer of neutralising agent or irrigated with a liquid neutralising agent.
    - If pH_F and pH_{FOX} results of treated soil validation samples are outside the acceptable thresholds, further lime treatment of soils will be undertaken prior use as backfill (linear infrastructure) or submission of samples to the laboratory (non-linear infrastructure);
    - If laboratory analysis of treated stockpile soils (non-linear infrastructure) are outside of the TPA+TAA criteria, further lime treatment of soils will be undertaken prior to re-use on-site or soils will be disposed to an appropriate off-site facility; and
    - If leachate and run-off exceed the performance criteria, neutralisation of the leachate and run-off to achieve the performance criteria will be undertaken prior to release to the environment.

4.2 Dewatering

4.2.1 Dewatering method

The aim of the preferred dewatering method should be to minimise the radius of influence of the cone of depression. Any dewatering activity should strive to minimise impacts to surrounding water bore users and sensitive surface water receptors. Common options for dewatering methods include:

- SUMP PUMPS: Sump pumping is the simplest method of dewatering excavations. Sumps are usually sited at the lowest point of the excavation and made big enough to hold sufficient water for pumping and to keep the floor of the excavation dry. A pump is provided for each sump and connected to a discharge pipe. Sump pumps are generally suitable for low-flow, short-term dewatering with small dewatering volumes
- WELL-POINT SYSTEMS: Well-point systems comprise a series of closely spaced wells connected to a header-pipe and usually pumped by a collective suction lift pump. Dewatering using well-points is generally suitable for low to moderate flow, medium-term dewatering. Some continuity of the permeability is required for maximum effectiveness, although this can be mitigated by varying the spacing and vertical distribution of the wells.
- POSITIVE CUT OFF (e.g. SHEET PILING): Sheet piling involves the installation of impermeable steel walls around the edge of the excavation to limit groundwater influx. Sheet piling will generally be necessary for deep excavations with significant drawdown of the water table to limit the cone of depression of the dewatering activities. Sheet piling is often used in combination with well-point systems to stabilise pressures around the excavations.

Other water exclusion methods such as soil refrigeration and impervious soil barriers can be considered where standard methods are deemed unsuitable.

4.2.2 Dewatering discharge treatment

Dewatering discharge may require treatment to ensure that it does not have any adverse impact to receiving water bodies. Treatment may include but is not limited to sediment filtration or settlement, neutralisation, and/or contaminant removal. The need for dewatering discharge treatment is determined through monitoring of the dewatering discharge, groundwater and/or surface waters in the area as described in Section 4.2.4.

It is noted that treatment of groundwater in all environments to near neutral pH (6.5 to 8.5) is generally required by the DEC to ensure future mobilisation of metals in the soil profile is not promoted. Table 4.5 summarises some of the key treatment methods and the groundwater quality indicators that should trigger treatment methods.

Table 4.5: Dewatering discharge treatment options

Water Quality Trigger	Treatment Method
pH < 5.0	Neutralisation treatment using calcite pellets. Lime sands, or hydrated lime, as appropriate for the project.
pH of dewatering discharge more than 1 pH unit less than pH of receiving water body	pH adjustment (e.g. neutralisation)
Total Titratable Acidity > 40 mg/L	Neutralisation treatment and aeration and settlement to precipitate dissolved metals
Total Suspended Solids – visible	Sediment filtration through geofabric or hay-bales if discharging to an open water body. No treatment required if reinfiltrating through an infiltration basin because the aquifer will work as a sediment filtration system
Metals/toxicants concentration in dewatering discharge could result in an increase of the seasonal background concentration of the receiving body by	Suitable toxicant filtration/flocculation method to be employed.

Water Quality Trigger	Treatment Method
>10%	
Nutrient concentrations in dewatering discharge could result in an increase of the seasonal background concentration of the receiving body by >10%	Nutrient-stripping containment basin (aerobic/anaerobic “wetland”)

4.2.3 Dewatering discharge disposal

Options of discharging excess water should be considered in the following order of priority:

- DUST SUPPRESSION: Dewatering discharge should in the first instance be used for dust suppression during construction works. As dewatering discharge volumes will generally exceed dust suppression requirements, additional discharge disposal methods will typically need to be employed.
- INFILTRATION SYSTEM: This is the preferred option as it recharges the water into the environment from which it has been removed. Its effectiveness is limited by the hydraulic properties of the soil strata to which the water is discharged (hydraulic conductivity, depth to groundwater table). Infiltration systems must generally include installation of an infiltration basin to prevent flooding of the surrounding environment, although in some select environments discharge to ground may be considered acceptable. This option will require monitoring of the water quality to ensure reinfiltrated discharge does not degrade the water quality of the receiving environment.
- DRAINAGE SYSTEM: This method may be considered where dewatering discharge volumes are high and space available for reinfiltration is limited. Employment of a drainage system is generally limited by the hydraulic capacity of the drainage system. This option will require monitoring of the water quality to ensure reinfiltrated discharge does not degrade the water quality of the receiving environment.
- SURFACE WATER BODIES: Discharge to surface water bodies must be undertaken in a manner that ensures no loss of amenity (odour or visual impacts), or change to the water quality in the receptors to ensure that the ecosystem of the receiving water body is sustained. Most surface water bodies have a high social significance and discharge to significant lakes and wetlands is typically controlled through regulatory licences. Prior to discharges going into these environments the Water Corporation Environment Branch must be contacted, all appropriate stakeholders notified, and applicable discharge licences obtained. Appropriate standards will be determined on a case by case basis in accordance with regulatory environmental guidelines.
- SEWER: Disposing of excess dewatering discharge to sewer is generally the last option. Both the Water Corporation Region and Industrial Waste Branch must be contacted for relevant guidelines. The region determines the hydraulic capacity of the system while the Industrial Waste Branch deals with water quality. Discharge to sewer generally also requires a Licence to Discharge from the Department of Water.

4.2.4 Monitoring and performance criteria

Where dewatering occurs in the presence of acid sulfate soils or where discharge is to occur to an environmentally sensitive environment, a combination of dewatering discharge, surface and or groundwater monitoring will be undertaken to ensure that long-term environmental harm does not occur in the receiving environment.

Dewatering discharge monitoring

Monitoring of dewatering discharge will occur when dewatering activities are expected to exceed one week (7 days) in a given area, when groundwater treatment systems are employed, or at sites where the cone of depression is predicted to extend to within 200 m of an environmentally sensitive area.

Where treatment of dewatering discharge occurs, monitoring of the water quality will occur both before and after any treatment process. Table 4.6 summarises the minimum monitoring to be undertaken by the dewatering contractor and acceptable performance criteria for the dewatering discharge (pre-treatment). Where dewatering discharge exceeds the performance criteria (pre- or post-treatment), it is an indication that treatment of the discharge is necessary prior to discharge to the environment.

Table 4.6: Dewatering discharge monitoring

Analyte	Frequency	Acceptable Performance Criteria
Acid Sulfate Soil Environments		
Field pH, EC, Total Titratable Acidity (TTA)	Daily for the duration of dewatering.	Pre-treatment pH > 5.5 Post-treatment pH between 6.5 – 8.5 EC within 10% of receiving environment TTA < 40 mg/L
Field Fe^{2+}, Fe^{3+}	Weekly	Fe^{2+} < 10 x applicable guidelines for the receiving environment Fe^{3+} stable
Laboratory pH, EC, TTA	Fortnightly	Laboratory results within 0.5 pH units and EC and TA within 20% of field values
Other Environments		
Visual water clarity where discharge to a surface water body occurs	Daily	Visual Water Clarity is “Clear”
TSS and TDS where discharge to a surface water body occurs	Weekly	TSS and TDS < 10% greater than the seasonal background of the receiving environment
Toxicants and nutrients	Twice-weekly	Performance criteria to be established on a site specific basis based on predicted loading to the receiving environment.

Groundwater and/or surface water monitoring

In addition to dewatering discharge monitoring, monitoring of suitable groundwater and/or surface water sites (e.g. at and along the pathway to the receptor) will be undertaken for dewatering activities with a duration greater than 4 weeks or at sites where the cone of depression is predicted to extend to within 200 m of an environmentally sensitive area.

Table 4.7 summarises the minimum frequency of monitoring to be undertaken by a suitably qualified site supervisor and acceptable performance criteria. These criteria may be modified in consideration of site-specific criteria as considered appropriate.

Table 4.7: Groundwater and/or surface water monitoring

Analyte	Frequency	Acceptable Performance Criteria
All environments		
Water Levels	Twice-weekly during dewatering	Performance criteria to be established on a site-by-site basis to ensure drawdown does not adversely impact surrounding bore users or environmental receptors
Water Levels	Weekly to fortnightly post-dewatering	Monitoring to continue until water levels reach pre-dewatering levels in consideration of seasonal water table fluctuations
Acid Sulfate Soil Environments		
Field pH, EC, Total Titratable Acidity (TTA), DO, redox	Twice-weekly during dewatering	∆pH <0.5 pH units in one week EC and TA within 15% of background water quality
Field Fe^{2+}, Fe^{3+}	Fortnightly during dewatering	Fe^{2+} < 10 x applicable guidelines for the receiving environment Fe^{3+} stable
Laboratory pH, EC, TTA	Fortnightly during dewatering	Laboratory results within 0.5 pH units and EC and TA within 20% of field values
Laboratory analysis of pH, SO_4, Cl total alkalinity, total acidity, total Al and Fe, dissolved Al, As, Cr, Cd, Fe, Mn, Ni, Zn, and Se, Total-N, Total-P, NH_4-N, H_2S	End of dewatering program, when water table level recovers and 1 month after groundwater level recovery	Analytes below applicable water quality guidelines for the resource or within 20% of background water quality where background concentrations already exceed applicable guidelines.
Other Environments		
Visual inspection of surface water bodies where discharge to a surface water body occurs	Daily during dewatering	GROUNDWATER: not applicable
		SURFACE WATER: Discharge causes no visible floating oil, foam, grease, scum, flocculant, or deposition of sediment or turbidity
TSS and TDS where discharge to a surface water body occurs	Fortnightly during dewatering	GROUNDWATER: not applicable
		SURFACE WATER: TSS and TDS < 10% greater than the seasonal background of the receiving environment
Toxicants and nutrients	Fortnightly during dewatering	GROUNDWATER: Analytes below applicable water quality guidelines for the resource or within 20% of background water quality where background concentrations already exceed applicable guidelines.
		SURFACE WATER: Analytes within 10% of the seasonal background concentration of the analyte in the receiving body.

4.2.5 Contingency plans

Contingency plans will be developed on a site-specific basis to address actions to be undertaken where performance criteria are not met. Contingency plans will consider, but not be limited to, implementation of the following:

- Additional treatment methods in the event that performance criteria are not met;
- Alternative disposal options in the event the preferred method is considered to cause environmental harm;

- A reduction of dewatering rates in the event that extent of drawdown is considered to be causing environmental harm;
- Addition of a comprehensive suite of groundwater monitoring at an appropriate frequency where dewatering discharge, groundwater or surface water quality varies significantly (and adversely) compared to pre-dewatering conditions;
- Additional assessment the causes of water quality deterioration in the event that long-term water quality is considered to have degraded for reasons directly attributable to dewatering. This may include assessment of soil and groundwater quality, and development of a suitable management strategy.

5. Report requirements

A Project Acid Sulfate Soil and Dewatering Risk Assessment Form (Appendix A) will be completed for all sites.

For those sites where acid sulfate soil and/or dewatering investigations are determined to be required, results from the acid sulfate soil and/or dewatering investigation and suitable management plans will be reported by a suitable consultant in accordance with the DEC reporting requirements as defined in the *Draft Identification and Investigation of Acid Sulfate Soils* (DEC, 2006) and *Preparation of Acid Sulfate Soil Management Plans* (DoE, 2003). The following reporting components will be included:

Site setting

This section will include descriptions of the following:

- Identification of the land parcel over which the project will be undertaken;
- Maps showing the location of the project and the extent of works;
- Regional geology and hydrogeology;
- Surrounding land use; and
- Surrounding environmental receptors.

Project description

This section will include a detailed project description including:

- Proposed start date;
- Duration of the project;
- Expected depth of earthworks and volume of soils to be disturbed;
- Prediction as to whether dewatering will be required; and
- Assessment of the PROJECT RISK using the information from Section 3.1 and the *Project Acid Sulfate Soil and Dewatering Assessment Form* contained in Appendix A of this document.

Investigation methodology

This section will describe the methodology adopted for the acid sulfate soil and groundwater investigations, and will include:

- Acid sulfate soil investigation level and dewatering investigation level risk assessments;
- Description of the soil bore installation and sampling activities undertaken including bore depths, number of samples taken, and laboratory analyses;
- Description of the groundwater investigations undertaken;
- Description of QA/QC field procedures; and
- Adopted assessment criteria for the investigations.

Acid sulfate soil investigation results

This section will detail the results of the acid sulfate soil investigation including:

- Site specific geology;

- Results of pH_F and pH_{FOX} testing;
- Laboratory results;
- Discussion of QA/QC results and impact on data assessment;
- Location map and/or cross-sections of acid generating soils compared to excavation footprints;
- Summary of acid generating soil types, and volumes of material likely to be disturbed; and
- Risk assessment of acid generating potential and implications for site management.

Groundwater investigation results

This section will detail the results of the groundwater investigation including:

- Site specific hydrogeology including aquifer description, flow directions, flow rates; and
- Groundwater quality.

Acid sulfate soil management strategies

This section will detail the specific management strategies that will be adopted for the site including:

- A discussion of the management level as determined in Table 4.1;
- Excavation management;
- Soil handling;
- Soil treatment;
- Disposal;
- Validation and performance criteria; and
- Contingency plans.

Dewatering management strategies

This section will detail the specific management strategies that will be adopted for the site, including:

- Discussion of the volume and rate of dewatering;
- Dewatering methods;
- Dewatering discharge treatment;
- Dewatering discharge disposal;
- Monitoring and performance criteria; and
- Contingency plans.

6. Responsibilities and timing

Table 6.1 summarises the responsibilities and preferred timing for the implementation of the acid sulfate soil and dewatering management strategy at a project level.

Table 6.1: Responsibilities and timing

EMS Component	**Responsible Party**	**Timeframe**
Project Investigation Phase		
Project scope definition	Project manager/design engineer	Post-design
Acid sulfate soil desktop risk assessment	Environmental officer/consultant	Post-design
Dewatering desktop risk assessment	Environmental officer/consultant	Post-design
Project Acid Sulfate Soil and Dewatering Assessment Form	Environmental officer/consultant	Post-design
Acid sulfate soil investigation	Geotechnical consultant	3 months prior to contract tender issue
Dewatering investigation	Geotechnical/environmental consultant	3 months prior to contract tender issue
Determine acid sulfate soil and dewatering management levels	Geotechnical/environmental consultant	Post-investigation
Prepare acid sulfate soil and dewatering management plan including determination of management strategies	Geotechnical/environmental consultant	Completed 1 month prior to contract tender issue
Prepare correspondence to DEC regarding management	Environmental officer/consultant	1 month prior to construction
Project Execution Phase		
Select and source suitable neutralisation agent	Construction manager	Pre-construction
Calculate required volumes of neutralising agent for acid sulfate soil treatment	Construction manager	Pre-construction
Calculate volume of neutralising agent required for containment pads to enable stockpiling	Construction manager	Pre-construction
Conform with stockpile construction requirements	Construction contractor	During construction
Conform with soil disposal requirements	Construction contractor	During construction
Conduct soil stockpile testing	Construction contractor or environmental consultant	During construction
Manage dewatering discharge	Construction contractor	During construction
Daily dewatering discharge monitoring	Construction contractor	During construction
Collect groundwater/surface water samples for laboratory water quality analysis	Environmental consultant	During/post construction
Review data for exceedences and advise of need to implement contingency plans	Construction manager/environmental officer or environmental consultant	During construction
Implement contingency plans	Construction contractor	During construction

7. References

Department of Environment, 2003. *Guidance for groundwater management in urban areas on acid Sulfate soils.* Acid Sulfate Soil Guideline Series. Land and Water Quality Branch.

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Department of Water, 2006. Water Quality Protection Note 13 – *Dewatering of soils at construction sites.*

Swan River Trust, 2001. Policy SRT/DE6 – *Dewatering*.

WAPC, 2003. WAPC Bulletin #64 – *Acid Sulfate Soils*.

Appendix A

Project Acid Sulfate Soil and Dewatering Risk Assessment Form

Project Acid Sulfate Soil and Dewatering Assessment Form – Perth and Albany-Torbay Regions

Project Description

Project Commencement Date:	

Project Risk Assessment

Project Scope Item	**Description**	**Project Risk Ranking (Table 1)**
Duration of project		
Planned depth of excavation		
Expected depth to groundwater		
Distance to environmental receptors		
Sensitivity of environmental receptors		
Beneficial use of groundwater resource		
	PROJECT RISK[1]	

1. The overall project scope risk will be defined by the highest factor risk assuming that two or more risk factors have been allocated that risk. Where only one risk factor defines the risk category, the project risk will be downgraded by one risk level.

Desktop Review Outcomes and Acid Sulfate Risk Assessment

Site Characteristic	**Description**	**Risk Rating (Table 2 or 3)**
Site Elevation		
Geology		
Wetlands		
Depth to Groundwater		
WAPC ASS Risk Classification		
	ACID SULFATE SOIL RISK[2]	
	ACID SULFATE SOIL FIELD INVESTIGATION LEVEL[3]	

2. The acid sulfate soil risk will be defined by the highest risk ranking of all site characteristics.
3. The acid sulfate soil field investigation level will be defined by the risk matrix presented in Table 5.

Dewatering Risk Assessment

Dewatering Factor	**Description**	**Risk Rating (Table 6)**
Duration of dewatering activities		
Distance to environmental Receptors		
Acid sulfate soil risk		
	DEWATERING RISK[4]	

4. The dewatering risk will be defined by the highest risk ranking of all dewatering factors.

Project Acid Sulfate Soil and Dewatering Assessment Form – Regional Areas

Project Description

Project Commencement Date:	

Project Risk Assessment

Project Scope Item	**Description**	**Project Risk Ranking (Table 1)**
Duration of project		
Planned depth of excavation		
Expected depth to groundwater		
Distance to environmental receptors		
Sensitivity of environmental receptors		
Beneficial use of groundwater resource		
	PROJECT RISK[1]	

1. The overall project scope risk will be defined by the highest factor risk assuming that two or more risk factors have been allocated that risk. Where only one risk factor defines the risk category, the project risk will be downgraded by one risk level.

Desktop Review Outcomes and Acid Sulfate Risk Assessment

Site Characteristic	**Description**	**Risk Rating (Table 4)**
Site Elevation		
Regolith		
Geology		
Soil Type		
Vegetation		
Water Bodies		
Depth to Groundwater		
	ACID SULFATE SOIL RISK[2]	
	ACID SULFATE SOIL FIELD INVESTIGATION LEVEL[3]	

2. The acid sulfate soil risk will be defined by the highest risk ranking of all site characteristics. It is noted that in regional areas of high surface elevation (>100 mAHD), risk classifications of MEDIUM or HIGH based on geology/regolith/soil type requires supporting information from a secondary source to be characterized as having a MEDIUM or HIGH risk.
3. The acid sulfate soil field investigation level will be defined by the risk matrix presented in Table 5.

Dewatering Risk Assessment

Dewatering Factor	**Description**	**Risk Rating (Table 6)**
Duration of dewatering activities		
Distance to environmental Receptors		
Acid sulfate soil risk		
	DEWATERING RISK[4]	

4. The dewatering risk will be defined by the highest risk ranking of all dewatering factors.

Project Risk Assessment – Risk Ranking Tables

Table 1: Project risk assessment

Project Factors	**Risk Level**		
	LOW	**MEDIUM**	**HIGH**
Duration of Project	Less than 1 month	1-3 months	>3 months
Depth of excavation	<3 mBGL	3 – 10 mBGL	>10 mBGL
Depth to groundwater	Depth to groundwater > depth of excavation	Depth of excavation < 5 m below depth to groundwater	Depth of excavation > 5 m below depth to groundwater
Distance to Sensitive Receptors	> 500 m	200 – 500 m	<200 m
Sensitivity of Environmental Receptors	Unclassified water body	Multiple Use	EPP or CC
Beneficial Use of Groundwater Resource	Irrigation or lower quality	Priority 3 resource	Priority 1/2 resource

Table 2: Acid sulfate soil risk classification - Perth region (see following page)

Table 3: Acid sulfate soil risk classification - Albany-Torbay region (see following page)

Table 4: Acid sulfate soil risk classification - Regional areas (see following page)

Table 5: Acid sulfate soil field investigation level

Acid Sulfate Soil Risk	**Project Scope Risk**		
	LOW	**MEDIUM**	**HIGH**
LOW	Level 1	Level 1	Level 2
MEDIUM-LOW	Level 1	Level 2	Level 3
MEDIUM	Level 2	Level 3	Level 4
HIGH	Level 3	Level 4	Level 4

Table 6: Dewatering risk level

Risk Ranking	**Duration**	**Proximity to Sensitive Receptors**	**Acid Sulfate Soil Environment**
LOW	Less than 1 month	Greater than 500 m	Low ASS risk
MEDIUM	1 – 3 months	200 – 500 m	Medium ASS risk
HIGH	> 3 months	<200 m	High ASS risk

Table 2: Acid sulphate soil risk classification criteria – Perth region

Site Elevation	Geology	Wetland Classification	Depth to Groundwater	WAPC ASS Risk Map Ranking	Acid Sulfate Soil Risk Classification
>20 mAHD	LIMESTONE GRANITES and GNEISSES LATERITE DOLERITE CALCAREOUS SAND SAND of colluvial origin SAND derived from limestone	None	>10 mBGL	Low to No Risk	LOW
5 – 20 mAHD	SAND of eolian origin SILT of colluvium origin	Multiple Use	5-10 mBGL	Moderate to Low Risk	MEDIUM-LOW
5 – 20 mAHD	SAND of eolian origin SILT or CLAY of alluvium origin	Multiple Use	<5 mBGL	Moderate to Low Risk	MEDIUM
>5 mAHD	PEAT and PEATY SAND SILT of lacustrine origin	Resource Enhanced or Conservation Category	<5 mBGL	High Risk	HIGH

1. Based on the GSWA 1:50,000 Environmental Geology Series metropolitan maps

Table 3: Acid sulphate soil risk classification criteria – Albany-Torbay region

Topography	Geology[1]	Wetland Classification	Depth to Groundwater	WAPC ASS Risk Map Ranking	Acid Sulfate Soil Risk Classification
>40 mAHD	LIMESTONE GRANITES, MIGMATITES and GNEISSES SANDS and GRAVELLY SANDS of granitic origin LATERITE and LATERITIC GRAVELS SAND of alluvium origin (tertiary) SILTSTONE and SPONGOLITE Beach and dune SAND	None	>10 mBGL	Low to No Risk	LOW
5 – 40 mAHD	SAND of alluvium origin (quaternary)	Multiple Use	5-10 mBGL	Moderate to Low Risk	MEDIUM-LOW
5 – 40 mAHD	SAND of alluvium origin (quaternary)	Multiple Use	<5 mBGL	Moderate to Low Risk	MEDIUM
>5 mAHD	PEATY SAND of lake and swamp origin SANDY SILT and SILTY SAND, and CLAYEY SILT of lacustrine origin	Resource Enhanced or Conservation Category	<5 mBGL	High Risk	HIGH

1. Based on the GSWA 1:50,000 Environmental Geology Series ALBANY and TORBAY maps

Table 4 Acid sulfate soil risk classification criteria – Regional areas

Topography	Geology/Lithology			Vegetation, Wetlands and Water Bodies		Depth to Groundwater	Acid Sulfate Soil Risk Classification
	Regolith	Geology	Soil Types	Vegetation	Water Bodies		
>100 mAHD	MODERATELY WEATHERED BEDROCK	DURICRUST (CALCRETE/ SILICRETE/ UNDIFFERENTIATED) SEDIMENTARY ROCKS (MESOZOIC) SEDIMENTARY ROCKS (PALEOZOIC) GRANITIC ROCKS (ARCHEAN-PROTEROZOIC)	DUPLEX SOILS RED AND YELLOW EARTHS HARD SETTING LOAMY SANDS WITH RED CLAYEY SUB SOILS	NATIVE GRASSLANDS NATIVE SHRUBS AND HEATHS CROPS NATIVE FORESTS AND WOODLANDS	NONE CREEKS – fresh to brackish RIVERS – fresh to brackish WATER BODIES – fresh to brackish	>10 mBGL	LOW
20 – 50 mAHD	TERRESTRIAL SEDIMENTS ALLUVIAL SEDIMENTS AEOLIAN SANDS	QUATERNARY DEPOSITS DURICRUST (FERRUGINOUS)	EARTHY SANDS LEACHED SANDS	NATIVE GRASSLANDS NATIVE SHRUBS AND HEATHS CROPS NATIVE FORESTS AND WOODLANDS	RIVERS –saline WATER BODIES – saline	5 – 10 mBGL	MEDIUM-LOW
5 – 20 mAHD	TERRESTRIAL SEDIMENTS ALLUVIAL SEDIMENTS AEOLIAN SANDS	QUATERNARY DEPOSITS DURICRUST (FERRUGINOUS)	EARTHY SANDS LEACHED SANDS	MALALEUCAS, EUCALYTUS	SEASONAL WETLANDS	<5 mBGL	MEDIUM
<5 mAHD	LACUSTRINE SEDIMENTS	QUATERNARY DEPOSITS in low-lying, wetland areas	LEACHED SANDS in low lying areas. CRACKING CLAYS, UNDERLAIN IN AREAS BY HARD PAN AREAS	MALALEUCAS, EUCALYTUS	WETLANDS	<5 mBGL	HIGH

Appendix B

Containment Pad Calculation Worksheet

Containment Pad Calculation Worksheet

This worksheet can be used to determine the amount of neutralising agent (aglime or lime sands) required to construct a containment pad suitable for the stockpiling of acid sulfate soils and to assist in determining suitable dimensions of the containment pad. This worksheet may require modification for use with alternative neutralising agents.

Step 1: Gather the relevant information project information

Parameter	Definition	Project Specific Value
A	Area of excavation (m^2)	
H	Depth of excavation (m)	
V	Volume of excavated material (A x H m^3)	
δ	Density of soil (T/m^3)	
B	Bulking factor post excavation	
%S	Maximum total sulfide concentration of soil to be stockpiled (%S)	
ENV	Effective neutralizing value of the neutralizing agent used for containment pad construction (expressed as a decimal percent)	
CP	Area of the containment pad (m^2)	

Step 2: Calculate the height of the stockpile (SPH expressed as metres)

V (m^3)	x	*B*	/	*CP (m^2)*	=	*SPH (m)*
________	x	________	/	________	=	

Step 3: Calculate the quantity of neutralising agent required (NA expressed as kg $CaCO_3$)

3.1 Calculate the neutralisation rate (NR expressed as kg $CaCO_3$/tonne of soil)

[0.2 x SPH (m)]	x	*[%S x 30.59]*	/	*ENV*	=	*NR (kg $CaCO_3$/T)*
________	x	________	/	________	=	

3.2 Calculate the volume of neutralising agent required

NR (kg $CaCO_3$/T)	x	*V (m^3)*	/	*δ (T/m^3)*	=	*NA (kg $CaCO_3$)*
________	x	________	/	________	=	

Step 4: Calculate the thickness of the containment pad (T expressed as metres)

[NA (kg $CaCO_3$) / 2000]	/	*CP (m^2)*	=	*T (m)*
________	/	________	=	

Appendix C

ENV Calculation Worksheet

ENV Calculation Worksheet

DEFINITIONS

Parameter	Definition	Units
NV	Neutralising value of the soil as determined through laboratory analysis using the Calcium Carbonate Equivalence method	%
S	Number of samples analysed	none
NV_{AVE}	Average neutralizing value of the soils	%
PSD	Particle size proportion as determined through laboratory analysis	%
UF	Utilisation factor for different particle sizes	none
ENV	Effective neutralizing value	%

Step 1: Calculate the average NV of the soil

SUM [NV of all samples] / *S* = NV_{AVE} *(%)*

________________ / ________ = [ ]

Step 2: Determine the Utilisation Value of the soil (% $Value_{Total}$)

Step 2.1: Determine the untilisation value for each of the particle size distribution categories.

Particle size	PSD Proportion (%)	x	Utilising Factor	=	%Value
>0.850 mm			0.1		
0.300 – 0.850 mm			0.6		
<0.300			1.0		

Step 2.2: Determine the %Value for the soil

$\%Value_{>0.850}$ + $\%Value_{0.300\text{-}0.850}$ + $\%Value_{<0.300}$ = *%Value*

________ + ________ + ________ = [ ]

Step 4: Calculate the ENV of the soil

NV_{AVE} / *&Value/100* = *ENV (%)*

________________ / ________________ = [ ]

Appendix D

Neutralising Agent Calculation Worksheet

Neutralising Agent Calculation Worksheet

This worksheet can be used to calculate the total amount of neutralising agent required for a site. It can also be used to calculate the total amount of neutralising agent required to treat individual soil units. The worksheet is designed to assist with calculations for aglime and lime sand neutralising agents only and may require modification for use with other neutralising agents.

Step 1: Gather the relevant information project information

Parameter	Definition	Project Specific Value
A	Area of excavation (m^2)	
T	Thickness of soil unit (m)	
V	Volume of soil to be treated (A x T m^3)	
δ	Density of soil (T/m^3)	
%S	Maximum total sulfide concentration of soil unit(%S)	
ENV	Effective neutralizing value of the neutralizing agent used to treat the soil (expressed as a decimal percent)	

Step 2: Calculate the neutralisation rate (NR expressed as kg $CaCO_3$/tonne of soil)

%S x *45.885* / *ENV* = *NR (kg $CaCO_3$/T)*

__________ x __________ / __________ = $\boxed{}$

Step 3: Calculate the quantity of neutralising agent required

NR (kg $CaCO_3$/T) x *V (m^3)* x *δ (T/m^3)* = *NA (kg $CaCO_3$)*

__________ x __________ x __________ = $\boxed{}$