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Grange Resources

Report for Southdown Magnetite Project - Cape Riche Seawater Desalination Plant

Air Assessment

April 2011

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

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Glossary of Acronyms and Terms

AHD	Australian height datum
Air NEPM	*National Environment Protection (Ambient Air Quality) Measure*
AWS	automatic weather station
BoM	Bureau of Meteorology
CIP	clean in place
DEC	Department of Environment and Conservation
DERM	Department of Environment and Resource Management (Queensland)
EPA	Environmental Protection Authority
EPA Victoria	Environment Protection Authority Victoria
GHD	GHD Pty Ltd
GL/a	gigalitre per annum
Grange	Grange Resources Limited
ha	hectare; 10,000 m^2
ML	million litres
ML/d	million litres per day
NO_x	oxides of nitrogen
OER	odour emission rate
OU	odour unit
PER	Public Environmental Review
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres.
PFS	Pre Feasibility Study
PVDF	polyvinylidene fluoride
Qld EPA	Queensland Environmental Protection Agency
RO	reverse osmosis
SEPP-AQM	*State Environment Protection Policy (Air Quality Management)*
SO_2	sulphur dioxide
TSP	Total suspended particles refer to particles up to 35 µm, but may include particles up to 80 µm in aerodynamic diameter under extreme (higher wind speed) conditions.

UF	ultrafiltration
VOC	volatile organic compound

Executive Summary

Grange Resources Limited (Grange) intends to develop a seawater desalination plant to supply up to 12 gigalitres per annum (GL/a) of water to the Southdown mine, as part of the Southdown Magnetite Project. The Cape Riche Seawater Desalination Plant comprises a reverse osmosis (RO) desalination facility, a pump station, as well as supply, intake and discharge pipelines extending from the outfall site at Cheyne Bay Inlet to the Plant and from the Plant to the Southdown mine site.

Emission Sources

Potential atmospheric emissions during construction and site establishment for the Plant will be emissions from heavy vehicle exhausts and dust generation from heavy equipment during earthworks and erosion from disturbed soil surfaces.

Previous experience at desalination plants indicates that the only significant operational emission is odour. Odour is expected to be generated during:

- Initial screening of gross solids at the intake pump station; and
- Storage and treatment of wastewater generated by strainer flushing and UF backwashing at the desalination plant.

Emissions from vehicles on-site are not considered to represent a significant source of emissions.

Odour Criteria

The odour impacts from the Plant were assessed by referring to appropriate odour criteria from the Victorian Environment Protection Authority (EPA Victoria), Queensland Environmental Protection Agency (Qld EPA) and WA Environmental Protection Authority (EPA).

Construction Assessment

Emissions from vehicles on-site are not considered to represent a significant source of emissions. Emissions from heavy equipment will be minimised by ensuring all vehicles on-site are well maintained and operated in an efficient manner.

A framework for management of dust emission during construction of the Plant has been developed and will be applied as part of construction dust management measures.

Operational Assessment

Odour dispersion modelling using AUSPLUME was completed to determine the upper limit for the source odour emission rate such that compliance with relevant odour criteria at the nearest sensitive receptors is demonstrated. The upper limits may then be used as performance criteria for the design. The same odour emission rate was used for all sources as there is no literature indicating the relative odour from the various sources.

Modelling indicates that odour emission rates of 2,000 OU m^3/s from each odour source for the Plant will meet the relevant odour criteria. Due to the size of the desalination plant (12 GL/a), it is considered highly unlikely this odour emission rate would be reached during standard operations or upset conditions.

Conclusion

This assessment demonstrates that odour emissions under routine operations can readily meet the EPA criterion at all sensitive receptors, so that odour impact due to site operations will not occur.

This assessment also outlines the measures required in a Dust Management Plan that will ensure that dust emission during the construction phase will be controlled so as not to cause adverse impact at the nearest off-site receptors.

This report provides an odour assessment for the Cape Riche Desalination Plant as described and should be read based on the limitations presented in Section 10.

1. Introduction

Grange Resources Limited (Grange) intends to develop a seawater desalination plant to supply up to 12 gigalitres per annum (GL/a) of water to the Southdown mine, as part of the Southdown Magnetite Project. The Cape Riche Seawater Desalination Plant comprises a reverse osmosis (RO) desalination facility, a pump station, as well as supply, intake and discharge pipelines extending from the outfall site at Cheyne Bay Inlet to the Plant and then from the Plant to the Southdown mine site.

1.1 Background

The Cape Riche Seawater Desalination Plant was proposed by Grange to supplement in-situ water supplies at the Southdown mine for the purpose of transporting ore to processing and port facilities in Albany via the planned slurry pipeline. The Plant is proposed to be constructed on freehold land 4.5 km east of Cape Riche, which is currently used for livestock and cropping agriculture.

The desalination facility will be supplied by a pump station located adjacent to the coast at Cape Riche. The pump station is planned to be submerged underground to insulate against noise and visual impacts, however, will still require an above ground transformer and electrical building with appropriate road access. The desalination plant will take water from the open channel intake located near Cheyne Inlet Beach and will discharge water from the Southern Ocean Brine Discharge, located on the southern side of Cape Riche.

The Southdown Magnetite Project involves the construction and operation of an open pit magnetite mine located approximately 90 km east north east of Albany, near Wellstead.

1.2 Scope of Work

GHD Pty Ltd (GHD) was commissioned by Grange to prepare a Public Environmental Review (PER) in order to complete environmental approvals for the Cape Riche Seawater Desalination Plant. As part of this commission, GHD completed an air quality assessment as per Department of Environment and Conservation (DEC) requirements.

This report assesses the potential air quality impacts from construction and operation of the Desalination Plant. The reports scope is to:

- Assess the likely level of dust generation and other pollutants associated with construction of the Plant;
- Assess odour impacts from operation of the Plant, including dispersion modelling and assessment against relevant odour criteria; and
- Specify intended air quality management and mitigation measures during construction and operation of the Plant to ensure compliance with relevant odour criteria.

1.3 Approach

The approach adopted by GHD for the assessment of emissions to air from the Cape Riche Seawater Desalination Plant is summarised in the following points. Each point is described in detail in the subsequent sections of the report.

- Outline of the Plant, including layout, equipment and process flows (Section 2);
- Identification of emission sources, emission characterisation and mitigation measures (Section 3);
- Identification of the appropriate odour criteria and guidelines applicable to this assessment (Section 4);
- Investigation of the existing environment, in terms of topography and land use, meteorology, background air quality and sensitive receptors (Section 5);
- Development of representative meteorological data for odour modeling (Section 6);
- Assessment of predicted air quality impacts during construction including development of a management framework to inform the task specific mitigation measures for use during construction (Section 7);
- Air dispersion modelling in order to determine maximum allowable emissions from odour sources and the impact of odour under upset/malfunction conditions (Section 8); and
- Conclusions drawn from the above assessment and recommendations for the monitoring of operational compliance (Section 9), subject to the Scope (Section 1.2) and Limitations (Section 10).

2. Project Proposal

The design of the Cape Riche Seawater Desalination Plant is provided in the *Southdown Magnetite and Kemaman Pellet Plant Project Pre Feasibility Study* (PFS) (Grange Resources/Sojitz 2010). This design has been used as a basis for this assessment. The sections below provide a summary of the information provided in the PFS with relevance to this air quality assessment.

2.1 Overview

The desalinated water supply system will consist of a seawater RO desalination plant at Cape Riche with pumped transfer of desalinated water to the mine site. The desalinated water will be used primarily as process water at the mine site, with a small portion further treated at the mine site to provide potable water.

The Plant has a design capacity of approximately 35 million litres per day (ML/d), based on the production of 12 GL/a with the desalination plant running at 95% availability. Figure 1 provides an indicative site layout. The key components of the Plant are as follows:

- Open Channel Intake and Discharge: The desalination plant will take water from the open channel intake located near Cheyne Inlet Beach and will discharge water from the Southern Ocean Brine Discharge, located on the southern side of Cape Riche.
- Intake Pump Station: In order to transport the saline water to the desalination plant site pumps will operate at the coast.
- Desalination Plant: The treatment of saline water will involve large scale RO to produce a treated water supply and brine discharge.
- Supply, Intake and Discharge Pipelines: Three major pipelines will be required for the desalination plant, including supply, intake and discharge lines.

Figure 2 provides a schematic of the desalination plant system.

2.2 Open Channel Intake and Discharge

The open channel intake located near Cheyne Inlet Beach will connect to the onshore intake pump station via a concrete lined channel. Seawater concentrate (brine) will be discharged from the Southern Ocean Brine Discharge, located on the southern side of Cape Riche.

1:70,000 (at A3)

0 0.75 1.5 2.25 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Seawater Supply Pipeline
- Treated Water Transfer
- Outfall Pipeline
- Desalination Plant
- Pump Station
- Pit Boundary
- Cadastral Boundary
- National Parks or Reserves

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Cape Riche Seawater Desalination Plant Indicative Site Layout

Job Number	61-26005
Revision	0
Date	02 MAY 2011

Figure 1

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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

Data source: Landgate: Cadastre, Reserve or National Park - 20101018, Road Names - 20110411; Grange Resources: Mosaic - 200901, Pit Boundary - 20100812; Harley Global: Seawater Pipeline, Desalination Plant, Pump Station, Outfall Pipeline, Treated Water Transfer - 20110502. Created by: tgoad

2.3 Intake Pump Station

The seawater pump station site occupies an area of approximately 0.25 hectares (ha). Seawater from the intake structure flows by gravity through the intake conduit to a below ground (-6 m AHD) seawater screening and pumping station. This assessment has assumed three vertical shaft centrifugal intake pumps extracting flows from the stilling well.

The intake pump station structure includes two travelling band screens upstream of the seawater pumps to reduce entrained marine biota into the system and to mitigate the risk of pump fouling. There are two screens in a duty/standby arrangement. The screens consist of fine mesh with 3 mm openings. Screened solid wastes will be placed in bins for periodic removal.

2.4 Desalination Plant

The desalination plant site is approximately 4.6 ha in area. Seawater entering the site from the intake pump station will first be stored in a 1 ML tank. The tank will be used for control storage prior to entering the desalination plant.

The desalination plant will consist of two main processes:

- Ultrafiltration (UF) pre-treatment plant to remove suspended solids from the seawater; and
- RO desalination plant to remove salt from the seawater.

2.4.1 Pre Treatment – Ultrafiltration

Pre-treatment will consist of:

- <u>pH Correction</u>: Sulphuric acid dosing to a target of 6.8 is used to achieve optimum conditions for coagulation.
- <u>Coagulation and Rapid Mixing</u>: Ferric chloride coagulant will be dosed via flow pacing to the seawater flow rate. Two inline mechanical mixers in a duty/standby arrangement will be provided. A static mixer may also be used in lieu of the mechanical mixers.
- <u>Straining and Ultrafiltration</u>: The design assumes self-cleaning pressure screen filters with an absolute aperture spacing of 80 µm. Each UF feed pump will have one filter installed downstream of the UF pumps.

  Seven UF pumps (six duty, one standby) will be used to feed the UF units. A blower and compressor room with two rotary screw compressors (duty/standby) will provide air for the filtration system. The UF pumps, feed system and strainers are expected to be located within a building to mitigate noise.
- <u>Wastes</u>: Strainer flushing consists of briefly diverting the feed stream to wastes, thereby flushing the surface of the screen. UF membrane backwashing will consist of (partial) vessel draining, air scours, back flushing and refilling. Two (duty/standby) rotary blowers will supply air to the UF system for backwash.

2.4.2 Reverse Osmosis

The RO plant will be a single pass design. The feed water will be divided and feed the low pressure feed pump station and the high pressure feed pump. The high pressure feed will pass through RO membranes, producing permeate.

- RO Train Design: The RO system will consist of six RO trains, each with one RO rack of seven membrane elements. A total of 24 pumps will be required for the RO and energy recovery system, all located within the RO building.
- Clean In Place System: Periodic chemical cleaning will be required for the system. The clean in place (CIP) system includes recirculation pumps, filters and a CIP tank and neutralisation tank. Solutions will be made up in the CIP tank and the pump will circulate the solution through the filter and to the RO membrane.
- Permeate Storage: Permeate will be collected in a storage tank with a working capacity of 0.5 ML (15 minutes storage at maximum design flow). The tank will supply water to the permeate pump station for post treatment and also to the backwash pump station for use in the plant.

2.4.3 Pre Treatment Wastewater

Treatment of wastewater generated by strainer flushing and UF backwash and CIP wastes consists of:

- Collection and Storage: Pre-treatment wastewater will be collected in the backwash holding tank. The tank is covered and will have two cells operated in parallel. Each cell will have fixed speed submersible mixers which will operate continuously. A dedicated pump station will feed wastewater to the thickeners. This pump station will be a rectangular concrete sump with two (duty/standby) submersible pump sets.
- Wastewater Thickening: Two conventional thickeners will operate in parallel. Each will have a motorised fixed speed, continually operating scraper to rake settled sludge to a central sump. Sludge will be periodically pumped from thickener collection sumps with two (duty/standby) fixed speed pumps to one thickened sludge storage tank. The sludge thickeners will not be enclosed in a building.
- Sludge Dewatering: Sludge will be dewatered via a batch operated decanting centrifuge plant, operating during day time hours. The plant will house two centrifuges operating in parallel. The centrifuge plant will be enclosed in a building. Dewatered sludge will be placed in skip bins for collection and off site disposal.
- Disposal of Liquids: Supernatant from sludge thickeners and filtrate from the dewatering plant will be stored in one supernatant tank. The supernatant tank water will be pumped to the concentrate storage tank, using two (duty/standby) pumps, for ocean disposal.

2.5 Supply, Intake and Discharge Pipelines

The 4.5 km long intake and outfall pipeline route between the seawater pumping station and the desalination plant follows an existing track and gravel road.

The pipeline route from the desalination plant to the mine site runs along Cape Road to the west then to the northwest to the junction with Mettler Road, follows Mettler Road to the south west to Kojaneerup

Road and follows the easement to the mine site. The route crosses the South Coast Highway at the South Coast Highway / Kojaneerup Road intersection adjacent to the mine site.

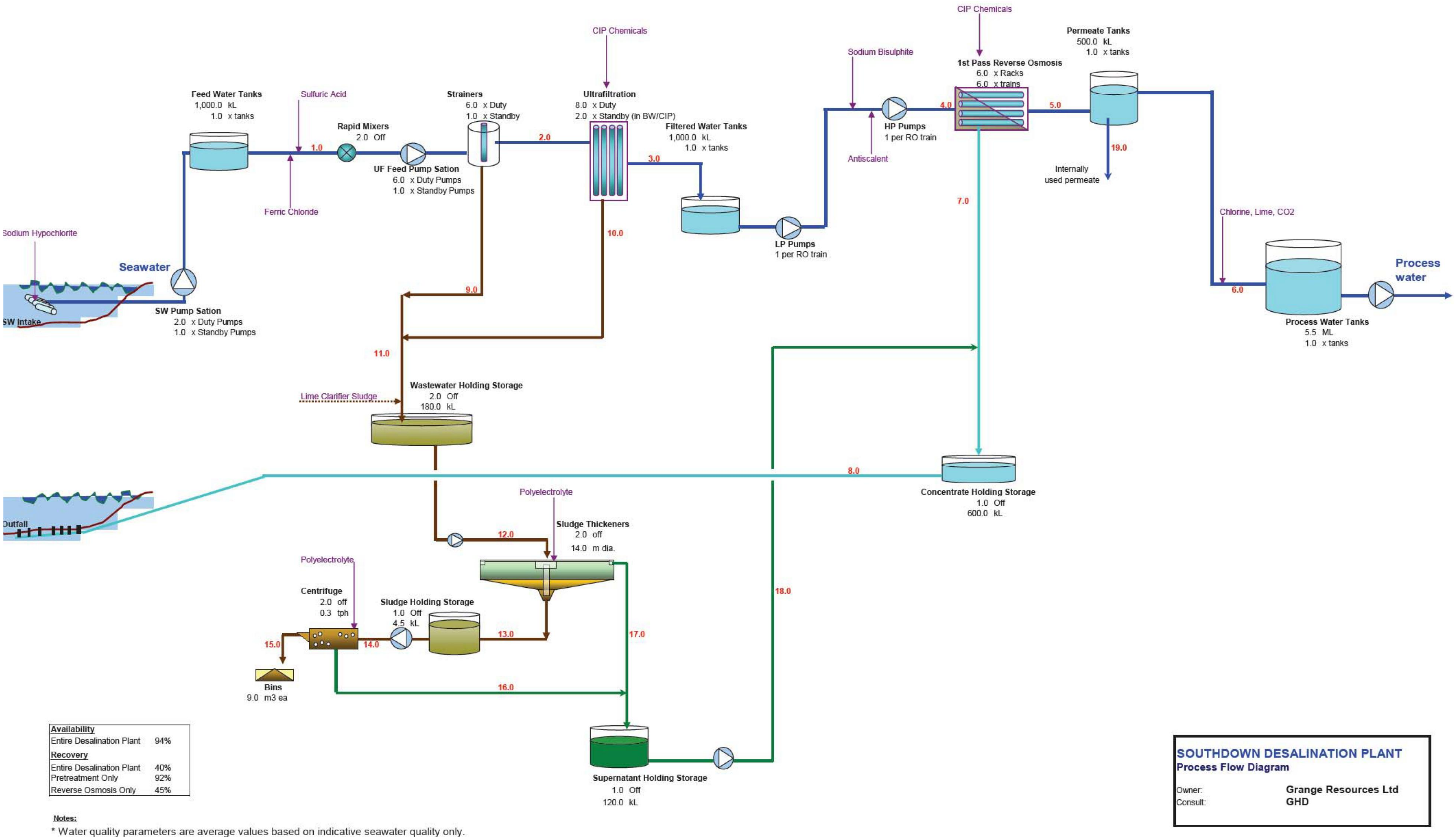

Figure 2 Desalination plant process flow diagram

3. Operational Emission Sources

The Cape Riche Seawater Desalination Plant will be a RO plant capable of producing up to 12 GL/a at 83% capacity (i.e. five of six RO trains working at one time). Experience at other desalination plants indicates that the only potential emission of concern during plant operation is odour.

3.1 Odour Emission Sources

Wastewater consists primarily of coagulated seawater solids, containing marine biota such as seaweed and fine solids such as larvae and plankton. Sources of odour are linked to the removal of marine biota from the seawater prior to the RO membranes.

Removal occurs at the intake pump station and at the pre-treatment stage of the RO plant. Odour is therefore expected to be generated during:

- Initial screening of gross solids at the intake pump station; and
- Storage and treatment of wastewater generated by strainer flushing and UF backwashing at the desalination plant.

Significant odours may be generated from these processes if there is an increase in stored mass from increased loading in the sea water from seasonal or storm events. Anaerobic storage conditions will also result in higher than normal odour emission rates and may well be considered offensive.

3.1.1 Screening (Intake Pump Station)

The design includes two travelling band screens upstream of the seawater intake pumps to reduce entrained marine biota into the system and to mitigate the risk of pump fouling. There are two screens in a duty/standby arrangement. The screens consist of fine mesh with 3 mm openings.

The screenings will be transported by gravity from the top of the travelling band screens via a sluice to the side of a wet well and collected in screenings baskets. As a basket is filled, it is lifted and moved using an overhead hoist, emptied into a skip bin and returned to a rack adjacent to the band screen.

The skips will be sealed so that their removal off-site by truck will not result in a mobile odour source.

3.1.2 Filtration (Desalination Plant)

The self-cleaning pressure screen filters included in the design are periodically backwashed with filtered seawater and the backwash water (containing coagulant and fine solids) is collected in the backwash holding tank. The tank is covered and each cell will have fixed speed submersible mixers which will operate continuously.

Two conventional sludge thickeners will operate in parallel, with settled sludge held in thickened sludge holding tanks. The moisture content of the thickened sludge is reduced further via a batch operated decanting centrifuge plant, with two centrifuges operating in parallel. The solid cake (waste sludge) is collected in skip bins for collection and off-site disposal. As these solids in part comprise microscopic marine biota, the stored waste sludge is a potential odour source.

3.2 Odour Mitigation Measures

The backwash holding tank is a roofed tank and will be equipped with submersible mixers to maintain aerobic conditions, reducing the production of odourous sulphides.

The sludge dewatering centrifuges will be housed in a building and wastes will be removed (frequency unknown at this stage) in covered skip bins, reducing the likelihood of odour emissions.

3.3 Odour Characterisation

There are limited literature values for odour emission rates from screenings and/or waste sludge from desalination plants. GHD has in the past unsuccessfully requested permission from the operator of the Kwinana desalination plant to allow odour emission rate (OER) measurements at the source (GHD 2008).

Odour dispersion modelling is therefore used to determine the performance specification with respect to the upper limit on odour emission rates (OER) from odour emitting areas of the desalination plant. This is a common and accepted approach where odour emissions are not readily available.

4. Odour Criteria

Air quality impacts are assessed by comparing monitoring results or model predictions with appropriate criteria. The odour criteria referred to in this assessment include:

- Environment Protection Authority Victoria (EPA Victoria);
- Queensland Environmental Protection Agency (Qld EPA); and
- WA Environmental Protection Authority (EPA) odour criteria.

4.1 Environment Protection Authority Victoria

EPA Victoria has established Design Criteria for odour under the Victorian *State Environment Protection Policy (Air Quality Management)* (SEPP-AQM). The relevant SEPP-AQM odour criterion is:

- 1 odour unit (OU), 3-minute average, 99.9th percentile (9th highest in a yearly data set).

An odour unit (OU) is the concentration of an odorant blend at which 50% of the population can detect odour in a laboratory setting (background odour being absent). In ambient conditions, there is normally a background odour that is not noticed as it is ubiquitous. This level will typically vary between 2 OU to 10 OU. The 1 OU criterion is therefore stringent, ensuring complying sources will rarely produce off-site odour impacts.

4.2 Queensland Environmental Protection Agency

Qld EPA (now the Department of Environment and Resource Management (DERM)) has established an odour annoyance threshold (concentration) guideline at the 'most exposed existing or likely future off-site sensitive receptors', as follows:

- 0.5 OU, 1-hour average, 99.5th percentile (44th highest) for tall stacks; and
- 2.5 OU, 1-hour average, 99.5th percentile (44th highest) for ground-level sources and down-washed plumes from short stacks.

The Queensland guideline values are based upon application, to the default annoyance threshold of 5 OU (equivalent to instantaneous / 3-minute averaging period), of conservative peak to mean ratios 10:1 for stacks and 2:1 for ground-level or down-washed plumes from short stacks (Qld EPA, 2005) [1].

4.3 WA Environmental Protection Authority

The EPA (2005) has established a 'green-light' odour criterion at existing or proposed sensitive premises:

- 2 OU, 3-minute average, 99.5th percentile (44th highest)

  AND

- 4 OU, 3-minute average, 99.9th percentile (9th highest).

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[1] For reference, the AUSPLUME peak to mean ratio for 3-minute to 1-hour averaging times is 1.8:1.

If this two-part criterion is met, no further assessment of odour is required. This interim criterion only applies for ground based emissions or emissions from short or wake affected stacks.

4.4 Odour Criteria Assessed

Odour assessment criteria for the Plant are summarised in Table 1.

Table 1 Odour assessment criteria

Pollutant	Criterion	Averaging period	Percentile	Basis
Odour- all sources	1 OU	3-minutes	99.9th	EPA Victoria
Odour – ground level and short stacks	4 OU	1-hour	99.5th	Qld EPA
Odour – all sources	2 OU AND 4 OU	3-minutes	99.5th AND 99.9th	WA EPA

5. Existing Environment

This section provides a summary of the existing environmental aspects relevant to assessment of odour impacts from the Cape Riche Seawater Desalination Plant, including topography, land use, meteorology, ambient air quality and sensitive receptors.

5.1 Topography and Land Use

The proposed seawater pump station site occupies an area of approximately 0.3 ha. The site slopes gently to the north and east towards the ocean. The ground level across the site ranges from approximately +7.5 m AHD to +12 m AHD.

The desalination site is approximately 4.6 ha in area, 4.5 km inland from Cape Riche. The site gently slopes in all directions from a hill crest in the centre of the southern half of the site. The ground level ranges from approximately +48 m AHD at the peak to approximately +36 m AHD in the north western corner. The site is used for grazing sheep and cattle by the current landowners.

The 4.5 km long intake and outfall pipeline route between the seawater pumping station and the desalination plant follows an existing track and gravel road. The route undulates but generally increases in elevation from +10 m AHD at the pump station to +45 m AHD at the plant.

The desalinated water main pipeline runs adjacent to existing gravel roads. The route from the plant site runs along Cape Road to the west then to the northwest to the junction with Mettler Road. It follows Mettler Road to the south west to Kojaneerup Road which the easement follows from there to the mine site. The route crosses the South Coast Highway at the South Coast Highway / Kojaneerup intersection adjacent to the mine site. The ground level rises from approximately +48 m AHD at the plant to approximately +135 m AHD at the mine site.

5.2 Meteorology

The Albany area experiences a temperate Mediterranean climate, typified by moderate temperatures, regular winter rainfall and strong winds. Weather patterns are known to be influenced by the oscillating low pressure system in the mid latitude belt of the Southern Ocean, which produces most weather events and rainfall through cold fronts. The frequency of these events is controlled by the semi-permanent Indian Ocean high pressure cell within the sub-tropical anticyclonic ridge. The north-south annual progression of the ridge results in less low pressure systems in the austral summer and more low pressure systems in the winter.

General meteorology and climate data from the Jacup automatic weather station (AWS) is considered representative of the Plant site. The following discussion is based on Bureau of Meteorology (BoM) *Climate Statistics for Australian Locations* obtained for the Jacup AWS (ID: 010905, located at 33.9º S, 119.1º E) (BoM 2010b).

5.2.1 Temperature

Table 2 shows long term mean maximum and minimum temperatures observed at Jacup AWS. This shows that Jacup experiences warm summers and cool winters, with a mean annual maximum temperature of 21.8ºC (range 15.6^{0}C to 27.4^{0}C) and a mean annual minimum temperature of 9.2ºC (range 5.5^{0}C to 13.6^{0}C) . The highest temperatures are observed in February and the lowest in July and August. Over the course of a year, Jacup averages 39 days above 30ºC, 13 days above 35ºC and two days above 40ºC (BoM 2010b).

Table 2 Mean monthly meteorological data at Jacup AWS

	Spring			Summer			Autumn			Winter		
	Sep	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Max. temperature (ºC)	18.6	21.4	24.5	25.9	27.3	27.4	25.6	22.8	19.8	16.7	15.6	16.5
Min. temperature (ºC)	6.2	7.4	9.8	11.4	12.9	13.6	12.5	10.7	8.5	6.4	5.5	5.5
Rainfall (mm)	47.9	42.0	30.7	26.4	36.6	20.6	31.1	43.3	31.3	40.9	50.5	46.5
Morning (09:00) wind speed (km/hr)	21.4	19.9	20.2	19.5	20.5	20.8	20.7	18.5	18.3	18.7	19.1	19.1
Afternoon (15:00) wind speed (km/hr)	22.0	21.5	22.8	23.3	24.3	22.9	21.4	18.3	18.5	20.1	21.4	21.0

5.2.2 Rainfall

Table 2 shows the spread of monthly rainfall at Jacup AWS. This table shows that Jacup experiences most rainfall during winter. However, it does rain consistently throughout the year. Jacup has an annual mean rainfall of 449 mm, with rainfall dominated by cold fronts moving eastward over the south west of WA. Jacup averages 78 days of greater than 1 mm rainfall during a year (BoM 2010b).

5.2.3 Wind

Historical wind directions and speeds for Jacup AWS at 08:00 – 10:00 and 14:00-16:00, based on BoM hourly observations, are shown in Figure 3. The wind roses show graphically the frequency of occurrence of winds by direction and strength, from varying compass points. The length of the bar represents the frequency of occurrence of winds from that direction and the colour corresponds to the wind speed categories, as defined in the legend.

Figure 3 shows northerly and westerly winds dominating during the morning and south westerly and easterly winds dominating during the afternoon.

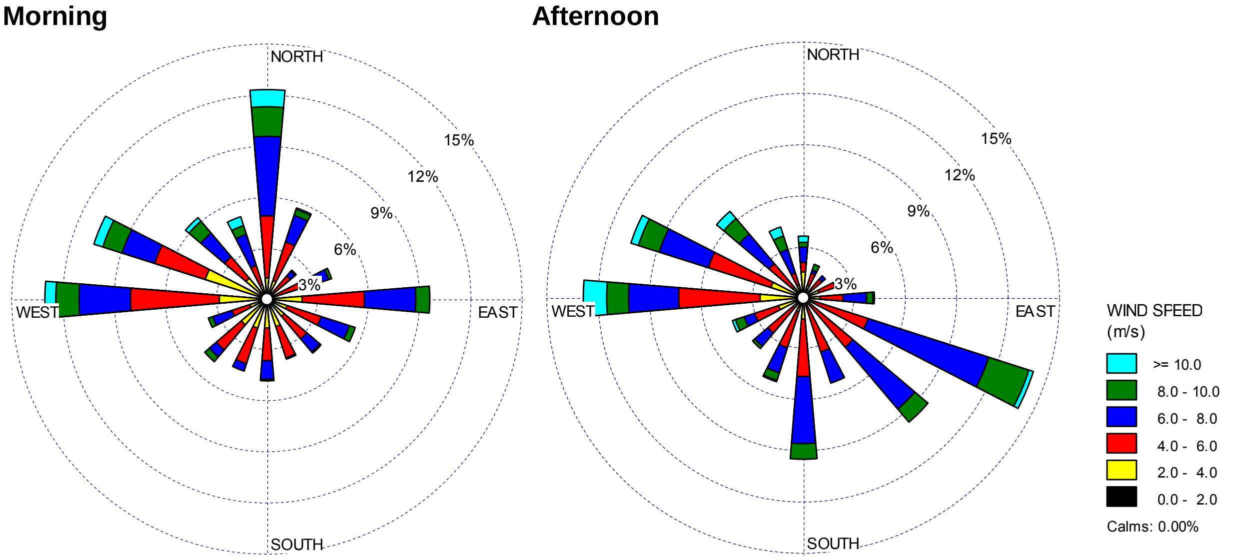


Figure 3 Morning and afternoon wind roses at Jacup, 2004

5.2.4 Cloudiness

Cloud cover is not measured at Jacup AWS. Measured cloud cover at Albany Airport AWS (BoM 2010a) is considered representative of the Cape Riche Seawater Desalination Plant site.

Table 3 shows the mean number of cloudy days, illustrating a frequent number of cloudy days throughout the year for Albany Airport. A common measured parameter that is a proxy for cloudiness is the mean number of hours of daily sunshine. The annual mean number of hours of daily sunshine at Albany Airport AWS is 7 hours per day, further illustrating the frequency of cloud systems along the coast of Albany.

Table 3 Cloud cover data at Albany Airport AWS

	Spring			Summer			Autumn			Winter		
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Cloudy days	16	17	17	13	12	13	14	16	16	14	15	14
Mean daily sunshine	6.2	6.8	7.4	8.0	8.2	7.6	6.5	6.1	5.4	5.1	5.5	6.1

5.3 Existing Air Quality

5.3.1 Dust

The 2006 Western Australian Air Quality Monitoring Report (DEC, 2007) includes PM_{10} concentrations based on monitoring at Albany. The 75th percentile concentration measured at a representative monitoring site is generally accepted to be representative of the background quality of the region. The 75th percentile concentration at Albany is 20.2 μg/m^3.

It should be noted that significant contributors to the observed PM_{10} levels in Albany are wood smoke and particulates from vehicles, particularly diesel vehicles. As the Cape Riche Seawater Desalination

Plant site is located in a rural area, an estimated background PM_{10} of 20 µg/m^3 is considered conservative.

No other pollutants are monitored by the regulator in the Albany region.

5.3.2 Odour

There are no available odour studies in the Albany region to obtain baseline odour levels. The Plant site is located on agricultural grazing land. Current odour is therefore related to agricultural sources. No other major odour sources in the area have been identified.

5.4 Sensitive Receptors

A number of sensitive receptors have been identified in the Cape Riche region, based on visiting the site and reviewing aerial photographs, as listed in Table 4.

Whilst the majority of these receptors are unlikely to experience any impact during the construction or operation of the Plant (due to the separation distance), they have been included in this assessment for the purpose of completeness.

Table 4 Sensitive receptors

Receptor name	Location (MGA 94)		Distance from	
	Easting (m)	Northing (m)	Desalination plant (m)	Pump station (m)
Cape Riche camp site	660,570	6,170,184	3,817	1,116
Moir residence	660,857	6,169,143	4,013	564
Lock residence	654,379	6,168,053	2,504	7,118
Turner residence	657,083	6,167,253	1,919	4,782

6. Meteorological Data

6.1 Site Representative Meteorological Data

Odour modelling for the Cape Riche Seawater Desalination Plant requires the use of representative hourly meteorological data spanning a year. Ideally, much of this data would be obtained from observations at the Plant site. Unfortunately, there are no such data available. In such situations, meteorological data from representative sites may be used. Data are deemed to be representative if the meteorological trends, surrounding land uses and topographic features for the site of interest are similar to, or are expected to be similar to, those of the site at which the data were recorded.

The nearest available meteorological observations (temperature (ºC), wind speed (m/s) and direction (degrees)) that are recorded on an hourly basis are Albany Airport AWS (approximately 80 km). Albany is a coastal site and temperature and wind observations are not considered representative of the Plant site due to the difference in orientation of the coastline (i.e. the shape of the coastline and resultant prevailing winds is different).

Meteorological observations (temperature, wind speed and direction) are also available from Jacup AWS, located approximately 90 km from the Plant site. Of available meteorological data in the area, Jacup observations are considered the most representative of the Plant site due to its proximity to the site and the orientation of the coast line. As such, temperature and wind speed and direction have been used to develop a meteorological data file for dispersion modelling.

Cloud cover data is required to determine atmospheric stability (Pasquill stability class) using Turner Workbook method for use in dispersion modelling. Jacup, however does not record cloud cover data. Albany Airport records cloud cover data and these measurements can be considered representative of the Plant site as cloud cover data is not likely to be significantly affected by coastline orientation (as wind conditions would be).

6.1.1 Missing Data

Jacup and Albany Airport observations for 1 January to 31 December 2004 were taken as the representative modelling year. This modelling year contained 99% of the 8,784 potential modelling hours. The data was processed to populate missing data appropriately. Temperature, wind direction and wind speed were averaged from adjacent data points.

Automatic weather stations do not measure wind speeds below 0.5 m/s. To account for this, all wind speeds recorded as <0.5 m/s were adjusted to 0.5 m/s and corresponding wind directions were averaged from adjacent data points with consideration, by a GHD's Meteorologist, of persistence for the longest data gaps.

6.2 2004 Modelling Year

The Jacup AWS station measurements were chosen as representative of the region. Analysis of air temperature, wind speeds and wind direction was undertaken to determine an appropriate modelling year for the study. The 2004 year was chosen as representative of the sites historical conditions as it had slightly below average rainfall, but not significantly so and similar temperature and wind profiles to the average historical measurements.

6.2.1 Temperature

Figure 4 shows the mean maximum temperatures for the chosen modelling year at Jacup AWS. Figure 4 including historical data for the site (1993-2011), shows good correlation between the chosen modelling year and historical trends. It is noted that the modelling year has a lower mean maximum temperature during January, but a higher mean maximum temperature during December.

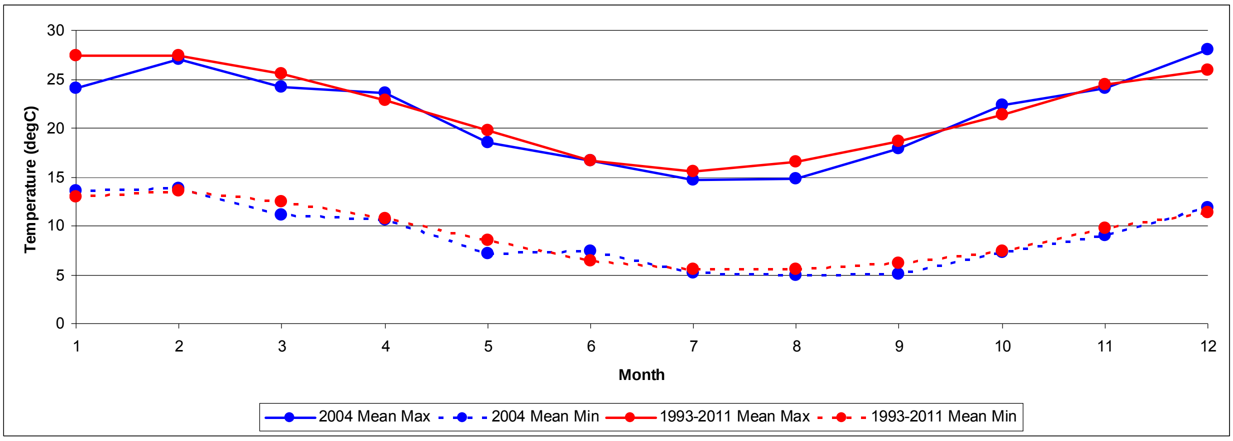


Figure 4 Observed temperatures at Jacup AWS

6.2.2 Wind Distribution

Figure 5 shows the seasonal and annual wind distribution for the 2004 modelling year at Jacup AWS. Figure 5 shows a strong seasonal cycle in wind direction during summer and winter. During summer the winds are predominantly from the south east quadrant, with east south east and easterly winds dominant. This is due to the sub-tropical ridge being mostly to the south of the continent and sea breezes developing on most days. Winter winds are predominantly from the northwest quadrant, with west northwest and westerly winds dominant. This is so because the sub-tropical ridge has migrated north and pre frontal northwest and post-frontal west southwest winds dominate the south coastal regions. Spring and autumn do not show a strong directional dominance as they are transitional seasons.

The predicted annual average wind speed for the site is 4.8 m/s, with higher average wind speeds in summer and spring. Whilst having the highest average wind speed, summer rarely records wind speeds greater than 10 m/s. In contrast, winter, spring and autumn have recorded wind speeds of greater than 10 m/s regularly.

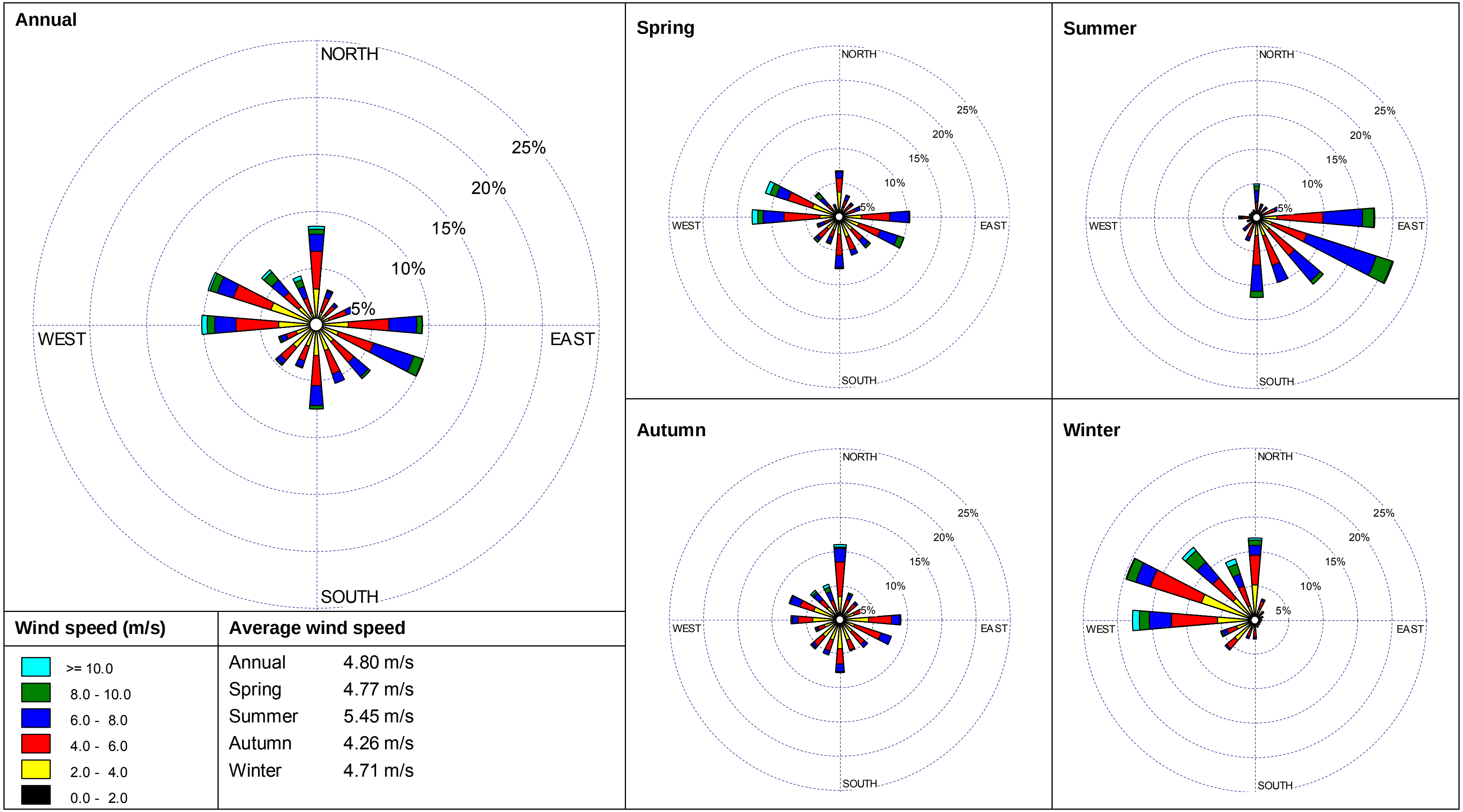


Figure 5 Annual and seasonal wind roses for observed meteorological data at Jacup AWS – 2004 modelling year

6.2.3 Atmospheric Stability

Dispersion modelling requires hourly varying atmospheric stability data, represented as a time series of Pasquill stability categories. Each of these categories can be broadly defined as follows:

- Stability Category A: Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud;
- Stability Category B: Moderately unstable atmospheric conditions occurring between mid–morning to mid-afternoon with light winds or very light winds with some cloud;
- Stability Category C: Slightly unstable atmospheric conditions occurring during early morning to late afternoon with moderate winds or lighter winds with significant cloud;
- Stability Category D: Neutral atmospheric conditions, occurring during the day or night with stronger winds during periods of total cloud cover, or during the twilight periods;
- Stability Category E: Slightly stable atmospheric conditions occurring during the night time with some to significant cloud and/or light to moderate winds; and
- Stability Category F: Moderately stable atmospheric conditions occurring during the nighttime with no significant cloud and light winds.

Table 5 shows the Pasquill stability category classes and illustrates the diurnal distribution for the Plant site based on Jacup AWS winds and Albany cloud cover. The annual and seasonal Pasquill stability class distribution for observed data for the Plant site is shown in Figure 6.

Table 5 shows stable conditions occur at night, which for the site generally occurs between approximately 18:00 and 06:00. Neutral conditions peak during the transitional twilight periods. Unstable conditions peak around the middle of the day when solar radiation and subsequent thermal convection are high. Stable conditions occur frequently, a result of the relatively low average wind speed.

Figure 6 shows that at the site stability classes are distributed across all wind directions. Figure 6 indicates that at the site class stabilities E and F are shown for all wind directions and are predominantly distributed in the south west and north east quadrants. Stability classes C and D are also predominant in the area while A and B classes are infrequent.

Table 5 Stability category distribution at the Plant site

Hour of day[2]	A	B	C	D	E	F
01				73	148	145
02				65	166	135
03				67	149	150
04				69	149	148
05				162	98	106
06			5	251	55	55
07		1	26	339		
08		4	48	314		
09		6	64	296		
10		16	66	284		
11	3	22	78	263		
12	2	35	109	220		
13	2	33	97	234		
14	4	44	80	238		
15		23	61	282		
16		7	60	299		
17		1	24	341		
18			1	303	31	31
19				234	78	54
20				195	92	79
21				174	107	85
22				155	123	88
23				74	140	152
24				65	163	138

[2] Hour 01 is the hour between 00:00 and 01:00.

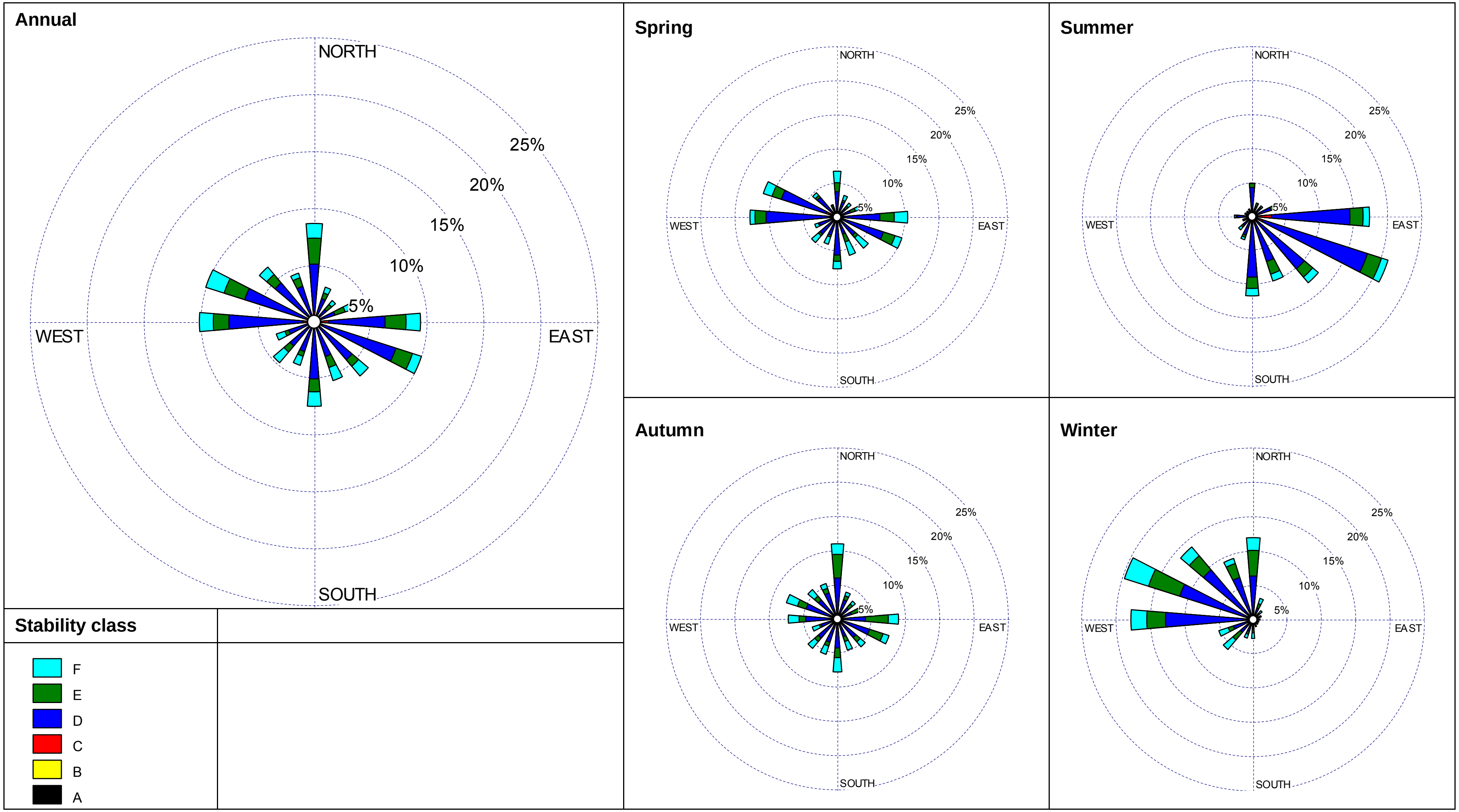


Figure 6 Annual and seasonal stability classes for observed meteorological data at Jacup AWS – 2004 modelling year

7. Construction Assessment

This section outlines assessment of air emissions likely to result during construction of the Cape Riche Seawater Desalination Plant and connecting pipelines.

Potential air quality impacts during construction and site establishment for the plant will be emissions from dust generation from heavy equipment during earthworks, wind erosion from disturbed soil surfaces and heavy vehicle exhaust emissions.

7.1 Construction Dust

The impacts of dust emissions fall under two distinct categories, being health and amenity.

Potential health impacts are attributable to the concentration of respirable particles in ambient air. Respirable particles of dust (PM_{10}), would have maximum impact under light winds and stable atmospheric conditions. These conditions most frequently occur overnight and very early in the morning, and therefore, become more significant only if construction operations extend outside typical operating hours.

The presence of total suspended particles (TSP), greater than 35 micron, is likely to affect amenity by way of reducing visibility (whilst in the air column) and by soiling of materials via dust deposition. Amenity impacts are most marked in high wind conditions, when larger particles may be displaced and transported a significant distance before being deposited and so soiling surfaces. Mitigation of amenity related dust impacts would in turn act to reduce health impacts due to dust emissions.

The extent to which these emissions may impact on the surrounding sensitive land uses would depend upon a number of site-specific factors.

Dust emissions will arise during construction of the plant and the pipelines. The following construction activities involve the movement and placement of soil, rock etc. and can be the source of dust emissions:

- Mechanical disturbance: dust emissions resulting from the operation of construction equipment and vehicles during site earthworks and solid waste removal from site; and
- Wind erosion: dust emissions from exposed and disturbed soil surfaces under high wind speeds during construction.

Extensive inventories (US EPA 2001; NPI 2001) for PM_{10} and TSP emissions from earth moving machinery are commonly used to characterise the source dust emission rates from activities on-site during the construction phase. At this stage, the reference design has not specified the schedule of operations and the exact type and number of dozers, scrapers, trucks and other earthmoving equipment, so that it is not possible to characterise these sources.

Dust emissions during construction are not considered to represent a significant source of emissions. Due to the transient elements of the pipeline construction, dust impacts at any individual site will be limited to when construction activity is within the area. For the construction of the plant and pipelines, a framework which includes a comprehensive range of mitigation measures for the management of dust emissions will be developed as a part of construction dust management measures.

7.1.1 Construction Dust Management Framework

As the reference design has not specified the schedule of operations and the exact type and number of dozers, scrapers, trucks and other earthmoving equipment, it is not possible to characterise construction dust sources. An indicative management framework has been developed and could be applied to ensure dust emissions are managed.

Dust emissions would be controlled by application of a dust management process, defined as part of the site environmental management plan. Using this approach, a staged dust management plan for dust mitigation and management measures would be influenced by the proximity of sensitive receptors along the pipeline route. Due to the separation distance between the plant site and the nearest sensitive receptor, the dust management measures would detail actions for typical dust control.

Typical Dust Management and Mitigation Measures

Typical dust management measures are based on the principles found in the *Environmental Guidelines for Major Construction Sites* (EPA Victoria 1996). From the identification of potential dust emission sources, appropriate dust management and mitigation measures for a typical level of control would include:

- All construction and maintenance equipment/vehicles to be operated and maintained to manufacturers specifications in order to minimise exhaust emissions;
- Defined haul routes to be used wherever it is necessary for vehicles to traverse unsealed surfaces or unformed roads;
- Vehicular speeds would be limited to 15 km/h on areas of unconsolidated or unsealed soil associated with the project;
- Prompt mitigation of visible dust emissions, which may involve a combination of:
  - Stabilisation of surface silt content through application of localised water sprays, or the use of appropriate chemical dust suppressants (suitable for access roads which are traversed less frequently);
  - Control of mechanically induced dust emissions (from clearing, scraping, excavation, loading, dumping filling and levelling activities) by application of water sprays;
  - Awareness of operational areas more frequently exposed to higher winds and the predominant wind directions in these areas at various times of the year. Temporary wind barriers may be employed where necessary;
  - Review of daily weather updates from BoM, or a private meteorology service provider, to give warning of likely strong winds to assist with daily management of wind blown dust from unconsolidated soil surfaces and material stockpiles; and
  - All haulage vehicles are to have their loads covered while transporting material to or from the work area.

High Level Dust Management and Mitigation Measures

It is proposed that a higher-level dust management system operate when the construction operations are within 200 m from sensitive receptors to the construction activity, most likely during construction of the pipelines. It is a requirement to develop a proactive and reactive dust management regime that makes use of real-time particulate monitoring to achieve this level of control. This regime may employ one or two real-time aerosol monitors, with PM_{10} size selective inlets, which will be located between construction operations and the identified sensitive receiver sites. The location of these sites will vary daily as the construction moves along the pipeline alignment.

These real-time monitors can be configured to provide a warning (via an audible or visible signal or as a communication link) of short-term elevations in concentrations of respirable dust. This will enable immediate dust suppression and remediation steps to be initiated. Reactive mitigation measures, to be agreed between the regulator and the contractor, may include:

- Application of additional water sprays; and
- Reducing the intensity of operations, including speed limits.

The threshold particulate concentration for alarm/warning activation would be based on an interpretation of the *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) standard for respirable dust. The Air NEPM 24-hour PM_{10} standard is 50 $\mu g/m^3$ but the short-term trigger level will be agreed with the regulator.

7.2 Heavy Machinery and Plant

Exhaust emissions from heavy vehicles would consist of products of combustion, including oxides of nitrogen (NO_x), sulphur dioxide (SO_2), particulate matter with an aerodynamic diameter of less than 10 and 2.5 micrometres (PM_{10} and $PM_{2.5}$) and volatile organic compounds (VOCs).

Vehicle emissions will arise from diesel powered equipment used during construction. Emissions from heavy equipment will be minimised by ensuring all vehicles on-site are well maintained and operated in an efficient manner.

Exhaust emissions from vehicles on-site are not considered to represent a significant source of emissions.

8. Operational Assessment

This section outlines assessment of odour emissions likely to result from operation of the Cape Riche Seawater Desalination Plant. The assessment includes quantification of odour emission sources, air dispersion modelling and assessment against relevant odour criteria.

8.1 Dispersion Modelling

Given that emission rates for odour sources have not been obtained, odour dispersion modelling was used to determine the upper limit for the source odour emission rate (OER) in order to ensure compliance with odour criteria. These upper limits may then be used as performance criteria for the design. The sections below outline the modelling conducted and results obtained.

8.1.1 AUSPLUME Model

AUSPLUME is a steady state Gaussian plume dispersion model that can be used to predict offsite pollutant concentrations for a wide variety of sources, which include stack, area and volume sources or any combination of these. It is highly flexible and has a range of options, which allow the user to adapt the model to suit particular applications and make best use of available source and meteorological data (EPA Victoria 2000).

8.1.2 AUSPLUME Model Configuration

Key components of the AUSPLUME model configuration are summarised below:

- Ground level concentrations were predicted over a two Cartesian receptor grids, centred over the plant area and the pump station. The plant area was modelled in a 7.5 km grid (75 m grid resolution) and the pump station was modelled in a 2.5 km grid with a 25 m grid resolution;
- A dataset of a year of hourly meteorological data representative of the plant site was developed based on measurements from a nearby BoM AWS site and Albany cloud cover (see Section 6). The modelling was undertaken using meteorological data for the 2004 year;
- Continuous emission rates for odour sources were input into the AUSPLUME configuration file;
- The influence of terrain on the dispersion of odour over the area of interest was considered significant. A terrain file was generated for the modelling domains, with elevations provided at 75 m and 25 m spacing for the desalination plant and pump station, respectively;
- Irwin's 'rural' wind profile exponents were used;
- Default vertical temperature gradients were assumed;
- Plume rise was computed as a function of distance downwind;
- Horizontal dispersion and vertical dispersion was parameterised according to equations for the Pasquill Gifford (sources <100 m high) and Briggs rural curves; and
- An aerodynamic roughness height of 0.3 m was used to represent the area of interest.

Further information on the options selected and the model configuration is provided in the AUSPLUME output files presented in Appendix A.

8.2 Odour Sources

Odour sources are predominantly from:

- Fine screening waste bins (intake pump station):
  - Two fine screening waste bins are located at the intake pump station and have approximate dimensions of 1.5 x 1.5 x 1 m.
- Backwash wastewater treatment (desalination plant):
  - The treatment of the backwash wastewater is predominantly conducted in buildings, or tanks, except for the uncovered sludge thickener tanks and the waste sludge conveyers and bins. The two thickener tanks have a 15 m diameter and are approximately 7.5 m high. Two waste sludge conveyers are located at the east of the dewatering building and empty into four waste sludge bins.

A simulation was conducted to determine the OER limits of the waste sources. The same odour emission rate was used for all sources as there is no literature indicating the relative odour from the various sources.

Table 6 provides a summary of the source parameters used for dispersion modelling.

Table 6 AUSPLUME source parameters

Source	Source ID	Easting (m)	Northing (m)	OER (OU m^3/s)	Horiz. spread (m)	Vert. spread (m)	Height (m)
Intake pump station							
Screen waste bin 1	SCRN01	661,279	6,169,448	1,750	1	0.5	1.5
Screen waste bin 2	SCRN02	661,275	6,169,455	1,750	1	0.5	1.5
Desalination plant							
Sludge thickener 1	TKNR01	656,821	6,169,200	4,000	10	2	7.5
Sludge thickener 2	TKNR02	656,839	6,169,200	4,000	10	2	7.5
Dewatering bin 1	DWTB01	656,837	6,169,188	4,000	2	1	7.5
Dewatering bin 2	DWTB02	656,837	6,169,183	4,000	2	1	3
Dewatering bin 3	DWTB03	656,837	6,169,178	4,000	2	1	3
Dewatering bin 4	DWTB04	656,837	6,169,173	4,000	2	1	3

8.3 Modelling Results

8.3.1 Intake Pump Station

Figure 7 shows the predicted 9th or 44th highest (99.9th or 99.5th percentile) odour concentrations for a source OER of 1,750 OU m^3/s from each of the odour sources at the pump station.

The predicted odour concentration corresponding to Qld EPA (4 OU, 1-hour, 99.5th percentile) and EPA Victoria (1 OU, 3-minutes, 99.9th percentile) odour criteria are represented by blue and green contours, respectively. The predicted odour concentration corresponding to the two part WA EPA odour criteria are represented by orange (2 OU, 3-minutes, 99.5th percentile) and dashed orange (4 OU, 3-minutes, 99.9th percentile) contours, respectively.

The simulation has assumed two full screening bins will be present at any time. This OER has been chosen from the results of a preliminary simulation with nominal OERs. The nominal OERs were then pro-rated to ensure the odour level at the nearest sensitive receptor was compliant with the most stringent odour criteria (EPA Victoria). Table 7 shows predicted 99.9 percentile concentrations at sensitive receptors, as well as the number of exceedances of relevant criteria. As seen in Figure 7 and Table 7, compliance with the most stringent criterion is met at all sensitive receptors.

Table 7 Predicted concentration and frequency values

Receptor	99.9 %ile, 3-min average		99.5 %ile, 3-min average	99.5%ile, 1-hr average
	Predicted conc. (OU)	Criterion conc. (OU)	Predicted # exceedances	Predicted # exceedances
Cape Riche campsite	0.52	1 OU[1] 2 OU[2]	0 of 44 allowed[3]	0 of 44 allowed[4]
Moir homestead	0.76	1 OU[1] 2 OU[2]	2 of 44 allowed[3]	0 of 44 allowed[4]

[1] EPA Victoria criterion

[2] WA EPA criterion

[3] WA EPA criterion is the 99.5 %ile (44th highest), i.e. 44 exceedances allowed

[4] Qld EPA criterion is the 99.5 %ile (44th highest), i.e. 44 exceedances allowed

The design OER for each odour source was chosen as 1,750 OU m^3/s. GHD experience indicates that these concentrations are unlikely to be reached during operations. Odour monitoring at source on commissioning of the pump station will provide odour emission rates and confirm operation of the Plant will not impact local residences.

8.3.2 Desalination Plant

Figure 8 shows the predicted 9th or 44th highest (99.9th or 99.5th percentile) odour concentrations for a source OER of 4,000 OU m^3/s from each of the odour sources at the desalination plant.

The predicted odour concentration corresponding to Qld EPA (4 OU, 1-hour, 99.5th percentile) and EPA Victoria (1 OU, 3-minutes, 99.9th percentile) odour criteria are represented by blue and green contours, respectively. The predicted odour concentration corresponding to the two part WA EPA odour criteria are represented by orange (2 OU, 3-minutes, 99.5th percentile) and dashed orange (4 OU, 3-minutes, 99.9th percentile) contours, respectively.

The simulation has assumed that all thickeners and waste bins will be operational at the same time. This OER has been chosen from the results of a preliminary simulation with nominal OERs. The nominal OERs were then pro-rated to ensure the odour level at the nearest sensitive receptor was compliant with the most stringent odour criteria (EPA Victoria). Table 8 shows predicted 99.9th percentile concentrations at sensitive receptors, as well as the number of exceedances of relevant criteria. As seen in Figure 7 and Table 7, compliance with the most stringent criterion is met at all sensitive receptors.

Table 8 Predicted concentration and frequency values

Receptor	99.9 %ile, 3-min average: Predicted conc. (OU)	99.9 %ile, 3-min average: Criterion conc. (OU)	99.5 %ile, 3-min average: Predicted # exceedances	99.5%ile, 1-hr average: Predicted # exceedances
Cape Riche campsite	0.32	1 OU[1] 2 OU[2]	0 of 44 allowed[3]	1 of 44 allowed[4]
Moir homestead	0.60	1 OU[1] 2 OU[2]	0 of 44 allowed[3]	0 of 44 allowed[4]
Lock homestead	0.29	1 OU[1] 2 OU[2]	0 of 44 allowed[3]	0 of 44 allowed[4]
Turner homestead	0.64	1 OU[1] 2 OU[2]	2 of 44 allowed[3]	0 of 44 allowed[4]

[1] EPA Victoria criterion

[2] WA EPA criterion

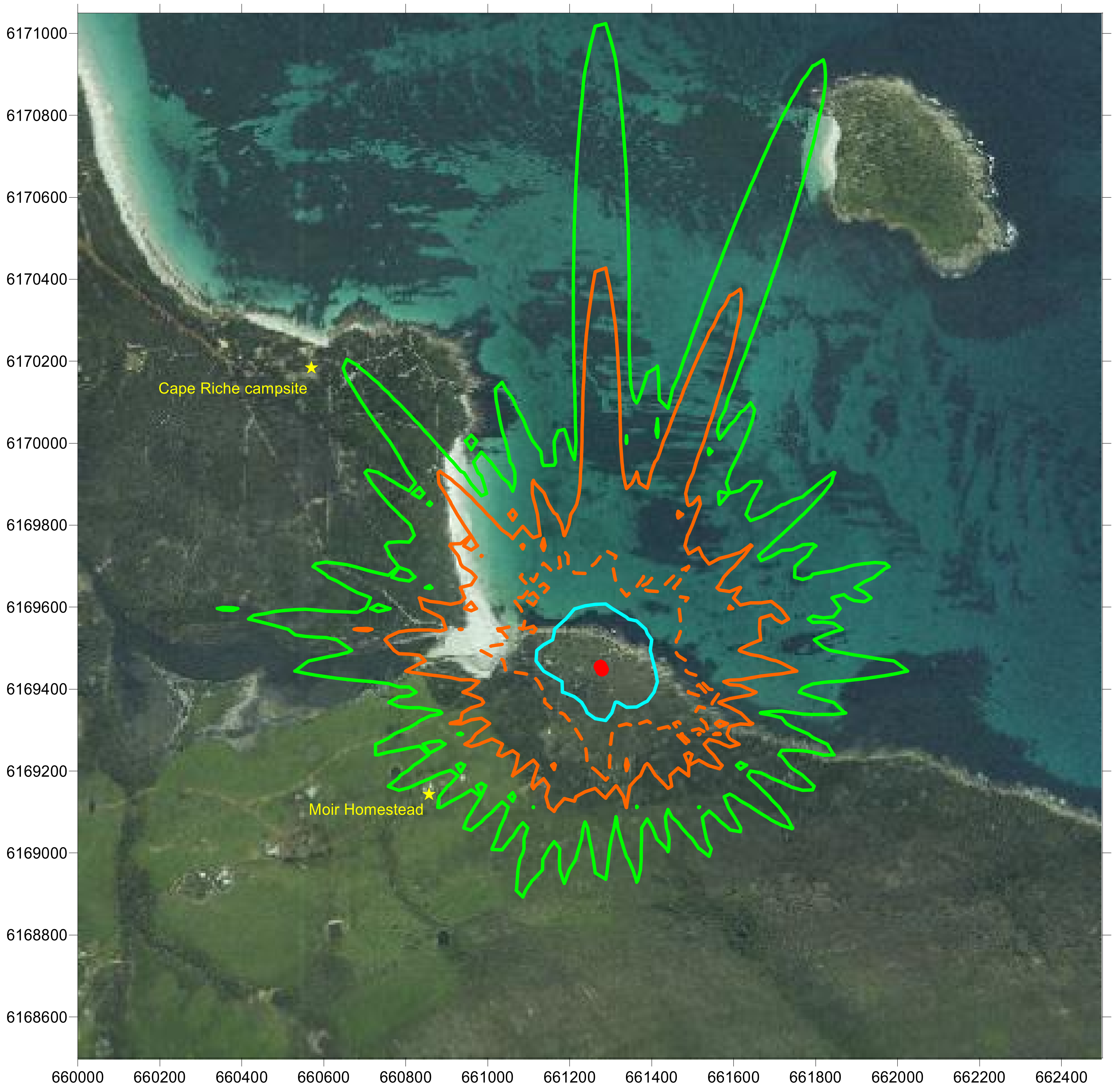
[3] WA EPA criterion is the 99.5 %ile (44th highest), i.e. 44 exceedances allowed

[4] Qld EPA criterion is the 99.5 %ile (44th highest), i.e. 44 exceedances allowed

The design OER for each odour source was chosen as 4,000 OU m^3/s. GHD experience indicates that these concentrations are unlikely to be reached during operations. Odour monitoring at source on commissioning of the desalination plant will provide odour emission rates and confirm operation of the Plant will not impact local residences.

8.4 Odour Impact from Combined Sources

The predicted impacts from the desalination plant and the pump station were not modelled in combination as the hedonic tone of each odour emission will be distinct from each other. The screenings emissions will be distinctly maritime in character, while the dewatered sludge is likely to have a character predominantly formed from the coagulant agents used in the filtering process.



LEGEND

- EPA Victoria 99.9th percentile 3-minute odour criterion
- WA EPA 99.9th percentile 3-minute odour criterion
- WA EPA 99.5th percentile 3-minute odour criterion
- Qld EPA 99.5th percentile 1-hour odour criterion
- Odour source
- Sensitive receptor

SCALE

0 200 400

Metres (at A3)

CREATED	CHECKED	APPROVED
LC	BC	DH

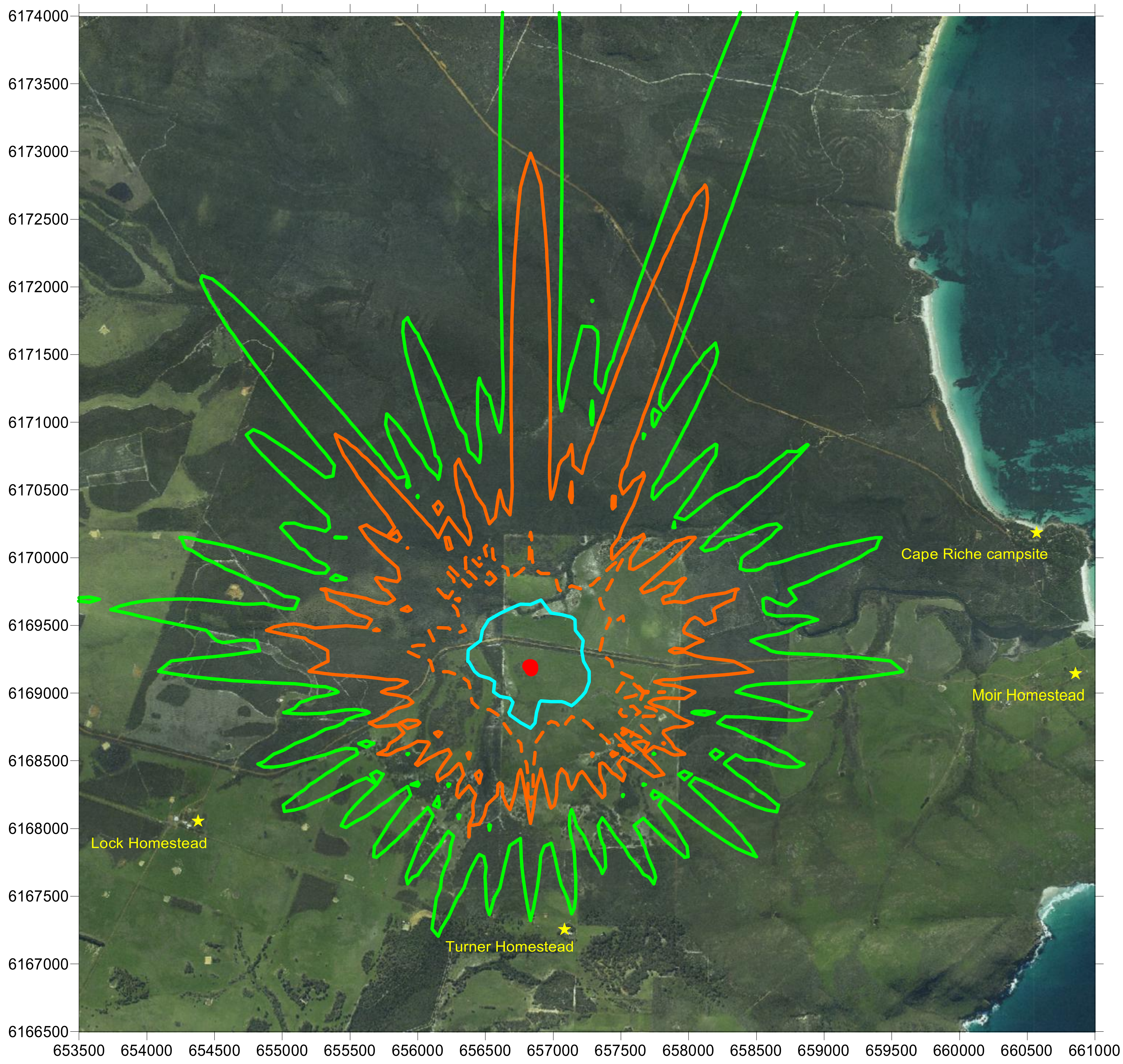
MAP PROJECTION: Universal Transverse Mercator
HORIZONTAL DATUM: Geocentric Datum of Australia (GDA)
GRID: Map Grid of Australia 1994 (MGA94), Zone 50

REVISION	DATE	FILE LOCATION
0	15.04.2011	G:/61/2600510/Tech - AUSPLUME

GRANGE RESOURCES
SOUTHDOWN MAGNETITE PROJECT - CAPE RICHE SEAWATER DESALINATION PLANT

PREDICTED ODOUR CONCENTRATIONS FROM THE INTAKE PUMP STATION

FIGURE 7



LEGEND

- EPA Victoria 99.9th percentile 3-minute odour criterion
- WA EPA 99.9th percentile 3-minute odour criterion
- WA EPA 99.5th percentile 3-minute odour criterion
- Qld EPA 99.5th percentile 1-hour odour criterion
- Odour source
- Sensitive receptor

SCALE

0 500 1000

Metres (at A3)

CREATED	CHECKED	APPROVED
LC	BC	DH

MAP PROJECTION: Universal Transverse Mercator
HORIZONTAL DATUM: Geocentric Datum of Australia (GDA)
GRID: Map Grid of Australia 1994 (MGA94), Zone 50

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0	15.04.2011	G:/61/2600510/Tech - AUSPLUME

GRANGE RESOURCES
SOUTHDOWN MAGNETITE PROJECT - CAPE RICHE SEAWATER DESALINATION PLANT

PREDICTED ODOUR CONCENTRATIONS FROM THE DESALINATION PLANT

FIGURE 8

8.5 Requirement for Best Practice

Best practice for odour abatement from desalination plants is difficult to determine as the composition of the intake screens and biota that will cause odours is not easily known. It is expected that the plant will be operated and managed with the aim to continually improve emissions.

Odour mitigation technologies such as de-odourisation houses have been used on large desalination plants to mitigate odour emissions. De-odourisation houses have not been included in the current desalination plant design. At this stage, it cannot be determined if odour mitigation using a de-odourisation house is required. Odour monitoring at source on commissioning of the desalination plant will provide odour emission rates and confirm the requirements for any additional mitigation measures.

8.6 Odour Abatement Contingencies

8.6.1 Intake Pump Station

The current design does not include odour abatement technologies. It is expected that if measured odour emissions are higher than odour emission limits outlined in this report, mitigation measures will be employed.

A de-odurisation house could be used to decrease emissions from the site. This involves enclosing the pump station and diverting all air flow out of the building into an odour control plant. The odour control plant would use appropriate filter material to remove odourous compounds from the air. A speciation analysis of odour may be used to determine the most appropriate filtration media.

8.6.2 Pre-treatment Wastewater

The current design does not include odour abatement technologies for air emissions. It is noted, however, that the design of the facilities does allow for a covered storage tank with aeration and an enclosed dewatering area.

Additional odour abatement may be achieved by:

- Increasing the rate of removal of stored solids, the primary source of odour at the desalination plant and/or enclosing the conveyor and storage bin area; and
- Chemical dosing.

9. Conclusions and Recommendations

This assessment demonstrates that odour emissions under routine operations can readily meet the EPA criterion at all sensitive receptors, so that odour impact due to site operations will not occur.

This assessment also outlines the measures required in a Dust Management Plan that will ensure that dust emission during the construction phase will be controlled so as not to cause adverse impact at the nearest off-site receptors.

Further quantification of the odour impact cannot be completed at this stage, but can be refined once the results of monitoring during operations are available. However the modelling undertaken in this report indicates that there have been no issues relating to emissions to air from the Plant during either construction or operation phases that might give rise to unacceptable off-site impact.

Hence in relation to dust and odour emissions from the Project, the beneficial use of amenity will be protected provided the dust mitigation measures outlined in this report are implemented and that the performance criteria in this report are applied.

10. Limitations

This *Report for Southdown Magnetite Project – Cape Riche Seawater Desalination Plant – Air Assessment* ("Report"):

1. Has been prepared by GHD Pty Ltd ("GHD") for Grange Resources ("Grange") for the purposes of approvals by State and Federal agencies;
2. May only be used and relied on by Grange and relevant State and Federal approvals authorities;
3. Must not be copied to, used by, or relied on by any person other than Grange or State and Federal approvals authorities without the prior written consent of GHD; and
4. May only be used for the purpose of investigation and analysis to determine the air quality impacts from operation of the Southdown Magnetite Project – Caper Riche Seawater Desalination Plant (and must not be used for any other purpose).

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than Grange arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in Section 1.2 of this Report. It is not the intention of the assessment to cover every element of the air environment, but rather to conduct the assessment with consideration to the prescribed work scope.

GHD accepts no responsibility for the integrity of the software coding of the approved dispersion model (AUSPLUME) used.

GHD has prepared this Report on the basis of information provided by Grange, which GHD has not independently verified or checked ("Unverified Information") beyond the agreed scope of work.

GHD expressly disclaims responsibility in connection with the Unverified Information, including (but not limited to) errors in, or omissions from, the Report, which were caused or contributed to by errors in, or omissions from, the Unverified Information.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation.

11. References

BoM (Bureau of Meteorology), 2010a. *Climate Data Online – Albany Airport (ID: 009741)*. Accessed via http://www.bom.gov.au/climate/data/, 3 February 2011.

BoM (Bureau of Meteorology), 2010b. *Climate Data Online – Jacup (ID: 010905)*. Accessed via http://www.bom.gov.au/climate/data/, 8 February 2011.

DEC (Department of Environment and Conservation), 2007. *2006 Western Australia Air Monitoring Report written to comply with the National Environmental Protection Measure (Ambient Air Quality) Technical Report AQM 2*, July 2007.

GHD, 2008. *Victorian Desalination Project – Gas Fired Power Station Concept Design Report*. Melbourne, June 2008.

Grange Resources Limited/Sojitz, 2010. *Southdown Magnetite and Kemaman Pellet Plant Project Pre Feasibility Study. Section 7 – Infrastructure*. Perth, December 2010.

NPI (National Pollutant Inventory), 2001. *Emission Estimation Technique Manual for Mining – Version 2.3*. Canberra, December 2001.

EPA Victoria (Environment Protection Authority Victoria), 2001. *State Environment Protection Policy (Air Quality Management), Victorian Government Gazette*. Melbourne, December 2001.

EPA Victoria, 2000. *AUSPLUME Gaussian Plume Dispersion Model – Technical User Manual*. Melbourne, November 2000.

EPA Victoria, 1996. *Best Practice Environmental Management - Environmental Guidelines for Major Construction Sites* - Publications 487. Melbourne, February 1996.

US EPA (United States Environmental Protection Agency), 2001. *AP-42: Compilation of Air Pollutant Emission Factors – Fifth Edition*.

Appendix A

Sample AUSPLUME Files

Meteorological data file

Text output file

Jacup with cloud data from Albany Aero All 2004 Data

04010101	17	4.1	110	E	5000	0
04010102	16	3.6	90	E	5000	0
04010103	16	2.6	100	F	5000	0
04010104	16	2.6	90	F	5000	0
04010105	16	2.1	80	D	5000	0
04010106	16	2.1	90	D	5000	0
04010107	16	2.1	50	D	5000	0
04010108	17	2.1	70	D	5000	0
04010109	20	2.0	90	D	5000	0
04010110	26	2.1	110	B	5000	0
04010111	28	2.1	100	A	5000	0
04010112	31	3.1	250	B	5000	0
04010113	33	2.1	240	A	5000	0
04010114	35	2.6	240	A	5000	0
04010115	32	7.2	140	D	5000	0
04010116	30	8.2	130	D	5000	0
04010117	27	8.2	130	D	5000	0
04010118	25	7.7	140	D	5000	0
04010119	22	7.2	150	D	5000	0
04010120	19	7.2	160	D	5000	0
04010121	17	6.7	160	D	5000	0
04010122	16	6.2	170	D	5000	0
04010123	16	5.1	150	E	5000	0
04010124	16	5.7	150	D	5000	0
04010201	16	4.1	150	E	5000	0
04010202	16	4.1	130	E	5000	0
04010203	16	3.6	130	E	5000	0
04010204	16	3.1	150	F	5000	0
04010205	16	2.6	160	D	5000	0
04010206	14	1.5	150	C	5000	0
04010207	16	3.1	160	D	5000	0
04010208	18	4.6	180	D	5000	0
04010209	20	4.1	160	D	5000	0
04010210	22	4.6	160	D	5000	0
04010211	24	4.6	150	D	5000	0
04010212	25	5.7	150	D	5000	0
04010213	26	4.6	120	C	5000	0
04010214	25	6.7	160	D	5000	0
04010215	22	7.2	170	D	5000	0
04010216	20	7.2	160	D	5000	0
04010217	20	6.2	160	D	5000	0
04010218	19	7.2	150	D	5000	0
04010219	18	6.2	140	D	5000	0
04010220	17	5.7	150	D	5000	0
04010221	16	5.1	130	D	5000	0
04010222	15	4.6	140	D	5000	0
04010223	15	4.6	140	E	5000	0
04010224	15	4.6	150	E	5000	0
04010301	15	4.6	150	E	5000	0
04010302	15	3.6	140	E	5000	0
04010303	15	4.1	130	E	5000	0
04010304	15	3.6	130	E	5000	0
04010305	15	4.6	130	D	5000	0
04010306	15	3.1	160	D	5000	0
04010307	15	3.6	130	D	5000	0
04010308	16	4.6	130	D	5000	0
04010309	16	5.1	140	D	5000	0
04010310	16	4.1	70	C	5000	0
04010311	17	4.6	110	B	5000	0
04010312	19	5.1	150	C	5000	0
04010313	19	4.1	140	B	5000	0
04010314	19	6.7	150	C	5000	0
04010315	17	6.2	150	D	5000	0
04010316	17	6.2	150	D	5000	0
04010317	17	7.2	160	D	5000	0
04010318	17	6.7	160	D	5000	0
04010319	16	6.7	150	D	5000	0
04010320	16	6.2	140	D	5000	0

1

FINAL_WA EPA 1

Concentration or deposition	Concentration
Emission rate units	OUV/second
Concentration units	Odour_Units
Units conversion factor	1.00E+00
Constant background concentration	0.00E+00
Terrain effects	Egan method
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Pasquill-Gifford
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.400m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIME: 3 minutes.

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FINAL_WA EPA 1

SOURCE CHARACTERISTICS

VOLUME SOURCE: TKNR01

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
656821	6169200	0m	8m	10m	2m

(Constant) emission rate = 4.00E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: TKNR02

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
656839	6169200	0m	8m	10m	2m

(Constant) emission rate = 4.00E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: CWTB01

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
656837	6169188	0m	3m	2m	1m

(Constant) emission rate = 4.00E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: CWTB02

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
656837	6169183	0m	3m	2m	1m

(Constant) emission rate = 4.00E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: CWTB03

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
656837	6169178	0m	3m	2m	1m

(Constant) emission rate = 4.00E+03 OUV/second
No gravitational settling or scavenging.

VOLUME SOURCE: CWTB04

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
656837	6169173	0m	3m	2m	1m

(Constant) emission rate = 4.00E+03 OUV/second
No gravitational settling or scavenging.

1

FINAL_WA EPA 1

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):
653500.m 653576.m 653652.m 653727.m 653803.m 653879.m 653955.m
654030.m 654106.m 654182.m 654258.m 654333.m 654409.m 654485.m

```
 654561.m  654636.m  654712.m  654788.m  654864.m  654939.m  655015.m
 655091.m  655167.m  655242.m  655318.m  655394.m  655470.m  655545.m
 655621.m  655697.m  655773.m  655848.m  655924.m  656000.m  656076.m
 656151.m  656227.m  656303.m  656379.m  656454.m  656530.m  656606.m
 656682.m  656757.m  656833.m  656909.m  656985.m  657060.m  657136.m
 657212.m  657288.m  657363.m  657439.m  657515.m  657591.m  657666.m
 657742.m  657818.m  657894.m  657969.m  658045.m  658121.m  658197.m
 658272.m  658348.m  658424.m  658500.m  658575.m  658651.m  658727.m
 658803.m  658878.m  658954.m  659030.m  659106.m  659181.m  659257.m
 659333.m  659409.m  659484.m  659560.m  659636.m  659712.m  659787.m
 659863.m  659939.m  660015.m  660090.m  660166.m  660242.m  660318.m
 660393.m  660469.m  660545.m  660621.m  660696.m  660772.m  660848.m
 660924.m  660999.m

 and these y-values (or northings):
6166500.m 6166576.m 6166652.m 6166728.m 6166804.m 6166880.m 6166956.m
6167032.m 6167108.m 6167184.m 6167260.m 6167336.m 6167412.m 6167488.m
6167564.m 6167640.m 6167716.m 6167792.m 6167868.m 6167944.m 6168020.m
6168096.m 6168172.m 6168248.m 6168324.m 6168400.m 6168476.m 6168552.m
6168628.m 6168704.m 6168780.m 6168856.m 6168932.m 6169008.m 6169084.m
6169160.m 6169236.m 6169312.m 6169388.m 6169464.m 6169540.m 6169616.m
6169692.m 6169768.m 6169844.m 6169920.m 6169996.m 6170072.m 6170148.m
6170224.m 6170300.m 6170376.m 6170452.m 6170528.m 6170604.m 6170680.m
6170756.m 6170832.m 6170908.m 6170984.m 6171060.m 6171136.m 6171212.m
6171288.m 6171364.m 6171440.m 6171516.m 6171592.m 6171668.m 6171744.m
6171820.m 6171896.m 6171972.m 6172048.m 6172124.m 6172200.m 6172276.m
6172352.m 6172428.m 6172504.m 6172580.m 6172656.m 6172732.m 6172808.m
6172884.m 6172960.m 6173036.m 6173112.m 6173188.m 6173264.m 6173340.m
6173416.m 6173492.m 6173568.m 6173644.m 6173720.m 6173796.m 6173872.m
6173948.m 6174024.m
```

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	660570	6170184	12.0	0.0	3	654379	6168053	93.0	0.0
2	660857	6169143	19.0	0.0	4	657083	6167253	148.0	0.0

METEOROLOGICAL DATA : Jacup with cloud data from Albany Aero All 2004 Data

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1 Peak values for the 100 worst cases (in Odour_Units)
Averaging time = 3 minutes

Rank	Value	Time Recorded hour,date	Coordinates (* denotes polar)
1	1.48E+03	04,24/05/04	(656833, 6169160, 0.0)
2	1.48E+03	03,05/09/04	(656833, 6169160, 0.0)
3	1.08E+03	02,24/05/04	(656833, 6169160, 0.0)
4	1.08E+03	03,24/05/04	(656833, 6169160, 0.0)
5	1.08E+03	05,03/10/04	(656833, 6169160, 0.0)
6	7.39E+02	05,29/09/04	(656833, 6169160, 0.0)
7	6.54E+02	21,27/09/04	(656833, 6169236, 0.0)
8	5.33E+02	03,04/03/04	(656833, 6169236, 0.0)
9	5.33E+02	03,30/04/04	(656833, 6169236, 0.0)
10	5.33E+02	04,30/04/04	(656833, 6169236, 0.0)
11	5.33E+02	20,10/07/04	(656833, 6169236, 0.0)
12	5.33E+02	21,10/07/04	(656833, 6169236, 0.0)
13	5.33E+02	20,25/07/04	(656833, 6169236, 0.0)
14	5.33E+02	22,25/07/04	(656833, 6169236, 0.0)
15	5.33E+02	23,25/07/04	(656833, 6169236, 0.0)
16	5.33E+02	01,31/08/04	(656833, 6169236, 0.0)
17	5.12E+02	06,02/10/04	(656833, 6169160, 0.0)
18	4.92E+02	01,12/09/04	(656833, 6169160, 0.0)

19	4.30E+02	20,16/05/04	(656833, 6169236, 0.0)
20	4.24E+02	01,30/09/04	(656833, 6169160, 0.0)
21	4.15E+02	01,15/04/04	(656833, 6169160, 0.0)
22	4.15E+02	02,15/04/04	(656833, 6169160, 0.0)
23	3.62E+02	21,27/05/04	(656833, 6169160, 0.0)
24	3.62E+02	22,31/08/04	(656833, 6169160, 0.0)
25	3.62E+02	24,31/08/04	(656833, 6169160, 0.0)
26	3.62E+02	01,23/09/04	(656833, 6169160, 0.0)
27	3.52E+02	20,20/07/04	(656833, 6169160, 0.0)
28	3.52E+02	04,29/09/04	(656833, 6169160, 0.0)
29	3.49E+02	18,27/04/04	(656833, 6169160, 0.0)
30	3.09E+02	23,14/04/04	(656909, 6169160, 0.0)
31	3.09E+02	21,07/08/04	(656909, 6169160, 0.0)
32	3.09E+02	22,07/08/04	(656909, 6169160, 0.0)
33	3.09E+02	24,08/08/04	(656909, 6169160, 0.0)
34	2.98E+02	23,06/03/04	(656757, 6169236, 0.0)
35	2.89E+02	05,01/04/04	(656909, 6169236, 0.0)
36	2.89E+02	02,06/04/04	(656909, 6169236, 0.0)
37	2.84E+02	19,17/04/04	(656833, 6169160, 0.0)
38	2.84E+02	23,06/07/04	(656833, 6169160, 0.0)
39	2.84E+02	04,19/07/04	(656833, 6169160, 0.0)
40	2.84E+02	19,19/07/04	(656833, 6169160, 0.0)
41	2.84E+02	05,20/09/04	(656833, 6169160, 0.0)
42	2.84E+02	02,29/09/04	(656833, 6169160, 0.0)
43	2.84E+02	04,03/10/04	(656833, 6169160, 0.0)
44	2.84E+02	24,08/10/04	(656833, 6169160, 0.0)
45	2.71E+02	03,30/08/04	(656909, 6169236, 0.0)
46	2.67E+02	01,19/04/04	(656833, 6169236, 0.0)
47	2.65E+02	23,19/04/04	(656833, 6169160, 0.0)
48	2.65E+02	05,02/10/04	(656833, 6169160, 0.0)
49	2.58E+02	20,27/04/04	(656833, 6169160, 0.0)
50	2.58E+02	03,20/06/04	(656833, 6169160, 0.0)
51	2.58E+02	18,19/07/04	(656833, 6169160, 0.0)
52	2.58E+02	21,31/08/04	(656833, 6169160, 0.0)
53	2.58E+02	23,31/08/04	(656833, 6169160, 0.0)
54	2.58E+02	22,04/09/04	(656833, 6169160, 0.0)
55	2.58E+02	02,23/09/04	(656833, 6169160, 0.0)
56	2.58E+02	05,23/09/04	(656833, 6169160, 0.0)
57	2.52E+02	24,08/03/04	(656833, 6169236, 0.0)
58	2.52E+02	20,14/05/04	(656833, 6169236, 0.0)
59	2.52E+02	19,27/05/04	(656833, 6169236, 0.0)
60	2.45E+02	20,14/07/04	(656833, 6169160, 0.0)
61	2.44E+02	04,17/10/04	(656757, 6169236, 0.0)
62	2.44E+02	23,03/10/04	(656757, 6169160, 0.0)
63	2.41E+02	05,03/04/04	(656757, 6169160, 0.0)
64	2.39E+02	10,25/06/04	(656833, 6169160, 0.0)
65	2.38E+02	20,17/04/04	(656833, 6169160, 0.0)
66	2.38E+02	01,18/04/04	(656833, 6169160, 0.0)
67	2.38E+02	22,06/05/04	(656833, 6169160, 0.0)
68	2.38E+02	23,14/05/04	(656833, 6169160, 0.0)
69	2.38E+02	03,15/05/04	(656833, 6169160, 0.0)
70	2.38E+02	22,26/05/04	(656833, 6169160, 0.0)
71	2.38E+02	23,26/05/04	(656833, 6169160, 0.0)
72	2.38E+02	24,26/05/04	(656833, 6169160, 0.0)
73	2.38E+02	03,15/06/04	(656833, 6169160, 0.0)
74	2.38E+02	04,15/06/04	(656833, 6169160, 0.0)
75	2.38E+02	23,25/06/04	(656833, 6169160, 0.0)
76	2.38E+02	23,05/07/04	(656833, 6169160, 0.0)
77	2.38E+02	05,19/07/04	(656833, 6169160, 0.0)
78	2.38E+02	21,29/07/04	(656833, 6169160, 0.0)
79	2.38E+02	24,11/09/04	(656833, 6169160, 0.0)
80	2.38E+02	02,12/09/04	(656833, 6169160, 0.0)
81	2.38E+02	05,18/09/04	(656833, 6169160, 0.0)
82	2.38E+02	23,22/09/04	(656833, 6169160, 0.0)
83	2.38E+02	03,29/09/04	(656833, 6169160, 0.0)
84	2.38E+02	01,02/10/04	(656833, 6169160, 0.0)
85	2.38E+02	02,02/10/04	(656833, 6169160, 0.0)
86	2.38E+02	03,02/10/04	(656833, 6169160, 0.0)
87	2.38E+02	04,02/10/04	(656833, 6169160, 0.0)

88	2.38E+02	05,10/10/04	(656833, 6169160,	0.0)
89	2.38E+02	03,16/12/04	(656833, 6169160,	0.0)
90	2.26E+02	06,31/03/04	(656833, 6169236,	0.0)
91	2.26E+02	07,31/05/04	(656833, 6169236,	0.0)
92	2.26E+02	22,12/11/04	(656833, 6169236,	0.0)
93	2.15E+02	02,30/04/04	(656833, 6169236,	0.0)
94	2.15E+02	20,24/06/04	(656833, 6169236,	0.0)
95	2.14E+02	09,25/06/04	(656833, 6169160,	0.0)
96	2.09E+02	01,09/05/04	(656833, 6169160,	0.0)
97	2.09E+02	18,03/06/04	(656833, 6169160,	0.0)
98	2.09E+02	01,20/09/04	(656833, 6169160,	0.0)
99	2.09E+02	03,03/10/04	(656833, 6169160,	0.0)
100	2.09E+02	02,10/10/04	(656833, 6169160,	0.0)

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