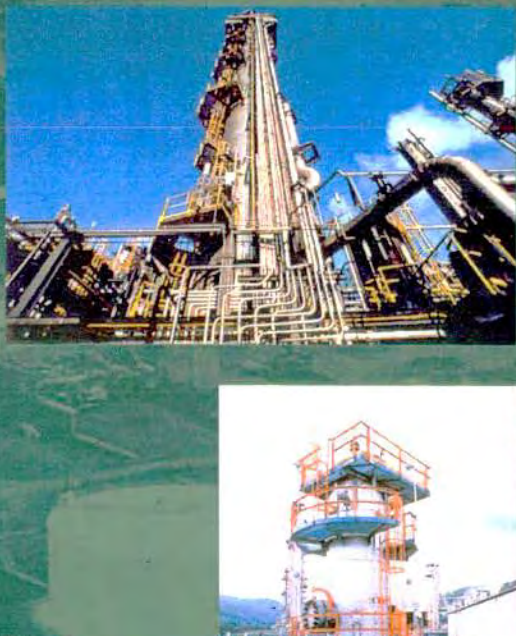
Burrup Fertilisers Pty Ltd

Proposed 2,200 tpd Ammonia Plant, Burrup Peninsula Western Australia

Public Environment Review

August 2001



SINCLAIR KNIGHT MERZ

Public Environmental Review

PROPOSED 2,200 tpd AMMONIA PLANT
BURRUP PENINSULA, WESTERN AUSTRALIA

Prepared for
Burrup Fertilisers Pty Ltd

August 2001

Sinclair Knight Merz Pty Ltd
7th Floor, Durack Centre
263 Adelaide Terrace
PO Box H615, Perth WA 6000
Telephone: (08) 9268 4400
Facsimile: (08) 9268 4488

BURRUP FERTILISERS PTY LTD
Proposed 2,200 tpd Ammonia Plant

INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

Burrup Fertilisers Pty Ltd proposes to construct an export oriented ammonia production plant on the Burrup Peninsula in the King Bay-Hearson Cove area. The proposed location of the plant is approximately 10 and 6 kilometres from the towns of Karratha and Dampier, respectively.

The proposed plant will convert natural gas into liquid ammonia at a design capacity of 2,200 tonnes per day. Ammonia is used in the manufacture of chemicals and fertilisers, and it is expected that at least 80% will be exported to the Oswal Group in India.

In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of four weeks from **Monday 6 August** closing on **Monday 3 September 2001**.

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

WHY WRITE A SUBMISSION?

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

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

WHY NOT JOIN A GROUP?

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

DEVELOPING A SUBMISSION

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

When making comments on specific elements of the PER:

- Clearly state your point of view;
- Indicate the source of your information or argument if this is applicable; and
- Suggest recommendations, safeguards or alternatives.

POINTS TO KEEP IN MIND

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

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

Remember to include:

- Your name and address;
- Date; and
- Whether you want your submission to be confidential.

The **closing date** for submissions is **Monday 3 September 2001**.

Submissions should be addressed to:

The Environmental Protection Authority
Westralia Square
141 St Georges Terrace
PERTH WA 6000
Attention: Graham Storey

Executive Summary

Introduction

Burrup Fertilisers Pty Ltd, the Proponent, proposes to develop an export oriented ammonia plant on land within the King Bay - Hearson Cove Industrial Area on the Burrup Peninsula, Western Australia. The ammonia plant will have a design capacity to produce 2,200 tonnes per day (tpd) of liquid ammonia from natural gas. At least 80% of the plant capacity will be exported to the phosphate complex of the Oswal Group at Paradeep in Orissa State, India.

Previously proposed for the King Bay-Hearson Cove Industrial Area have been an ammonia/urea plant by Plenty River Corporation and a gas to synthetic hydrocarbon plant by Syntroleum Sweetwater.

The Environmental Protection Authority has set the level of environmental assessment for this project as a Public Environmental Review (PER) in recognition of potential environmental impacts and the high public interest in the project.

The purpose of the PER is to:

- Evaluate the significant environmental factors associated with the project; and
- Formulate management and monitoring strategies designed to enhance the positive aspects and minimise any potential adverse environmental impacts.

This document addresses the key environmental factors which have the potential to cause significant biophysical or social effects, or which are known to be of public interest.

Benefits of the Project

The development of the ammonia plant will result in the establishment of a significant value-added processing industry of an estimated capital cost of approximately $630 million. The ammonia plant will generate annual export revenues of $160 million, increased employment and multiplier effects at the local, regional, state and national levels.

The ammonia plant is designed using the latest low energy Purifier Ammonia technology available from Kellogg Brown and Root. The ammonia plant utilises Best Available Techniques (BAT) endorsed by the European Fertiliser Manufacturer's Association to achieve the highest environmental standards of operation.

Project Description

The main components of the project include:

- 2,200 tonnes per day ammonia plant;
- Power plant consisting of 20 MW steam turbines and two gas-fired auxiliary boilers;
- Two vent stacks where gases, excluding ammonia, will be vented with steam during normal operating conditions, start-up and upset conditions;
- Two 40,000 tonne atmospheric pressure, double-walled, double-integrity ammonia storage tanks, complete with flare stack;
- Closed circuit seawater-freshwater cooling system and single seawater cooling tower;
- Supply of 74 TJ/day of natural gas from the Harriet Joint Venture;

- Supply of seawater and freshwater via a thermal desalination plant proposed by the Water Corporation;
- Demineralisation water plant;
- Wastewater treatment plant;
- Ammonia loading and recirculation facilities at the Dampier Public Wharf; and
- Associated support facilities.

This Public Environmental Review document seeks approval to:

- Establish a 2,200 tpd plant; and
- Disturb land, about 28 hectares, within the 72 hectare project lease for the ammonia plant site, construction laydown area and a corridor for the access road and ammonia product pipeline.

Specifically this document does not assess:

- Potential impacts related to the construction of the natural gas pipeline. Approval to construct the pipeline and investigations of environmental impacts will be undertaken by Apache Energy.
- Potential impacts related to the establishment of a thermal desalination plant. This will be provided by the Water Corporation and will be subject to a separate approval process.
- Potential impacts related to the construction of a seawater pipeline and saline water return line from the project lease to Burrup Road. Approval to construct these pipelines and investigations of environmental impacts will be undertaken by the Water Corporation.
- Potential impacts to the marine environment related to the discharge of treated wastewater via the Water Corporation's saline water outlet pipe to King Bay. The Proponent understands that the Water Corporation will seek separate approval from the Department of Environmental Protection for the proposed discharges over and above their current approval.
- Potential impacts to the marine environment from capital and maintenance dredging. Approval to dredge and investigations of environmental impacts from dredging will be undertaken by the Dampier Port Authority.

The ammonia plant is designed for a 25 year operational life and will be operated on a 24-hour basis. Construction is anticipated to commence in March 2002 and will extend over a period of 20 months. During construction, the workforce will peak to 500 people. During the operational phase, the plant will provide a permanent workforce of up to 60 people, with at least 50 people based in the Karratha region. A skilled workforce will be recruited from Western Australia.

Flora, Vegetation and Fauna Habitats

Approximately 28 hectares of the project lease will need to be cleared to accommodate the ammonia plant, construction laydown area and the corridors for the access road and product pipeline. Much of this area occurs in the low-lying areas of the project lease.

The proposed plant layout and infrastructure have been sited to avoid rockpiles and upper slopes which support significant vegetation assemblages, priority flora (*Terminalia supranitifolia*) and habitats for non-molluscan fauna.

The vegetation assemblages occurring on the low-lying areas of the project lease are considered to be the best example of such communities on the Burrup Peninsula. Taking this into consideration and also that the ammonia project is one of several industrial proposals for the King Bay – Hearson Cove

Industrial Area, the Proponent is prepared to replace several prominent flora species and co-operate in the management and monitoring of potential impacts of industry which is to be outlined in a future local management strategy for the King Bay – Hearson Cove Valley.

Marine Environment

Engineering design features and management strategies are proposed to minimise the potential for marine habitats surrounding the Dampier Public Wharf and the mangrove communities of King Bay from being impacted by spills, disposal of contaminated stormwater and ballast water, or leaching of antifouling paints.

To minimise the potential for spills, the Proponent will carefully control the transfer of ammonia from the plant to the vessel. Continuous online monitoring of flow rate and pressure will be undertaken during loading. In the event of an emergency, the flow of ammonia to the ship will be terminated via an automatic shut-off valve and ammonia will be recycled back to the plant through the recirculation line.

In addition to complying with all relevant legislation the Proponent will offer to assist with the implementation of the Port of Dampier's - Marine Pollution Contingency Plan and Environmental Management Plan. The Proponent will also require all ships carrying ammonia product to meet the ballast water requirements of the AQIS guidelines and the Port's Environmental Management Plan.

The uptake of seawater for cooling and the discharge of cooling water blowdown (brine) and treated wastewater will be managed by the Water Corporation according to licence conditions. Dredging required at the Dampier Public Wharf to accommodate the ammonia ships will be managed by the Dampier Port Authority. All necessary environmental approvals for these activities will be sought by the Water Corporation and the Dampier Port Authority, respectively.

Atmospheric Emissions

Under normal operating conditions, the main atmospheric emissions from the ammonia plant will be nitrogen oxides (16.7 g/s) and carbon monoxide (3.41 g/s). To assess nitrogen dioxide against criteria of the National Environmental Protection Measure (NEPM), regional impacts were investigated using a photochemical smog model (TAPM) and local impacts were investigated using the DISPMOD and AUSPLUME models.

The investigation of photochemical smog by CSIRO predicted that the maximum concentrations of ozone and nitrogen dioxide from the simultaneous operation of the proposed ammonia plant, Woodside Petroleum's expanded operations and the Plenty River and Syntroleum plants would be 70 ppb, or 70% of the NEPM standard.

The assessment of maximum NO_x concentrations during normal operating conditions, using the DISPMOD and AUSPLUME models, predicted concentrations well below the NEPM standard. During start-up, maintenance periods and shutdowns and also assuming worst case meteorological conditions, maximum ground level concentrations of NO_2 were well below the NEPM standard. The impacts from flaring were also investigated. Using the most conservative model, AUSPLUME, the maximum NO_2 concentrations were predicted to occur 700 metres to the north of the plant with only a small area to the north and south expected to potentially exceed the NEPM standard. Given the extreme rarity of flaring (less than 1-in-100 years) the probability of the NEPM standard being exceeded was predicted to be only once in 640 years.

Emissions of sulphur dioxides and particulates were predicted to be negligible and well below NEPM standards.

Odour

Ammonia is a colourless gas with a pungent, irritating odour at low thresholds. Odorous emissions of ammonia may only occur on extremely rare occasions when there is a failure of the refrigeration plant belonging to the ammonia storage tanks. In the unlikely event that this occurs, the maximum concentrations of ammonia was predicted to exceed the Victorian EPA guideline of 250 $\mu g/m^3$, but was still only 13% of the odour guideline of 11,700 $\mu g/m^3$ and only 6% of the Workplace exposure standard of 24,000 $\mu g/m^3$. Given the extreme rarity of such an event, the probability of the guideline being exceeded was predicted to be only once every 2800 years.

Greenhouse Gas

Approximately 1,411,000 tonnes per annum of carbon dioxide will be emitted to the atmosphere over the duration of the plant's operating life (25 years). A comparison of greenhouse intensities of the proposed ammonia plant (1.81 t CO_2/ t NH_3) with other ammonia projects in the first instance indicated that the proposed plant is at the upper range of BAT (1.65 – 1.81 t CO_2/t NH_3). However, applying a correction factor of -2.9% to account for the difference in reference conditions, the greenhouse intensity of the proposed KBR technology is more appropriately calculated as 1.76 t CO_2/ t NH_3.

Upon project approval, the Proponent will enter the Greenhouse Challenge and investigate further "beyond no regrets" options including: the potential for downstream processing industries to utilise CO_2 off gas; injection of CO_2 gas into a suitable aquifer or reservoir; or the establishment of tree farms within Australia.

Noise

Noise emissions were modelled for differing meteorological conditions and assessed on a cumulative basis including the Plenty River plant and the Syntroleum plant. Noise modelling of the proposed ammonia plant in isolation indicated that the proposed plant would meet the *Environmental Protection (Noise) Regulations 1997* at Dampier and Hearson Cove. However, based on the preliminary layout of plant components, noise levels at the lease boundary were predicted to exceed criteria by 8 dB(A).

The engineering feasibility study has included substantial provision for noise in the Bankable Feasibility Study to ensure compliance with boundary criteria. Allowing for at least 8 dB(A) reduction in plant emissions by the adoption of noise attenuation controls, the resulting noise levels at Hearson Cove would be in the order of 25 dB(A) to 32 dB(A). This is 5dB(A) less than the predicted noise levels from the approved Syntroleum plant. On this basis the proposed ammonia plant will be an insignificant contributor of noise at Hearson Cove.

Solid and Liquid Waste Management

The proposed ammonia plant will produce a variety of solid and liquid wastes. The main solid waste will be spent catalyst which will be returned to the manufacturer wherever possible. The main liquid waste will be cooling tower blowdown (brine). Cooling water discharge and other process liquid wastes will be treated on site in a Vendor Wastewater Treatment Package prior to discharge to the Water Corporation's saline water outlet pipe. The quality and quantity of treated wastewater discharged to the saline water outlet pipeline will meet the requirements of the Water Corporation and the Department of Environmental Protection.

The Water Corporation will be responsible for obtaining environmental approval to discharge treated wastewater to King Bay via the saline water return outlet pipe. Similar approvals for the discharge of brine via the Water Corporation saline water outlet pipe have been granted for Syntroleum's proposed plant.

Aboriginal Heritage

A large number of archaeological sites have been recorded in the area as a result of previous developments on the Burrup Peninsula. Two previously recorded archaeological sites (DRD136 and DRD138) and one newly discovered archaeological site (BF/FS1) were found within the project lease and these may be impacted by the proposed works. A further seven previously recorded archaeological sites occur within the project lease but are not located within the vicinity of proposed disturbance.

The three sites that may be impacted are all of low archaeological significance. Sites DRD136 and DRD138 were previously recorded by the Department of Resources Development in 1997, however there was no evidence at these reported site locations showing that these sites contain Aboriginal archaeological material.

Permission to disturb the land on which these sites occur will be obtained from the Minister for Aboriginal Affairs under Section 18 of the *Aboriginal Heritage Act 1972* prior to the commencement of construction. The Proponent also commits to the employment of Aboriginal representatives during project works to monitor all ground disturbances and earthworks.

Public Safety

A Preliminary Risk Analysis (PRA) indicated that the plant complies with EPA Criteria for individual risk. The 50×10^{-6} individual risk contour from the Burrup Ammonia Plant does not extend beyond the site boundary. The 10×10^{-6} risk contour extends west over the proposed Plenty River plant and south towards the proposed Syntroleum plant. However, it does not extend far enough east to impact on the Hearson Cove recreational area.

The societal risk from the ammonia plant was also found to be within the tolerable section of the WA societal risk criteria for new plants. This suggests that the risks are acceptable provided that risk reduction measures are considered.

Taking into consideration cumulative risks from nearby proposed industry including plants proposed by Plenty River and Syntroleum, the cumulative risks from these plants are within EPA acceptance criteria. The proposed ammonia plant and the adjacent Plenty River plant both comply with individual risk criteria on their common boundary. The Syntroleum plant is sufficiently removed from the other plants such that it will not be a significant contributor to the cumulative risk levels imposed on either of those industries.

Aesthetics

A three dimensional model was developed to investigate the visual impact of the ammonia plant on users of Burrup Road, Hearson Village Road, Hearson Cove Road and Hearson Cove. The ammonia plant would be visible from Burrup Road and Hearson Cove Road as the surrounding vacant land is low-lying. From Village Road the plant will be largely concealed by the tall rockpiles with the exception of the emission stacks and ammonia flare. From Hearson Cove, the CO_2 stripper stack of the plant would be visible, however the majority of the plant would be concealed behind the sand dunes and vegetation upon the dunes.

The proposed ammonia plant will not impact on the visual amenity of residents in Dampier or any other frequented sites south of Hearson Cove Road.

Extensive lighting is a common characteristic of chemical and industrial plants and is a mandatory safety feature. Residents of Dampier and Karratha and recreational users of Hearson and Cowrie Coves are well accustomed to industrial lighting of nearby industries such as the Woodside LNG plant.

To minimise visual impact, the Proponent will design lighting to best practice and Australian Standards, maintain a high standard of housekeeping and, where possible, blend buildings into the surrounding terrain.

Management Strategies

Management strategies proposed by the Proponent will ensure that impacts on the environment will be minimised during the construction and operational phases of the proposal. A formal Environmental Management System (EMS) will be developed and implemented by the Proponent. All of the management strategies will be detailed in the Environmental Management Plans prepared for the project. A draft Environmental Management Plan outlining the document scope and structure within a formal Environmental Management System is presented in **Appendix G** of this PER document.

The proposed management strategies have been reflected in a series of Proponent commitments, which will be enforced under the following legislative requirements:

- Proponent Management Commitments and Ministerial Conditions of Approval under Part IV of the *Environmental Protection Act 1986*;
- Works Approval Conditions under Part V of the *Environmental Protection Act 1986*; and
- Licensing or Registration Conditions under Part V of the *Environmental Protection Act 1986.*

A summary of the environmental issues related to the development of an ammonia plant and management strategies proposed to minimise environmental impacts is provided in **Table ES1.**

Table ES1 – Summary of Environmental Issue

Environmental Factor	Management Objectivt	Predicted Outcome
BIOPHYSICAL		
Terrestrial Flora *Vegetation Communities*	Maintain the abundance, species ainage lines and diversity, geographic distribution a productivity of vegetation commureloped prior to nsure species tries in the co- ment plan for the	The project will have a direct impact on vegetation assemblages from clearing. This will be unavoidable however the siting of the plant has been optimised to avoid disturbance to the significant rockpiles and the important flora, vegetation assemblages, fauna and heritage attributes associated with the rockpiles.
Terrestrial Flora *Declared Rare and Priority Flora*	Protect Declared Rare and Prioritading Priority Flora Flora, consistent with the provisiorpecies availability the *Wildlife Conservation Act 195(* es will commence Priority 1 Flora	The project will result in the removal of Priority Flora species. Where practicable these species will be re-established as part of the rehabilitation plan.
Terrestrial Fauna *Specially Protected (Threatened) Fauna*	Maintain the abundance, species piles, low lying diversity and geographical distribuınimised. of terrestrial fauna. Protect Speciasence of Priority 4 Protected (Threatened) Fauna, consistent with the provisions of th *Wildlife Conservation Act 1950.* de by the Pebble ior to construction industry to a future	The project will have a direct impact on non-marine molluscan fauna that occur in areas that need to be cleared. The project is unlikely to have a direct impact on larger fauna species but will result in the removal of some habitats.
Marine Ecology including Sea Floor, Marine Flora and Fauna	Maintain ecological integrity and carefully biodiversity and ensure that any mmonia to the impacts on locally significant marir via the recirculation communities are avoided. ality of wastewater quality. Port Authority's EMP	Careful controls and compliance to guidelines and standards will ensure that the project will not adversely impact on the marine environment.
Landform, Drainage and Site Hydrology	Maintain the integrity, functions andisturbance to the environmental values of landformsie project lease. natural surface water drainage. reduce	The need for cut and fill is unavoidable however the impacts on landforms, drainage and site hydrology will be minimised by optimising the plant layout.
Landform, Drainage and Site Hydrology *Impact of High Tide Flow Events*	Protect the hydrological role of theood level. flood plain so that any changes dod and tested prior to result in unacceptable environmen impact. plan will be	The project is likely to have a negligible impact on high tide flow events and the quality of water from such events.
Water Quality	Maintain the quality of surface andANZECC guidelines. groundwater to ensure that existint and storage	The project is likely to have negligible impact on the quality of surface and

Environmental Factor	Management Objective	Existing Environment		Environmental Management	Predicted Outcome
Surface and Groundwater Quality	and potential uses, including ecosystem maintenance, are protected consistent with the National Water Quality Management Strategy – Australian and New Zealand Guidelines for Fresh and Marine Water Quality (*draft* October 2000).	rainfall events. Tidal excursions that occur within the King Bay - Hearson Cove tidal flat area occur during major spring tides. Groundwater levels are shallow and range from 0.1 to 1.1 metres below ground level.	ice er e	vessels will be maintained and inspected regularly.	ground water.
POLLUTION MANAGEMENT					
Atmospheric Emissions *Gaseous and Particulate Emissions.*	(i)Ensure that gaseous emissions, from this proposal in isolation and in combination with emissions from neighbouring sources and background concentrations, do not cause ambient ground level concentrations to exceed appropriate criteria, or cause an environmental or human health/amenity problem; and (ii) Use all reasonable and practicable measures to minimise the discharge of significant atmospheric wastes such as NO_x, SO_X , greenhouse gases, toxic gases, particulates and smoke.	Existing emission sources within the Dampier and Karratha region include Woodside Petroleum's onshore treatment plant on the Burrup Peninsula and Hamersley Irons power station at Parker Point near Dampier. Future emission sources includes expansion of Woodside's LNG processing facilities, the Plenty River plant and the Syntroleum plant. Present concentrations of major photochemical pollutants, NO_2 and ozone are well below the NEPM standards.	mal	The ammonia plant is designed to Best Available Techniques (BAT) as endorsed by the European Fertiliser Manufacturer's Association to minimise emissions to the environment and will be maintained to a high standard.	The project is likely to have a negligible impact on the environment, as gaseous and particulate emissions will comply with NEPM standards.
Atmospheric Emissions *Nitrogen Oxides (NO_x)*	Ambient NO_x levels from the proposal should be compared with the NEPM for ambient air quality, and may be compared to other standards recognised in Australia.	Existing ambient levels of NO_x are well below the NEPM standard.	ve lard. e orth y M nce	The ammonia plant is designed to Best Available Techniques (BAT) as endorsed by the European Fertiliser Manufacturer's Association to minimise emissions to the environment and will be maintained to a high standard.	The project is likely to have a negligible impact on the environment as NO_x emissions will comply with NEPM standards.
Atmospheric Emissions *Photochemical Smog*	Predicted ambient ozone levels from the proposal should be compared with the NEPM for Ambient Air Quality.	The maximum predicted concentration of ozone from the Woodside expansion and Plenty River and Syntroleum plants is below the NEPM standard.	en	The ammonia plant is designed to Best Available Techniques (BAT) as endorsed by the European Fertiliser Manufacturer's Association to minimise emissions to the environment and will be maintained to a high standard.	The project is likely to have a negligible impact on the environment as emissions of NO_2 and ozone will comply with NEPM standards.
Atmospheric Emissions *Odour*	No unreasonable impacts at boundary of the plant and Hearson Cove.	The King Bay – Hearson Cove Valley is currently vacant and there are no sources of odour in the vicinity of the project lease.	e is onia ard. nd an	The ammonia plant is designed to Best Available Techniques (BAT) and will be equipped with double standby support in the event of equipment failures.	The emission of ammonia will only occur on extremely rare occasions and is unlikely to cause nuisance odour effects. There will be a negligible impact on the surrounding environment.
Atmospheric Emissions *Dust*	(i) Ensure that dust generated during construction and operation does not cause any environmental or human health problem or significantly impact on amenity; and (ii) Use all reasonable and practicable measures to minimise airborne dust.	The majority of the Project Lease is uncleared. The nearest sensitive receptors will be at Hearson Cove. Existing concentrations of particulate matter in the wider region are known to have exceeded the NEPM standard 18 times in 2000. This is considered to be the result of distant bush fires, local iron ore stockpiling and ship loading operations.	n ite n a	Dust suppression measures will be used during the construction phase.	Dust and particulate matter are likely to have a negligible impact on the environment, human health or amenity.
Greenhouse Gases	Minimise greenhouse gas emissions in absolute terms and reduce emissions per unit product to as low as reasonably practicable. To mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies.	There are currently no existing sources of greenhouse gas emissions from the project lease.	gas will	The ammonia plant is designed to BAT to minimise CO_2 emissions and includes a range of specific "no regret" measures including: ❑ Adoption of excess air reforming process; ❑ Recovery of waste heat; ❑ Recovery of fugitive emissions; ❑ Use of hydraulic turbines to recover energy; ❑ Export of power and waste heat to thermal desalination plant; and ❑ Use of low CO_2 natural gas.	The project will have reduced emissions of greenhouse gases compared to other ammonia production technologies.

Environmental Factor	Management Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
				Continuing investigation will be undertaken to determine the potential for: ❑ Downstream processing facilities to take CO_2 off gas; ❑ Re-injection of CO_2 into suitable aquifer or reservoir; and ❑ Establishing tree farms in Australia; In line with the Proponent's goal to minimise energy usage and adopt BAT, the Proponent will enter the Greenhouse Challenge upon project "go ahead".	
Waste *Liquid and Solid Waste*	Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on site or disposed of off site at an appropriate facility. Where this is not feasible, contaminated material should be managed on site to prevent groundwater and surface water contamination or risk to public health.	There are currently no existing sources of solid and liquid waste from the project lease.	The construction and operation of the ammonia plant will result in the generation of solid and liquid waste. Major wastes include spent catalyst and cooling water blowdown. Contaminated wastewater has the potential to degrade the existing quality of marine and surface water.	Contaminated stormwater will be collected and treated. All stormwater will be tested prior to being released off-site. Liquid waste streams will meet the requirements of the Water Corporation and DEP. Domestic wastewater will be treated and effluent disposed as per regulatory requirements.	Solid and liquid wastes are likely to have a negligible impact on the environment.
Non-Chemical Emissions *Noise*	Ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the *Environmental Protection (Noise) Regulations 1997*. Protect the amenity of visitors to Hearson Cove.	There are currently no existing sources of noise within the project lease. Background noise levels at Hearson Cove and the project lease vary between 22 dB(A) and 30 dB(A). Background noise levels at the proposed Syntroleum plant site vary between 35 dB(A) and 42 dB(A).	Noise will be generated during the construction and operational phases of the project. Noise modelling of the ammonia plant in isolation indicates that the proposed plant will meet the *Noise Regulations* at Dampier and Hearson Cove. Based on the preliminary layout of plant components, noise criteria at the lease boundary will be exceeded by 8 dB(A)	The layout of plant components will be optimised and noise attenuation measures will be incorporated during the detailed engineering design phase to ensure that boundary noise levels meet criteria.	Boundary noise levels will comply with the *Noise Regulations*. The ammonia plant will be an insignificant contributor to cumulative noise levels at Hearson Cove.
Non-Chemical Emissions *Light*	Manage potential impacts from plant light overspill to visitors at Hearson Cove, as to the loss of amenity.	There is currently no artificial light source located near the project lease. Nearby industry, in particular the Woodside LNG plant and facilities, are well lit at night. The flare from this operation can be seen from Karratha at night.	Light spill may be a nuisance to nearby sensitive receptors and may impact fauna near the project lease.	Lighting of chemical and industrial plants is a mandatory safety feature. Lighting will be designed according to Australian Standards to minimise overspill.	Light overspill is likely to have a negligible impact on users of Hearson Cove and the surrounding environment.
SOCIAL SURROUNDINGS					
Public Safety *Risk and Hazard*	Ensure that risk is managed to meet the EPA's criteria for offsite individual fatality risk (Interim Guidance Statement No. 2), and that ALARP is demonstrated, and the DME's requirements in respect of public safety are met.	The nearest sensitive land uses are Dampier, 6 km to the south, and Hearson Cove, 1.2 km to the east.	The production, handling and transport of hazardous materials has the potential to cause harm or fatality to individuals. A Preliminary Risk Assessment has been undertaken in accordance with Interim Guidance Note No. 2. Individual, societal and cumulative risks are within EPA acceptance criteria, provided risk reduction measures are undertaken.	A Quantitative Risk Assessment will be undertaken during the detailed engineering design phase of the plant. Recommendations to reduce risk will be incorporated into the plant design. The following systems and documentation will be prepared prior to commissioning: ❑ Safety Management System; ❑ Safety Management Plan; and ❑ Emergency Response Plan. During the detailed engineering design phase, emergency release coupling and water curtains/sprays will be included where practicable.	Risks to the public will be acceptable.
Public Safety *Road Transport and Traffic Impacts*	Ensure that roads are maintained and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements.	The project lease is bounded by Hearson Cove Road in the south and Hearson Village Road in the north. Burrup Road is located about 1 km to the west. All of these roads are sealed.	During construction, traffic along Burrup Road will increase due to the construction workforce and transport of materials. Short delays may occur during pipe laying activities. During operation there will be minimal increase in traffic movement.	Traffic delays will be co-ordinated with Main Roads Western Australia and the Shire of Roebourne. A Traffic Management Plan will be developed to meet service and safety requirements.	Appropriate scheduling will attempt to minimise delays and road closure.
Culture and Heritage *Aboriginal Culture and Heritage*	(i) Ensure that the proposal complies with the requirement of the Aboriginal Heritage Act 1972; and (ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Ten archaeological sites occur within the project lease: ❑ One newly discovered site; ❑ Four registered sites; and ❑ Five unregistered sites.	Three archaeological sites will be impacted: ❑ BF/FS1 – shell middens and artefacts; ❑ DRD136 – previously identified by DRD to contain engravings and grindings. However there was no evidence of this material at the reported site location. ❑ DRD138 - previously identified by DRD to contain artefacts and shell accumulations. However there was no evidence of this material at the reported site location.	Aboriginal representatives will be employed during project works to monitor all ground disturbances and earthworks. All sites occurring within the project lease will be pegged and flagged. All personnel will be made aware of the significance of each of the sites. Permission to disturb the three archaeological sites will be sought under Section 18 of the *Aboriginal Heritage Act*.	The loss of three archaeological sites (with archaeological material of two sites not being able to be relocated) will be unavoidable.

Environmental Factor	Management Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Culture and Heritage *Register of the National Estate*	Identify any areas which are in close proximity to the proposal that are listed on the Register on the National Estate or those areas on the Interim List, under the *Australian Heritage Commission Act 1975.*	A search of the Register of National Estate indicates that nine places are listed for the regions of Karratha, Dampier and the Burrup Peninsula. The Dampier Archipelago is the only 'place' that may be impacted by the project.	The Dampier Archipelago may be impacted from spillages of liquid ammonia and oil from vessels, contaminated wastewater, exotic marine species and TBT from antifouling on vessels.	Strategies proposed for the management of wastewater, water quality and marine ecology will be implemented.	It is likely that the project will have a negligible impact on the Dampier Archipelago.
Aesthetic *Visual Amenity and Recreation*	Visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse. Not to compromise recreational uses of the Hearson Cove area, as developed by local authority and planning agencies.	The project lease is currently undeveloped and contains prominent granophyre rockpiles in the north which slope down gradient to the tidal flats in the south.	The ammonia plant will be visible from Burrup Road and Hearson Cove Road. From Hearson Village Road, the majority of the plant will be concealed by the rockpiles. From Hearson Cove, two stacks will be visible from the sand dunes. The remainder of the plant will be concealed by the sand dunes and vegetation upon the dunes.	Little can be done to conceal the plant when viewed from Burrup Road and Hearson Cove Road. Where possible the plant will be coloured to blend into the surrounding terrain. A high standard of housekeeping will be maintained.	The siting of the ammonia plant and infrastructure have been optimised to minimise the impact on significant environmental attributes. Although the ammonia plant will impact the visual amenity from Burrup and Hearson Cove Roads, the appearance of the plant will be consistent with the industrial zoning of the land.

Contents

List of Appendices

List of Tables

List of Figures

List of Plates

1. Introduction

1.1 The Proposal

Burrup Fertilisers Pty Ltd (Burrup Fertilisers) proposes to construct an export oriented ammonia plant in the Dampier region of Western Australia. The proposed plant will convert natural gas into liquid ammonia at a design capacity of 2,200 tonnes per day (tpd). A site has been selected for the ammonia plant and this is located between King Bay and Hearson Cove on the Burrup Peninsula.

The principal objective of the project is to utilise the natural gas resources of Western Australia to establish an export oriented ammonia plant that meets the captive needs of the phosphate complex of the Oswal Group at Paradeep in Orissa State, India. The secondary objectives of the proposal are to:

- Locate the ammonia plant in close proximity to world class natural gas reserves on competitive contract terms;
- Design the ammonia plant using Best Available Techniques (BAT) and state-of-the-art technology as endorsed by the European Fertiliser Industry to reduce energy consumption, minimise emissions and manage potential environmental impacts;
- Construct and operate the plant in compliance with government policy, legislation and regulations;
- Minimise the potential impacts of plant construction and operation on the surrounding natural, cultural and social environments; and
- Contribute to the social and economic growth of Karratha, Dampier and the wider State of Western Australia.

This proposal document has been placed on the website **www.burrupfertilisers.com** to enable a wider circulation of the proposal details for the public.

1.2 The Proponent

The Proponent of the project is:

Burrup Fertilisers Pty Ltd
Level 8
St Georges Square
225 St Georges Terrace
PERTH WA 6000

This company is a private company that is being promoted by Oswal Projects Limited (OPL). OPL is part of the Oswal Group, which has a large natural gas based fertiliser complex at Sahjahanpur in Uttar Pradesh State of India. This complex produces 1,500 tonnes of ammonia per day and 2,600 tonnes of urea per day. Oswal Projects is a well established company having over 25 years experience in the chemical industry and seven years operating experience of ammonia plants. The company has also built the world's largest di-ammonium phosphate (DAP)/nitrogen-phosphorus-potassium (NPK) plant at Paradeep in India, which has been operating since 2000.

1.3 Project Scope and Background

The scope of this proposal is to develop an export oriented ammonia plant and covers the following major components:

- 2,200 tpd ammonia plant;
- Natural gas pipeline to the ammonia plant supplied by others (Apache Energy);
- Primary and secondary reformers (ammonia production unit);
- Captive power plant of up to 20 MW capacity;
- Two 100 tonne/hour package boilers supplying medium pressure steam for plant start-up;
- Two vent stacks where gases, excluding ammonia, will be vented with steam during normal operation, start-up and upset conditions;
- Instrument and service air system including an instrument air drying unit and two air compressors;
- Catalyst loading and unloading facilities;
- Two 40,000 tonne atmospheric pressure, cryogenic ammonia storage tanks, complete with flare stack;
- Closed circuit seawater-freshwater cooling system;
- A single seawater cooling tower;
- Demineralisation water plant;
- Effluent treatment plant;
- Cooling water supply and return lines supplied by others (Water Corporation);
- Thermal desalination plant supplied and operated by others (Water Corporation);
- Sulphuric acid and caustic unloading, storage and distribution facilities;
- Inert gas generation unit of gaseous nitrogen and on-site storage of liquid nitrogen;
- Two 2.0 MW emergency diesel generators;
- Ammonia loading and recirculation facilities at the Dampier Public Wharf;
- Operational aspects of the ammonia pipeline from the plant to the Dampier Public Wharf;
- Dredging and upgrade of the Dampier Public Wharf for shipping of ammonia supplied by others (Dampier Port Authority); and
- Associated support facilities.

Some of the above facilities will be provided by others, namely Apache Energy, the Water Corporation and the Dampier Port Authority, under commercial arrangement with the Proponent. Environmental permits and approvals for the facilities provided by others will be sought by the nominated proponent as a separate process to this Public Environmental Review.

This Public Environmental Review document seeks approval to:

- Establish a 2,200 tpd plant; and
- Disturb land, about 28 hectares, within the 72 hectare project lease for the ammonia plant site, construction laydown area and a corridor for the access road and ammonia product pipeline.

Specifically this document does not assess:

- Potential impacts related to the construction of the natural gas pipeline. Approval to construct the pipeline and investigations of environmental impacts will be undertaken by Apache Energy.
- Potential impacts related to the establishment of a thermal desalination plant. This will be provided by the Water Corporation and will be subject to a separate approval process.
- Potential impacts related to the construction of a seawater pipeline and saline water return line from the project lease to Burrup Road. Approval to construct these pipelines and investigations of environmental impacts will be undertaken by the Water Corporation jointly with the approval process for the thermal desalination plant.
- Potential impacts to the marine environment related to the discharge of treated wastewater via the Water Corporation's saline water outlet pipe to King Bay. The Water Corporation currently has approval to discharge saline water to King Bay. The Proponent understands that the Water Corporation will seek separate approval from the Department of Environmental Protection for the proposed discharges over and above their current approval.

Potential impacts to the marine environment from capital and maintenance dredging. Approval to dredge and investigations of environmental impacts from dredging will be undertaken by the Dampier Port Authority.

Preliminary details of this project were referred to the Environmental Protection Authority (EPA) in March 2001 through the submission of a Project Definition Document (Sinclair Knight Merz, 2001). The EPA determined that the proposal would be assessed as a Public Environmental Review (PER) under Part IV of the *Environmental Protection Act 1986.* To provide the Proponent adequate guidance to assess environmental factors relevant to the project, the EPA issued a set of guidelines. These guidelines contain the following information:

- Part A: Specific guidelines for the preparation of the Public Environmental Review document;
- Part B: Generic guidelines for the preparation of an environmental review document;
- Attachment 1: Example of the invitation to make a submission;
- Attachment 2: Advertising the environmental review;
- Attachment 3: Project location map;
- Attachment 4: Air quality and air pollution modelling guidelines; and
- Attachment 5: Scope of work for a Preliminary Risk Assessment.

The specific guidelines (Part A) are provided in **Appendix A**. The generic guidelines and attachments are available upon request.

Similarly, the project was referred to Environment Australia under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* where details of the project were outlined in a Referral Form. The referral concluded that there would be no impact on matters of national environmental significance.

This referral was placed on the *EPBC Act* website (**www.ea.gov.au/epbc/**) established by Environment Australia for public comment. Following review, the Commonwealth Minister for the Environment and Heritage, Mr Robert Hill, confirmed on 2 April 2001 that the proposed project is not an action affected by the controlling provisions of the *EPBC Act* (**Appendix B**). Environmental approval for the project is therefore required through the State environmental assessment process only and will not require further approval from the Commonwealth level to allow the project to proceed.

1.4 Project Schedule

The export oriented ammonia plant is designed for a 25 year operational life. A Pre-feasibility Study has been completed for the project and a Bankable Feasibility Study is in preparation. **Table 1-1** lists the milestone targets and dates for the project.

Table 1-1 Key Project Milestones

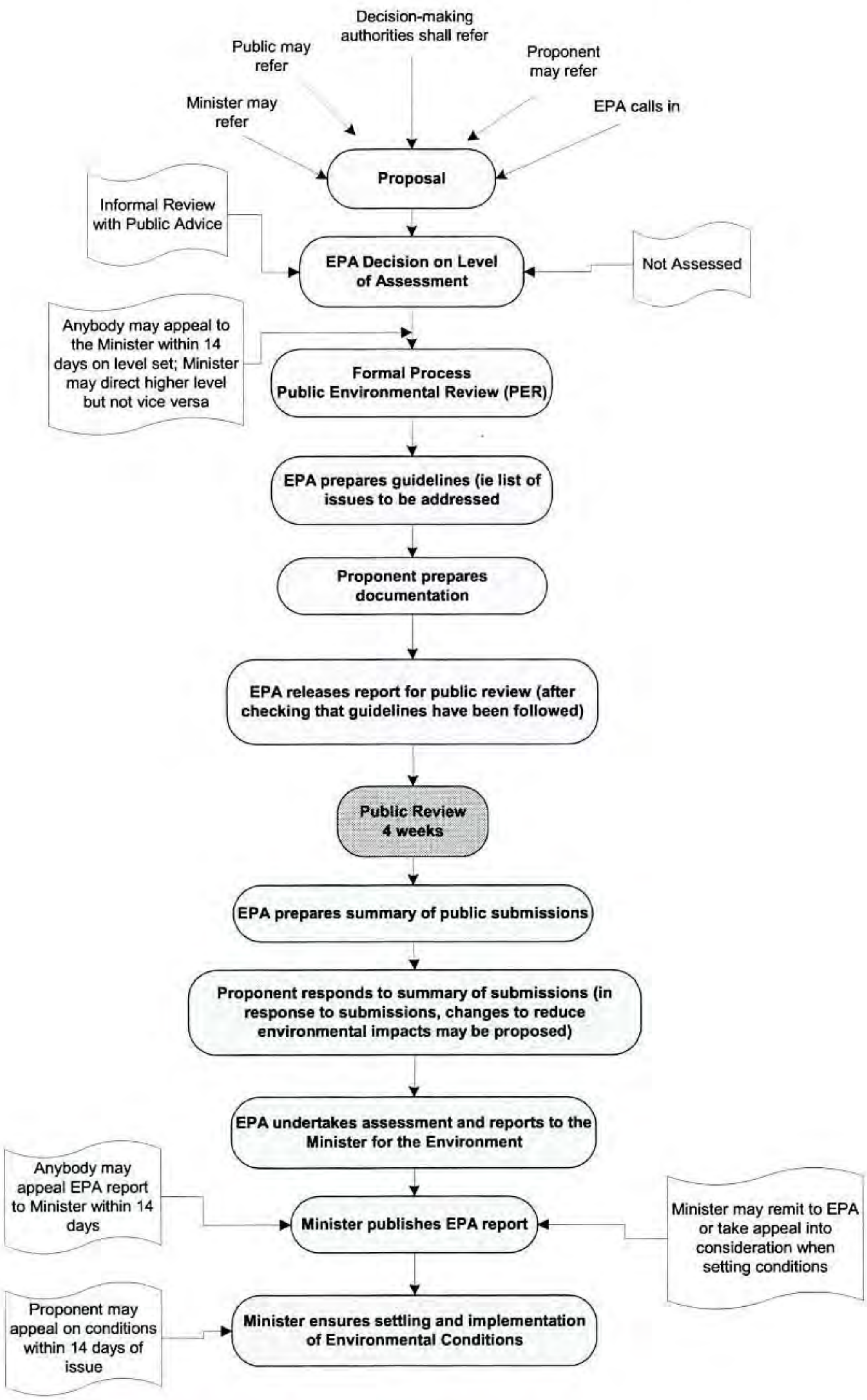
Milestone	Date
Completion of Bankable Feasibility Study	August 2001
Commencement of Detailed Engineering	September 2001
Works Approval Application	January 2002
Commence Site Preparation	March 2002
Complete Plant Construction	December 2003
Commissioning of Plant	July 2004

1.5 Legislative Framework and Environmental Approval Process

The Environmental Impact Assessment (EIA) procedure is a formalised process designed to provide information to the EPA, the Department of Environmental Protection (DEP) and the public about proposed developments with the potential to impact on the natural and social environment.

The Project will be assessed under the provisions of Part IV of the Western Australian *Environmental Protection Act 1986*. Administrative procedures associated with this assessment are illustrated in **Figure 1-1.**

Figure 1-1 Environmental Impact Assessment Process Flow Chart



The PER is a public document and is subject to a four week public review period, during which the public and other groups are invited to make submissions to the EPA. The EPA will then assess the proposal with consideration of:

- Issues raised by the public;
- The Proponent's response to those issues;
- Specialist advice from government bodies;
- EPA's own investigations and research; and
- Research undertaken by other expert agencies, if required.

The EPA will then submit its report and recommendation to the Minister for the Environment on the environmental acceptability of the project and the environmental conditions which should apply if the project is to proceed.

The EPA's report will be published in the form of a "Bulletin" and the public may appeal to the Minister against the content of the report or its recommendations. The final decision on whether the project may proceed will be made by the Minister with consideration of any appeals. Following the issue of environmental conditions of approval from the Minister for Environment under Section 45 of the *Act*, works approvals and permits can then be issued by the other decision-making authorities to allow construction to commence.

1.6 Relevant Legislation

In addition to gaining environmental approval from the Minister for Environment, the Proponent is required to comply with other legislation and regulations. A summary of key legislation and regulations include and are not limited to (**Table 1-2**):

Table 1-2 Key Environmental Legislation

Legislation/Regulation	Application	Administrator
Aboriginal Heritage Act 1972-1980	Protects Aboriginal sites from disturbance	Aboriginal Affairs Department
Agriculture and related Resources Protection Act 1976	Management of weeds and pests	Agriculture Western Australia
Australian Heritage Commission Act 1975	Identifies areas of national heritage significance	Australian Heritage Commission
Bush Fires Act 1974	Manages fire safety	Bush Fires Board
Conservation and Land Management Act 1984	Protection and management of nature reserves, state forest, marine parks etc	Department of Conservation and Land Management
Clean Air Regulations 1967	Regulates air borne emissions	Department of Environmental Protection
Dampier Port Authority Act 1985	Protects marine waters within the boundaries of the Dampier Port Authority	Dampier Port Authority
Dangerous Goods Regulations 1992	Regulations for management and handling of dangerous goods	Department of Minerals and Energy
Environment Protection and Biodiversity Conservation Act 1999	Protects matters of national environmental significance	Environment Australia

Legislation/Regulation	Application	Administrator
Environmental Protection (NEPM-NPI) Regulations 1998	Requires industries to estimate emissions to air, land and water on an annual basis	Environment Australia
Environmental Protection (Noise) Regulations 1997	Noise limits, methods for noise assessment and control	Department of Environmental Protection
Environmental Protection (Liquid Waste) Regulations 1996	Control and abatement of liquid waste	Department of Environmental Protection
Environmental Protection (Sea Dumping) Act 1981	Permits for dumping dredge spoil at sea	Environment Australia
Environmental Protection Act 1986	Prevention, control and abatement of pollution and conservation protection and enhancement of environment	Department of Environmental Protection
Explosives and Dangerous Goods Act 1961-1986	Regulates the manufacture, use and storage of explosives & dangerous goods	Department of Minerals and Energy
Fisheries Resources Management Act 1984	Conservation and development of fish resources within the State	Fisheries WA
Health Act 1911	Provides regulation for the protection of public health eg sewage disposal	Department of Health
Marine and Harbours Act 1981	Provision of safe and efficient shipping and boating	Transport WA
Native Title Act 1993	Handles Aboriginal claims for land ownership	Aboriginal Affairs Department
Ozone Protection Act 1989 (Federal)	Controlling the manufacture of ozone depleting substances	Environment Australia
Pollution of Waters by Oil and Noxious Substances Act 1987	Protection of sea and certain waters from pollution by oil and other pollutants. Inspection of vessels and infrastructure	Department of Environmental Protection
Port Authorities Act 1999	The control, management and operation of ports	WA Ports
Shipping and Pilotage Act 1967	Shipping and pilotage in and about the ports, fishing boat harbours and mooring control areas of the State	Transport WA
Soil and Land Conservation Act 1945	Prevents disturbance to soil without authority	Agriculture Western Australia
State Planning Commission Act 1985	Controls land development in the state	Ministry for Planning
Waterways Conservation Act 1976	Conservation and management of waters and the associated land and environment	Water and Rivers Commission
Western Australian Marine Act 1982	Regulation of navigation and shipping	Transport WA
Wildlife Conservation Act 1950	Protection of rare and endangered flora and fauna	Department of Conservation and Land Management

1.7 Scope, Purpose and Structure of the Public Environmental Review

This document forms the Public Environmental Review for the ammonia plant proposed by Burrup Fertilisers Pty Ltd, as required under Part IV of the *Environmental Protection Act 1986*. This document aims to identify and assess the environmental effects of the proposal and to describe the management strategies the Proponent will adopt to manage and minimise any adverse environmental impacts. In doing so, management strategies are used to form a series of Proponent commitments, which will form the basis of environmental approval for the project. This document provides the following information:

- Introduction to the project, overview of the environmental approval process and purpose of the Public Environmental Review (**Section 1**);
- Project location and status of the land tenure (**Section 2**);
- Background to the ammonia substance, project benefits, justification and evaluation of alternatives (**Section 3**);
- Detailed description of the works proposed for the establishment of an ammonia plant (**Section 4**);
- Environmental and social setting of the project (**Section 5**);
- Potential construction impacts and proposed management and monitoring strategies (**Section 6**);
- Potential operational impacts and proposed management and monitoring strategies (**Section 7**);
- Potential impacts and proposed management and monitoring strategies on the social surroundings of the project area (**Section 8**);
- Comments and input from public consultations (**Section 9**);
- Summary of Proponent commitments (**Section 10**);
- EPA guidelines for the Public Environmental Review and correspondence from the Commonwealth Minister for Environment and Heritage (**Appendix A and B**);
- Supporting technical information related to the proposal (**Appendices C to F**); and
- Draft Environmental Management Plan (**Appendix G**).

1.8 Identification of Environmental Issues

The Proponent has held preliminary consultations with government authorities and community stakeholders involved with the ammonia plant. Preliminary consultations to date have included meetings, media releases and an establishment of a website (www.burrupfertilisers.com) with the primary objective of identifying key environmental issues.

Table 1-3 provides a list of the government authorities and community groups that were consulted during the preliminary consultation phase and the environmental issues that were specifically raised by each organisation. It is acknowledged that although some organisations may have focussed on a limited number specific environmental issues during the preliminary consultations, they will likely be interested in many of the other environmental issues associated with the project.

Table 1-3 also provides reference to the relevant section in the PER document where these issues are discussed in further detail.

The Proponent will continue to consult with government authorities and community stakeholders throughout the formal public review process. Section 9 outlines the proposed program of consultation.

Table 1-3 Environmental Issues identified during Preliminary Consultations

Environmental Issues	Organisation																					
	Section in PER Document	Aboriginal Affairs Department	Apache Energy	Dampier Archipelago Preservation Association	Dampier Port Authority	Department of Conservation and Land Management	Department of Environmental Protection	Department of Land Administration	Department of Minerals and Energy	Department of Resources Development	Karratha Chamber of Industry and Commerce	Main Roads Western Australia	Mermaid Marine	Ministry for Planning	Native Title Claimant Groups	Nickol Bay Naturalists Club	Office of Energy	Pilbara Development Commission	Roebourne Shire Council	Water and Rivers Commission	Water Corporation	Western Power
BIOPHYSICAL ISSUES																						
Flora and Fauna	5.7; 6.1.1; 6.1.2						✓								✓							
Conservation Areas	5.7; 6.1.1; 6.1.2					✓									✓	✓						
Marine Environment	5.9; 7.1.1			✓											✓							
Mangroves	5.9; 7.1.1					✓									✓	✓						
Flood, Storm/ Tide Levels	5.2.5; 5.2.6; 5.5; 6.1.4									✓			✓					✓				
POLLUTION ISSUES																						
Atmospheric Emissions	7.2.1					✓	✓				✓				✓	✓						
Dust	6.2.1; 7.2.9					✓	✓															
Odour	7.2.1.10					✓																
Noise	6.2.2; 7.1.2					✓	✓															
Wastewater	4.4.6.4; 6.2.3.2; 7.1.2; 7.1.1.4; 7.1.3.1									✓					✓				✓		✓	
Ballast Water	7.1.1.5			✓		✓																
Brine Return	4.4.6.4; 6.2.3.2; 7.1.2; 7.1.1.4; 7.1.3.1			✓																		
Hazardous Materials	7.1.3.4								✓													
SOCIAL ISSUES																						
Aboriginal/European Heritage	8.5; 8.6	✓					✓								✓							
Recreation (Hearson and Cowrie Coves)	8.7	✓		✓		✓					✓			✓	✓	✓		✓	✓			
Workforce & Accommodation	4.6							✓			✓			✓				✓	✓			
Community Benefits	3.4										✓								✓			
Public Safety	8.2				✓		✓		✓													
Visual Amenity	8.4						✓															
Land Tenure		✓						✓	✓	✓												✓
INFRASTRUCTURE AND ENGINEERING ISSUES																						
Service Corridors	2.2; 4.3.1; 4.4									✓		✓										✓
Road Upgrades	4.4.1; 8.2.2											✓										
Pipeline Logistics	4.4.2; 4.4.3; 4.4.5; 4.4.6		✓				✓			✓		✓					✓				✓	
Power Supply	4.4.7																✓					✓
Port Loading Facilities	4.4.4				✓																	
Port Upgrade	4.4.5; 7.1.1.7				✓					✓												
Shipping	4.4.5				✓																	
Landing Facility	4.4.4				✓	✓				✓	✓		✓		✓	✓						
OTHER ISSUES																						
Co-ordinated Project Planning for Burrup	N/A									✓	✓			✓				✓	✓		✓	
Project Referral under *EPBC Act*	1.3						✓															

2. Project Location

The proposed site for the ammonia plant is located on the Burrup Peninsula which is in the northwest Pilbara region of Western Australia, approximately 1,300 kilometres north of Perth. The Burrup Peninsula extends approximately 20 kilometres north of the coast into the Dampier Archipelago and is surrounded by the shallow waters of Nickol Bay to the east and Mermaid Sound to the west.

The close proximity of the Peninsula to world scale mineral deposits and abundant natural gas resources makes it a strategic area for petroleum based resource development projects. The Peninsula has well-established port facilities, infrastructure, utilities and social fabric. This has awarded the area recognition for being a major industrial and port site in Australia.

The area also supports a rich marine and terrestrial flora environment and is known to consist of the world's richest concentration of indigenous rock art worthy of preserving.

Major resource developments that are currently present on the Burrup Peninsula include:

- Liquefied natural gas production and export;
- Domestic gas treatment;
- Iron ore export; and
- Solar salt production and export.

The selected project site is a lease of about 72 hectares in area and is located between King Bay in the west and Hearson Cove in the east (**Figure 2-1**). The site is approximately 10 and 6 kilometres from the towns of Karratha and Dampier respectively. The site is located on crown land within the Shire of Roebourne and has been identified for industrial use in the Burrup Peninsula Land Use Plan and Management Strategy (O'Brien Planning Consultants, 1996), which was endorsed by Cabinet.

2.1 Land Use Planning

Land use planning for the Burrup Peninsula is governed by a number of planning strategy documents that have been developed in the past five years. The following documents have provided a direction for planning in Karratha as well as the Burrup Peninsula:

- An Overview of Future Development in the Karratha/Dampier Region – to 2010: Identification of Planning Requirements and Management Options (December 1995);
- Burrup Peninsula Land Use Plan and Management Strategy (September 1996);
- Pilbara Land Use Strategy (July 1997);
- State Planning Strategy (December 1997); and
- Karratha Area Development Strategy (April 1998).

Providing specific planning strategies and guidance for development on the Burrup Peninsula is the Burrup Peninsula Land Use Plan and Management Strategy. This Strategy was developed for:

'*The allocation of vacant Crown land to assist in meeting the strategic industrial land requirements of the State and to preserve the quality of the outstanding natural resources and cultural heritage while also providing for the recreational and educational needs of the general public*'.

Five industrial areas, covering a total area of 1,820 hectares have been allocated by Government for future industry use with each area having defined development values and management objectives. The following development value for the King Bay-Hearson Cove Industrial Area is stated in the plan:

'This area is strategically located to accommodate major new resource developments. It contains the largest expanse of relatively flat land on the Peninsula. The Area contains some environmental and heritage values but not in such concentrations as on other parts of the Peninsula. An important mangrove community is located on the western margin of this Area. Parts of the Area have been utilised in the past for the Woodside Construction Village, laydown area and lime sand mining. Access to recreation areas at Hearson Cove and Cowrie Cove currently transect the Area.'

The management objectives stated for this Industrial Area are:

- *To use the Area for strategic industries that depend on proximity to the major industries and port facilities in the Burrup west and Conzinc South Areas;*
- *To ensure that the impact of development on the mangroves in King Bay and on recreation at Hearson Cove is minimised;*
- *To minimise the impact of industry on the adjacent Conservation, Heritage and Recreation Area; and*
- *To collect and review data on the known or likely impact of storm surge and tsunamis on the Area.*

Policy statements made for this Industrial Area are:

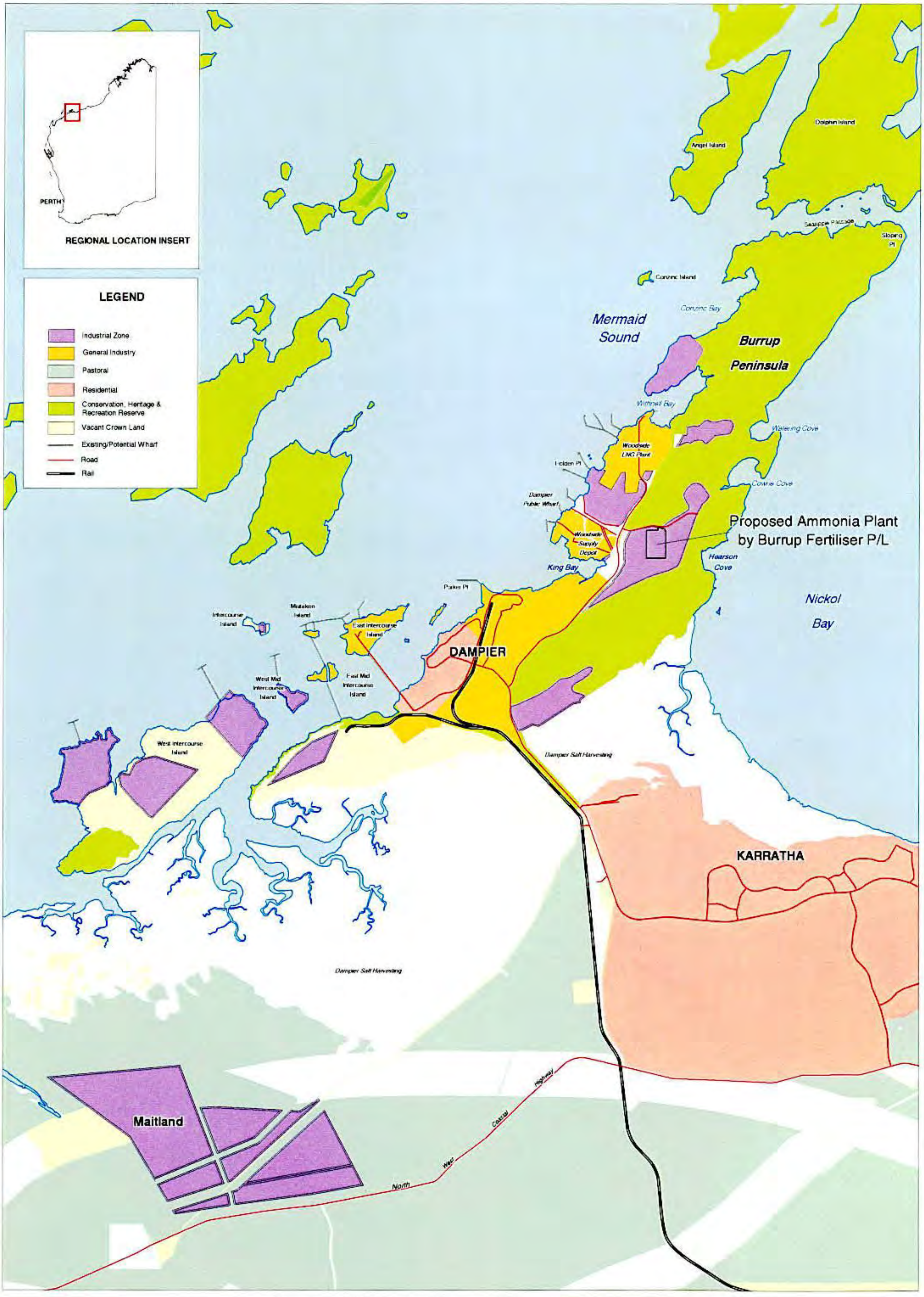
- *The mangroves in King Bay are to be protected by ensuring appropriate controls on effluent discharge and fugitive emissions, and by detailed assessment of the impact of development on the local hydrology;*
- *Development should be designed and located to minimise impacts on values (including landscape) of the adjoining Conservation, Heritage and Recreation Area;*
- *Storm surge should be considered in the design of developments;*
- *A Hearson Cove/Cowrie Cove access route which avoids transecting the Industrial Area should be investigated.*

This Public Environmental Review document addresses the environmental issues that are raised in these management strategies and policy statements to ensure that the proposed ammonia plant complies with the planning objectives of the King Bay – Hearson Cove Industrial Area.

2.2 Land Tenure

The proposed ammonia plant site is intended to be established on land currently designated as Unallocated Crown Land (UCL). This land, together with a small portion of UCL through which the ammonia pipelines pass, is the subject of the State's intention to take interests, including the compulsory acquisition of Native Title rights and interests pursuant to the *Land Administration Act 1997*. Under the *Native Title Act 1993* (NTA) the lease area and selected pipeline corridors will become the subject of negotiation with the following three Native Title claimant groups as the Proponent will seek tenure to this area in the form of a lease:

- Ngaluma-Injibandi;
- Wong-Goo-Tt-Oo; and



SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT

LOCALITY MAP

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 2.1

Client: Burrup Fertilisers Pty Ltd
Job No: De01890
Date Drawn: 21 July 2001
File Name: location_mapfig21.wor
Map: A4-6921 Rev 1

- Yaburara and Coastal Mardudhunera people.

The elements of negotiation and consultation as identified by the Proponent pursuant to the *Native Title Act* have been embodied within deeds particular to each of the three registered Native Title claimant groups. The deeds address extinguishment of Native Title rights within the UCL areas and also consider compensation to be paid by the Proponent to the claimants with respect to loss of these rights.

It is the Proponent's intention to meet and discuss the deeds with each of the claimant groups and/or their respective representatives with a view to reach agreement and execute the deeds in parallel with the public review period of the PER document.

In summary, the Proponent will require titles for the following specific parcels of land:

- A lease for the 72 hectare project site proposed for the ammonia plant. The lease will be sought from the State (through DOLA) under the *Land Administration Act*. The application will be progressed under the "right to negotiate" procedures of the *Native Title Act*.
- An easement located within the existing Hearson Village Road reserve for a gas supply pipeline from the existing Dampier to Bunbury Natural Gas (DBNG) pipeline to the ammonia plant's northern lease boundary. The Proponent's title will be an easement under the *Petroleum Pipelines Act* from the State (through DOLA) acting with the consents of the Shire of Roebourne (within the Hearson Village Road reserve) and of the Commissioner of Main Roads (within the Burrup Road). Native Title has been extinguished on road reserves and therefore the gas supply pipeline raises no Native Title issues.
- Two easements for the ammonia export pipelines to the Dampier Public Wharf and an ammonia recirculation line from the Dampier Public Wharf. The first easement will be under the *Land Administration Act* from the State (through DOLA). The second will be granted by the Dampier Port Authority (DPA) pursuant to its powers under the *Port Authorities Act*.

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3. Project Benefits, Justification and Evaluation of Alternatives

3.1 Need for the Project

The principal reason for the construction of the Burrup ammonia plant is to supply ammonia to the Oswal Group in India for the production of DAP/NPK fertilisers. All of the liquid ammonia produced will be sold to an ammonia distributor under a confidential agreement with the Proponent. The distributor will supply at least 80% of this ammonia to the Oswal Group and will be responsible for selling the remainder on the world market. The proposed ammonia plant will be one of the world's largest producing ammonia plants with the next largest plant currently operating having a capacity to produce 1850 to 2000 tpd. In comparison, the existing ammonia plant in Kwinana south of Perth has a capacity to produce about 650 tpd (Dames & Moore, 1997).

3.2 Characteristics of Ammonia

Ammonia is a nitrogen based, colourless gas that is most commonly known for its use in fertilisers, mining explosives, household cleaning products and chemical industries. It is the second largest synthetic chemical product utilised on the world market as shown in **Table 3-1** (Appl, 1997). About 90% of world ammonia production is processed or used in the countries where it is produced (IFIA, 2001). The remaining 10% of world ammonia production enters international trade directly. Major net exporters of ammonia in 1997 were Russia and the Ukraine (43%), Trinidad (22%) and the Middle East (13%) (IFIA, 2001). The major net importers were the USA (43%) and West Europe (26%).

Table 3-1 World Capacity for Major Basic Chemicals in 1995

Chemical	Capacity (million tonnes/year)
Sulphuric Acid	207
Ammonia	143
Urea	105
Ethylene	81
Chlorine	46
Soda	43
Hydrogen	31
Methanol	26

Source : Appl, 1997.

Ammonia can be easily converted to liquid form when pressurised or refrigerated below -33°C. It has a pungent odour and in concentrations exceeding 20 ppm can be a nuisance to nearby receptors (GIH, 1986) and is dangerous to human health at higher concentrations. It is highly soluble in water with a general trend of decreasing solubility with increasing water temperature (Budavari, 1996). Ammonia is generally regarded as non-flammable but will explode when ignited under favourable conditions with air (Budavari, 1996).

3.3 Uses of Ammonia

Ammonia is a key ingredient in the manufacture of chemicals and fertilisers, including ammonium nitrate (blasting agent), sodium cyanide and concentrated nitrogen fertilisers. It is also used extensively in nickel refining. The greatest use of ammonia is in the production of fertilisers, namely di-ammonium phosphate and urea. Fertiliser production uses approximately 85% of the world supply of ammonia (IFIA, 2001) and has been found to be directly proportional to the growth of world population (Appl, 1997). In the early 1990s ammonia consumption was below production capacity however in recent years demand has increased at a rate greater than capacity. **Table 3-2** shows an average world capacity utilisation rate well above 85%, a level never before achieved on a global scale (Appl, 1997).

Table 3-2 Ammonia World Supply and Demand Balance

	Balance (million tonne ammonia /year)					
	1990	**1992**	**1994**	**1996**	**1998**	**2000**
Capacity	122.5	124.5	116.3	Not available	121.5	124.4
Demand	96.4	93.1	93.4	Not available	104.4	108.6
Capacity utilisation rate needed to meet demand	78.7%	74.7%	80.3%	Not available	85.9%	87.3%

Source : Appl, 1997.

3.4 Benefits of the Project

3.4.1 Downstream Processing on the Burrup Peninsula

Western Australia is a leading producer of value-added products from mineral and energy resources. The state's downstream processing industries supply world and local markets with a range of value-added products. The West Australian government is committed to develop the potential for more processing industries whilst adding value to the State's natural resources. The construction of the ammonia plant on the Burrup Peninsula will result in the establishment of a significant value-added processing industry of a primary resource. The ammonia plant may also provide the ability for even further downstream processing of ammonia including the production of fertilisers or ammonia nitrate for the agriculture and mining industries, respectively.

Other downstream processing proposals for the Burrup Peninsula have included:

- Petrochemical plant estimated at a value of $3 billion. This plant would use ethane from natural gas streams and salt to produce petrochemical feedstocks for domestic and overseas industry (DRD, 1998).
- Ammonia/urea plant estimated at a value of $750 million. This plant would use natural gas to produce liquid ammonia and granulated urea for domestic and international markets (Plenty River; Woodward Clyde, 1998).
- Synthetic hydrocarbon plant estimated at a value of up to $800 million. This plant would convert natural gas to synthetic hydrocarbons for sale to domestic and international markets (Syntroleum; HLA-Envirosciences, 1999).

There are several potential synergies with other proposals on the Burrup Peninsula through jointly developed infrastructure, power generation and export, water and natural gas supply, emergency response services, etc. Project planning is being co-ordinated by the Department of Resources Development (DRD) to facilitate industrial development on the Burrup Peninsula in an efficient and orderly manner.

The State government is committed to providing up to \$30 million worth of support for multi-user infrastructure on industrial land located on the Burrup Peninsula.

3.4.2 Development of Natural Gas Reserves

The offshore region of the north-west Pilbara contains Australia's most prospective and productive hydrocarbon province. Within Australia, there are estimated to be 98 Trillion cubic feet (Tcf) of recoverable gas reserves with Western Australia having at least 62 Tcf of recoverable gas reserves (Woodside, 1998). Potential further gas reserves in the region are estimated between 50 and 170 Tcf (HLA-Envirosciences, 1999). The proposed ammonia plant will be supplied with approximately 74 TJ/d of sales quality gas by the Harriet Gas Sellers through a dedicated gas lateral connected to the DBNG pipeline in the vicinity of King Bay Road. The supply contract will be for a period of 25 years, which is expected to be valued at over \$500 million.

The Harriet Gas Sellers comprise several subsidiaries of Apache Energy Limited (Operator), Kufpec Australia Pty Ltd and Tap Oil Limited:

- **Apache Energy Limited** is an Australian subsidiary of Apache Corporation which has its principal office in Houston, USA. Apache Corporation ranks among the largest independent oil and gas companies in the USA with operations in North America, Egypt, Western Australia, Poland, the People's Republic of China and Argentina. It is listed on the New York Stock Exchange.
- **Kufpec Australia Pty Ltd** is a wholly owned subsidiary of Kuwait Foreign Petroleum Exploration Company k.s.c., which in turn is wholly owned by Kuwait Petroleum Corporation. Kufpec has oil and gas operations in several countries outside Kuwait, including Australia, China, Egypt, Indonesia, Pakistan, Tunisia and Yemen.
- **Tap Oil Limited** is a medium size Australian exploration and production company. Tap is West Australian based and its operations are focused on permits in the Carnarvon Basin of Western Australia. Tap is one of the top ten ranked oil and gas companies listed on the Australian Stock Exchange.

3.4.3 Summary of Project Benefits

The Australian Commonwealth and largely the State of Western Australia, in particular the regional centres of Karratha and Dampier, will benefit from the project in the following ways:

- Capital investment of \$630 million.
- Direct employment of construction and operating workforces, plus associated indirect employment is likely to contribute to an estimated total annual income of \$13 million. The majority of this income will be directed to the townspeople of Karratha and Dampier as the workforce will be sourced locally wherever possible.
- Value-added processing of a primary resource will result in the investment of \$500 million for a guaranteed natural gas supply for 25 years which will generate an estimated ammonia export revenue of over \$160 million annually and \$4 billion over 25 years.

- The project will add substantially to Commonwealth tax revenues. Annual gross profit, before depreciation and abnormals, will be about \$30 million. Under the current income tax arrangement, this profit will generate approximately \$10 million of company tax per year, hence \$250 million over a 25 year lifespan. The Proponent will also contribute by way of payroll tax and rent for the project lease.
- Increased local and regional business activity in the form of maintenance, supply, cleaning and security etc. that the project is likely to generate is estimated at about \$30 million per year. There will also be one-off costs associated with the establishment of employees in Karratha which is estimated to be about \$10 million.
- Additional stimulus to the State's business sector as a result of the project, including manufacturing, construction, plant hire, engineering and related consultancies, is estimated at about \$20 million per year.
- Contributions to local training and employment programs for employees.

3.4.4 No Project Option

In the event that the project does not proceed, there would be a considerable loss of revenues to the townships of Karratha and Dampier as well as to the State of Western Australia and the Commonwealth.

None of the above listed benefits will occur under the 'no development option' and will result in total combined loss valued at about \$7 billion.

Direct losses will be associated with:

- Employment opportunities;
- Infrastructure;
- Introduction of advanced technology not yet established in the ammonia industry of Western Australia; and
- Economic growth of Karratha and Dampier.

3.5 Evaluation of Alternatives

3.5.1 Alternative Technology and Best Available Techniques

The technology being used to design the proposed ammonia plant is the latest low energy Purifier Ammonia technology currently at the forefront of chemical manufacturing and engineering design. This section describes the alternative technologies that are available and demonstrates that the proposed ammonia plant is designed to Best Available Techniques (BAT) as recommended by the European Fertiliser Manufacturer's Association.

3.5.1.1 Feedstock Options

Ammonia is basically produced from water, air, energy and hydrocarbons. For the three reforming processes used in the world, the energy source is usually derived from the following feedstocks:

- Steam reforming - natural gas;
- Partial oxidation - heavy fuel oil or vacuum residue; and
- Partial oxidation - coal.

For each of these feedstocks, the process of producing ammonia varies, with the simplest being the use of natural gas and the most complex being the use of coal. About 77% of world ammonia capacity is produced by natural gas with coal gasification no longer being used in the European ammonia industry (EFMA, 2000). The proposed ammonia plant will use the natural gas-steam reforming process. The benefits of natural gas include (Appl, 1997; EFMA, 2000):

- Greater energy efficiency (**Table 3-3**);
- Smaller relative investment cost (**Table 3-3**);
- More hydrogen-rich compared to other feedstocks and contributes greater proportion of the hydrogen in the synthesis gas than any other;
- Lighter feedstock therefore the process to convert it to synthesis gas is easier and more cost effective;
- Most widespread, easily available and deliverable feedstock; and
- Lower emissions to the environment.

For the present time and the near future, the steam/air reforming concepts based on natural gas are considered to be the dominating group of BAT for ammonia production processes (EFMA, 2000).

Table 3-3 Relative Investment Cost and Total Energy /Demand for Ammonia Production and Various Feedstocks

Feedstock	Process	Relative Energy Consumption*	Total Energy (LHV) GJ/ t NH_3**	Relative Investment Cost**	Relative Production Cost*
Natural gas	Steam Reforming	1.0	28	1	1.0
Fuel/Oil	Partial Oxidation	1.3	38	1.4-1.5	1.2
Coal	Partial Oxidation	1.7	48	2.0-3.0	1.7

* EFMA, 2000.
** Appl, 1997.
LHV-Lower Heating Value

3.5.1.2 Steam Reforming Options and Burner Design Options

Two advanced technologies that utilise natural gas as the feedstock and steam in the reforming process, have been considered for the proposed ammonia plant. These technologies have been developed by Kellogg Brown and Root (KBR) and Haldor Tapsoe (HT).

A detailed assessment of both technologies was undertaken to identify benefits and constraints and to select the most suitable technology. Criteria that were considered by the Proponent prior to selecting KBR technology were:

- Energy efficiency;
- Type of technology;
- Maintenance;
- Safety;
- Reliability;
- Capital, operating and maintenance costs; and
- Emissions to the environment.

The main difference between KBR and HT technologies is the type of primary reformer used and the firing conditions within the reformer. The primary reformer is used to produce a synthesis gas consisting of hydrogen and methane. This synthesis gas is then used in the secondary reformer where more hydrogen gas is produced. A detailed process description is provided in **Appendix C**.

KBR technology adopts top-fired reformers which are generally more preferred for large capacity plants. Top-fired reformers in world-scale ammonia plants contain between 200 and 300 tubes that are used to produce the synthesis gas. The primary reformer of the proposed ammonia plant will contain between 200 and 250 tubes and about 150 vertical burners. The advantages of KBR technology and, in particular, the technology in top-fired reformers, include:

- Firing occurs at one level so the number of burners in relation to the number of tubes is smaller than in side-fired systems. This simplifies distribution piping for fuel gas and preheated combustion air which is now standard in all efficient plants;
- The radiation efficiency is higher than in other designs;
- The burners are located close to the "cold" inlet of the feed/steam mixture which is where the strongest heating is needed. Heat fluxes of 125,000 W/m^2 and more can be attained in this area;
- Introduced Purifier Process ™ where excess nitrogen, methane and argon are removed as waste gas in a cryogenic purifier and sent to fuel during the secondary reforming process. Results in a purer than usual synthesis gas which reduces the reformer heat duty by as much as 50% (Appl, 1997) and energy requirement in synthesis loop;
- Low energy ammonia process about 29.7 MJ/t NH_3;
- Less catalyst used;
- Less pressure in synthesis loop, about 13,730-15,200 kPa;
- Less structural steel is needed in construction; and
- Lower capital and operating costs.

In side-fired reformers adopted by HT technology, the burners are located in the walls of the furnace box which accommodates one or two rows of tubes. Established operating ammonia plants using HT technology contain about 500 tubes and about 500 side burners in the primary reformer, which is considerably greater than that required for KBR technology. The disadvantages of using side-fired reformers include:

- The larger number of burners makes the fuel and preheated combustion air distribution more complicated and expensive;
- Height and width of the reformer is fixed by the radiation geometry of the tubes and furnace box walls and is thus only able to accommodate 100 to 150 tubes. Therefore it is better suited for smaller capacities, although it is possible to extend the reformer lengthwise to accommodate more tubes for greater capacities;
- Radiation efficiency is smaller than in the top-fired system;
- Direct impingement of flames on tubes is difficult to prevent. This will result in the formation of coke on the tubes which is hazardous. Coke absorbs heat and may reach up to 300°C producing a potentially explosive environment;
- Energy efficiency is lower (about 30.9 – 31.4 MJ/t NH_3) than in the KBR technology;
- Higher pressure in synthesis loop, about 17,650 – 19,610 kPa; and
- Greater lifecycle costs as a result of higher operating and maintenance costs.

Also considered by the Proponent is the heat exchange autothermal technology. This technology recycles high-level heat of the secondary reformer outlet gas, which would ordinarily be used to raise steam, to a newly developed primary reformer. Emissions to the atmosphere would be reduced by eliminating the flue-gas from the primary reformer and would be expected to reduce NO_x emissions by about 50% compared to conventional steam reforming.

Only two plants in the world are operating with this technology at a capacity of up to 1,200 tpd. One 1,800 tpd proposed plant is currently being constructed. Heat exchange autothermal technology is a technology licensed to KBR (KRES – Purifier) and is available to the Proponent. However, given the limited number of years of operating experience and the unproven capacity of the technology to operate at a scale of 2,200 tpd, the potential risks associated with adopting this technology is not acceptable to the Proponent without further detailed design.

In conclusion, the Proponent is adopting a modern version of the conventional steam reforming technology. This technology is currently BAT and will still be used for new plant for many years to come (EFMA, 2000). Advanced ammonia plants using modern versions of the conventional steam reforming and excess air reforming processes are expected to develop BAT in the following directions (EFMA, 2000):

1. Lowering the steam to carbon ratio;
2. Shifting duty from primary to secondary reformer resulting in less severe primary reformer operation;
3. Improving final purification;
4. Improving synthesis loop efficiency;
5. Improving power energy system;
6. Use of low NOx burners;
7. Higher reliability – highest onstream factor;
8. Lower maintenance; and
9. Longer catalyst life.

The technology and engineering design of the proposed ammonia plant satisfies all of the above BATs to achieve a state-of-the-art chemical manufacturing facility which is expected to be the most technologically advanced ammonia plant in the world.

3.5.2 Alternative Sites

A number of alternative sites, within and outside of Australia, were investigated for the proposed ammonia plant with particular attention given to the following critical factors:

- Availability of suitable industrial zoned land;
- Proximity and reliability of a natural gas supply;
- Proximity and availability of year-round port facilities;
- Year-round road access;
- Availability of services, such as power and water;
- Proximity of a community with the appropriate support facilities;

- Availability of skilled labour; and
- Potential synergies with other industries.

Overseas locations including Trinidad and Venezuela were investigated. However, Western Australia was found to be the most advantageous for the development and operation of the plant.

The proposed 72-hectare location of the ammonia plant on the Burrup Peninsula was allocated to the Proponent as a potential site by the Department of Resources Development in July 2000. This site is located within the King Bay-Hearson Cove Industrial Area.

The King Bay – Hearson Cove Industrial Area was found suitable for the proposed ammonia plant for the following reasons:

- **The proposed site is already zoned for strategic industrial use**
  The Burrup Peninsula contains five areas zoned for industrial use of which King Bay-Hearson Cove is the largest, being 670 hectares in area. These industrial areas are government endorsed as identified in the Burrup Peninsula Land Use Plan and Management Strategy (O'Brien Planning Consultants, 1996).
- **The proposed ammonia plant development is compatible with adjacent industries**
  An existing LNG facility is located about 2.5 kilometres to the northwest and an existing marine supply depot is located about 1.5 kilometres to the west. A proposed ammonia/urea plant is located to the west and a proposed synthetic fuels plant is located to the southwest.
- **The site is located in proximity to a reliable natural gas supply**
  As previously discussed in **Section 3.4.2,** a reliable natural gas supply is available from Apache Energy Gas at competitive prices. The DBNG pipeline traverses the Burrup Peninsula and is located approximately 1 kilometre to the west of the project lease.
- **State government support**
  There is State Government support for multi-user infrastructure on industrial land located on the Burrup Peninsula which is valued at about $30 million.
- **The site is located in proximity to existing available port facilities**
  The Dampier Public Wharf is located about 3 kilometres to the west-northwest of the proposed site and is one of the largest ports in Australia based on tonnage of cargo. The project will have access to the existing wharf facilities, although some upgrading works will be required, including dredging.
- **The site is serviced by existing trafficable roads**
  The Burrup Peninsula is serviced by the main north-south aligned Burrup Road. Bordering the site to the north is the Hearson Village Road (abbreviated to Village Road hereafter) which is sealed.
- **All required services for the project are available or can be obtained at commercial rates**
  Services such as power and water are available primarily through synergies with other proposed projects. The Proponent is designing the plant to be self-sufficient in terms of power. During construction, power will be sourced from captive power generators. Water is available via commercial agreements with the Water Corporation and the development of a thermal desalination plant, to be located adjacent to the ammonia plant on the project lease.
- **The site is located in proximity to the towns of Karratha and Dampier**
  The proposed site is located about 6 and 10 kilometres from Dampier and Karratha respectively. This distance will ensure minimal impact of the plant on local communities while providing a practical commuting distance for employees.

- **The project can draw upon suitably qualified and locally available workforce**
  Karratha and Dampier have developed a qualified and experienced workforce as a result of large scale mineral and petroleum resource developments. The majority of the existing workforce is employed in the resources industry including: Hamersley Iron, Dampier Salt and Woodside Offshore Petroleum Ltd's North West Shelf Gas Project.

3.5.3 Alternative Plant Layouts

Within the 72 hectare project lease allocated for the ammonia plant, two possible plant footprints have been considered. Both of these footprints are 16 hectares in area, excluding the thermal desalination plant which is 1 hectare in area. The footprints are situated in the southern portion of the 72 hectare site primarily to avoid the culturally and ecologically significant rockpiles to the north. The layout of the two footprints are illustrated in **Figure 3-1.**

- **Option 1 – Northern Footprint**
  Option 1 will involve the development of a two-tiered level site layout elevated at 5 and 6 mAHD to accommodate the slope of the terrain in this area. The construction laydown area will be located to the south of this footprint extending to a distance of up to 150 metres southwards from the footprint boundary. The overall engineering design of this layout is more complex than Option 2. Blasting will be required to remove granophyre rock. The bulk earthworks required for this option will be lower than that required for Option 2, thus the cost of Option 1 is less than Option 2.

- **Option 2 – Southern Footprint**
  Option 2 will involve the development of a level site layout which will be located on a greater proportion of the sandy silts situated in the southern portion of the project lease. As a result, no blasting will be required. The construction laydown area will be located to the north of this footprint extending to a distance of up to 150 metres northwards from the footprint boundary. A greater volume of landfill will be required to raise the elevation of the footprint to 4.9 mAHD. For this reason the cost of Option 2 will be substantially higher than Option 1.

For the purposes of this environmental impact assessment, the potential area of direct disturbance is defined by the combined outer boundaries of both footprints, which covers an area of 25 hectares (including the 1 ha desalination plant proposed by Water Corporation) (**Figure 3-1**). This allows the assessment of environmental and heritage issues to be conservative in that the 25-hectare area will envelop all proposed disturbances related to the plant, excluding disturbances related to the construction of the access road and product pipeline. However, it is important to re-emphasise that the final footprint of disturbance for the main plant site (including the 1-hectare thermal desalination plant) will only impact on 17 hectares of land within the wider footprint.

For the assessment of operational plant impacts (risk, noise and air quality), it is assumed that the plant will be located on the southern footprint (Option 2). This footprint will provide a conservative estimation of potential operational impacts as it is closer to recreational areas, the towns of Karratha and Dampier and it is situated on slightly lower terrain.

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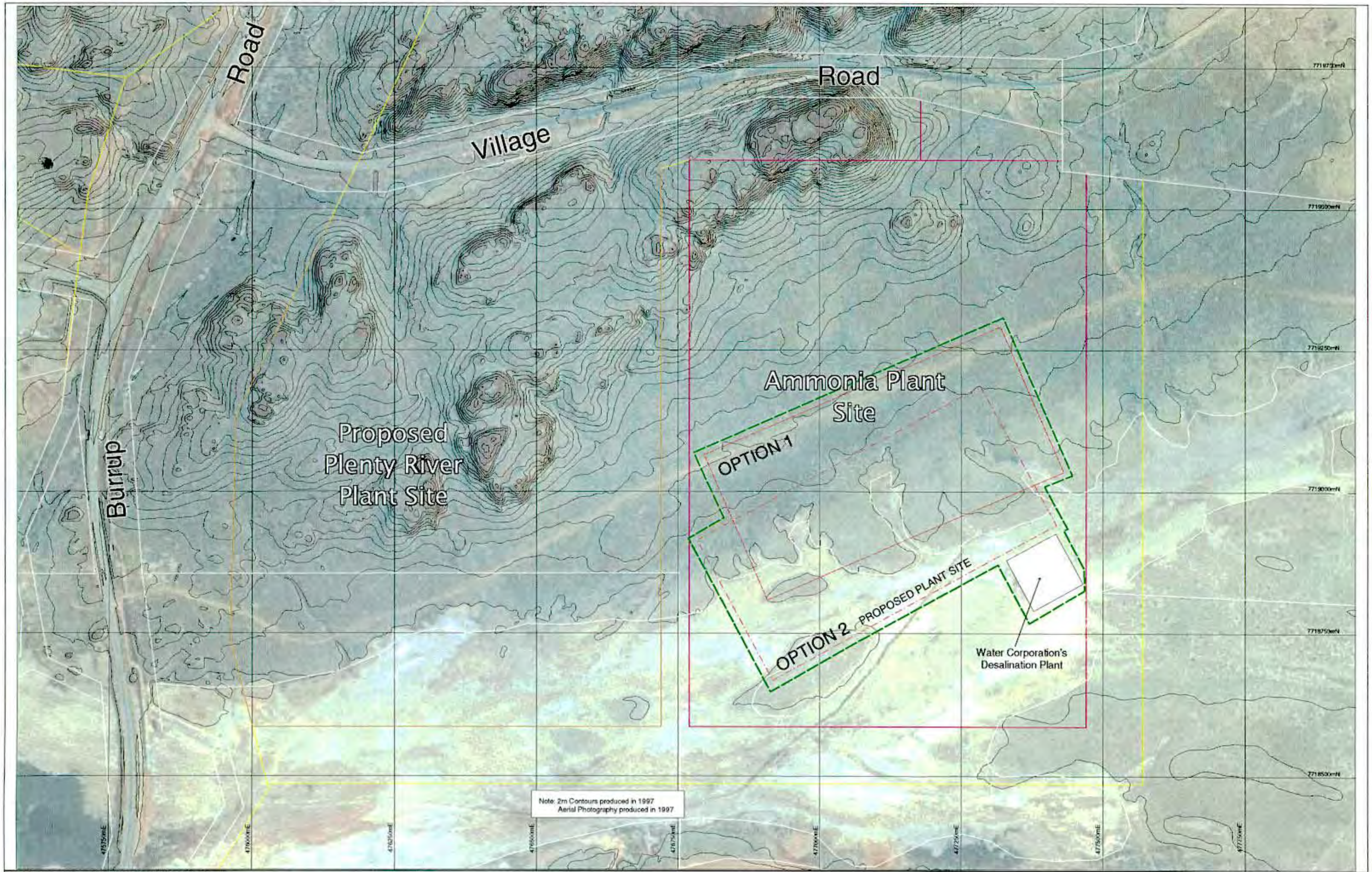

Photography and Contours supplied by the Department of Resources Development

Note: Secondary service corridors shown to Ammonia Plant Site are preliminary and subject to approval

SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

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BURRUP AMMONIA PLANT
FOOTPRINT OPTIONS FOR THE PROPOSED PLANT SITE

LEGEND

- Ammonia Plant Lease
- Option 1 Footprint
- Option 2 Footprint
- Area of Disturbance
- Service Corridors

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 3.1

Client: Burrup Fertilisers Pty Ltd
Job No.DE01890.010
Date Drawn: 21 July 2001
FileName: DE01890_01_fig3_1.wor
Map: A4-6922

4. Project Description

4.1 Project Overview

The proposed ammonia plant will be developed in the King Bay – Hearson Cove Industrial Area on the Burrup Peninsula (**Figure 2-1**). The plant will have a design capacity to produce up to 2,200 tonnes per day of liquid ammonia. A description of the ammonia production process is provided in **Section 4.2**.

A preliminary layout of the proposed plant is illustrated in **Figure 4-1**, including the Water Corporation's thermal desalination plant. **Table 4-1** provides a summary of the key project characteristics:

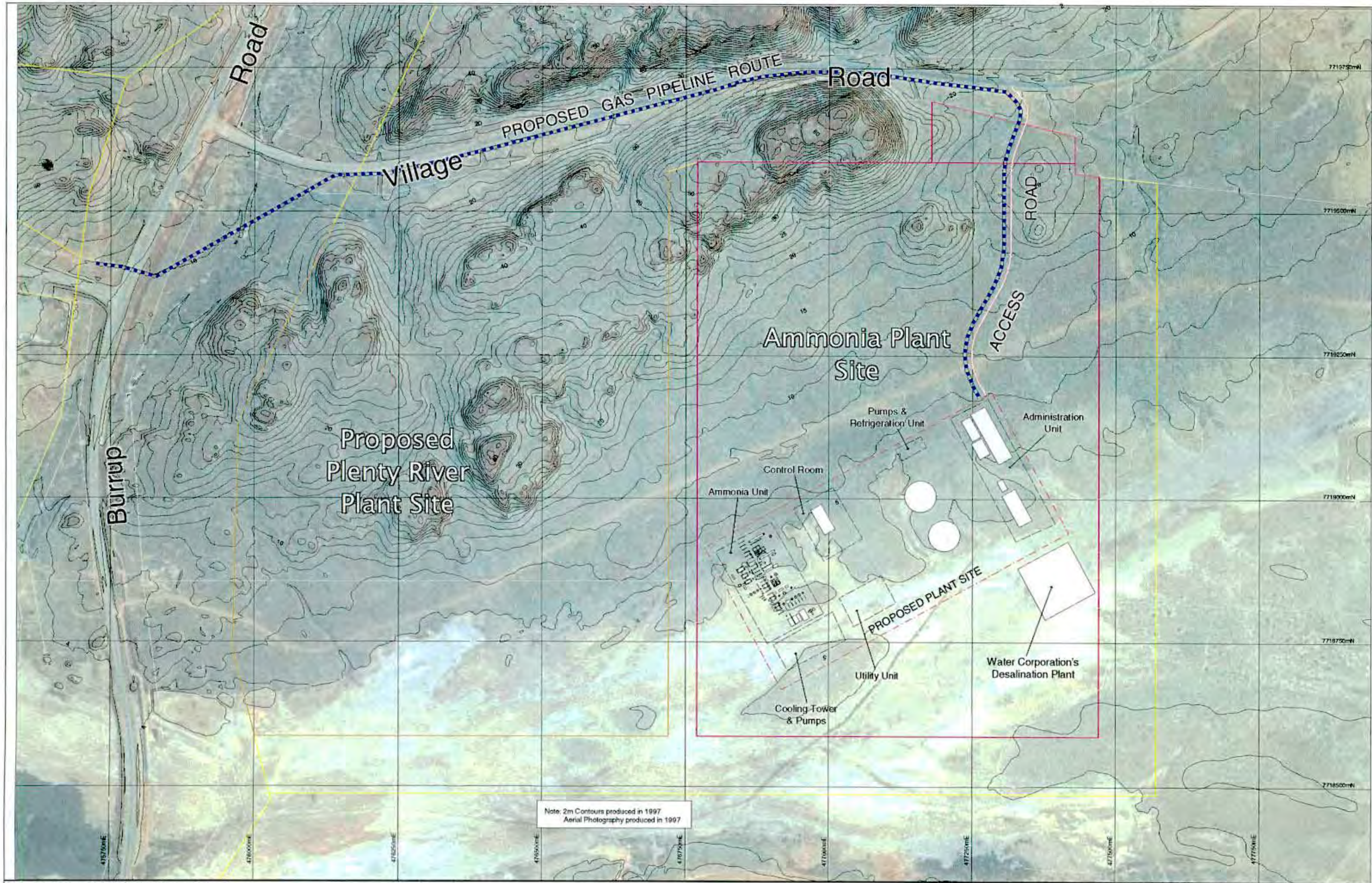
Table 4-1 Key Project Characteristics

Characteristic	Description
Project Purpose	To produce liquid ammonia from natural gas using advanced production technology for sale mostly to international markets.
Project Life	25+ years
Project Value	Approximately A$630 million
Plant Capacity	2,200 tpd (design case); 770,000 tpa
Area of Project Lease	72 ha
Area of Disturbance	*Item* — *Area (ha)* Ammonia plant and laydown — 24.0 Desalination plant proposed by Water Corporation — 1.0 Access road and product pipeline to plant — 2.4 Total — 27.4 say — 28 (maximum)
Plant Facilities	Administration, maintenance and warehouse unit Ammonia storage unit Pumps and refrigeration unit Utility unit Control room Ammonia process unit Cooling tower
Plant Operation	24 hours per day, 350 days per year (design case)
Shutdown Time	Planned shutdown – 10 days per annum Emergency shutdown – 5 days per annum for 4 hrs/day
Ammonia Storage	2 x 40,000 tonne cryogenic, double-walled, double integrity tanks
Potable Water	7-10m^3/hr
Seawater	Approximately 2000m^3/hr; 48ML/day
Power Generation	Internal generation. Two (1 x operating 100% capacity and 1 x operating 25% capacity) 20 MW steam turbine generators. Supply of energy (approx 4MW of electricity) to the desalination plant.
Power Export	None
Emergency Power	Two emergency diesel generators (2.0MW) for start-up power. May also provide power for construction.

Characteristic	Description
Steam Generation	Two (1 x operating and 1 x standby) 100t/hr of medium pressure steam for plant start-up
Low Pressure Steam Export	Capacity for about 10 t/hr
Energy Efficiency	Approximately 29.7 ~ 29.9 MJ/ t NH_3 (ammonia plant); Approximately 32.6 MJ/t NH_3 (entire project including shipping, transport of product, cooling etc.)
Natural Gas Input	Approximately 74 TJ/day
Natural Gas Pipeline	Approximately 1.3 km; below ground; from DBNG pipeline to the plant; to be constructed by Apache Energy.
Seawater Pipeline	Approximately 1.2 km; likely to be below ground; from desalination plant to connect to brine discharge line along Burrup Road, to be constructed by Water Corporation.
Ammonia Pipeline	Approximately 4.3 km; above ground; from the plant to the Dampier Public Wharf.
Catalysts	Aluminium, cobalt, copper, iron, magnesium , molybdenum and nickel oxides

Approximate Gaseous Emissions under Normal Operations:	Daily Load (kg/day)	Per tonne NH_3 (kg/t NH_3)	Annual Load (t/yr)
NO_x	1439	0.65	503
CO_2	4.03×10^6	1832	1,411,000
CO	295	0.13	103
SO_2	1.7	0.0008	0.6
NH_3	Nil	Nil	Nil
VOC	Nil	Nil	Nil

Characteristic	Description
Wastewater Discharges: Package Boiler Blowdown Cooling Tower Blowdown Demineraliser Regenerant Wastewater Reformer Jacket Blowdown Reformer Boiler Blowdown Intercooler Waste Process Condensate Sanitary Wastewater Surface Runoff	Quality and quantity of wastewater discharges will meet the requirements of the Water Corporation as per licence conditions stipulated by DEP.
Solid Waste:	Approximate quantities of solid wastes produced:
Demineraliser Spent (Cation/Anion Resin)	27,000 kg every 3 years (Di-vinyl Benzene, Polystyrene Resin)
Desulphuriser Spent Catalyst	33,200 kg every 3 years (zinc oxides); 15,700 every 6 years (cobalt and molybdenum oxides)
Biosolids	Stabilised biosolids from wastewater treatment plant
Domestic Waste	Variable quantity disposed to landfill weekly.
Construction Period	Approximately 20 months
Workforce	Construction: 500 (peak) Operation (on-site): 50 (peak to accommodate two shift changes) (off-site): 10



Photography and Contours supplied by the Department of Resources Development

Note: Secondary service corridors shown to Ammonia Plant Site are preliminary and subject to approval

SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT
PRELIMINARY PLANT LAYOUT

LEGEND

- Ammonia Plant Lease
- Service Corridors
- Proposed Access Road
- Proposed Gas Pipeline Route

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 4.1

Client: Burrup Fertilisers Pty Ltd
Job No DE01890.010
Date Drawn: 21 July 2001
FileName: DE01890_01_fig4_1.wor
Map: A4-6923 Rev 1

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4.2 Ammonia Process Description

The ammonia process is based on the KBR Purifier Process™, a low energy natural gas reforming process offered and licensed by Kellogg Brown and Root. The ammonia plant design is based upon producing a maximum capacity of 2,200 tpd and average capacity of 2,000 tpd, which is exported to two 40,000 tonne cryogenic atmospheric ammonia storage tanks at -33 °C.

All the components of the ammonia plant are based on well proven technology. All process equipment is single train. All compressors are centrifugal compressors and are driven by steam turbines. The boiler feed water pump also has a steam turbine drive, with a motor drive spare for reliability of operation.

The ammonia plant process is illustrated in **Figure 4-2** in simplified format showing major inputs and outputs. The detailed process steps are:

- Feed gas desulphurisation;
- Primary reforming;
- Process air compression;
- Secondary reforming;
- Carbon monoxide shift conversion;
- Carbon dioxide removal;
- Methanation;
- Drying;
- Cryogenic purification;
- Compression;
- Ammonia synthesis;
- Loop purge ammonia recovery;
- Ammonia refrigeration;
- Process condensate stripper;
- Steam system;
- Package boiler; and
- Turndown operation.

Each of these process steps is described in detail in **Appendix C** and a brief summary is provided below.

Feed Pre-treatment
Natural gas feed is directed to a feed gas knockout drum where liquids and solids are removed. Upon exiting the drum, the various fuel and feed streams are taken. Part of the natural gas is sent to the package boiler and primary reformer. The remainder is fed to the desulphurisation unit via the convection section of the primary reformer for heating.

The desulphurisation unit removes organic sulphur compounds from the heated gas by passing it over a catalyst bed of cobalt/molybdenum oxide. Organic sulphur compounds are hydrogenated to form hydrogen sulphide. This sulphide reacts with zinc oxide and is retained in the catalyst bed.

Primary Reforming

The desulphurised feed is mixed with medium pressure steam and is preheated in the convection section of the primary reformer. The hot mixed feed is distributed to the primary reformer catalyst tubes, which are suspended in the radiant section of the furnace. The feed gas passes down the reforming catalyst and is reacted to form hydrogen, carbon monoxide and carbon dioxide. The combination of reactions are endothermic (ie requires and absorbs heat) with the duty supplied by fuel gas burners located between the rows of tubes.

The reforming furnace is designed to attain maximum thermal efficiency (approximately 92%) by recovering heat in the convection section from the flue gases.

Secondary Reforming

The process gas leaving the primary reformer furnace contains about 52.3% hydrogen and 28% methane (dry volume basis) as it leaves the primary reformer furnace. Having the Purifier process, about 50% more air is injected, compared to conventional non-purifier technology, in a special mixing and combustion chamber above a nickel catalyst bed to produce a 3:1 hydrogen to nitrogen synthesis gas. The extra air provides additional reaction heat in the secondary reformer and helps to keep the temperature of the gas exiting the primary reformer as low as possible.

The gas is directed to a secondary reformer waste heat boiler where high pressure steam is produced to partially cool the gas.

Shift Conversion

In this shift conversion step, carbon monoxide is reacted with steam to produce carbon dioxide and additional hydrogen.

$CO + H_2O$ <-------> $CO_2 + H_2$

This reaction is favoured by high temperatures, but the maximum conversion of CO to CO_2 (equilibrium) is favoured by low temperatures. Both high and low temperature conversions utilise different catalysts. The high temperature shift conversion utilises iron oxide and the low temperature shift conversion utilises a copper based catalyst.

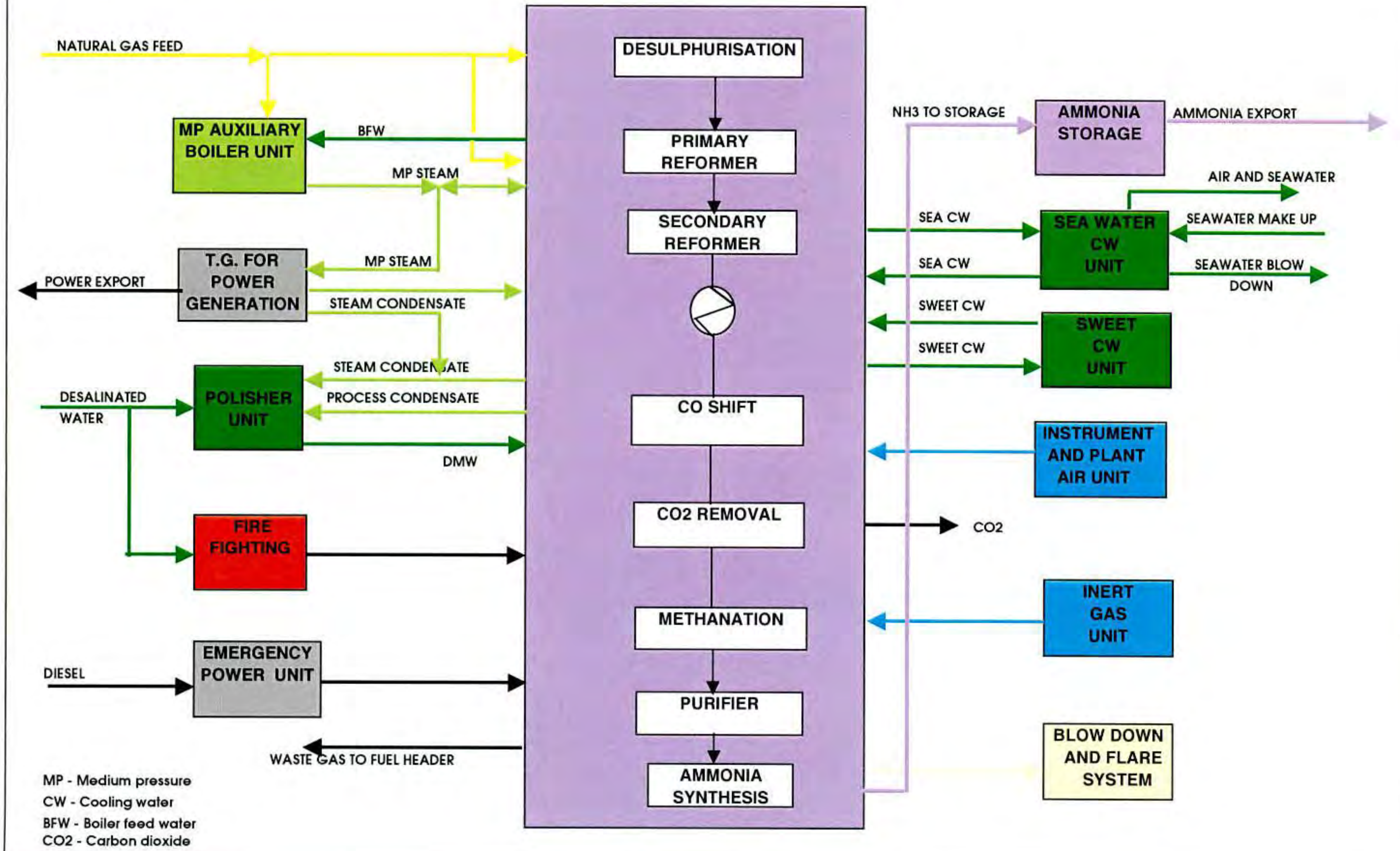
Heat recovered from the low temperature shift conversion is used to preheat high pressure boiler feed water and deaerator feed water in the Methanator, and provide heat for the MDEA CO_2 removal process.

Condensate Stripping

This involves the cooling of the process gas where condensed water is separated and impurities are stripped from the condensate.

Carbon Dioxide Removal

Carbon dioxide contained in the shifted process gas is removed by absorption in a liquid absorbent, MDEA solution. The absorbent is stripped of CO_2 and regenerated for re-use. The recovered carbon dioxide is cooled and vented.



SINCLAIR KNIGHT MERZ
Sinclair Knight Merz
263 Adelaide Terrace
PO Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT

AMMONIA PROCESS FLOW CHART

FIGURE 4.2

Client: Burrup Fertilisers Pty Ltd
Job No. De01890
Filename De01890.00/graphics/fig4.2.xls

Methanation

This process occurs within the Methanator Feed/Effluent Exchanger where high temperature heat is recovered in the methanator effluent by heat exchange against the feed gas. The gas then flows through the methanator where remaining carbon oxides combine with hydrogen over a nickel catalyst to form methane and water:

$CO_2 + 4H_2$ -------> $CH_4 + 2H_2O$ + heat

$CO + 3\ H_2$ ------->$CH_4 + H_2O$ + heat

Drying

The methanator effluent is cooled by heat exchange with methanator feed and cooling water. The chilled gas flows to the synthesis gas driers containing solid desiccants. Exiting these driers the water and $CO+CO_2$ content of the gas is reduced.

Cryogenic Purification

Dried raw synthesis gas is cooled prior to entering the purifier rectifier column. This purifier column removes excess nitrogen, all of the methane and about 61% of the argon. The operation of the purifier is controlled by a hydrogen analyser on the synthesis gas to maintain the hydrogen to nitrogen ratio of 3:1. The only remaining contaminant in the make-up synthesis gas is about 0.27% argon.

Compression

The synthesis gas is compressed to a suitable pressure required for the ammonia synthesis loop.

Ammonia Synthesis

The synthesis gas is passed through the ammonia synthesis converter comprising of four beds of iron promoted conventional catalyst. The reaction is:

$N_2 + 3H_2$ <-------> $2NH_3$ + heat

The heat of reaction is recovered by the steam system in the ammonia converter effluent/steam generator and boiler feed water preheater. The converter effluent is cooled to condense most of the produced ammonia. The remaining synthesis gas is recycled to the converter, except for a small purge. The purge is recycled to the Purifier.

Refrigeration

Ammonia is condensed from the converter effluent stream by chilling with ammonia refrigerant at four levels in the unitised chiller. The ammonia vapours are routed to the ammonia refrigeration compressor where the vapours are condensed. Cold liquid ammonia is used as a refrigerant. The refrigeration system is designed to deliver the ammonia product at –33°C. Cold ammonia is then pumped to the cryogenic storage tanks.

Steam System

High, medium and low pressure steam will be produced by the plant. High-pressure superheated steam is utilised in the synthetic gas and refrigeration compressor turbines. The synthesis gas turbine is a combination extraction and condensing machine and the refrigeration compressor turbine is a condensing machine. In the former turbine, medium pressure steam is extracted to supply process steam and the requirements for the process air compressor and various other components.

Low pressure steam is generated from the back pressure turbine driver for the primary reformer and steam generator. Excess low pressure steam is admitted to the turbo generator to make electric power.

Further supporting detail about the ammonia process is provided in **Appendix C**.

4.3 Development Strategy

4.3.1 Land Required

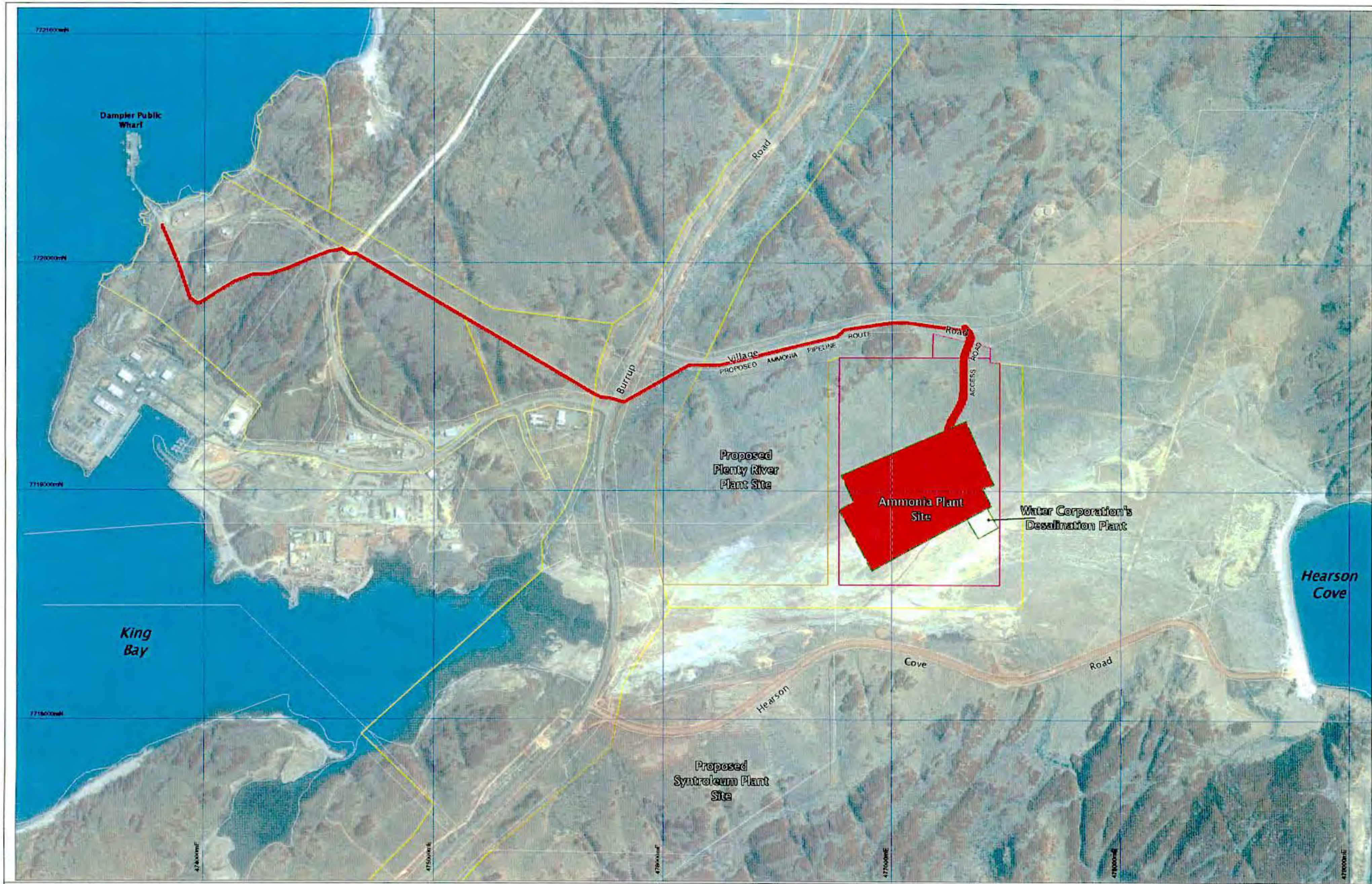
Approximately 28 hectares of land *within* the project lease will be disturbed to accommodate all the facilities, associated infrastructure and the construction laydown area. Approximately 7.5 hectares of land within allocated service corridors will be disturbed for the 4.3 kilometre ammonia pipeline from the project lease to the Dampier Public Wharf. The construction laydown area will extend up to 150 metres from the southern or northern perimeter of the plant footprint depending upon the selection of footprint options (**Figure 4-3**). The area of disturbance for construction laydown is included with the 28 hectare total area. A summary of the expected land disturbances is provided in **Table 4-2.**

Table 4-2 Estimated Land Disturbances for the Construction of Proposed Facilities and Infrastructure

Facility/Infrastructure	Area Disturbed (ha)
Access road and natural gas pipeline to plant	2.4
Construction Laydown Area	8 (maximum)
Ammonia Plant	16.0
- Administration Unit	1.3
- Ammonia Storage Unit	4.0
- Utility Unit	0.6
- Control Room	1.1
- Ammonia Unit	2.0
- Cooling Tower Unit	0.7
- Area of separation between units	6.3
Desalination Plant	1
Seawater Pipeline	~ 1.4 To be undertaken by Water Corporation
Ammonia Product Pipeline	4.3 Clearing and levelling west of Burrup Road to be undertaken by DRD (possibly excluding DPA land)
Natural Gas Supply Pipeline	~1.5 To be undertaken by Apache Energy

Based on the requirements of these facilities it is proposed that the following earthworks will be undertaken:

- Cutting and removal of 16,000m³ of soil, this material will be used as fill;
- Cutting and removal of 17,000m³ of rock, this material will be used as fill; and
- Import of 70,000m³ of engineered fill.



Photography supplied by the Department of Resources Development and produced in 1997

Note: Secondary service corridors shown to Ammonia Plant Site are preliminary and subject to approval

SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

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BURRUP AMMONIA PLANT

PROPOSED LAND DISTURBANCES FOR THE AMMONIA PLANT AND ASSOCIATED FACILITIES

LEGEND
- Ammonia Plant Lease
- Proposed Land Disturbance
- Service Corridors

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 4.3

Client: Burrup Fertilisers Pty Ltd
Job No. SW01198
Date Drawn: 21 July 2001
FileName: DE01890_01_Fig4_3.wor
Map No: A3-553

Land within service corridors will also be required for the following pipelines:

Existing Northern Service Corridor

- Natural gas;
- Ammonia product line; and
- Ammonia recirculation line.

Proposed Southern Service Corridor

- Seawater (cooling water) line; and
- Brine return line.

The Proponent will be responsible for the construction of the ammonia export pipeline and recirculation line from the plant to the Dampier Public Wharf. Between Burrup Road and land vested under the Port of Dampier, clearing and levelling of the route west of Burrup Road will be undertaken by DRD. The Harriet Joint Venture and acting manager, Apache Energy, will be responsible for constructing the natural gas supply pipeline to the outside battery limit of the plant. Similarly the Water Corporation will be responsible for the construction of the seawater pipeline and brine return line to the outside battery limit of the plant.

4.3.2 Burrup Ammonia Plant

The ammonia plant will consist primarily of seven components as illustrated in **Figure 4-1:**

- Ammonia unit;
- Ammonia storage unit, pumps and refrigeration unit;
- Control Room, switch-gear, transformers and metering;
- Utility unit;
- Cooling tower and pumps;
- Thermal Desalination plant (operated and owned by Water Corporation); and
- Administration, cafeteria, safety, maintenance and warehouse unit.

The seven components of the ammonia plant are briefly described in the following sections.

4.3.2.1 Ammonia Unit

The ammonia unit encompasses the core ammonia production process. The main components used in the ammonia production process are located within this unit and include:

- Desulphurisation section;
- Primary Reformer;
- Secondary Reformer;
- Shift vessels that convert carbon monoxide to carbon dioxide;
- Carbon dioxide removal section;
- Methanation section;
- Cryogenic purification section for synthesis gas;

- Compressors;
- Ammonia synthesis reactor; and
- Ammonia refrigeration.

4.3.2.2 Ammonia Storage Unit

The ammonia storage unit will comprise two 40,000 tonne double-walled, double-integrity liquid ammonia tanks which will be refrigerated to -33°C. The ammonia storage tanks will be constructed to American Petroleum Industry (API) standards. Within this unit will be a fire water system located adjacent to tanks, loading pumps, refrigeration unit and flare stacks.

4.3.2.3 Control Room

The control room is used as a central control centre where the technical operation of the plant is managed. This control room will be blast, fire and weather proof. The control room will consist of a fully distributed and advanced control system to ensure the safe operation and management of the plant. The control room will be manned by at least one person at all times.

4.3.2.4 Utility Unit

The utility unit will mainly comprise equipment needed to assist the ammonia production process. Such equipment will include:

- Steam turbines;
- Boilers;
- Demineralisation plant;
- Instrumental compressor unit; and
- Inert nitrogen unit.

4.3.2.5 Cooling Tower Unit

The cooling tower unit will comprise one seawater cooling tower operating on a closed circuit. The unit will comprise re-circulation pumps to assist in cycling cooling water through the ammonia unit. The Water Corporation will supply make-up seawater for the cooling circuit under commercial agreement with the Proponent and the cooling tower blowdown (concentrated seawater or brine) will be returned to the Water Corporation.

4.3.2.6 Thermal Desalination Plant

The thermal desalination plant proposed by the Water Corporation will provide desalinated water to the ammonia plant. The thermal desalination plant will cover an approximate area of 1 hectare and will be located adjacent to the ammonia plant.

The Water Corporation will own and operate the plant which will be subject to a separate referral to the EPA for assessment. A similar thermal desalination plant has been proposed for location within Syntroleum's gas to synthetic hydrocarbons plant to service the cooling and high purity water requirements of new industries on the Burrup Peninsula. The desalination plant and associated intake and discharge pipelines are multi-user and include the provision for off-takes to other industrial developments. Environmental approvals and an environmental operating licence have been obtained for this desalination plant which includes the abstraction of 100 ML/day of seawater from King Bay and the return discharge of 70 ML/day of brine.

4.3.2.7 Administration Unit

The administration unit will primarily serve as the overall management section for the operation of the plant. The administration unit will consist of:

- Human resources and public relations department;
- Accounting, payroll and finance department;
- Key personnel responsible for the onsite management of the plant;
- Warehouse area and equipment maintenance department;
- Vehicle maintenance department;
- Canteen; and
- Gatehouse.

The administration unit will also be responsible for presenting site visitors safety inductions as well as public relations and tourism orientated presentations.

4.4 Services and Utilities

4.4.1 Access

Access to the plant will be from the north, off Village Road (**Figure 4-1**). The access road will avoid the large rockpiles in the northern portion of the site. The road will be approximately 800 metres in length and 6 metres in width with 1 metre shoulders on either side. This road will be sealed.

4.4.2 Natural Gas Supply Pipeline

The natural gas feedstock for the ammonia plant will require construction of a 1.3 kilometre dedicated natural gas supply pipeline to the outside battery limit of the ammonia plant. This pipeline will be constructed below ground by the Harriet Joint Venture with Apache Energy as acting Manager. The construction of the pipeline will comply with relevant Australian Standards and legislation including the *Energy Operators (Powers) Act 1979*. The diameter of the pipeline will be about 250mm to supply gas at a pressure of about 5 MPag. This will be sufficient to meet the current requirements of Burrup Fertilisers for the proposed 2,200 tpd production.

The natural gas pipeline will be constructed from the DBNG pipeline and will follow the existing disturbed road reserve (**Figure 4-4**) along Village Road and will enter the project lease from the north and then run about 800 metres south through the centre of the project lease, avoiding the significant rockpiles. This will occur over a 12 metre wide corridor. The DBNG pipeline is owned and operated by Epic Energy. In order to achieve a lateral gas supply connection to the DBNG pipeline, without interrupting supply of gas to Epic Energy's existing customers, a standard hot tap technique will be used.

The terminus of the gas pipeline at the ammonia plant will connect to the Natural Gas Knockout Drum which is used to remove solid and water impurities prior to the gas entering the ammonia production process.

On completion of the pipeline construction, Apache Energy will be responsible for ensuring that the length of the pipeline is hydrotested using potable water with inhibitors to minimise corrosive effects. On completion of hydrotesting, the water will be pumped into a road tanker for disposal at an approved location.

The pipeline route's 12 metre wide construction corridor will then be graded to match existing contours and to prevent erosion along its length. Suitable seed types collected from the immediate area will be used in association with replaced topsoil to assist with vegetation rehabilitation.

4.4.3 Product Pipelines

Two above ground ammonia pipelines will be required to transport refrigerated liquid ammonia between the plant site and the Dampier Public Wharf, a distance of about 4.3 kilometres. The export pipeline will run from the Dampier Public Wharf along the Burrup West service corridor, underneath Burrup Road via culverts then along the road reserve bordering the northern boundary of the project lease. The pipeline will enter the lease from the north **(Figure 4-4)**. The pipeline route between Burrup Road and land vested under the Port of Dampier, will be cleared and levelled by DRD and will be subject to separate approval process. A second pipeline will be required as a recirculation line. This will allow ammonia to be returned to the plant and will facilitate the cooling of the pipeline prior to loading ammonia on the ship. The ammonia storage on the ship will be refrigerated to keep ammonia in liquid form. The product and recirculation pipelines will be insulated to reduce heat gains and will comprise isolation valves at regular intervals which will be operated from an automated main control centre.

The pipelines will be constructed above ground to avoid damage to the insulation and to facilitate regular maintenance inspections. It would also be impractical to install the pipelines below ground, as they would need to be placed in a culvert along the entire length of the line, which would incur considerable costs.

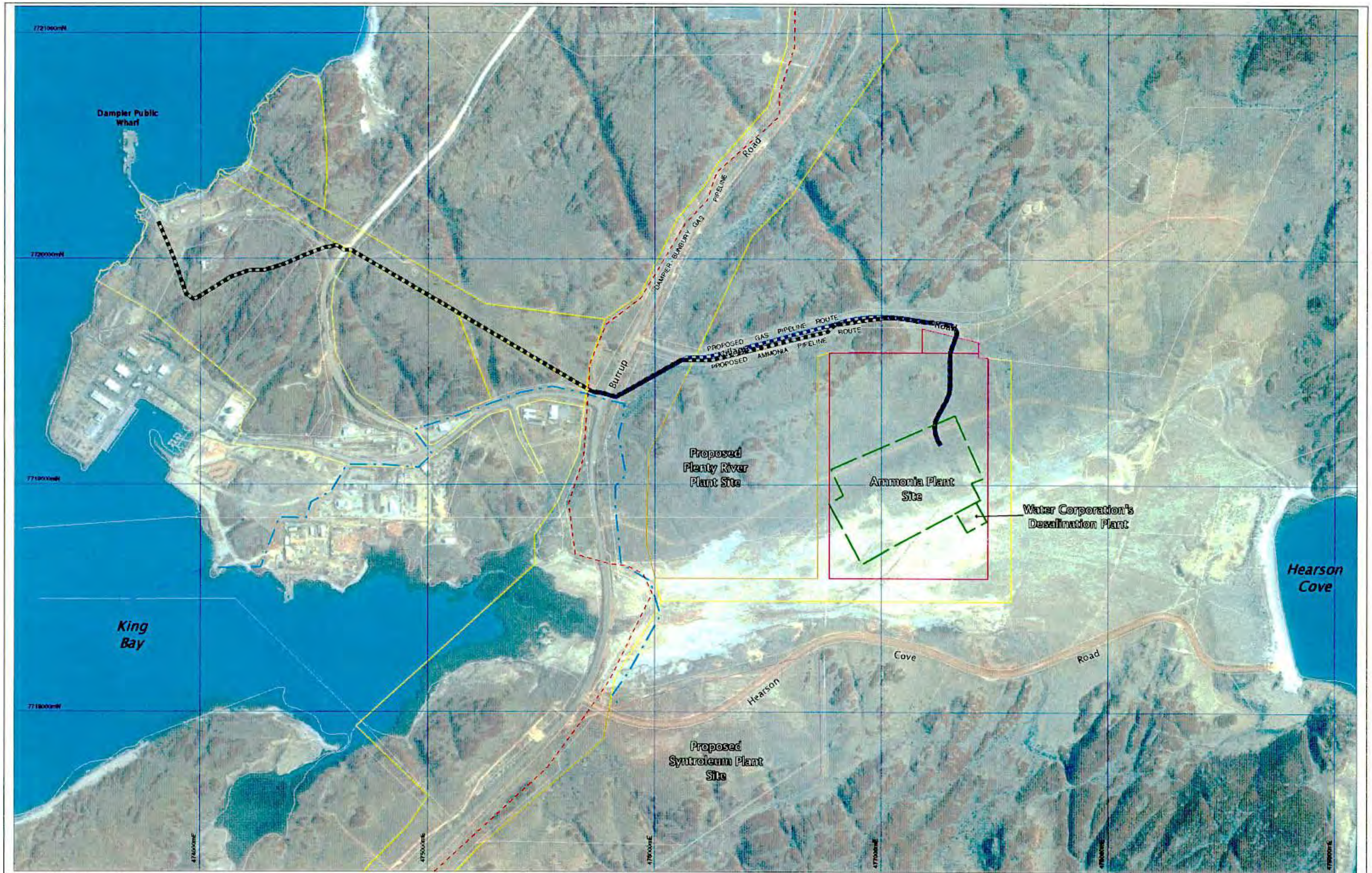
Following construction of the ammonia pipelines, the entire length will be hydrotested using potable water with inhibitors to minimise corrosive effects. Following hydrotesting, the water will be pumped into a road tanker for disposal at an approved location.

Following the construction of the ammonia pipelines the 10-metre wide construction corridor will be graded to match existing contours and to prevent erosion along its length. Suitable seed types collected from the immediate area will be used in association with replaced topsoils to assist with vegetation rehabilitation.

It is important to note that these pipelines will only contain ammonia during the ship loading process. The ship loading process will occur once every fortnight over a duration of about 35 hours.

4.4.4 Landing of Prefabricated Components

The landing of components for the plant can be undertaken via the Dampier Public Wharf or Mermaid Marine's Wharf. The Dampier Public Wharf currently has a maximum capacity of 300 tonnes which may require some plant components to be cut down to size. Alternatively Mermaid Marine's Wharf has a larger capacity of 2000 tonnes which is well within the capability of accepting all necessary components for the ammonia plant. Mermaid Marine's Wharf is currently under construction and is expected to be completed by September 2001.



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Note: Secondary service corridors shown to Ammonia Plant Site are preliminary and subject to approval

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Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

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BURRUP AMMONIA PLANT
PROPOSED PIPELINE ROUTES

LEGEND

- Ammonia Plant Lease
- Other Lease Sites
- Service Corridors
- Proposed Ammonia Pipeline Route
- Proposed Gas Pipeline Route (Apache Energy)
- Proposed Seawater Pipeline (Water Corporation)
- Dampier - Bunbury Gas Pipeline

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 4.4

Client: Burrup Fertilisers Pty Ltd
Job No: SW01198
Date Drawn: 21 July 2001
FileName: DE01890_01_Fig4_3.wor
Map No: A3-554

Use of either of the facilities for the landing of plant components will be negotiated under a commercial agreement between the Proponent and Mermaid Marine or the Dampier Port Authority.

4.4.5 Shipping

The Proponent will produce 770,000 tpa of ammonia, based on 350 operating days per year and 2,200 tpd production rate, to accommodate two shipments per month.

The ships that will be required to export ammonia will be 50,000 tonne ships capable of storing 35,000 tonnes liquid ammonia. The ships are 220 metres in length and are able to comfortably fit within the Dampier Port Authority's existing 250 metre length wharf.

Dredging will be required to accommodate the under keel clearance for ammonia ships, as they are significantly deep. Dredging and any additional port upgrades will be undertaken by the Dampier Port Authority and will be subject to a separate referral to the EPA for assessment.

The ammonia loading process is activated from the plant site. Refrigerated ammonia is cycled several times through the export pipeline and returned via the recirculation line under low pressure and low flow conditions to cool the pipeline. An isolation valve at the loading facility is closed to allow ammonia to cycle through to the recirculation line.

Loading of the ship will be undertaken with the use of a specially designed marine loading arm, capable of loading up to 1000 t/hr. It is proposed that the loading arm will be similar to that proposed by Syntroleum's gas to hydrocarbon plant with a possible option of sharing this facility. The loading arm will be flexible and erected on a transportable base to allow quick, easy and safe loading.

The ammonia export pipeline will be situated on the underside of the loading wharf to the ship loading point. The flexible arm will be connected to the permanent export pipeline. The ship will also comprise permanent piping with a flexible attachment to allow for the rise and fall of the ship due to changes in tide and the sinking of the ship as it becomes increasingly heavier as it is loaded.

The ammonia storage vessels on the ship will be refrigerated and at atmospheric pressure to maintain the ammonia product in liquid form. As a result there will be no requirement for the storage vessels to be made inert as vapour space in the vessels will not contain ammonia. The entire process of loading ammonia will take about 35 hours, given that the ammonia flow rate is about 1000 t/hr.

Whilst loading, a 200 metre exclusion zone around the Dampier Port Authority wharf will apply with the general rule that no unauthorised personnel will be permitted within this zone during loading.

Once the ship is loaded, the supply of ammonia from the plant site is terminated and the valves of the export line are closed. The inventory of ammonia in the loading arm is placed on the ship. The inventory of ammonia in the export line will flow by gravity either to the wharf or the plant. Because the export line will be constructed on land that rises and falls prior to reaching the wharf, the ammonia that gravitates to the wharf will be boiled off and vapours returned to the plant and the ammonia that gravitates towards the plant will be returned to the storage tank.

4.4.6 Water Supply and Treatment

4.4.6.1 Desalinated Water

It is estimated that the raw water requirements for the plant will be approximately 135 m^3/hr. The majority of the water will be treated on site in the demineralisation unit to prepare demineralised boiler quality water for process use. The raw water will be supplied by the Water Corporation and will be piped from their thermal desalination plant directly to the demineralisation unit. The waste stream from the demineralisation unit will contain a concentrated level of mineral salts removed from the raw water. This water will be treated to remove the concentrated mineral salts and is further discussed in **Section 7.2.6**.

4.4.6.2 Cooling Water

The ammonia plant will be cooled using a closed circuit seawater cooling system. The heat will be removed by evaporation of the seawater in the cooling tower. Make-up seawater will be obtained at a rate of about 48 ML/day from King Bay via the Water Corporation's saline pipeline intake. On average, the hourly demand for make-up seawater for the ammonia will be about 2000 m^3 /hr peaking to 3000 m^3/hr.

The Water Corporation has obtained approval to construct multi-user intake and discharge pipelines. The seawater intake pipeline will have provision for off-take for other industrial developments (Water Corporation, 2001). Both the intake and discharge pipelines will run along the east side of Burrup Road from the Syntroleum plant to King Bay Road. The pipelines will be installed below ground between the Syntroleum plant and the north side of King Bay tidal mudflats. North of the mudflats, the pipelines will be installed above ground within the DRD's proposed service corridor to the intersection of King Bay Road.

The route crosses Burrup Road at King Bay Road and follows the latter along the northern boundary. The pipelines will run above ground within the Water Corporation easement on the north side of King Bay road to the northeast corner of the Bramble's facility (Water Corporation, 2001). The pipelines will be installed below ground near MOF Road and will cross King Bay Road, run along the western boundary of Mermaid Road and then follow Mermaid Marine's lease boundary to the Mermaid Marine groyne (**Figure 4-4**).

Seawater for Burrup Fertiliser's ammonia plant can be obtained from the seawater intake pipeline from two possible locations:

- The **First Option** considers tapping into the proposed seawater pipeline at the corner of Burrup Road and King Bay Road.
- The **Second Option** is to obtain seawater from the pipeline where the proposed service corridor south of the ammonia site intersects Burrup Road service corridor.

Treated liquid waste produced by the ammonia plant will also be discharged via Water Corporation's discharge pipeline. The Water Corporation will be required to obtain approval for the discharge of treated process wastewater. The discharge of liquid waste is further discussed in **Section 7.2.3 and 7.2.6.**

The Water Corporation will also be responsible for the construction and approval of the seawater pipeline and will select either of the two above options in agreement with the Proponent. It is likely that the intake and discharge pipelines will be constructed below ground.

4.4.6.3 Water for Fire Fighting

Water for fire fighting and emergency response will be contained in the process water tank which will also store desalinated water produced from the Water Corporation's thermal desalination plant.

4.4.6.4 Wastewater Streams

The proposed ammonia plant will produce the following wastewater streams:

- Package boiler and reformer steam drum boiler blowdown;
- Cooling tower blowdown;
- Neutralised demineraliser regenerant wastewater;
- Reformer jacket water blowdown;
- Air compressor intercooler wastewater;
- Process and steam condensate;
- Sanitary wastewater; and
- Surface runoff.

A schematic flow diagram of the proposed wastewater collection and treatment system is provided in **Figure 4-5** and **Figure 4-6**. **Figure 4-5** illustrates the collection of stormwater by floor drains and separation of clean stormwater and potentially contaminated stormwater. Contaminated stormwater, process condensate, steam condensate and intercooler wastewater will be passed through an oil interceptor equipped with an oil skimmer. Oily waste will be stored in a sealed wastewater effluent sump. Oily waste will be transferred to a vacuum truck for approved disposal.

The wastewater effluent sump will also contain:

- Treated sanitary wastewater;
- Process condensate;
- CO_2 removal purge (normally no flow); and
- Boiler blowdown.

Clean stormwater, raw water filter backwash, steam condensate and neutralised laboratory wastewater will be collected and tested prior to being discharged off-site.

Wastewater in the effluent sump, neutralised demineraliser regenerant wastewater and cooling tower blowdown will be treated as required prior to being discharged via the Water Corporation's brine discharge pipeline (refer to **Section 7.2.3**).

4.4.7 Power Generation

The electrical power for the plant will be supplied by a captive power plant with a 20 MW steam turbine generator to generate 18.7 MW of power. The ammonia plant will contain an additional 20 MW generator on standby in the event that the operating turbine fails. The two turbines will not be required to operate simultaneously. The steam turbines will be run by medium-pressure steam at 4650 kPa(a) and at 375°C sourced from the ammonia plant and auxiliary boilers.

Approximately 4 MW of power and 10 t/hr of low pressure steam will be supplied to the thermal desalination plant to satisfy the operating requirements of this plant.

Two diesel generators each of 2.0 MW capacity will be installed to provide construction power and start-up power. These generators will be retained for emergency and will not be required during the normal operation of the plant.

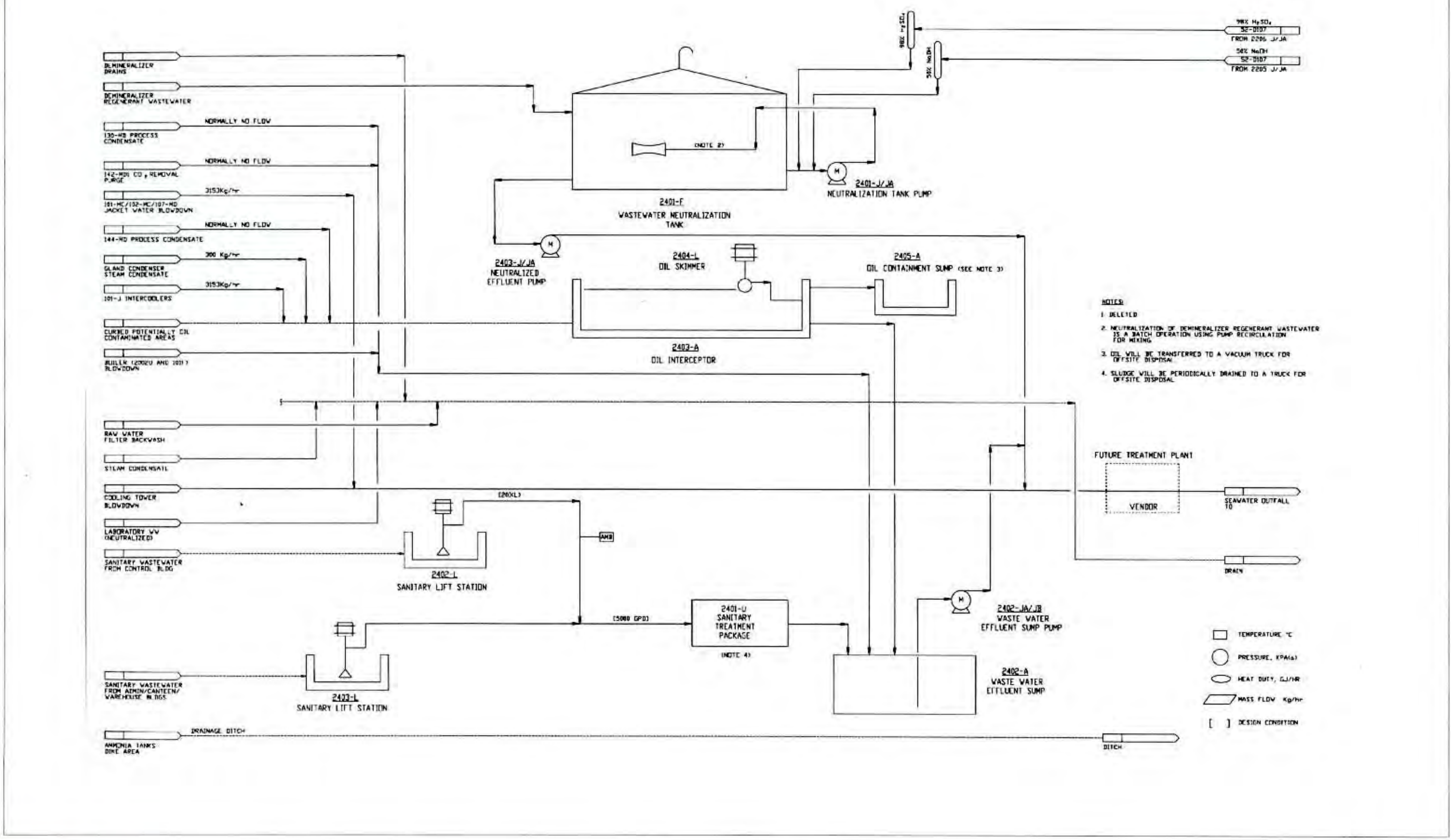
Power from the local power grid will not be required at any stage of the project.

There may be the potential for the project to become a future net exporter of power to the grid under a commercial agreement with Western Power. Power export would be subject to approvals under the *Electricity Act 1945*.

4.4.8 Support Facilities

Support facilities that will be required for the ammonia plant are shown on **Figure 4.1** and include:

- Control Room: This building will house the control equipment for the plant and will be constructed to ensure that it is blast, fire and weather proof. Adjacent to the building will be an allocated area for the transformers.
- Substation Building and Transformer Yard: This building will be adjacent to the control room and will house the rack room, UPS and switchgear room.
- Warehouse and Maintenance Buildings: This structure will be located within the Administration Unit of the plant and will house the maintenance facilities and also spare parts for the plant. A portion of the plan will be used for offices. A fenced area adjacent to this building would be used for outdoor storage and minor pipe fabrication.
- Safety, First Aid, Security and Fire Station Building: This building will house the safety, first aid, security and fire station.
- Vehicle Maintenance Building: This building is located within the Administration Unit of the plant and is similar to the Warehouse and Maintenance building.



Note: Source Kellogg Brown & Root

SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT
WASTEWATER COLLECTION & TREATMENT SYSTEM

FIGURE 4.5
Client: Burrup Fertilisers Pty Ltd
Job No: SW01198
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FileName: DE01890_01_Fig4_5.wor

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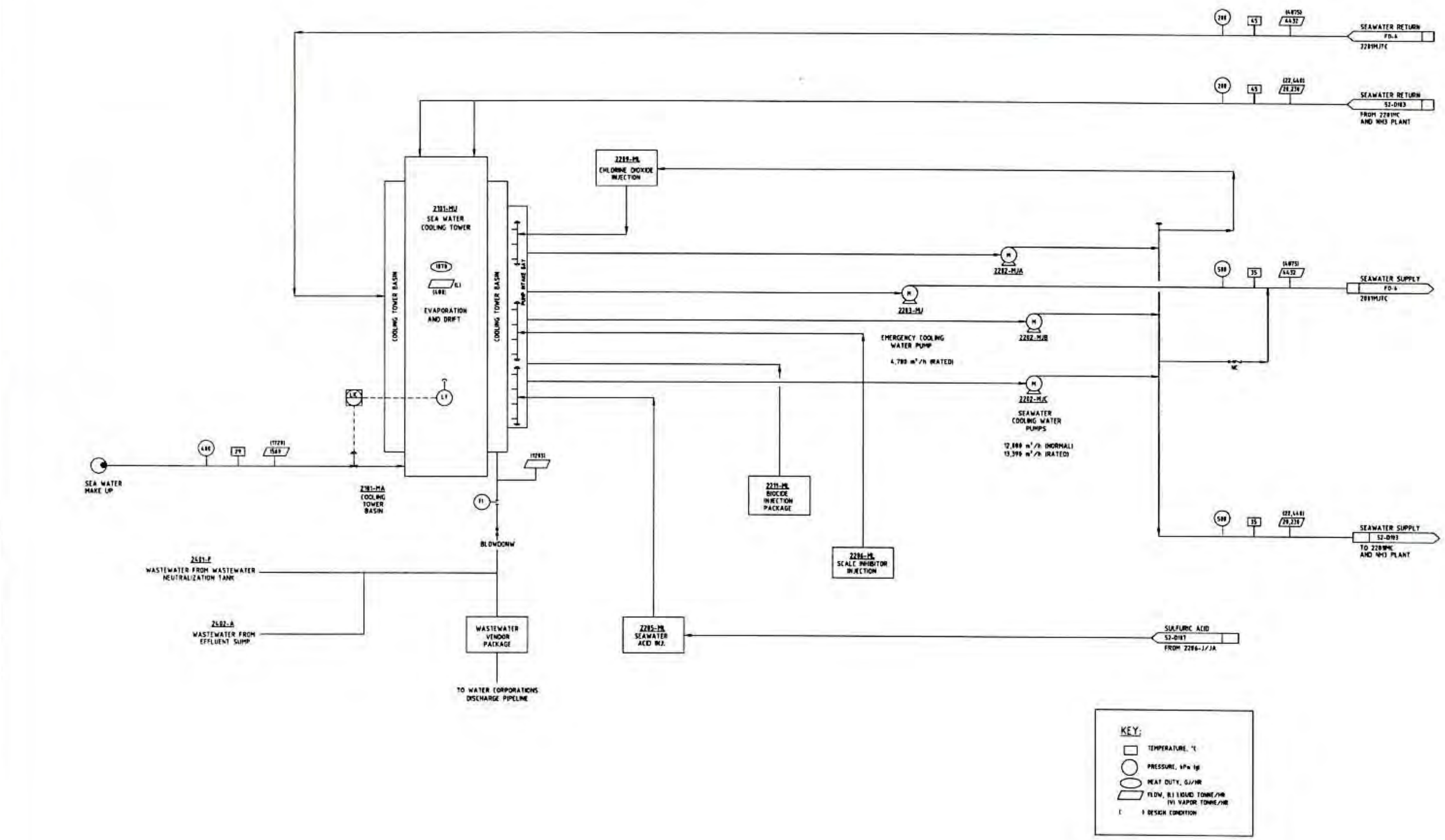

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BURRUP AMMONIA PLANT
COOLING WATER DISCHARGE & TREATMENT SYSTEM

FIGURE 4.6

Client: Burrup Fertilisers Pty Ltd
Job No. SW01198
Date Drawn: 21 July 2001
FileName: DE01890_01_Fig4_6.wor

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- Administration Building, Laboratory and Canteen: One building will house the administrative offices, the laboratory and the canteen. This building will be located within the Administration Unit. The canteen will provide an allocated dining area that is separate and removed from potentially hazardous plant areas of the site.
- Gatehouse: A gatehouse is located within the Administration Unit and will be provided on site for the purposes of security.

4.5 Hours of Operation

The proposed ammonia plant will be operated on a 24 hour basis and will be manned 365 days of the year. Two shifts will operate over the 24 hours with about 40 employees operating the plant during the day shift and 10 employees during the night shift.

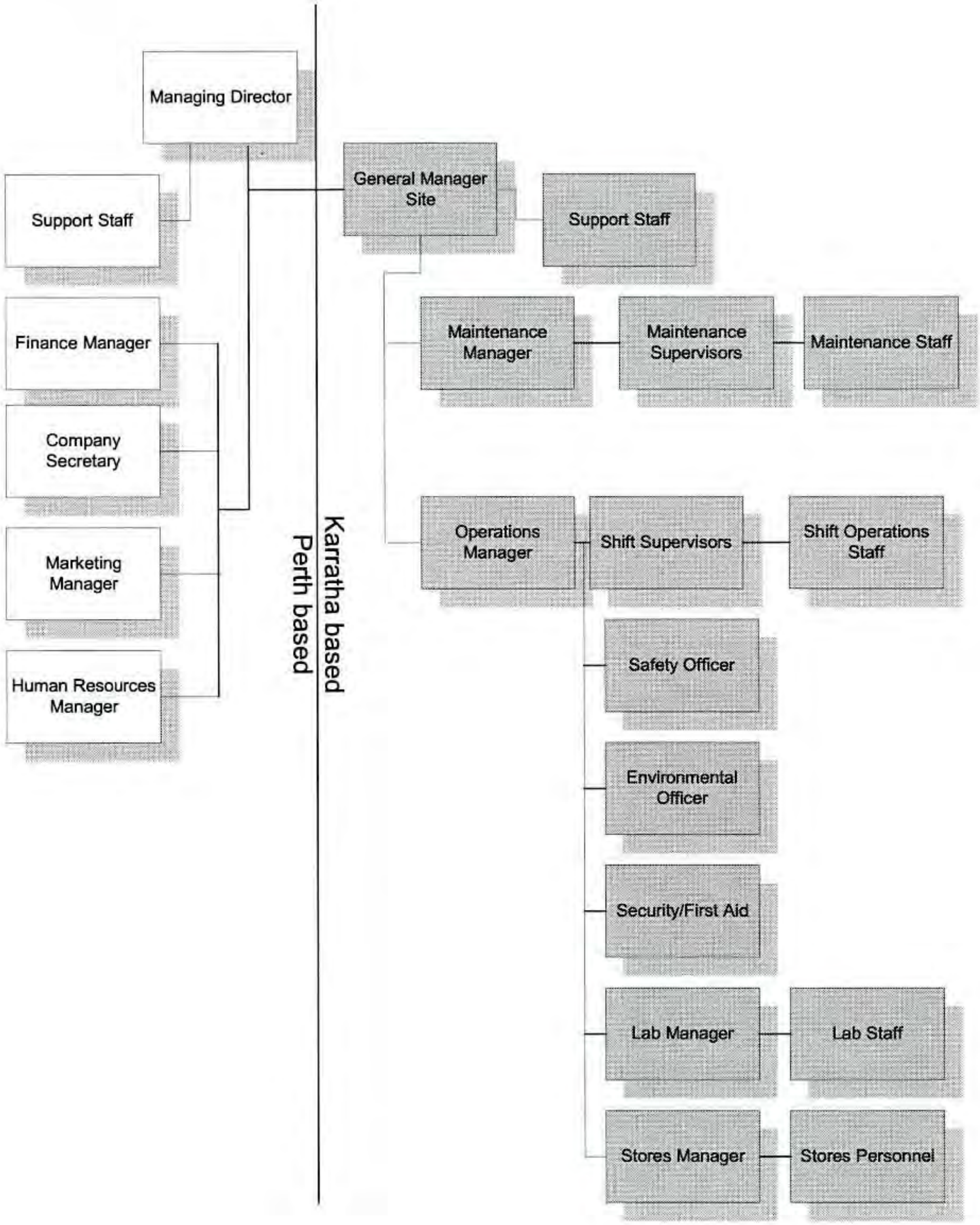
4.6 Workforce

Construction and operations personnel will be sourced primarily from Western Australia with some management personnel from overseas. During the construction phase of the project, employment is anticipated to peak at 500 people.

During the operation of the plant, it is estimated that a workforce of up to 60 personnel will be employed. Approximately 50 operational personnel will be based in Karratha and approximately 10 management personnel will be based in Perth. A breakdown of the manning requirements is given in **Figure 4-7**. The workforce will be recruited from Western Australia if personnel with appropriate skills are available. Managerial and possibly some senior technical personnel could come from overseas.

A number of options are available to accommodate the construction and operational workforce within Karratha. This is discussed in **Section 8.3**.

Figure 4-1 Operational Manning Requirements and Proposed Organisational Structure



5. Existing Environment

5.1 Introduction

The following sections present a description of the regional and local environmental characteristics of the project lease and its surrounds. The Burrup Peninsula and surrounding Dampier Archipelago is considered to be of international significance supporting significant natural environmental, scenery and Aboriginal heritage values (CALM, 1999a).

Much of the Burrup Peninsula remains undisturbed, free from weeds and feral animals and adjoins a significant and sensitive marine environment. The Peninsula also contains the world's richest known concentration of indigenous rock art (O'Brien Planning Consultants, 1996).

5.2 Climate

The Burrup Peninsula is situated within an arid (mainly summer rainfall) tropical desert zone based on the Koppen classification system. The general seasonal characteristics of this area are hot summers with periodic, heavy rains and mild winters with occasional rainfalls. The four specific weather phenomena that are of the greatest importance to the region are:

- The summer monsoon which brings most of the annual rainfall;
- Tropical cyclones which are associated with damaging winds and flooding;
- Strong easterly winds in the winter caused by the development of intensification of anticyclones over southern Western Australia or South Australia; and
- Major cloud bands that develop in winter and extend from the north-west coast across the continent bringing significant rain to the north-west and the interior of the country.

Long term meteorological data (including rainfall, temperature, humidity and wind data) has been recorded since 1969, at the operations of Dampier Salt by the Bureau of Meteorology. A summary of the meteorological data for the period 1969-2000 is presented in **Table 5-1**.

5.2.1 Temperature and Humidity

There are generally two main seasons for Dampier and Karratha, a hot summer extending from October to April and a mild winter from May to September.

The mean annual maximum and minimum temperatures for Karratha are 32.2°C and 20.5°C, respectively. Mean monthly maximum temperatures range from 26.1°C in July to 36.2°C in March. Mean monthly minimum temperatures range from 13.4°C in July to 26.5°C in February.

The annual mean relative humidity for Karratha is 47.0% at 9 am and decreases to 40.0% at 3 pm.

Table 5-1 Summary of Climatic Data for Dampier-Karratha from 1969 to 2000

Month	Temperature (°C)		Relative Humidity (%)		Pan Evaporation (mm)	Rainfall (mm)	
	Mean Daily Maximum	Mean Daily Minimum	9am Mean	3pm Mean	Mean Daily	Mean	Mean No. of Rain Days
January	35.9	26.1	58	51	11.6	26.7	4
February	36.1	26.5	60	51	10.9	67.8	6
March	36.2	25.6	54	44	10.6	41.7	4
April	34.4	22.8	45	37	9.6	21.8	2
May	29.9	18.2	45	38	7.2	29.6	4
June	26.6	15.1	47	40	6.2	35.8	4
July	26.1	13.4	44	36	6.4	15.1	3
August	27.7	14.6	43	35	7.3	6.3	1
September	30.5	16.8	37	33	9.5	1.4	1
October	32.6	19.6	39	37	11.1	0.5	0
November	34.3	22.2	41	41	12.3	0.4	0
December	35.7	24.6	49	44	12.4	14.1	2
Annual Mean	**32.2**	**20.5**	**47.0**	**40.0**	**9.6**	**21.8**	**3**
Annual Total					**3,500**	**261**	**31**

5.2.2 Rainfall and Evaporation

The Pilbara region has a highly variable rainfall which is dominated by tropical cyclone activity in summer. The moist tropical storms penetrating from the north bring sporadic and heavy thunderstorms. With the exception of cyclonic events, rainfall is erratic and very localised due to thunderstorm activity.

Rainfall in the region is seasonal, usually with two peaks per year. The first peak is from January to March due to tropical thunderstorms and cyclonic activity. The second peak is from May to June due to the passage of low pressure systems through the south of Western Australia. Mean monthly rainfall varies from 0.4 mm in November to 67.8 mm in February. The annual average rainfall is 261 mm, with an average of 31 rain days.

Mean daily pan evaporation ranges from a minimum of 6.2 mm in June to a maximum of 12.4 mm in December. Total annual evaporation is approximately 3,500 mm per year, which exceeds annual rainfall by approximately 3,240 mm.

5.2.3 Wind

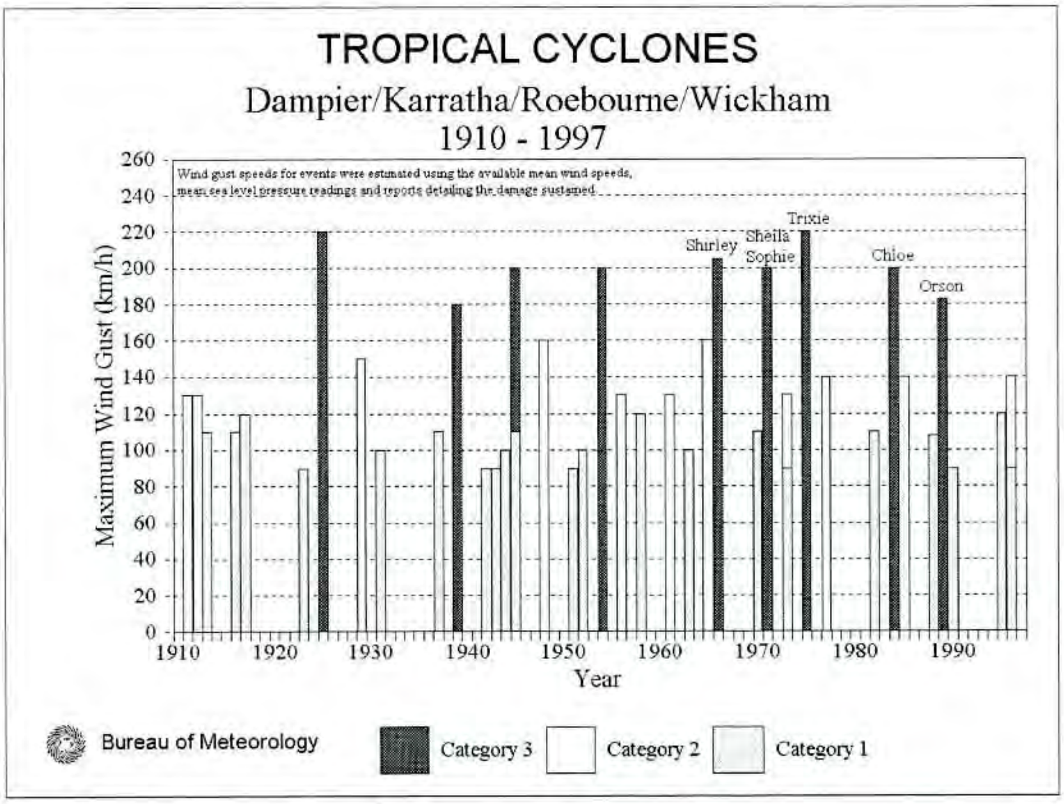
Winds are predominantly from the east during winter. East to south easterly winds are dominant in the mornings, shifting to north-easterly in the afternoon and easing in the evening in response to diurnal land temperature changes. Average wind speeds range from 11 – 20 km/h, however, wind speeds from these directions can exceed 70 km/hr during storms generated by the interaction of high pressure belts and northern tropical low pressure systems.

During summer, winds are predominantly westerly in the morning, shifting to dominant north-westerly onshore winds in the afternoon. Average wind speeds from these directions are 11-20 km/hr in the mornings and 21-30 km/hr in the afternoon. Wind speeds in excess of 35 km/hr can be experienced for sustained periods of up to four days.

5.2.4 Cyclones

Tropical cyclones occur between the months of mid December to April. On average, two cyclones cross the Pilbara coast per year. During cyclones, wind speeds of up to 250 km/hr, heavy swells and torrential rain can be experienced. Data from the Bureau of Meteorology, as illustrated in **Figure 5-1**, summarise the frequency, category and maximum wind gusts from cyclones that have occurred in the Dampier and Karratha Region.

Figure 5-1 Tropical Cyclones that have Occurred in the Dampier/Karratha Region



5.2.5 Tides

The tidal range at Dampier is moderate and semi-diurnal in nature. The tides in King Bay range from 0.1m (LAT) to 5.2m (HAT), which corresponds to –2.7 mAHD to 2.4 mAHD (Woodward-Clyde, 1998).

5.2.6 Storm Surge

An abnormal elevation of sea level can occur when a cyclone approaches the coast. Peak steady water levels have been estimated for a number of locations on the Karratha coast in the Karratha Storm Surge Inundation Study (Bureau of Meteorology, 1996). The peak steady water level is the elevation of the sea surface above AHD caused by the combined effect of storm surge, tide and wave set-up. This water level is estimated to reach up to 4.8 mAHD within the vicinity of the project lease, for a 1-

in-100 year event. In and around the Karratha township a water level of 6.2 m has been estimated for a 1-in-100 year event (Bureau of Meteorology, 1996).

5.3 Geology and Soils

The geology of the Burrup Peninsula has been previously investigated by the Geological Survey of Western Australia and has been described by O'Brien Planning Consultants (1994).

The Burrup Peninsula is composed mainly of an intrusive Proterozoic igneous rock outcrop known as the Gidley Granophyre, which is approximately 2,200 million years old. The main outcrop of Gidley Granophyre occurs in the Dampier Archipelago and the adjacent mainland, along basal unconformity of the Fortescue Group (Hickman, 1983). The base of the intrusion consists of a differentiated coarse-grained gabbro and the main body is a fine-grained granophyre. The gabbro weathers to a dark brown and the granophyre to a lighter red-brown, and both rock types are resistant to erosion and form aggregates of split boulder screes.

The project lease and service corridors contain large areas of exposed granophyre bedrock with little or no soil cover. The relatively rapid weathering of the dolerite dykes (compared to the gabbro or the granophyre) has resulted in the formation of deeply incised, narrow valleys trending either southwest to northeast or east to west.

A large dolerite dyke is present in the King Bay Hearson Cove lineament. As a result there is less outcrop of the rhyadacite than in other areas of the Peninsula. The outcrops are generally located on the southern and eastern boundaries of the project lease.

Mudflats located in the southern portion of the site indicate a soil profile of low energy marine depositional environment. The soil profile is largely comprised of sandy silts to silty sands generally brown to grey in colour with occasional variations including green, yellow and red mottling. The sediments are typically organically rich and often contain a thin veneer of shelly lenses.

The soils of the area are generally alkaline as a result of the high carbonate content originating from marine sands and underlying calcrete bedrock.

5.4 Topography and Landforms

The Burrup Peninsula is a rugged headland that extends north from the Pilbara coast, bounded by Mermaid Sound to the west and Nickol Bay to the east. The most prominent feature on the Peninsula are large areas of weather resistant rocky outcrops and scree slopes.

The proposed site is situated at the base of high scree slopes on its northern boundary, part of an extensive high scree range, which rises to above 60 metres above sea level in places and serves as a catchment for water during rainfall events. The range is cut by steeply inclined valleys, which occur along fault lines and minor drainage lines that feed into shallow drainage gullies through the site, and then south to the tidal flats before the inlet at King Bay.

The tidal flats form an east-west trending valley at approximately 4 mAHD and divide the Peninsula into two separate units from King Bay in the west to Hearson Cove in the east. The invert of this valley is composed of marine sediment.

The five major landform features found on and adjacent to the site include:

- A small area of high scree slope on the northern border of the lease;

- Uplands and upper hill slopes associated with the upper scree slopes;
- Gentle, low, undulating hill slopes with occasional small rock outcrops and shallow drainage gullies;
- Tidal flats; and
- Tidal inlet and associated saline flats.

5.5 Hydrology

There are no permanent surface water features on the Burrup Peninsula as creeks and rock pools are rainfall dependent. Surface water flows through the site in a south to south westerly direction in drainage channels that originate as steep sided valleys in the hillsides to the north. These drainage channels fan out onto the lower level tidal mud flats of the south which drain westward to King Bay and Mermaid Sound. The soils of the lower slopes and tidal flats are highly permeable and will recharge groundwater.

During periods of extreme spring tides and storm surge these tidal mud flats are periodically inundated with seawater for up to several hours. This tidal action supports the King Bay mangrove community west of Burrup Road by providing sedimentation, seawater recharge to maintain prevailing salinity fields, nutrient delivery and recruitment of benthos (Semeniuk, 1994). Evaporation of seawater over the tidal mudflats east of Burrup Road result in surface salinities ranging from 90,000 ppm to 300,000 ppm (Semeniuk, 1994). Such concentrations are undesirable for the growth of mangroves. Considering these factors the surface hydrology and processes on the tidal mud flat have no direct importance to the mangroves of King Bay (Semeniuk, 1994).

5.6 Hydrogeology

The density of granophyre and its surface proximity prevents long term subsurface water storage. The soils and underlying bedrock are highly permeable assisting the recharge of groundwater during rainfall events. The direction of groundwater flow is likely to be in a south-southeasterly direction from the high rocky slopes in the north to the intertidal flats in the south.

Groundwater investigations have been undertaken near the project lease by Soil & Rock Engineering (1999) and HLA-Envirosciences (1999). From these investigations groundwater levels are generally shallow due to the level of the site in relation to the tide and range from about 0.1 metres to 1.1 metres below ground level. The ground water level is expected to be higher during spring tides.

Analysis of potential contaminates in groundwater indicates that no hydrocarbons or organic compounds were detected (HLA-Envirosciences, 1999). Levels of metals, sulphates and pH are within regulatory guidelines with sulphates levels being marginally higher than normal background concentrations (HLA-Envirosciences, 1999).

Total dissolved salt (TDS) concentrations were measured to be about 77,000 mS/cm which is greater than the TDS concentration for seawater (40,000 – 50,000 mS/cm). This is typical of supra-tidal environments that are subject to greater evaporation rates (HLA-Envirosciences, 1999).

5.7 Terrestrial Flora and Fauna

5.7.1 Vegetation of the Burrup Peninsula

The Burrup Peninsula is located at the western end of the Abydos Plains in the Pilbara region of Western Australia. The Peninsula lies within the Fortescue Botanical District, which is part of the biogeographical region known as the Eremaean Botanical Province (Beard, 1975), and within the Pilbara biogeographic region in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995). Beard (1975) described the vegetation of the botanical province as predominantly open grassy plains or mixed grass and spinifex with shrub steppe occurring further inland on the granite plains. Thackway and Cresswell (1995) described the vegetation as "quarternary alluvial plains with a grass savanna of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia translucens* over *Triodia pungens*. Samphire, *Sporobolus* and Mangal occur on marine alluvial flats". However, Blackwell et *al.* (1979) found that the vegetation of the Burrup Peninsula was different from that of the rest of the botanical province in that it contained a relatively high number of species more typical of the Northern (Kimberley) Botanical Province.

In May 2000, a vegetation survey of the Burrup Peninsula was conducted, on behalf of the Department of Resources Development (DRD), by botanists M.E. Trudgen, A.S. Weston and V. Long. The purpose of the survey was to map the vegetation of the Burrup Peninsula and to identify any significant flora or vegetation types that occur there. To put the results of these surveys into a regional context, particularly with regard to the significant flora, comparisons were made with vegetation communities from Whim Creek, the Chichester Ranges and the hills south of Karratha.

Preliminary results of the survey indicate that the vegetation of the Peninsula and the surrounding islands are of significant conservation value and are restricted in distribution as the floristic and vegetation zones are strongly modified by the local geology and microclimate.

5.7.2 Objectives

Astron Environmental Pty Ltd was commissioned by Sinclair Knight Merz to determine the vegetation types and flora species of the proposed site. The scope of work included:

- A review of information collected during previous biological surveys of the Burrup Peninsula and adjacent areas;
- A search of Department of Conservation and Land Management (CALM) databases for Declared Rare and Priority Listed Flora species;
- A review of aerial photographs to identify broad vegetation types according to topography; and
- Two vegetation surveys of the project lease and adjacent service corridors.

To date, Astron Environmental has completed the first of two vegetation surveys. The first vegetation survey was completed in April 2001 to coincide with the wet summer season and the second is to be carried out during the dry season.

5.7.3 Methodology

Before the survey was undertaken, a literature survey that included a search of the Declared Rare and Priority Species database was completed. Aerial photographs of the study area were examined to determine broad vegetation units and existing areas of disturbance. Landform, as determined from topographic maps, was studied as a guide to likely vegetation communities.

A total of 24 sampling sites were selected on the proposed plant site. This was done using aerial photographs as well as vehicle and foot traverses made in the field. Sampling sites were generally 50 x 50 metre quadrats, to enable valid comparisons and analysis of data with the Burrup Vegetation Survey (2000) commissioned by the DRD. Vegetation density, height, the presence of major species, Priority, Significant or weed species, and other species were recorded. Particular note was made of the location and abundance of Priority species, weed species and significant flora or vegetation units.

Landform, soil type, rock, aspect and litter were recorded at each of the vegetation sampling sites. The strata were recorded using the height intervals given in the modification of Specht's vegetation description (Aplin, 1979). This classification system was used to ensure conformance with the Burrup Vegetation Survey (2000).

Although at the time of the survey the exact location of the pipeline routes east of Burrup Road had not been decided, the corridors along both the northern and southern side of the plant site as far as the DRD pipeline corridor alignment were briefly reviewed.

5.7.4 Vegetation Assemblages

Seven broad vegetation types with their corresponding vegetation assemblages have been found to occur within the project lease:

- Rocky uplands and outcrops – occurs on 5% of the project lease;
- Upland and upper slopes – occurs on 5% of the project lease;
- Lower undulating slopes with shallowly incised drainage lines – occurs on 25 % of the project lease;
- Coastal flats – occurs on 20% of the project lease;
- Drainage and broad drainage zones – occurs on 5% of the project lease;
- Saline inlet and supratidal flats – occurs on 15% of the project lease; and
- Tidal inlet- occurs on 25% of the inlet.

These seven vegetation types were divided into fifteen vegetation assemblages in accordance with Specht, modified by Alpin (1979).

The seven vegetation types and their assemblages are described as follows and their distribution is illustrated in **Figure 5-2**. The latter two vegetation types are discussed together in **Section 5.7.3.6** as they are both subject to periodic inundation by seawater with the tidal inlet vegetation type having little to no vegetation as a result of this inundation.

5.7.4.1 Rocky Uplands and Outcrops

Vegetation Type: Open Low Woodland over mixed Shrubland over Open Hummock and Tussock Grass on rocky outcrops and in small soil pockets.

This vegetation type was found undisturbed in the north-west portion of the lease and occurs within the service corridor along the northern side of the lease. The associated vegetation occurs in less abundance, on small rockpiles outcropping on hillocks on the lower slopes. The vegetation assemblage associated with this habitat type is:

> **Vegetation Assemblage 1a (Plate 5-1):** Open Low Woodland (2-10%; <10m) of *Brachychiton acuminatus/ Ficus platypoda* var. *lachnocaulon/Terminalia supranitifolia,* over mixed Shrubland (10-30%; 1-1.5m) of *Acacia coriacea/ Rhagodia preissii preissii* over Open Hummock *T. epactia* and Tussock Grass *Cymbopogon ambiguus* and Open Herbs (10-30%) in soil pockets.

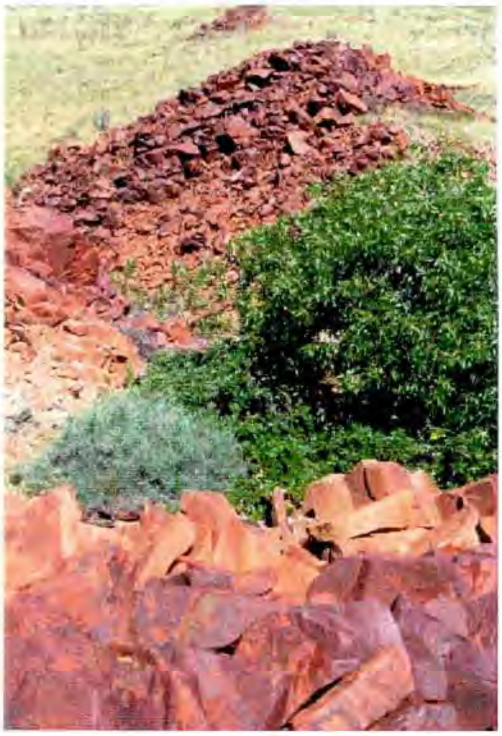


PLATE 5-1: Vegetation Unit 1a - *Brachychiton acuminatus, Terminalia supranitifolia* Open Low Woodland over *Rhagodia preissii preissii* on rocky uplands and outcrops. *T. supranitifolia* is a Priority 1 species.

5.7.4.2 Upland and Upper Slopes

Vegetation Type: Scattered to Open mixed Shrubland over Low Open Shrubland over Hummock Grass over Herbland on rocky upland and upper slopes.

This vegetation type is found immediately below the outcropping rock and scree high up on the slopes in the north-western portion of the lease and accounts for a large portion of the northern pipeline route. It is also found along upland grassed corridors and small plateaux on top of the range. The vegetation assemblage associated with this habitat type is:

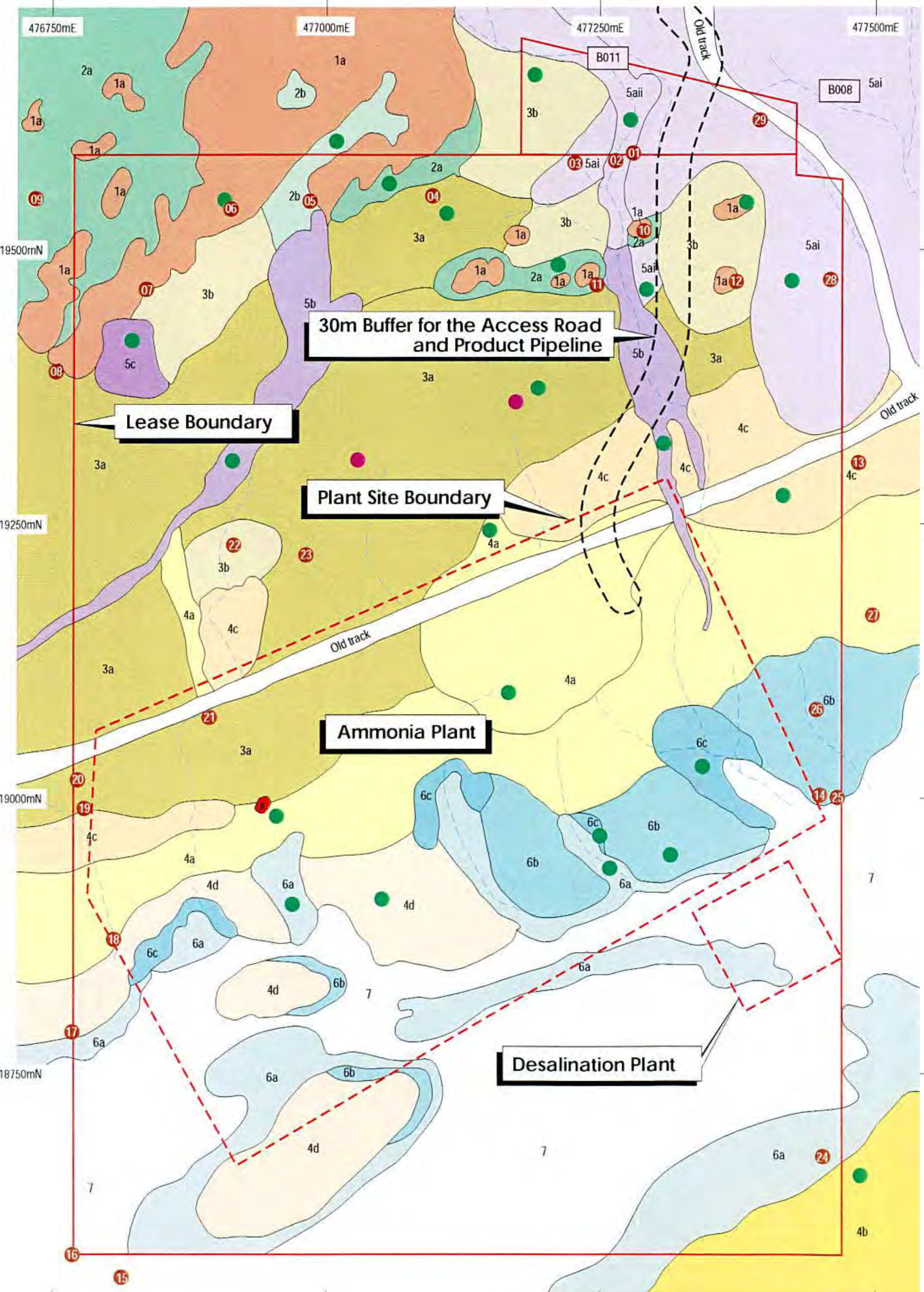
Vegetation Assemblage 2a: Scattered (2% to Open (2-10%; 1-1.5m) mixed Shrubland of *Grevillea pyramidalis, Cullen pustulata, A. bivenosa* over Low Open Shrubland (2-20%; 0.5m) *Indigofera monophylla* over mixed Hummock and Tussock Grassland (30-70%) *T. epactia, C. ambiguus* over dense (20-40%) *Rhynchosia minima* Herbland.

5.7.4.3 Lower Undulating Slopes with Shallow Incised Drainage Lines

Vegetation Type: Mixed Shrubland over Low Open Shrubland over Closed Hummock Grassland over Herbland on lower undulating slopes with shallow incised drainage lines.

This vegetation type comprises the central portion of the lease. It is gently undulating for the most part but also includes a small number of minor hillocks. Along very shallow incised drainage lines, species composition remained similar to the surrounding vegetation type but tended to be more abundant. The vegetation assemblages associated with this habitat type include:

Vegetation Assemblage 3a (Plates 5-2 and 5-3): Mixed Shrubland (10-30%; 1-2m) *Grevillea pyramidalis, A. inaequilatera/Hakea lorea* over Low Open Shrubland (2-10%; 0.5m) *Corchorus walcottii, Indigofera monophylla* over Closed *T. epactia* Hummock Grassland (50-90%) over Herbland (20-30%) *R. cf minima, Mukia maderaspatana.*



REFERENCE

1. ROCKY UPLANDS AND OUTCROPS

Open Low Woodland B over mixed Shrubland over Open Hummock and Tussock Grass on rocky outcrops and in small soil pockets.

1a	Open Low Woodland (2-10%; <10m) of ***Brachychiton acuminatus/Ficus platypoda lachnocaulon/Terminalia supranitifolia***, over mixed Shrubland (10-30%; 1-1.5m) of ***Acacia coriacea/ Rhagodia preissii preissii*** over Open Hummock ***T. epactia*** and Tussock Grass ***Cymbopogon ambiguus*** and Open Herbs (10-30%) in soil pockets.

2. UPLAND AND UPPER SLOPES

Scattered to Open mixed Shrubland over Low Open Shrubland over Hummock Grass over Herbland.

2a	Scattered (2%) to Open (2-10%; 1-1.5m) mixed Shrubland of ***Grevillea pyramidalis, Cullen pustulata, A. bivenosa*** over Low Open Shrubland (2-20%; 0.0.5m) ***Indigofera monophylla*** over mixed Hummock and Tussock Grassland (30-70%) ***T. epactia, C. ambiguus*** over often dense (20-40%) ***Rhynchosia minima*** Herbland.
2b	Scattered (2%) ***Cullen pustulata*** over Low Shrubland to Open Heath (30-50%; 1m) ***Tephrosia leptoclada*** with ***I. monophylla*** over Hummock Grassland (30-70%) ***T. epactia***.

3. LOWER UNDULATING SLOPES WITH SHALLOWLY INCISED DRAINAGE LINES

Mixed Shrubland over Low Open Shrubland over Closed Hummock Grassland over Herbland.

3a	Mixed Shrubland (10-30%; 1-2m) ***Grevillea pyramidalis, A. inaequilatera/ Hakea lorea*** over Low Open Shrubland (2-10%; 0.5m) ***Corchorus walcottii, Indigofera monophylla*** over Closed ***T. epactia*** Hummock Grassland (50-90%) over Herbland (20-30%) ***R.*** cf ***minima, Mukia maderaspatana***.
3b	Closed Grassland (70-90%) ***T. epactia*** over Low Open Shrubs (2-10%; <1m) ***Tephrosia aff supina*** (MET 12357) over Herbs (10-30%) ***Rhynchosia*** cf ***minima/Mukia maderaspatana***.

4. COASTAL FLATS

High Open to Open Heath of ***A. bivenosa*** over Low Open Shrubland over mixed Closed Grassland over Herbs.

4a	High Open Shrubland (2-10-30%; >2m) spindly ***A. bivenosa*** over Low Open Shrubland (2-10%; <1m) ***Aerva javanica/Corchorus walcottii*** over mixed Closed Grassland (50-90%) ***T. epactia, Whiteochloa airoides***, over ***R.*** cf ***minima*** Herbs.
4b	Shrubland to Open Heath (30-50%; 1-2m) ***A. bivenosa*** over Low Shrubland (10-30%; <1m) ***Trianthema turgidifolia/A. javanica*** over mixed Open Grassland (10-30%) ***T. angusta/C. ciliaris*** over Herbs (10-30%).
4c	Shrubland (10-30%; 1-2m) ***A. bivenosa/H. lorea*** over Low Shrubland (10-30%; <1m) ***Indigofera monophylla*** over Closed Hummock Grass (50-80%) and Herbs.
4d	High Open Shrubland (2-5%; 2m) ***A. bivenosa*** over Low Shrubland (10-30%; <1m) ***Aerva javanica*** over mixed Grassland (30-70%) ***T. epactia/Whitechloa airoides***.

x denotes individual stand of ***Codonocarpus cotinifolius.***

5. DRAINLINES AND BROAD DRAINAGE ZONES

Shrubland to Open Heath of ***Grevillea pyramidalis/A. inaequilatera*** Low Shrubland to Low Heath over Mid-dense Hummock Grass.

5ai/5aii	5ai Shrubland to 5aii Open Heath (20-70%; 1-2m) of ***Grevillea pyramidalis*** over Low Shrubland to Low Heath (10-30-50%; <1m) ***Corchorus walcottii*** over ***T. epactia*** Hummock Grassland (30-70%).
5b	Shrubland to Open Heath (20-50%; 1-2m) ***Acacia inaequilatera/Grevillea pyramidalis/Senna glutinosa glutinosa*** over Low Shrubland (10-30%; <1m) ***C. walcottii/Rhynchosia*** cf ***minima*** over ***T. epactia*** Hummock Grass (30-70%).
5c	Open Heath (30-50%; 1-2m) ***A. inaequilatera*** over Dwarf Shrubland (10-30%; 0.5m) ***Stemodia grossa/C. walcottii*** over ***T. epactia*** Hummock Grass (30-70%).

6. SALINE INLET AND SUPRATIDAL FLATS

Supratidal flats with Halosarcia-Trianthema succulent Dwarf Scrub.

6a	Dwarf Shrubland (10-30%; 0.5m) ***Halosarcia halocnemoides tenuis/Trianthema turgidifolia*** over Open Grass (10-30%) ***Sporobolus virginicus/Eragrostis falcatta***.
6b	Dwarf Shrubland (10-30%; 0.5m) ***Lawrencia viridigrisea/Hemichroa diandra/H. halocnemoides tenuis*** over Open Grass (10-30%) ***Sporobolus virginicus***.
6c	Low Shrubland (10-30%; 1m) ***A. ampliceps*** over Dwarf Shrubland (10-30%; 0.5m) ***L. viridigrisea/Neobassia astrocarpa*** over mixed Grassland (30-70%) ***Sporobolus virginicus/Triodia angusta***.
7	**TIDAL INLET**
B008	Survey Sites of the Burrup Vegetation Survey (Trudgen,2001)

Vegetation sampling site

Pebble mouse mound (abandoned)

01 Snail survey station

NORTH

0 50 100 150 200

METRES

Astron environmental

SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT

LOCATION OF FLORA AND FAUNA SURVEY STATIONS & DISTRIBUTION OF VEGETATION ASSEMBLAGES WITHIN THE PROJECT LEASE

FIGURE 5.2

Client: Burrup Fertilisers Pty Ltd
Job No. De01890
Date Drawn: 21 July 2001
File Name: Figure 52.dgn

K:\DEVN\00\De01890\figure52.dgn
ENVIRONMENTAL DRAFTING (08) 9278 8211

Vegetation Assemblage 3b (Plates 5-2 and 5-3): Closed Grassland (70-90%) *T. epactia* over Low Open Shrubs (2-10%; <1m) *Tephrosia aff supina* (MET 12357) over Herbs (10-30) *Rhynchosia* cf *minima/Mukia maderaspatana*.

PLATE 5-2: Vegetation Unit 3 - Mixed Shrubland of *Grevillea pyramidalis, A. inaequilatera, Hakea lorea* over Low Shrubland of *Corchorus walcottii, Indigofera monophylla* over Close *Triodia epactia* Hummock Grassland on lower undulating slopes.

PLATE 5-3: Vegetation Unit 3 - Shrubland to Open Heath of *Grevillea pyramidalis* over Low Shrubland to Heath *Corchorus walcottii, Indigofera monophylla* over *T. epactia* Hummock Grassland in drainage line.

5.7.4.4 Coastal Flats

Vegetation Type: High Open to Open Heath of *Acacia bivenosa* over Low Open Shrubland over mixed Closed Grassland over Herbs on the coastal flats.

The coastal flats run parallel to the saline inlet to the south and the lower hill slopes to the north. Soils here become more sandy and slightly saline. A corridor of disturbance some four metres wide more or less marks the northern boundary of this habitat. The vegetation assemblages associated with this habitat type include:

Vegetation Assemblage 4a*:* High Open Shrubland (2-10-30%; >2m) spindly *A. bivenosa* over Low Open Shrubland (2-10%; <1m) *Aerva javanica/Corchorus walcottii* over mixed Closed Grassland (50-90%) *T. epactia* over *R.* cf *minima* Herbs.

Vegetation Assemblage 4b (Plate 5-4): Shrubland to Open Heath (30-50%; 1-2m) *A. bivenosa* over Low Shrubland (10-30%; <1m) *Trianthema turgidifolia/A. javanica* over mixed Open Grassland (10-30%) *T. angusta/C. ciliaris* over Herbs (10-30%).

Vegetation Assemblage 4c: Shrubland (10-30%; 1-2m) *A. bivenosa/H. lorea* over Low Shrubland (10-30%; <1m) *Indigofera monophylla* over Closed Hummock Grass (50-80%) and Herbs.

PLATE 5-4: Vegetation Unit 4b - Shrubland to Open Heath of *Acacia bivenosa* over Low Shrubland *Trianthema turgidifolia*, *Aerva javanica* over Open Grassland of *Cenchrus ciliaris*, *Triodia angusta* on coastal flats.

5.7.4.5 Drainage Lines and Broad Drainage Zones

Vegetation Type: Shrubland to Open Heath of *Grevillea pyramidalis/A. inaequilatera* Low Shrubland to Low Heath over mid-dense Hummock Grass.

A broad drainage basin occurs in the north-eastern corner of the lease. A more defined drain line runs through the basin from north to the saline inlet south. Another broad drainage line runs from the base of the rocky scree slopes turning out to the west. Other minor drainage lines occur within the coastal flats vegetation type as mentioned above. The vegetation assemblages associated with this vegetation type include:

Vegetation Assemblage 5ai and 5aii: Shrubland (5ai) to Open Heath (5aii) (20-70%; 1-2m) of *Grevillea pyramidalis* over Low Shrubland to Low Heath (10-30-50%; <1m) *Corchorus walcottii/Indigofera monophylla* over *T. epactia* Hummock Grassland (30-70%). 5ai and 5aii are both dominated by *G. pyramidalis* but the density of each differs.

Vegetation Assemblage 5b: Shrubland to Open Heath (20-50%; 1-2m) *Acacia inaequilatera/Grevillea pyramidalis/Senna glutinosa glutinosa* over Low Shrubland (10-30%; <1m) *C. walcottii/Rhynchosia cf minima* over *T. epactia* Hummock Grass (30-70%).

Vegetation Assemblage 5c (Plate 5-5): Open Heath (30-50%; 1-2m) *A. inaequilatera/G. pyramidalis* over Dwarf Shrubland (10-30%; 0.5m) *Stemodia grossa/C. walcottii* over *T. epactia* Hummock Grass (30-70%).

PLATE 5-5: Vegetation Unit 5c - *Open Heath of* Acacia inaequilatera/ *Grevillea pyramidalis* over Dwarf Shrubland of *Stemodia grossa, Corchorus walcottii* over *T. epactia* open Grass in drainage pocket.

5.7.4.6 Saline Inlet and Supratidal Flats

Habitat: Supratidal flats with *Halosarcia-Trianthema* succulent Dwarf Scrub.

The saline inlet runs approximately east-west through the southern third of the lease area. Included in this habitat is the inlet, much of which is not vegetated, and the vegetation immediately fringing the inlet. The possible southern pipeline route traverses through the vegetation communities described below.

Vegetation Assemblage 6a (Plate 5-6): Dwarf Shrubland (10-30%; 0.5m) *Halosarcia halocnemoides tenuis/Trianthema turgidifolia* over Open Grass (10-30%) *Sporobolus virginicus/Eragrostis falcatta.*

Vegetation Assemblage 6b (Plate 5-7): Dwarf Shrubland (10-30%; 0.5m) *Lawrencia viridigrisea/Hemichroa diandra/H. halocnemoides tenuis* over low Grass (30-70%) *Sporobolus virginicus.*

Vegetation Assemblage 6c: Low Shrubland (10-30%; 1m) *A. ampliceps* over Dwarf Shrubland (10-30%; 0.5m) *L. viridigrisea/Neobassia astrocarpa* over mixed Grassland (30-70%) *Sporobolus virginicus/Triodia angusta.*

PLATE 5-6: Vegetation Unit 6a - Dwarf Shrubland of *Halosarcia halocnemoides tenuis, Trianthema turgidifolia* over Open Grass of *Sporobolus virginicus, Eragrostis falcatta* on saline inlet.

PLATE 5-7: Vegetation Unit 6b - Dwarf Shrubland of *Lawrencia viridigrisea, Hemichroa diandra, H. halocnemoides tenuis* over low *Sporobolus virginicus* grassland, bordering saline inlet.

5.7.5 Regional Coverage

The regional coverage of the vegetation assemblages found on the project lease will be investigated with information obtained from the Burrup Vegetation Survey, commissioned by the Department of Resources Development. It is anticipated that results will be made available in August, which is the approximate period when a second winter flora and vegetation survey of the project lease will be undertaken. However, a preliminary review of the findings of the Burrup Vegetation Survey as they relate to this project has been prepared (Trudgen, 2001) and is summarised in **Section 6.1.1.2**.

5.7.6 Significant Vegetation Communities

The designation of significant vegetation is based on the criteria listed below compiled from Astron and Trudgen, Weston & Long. These criteria have been established in the absence of any government or industry-agreed definitions. Significant vegetation is that which is:

- Poorly represented in the region;
- Makes a significant contribution to a particular ecological system;
- Contains an abundance of Priority and/or significant species; and /or
- In a relatively pristine state.

Vegetation that is considered significant on the Burrup Peninsula includes tall or dense stands of woodland and scrub, mangroves, small wetland communities found at permanent or semi-permanent water sources, dense rock pocket associations and communities and coastal dune associations.

Vegetation assemblages considered of conservation significance at the proposed plant site include:

- **Vegetation Assemblage 1a:** Stands of rockpile vegetation including relatively large *Ficus platypoda* var. *lachnocaulon* trees with *B. acuminatus, E. saligna, F. virosa, T. supranitifolia* and *Pittosporum phylliraeoides*. Although these stands of flora are common on rockpiles over the Burrup, they occur in isolation and each act as island refugia for fauna. The shade they provide also creates habitat for less frequently occurring lower strata species such as *Plumbago zeylanicum, Dicliptera armata, Jasminum didymum lineare* and *Enchylaena tomentosa*. The aesthetic value of these dense stands against the harsh red rocks in which they occur is also considered high.
- **Vegetation Assemblages 5a, 5b and 5c:** Shrubland to Open Heath of *Grevillea pyramidalis/A. inaequilatera* Low Shrubland to Low Heath over mid-dense Hummock Grass. The dense open heath of *Grevillea pyramidalis* and *G. pyramidalis/A. ineaquilatera* over low heath of *C. walcottii/S. grossa* over *T. epactia* grassland is also considered as worthy of conservation significance. These stands are not common to the Burrup Peninsula or regionally within the Pilbara. There are only two other locations which contain these particular vegetation types, one just outside the southern border of the Syntroleum site (marked for industry) and a second along a valley north-east of Withnell Bay (area allocated for conservation).
- **Vegetation Assemblages 6a, b, and c:** The samphire communities that occur along the tidal inlet in the southern portion of the study area are also considered of conservation significance (Long, 1994). Samphires are succulent, highly saline tolerant species specifically adapted to salt flats. Although these vegetation communities are found to occur scattered over the Burrup, the most significant of these in both area and diversity is located along a wide corridor which dissects the Peninsula between King Bay and Hearson Cove (Long, 1994).

The regional and local significance of the above vegetation communities has been considered in optimising the location of the ammonia plant (refer to **Section 6.1.1.)**

5.7.7 Flora

5.7.7.1 Common Flora

To date, a total of 375 vascular species have been recorded for the Burrup Peninsula (Weston, 1997). Within the project area, 119 vascular plants were recorded representing 42 families (**Appendix D**). The most commonly recorded family was the *Papillionaceae* (peas) with 16 species in eight genera followed by *Poaceae* (grasses) with 14 species in 11 genera.

This indicates high species diversity for such a small area as just under one third of the number of species known on the Burrup Peninsula are represented here. This is attributable to a variety of micro-habitats and micro-climates that form amongst the landforms of the area and can support a rich and diverse array of flora species.

5.7.7.2 Rare and Priority Listed Flora

Four vascular plants classified on the CALM Declared Rare and Priority Flora List are known from the Burrup Peninsula. These are:

❑ *Abutilon trudgenii ms*	Priority 3
❑ *Gymnanthera cunninghamii*	Priority 3
❑ *Terminalia supranitifolia*	Priority 1
❑ *Eriachne tenuiculmus*	Priority 3

The priority codes relating to these species are defined as follows (CALM, 2000):

Priority 1
Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size or being on lands under immediate threat. Such taxa are under consideration for declaration as "rare flora" but are in urgent need of further survey.

Priority 3
Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (ie. not currently endangered). Such taxa are under consideration for declaration as "rare flora" but are in urgent need of further survey.

Only one of the four priority listed species was found during the first survey, *Terminalia supranitifolia,* where a total of 35 trees were found in the lease. This is a low tree species not usually more than 1.25 metres in height but has been observed to reach up to 7 metres. It is generally found on or around the base of scree slopes or small, rocky outcrops in association with *Brachychiton acuminatus, Ehretia saligna* and *Fluegga virosa.* The number of *T. suprantifolia* trees that will be directly impacted by the project will be determined during the second vegetation survey.

Past surveys have shown *T. supranitifolia* to occur only in the northern portion of the Burrup Peninsula and Dolphin Island (Blackwell at al., 1979). It has not been observed south of the Dampier causeway or on islands of the Dampier Archipelago (V. Long pers. comm.). Although *T. supranitifolia* appears to be abundant in areas where it does occur, its distribution and abundance across the Peninsula is unknown.
Strategies to minimise potential impacts on vegetation and significant flora, including rehabilitation of disturbed areas, are discussed in **Section 6.1.1.**

5.7.8 Weeds

Environmental weeds have been defined as plants that establish themselves in natural ecosystems (marine, aquatic and terrestrial) and proceed to modify the natural environment (CALM, 1999b).

Over the years a number of environmental weeds have become established on the Burrup Peninsula, with new introductions continuing to occur. The following list of 13 weed species has been compiled from personal observations (V. Long) and previous surveys conducted on the Burrup (Blackwell et *al.*, 1979), Astron Environmental (1997; 1998; 2000). These have all been determined as weeds by CALM (1999) and their rating is given in **Table 5-2**.

Table 5-2 Weeds Known to Occur on the Burrup Peninsula

Species Name	Common Name	Rating
Aerva javanica	Kapok	High
Cenchrus ciliaris	Buffel Grass	High
Cenchrus setigerus	Birdwood Grass	High
Cenchrus enchinatus	Mossman River Grass	Low
Rumex vesciarius	Ruby Dock	High
Stylosanthes hamata	Carribean stylo	Mild
Bidens bipinnata	Bipinnate Beggar-Ticks	Not Determined
Euphorbia hirsuta	Strawberry Weed	Moderate
Passiflora foetida	Wild Passionfruit	High
Solanum nigrum	Nightshade	Moderate
Chloris barbata	Purple-top chloris	Low
Pennisetum setaceum	Fountain grass	Mild
Malvastrum americanum	-	Moderate

Of these weeds, only two species *Aerva javanica* (Kapok) and *Cenchrus ciliaris* (Buffel Grass) were found during the first vegetation survey. It is possible that additional weed species may be found within the project lease during the second winter survey.

Weed management and monitoring strategies are addressed in **Section 6.1.1.**

5.8 Terrestrial Fauna and Habitats

Astron Environmental Pty Ltd was engaged by Sinclair Knight Merz to assess terrestrial fauna and habitats of the project lease. In addition to this, an investigation of the non-marine molluscan fauna of the site was also undertaken by the Western Australia Museum of Natural Science, through subcontract to Astron Environmental.

The fauna survey involved a desktop study summarising published reports, previous fauna surveys and review of records from the Astron Environmental and CALM databases describing habitats and fauna known to occur within the vicinity of the project lease. Opportunistic sitings of vertebrate fauna were undertaken during the three-day flora survey.

The methodology for the non-marine molluscan fauna survey is detailed in **Section 5.8.2.6**.

5.8.1 Fauna Habitats

Zoogeographically, most of the vertebrate species occurring around the Burrup Peninsula are widely distributed throughout the Pilbara and through much of the Eyrian Subregion. None of the fauna habitats are unique to any single position on the Peninsula but are well represented throughout the area. Six main fauna habitats, based on topography and vegetation types, have been identified on the Burrup Peninsula (Astron Environmental, 1999a). These include:

1. Rocky Outcrops, Rockpiles and Rocky Scree Slopes;
2. Valleys and Drainage Gullies;
3. Grassland Steppes;
4. Disturbed Habitats;
5. Saline Tidal and Supratidal Flats; and
6. Coastal Fringe.

The proposed site for the ammonia plant is comprised of four of these habitats, including rocky outcrops in the north-west corner of the site, grassland steppes which extend over much of the flats, disturbed areas surrounding the existing track and saline tidal flats covering the southern quarter of the site.

These different landforms support a number of different habitat and vegetation assemblages on which fauna depend for survival. Each habitat type provides shelter for varied vertebrate species and can be representative of the fauna groups that occur there.

5.8.1.1 Rocky Outcrops, Rockpiles and Rocky Scree Slopes

Rocky outcrops, rockpiles and scree slopes are common throughout the Peninsula, from the fringe of the saline mudflats, to the edge of the drainage valleys and the top of the uplands and plateaux. This habitat is characterised by areas of large rocks and boulders (predominantly rhyodocite) surrounding sparse intermittent patches of vegetation. Vegetation in the rocky areas is predominantly comprised of an open low *Terminalia supranitifolia/Brachychiton acuminatus* woodland with a mixed open low scrub (*Ipomoea costata*, *Rhagodia eremaea* and *Fluegga virosa*) and an open to mid-dense grass of *Triodia epactia* and *Cymbopogon ambiguous*. Within the project lease there is an area of rocky outcrop in the north-west corner of the proposed plant site.

5.8.1.2 Valleys and Drainage Gullies

This habitat occurs in the broad drainage valleys around the Peninsula. It is dominated by a mid to dense mixed *Triodia angusta/Triodia epactia* hummock grasses with low mixed woodland of *Corymbia hamersleyana*. Some ephemeral rockpools occur within this unit. A broad drainage basin occurs in the north-east corner of the project lease. This drainage basin enters the project lease near to the plant footprint and diverts eastwards back out of the project lease. A more defined drainage line runs through the basin from the rockpiles in the north to the saline inlet in the south. Another broad drainage line runs from the base of the rocky scree slopes in the northern portion of the project lease and diverts to the west beyond the project lease.

5.8.1.3 Grassland Steppes

Grassland steppes are found on the rocky slopes and plateaux scattered throughout the Burrup Peninsula. These grasslands are usually dominated by mixed mid dense *Triodia epactia* hummock grass and *Themeda triandra* grass. It occupies a large proportion of the proposed plant site, and is divided into Upland and Upper Slopes and Lower Undulating Slopes with Shallow Incised Drainage Lines.

5.8.1.4 Disturbed Habitats

Disturbed habitats on the Burrup Peninsula include old borrow pits, road easements, vehicle tracks and laydown areas. The disturbed habitat within the project lease is a flat graded track approximately 3m wide that dissects the lease from east to west. It is comprised primarily of *Cenchrus ciliaris* grassland with emergent *Acacia bivenosa*.

5.8.1.5 Saline Tidal and Supratidal Flats

Saline flats are located in a sediment-filled strait between King Bay and Hearson Cove and contain vegetation which is predominantly low samphire scrub of *Halosarcia* spp. and *Frankenia ambita* over open low grass of *Eragrostis falcatta, E. dielsii* and *Sporobolus virginicus*. Mangrove forest, comprising predominantly *Avicennia marina marina*, and *Rhyzophora stylosa* also grow around the fringes of this habitat although no mangroves are found on this site. Saline and coastal flats (however no mangroves) occupy approximately one half of the project lease.

5.8.1.6 Coastal Fringe

Coastal fringe areas include coastal dunes, beaches and littoral zones. Dunes are predominantly vegetated by *Spinifex longifolius* with isolated *Acacia bivenosa.* Beaches occur in bays along the Burrup Peninsula and have a coarse sand/shell sediment. Beaches usually terminate in rocky headlands. The littoral zone is divided into various components including tidal flats, fringing mangal forests, intertidal beaches, limestone pavements, near shore waters, coral reefs and intertidal rocky platforms. Rocky platforms provide an extensive habitat for many marine invertebrates. None of these habitats are found within the boundaries of the project lease.

5.8.2 Fauna

Previous surveys undertaken on the Burrup Peninsula have recorded a total of 213 vertebrate species (**Appendix E**). This information was compiled from both published reports and unpublished data from CALM (P. Kendrick, unpub. data). The fauna may be classified into two groups, one dependant on land habitats and one dependent on the littoral zone.

The littoral zone fauna consists mainly of birds, particularly waders that are abundant and diverse and feed primarily on the food-rich intertidal flats. The mangroves also support a diverse range of avifauna. Inland, the animals feed mainly on ground-dwelling invertebrate fauna, as shrub and tree communities are restricted in area and provide relatively few food niches.

The vertebrate fauna is subjected to occasional catastrophic events such as cyclones, fire and drought, which cause populations to fluctuate in the short term (Woodside, 1979). These are however natural impacts, to which the animals are adapted.

5.8.2.1 Mammals

Surveys conducted by both Astron and CALM reveal there are 43 identified species of mammals occurring on the Burrup Peninsula. These consist of 11 marsupials, one monotreme, seven native rodents, 18 bats and five introduced mammals (Butler, 1994, P. Kendrick, unpub. data). Mammal species, which potentially occur in the project area, are listed in **Appendix E; Table E1** (Astron Environmental, 1999b, CALM unpub.data).

Areas that include a combination of deep valleys, rock piles, outcrops and fringing vegetation provide microhabitats for a number of locally occurring small mammal species. Included amongst these are the Common Rock Rat (*Zyzomys argurus*), the Common Planigale (*Planigale maculata*) and the Pilbara Ningaui (*Ningaui timealeyi*). This mosaic of microhabitats could also provide habitats for the common but restricted Northern Quoll (*Dasyurus hallucatus*).

5.8.2.2 Birds

The largest vertebrate group represented on the Burrup Peninsula is birds, with 127 recorded species. None of these are scarce or endemic. The families which make the greatest contribution to species richness are the Columbidae (Pigeons and Doves), Meliphagidae (Honeyeaters), and Accipitridae (Kites, Goshawks, Eagles and Harriers). **Table E2** of **Appendix E** contains bird species that occur on the Burrup, whereas **Table 5-3** lists those that were observed within the Project Area during the three day flora survey.

Table 5-3 Bird Species Recorded within the Project Area

FAMILY	GENUS SPECIES	COMMON NAME
Eagles	*Falco cenchroides*	Australian Kestrel
Pigeons/Doves	*Geophaps lophotes*	Crested Pigeon
Cockatoos	*Cacatua roseicapilla*	Galah
Swallows/Martins	*Hirundo nigricans*	Tree Martin
Cuckoo-shrikes	*Coracina novaehollandiae*	BlacK-faced Cuckoo-shrike
Warblers	*Cinclorhamphus cruralis*	Brown Songlark
Honeyeaters	*Manorina flavigula*	Yellow-throated Miner
Finches/Weavers	*Taeniopygia guttata*	Zebra Finch
Wood Swallows	*Artamus personatus*	Masked Woodswallow
Magpie-larks	*Grallina cyanoleuca*	Australian Magpie-lark
Magpies/Butcherbirds	*Cracticus mentalis*	Pied Butcherbird

Birds such as at the Australian Kestral, Galah and the Cuckoo shrike are mobile species with large home ranges and are likely to use the plant site for feeding and resting. Smaller species, including honeyeaters, zebra finches, magpies larks, butcherbirds, crested pigeons are also likely to frequent the area for feeding and resting, but may also use the plant site for nesting.

5.8.2.3 Reptiles

Ninety-four terrestrial reptile species consisting of 17 geckos, seven legless lizards, eight dragon lizards, seven monitor lizards, 26 skinks and 21 land snakes, have been recorded from the Burrup Peninsula. Other groups with fewer species include water snakes, sea snakes, tree frogs, worm snakes and blind snakes. A number of these species are endemic or are species of limited distribution. These species are listed in **Appendix E; Table E3**.

5.8.2.4 Introduced and Pest Species

Although no introduced or pest species were observed on the project lease it is known that six introduced species inhabit the Burrup Peninsula. Five species are introduced mammals (fox, dog, cat, house mouse and black rat) **Appendix E; Table E1**) and one species is an introduced insect, the common honey bee (*Apis mellifera*).

5.8.2.5 Invertebrate Fauna

There has been very little investigation into invertebrate fauna of the area. To date, scientists of the WA Museum, who have made opportunistic collections during other projects, have done most of the work. Occasional snail collections have been made since 1961, enabling a reasonable understanding of the land snail diversity (S. Slack-Smith, pers. com.). Land snails have been the most studied invertebrates of the Burrup for two reasons. Firstly because they are regarded as important bio-indicators, as they are effectively stationary so cannot avoid human impacts, and secondly because they leave empty shells which aid in determining species diversity and population size.

The first formal survey of native molluscs was undertaken by the Western Australian Museum of Natural History on the tidal flat extending between King Bay and Hearson Cove in 1999. The study identified eight species of snail, one of which, *Rhagoda sp.*, was known but previously undescribed and is endemic to the Burrup Peninsula (Slack-Smith, 1999). Another species *Quistrachia legendrei* distribution is 'limited' to the mainland area of Dampier and some of the islands of the Dampier Archipelago (Solem, 1997).

No other significant study has been undertaken on the invertebrate species of the area. However, opportunistic sightings (J. Kruger and V. Long, pers. obs.) reveal honeybees, an invasive feral species, occur in the area. The WA protected Jewel Beetle was observed on the flowers of some acacia bushes (O'Brien Planning Consultants, 1996).

5.8.2.6 Non-Marine Molluscan Fauna

The Western Australian Museum was subcontracted by Astron Environmental on behalf of Sinclair Knight Merz to undertaken a survey of the non-marine molluscan fauna of the project lease.

Methodology
The survey was undertaken over two days in March 2001 whereby samples were taken from rocks, litter and/or soil at a total of 29 stations scattered throughout the project lease and in the immediate vicinity of the project lease boundary.

The distribution of these survey stations is illustrated in **Figure 5-2.**

Larger snails, dead and living, were taken by hand or in samples of soil and litter. The soil/litter samples were roughly sieved immediately after collection. Small to minute snails, both juvenile and adult, were found in these preliminary in situ sievings or during subsequent examination under a stereomicroscope in the laboratory.

Both dead-taken and live-taken specimens were retained for identification. All were registered and placed into the research collections of the Western Australian Museum as voucher specimens.

Rationale for the Selection of Survey Stations
Survey stations were selected so that the diversity of habitats present in the area would be sampled, with some emphasis on those which were most likely to support snails. The survey stations were chosen to give as comprehensive a coverage of the area as possible, with some concentration on the periphery of the area to better establish the distributional patterns of the snail species within and beyond the site. The station sites reflect habitat types both likely and unlikely to be inhabited by terrestrial molluscs, although more emphasis was given to those sites considered more favourable for snails.

The central area of the site is a smooth and gradual slope to the south, with a relatively homogeneous cover of grasses and sparse low shrubs and evidence of considerable previous disturbance. For these reasons, that area received little detailed attention during the survey. Observations made during a number of traverses across this area during the course of the survey, together with the progressive results of the sampling around it, gave no indication for a need to change these priorities.

Furthermore, comparatively little attention was paid to the hilly area occupying the north-west corner of the site, as this area will be avoided by the ammonia plant.

In addition, little attention was given to the area of the saline flat which extends along the southern section of the site. At the time of the survey, this area was damp to wet due to the inundation of seawater during the last period of spring tides.

A limiting factor of the survey was the absence of a footprint map of the proposed plant and access road. These details had not been determined until May 2001. Subsequent comparison of the survey stations with the footprints of the plant and access road and the Astron Vegetation Map indicated an almost-complete coverage of all of the vegetation types that will be disturbed by the proposed plant and access road. Only the vegetation type "6c", represented by three small areas of the project lease, was not covered:

- Vegetation Type 3a – Snail Survey Stations # 21, 22, 23;
- Vegetation Type 4a - Snail Survey Stations # 27;

- Vegetation Type 4c - Snail Survey Stations # 13, 19, 20;
- Vegetation Type 4d - Snail Survey Stations # 17, 18;
- Vegetation Type 6a - Snail Survey Station # 16;
- Vegetation Type 6b - Snail Survey Stations # 14, 25, 26;
- Vegetation Type 6c – no Snail Survey Stations.

Non-Marine Molluscan Fauna of the Project Lease

The following five species of native terrestrial snails, which belong to two pulmonate gastropod families, were recorded from the project lease during the survey. All of these species have been recorded from other localities elsewhere on the Burrup Peninsula (Slack-Smith, 1999; 2000).

- **Family Camaenidae**

Quistrachia legendrei Solem, 1997

This species of the Western Australian genus *Quistrachia* appears to be confined to the mainland in the vicinity of Dampier and to some of the islands of the Dampier Archipelago (Solem, 1997). Records are available of its presence along the length of the Burrup Peninsula. It is a rock-dwelling species which, at the onset of its period of aestivation, retires well within a rock pile and cements itself to rock surfaces with mucus applied around its aperture.

This and other species of the genus *Quistrachia* occur between the Eastern Kimberley region west to Dampier Land, and in the Pilbara from Barrow Island, the Dampier area and inland ranges south to the Cape Range Peninsula and Warroora Station (Solem, 1985; 1997).

Results from this survey indicate that *Quistrachia legendrei* is confined to the rocky hills located in the northern part of the project lease, outside the area of disturbance of the main plant site.

Rhagada sp.

This camaenid taxon is recognised as a distinct species which, at present, has not been scientifically described and named. From records currently available, its area of distribution appears to extend northwards along the Burrup Peninsula from east of Dampier (approximately south of King Bay) (Slack-Smith 1999, 2000).

The genus Rhagada is distributed from the Eastern Kimberley region west to Dampier Land and south through the Pilbara (coastal areas and inland ranges) to the northern parts of the Shark Bay area (Solem, 1985; 1997).

In some localities this un-named *Rhagada* sp. is sympatric with the much more widespread species *Rhagada convicta*. However, this latter species was not found during this survey.

Rhagada sp. appears to favour habitats where it can obtain shelter from the high temperatures of summer. It shelters under rocks, under deep litter and in the soil at the bases of trees on or at the base of rocky slopes. At the onset of aestivation it seals its aperture with a thick plug of mucus, but does not seal to rocks or other hard substrates.

Results of this survey indicate that this species of *Rhagada* is confined to the hills and rock outcrops in the more northern part of the project lease, outside the area of disturbance of the main plant site.

- **Family Pupillidae**

  Pupoides aff. beltianus Tate, 1894.
  If the Pilbara to Shark Bay populations of this dextrally coiled pupillid are conspecific with the Central Australian *Pupoides beltianus* then that species has a very large area of distribution. However, Solem (1986) maintained that the material then available for study was inadequate to form a definite opinion, and left the question open in his later work (Solem, 1988). There has not been any subsequent research on this question.

  The genus *Pupoides* has a wide distributional range, occurring in North and Central America and the West Indies, southern Asia, Africa and in the semi-desert areas of Australia (Solem 1988). In general, snails of this genus burrow into the soil under litter or beneath rocks, sealing the shell aperture with mucus prior to aestivation.

  The results of this survey indicate that *Pupoides aff. beltianus* seems to favour the higher ground, particularly the rocky outcrops, characteristic of the more northern part of the project lease, outside the area of disturbance of the main plant site.

  Pupoides contrarius E.A. Smith, 1894
  This sinistrally-coiled pupillid is reported as having a wide distributional range along the western part of Western Australia, having been recorded from the Broome area south to the Montebello Islands, Shark Bay and the Houtman Abrolhos. However, because of a significant size variation between populations, Solem (1986) raised the possibility that two species were being confused under this name.

  Having recently been recorded from the Burrup Peninsula just south of the road from the Burrup Road to Hearson Cove (Slack-Smith, 2000), this survey extends the known range of *Pupoides contrarius* slightly to the north. Most of the areas where it was collected during this survey are from low-lying land in the southern part of the project lease (Stations 2, 17, 18, 19, 20, 21, 24, 26 and 27), being most abundant, dead and living, at Stations 18 and 20 (**Figure 5-2**). This low lying land in the southern part of the project lease will be disturbed by the main plant site.

  Gastrocopta ?pilbarana Solem, 1986
  These tiny snails of the genus *Gastrocopta* have been tentatively placed into the species *G. ?pilbarana*. In at least some sections of its distributional range, which extends from the inland Pilbara (Chichester Range) to the Shark Bay area, this species appears to be sympatric with *G. deserti*. Specimens of this species, recorded for the first time from the Burrup Peninsula in 1999, again in 2000 and from this survey, show similarities to both species.

  Gastrocopta ?pilbarana was found at only two stations during this survey. Both stations are located on the rocky southern slope of the highest hill within the project lease, outside the area of disturbance of the main plant site.

Regional Distribution of Non-Marine Molluscan Fauna
In the absence of comprehensive surveys of the non-marine fauna of the Burrup Peninsula, adjacent areas of Dampier and Karratha and of the islands of the Dampier Archipelago, it is difficult if not impossible to comment meaningfully on the local or regional status of either species or their populations. The data and information that is available to date for the Pilbara region are based almost completely on casual collecting over many years. They do not cover the diversity of the molluscan fauna of that region nor give more than an indication of the morphological and geographic ranges of the known species or of their biology.

A discussion of potential impacts on non-marine molluscan fauna and proposed management and monitoring strategies is provided in **Section 6.1.2.**

5.8.3 Significant Fauna Species

Certain habitats that have been identified at adjacent sites indicate that several restricted or reserve listed species have the potential to occur within the project lease.

In the coastal Pilbara, the Western Pebble Mound Mouse, *Pseudomys chapmani* is identified only from the distinct mounds it creates. It is currently listed as a Priority 4 species on the CALM Priority Fauna list (CALM, 1998). Although previous surveys have not captured *P.chapmani*, their mounds are relatively common on the Burrup Peninsula, two of which occur within the project lease (**Figure 5-2**).

The water rat *Hydromys chrysogaster* is another Priority 4 endangered mammal found in the area. Because this rat is restricted to permanent fresh water, mangrove flats and beaches, it is likely to occur within the saline flats and in the drainage gullies of the project lease after rainfall.

There are a large number of bird species that occur on the Burrup Peninsula which are considered to be significant and have special conservation status. Australian Legislation protects most of these while others are protected through international agreements with countries like Japan and China. These species are listed in **Table E4** of **Appendix E** (Astron Environmental, 1999a).

The Pilbara Olive Python, *Morelia olivacea barroni*, is a large nocturnal python, which occurs in rocky outcrops and rockpile habitats. This python is restricted to the Pilbara region (Storr *et al.* 1986), and is listed on CALM's Declared Threatened Fauna List. All known populations of the olive python are under threat of extinction. Although it is not common on the Burrup Peninsula, this python species has been recorded in Chinamans Gorge (Astron, 1998).

A discussion of potential impacts on terrestrial fauna and proposed management and monitoring strategies is provided in **Section 6.1.2.**

5.9 Marine Environment

The proposed ammonia plant has the potential to influence the marine environment in King Bay, the nearshore waters of Mermaid Sound and portions of the Dampier Archipelago, as follows:

1. The proposed ammonia loading facility will use the existing Dampier Public Wharf that extends into the nearshore waters of Mermaid Sound.
2. Dredging of the seabed will be required to extend the berthing pocket to deep water for the ammonia ships.
3. Shipping activities associated with the project will follow the newly dredged channel to deep water to adjoin the existing shipping channel through the Dampier Archipelago and Mermaid Sound.
4. Seawater will be sourced from and cooling water discharged into King Bay; and
5. Stormwater runoff from uncontaminated areas of the plant will be collected and discharged via the King Bay tidal inlet, and move down gradient through to King Bay.

It should be noted that environmental approvals associated with items 2 and 4 above are being addressed separately by the Dampier Port Authority and the Water Corporation, respectively, and therefore detailed marine field surveys are not a requirement for this environmental approvals process.

The following descriptions are based upon information provided in The Dampier Port Authority Environmental Management Plan (Bowman Bishaw & Gorham, 1994) supplemented with available information from Woodside Offshore Petroleum Ltd, and other published data.

5.9.1 Marine Environment Surrounding the Proposed Loading Facility

The marine environment in the region of the proposed loading facility is typical of that along the western coast of the Burrup Peninsula where the Port of Dampier is located. The Dampier Public Wharf is located on a section of rocky shoreline just to the north of the Woodside Supply Base and King Bay. Nearby to the north of the Public Wharf is Holden Point, a rocky headland, a small sandy bay and Woodside's LNG Plant.

The shoreline near the Public Wharf is typically rocky with small sandy patches of beach and a small number of shallow tidal embayments. The rocks below the high tide mark are heavily encrusted with oysters and barnacles. Further down the slope, below mean sea level, is an area of scattered corals on the rocky pavement substrate. Below this, a community of molluscs and echinoderms are found on the shell-grit and muddy sand substrate.

The marine assemblages in the near-shore environment of the Public Wharf can be summarised as follows:

- Oyster-barnacle assemblage: occurring on intertidal solid substrates between mean sea level and high neap tide. This is the main intertidal assemblage along the western shore of the Burrup Peninsula.
- Scattered coral assemblage: colonises low tidal rock substrate.
- Mollusc-echinoderm assemblage: on unconsolidated sediments in shallow subtidal and low intertidal areas in protected embayments (Woodside, 1993).
- No rare or endangered species or habitats have been identified in the immediate area of the proposed loading facility at the existing Dampier Public Wharf.

As part of their environmental management program, Woodside Energy has conducted chemical and ecological monitoring of Mermaid Sound including sampling sites close to the Dampier Public Warf. Analysis of heavy metals in rock oysters during 1993 found elevated levels of copper at most sites from the southern part of Dampier Port and north to the Woodside LNG Plant. Levels of zinc were elevated at one site near the Woodside LNG Plant. Other heavy metals were not elevated within the Port or at the Plant (Woodside, 1993).

Woodside also conducted testing for organotin compounds, which are released from antifouling on ships. They found elevated levels in oysters on the southern and northern side of King Bay but not throughout the rest of the Port or Mermaid Sound (Woodside, 1993). More recent sampling has been undertaken by Woodside however, the results of these studies are not as yet available for the purposes of this study.

5.9.2 Marine Environment within King Bay

King Bay is located just to the south of the Dampier Public Wharf. The outer part of the bay has similar rocky shoreline and mud/sand sediments and is deep enough to accommodate the Woodside Supply Base, located on the northern tip. The inner part of King Bay has shallow sand and mud flats, with mangrove communities extending to the mean high water level.

Mangrove communities or mangals are generally backed by mud flats and fronted by intertidal flats of a more sandy nature. These generally support a large infauna of burrowing organisms, which provide an important food source for other organisms.

Of the seventeen mangrove species found on the Western Australian coast, six occur in the Dampier Archipelago. Mangrove communities are ecologically important. They are net exporters of nutrients and are important habitats for, among other things, juvenile fish, crustaceans and turtles (CALM, 1990).

The mud flats that back onto mangroves are also important habitats. These are only inundated on spring high tides and have high salinity surface water, which precludes the growth of mangroves (Gordon, 1983). The mud flats support blue-green algal mat communities that fix atmospheric nitrogen and contribute to the primary production of the area.

Mangrove communities and mudflats occur in other sheltered bays of the Burrup Peninsula including Withnell and Conzinc Bay. The most extensive mangals and mudflats in the Dampier region occur in the Maitland River delta and around West Intercourse Island.

5.9.3 Marine Environment within Mermaid Sound and the Dampier Archipelago

The marine environment of the Dampier Archipelago provides a wide range of habitats and a diverse fauna. The diversity of these habitats of the Dampier Archipelago and the fauna that they support has been recognised by the Department of Conservation and Land Management. The department has submitted a proposal for a Marine Reserve to encompass waters of the Dampier Archipelago and waters surrounding the Burrup Peninsula (Marine Parks and Reserves Selection Working Group, 1994). This proposal excludes the immediate area designated for the Port of Dampier and the Public Wharf.

The range of shoreline and nearshore habitats in the region include:

- Rocky shores;
- Sandy beaches;
- Intertidal reef-flat;
- Coral reefs;
- Macroalgal/seagrass beds;
- Invertebrate filter feeding communities;
- Soft sediment subtidal areas; and
- Open waters.

Further description of each of these habitats is provided in **Appendix F.**

Project design features and management strategies to minimise potential impacts on the marine environment are discussed in **Section 7.1.1**.

5.10 Social Environment

5.10.1 The Pilbara – A Regional Perspective

The Pilbara covers an extensive area of Western Australia and generates one of the largest export revenues for the State due to the rich mineral and petroleum deposits that occur within the region. Much of this activity is concentrated in the western third of the region with the remainder eastern two-thirds comprising desert conditions and few inhabitants.

The Pilbara region comprises five local government areas, these being:

- Shire of Roebourne;
- Shire of Ashburton;
- East Pilbara Shire;
- Shire of Exmouth; and
- Town of Port Hedland.

5.10.1.1 Economic Development

Downstream processing of the Pilbara's raw material occurs within the region itself and is closely linked to individual primary industries. Much of this activity is associated with oil and gas production. For example, the LNG facility and the North West Shelf Project established by Woodside on the Burrup Peninsula is a massive investment in processing raw material.

The Pilbara region has many favourable elements considered essential for extensive processing opportunities, including diverse raw supplies, energy supplies, developed infrastructure and established trading links.

Research and development opportunities are also being utilised, for example the production of beta carotene has been investigated in the past by Aqua Carotene Industries.

The building and construction sector of the Pilbara economy is largely dependent on the growth and activity of the mining industry. Construction (non-residential) in the Pilbara is valued at over $25 million (Pilbara Development Commission, 1995). Building and construction workforces are often recruited from other regions outside of the Pilbara however there has been an increasing trend for the workforce to reside in the Pilbara.

5.10.1.2 Population Characteristics

Population growth in the Pilbara region stagnated or declined during the period from 1986 to 1996. The population of the region was distributed between Port Hedland and the Shires of Ashburton, East Pilbara and Roebourne in 1996. **Table 5-4** illustrates the population statistics for each local government area over this period. This information is based upon the 1996 Census statistics collected by the Australian Bureau of Statistics. It is important to note that a further Census is scheduled for August 2001 which will provide the most up to date information.

Table 5-4 Population Distribution of the Pilbara Region

Shire/Town	1981	1986	1991	1996
Ashburton	8,750	8,706	7,922	7,397
East Pilbara	9,850	9,397	10,111	9,092
Port Hedland	13,370	13,320	12,516	11,748
Roebourne	15,173	16,704	17,291	14,954
TOTAL	**47,143**	**48,127**	**47,840**	**43,191**

Source: HLA-Envirosciences (1999); Table 4.3 and WAPC (1998); Table 2.

Short term population projections for Western Australia forecast continued growth at a rate of about 1.5 per cent per annum, based on natural increases, overseas migration and interstate migration (HLA-Envirosciences, 1999). The Pilbara region is expected to record a sustained growth in population from 47,840 people in 1991 to 53,500 by 2021 with the Shire of Roebourne expecting to accommodate approximately 36 per cent of this population (WAPC, 1997).

5.10.2 Shire of Roebourne – Karratha and Dampier

The proposed ammonia plant is located within the Shire of Roebourne and will have potential impacts on the townships of Karratha and Dampier. Other towns in the Shire include Roebourne, Wickham and Point Samson.

5.10.2.1 Karratha

The township of Karratha is located about 10 kilometres to the southeast of the proposed ammonia plant and was established in about 1968 to primarily serve as a regional centre for the expansion of Hamersley Iron and Dampier Salt operations (Pilbara Development Commission, 1995; WAPC, 1998). The term "Karratha" is derived from the Aboriginal language and means "good country". More recently, the town has expanded to accommodate the workforce of the North West Shelf Gas Project. Many of the town's facilities and services have been contributed by the major industry groups. In 1975, Karratha became the administrative centre for the Shire of Roebourne.

5.10.2.2 Dampier

The township of Dampier is located about 6 kilometres south of the proposed ammonia plant and is the nearest community centre to the Project Area. Dampier was built in 1966 by Hamersley Iron Pty Ltd to accommodate employees and their families of its nearby operations (Pilbara Development Commission, 1995). The town is now administered by the Shire of Roebourne but still remains within the Hamersley Iron Special agreement lease which gives the Company a large decision making role in issues affecting the town. The population of Dampier is about 1,425 and is expected to increase to an optimum level based on physical and environmental constraints. It is envisaged that the town will also pay a large role for tourism and will become the gateway to the Dampier Archipelago and Burrup Peninsula (Pilbara Development Commission, 1995).

The Port of Dampier was also established by Hamersley Iron for export of iron ore mined from inland mines at Tom Price, Brockman, Marandoo and Parabadoo. The Port has been operating as a Statutory Authority since March 1989.

5.10.2.3 Economic Development and Tourism

Tourists and other travellers are attracted to the Karratha by the spectacular terrain, offshore islands of the Dampier Archipelago, recreational fishing, mining and petroleum projects (Hamersley, Woodside and Robe River operations) and heritage (Aboriginal heritage on the Burrup Peninsula).

Karratha is considered to support the region's most significant economic and developed resource industries with an approximate contribution of 25% to the State's total export earnings (WAPC, 1998). The deregulation of the energy industry and increasing success of offshore gas fields exploration and developments have attracted considerable interest from several downstream processing industries to Karratha and in particularly to the Burrup Peninsula. The potential investment of petrochemical/chemical projects earmarked for the Peninsula have been estimated to be about $4 billion (excluding this project) and include (DRD, 2001):

- Syntroleum Sweetwater – Establishment of a gas to synthetic hydrocarbon plant with an estimated expenditure of $600 million, construction workforce of 1000 and operational workforce of 80;
- Plenty River Corporation – establishment of an ammonia/urea plant with an estimated expenditure of $800 million, construction workforce of 1000 and operational workforce of 120;
- Sasol Chevron Global Joint Venture – establishment of gas to liquids plant with an estimated expenditure of $2.04 billion; and
- Mitsubishi Gas – establishment of a dimethyl-ether plant with an estimated expenditure of $600 million, construction workforce of 2000 and operational workforce of 150.

The economic benefits associated with the proposed ammonia plant are highlighted in **Section 3.4.**

5.10.2.4 Population Characteristics

In 1996 the population of the Shire of Roebourne was 14,954 with the population in Karratha making up almost 70% of this population.

Table 5-5 Population Characteristics of the Shire of Roebourne

Town	1981	1986	1991	1996
Karratha	8,341	9,533	11,325	10,057
Dampier	2,471	2,201	1,810	1,424
Roebourne	1,688	1,269	1,213	958
Wickham	2,387	2,445	1,973	1,649
Pt Sampson	N/A	N/A	180	255
Balance	286	1,256	790	611
TOTAL	15,173	16,704	17,291	14,954

Source: WAPC (1998); Table 2

A further assessment of population change in Karratha by the Ministry for Planning was undertaken in May 2000. Several key population indicators were examined to determine the change in population from the 1996 Census. These indicators included:

- School enrolments;
- Electoral enrolments;
- Water Corporation inflow data;
- Western Power account data; and
- Shire of Roebourne waste disposal data.

These indicators predicted a marginal increase in Karratha with the population peaking in 1998 as a result of speculation of new resource developments in the region. Based on the percentage change experienced in each of the indicators it is estimated that the population in Karratha has increased by about 300 people since 1996 and nearly 9,000 people are permanent residents (**Table 5-6**).

Table 5-6 Summary of Population Estimate for Karratha in 2000

Year	Resident Population	Visitor and Temporary Population	TOTAL
Census 1996	8,653	1,405	10,057
2000 (est.)	8,909	1,450	10,359

Source: MfP (2000); Table 5.

Based on 1996 Census data, the majority of the population in the Shire of Roebourne is employed in the mining industry followed by construction and transport and storage **(Table 5-7)**.

Table 5-7 Employment in the Shire of Roebourne

Industry	Persons	Percentage of Total Shire Population
Mining	1,426	20.3%
Manufacturing	330	4.7%
Electricity, Gas and Water Supply	121	1.7%
Construction	618	8.8%
Transport and Storage	448	6.4%

5.10.2.5 Community Infrastructure

Dampier has become increasingly reliant on major facilities provided by the larger more well established town of Karratha. However, it does comprise a comprehensive range of facilities and services which include a primary school, a community centre, churches, recreational centres, a shopping centre, post office, hospital and tourist accommodation.

Karratha, being more modern and well equipped, comprises:

- Light industrial area;
- Modern shopping centre;
- District hospital which has provision for helicopter access;
- Educational facilities that include two high schools and a tertiary college;
- Regional police court and facilities;
- Cultural and sporting facilities;
- Tourist accommodation and various social and tourist facilities;
- State emergency service with well developed cyclone preparedness and emergency procedures; and
- Well developed urban infrastructure including footpath systems, landscaped areas etc which have been financially assisted by major development companies.

Potential social impacts on the Pilbara region and the local communities and proposed management strategies are discussed in **Section 8.**

5.11 European Heritage

European heritage and settlement of Karratha and the surrounding region has been well documented by several studies. Brief descriptions have been provided by the Pilbara Development Commission (1995) and WAPC (1998) which are summarised below.

The earliest recorded contact by a European explorer in the region of Karratha dates back to 1689 when William Dampier sailed the "Roebuck" and anchored in the Dampier Archipelago Islands. A decade prior to this Dampier had explored the region on the "Cygnet". Anecdotal evidence also suggests that as early as 1618, European ships were occasionally sighted off the Pilbara coastline.

The explorers Baudin and King later followed Dampier with Lieutenant Philip Parker King naming Nickol Bay. The coastal areas were surveyed by King in 1822. Some considerable years later in

1861, FT Gregory undertook the first land based expedition. He landed at Hearson Cove and explored the rivers and discovered the Nickol Bay region which was recommended for pastoral purposes and travelled to such areas as the Hamersley Ranges and Millstream. Here the abundance of iron ore in the Pilbara was first recorded.

The area was first settled in 1863 at Cossack by Walter Padbury who was soon followed by John Withnell. The small settlement provided the impetus to establish the town of Roebourne in 1866.

The pastoral and pearling industries became well established in the area in the late 1800s with the pastoral industry becoming the dominant industry. In the 1960s large discoveries of iron ore deposits occurred and the mining industry boomed as a result. The discovery of offshore gas and petroleum in the 1960s and 1970s and more recently solar salt production added to the resource based prosperity of the region.

Buildings and places of heritage value associated with European settlement can be found throughout Karratha. These may include historic homesteads, buildings, pastoral stockyards, grave sites, shipwrecks and campsites. Landscape and natural areas such as beaches, hills and valleys may also be considered as having some heritage value.

A search of heritage places listed on the Register of the National Estate and the database managed by the Heritage Council of Western Australia was undertaken in June 2001. The regions of Karratha, Dampier and the Burrup Peninsula were searched and revealed that nine places are registered under the National Estate and fourteen places are registered by the Heritage Council of Western Australia (**Table 5-8**). Of these, only one place is relevant to the proposed ammonia project, this being Hearson Cove.

Hearson Cove is located about 1.2 kilometres to the east of the project lease and is a popular recreational shell beach. The proposed plant and all associated infrastructure are located away from the beach and there will be no direct disturbance of this heritage place. Project design features and management strategies to ensure public safety and minimise potential issues related on noise and visual amenity are addressed in **Sections 6, 7** and **8.**

Table 5-8 European Heritage Listed Places in Karratha, Dampier and Burrup Peninsula

Place Name	ID Number	Location	Status
National Estate			
Coastal Margin Cape Preston to Cape Keraudren	N/A	Port Hedland	Indicative Place
Coastal Islands Mary Anne to Regnard	N/A	Mardie	Registered
Dampier Archipelago Marine Areas	N/A	Dampier	Indicative Place
Dampier Archipelago	N/A	Dampier	Registered
Grave Site on Dolphin Island	N/A	Dampier	Registered
Karratha Station Group	N/A	Karratha	Registered
Legendre Island Lighthouse	N/A	Dampier	Registered
Malus Island Whaling Site	N/A	Dampier	Registered
Pearling Relics Blackhawk Bay	N/A	Dampier	Registered
Heritage Council of WA			
Black Hawke Bay	8662	Gidley Island, Dampier Archipelago	Registered
Dampier Fire Station	14493	High St Dampier	Registered
Karratha Fire Station	14528	Welcome Rd, Karratha	Registered
Enderby Island	8668	Mermaid Strait	Registered
Kindergarten and Church	15212	Church Rd, Dampier	Registered

Place Name	ID Number	Location	Status
Malus Island – Whaling Site	4585	Mermaid Sound, Dampier Archipelago	Registered
North West Shelf	12666	Burrup Peninsula Dampier	Registered
West Lewis Island Pastoral Settlement (Ruins)	8691	Mermaid Sound, Dampier Archipelago	Registered
Chuch	15211	Padbury Way, Karratha	Registered
Manse	15213	Padbury Way, Karratha	Registered
Karratha War Memorial	13822	Welcome Rd, Karratha	Registered
Pegs Well (ruins)	8678	Hedland Place, Karratha	Registered
Dolphin Island	8667	Dolphin Island off Burrup Peninsula	Registered
Hearson Cove	8670	Hearson Cove Rd, Burrup Peninsula	Registered

5.12 Aboriginal Heritage

The Burrup Peninsula extends seaward in close proximity to the offshore islands that form part of the Dampier Archipelago, named after the English privateer and adventurer William Dampier who visited the islands in August 1699. Dampier's visit provides the first potential evidence of occupation of the Archipelago by Aboriginal people when smoke was noted from afar though on landing Dampier's party found only hearth fires and no other evidence of occupation.

It wasn't until 1818 during Philip King's charting of the archipelago from the vessel Mermaid that Europeans first made contact with the Aboriginal inhabitants of the islands. It is generally thought that these inhabitants were members of the Yaburarra group, either a small tribe in their own right or a sub-group of the Ngarluma tribe which occupied the coastal plain. Further encounters undoubtedly occurred during the mid 1800s when the area was favoured by whalers.

In 1861 F. T. Gregory, an explorer seeking suitable pastoral country, established a base at Hearson Cove and from there made excursions into the hinterland. Members of his party that remained at the base camp "established a friendly understanding" with the Aboriginal inhabitants and simple trade exchanges were made. Gregory's favourable reports of good grazing land to the south of the Peninsula led to settlements at Cossack near the mouth of the Harding River in 1863 and soon after at Roebourne. These areas were home to the Ngarluma people who, despite the intrusion of the settlers, made no effort to expel them. Relations between the early settlers and the Aboriginal inhabitants appear to have progressed on a harmonious basis but a severe drought from 1864 to 1866, together with a smallpox epidemic in 1866, resulted in food shortages for the Aboriginal inhabitants. By necessity, the Aboriginal people probably availed themselves to the pastoralists stock as a means of sustenance and these actions became a noted source of conflict between the settlers and the Aboriginal inhabitants of the area.

The small clan of Yaburarra inhabiting the Burrup Peninsula and offshore islands of the Dampier Archipelago appear to have remained relatively isolated from the intrusion of the settlers but this changed radically in the few short years following 1865 when rich pearl beds were discovered in Nickol Bay. Competition for scarce fresh water together with the progression to diving for pearl shell, whereby the Aboriginal men were drawn into service by the pearlers, led to conflict initially arising from Aboriginal incursions into the pearlers camps to steal supplies. The conflict escalated as is evidenced by massacres of the Aboriginal inhabitants on the Burrup at Flying Foam Passage and possibly at Hearson Cove. The retaliatory spearing of police led to fierce reprisals culminating in sweeps by groups of special constables whereby individual Aboriginals and groups were indiscriminately fired upon.

By 1870 the Yaburarra were either scattered, acculturated, subject to labour raids, had succumbed to introduced diseases or were massacred.

5.12.1 Sites of Historical Significance

Numerous archaeological investigations of the Burrup Peninsula between 1962 and the present date attest to the fact that Aboriginal people inhabited the area 7,000 years prior to European settlement. This span coincides with the last sea level rise around 6,000 to 7,000 years ago (Vinnicombe, 1987). Other sites within the Pilbara put Aboriginal occupation in excess of 20,000 years (Maynard, 1977; Troilett, 1982).

The Burrup Peninsula Aboriginal Heritage Project was commissioned by CALM as part of the National Estates Programme and undertaken in 1992-93 (Veth, et al, 1993). A sampling strategy devised by Mattner (1989) was used and this was based on 100 metre wide east-west transects every 500 metres. As a result of the survey, 498 sites were recorded in the northern, central and eastern parts of the peninsula and from this, a density of 56.7 sites per square kilometre was estimated. The recorded main sites comprised; stone pits (33.7%), artefact scatters (20.9%) and engravings (19.3%).

Extensive archaeological records pertaining to the Burrup Peninsula are maintained by the Aboriginal Affairs Department in Perth. During feasibility work associated with the ammonia plant, the Proponent engaged Quartermaine Consultants to undertake an archival review of archaeological data pertaining to areas identified as suitable for the establishment of project infrastructure. The key areas considered during this review were; the ammonia plant site; the gas supply pipeline route; the ammonia export pipelines route; and the proposed route for water pipelines to service the plant site. Archival research established that these intended project areas had been the subject of previous archaeological surveys and ethnographic interpretive work undertaken in association with the recognised Aboriginal custodians of the Burrup Peninsula. A number of the reports remain unpublished or require permission from either the Aboriginal custodians or the proponent that initiated the surveys and therefore the Proponent considered it prudent to repeat archaeological and ethnographic survey work as a means to ensure that the interests of the Aboriginal custodians of the project lease and surrounds were best served. These survey results are presented below.

5.12.2 Archaeological Survey Results

5.12.2.1 Project Lease

A total of ten Aboriginal heritage sites have been recorded to occur within the project lease. These sites are listed in **Table 5-9**. Four of the ten sites are registered with the Aboriginal Affairs Department. None of these sites will be disturbed during plant construction or operations. Five sites were previously recorded by DRD in 1997 (pers. comm. H. Wyeth) but are unregistered and one site is a newly discovered site (BF/FS1).

Table 5-9 Aboriginal Heritage Sites Occurring within the Project Lease

Site No	Site Type	Status	Project Impact
P2405	Engravings, structure	PIS	Outside works area
P2406	Engravings, structure artefacts	PIS	Outside works area
P2328	Artefacts	PIS	Outside works area
P2568	Quarry	PIS	Outside lease area
DRD 130	Engraving	NR	Outside works area
DRD 134	Engravings, exploited stone sources, artefacts	NR	Outside lease area
DRD 135	Artefacts (?)	NR	Outside works area
DRD 136	Engravings, grinding surfaces	NR	Section 18 clearance required
DRD 138	Shell accumulations (?), artefacts (?)	NR	Section 18 clearance required
BF/FS1	Midden, artefacts	NR	Section 18 clearance required

PIS = Preserved in Situ
NR = Not Registered

5.12.2.2 Gas Supply, Ammonia Export and Water Pipeline Routes

The archaeological survey indicated that six registered Aboriginal heritage sites occur within 100 metres of the proposed gas, ammonia and water pipeline routes. Five of the six sites are classified as cleared and one is classified as partially cleared (**Table 5-10**).

The potential impacts and management of Aboriginal Heritage issues are discussed in **Section 8.5.**

Table 5-10 Aboriginal Heritage Sites Occurring within 100m of Proposed Pipelines

Site No	Site Type	Status	Project Impact
P2411	Artefacts	C	Outside works area
P2334	Engravings, artefacts	C	Outside works area
P2332	Structures, engravings, artefacts, midden, grinding	PC	Outside works area
P2338	Midden	C	Outside works area
P1959	Structure	C	Outside works area
P3454	Engravings	C	Outside works area

PC = Partially Cleared;
C = Cleared.

6. Construction Impacts, Management and Monitoring

The following section details potential impacts, management objectives and strategies and proposed monitoring for key environmental issues associated with the construction phase of the project.

To ensure that these management strategies are fulfilled, the Proponent will prepare an Environmental Management System (EMS) which will also facilitate the implementation of the Company's Environment Policy, compliance with legislative requirements and other obligations and will permit the continual improvement in environmental performance.

Management Commitment 6.0.1: *The Proponent will commence to prepare an Environmental Management System for the proposed ammonia plant within six months of project approval.*

As part of the EMS, an Environmental Management Plan for the construction and operation of the ammonia plant and associated infrastructure will be developed to address the specific details in relation to monitoring procedures, methods and frequency, expanding on the management strategies provided in **Sections 6, 7** and **8** of this document. The Construction Management Plan will be prepared prior to the commencement of construction. The Operations Management Plan will be prepared prior to the commencement of operations.

Management Commitment 6.0.2: *The Proponent will prepare an Environmental Management Plan for the construction and operational phases of the plant.*

6.1 Biophysical Environment

6.1.1 Terrestrial Flora and Vegetation

Management Objective – To maintain abundance, species diversity, geographic distribution and productivity of vegetation communities and to protect Declared Rare and Priority Flora consistent with the provisions of the Wildlife Conservation Act 1950.

Seven vegetation types and 15 vegetation assemblages were found to occur on the project lease and these have been described in detail in **Section 5.7.4** and their distribution illustrated in **Figure 5-2**. In summary these vegetation types are:

- Rocky uplands and outcrops;
- Upland and upper slopes;
- Lower undulating slopes with shallowly incised drainage lines;
- Coastal flats;
- Drainage and broad drainage zones;
- Saline inlet and supratidal flats; and
- Tidal inlet.

Having assessed all of the possible options of siting the ammonia plant, access road and ammonia pipeline in an optimum location whereby impacts to the environment will be kept to a minimum, the proposed layout as illustrated in **Figure 4-3** was selected on the basis that:

- The rockpiles and upper slopes located in the northern portion of the project lease should not be impacted as they are considered to be significant in terms of supporting:
  - Significant vegetation assemblages;
  - Priority flora (*Terminalia supranitifolia*);
  - Habitats for non-molluscan fauna; and
  - High density of Aboriginal artefacts.

  Further to the environmental significance of these rockpiles, the degree of disturbance required to provide a level foundation for the ammonia plant in the vicinity of the rockpiles will be much greater than required for the lower and more level areas of the lease. To provide a level foundation within the vicinity of the rockpiles a large amount of unnecessary and costly blasting would be required.
- The lower slopes will provide a more suitable foundation for the ammonia plant and will:
  - Avoid disturbance to the significant rockpiles and the important flora, vegetation, fauna and heritage attributes associated with the rockpiles;
  - Remove the need to undertake large quantities of blasting;
  - Require a lesser quantity of cut and fill to produce a level foundation;
  - Less likely impact on Aboriginal artefacts as these are known to occur in the rockpiles in higher concentrations; and
  - Be more cost effective.

6.1.1.1 Potential Impacts

Despite the obvious advantages of siting the ammonia plant over the lower and more level terrain of the site, the following direct and indirect impacts will occur:

- Removal of up to 28 hectares of vegetation for the plant site, construction laydown area, corridor for the access road and product pipeline which comprises six vegetation types and twelve vegetation assemblages:
  - Uplands and lower slopes – vegetation assemblage 2a;
  - Lower undulating slopes with shallowly incised drainage lines – vegetation assemblages 3a and b;
  - Coastal flats – vegetation assemblages 4a, c and d;
  - Drainage lines and broad drainage zones - vegetation assemblages 5ai and b;
  - Saline inlet and supratidal flats – vegetation assemblage 6a, b and c; and
  - Tidal inlet – vegetation type 7. This unit does not support any vegetation (Astron Environmental, 2001).
- Potential removal of some priority flora species, *Terminalia supranitifolia*, although it is generally found on or around the base of scree slopes and rocky outcrops;
- Potential introduction and spread of exotic weeds;
- Potential leakage of environmentally hazardous materials from pipelines and storage vessels.

Table 6-1 provides an estimate of the area covered by each vegetation assemblage that will be impacted, the required areas to be cleared and the percentage of removal required under the current proposal. Vegetation assemblages 4a, 4d, 6b and 6c will be impacted the most with over 50% of the vegetation assemblage required to be impacted by the plant or the corridor for the access road and product pipeline (**Figure 5-2**).

Table 6-1 Approximate Vegetation Clearing Requirements

Vegetation Assemblage	Coverage within Project Lease and Adjacent Service Corridors (m^2)	Required Area to be Cleared (m^2)	% Removal*
Vegetation Type 2			
2a	41,027	67	0.2
Total Area of Vegetation Type 2	94,110	67	0.07
Vegetation Type 3			
3a	172,990	27,885	16.1
3b	41,243	2,755	6.7
Total Area of Vegetation Type 3	214,233	30,640	14.3
Vegetation Type 4			
4a	107,548	74,417	69.2
4c	41,284	8,771	21.3
4d	46,582	27,155	58.3
Total Area of Vegetation Type 4	218,412	27,163	12.4
Vegetation Type 5			
5ai	72,108	4,453	6.2
5b	22,749	3,236	14.2
Total Area of Vegetation Type 5	107,994	7,689	7.1
Vegetation Type 6			
6a	66,517	25,460	38.3
6b	38,534	23,830	61.8
6c	11,054	11,009	99.6
Total Area of Vegetation Type 6	116,105	60,299	51.9
Vegetation type 7			
7	183,744	29,226	15.9

*Percentage removal indicates the amount of a vegetation assemblage to be removed from the vegetation area surveyed as shown in **Figure 5-2**. It does not represent the area for the wider region of the Burrup Peninsula.

Quantitative data for the distribution of vegetation assemblages or communities over the wider region of the Burrup Peninsula is currently being compiled by the Department of Resources Development and will be made available to the Proponent during the second winter survey. However, a preliminary review of the findings of the Burrup Vegetation Survey as they relate to this project has been prepared (Trudgen, 2001) and is summarised below:

6.1.1.2 Significance of Potential Impacts

The regional importance of the vegetation found on the Burrup Peninsula has been recently assessed by Trudgen (2001) as part of the Burrup Vegetation Survey.

In light of Astron Environmental's survey and data obtained from the Burrup Vegetation Survey, Trudgen (2001) undertook an assessment of the conservation value of vegetation found within the King Bay–Hearson Cove Valley. This assessment was undertaken on behalf of the Department of Resources Development with particular attention given to the vegetation assemblages occurring on the low lying areas of the project lease. The major findings of this assessment are discussed below.

The clearing of vegetation for the plant site, access road and ammonia pipeline will be unavoidable. The conservation value of the four vegetation types that will be removed, as detailed in **Table 6-1** (the tidal inlet vegetation type does not support vegetation), are considered to generally represent the best stands of the assemblage found on the Burrup Peninsula (Trudgen, 2001). It is important to emphasise that no assemblage occurs twice in separate locations in an identical condition. Hence, vegetation identified as belonging to the same community category will vary from location to location.

The conservation values of the vegetation types occurring on the low lying areas of the project lease are described as follows:

- **Vegetation Type 3 – Lower undulating slopes with shallow incised drainage lines**
  The gentle slopes on which this vegetation type occurs are uncommon on the Burrup Peninsula with possibly some small areas of similar vegetation occurring near Withnell Bay (Trudgen, 2001). Although this vegetation type and its associated assemblages are known to occur in other areas of the Peninsula the characteristics of the assemblage are likely to be marginally different from place to place.
- **Vegetation Type 4 – Coastal flats**
  The vegetation assemblages associated with this vegetation type are considered by Trudgen (2001) as the best example of such communities on the Burrup Peninsula, given that the King Bay – Hearson Cove Valley is the only valley of its type on the Peninsula. Trudgen (2001) records that one floristic site of this vegetation type, which was surveyed as part of the regional vegetation survey, was structurally different to that observed within the project lease.
- **Vegetation Type 5 - Drainage lines and broad drainage zones**
  Although the taller flora species of this vegetation type (*Grevillea pyramidalis*, *Acacia inaequilatera*) are widespread, the dense stands of *G. pyramidalis* are uncommon on the Burrup Peninsula (Trudgen, 2001). *Triodia* cf. *epactia* and *Corchorus walcottii* occur on the Burrup Peninsula but are fairly restricted. This vegetation type is known to occur outside of the southern border of the Syntroleum site (marked for industry) and a second stand is located along a valley north-east of Withnell Bay (area allocated for conservation) (Astron, 2001a). Trudgen (2001) comments that the floristic composition of this vegetation type is similar to others found on

the Burrup. However, based on the structure and dominance of the vegetation type, it is considered to be uncommon and restricted to the Burrup Peninsula core survey area.

Vegetation sites surveyed by Trudgen (2001) that support similar vegetation types as vegetation type 5, identified by Astron (2001a), were found to support a less abundant population of *G. pyramidalis*. Thus, it must be noted that this vegetation type is very broad (Trudgen, 2001) and includes a variety of floristic abundances.

- **Vegetation Type 6 – Saline inlet and supratidal flats**
  This vegetation type is considered to be the best on the Burrup Peninsula in terms of both size and diversity of plant (samphire) communities in them (Trudgen, 2001). This vegetation type occurs along the edge of the tidal inlet that extends from King Bay in the west to Hearson Cove in the east. The samphire communities are known to occur in other areas of the Burrup Peninsula (Long, 1994). Trudgen (2001) considers this community likely to have significant values for flora as many of the species in them are restricted to the saline and intertidal habitats. However, due to the presence of such vegetation sporadically along the Pilbara coastline, they are less significant at a regional level.
- **Vegetation Type 7 – Tidal inlet**
  This vegetation type is almost devoid of vegetation as a result of the extremely high saline conditions. As a result this unit is not considered to be important in supporting significant vegetation communities.

In summary, the vegetation of the King Bay – Hearson Cove Valley is considered to have a high conservation value given that (Trudgen, 2001):

- The valley is the only broad valley with gentle lower slopes across the Burrup Peninsula;
- The valley supports the best stands of a part of the range of vegetation units on the Peninsula;
- Floristic variation of the communities found in the valley is uncommon elsewhere on the Peninsula; and
- The vegetation of the valley occurs on both sides of the valley in catenas that extend from the rocky ridges down to the tidal flats.

Summarising the results Trudgen (2001) and Astron (2001) the conservation significance of vegetation assemblages occurring within the project lease are provided in **Table 6-2**.

Table 6-2 Conservation Significance of Vegetation Assemblages occurring within the Project Lease

Vegetation Type	Site Placement (m^2)		Conservation Status			Conservation Significance (4)
	Area to be impacted	Wider Lease and Adjacent Service Corridors (1)	Feature of Main Broad Valley	Burrup Peninsula(2)	Regional	
Rocky Uplands and Outcrops						
1a	0	53,875	No, feature occurring along the periphery of the valley	Stronghold	Limited	a,b,c and d
Upland and Upper Slopes						
2a and b	67	47,055	No, occurring intermittently amongst unit 1a.	Unknown at this stage	Unknown	b and d
Lower Undulating Slopes with Shallow Incised Drainage Lines						
3a and b	30,640	214,233	Yes	Uncommon, best example	Some elements widespread (3)	b and d
Coastal Flats						
4a, b, c, and d	110,343	218,412	Yes	Best example	Some elements widespread (3)	b and d
Drainlines and Broad Drainage Zones						
5ai/aii, b and c	7,689	107,995	No, occurring intermittently.	Dense *Grevillea* – 1 of 3 patches	Dense *Grevillea* uncommon (3)	a,b,c and d
Saline Inlet and Supratidal Flats						
6a, b and c	60,299	116,105	Yes	Limited occurrence due to lack of suitable habitat	Sporadic but component species of communities not known	b and d
Tidal Inlet						
7	29,226	183,744	Yes	No vegetation occurs within this unit	Unknown	d

(1) Surveyed area as shown in **Figure 5.2.**
(2) To be confirmed during the second vegetation survey and with additional information obtained from the Burrup Vegetation Survey by Trudgen.
(3) Features *Corchorus* & *Triodia* restricted to the Peninsula and Islands and immediate hinterland.
(4) Significance criteria: a) poorly represented in the region; b) makes a significant contribution to a particular ecosystem; c) contains an abundance of Priority and/or significant species; and/or d) in a relatively pristine state.

6.1.1.3 Management Strategies

Considering that the project lease is one of several project sites within the King-Bay/Hearson Cove industrial area, the Proponent will be prepared to co-operate and assist in the management and monitoring of potential impacts of industry as outlined in a local management strategy for the King-Bay Hearson Cove Valley.

The King Bay-Hearson Cove Valley has been recognised in the Burrup Land Use Management Plan for strategic industrial development (O'Brien Planning Consultants, 1996). However, given the wide distribution of discrete conservation values across the valley, it is important to recognise the impact of development on these. The Proponent is aware of the development of a constraints mapping study of the King Bay – Hearson Cove Valley, within the context of the broader regional vegetation survey.

The Proponent has already optimised the layout of facilities within its project lease (refer to **Section 6.1.1**) to minimise impacts on environmental and heritage features. In addition, the Proponent will undertake the following management strategies:

- The extent of vegetation removal will be minimised as far as practicable by ensuring that:
  - The layout of plant components and the construction laydown area are determined during the detailed engineering design phase such that areas of disturbance are minimised;
  - Adequate guidance is provided in the Construction EMP to ensure clearing is undertaken as planned. This will incorporate tasks including the surveying the pegging of areas that need to be cleared and the prevention of clearing beyond pegged areas.
- Where practicable, topsoil will be stockpiled for use in rehabilitation.
- Disturbance to rockpiles during the construction and operations activities will be avoided where practicable, as they are a major habitat for the Priority 1 species *Terminalia supranitifolia.*
- Disturbances to drainage lines will be minimised where practicable, in particular the drainage line occurring in the north-eastern corner of the lease.
- Impacts on the samphire flats that occur in the southern portion of the site will be minimised where practicable.
- A Rehabilitation Plan will be prepared to rehabilitate areas of temporary disturbance with appropriate vegetation as nominated by the plan. As part of the rehabilitation plan a list of target flora species will be developed and where practicable, the re-establishment of prominent species (*including E. vespertilio, C. cotinifolius, B. acuminatus* and other "Kimberley" species, *G. pryamidalis, H. lorea*) will be undertaken dependent upon the success of germination trials. The Rehabilitation Plan will also state completion criteria which will be developed in consultation with the Departments of Environmental Protection and Conservation and Land Management.
- Seed collection of several prominent flora species will be undertaken as soon as possible. This is essential as it can take several seasons before sufficient viable seed is available. This will be undertaken by suitably qualified people.
- The Proponent will commence germination trials in a local nursery for propagating several prominent flora species which may include *E. vepertilio, C. cotinifolius, B. acuminatus, G. pryamidalis, H. lorea* and the Priority 1 flora species *Terminalia supranitifolia*, prior to construction. The results of the trials will assist the re-establishment of flora during the rehabilitation stage.

Management Commitment 6.1.1.1: *Removal of vegetation will be kept to a minimum by considering the layout of plant components and laydown areas during the detailed engineering design phase and providing adequate guidance in the Construction EMP.*

Management Commitment 6.1.1.2: *Disturbance to rockpiles, drainage lines and samphire communities will be avoided where practicable.*

Management Commitment 6.1.1.3: *The Proponent will develop a Rehabilitation Plan prior to construction to rehabilitate areas of temporary disturbance.*

Management Commitment 6.1.1.4: *The Proponent will commence seed collection as soon as possible.*

Management Commitment 6.1.1.5: *The Proponent will commence germination trials at a local nursery for several prominent flora species, including the Priority 1 species Terminalia supranitifolia, prior to construction.*

Management Commitment 6.1.1.6: *Where practicable the Proponent will attempt to replace the Priority 1 flora species, Terminalia supranitifolia, that will be disturbed as a result of this proposal.*

Management commitment 6.1.1.7: *A Weed Management Plan will be developed by the Proponent and included in the Environmental Management Plan for construction.*

Management Commitment 6.1.1.8: *The Proponent commits to undertake a second vegetation survey whereby the potential impacts from the proposed project will be reassessed in light of any further information that has become available from the Burrup Vegetation Survey.*

Management Commitment 6.1.1.9: *The Proponent will assist government and nearby industries in the co-ordination and implementation of a local management plan for the King-Bay Hearson Cove valley.*

- Disturbance to the Priority 1 species, *Terminalia supranitifolia*, will be avoided, where practicable and the Proponent will attempt to replace this Priority 1 flora species which will be disturbed as a result of this proposal.
- A Weed Management Plan will be prepared and included in the Environmental Management Plan for construction and will incorporate the following measures:
  - Inspection of all vehicles, machinery and other equipment brought on the project lease to ensure that such equipment is free of weeds and seeds of weeds;
  - The construction workforce will not be permitted to travel cross-country whether it be via vehicle or foot; and
  - All traffic is to be kept to designated tracks.
- The Proponent commits to undertake a second vegetation survey whereby the potential impacts from the proposed project will be reassessed in light of any further information that has become available from the Burrup Vegetation Survey.
- The Proponent will assist the Departments of Resources Development and Conservation and Land Management and other nearby industries where practicable in the co-ordination and implementation of a local management plan for the King Bay – Hearson Cove Valley.

6.1.1.4 Monitoring

During construction and operation of the ammonia plant the following monitoring requirements will be undertaken:

- All clearing and earthworks will be supervised by the contract supervisor to ensure that clearing is undertaken as required;
- The implementation of the rehabilitation plan will be monitored to ensure that tasks and procedures are being carried out correctly;
- Following the rehabilitation of disturbed areas, the re-establishment and growth of vegetation will be monitored with particular attention given to vegetation growth following the first substantial rains; and
- The presence or spread of weeds will be monitored and if necessary appropriate measures will be adopted to manage weeds.

6.1.2 Terrestrial Fauna and Habitats

Management Objective – To maintain abundance, species diversity, geographic distribution and productivity of terrestrial fauna and to protect Specially Protected (Threatened) Fauna, consistent with the provisions of the Wildlife Conservation Act 1950.

The project lease comprises five fauna habitats as described in details in **Section 5.8.1.** In summary these habitat types are:

- Rocky outcrops, rockpiles and rocky scree slopes;
- Valleys and drainage gullies;
- Grassland steppes;

- Disturbed habitats; and
- Saline tidal and supratidal flats.

6.1.2.1 Potential Impacts

The potential impacts of the construction of the plant and associated facilities on fauna and their habitats will include:

- Direct impact and removal of habitats that occur within the areas required for the plant, access road and ammonia pipeline;
- Potential, however unlikely, impact on Priority 4 species including the Pebble Mound Mouse and *Rattus tunneyi.* The potential presence of these mammals on the lease is based upon the existence of two abandoned mounds and burrows in the saline tidal flats of the project lease. The presence of these mammals will be confirmed by a proposed trapping programme;
- Fragmentation of saline tidal and supratidal flat habitats that exist in an east-west alignment and run parallel to the saline flats;
- Direct impact on the population of the two non-marine molluscan fauna, *Pupoides aff. beltainus* and *P. contrarius*, that occur in the low-lying areas of the project lease; and
- Although surface water drainage regimes upslope of the plant site will not be affected by the proposed development, there may be impacts on the intertidal vegetation downstream of the plant site.

6.1.2.2 Significance of Potential Impacts

The fauna habitats found within the project lease are typical of those located on the Burrup Peninsula. None of the fauna habitats are considered to be unique or warrant any special protection and are well represented throughout the area.

Zoogeographically, most of the vertebrate species occurring around the Burrup Peninsula are widely distributed throughout the Pilbara. Although there is potential for some Pilbara endemic species to occur within the project lease, no endemic fauna species were observed on the lease (Astron Environmental, 2001b) nor are vertebrate species considered to be restricted to the Peninsula (HLA-Envirosciences, 1999).

None of the five species of native terrestrial snails identified by Slack-Smith (2001) are considered to be rare and/ or endangered nor are they considered to have a distributional range limited to the project lease. The local and regional significance of the five snail species can not be determined with current available information as comprehensive surveys of the non-marine fauna of the Burrup Peninsula, adjacent areas of Dampier and Karratha and of the islands of the Dampier Archipelago have never been carried out. On a wider scale, the data available for the Pilbara region are based almost completely on casual collecting over many years and there is a lack of scientific investigations of diversity, morphological and geographic ranges of the known species or their biology.

Of the five snail species, three species being *Rhagada* sp., *Quistrachia legendrei* and *Gastrocopta ?pilbarana*, inhabit only the larger rockpiles and high hills of

Management Commitment 6.1.2.1: *Disturbance of important fauna habitats including those of non-marine molluscan fauna, such as rockpiles and low lying grassed slopes and areas of marine influence, will be minimised where practicable.*

Management Commitment 6.1.2.2: *The Proponent will undertake a trapping survey in September/October and the results of the survey will be made available prior to the conclusion of the EPA's assessment.*

Management Commitment 6.1.2.3: *The Proponent will be prepared to contribute alongside industry and government bodies to a co-ordinated regional survey of molluscan fauna*

Management Commitment 6.1.2.4: *The presence and quantity of mounds and burrows made by the Pebble Mound Mouse and Rattus tunneyi will be catalogued prior to construction and updated on a regular basis.*

Management Commitment 6.1.2.5: *Approved procedures for evacuating fauna will be followed if active mounds and burrows are identified.*

the project lease. None of the species were found, dead or alive, on low slopes or flats where rock was absent. As discussed in **Section 6.1.1** the siting of the plant is optimised to prevent disturbance to the rockpile areas of the project lease. Consequently, there will be no impact on these three snail species.

The remaining two species, being *Pupoides* aff. *beltainus* and *P. contrarius* are common to low grassed slopes with *P. contrarius* also inhabiting areas subject to marine influence. Impact on the population of these two species will be unavoidable as much of the proposed disturbance is located on the lower and more level terrain of the lease.

Without knowing the distribution of *Pupoides* aff. *beltainus* and *P. contrarius* elsewhere on the Burrup Peninsula it is difficult to ascertain the status of the species or their populations now or in the event of disturbance.

6.1.2.3 Management Strategies

To minimise the impacts on fauna and their habitats from the proposed development the Proponent will undertake the following management strategies:

- Where practicable, disturbance of vegetation and the habitats that are provided by vegetation will be minimised.
- Where practicable, disturbance to the rockpiles will be avoided as they provide important habitats for not only non-marine molluscan fauna species, including *Pupoides* aff. *Beltainus,* but also large macropods and reptiles.
- Where practicable, disturbance of the low lying grassed slopes and areas of marine influence which are important habitats for *Pupoides contrarius* will be minimised.
- The Proponent will undertake a trapping survey in September/October to further investigate the potential occurrence of the Pebble Mound Mouse, *Rattus tunneyi* and other mammal and reptile species that are currently un-described (e.g. *Planigale* sp., and the skink *Lerista* "muelleri"). The results of the trapping survey will be made available prior to the conclusion of the Environmental Protection Authority's assessment.
- The Proponent will assist the Departments of Resources Development and Conservation and Land Management and other nearby industries, where practicable, in the co-ordination and implementation of a local management plan for the King Bay-Hearson Cove Valley **(Commitment 6.1.1.8)**.
- The Proponent will be prepared to contribute, alongside industry and government bodies, to a co-ordinated regional survey of molluscan fauna.

6.1.2.4 Monitoring

During construction and operation of the ammonia plant the following monitoring programme will be undertaken:

- All clearing and earthworks will be supervised by the contract supervisor to ensure that clearing is undertaken as required and disturbance to habitats are kept to a minimum.
- The presence and quantity of mounds of the Pebble Mound Mouse on the project lease will be catalogued prior to construction. This will be updated

as required during the operational phase of the plant. Sitings of new burrows will be reported to the Environmental Manager of the operations.

- The presence and quantity of borrows made by *Rattus tunneyi* on the project lease will be catalogued by the Proponent prior to construction. This will be updated as required during the operational phase of the plant.
- In the event of active mounds and burrows being identified, approved procedures for evacuating fauna will be followed and these will be incorporated into the Environmental Management Plan for construction.

6.1.3 Topography and Landforms

Management objective – To maintain the integrity, functions and environmental values of landforms.

6.1.3.1 Potential Impacts

There will be several changes to the topography within the project lease as a result of the following:

- Ammonia plant site (cut and fill);
- Access road; and
- Product pipeline.

These items will require approximately 28 hectares of land and a relatively flat base for construction. The ammonia plant has been sited in an optimum location within the lease in order to minimise the amount of earthworks and blasting required and therefore minimises the impact on landforms. Cut, fill and piling will be required to establish a suitable foundation for the construction of the ammonia plant and to ensure that the site is elevated above the 1-in-100 year storm surge level of 4.8 mAHD. Approximately 70,000 m^3 of fill and gravel is required from external sources for levelling. Where possible, this will be obtained from existing quarries and borrow pits as approved by the Shire of Roebourne. In the event that additional sources of fill are needed, the Proponent will investigate other potential sources with compliance to the requirements of the Shire.

The proposed access road is sited parallel and near to a natural drainage line where disturbance to landforms is kept to a minimum. The rockpiles and high scree slopes in the northern portion of the site are avoided by the access road. The product pipeline will follow the same route as the access road to also avoid disturbances to landforms.

Disturbance to landforms may also lead to soil erosion as a result of incomplete rehabilitation of previously disturbed areas and discharge or channelling of stormwater runoff off-site.

6.1.3.2 Management Strategies

Disturbance to landforms as a result of the plant site, access road and product pipeline is unavoidable. To ensure that impacts on landforms and topography are limited to these specific disturbances the Proponent will undertake the following management strategies:

Management Commitment 6.1.3.1: *Disturbance to landforms will be minimised, where practicable.*

Management Commitment 6.1.3.2: *Disturbance to rockpiles and high scree slopes will be avoided, where practicable.*

Management Commitment 6.1.3.3: *All planned disturbances will be marked on maps and pegged prior to the commencement of earthworks.*

Management Commitment 6.1.3.4: *Vegetation and topsoil will be stockpiled for rehabilitation of areas of temporary disturbance.*

Management Commitment 6.1.3.5: *Fill and gravel will be sourced during the detailed design phase and as approved by the Shire of Roebourne.*

Management Commitment 6.1.3.6: *All excavations will be backfilled following construction.*

Management Commitment 6.1.3.7: *All vehicles will be kept to designated tracks.*

- Where practicable, disturbance to landforms will be minimised;
- Where practicable, disturbance to rockpiles and high scree slopes will be avoided;
- All planned disturbances to landforms will be marked clearly on maps and pegged prior to the commencement of earthworks;
- Vegetation and topsoil cleared from disturbed areas will be stockpiled for rehabilitation of the construction laydown area and other areas of temporary disturbance;
- Fill and gravel will be sourced during the detailed design phase and as approved by the Shire of Roebourne;
- All excavations will be backfilled following construction to form a level surface suitable for rehabilitation; and
- All vehicles will be kept to designated tracks and travelling over undisturbed vegetation will be prohibited.

6.1.3.3 Monitoring

To ensure that management strategies are implemented to minimise the disturbance to landforms the Proponent will undertake the following monitoring:

- All disturbances will be supervised by a suitably qualified person to ensure compliance with management strategies and objectives of the Environmental Management Plan.
- Rehabilitation of disturbed areas will be supervised and ongoing monitoring will be undertaken to ensure that the re-establishment of vegetation is successful and that erosion has not occurred.

6.1.4 Drainage and Site Hydrology

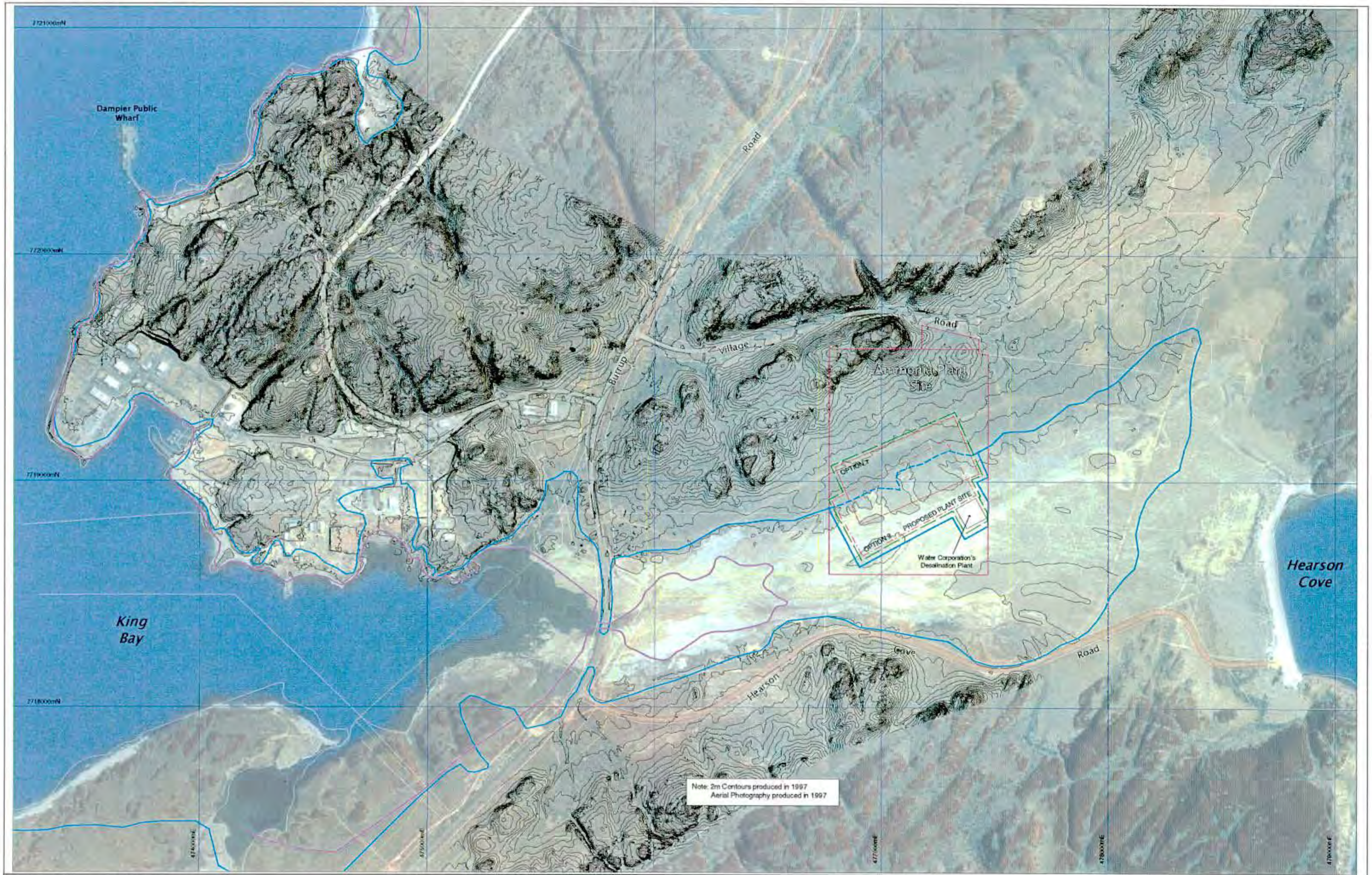
Management Objectives– To maintain the integrity, functions and environmental values of natural surface water drainage.

The surface hydrology of the site is driven by two actions. These are:

- Tidal excursion, which occurs within the King Bay-Hearson Cove tidal flat area; and
- Runoff generated from rainfall events.

There are no permanent surface water bodies or streams within the site. There are a number of minor drainage lines within the project lease that are ephemeral in nature, discharging only during rainfall events. The largest drainage line traversing the project lease is on the eastern boundary. This stream is also an ephemeral stream.

Examination of tidal excursions at the flat indicates that, even at the highest astronomical tide, the water level should not enter the lease boundary. The highest astronomical tide is 2.42 mAHD (Woodward-Clyde, 1998), whilst the land downslope of the site is at 2.6 mAHD. This indicates that, during the normal tidal cycles, the tide would not reach the plant area (**Figure 6-1**).



Photography and Contours supplied by the Department of Resouces Development

Note: Secondary service corridors shown to Ammonia Plant Site are preliminary and subject to approval

SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT

TIDE AND FLOOD (One in 100 year) LEVELS OF KING BAY - HEARSON COVE

LEGEND

- Proposed One in 100yr Flood Line (4.8 AHD) following construction on raised fill
- Existing One in 100yr Flood Line (4.8 AHD)
- High Tide Line (2.4 AHD)

0 250 500m

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 6.1

Client: Burrup Fertilisers Pty Ltd
Job No. SW01198
Date Drawn: 21 July 2001
FileName: DE01890_01_Fig6_1.wor

K:\Swan\01100\SW01198\Spatial\De01890_fig6_1.wor

Examination of the 1-in-100 year flood line (4.8 mAHD) indicates that tidal excursions under cyclonic events would lead to flooding of the southern area of the lease area. For this reason, all of the plant components will be constructed on raised fill to an elevation of approximately 4.9 mAHD.

6.1.4.1 Potential Impacts

The potential impacts associated with the proposal include the following:

- Flooding caused by tidal excursions during cyclonic events, resulting in erosion and subsequent deposition of the site material;
- Contamination of surface runoff from the construction activities (eg. leaks and spills); and
- Increased surface runoff volumes due to the creation of additional hard surfaces.

Interruption of surface runoff from the project lease will not impact the King Bay mangrove community west of Burrup Road as these mangroves depend largely upon the tidal fluctuations for survival rather than surface water. Not withstanding this, there is a potential for contaminated surface water to have an adverse impact on this community if not appropriately managed.

6.1.4.2 Management Strategies

The potential impacts identified above will be managed with reference to the Draft Guidance No. 26 '*Management of Surface Run-Off from Industrial and Commercial Sites*' but will specifically include the following strategies:

- To prevent tidal impacts, the site will be filled to above the 100 year storm surge level and the inundated fill areas will be protected using rock armouring (to prevent erosion during tidal excursions).
- Upstream uncontaminated surface runoff will be diverted around the construction site and discharged downstream to an area that will not adversely impact the condition of vegetation or result in erosion.
- Sediment traps will be installed at the outlet of the diversion drains to minimise erosion and attenuate flows, prior to discharge back into the environment.
- Clean stormwater drainage collection system will be provided comprising open channels, pipes and sedimentation basin(s). Sedimentation basin(s) will be designed to collect stormwater from clean areas on the construction site where it will be tested, as part of a water quality monitoring program, prior to it being discharged off-site.
- During construction, all infrastructure which potentially could leak or spill contaminated substances will be sealed and bunded and runoff collected from these areas will be treated using Best Management Practices (such as employing oil-spill separators) and discharged into a lined storage area for water quality testing, prior to release into the environment. Should the water quality not achieve guidelines, it will be discharged into the wastewater treatment system. Further management of liquid wastes during the operational phase is discussed in **Section 7.2.3**.

Management Commitment 6.1.4.1: *Surface water flows will be diverted around the construction site.*

Management Commitment 6.1.4.2: *Runoff from potentially contaminated areas will be collected, treated and tested prior to discharge.*

Management Commitment 6.1.4.3: *A water quality monitoring program will be developed, prior to construction.*

Management Commitment 6.1.4.4: *An Erosion Control Plan will be developed, prior to construction.*

- The drainage system will be designed to transfer flows during a 1-in-50-year event and the sedimentation basin(s) will be designed to withstand a 1-in-100-year event.
- A water quality monitoring program will be established to ensure stormwater discharge is within guideline limits.
- An Erosion Control Plan will be established prior to construction activity and will include the use of such measures as sediment fences and geotextiles.
- Drainage and water collection structures will be inspected and properly maintained during the project life.

6.2 Pollution

6.2.1 Dust

Management Objective – To ensure that dust generated during construction does not cause any environmental or human health problem or significantly impact on amenity and use all reasonable practicable measures to minimise airborne dust.

6.2.1.1 Potential Impacts

During construction dust will be generated from:

- Clearing of vegetation;
- Earthmoving activities;
- Vehicular movement on unsealed tracks; and
- Blasting.

Dust emissions have the potential to adversely affect the condition of the surrounding vegetation and fauna, human health and public amenity.

6.2.1.2 Management Strategies

Dust control strategies will be implemented throughout the duration of the construction phase. Management strategies to reduce ambient dust levels will include:

Management Commitment 6.2.1.1: *Dust control strategies will be implemented for all dust generating activities being carried out during the construction phase.*

- Regular watering of unsealed roads and exposed surfaces will be undertaken;
- Permanent access roads will be sealed;
- Revegetation of temporary disturbed land will occur as soon as practicable to minimise exposed surfaces;
- General housekeeping practices will be undertaken to ensure that there is no accumulation of waste materials within the lease that may generate dust; and
- The construction contractor will be informed of the requirements to minimise ambient dust levels wherever possible.

These strategies will also be reflected in a Blasting Management Plan which will be prepared by the construction contractor to the satisfaction of the Department of Minerals Energy.

6.2.1.3 Monitoring

The performance of the dust control strategies will be monitored and maintained during the construction phase.

***Management Commitment 6.2.1.2:** The performance of the dust control strategies will be monitored and maintained during the construction phase.*

6.2.2 Noise

Management Objective – To ensure that noise impacts emanating from the construction of the proposed plant comply with statutory requirements specified in the Environmental (Noise) Regulations 1997 and to protect the amenity of visitors to Hearson Cove.

6.2.2.1 Existing Noise Conditions

In order to assist in quantifying and qualifying the prevailing noise environment around the proposed site, operator attended noise surveys were undertaken using a sound level meter and spectral analyser during the late evening of Friday the 15 March and the early morning periods of Saturday 16 March 2001.

Results of the noise surveys are presented in **Table 6-3. Table 6-3** indicates that existing background noise levels (L_{A90}) at Hearson Cove were dominated by wind and insect noise, and ranged from approximately 30 dB(A) in the late evening to 25 dB(A) in the early morning. Greater wave noise and bird calls were observed in the early morning, than in the evening. Existing background noise levels recorded at Village Road on the northern boundary of the proposed site were lower than at Hearson Cove, ranging from about 26 dB(A) in the evening to about 22 dB(A) in the early morning. Wind and insect noise also influenced the noise characteristics along Village Road, and animal movements were also detected.

It should be noted that these observations are based on a single diurnal cycle. Long-term monitoring may show variations due to changes in the tides, prevailing winds, and the influence of "people noise".

Existing background noise levels (L_{A90}) at the proposed Syntroleum plant site were reported to vary from 42 dB(A) during the evening to 35 dB(A) during the day (HLA-Envirosciences, 1999). These levels are on average 10dB(A) higher than those measured at Hearson Cove. This is mainly attributed to traffic noise along Burrup Road as the noise levels were measured from a location of about 100 metres east of Burrup Road.

6.2.2.2 Noise Criteria - Construction Phase

Noise from the construction works is addressed by Regulation 13 of the *Environmental Protection (Noise) Regulations 1997.* Under Regulation 13 a Noise Management Plan is required to manage the potential impacts from construction noise.

The applicable noise criteria for the operational phase are provided in **Table 7-14.** Although there are no specific criteria for construction noise, the comparison of construction noise with criteria in **Table 7-14** provides an adequate guide to assessing potential impacts. Construction noise potentially exceeding the criteria stipulated in **Table 7-14** will need to be managed by a Noise Management Plan under Regulation 13.

Table 6-3 Results of Operator Attended Noise Surveys

Noise Data								Meteorological Conditions			
Date	Time Start	Site/Location	L_{A1}	L_{A10}	L_{Aeq}	L_{A90}	Notes and Comments	Wind Speed	Wind Direction	Temperature	% Cloud Cover
15-Mar-01	21:10	Hearson Cove	42.8	34.5	33.8	30	Prevailing noise – wind noise, insects (crickets, moths fluttering on ground), no waves, no leaf noise, low pitch humming noise of truck on road, bird calls near end of 15 min period.	Low 1 m/s, High 4.4 m/s, Mostly >3 m/s	WNW	34	0
15-Mar-01	21:50	Hearson Cove	39.4	35.7	33.8	29.5	Prevailing noise – wind noise, insects (crickets, moths fluttering on ground), no waves, no leaf noise, bird calls near 5 min mark, high wind velocities.	Low 1.25 m/s, High 4.70 m/s, Mostly <2 m/s	WNW	33	0
15-Mar-01	22:20	Village Road	34.4	28.9	29	25.7	Prevailing noise - wind noise, light rustling of leaves, insects, breathing of small animals. Possible noise from digital camera ~ 10 m away.	Low 1.5 m/s, High 2.5 m/s, Mostly ~2.0 m/s	WNW	31	0
15-Mar-01	22:47	Village Road	39.5	32.8	30.5	25.9	Prevailing noise - wind noise, light rustling of leaves, insects, breathing of small animals. Short faint siren from industry. Bird calls.	Low 0.6 m/s, High 1.5 m/s, Mostly <1.0 m/s	WNW - W	31	0
16-Mar-01	4:41	Village Road	31.8	26.6	24.8	21.9	Prevailing noise - wind noise, insects, animal movements, bird calls at 8 min mark, traffic noise at 10 min mark.	Low 0.2 m/s, High 3.0 m/s, Mostly <1.5m/s	NW - W	28	0
16-Mar-01	5:10	Hearson Cove	44.2	34.7	32.8	25.1	Prevailing noise - wind noise, insects, leaf noise, wave noise and bird calls	Low 2.5 m/s, High 4.0 m/s, Mostly ~3.0 m/s	NW - W	29	0
16-Mar-01	5:33	Hearson Cove	40.4	32.6	32.1	25	Prevailing noise - wind noise, insects, leaf noise, wave noise and bird calls (louder)	Low 1.5 m/s, High 4.3 m/s, Mostly ~2.5 m/s	NW - W	28	0

Note: Definition of indices are:

$L_{A,Max}$ – The loudest noise level measured during the 15 minute sampling period

L_{A1} – the noise level exceeded for 1 % of the 15 minute sampling period, equating to the loudest 90 seconds measured during the survey period;

L_{A10} - the noise level exceeded for 10% of the 15 minute sampling period or the loudest 90 seconds. This is frequently referred to as the average-maximum noise level;

L_{A90} - this the noise level exceeded for 90 percent of the 15 minute sampling period, and is frequently referred to as the background noise level.

6.2.2.3 Potential Impacts

Noise from the construction phase of the project would be governed by noise from general civil or earthworks operations. In addition to general construction noise, blasting may be required for a limited period of time. This will be determined during the detailed engineering phase.

Typical sound power levels were assigned to the major plant items required for construction as per **Table 6-4** and **Table 6-5** based on:

- Sinclair Knight Merz's acoustical database;
- Typical emissions detailed in Australian Standard AS 2436 *Guide to Noise Control on Construction, Maintenance and Demolition Sites;* and
- Previous acoustical studies undertaken for proposed nearby developments (Woodward-Clyde, 1998; HLA-Envirosciences, 1999).

Table 6-4 Construction Equipment and Assigned Sound Power Levels Required for Plant Construction

Stage of Construction	Type of Equipment	Noise Level at 7 metres dB(A)
Earthworks	4 x excavators	86
	2 x graders	85
	2 x scrapers	92
	2 x dozers	88
	4 x trucks	80
	2 x compactors	85
Assembly	2 x generators	79
	20 x trucks	80
	30 light vehicles	72
	10 x cranes (light)	84
	15 Medium Cranes	86
	6 Heavy Cranes	88
	50 x light power tools	75
	50 x welding m/c generators	88

In addition to the construction of the main plant, two ammonia product pipelines will also be constructed between the Dampier Public Wharf and the facility. Construction of the pipelines will be by the use of conventional excavator, pipe-lifting equipment, welders, and graders (refer to **Table 6-5**).

Table 6-5 Construction Equipment and Assigned Sound Power Levels Required for the Construction of the Product Pipeline

Type of Equipment	Noise Level at 7 metres dB(A)
1 x pipe lifting machine	85
1 x excavator	86
1 x front end loader	86
2 x trucks	80
1 x welder	71
1 x generator for welding	88

Noise from the construction phase will be highly variable throughout the project. Predicted noise levels during the construction phase as experienced at the nearest residential area (Dampier) or recreational area (Hearson Cove) will vary according to the levels presented in **Table 6-6**.

Table 6-6 Construction Noise Levels

Location	Range of Noise Levels
Nearest residential dwelling – Dampier	<<20 dB(A)
Hearson Cove	20 dB(A) to 34 dB(A)

The range of noise levels presented in **Table 6-6** reflects a variable duty cycle of plant and equipment, operating under differing atmospheric conditions and incorporates noise from general construction activities, including the pipe-laying operations. The general construction noise levels are significantly lower than the stringent operational limits applicable from the site. Consequently, the construction noise would not be expected to result in any acoustical impacts. Further to this, preliminary results of the geotechnical survey of the project lease indicate that no piling will be required during construction.

During the civil works phase of the project, approximately 17,000 m^3 of rock will be required to be removed from the site. Ground testing during the detailed design phase of the project will be undertaken to determine (in part) whether the rock can be ripped, or whether blasting will be required.

The Maximium Instanteous Charge (MIC) is the amount of explosive discharged at any particular point of time, and is also the main controlling factor which influences the resulting level of overpressure, and vibration. A review of the site would indicate that MIC could be readily controlled (and also remain an economically viable process) so as not to result in any adverse vibration impacts.

6.2.2.4 Management Strategies

Management Commitment 6.2.2.1: *The Proponent will prepare a Noise Management Plan to the satisfaction of the Department of Environmental Protection, as part of the Construction Environmental Management Plan.*

To manage noise from the construction of the ammonia plant, the Proponent will prepare a Noise Management Plan to the satisfaction of the Department of Environmental Protection as part of the Construction Environmental Management Plan.

Should blasting be required, the construction contractor will be required to prepare a Blasting Management Plan to the satisfaction of the Department of Minerals and Energy as a prerequisite of obtaining a blasting permit. This Plan shall include details of procedures, schematic blast design, and statements of compliance with respect to the environmental limits detailed in Section 11 of the *Environmental Protection (Noise) Regulations 1997*.

6.2.2.5 Monitoring

Given the relatively low levels of construction noise predicted from the site, it is not recommended that monitoring of the construction noise levels be conducted, unless complaints are lodged with the Proponent, Council or the EPA. In such circumstances, repeated complaints would be investigated by operator attended noise monitoring, and a report would be prepared to address the extent of any impacts and a range of practical and feasible mitigation measures that should be adopted.

6.2.3 Waste Management

Management Objectives – To minimise, reuse or recycle waste where possible; to treat on site or dispose offsite liquid and solid wastes at an appropriate landfill facility; and to manage contaminated materials to minimise potential for groundwater and surface water contamination or risk to public health.

6.2.3.1 Solid Waste

Potential Impacts

The discharge of solid waste to the environment has the potential to reduce the quality of surface, ground and marine waters through leachate contaminants, to generate odour and to increase the number of vermin. Potential changes in water quality could affect sensitive flora and fauna, such as mangroves and coral, which rely on the maintenance of existing conditions.

During construction, solid waste will be comprised of domestic waste and construction waste from the plant area. Domestic waste quantities are expected to total approximately 1 t/day. Construction waste will depend on a range of variables that cannot be defined at this stage of the feasibility study. However, it is expected to comprise of:

- Packaging materials (plastic, cardboard, paper and pellets);
- Pipe offcuts and reinforcing steel;
- Damaged products (plasterboard, bricks, tiles, etc);
- Surplus fill (none expected);
- Timber scraps;
- Geotextiles;
- Paving materials;
- Electrical off-cuts; and
- Concrete.

No hazardous solid wastes are expected to be generated during construction activities.

Management Strategies

Solid waste management plans will be prepared as a requirement for each construction contract. These plans will include sections on waste reduction, material reuse and material recycling with the objective of minimising the quantity of waste requiring disposal.

Management Commitment 6.2.3.1*: All waste will be disposed in accordance with regulatory requirements.*

All solid waste generated on site during construction will be disposed to Karratha landfill in accordance with Shire of Roebourne and DEP requirements.

Monitoring
Waste plans prepared for each contract will be audited to confirm that work being undertaken complies with the established procedures.

Management Commitment 6.2.3.2: *Solid waste quantities will be reported annually.*

Details of quantities of solid waste materials recycled and disposed to landfill will be maintained for reporting purposes.

6.2.3.2 Liquid Waste

Potential Impacts
Construction activities have the potential to impact on the following:

- Natural drainage patterns;
- Storm surge and flooding conditions on the site; and
- Surface water and ground water quality.

During construction of the facilities, a labour force of up to 500 persons will be employed at the site. The construction phase workforce will be housed in residential areas or accommodation facilities that are located off site.

During construction liquid waste will be comprised of domestic wastewater and surface runoff from the plant area. Domestic wastewater quantities are expected to total approximately 40 kL/day. Surface runoff will be dependent on rainfall and the runoff characteristics of areas within the construction site.

Management Strategies
The management of liquid waste on-site during construction activities will comprise two systems as follows:

- Temporary septic system for domestic sanitary waste; and
- Surface drainage system including a detention basin to remove suspended solids and to allow containment of suspended solids / pollutants should it be required.

Liquid waste generated during the construction phase will be managed as follows:

Management Commitment 6.2.3.3: *Domestic wastewater during construction will be disposed in accordance with Health department and local authority guidelines.*

- Fuel storage will be in bunded areas;
- Domestic effluent will be either disposed to land through leach drains in accordance with the requirements of the Health department and local authority guidelines or alternatively effluent will be stored in tanks, removed by a licensed contractor and treated off-site at a licensed facility;
- Site drainage system will include open interceptor drains that deliver stormwater to a sediment basin(s) (**Commitment 6.1.4.1**); and
- Sediment basin(s) will collect all stormwater from the construction site and will be designed to allow its controlled release off-site following confirmation that its quality is acceptable for offsite disposal (**Commitments 6.1.4.2 and 6.1.4.3**).

Construction of the ammonia plant will disrupt the natural drainage patterns across the site. Surface water flow is from the rocky outcrops in the north of the site towards the tidal mudflats in the south of the site. There are no permanent water courses on the site. Surface flows are ephemeral, based on periods during and immediately after rainfall events. The site will be engineered to divert surface flows around the construction area and to prevent inundation during king tidal and surge conditions **(Commitment 6.1.4.1)**

Monitoring
Stormwater will be monitored prior to discharge, with monitored parameters including TSS, pH, turbidity, total hydrocarbons and volumes (**Commitment 6.1.4.3**).

6.2.4 Capital Dredging

Dredging will be required to accommodate the under keel clearance for ammonia ships, as they have a draft when loaded that exceeds the existing water depth of 10 metres. The vessels that will be required to export ammonia will be 50,000 t ships that have an 11 metre draft when loaded. The depth of water required is 12 to 13 metres to provide a safe under-keel clearance for the vessels. Dredging will involve removal of approximately 1.6 million cubic metres of spoil to create a deeper berth, turning basin and channel into Mermaid Sound. The dredge spoil would be either dumped at sea (via permit) or would be disposed to land.

Potential Impacts
Potential impacts associated with capital dredging and sea dumping would include:

- Turbidity resulting from the dredging and sea dumping processes;
- Loss of habitat in the area of dredging;
- Smothering of habitat the sea dumping location; and
- Resuspension of contaminants (if any) contained in the sediments.

It is likely that habitat impacts resulting from dredging and sea dumping would be short term, as a result of recolonisation processes. Sediments would be sampled prior to disturbance and, if found to be highly contaminated, would be disposed to land rather than dumped at sea.

Management Strategies
Dredging and any additional port upgrades will be undertaken by the Dampier Port Authority and will be subject to a separate sea dumping application to Environment Australia and a referral to the EPA for assessment. The application for sea dumping will address the management and mitigation of impacts and monitoring associated with the process. The Proponent understands that the Dampier Port Authority will commence shortly the approval process for capital dredging.

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7. Operational Impacts, Management and Monitoring

The following section details potential impacts, management objectives and strategies and proposed monitoring for key environmental issues associated with the operational phase of the project.

An Environmental Management Plan for the operational phase of the ammonia plant will be developed (**Commitment 6.0.2**) to expand on the management strategies stated in this section and to also provide specific details of monitoring procedures, methods, frequency and responsibilities.

7.1 Biophysical Environment

7.1.1 Marine Ecology

Management Objective – To maintain marine ecological integrity and biodiversity and minimise potential impacts on locally significant marine communities.

Use of the existing Port and, in particular, the Public Wharf, will avoid the need for construction of additional port facilities, thereby greatly reducing the impact of the proposal on the marine environment. The Port of Dampier is one of the largest in Australia based on tonnage of cargo and the increase in shipping associated with the project will be minimal.

The marine habitats that have the potential to be impacted by the proposed project include the intertidal sand shoals and mangroves in King Bay and the coral pavement near the Dampier Public Wharf. Potential operational impacts on the shoreline and nearshore habitats could result from the following project related activities:

- Spills;
- Stormwater and other discharges; and
- Shipping.

Potential environmental impacts on shoreline and nearshore habitats that may result from project related activities include:

- Spillage of ammonia at the loadout or storage facility;
- Spillage of product from vessel collisions;
- Oil spills from vessel collisions;
- Disposal of stormwater potentially containing contaminants from the site to coastal areas;
- Impacts associated with disposal (by the Water Corporation) of cooling water and treated wastewater from the plant;
- Pollution of marine areas with TBT from antifouling on vessels;
- Introduction of exotic marine species from ballast water or from vessel hulls; and

- Impacts associated with maintenance dredging (by the Dampier Port Authority) to keep channels open for larger vessels to use the wharf.

The management of spills, stormwater and impacts associated with shipping practices is described below. Detailed management of these potential impacts will be addressed in a comprehensive Environmental Management Plan.

Potential impacts and management issues associated with discharge of cooling water and treated wastewater from the plant, and maintenance dredging will be addressed by others under separate environmental approval processes and therefore are only briefly mentioned below for completeness.

7.1.1.1 Ammonia Spills

Potential Impacts

Ammonia spills on land will volatilise and be dispersed into the atmosphere; however, ammonia will readily dissolve into water that it comes into contact with. Ammonia is a nutrient that has the potential to stimulate algal growth (phytoplankton and macroalgae). This algal growth, if excessive or unchecked, can result in significant detrimental impacts on coral or seagrass communities via smothering or reduction in available light. The marine waters in the region of the Burrup Peninsula are generally nutrient poor and any significant influx of nitrogenous material, such as ammonia, would ultimately lead to the effects of eutrophication.

Minimisation and Management of Spills - Ammonia

Management Commitment 7.1.1.1: *The Proponent will at all times carefully control the transfer of ammonia from the plant to the ship.*

Management Commitment 7.1.1.2: *In the event of a ship emergency, leak, blown line or failed connection with the vessel, the flow of ammonia to the ship will be terminated and recycled back to the plant.*

Management Commitment 7.1.1.3: *The Proponent will prepare an Ammonia Spill Contingency Plan as part of the Operation Environmental Management Plan.*

The process of transferring ammonia from the plant to the vessel will be carefully controlled with continuous monitoring of flow rate and pressure. In advance of the export pipeline being connected to the ship, it will be cooled down. This will be achieved by recirculating liquid ammonia through the primary product pipeline at low flow and low pressure and returned to the plant via a dedicated recirculation line. When the pipe has been cooled the valving at the port will be adjusted such that liquid ammonia is delivered to the refrigerated storage area of the ship. The plant controls the delivery flow rate and pressure. When the ship is full, the delivery valve to the ship is closed and the supply pump is stopped. The liquid left in the pipeline is allowed to boil (ammonia boils at -33 ºC) and slowly returns to the plant storage tanks.

In the event of a ship emergency, leak, blown line or failed connection with the vessel (as detected by a change in flow rate or pressure from the norm) the flow of ammonia to the ship will be terminated via an automatic shut-off valve. Ammonia will then be recycled back to the plant via the recirculation line. Ammonia that escapes the loading arm or export pipeline as a result of a leak will very rapidly evaporate to the atmosphere. Ammonia reaching the marine environment will readily dissolve, as it is highly soluble in water. Ammonia potentially reaching the marine environment will be addressed by an Ammonia Spill Contingency Plan which will be established as part of the Operation Environmental Management Plan.

The focus of the Ammonia Spill Contingency Plan will be to rectify the cause of the spill so that subsequent spills do not occur. This may involve the redesign of equipment and/or the installation of additional containment measures. In addition, the Ammonia Spill Contingency Plan will include a reactive monitoring program to determine the dispersion and impacts of ammonia.

7.1.1.2 Oil Spills

Potential Impacts
The possibility of vessel collision with another vessel, the sea bed or other structures is highly unlikely; however, the consequence of such an event could be the discharge of large quantities of fuel (oil) into the marine environment. The oil spill could potentially wash ashore or into a shallow intertidal habitat resulting in the mortality of much of the biota present in the affected area. Such events have occurred in Western Australia, albeit infrequently, resulting in significant environmental impacts. The impacts are generally localised and are short-term provided they are adequately managed.

Minimisation and Management of Spills - Oil Spills
The risk of marine pollution in Mermaid Sound will be managed by the Dampier Port Authority through the Port of Dampier – Marine Pollution Contingency Plan (DPA, 1995). The Marine Pollution Contingency Plan (MPCP) was prepared by the DPA primarily to address the management of marine oil spills. The purpose of the plan is to ensure that a timely and cost effective approach is applied to minimising the impact of any such pollution incident on the environment.

Management Commitment *7.1.1.4: The Proponent will offer to join the committee of Terminal Operators under Dampier Port Authority jurisdiction.*

A committee of Terminal Operators has been established which meets twice a year to ensure that the plan remains up to date. The Proponent will offer to become a participant in the committee once the project commences.

Under the MPCP, the release or likely release of oil from any vessel in Australian Waters must be reported to the Australian Maritime Safety Authority (AMSA) by the master of that vessel. The initial notification of a spill is directed to the DPA Harbour Master, who acts as the On Scene Co-ordinator (OSC). The DPA is the custodian of the oil spill equipment capable of controlling a Tier 3 oil spill.

7.1.1.3 Stormwater Discharge

Potential Impacts
Stormwater discharge has the ability to reduce water quality by either introducing contaminants such as ammonia and hydrocarbons, or by changing the physical properties such as temperature, salinity or turbidity. The potential impacts of ammonia on the marine environment are discussed in **Section 7.1.1.1**.

Management of Stormwater Discharge
The management of stormwater is discussed in **Sections 7.1.2 and 7.2.3** and includes the following features that will be implemented as part of the design process:

- Separate fuel and oil storage system;
- Clean stormwater drainage collection system comprising open channels, pipes and sedimentation basin(s) to facilitate water quality testing prior to discharge;
- Installation of oil interceptor traps/oil separators to remove hydrocarbons from areas that can be contaminated with hydrocarbons;

Management Commitment 7.1.1.5: *During the detailed design of the ammonia plant, the Proponent will ensure that adequate design features are in place to manage the quality of stormwater discharges such that the receiving environment is not adversely impacted.*

- Potentially contaminated stormwater collection system comprising sealed and bunded collection areas and lined sedimentation basin(s); and
- Drainage system designed to transfer flows during a 1-in-50-year event with sedimentation basin(s) designed to withstand a 1-in-100-year event.

7.1.1.4 Wastewater Discharge

Potential Impacts

The potential impacts associated with the return of treated wastewater discharges via the Water Corporation's outlet into King Bay are:

- Temperature;
- Salinity (TDS);
- Nutrients (PO_4 and NH_4);
- Methanol; and
- Antiscalants and biocides.

The common user Burrup Peninsula seawater and brine disposal scheme is in the final stages of gaining environmental approval under application by the Water Corporation. This approval will be subject to several commitments that will have an impact on all users, including the Proponent.

The Proponent understands that the Water Corporation has made the following commitments with respect to the brine stream discharged into King Bay:

- The total dissolved solids concentration of the brine stream shall not exceed 53,000 mg/L;
- The temperature of the brine stream shall be within 2oC of the 24-hour average ambient seawater temperature;
- No industrial wastes shall be discharged into the brine stream without prior separate approval of the Department of Environmental Protection (DEP);
- No heavy metals shall be discharged into the brine stream;
- No biocides used in the process shall be discharged to sea; and
- The use of process chemical additives that will be discharged in the brine stream is subject to approval by the DEP. The chronic toxicity of chemical additives to the process water will be tested on appropriate marine biota.

The Proponent will be bound by contract to the Water Corporation to uphold commitments made by the Water Corporation to the DEP. With respect to the proceeding six points, the Proponent advises:

- Brine return TDS will be controlled at 53,000 mg/L;
- Available data on seawater and wet bulb temperatures indicates the brine return temperature will naturally be within 2°C of the 24-hour average seawater temperature;
- The Proponent understands that the Water Corporation will seek separate approval from the DEP for the proposed discharges over and above current approval;

- No heavy metals will be discharged over and above that occurring in the supplied seawater; and
- The Proponent will treat the discharge brine stream to remove free chlorine, bromine and other biocides. The Vendor Wastewater Treatment Package responsible for this has not been selected at this stage of the project, but adequate cost allowances have been made.

Management of Wastewater Discharges
Wastewater discharges including cooling water blowdown, wastewater from the demineralisation plant, and treated wastewater will be managed by the Water Corporation of Western Australia under a separate approval process. The Water Corporation is required to meet the requirements of the Department of Environmental Protection for the discharge of wastewater and the Proponent will design the ammonia plant to meet these requirements (refer to **Section 7.2.3.1** with respect to liquid waste management).

Management Commitment 7.1.1.6: *The Proponent will design the ammonia plant to meet the requirements of the DEP with respect to the discharge of wastewater into the Water Corporation's pipeline.*

7.1.1.5 Ballast Water Discharge

Potential Impacts
Ballast water from coastal waters elsewhere in Australia or overseas has the potential to impact upon marine communities through the introduction of exotic organisms. A range of marine organisms may be transported in large numbers within ballast water and some of these organisms may be capable of invading new ecosystems and upsetting the ecological balance. Diseases may also be introduced by ballast wastewater containing viruses or bacteria, posing a health threat to indigenous human, animal and plant life.

Regulatory Requirements
The Australian Quarantine and Inspection Service (AQIS) released a Regulation Impact Statement that relates to recent amendments to the *Quarantine Act 1908* through the *Quarantine Amendment Act 1999*, as well as proposed amendments to the *Quarantine Regulations 2000*. The amendments to the Quarantine Act were made in anticipation of the new Mandatory Ballast Water Management Arrangements for the international shipping industry released in July 2001.

The decision to introduce the new mandatory arrangements was announced by the Minister for Agriculture, Fisheries and Forestry, the Hon Warren Truss MP, on 15 September 1999. The new framework builds upon the current Australian Ballast Water Guidelines and is consistent with Australia's efforts to prevent exotic marine pests from invading its unique marine environment.

The Mandatory Ballast Water Management Arrangements require the following:

- Accurate reporting to AQIS regarding ballast water arrangements (mandatory requirement under the *Quarantine Act 1908*). Vessels that do not carry ballast water will still be required to undertake mandatory reporting to AQIS.
- If required, undertaking exchange and/or other treatment/management option/s as directed by AQIS, prior to discharge of ballast water in Australian waters (including non-proclaimed ports).
- Re-submission and/or updating of ballast water information provided, when ballast water details for the voyage have altered.

- Mandatory access to safe onboard ballast sampling points.
- Disposal of sediment only on land resulting from ballast tank and/or hold cleaning (in accordance with AQIS requirements).
- No discharge of ballast water within Australian waters without prior written permission from a Quarantine Officer.

Management of Impacts Associated with Shipping - Ballast Water
Adopting AQIS guidelines and appropriate ballast water management procedures can significantly reduce the risk of introducing marine pest species to the Port of Dampier. At present the Port of Dampier has not been surveyed for introduced marine pest species and thus no baseline data is available. However, the Dampier Archipelago Biological Survey undertaken recently by the WA Museum has documented exotic species in the Dampier Archipelago (WA Museum, in prep.).

AQIS has developed as web-based decision support system that became available for use in July 2001. The Australian Ballast Water Decision Support System (DSS) is a computer based system that will be used to process information and assess the quarantine risk of ballast water. International vessels intending to discharge ballast water in Australian waters will be able to manage their ballast water en-route by:

- Accessing the DSS by lodging ballast water information at the 'last port of call' or en-route and managing tanks posing a high risk to intended ports of discharge; and/or alternatively;
- Undertaking an independent treatment procedure of their ballast water (exchange or other comparable method accepted by AQIS) prior to entering Australian waters.

The DSS performs a risk assessment on a tank-by-tank basis (based on ballast water information supplied by the vessel). It will allow international vessels to determine en-route if their ballast water poses a risk of introducing exotic marine pests. Those tanks identified by the DSS to be carrying high risk ballast water will require treatment/management by a method acceptable to AQIS. According to AQIS (pers. comm.), the risk of marine pest species introduction from India would be high (unless appropriate precautions are taken) given the similarity of marine environmental conditions with the Port of Dampier. Current treatment/management options include:

- Exchange of ballast water at sea, through sequential exchange (empty/refill), flow through (3x the ballast tank's volume), or the dilution method.
- Non-discharge of high risk ballast tanks.
- Tank to tank transfer, preventing discharge of high-risk tanks' ballast water.

Comparable treatment options may be considered for acceptance by AQIS as they are developed.

Ballast water management will be undertaken to the requirements of the Dampier Port Authority and AQIS guidelines. All vessels associated with the project will be required to:

- Adhere to AQIS guidelines to manage ballast water;

- Complete an 'audit and advice procedure' as stated in the Port of Dampier EMP which ensures:
  - Vessel has been accepted by the Australian quarantine and Inspection Service;
  - Ballast water exchange has occurred at sea whilst in clear (free from suspended sediment) oceanic water remote from coastal influences; and
  - A record of the time and position of re-ballasting is always kept;
- Ensure that no ballast water or sediment resulting from tank or hold cleaning is discharged within the Port; and
- Exercise care when deballasting to prevent the suspension of sediment.

***Management Commitment 7.1.1.7:** All vessels carrying Burrup Fertiliser products will be required to meet AQIS guidelines.*

***Management Commitment 7.1.1.8:** All vessels carrying Burrup Fertiliser products will meet the ballast water requirements of the Port of Dampier EMP.*

7.1.1.6 Antifoulant Contamination

Potential Impacts

The leaching of antifouling paints containing tributyltin (TBT) from vessels has the potential to adversely impact upon marine organisms. TBT is highly toxic at very low concentrations and causes imposex in marine gastropod molluscs at sublethal levels. TBT is relatively quickly broken down in the presence of oxygen while in the water column; however, in sediments it can persist for periods of years, particularly in anoxic conditions.

Baseline information of TBT is not presently available for the Dampier Public Wharf; however, the Proponent understands that investigations will be undertaken as part of the application for capital dredging. Data obtained during these investigations will provide an indication of historical contamination by TBT; however, once dredging is completed the existing TBT will have been removed. Ongoing maintenance dredging will also require analysis for TBT that would be included as a monitoring strategy (refer to **Section 7.1.1.7**).

Regulatory Requirements

In November 1999 the International Maritime Organisation (IMO) directed the Marine Environment Protection Committee to develop an instrument, legally binding throughout the world, to address the harmful effects of antifouling systems used on ships. The objective was to institute a global ban on the application of TBT paints on ships by 1 January 2003 and a complete prohibition on the presence of TBT paints on ships by 1 January 2008. The 5-year gap allows for ships legally coated with TBT before 1 January 2003 to operate until their next dry-docking for maintenance.

Most Australian States have adopted legislation that:

- Prohibits the use of TBT paints on vessels less than 25 metres in length;
- Limits the leaching rate of TBT paints used on vessels of greater than 25 metres to 4-5 $\mu g/cm^2/d$;
- Prohibits the in-water cleaning of hulls (in order to prevent debris and TBT paint flakes accumulating on the seabed); and
- Requires ship maintenance facilities to contain and dispose of hull debris in an approved manner.

The Australian and New Zealand Environment and Conservation Council (ANZECC) has published a Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance. This has provided guidance to industry and regulators in applying a consistent approach to the management of these activities.

Management of Impacts Associated with Shipping - Antifoulant Contamination
The dedicated vessels associated with this project will be originating from the Indian port of Paradeep. No vessel hull scraping or antifoulant painting will take place in the Port of Dampier, reducing the risk of TBT contamination of the area. Vessels, while at berth, will not be required to move to facilitate loading, further reducing the risk of antifoulant entering the environment by being removed by abrasion with the wharf.

The leaching of TBT from antifouling paints used on vessels is likely to be minimal because of the small size of the vessels and, combined with the low level to vessel traffic associated with this project, is likely to result in a negligible impact on the environment.

Management Commitment 7.1.1.9: *The Proponent will ensure that all vessels comply with relevant legislation concerning antifoulants (TBT).*

Vessels will be required to comply with the relevant local marine legislation, including the *Port Authorities Act 1999* and *Dampier Port Authority Regulations 1989*, and international marine pollution conventions (MARPOL 73/78).

7.1.1.7 Maintenance Dredging

Potential Impacts
The vessels proposed in the project for transport of product to India require greater under keel clearance than is presently available at the Dampier Public Wharf. Therefore, capital dredging would be required to allow these vessels to berth safely and this is discussed in **Section 6.2.4**. Following the initial capital dredging works, there may be a requirement for periodic maintenance over the operational life of the project. Dredging itself is unlikely to have a significant impact on the local marine environment; however, the disposal of the dredge spoil may. Disposal may involve sea dumping or the spoil may be suitable for land reclamation. Both disposal options can affect water quality, either via dumping at sea or from return water discharged from settling ponds. Contaminants that may be present in the sediments could become dissolved into the water leading to toxicity effects on marine biota. In addition, turbidity resulting from the disposal process could reduce light levels, smother benthic biota or impact on pelagic biota through impairment of respiration.

Management of Impacts Associated with Shipping – Maintenance Dredging
Maintenance dredging at the Dampier Public Wharf is the responsibility of the Dampier Port Authority and all required environmental approvals will be sought by the Port Authority in due course. Management of maintenance dredging is, therefore, not included in this environmental approval process.

7.1.2 Water Quality

Management Objective: Maintain the quality of surface and groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the National Water Quality Management Strategy – Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC / ARMCANZ, 2001).

7.1.2.1 Potential Impacts

There a number of minor drainage lines that occur within the project lease which are ephemeral and discharge surface runoff from the rockpile and high scree slopes in the northern portion of the site to the saline tidal flat area in the south. Drainage lines that naturally cross the proposed plant site will be intercepted and redirected as discussed in **Section 6.1.4**.

The construction and development of a suitable level foundation for the ammonia plant will not impact the groundwater table. The creation of impervious surfaces will reduce the recharge capacity of the local groundwater aquifer, however this impact is considered to be negligible.

The potential impacts on surface and groundwater quality are discussed in other sections of this document that include:

- Drainage and site hydrology (**Section 6.1.4**) and
- Liquid and solid waste management waste (**Sections 6.2.3 and 7.2.3**)

7.1.2.2 Management Strategies

To minimise the potential impacts on surface and groundwater quality several management strategies and management commitments have been made in **Sections 6.1.4, 6.2.3.2 and 7.2.3.1** and are summarised in **Table 7-1**. These management strategies will ensure that water discharged to the environment will comply with the National Water Quality Management Strategy – Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC / ARMCANZ, 2001).

Table 7-1 Summary of Water Quality Protection Measures

Section	Proposed Management Strategies
Drainage and Site Hydrology	
6.1.4	To prevent tidal impacts, the site will be filled to above the 100-year storm surge level and the inundated fill areas will be protected using rock armouring (to prevent erosion during tidal excursions). Upstream uncontaminated surface runoff will be diverted around the construction site and discharged downstream to an area that will not adversely impact the condition of vegetation or result in erosion. Sediment traps will be installed at the outlet of the diversion drains to minimise erosion and attenuate flows, prior to discharge back into the environment. Clean stormwater drainage collection system will be provided comprising open channels, pipes and sedimentation basin(s). Sedimentation basin(s) will be designed to collect stormwater from clean areas on the construction site where it will be tested, as part of a water quality monitoring program, prior to it being discharged off-site.
Wastewater Management during Construction	
6.2.3.2	The management of liquid waste on-site during construction activities will comprise two systems as follows: ▪ Temporary septic system for domestic sanitary waste; and ▪ Surface drainage system including a detention basin to remove suspended solids and to allow containment of suspended solids / pollutants should it be required.

Section	Proposed Management Strategies
	Liquid waste generated during the construction phase will be managed by: ▪ Fuel storage will be in bunded areas; ▪ Domestic effluent will be either disposed to land through leach drains in accordance with the requirements of the health department and local authority guidelines or alternatively effluent will be stored in tanks, removed by a licensed contractor and treated off-site at a licensed facility; ▪ Site drainage system with open interceptor drains that deliver stormwater to a sediment basin(s) (**Commitment 6.1.4.1**); and ▪ Sediment basin(s) that collect all stormwater from the construction site and are designed to allow its controlled release off-site following confirmation that its quality is acceptable for offsite disposal (**Commitment 6.1.4.2**).
Wastewater Management during Operation	
7.2.3.1	The Proponent will be bound by contract to the Water Corporation to uphold commitments made by the Water Corporation to the DEP. The Proponent advises: ▪ Brine return TDS will be controlled at 53,000 mg/L; ▪ Available data on seawater and wet bulb temperatures indicates the brine return temperature will naturally be within 2°C of the 24-hour average seawater temperature; ▪ The Proponent understands that the Water Corporation will seek separate approval from the DEP for the proposed plant discharges over and above their current approval; ▪ No heavy metals will be discharged over and above that occurring in the supplied seawater; and ▪ The Proponent will treat the discharge brine stream to remove free chlorine, bromine and other biocides. The Vendor Wastewater Treatment Package responsible for this has not been selected at this stage of the project, but adequate cost allowances have been made. Separate fuel and oil storage system will be designed. Stormwater from the site will be collected in two separate systems. Areas that have the potential to be contaminated by spillages, ruptures or overflows will be physically segregated by barriers from the reminder of the site. Stormwater from potentially contaminated areas will be collected by a contaminated stormwater system. Stormwater from the remaining plant area will be collected in a clean stormwater system. The clean stormwater drainage collection system will include open channels, pipes and sedimentation basin(s). Sedimentation basin(s) will be designed to collect stormwater from clean areas in the plant prior to its controlled discharge off-site. The contaminated stormwater collection system will include sealed and bunded collection areas and lined sedimentation basin(s). Lined sedimentation basin(s) will be designed to allow testing of water quality and to permit the controlled discharge off-site or allow for containment prior to further treatment before release off-site. The drainage system will be designed to transfer flows during a 1-in-50-year event and the sedimentation basin(s) will be designed to withstand a 1-in-100-year event. Process liquid wastes will be treated on-site in a Vendor Wastewater Treatment Package prior to being discharged into the Water Corporation's saline water outlet pipeline. Domestic wastewater will be treated to secondary standard (20mg/L(BOD) and 30mg/L(SS)) prior to disposal. Sanitary wastewater will be disposed to either land or ocean in accordance with the requirements of Water Corporation, Shire of Roebourne and DEP or alternatively effluent will be transferred to the Water Corporation saline water outlet pipeline.
	All treated wastewater discharged into the Water Corporation saline water outlet pipeline will be continuously monitored for flow rate and accumulated flow, temperature, conductivity, oxidation-reduction potential and turbidity. Other regular monitoring will include free chlorine, free bromine, metals, N, P and other parameters required by Water Corporation and DEP.

Section	Proposed Management Strategies
	Stormwater will be monitored prior to discharge, with monitored parameters including TSS, pH, turbidity, total hydrocarbons and volumes. Treated domestic wastewater will be monitored to confirm its suitability for disposal, with monitored parameters including TSS, pH, BOD, N, P and faecal contaminants.

7.1.2.3 Monitoring

To ensure that management strategies are being implemented successfully, the following monitoring will be undertaken:

- All erosion and sediment control features of the plant will be inspected regularly and after each rainfall event.
- All plant equipment and storage vessels on site will be maintained and regularly checked for leaks of fuels, oils and chemicals.

Management Commitment 7.1.2.1: *All erosion and sediment control features of the plant will be inspected regularly and after each rainfall event.*

Management Commitment 7.1.2.2: *All plant equipment and storage vessels on site will be maintained and regularly inspected for leaks of fuels, oils and chemicals.*

7.2 Pollution

7.2.1 Atmospheric Emissions

Management Objective – To ensure that gaseous emissions, from the proposal in isolation and in combination with emissions from neighbouring sources and background concentrations, do not cause ambient ground level concentrations to exceed appropriate criteria or cause an environmental or human health, amenity problem.

Atmospheric emissions from the ammonia plant will occur under normal operating conditions, during startup and under upset conditions with the emissions of concern being nitrogen oxides, carbon dioxide, ammonia and to a lesser degree sulphur dioxide and particulate matter below 10 µm (PM10).

7.2.1.1 Emissions Under Normal Operation

The emission characteristics under normal operation are presented in **Table 7-2**.

Table 7-2 Atmospheric Emissions Characteristics – Normal Operations

Source	Stack Height (m)	Stack Diam. (m)	Emission Volume Am^3/hr	Emission Temp. (°C)	Exit Velocity (m/s)	NO_X (g/s)	SO_2 (g/s)	VOC (g/s)	PM10 (g/s)	CO (g/s)
Primary Reformer	36	3.56	455,000	140	12.7	15.4	Negl	0.0	0.28	3.1
CO_2 Stripper	60	0.87	76,800	45	36.5	0.0	Negl	0.0	0.0	0.0
Package Boiler	15	1.69	40,250	177	5.0	1.3	0.02	0.0	0.03	0.31
Total	-	-	-	-		**16.7**	**0.02**	**0.0**	**0.31**	**3.41**

Notes:
1) Am^3/hr is at actual stack conditions;
2) NO_X expressed as 100% NO_2;
3) VOC defined as volatile organic carbons;
4) Emissions at normal conditions are anticipated to occur for 350 days a year; and
5) A package boiler will operate at 25% load during normal operations.

These indicate that, under normal conditions, major emissions will be NO_X from the primary reformer and package boiler, with minor amounts of CO, SO_2, PM10 and negligible amounts of VOC emissions. The CO_2 stripper stack will comprise 99.8% by volume (dry) of CO_2, which equates to an emission of 123 t/hr.

7.2.1.2 Emissions under Start Up, Plant Upsets and Maintenance Periods

Start Up Conditions

Plant start up will occur under both cold and hot start ups. A cold start up occurs where the plant has been down for more than eight to ten hours. Under a cold start up, both package boilers will be fired on gas to produce a maximum of 100 tph of steam needed to commence the process before the ammonia production process is stabilised. Additionally, the start up heater will also be operated to heat gases. This will occur some six hours before the intended start up of the ammonia plant and then continue for a further six hours as the ammonia process is initiated and stabilised. As steam generation within the ammonia process becomes available, the gas burners to the boiler will be reduced and then terminated with the hot air supplied entirely from waste heat from reformer process. During this period of startup, the feed gas valve is opened and gas is passed through the various stages of the process. At various stages during the start up, gases are vented to atmosphere for a short period. These gases will consist primarily of hydrogen, nitrogen and methane. Discussion of venting is covered in the risk assessment in **Section 8.2.**

Emissions from start up along with their expected frequency and duration are presented in **Table 7-3**.

Table 7-3 Atmospheric Emissions Characteristics – Start Up and Upset Conditions

Source	Stack Height (m)	Stack Diam. (m)	Emission Volume Am^3/hr	Emission Temp. (°C)	Exit Velocity (m/s)	NO_X (g/s)	SO_2 (g/s)	Partic. (g/s)	NH_3 (g/s)
Start Up- Cold Start up once per year for 12 hours, hot start up 5 per year for 12 hours									
Package Boiler #1	15	1.69	161,000	177	20	5.0	0.08	0.11	0.0
Package Boiler #2	15	1.69	161,000	177	20	5.0	0.08	0.11	0.0
Start Up Heater	18.7	1.68	78,400	900	9.8	0.94	0.01	0.014	0.0
Vent A	25	3.0	Gases comprising H_2, N_2 and CH_4 (see Risk assessment section)						
Vent B	60	2.0	Gases comprising H_2, N_2 and CH_4 (see Risk assessment section)						
Emergency Shutdown - up to 5 events per year									
Vent A	25	3.0	Gases comprising H_2, N_2 and CH_4 (see Risk assessment section)						
Vent B	60	2.0	Gases comprising H_2, N_2 and CH_4 (see Risk assessment section)						
Refrigeration Plant Failure - Not anticipated to occur, less than 1-in-100 years									
Ammonia Storage Tank Flare	30	Not applic	Not Applic	Not Applic	Not Applic	6.1	0.0	0.0	5.6
Maintenance Period - one 10 day period per year									
Package Boiler #1	15	1.69	161,000	177	20	5.0	0.08	0.0	0.0
Package Boiler #2	15	1.69	161,000	177	20	5.0	0.08	0.0	0.0
Maintenance Period - Full plant shutdown one 12 hour period per year									
Diesel Generator #1	6	0.40	18,000	260	40	3.05	0.36	0.09	0.0
Diesel Generator #2	6	0.40	18,000	260	40	3.05	0.36	0.09	0.0

Upset Conditions

Emergency Shutdowns

Upset emissions from the plant can occur from emergency shutdown of the plant and potentially from flaring of the ammonia from the storage tanks. Under such a condition, the feed gas will be closed, emergency valves will release and the gases from sections of the process will be vented. Generally, as in the start up venting, these gases will comprise hydrogen, nitrogen, methane and steam. Further discussion of emergency shutdown is provided in the risk assessment in **Section 8.2**.

Refrigeration Plant Failure

In the event that the refrigeration plant to the ammonia storage fails, ammonia liquid that vaporises will be flared at the ammonia storage tank flare. This event however will only occur if the plant site has a blackout. This is considered extremely unlikely given the double redundancy in all systems. Power is normally generated by steam from the reformer process or package boiler to the turbo alternator, with a diesel generator backup system.

In the event that the refrigeration plant ceases to operate, the liquid ammonia will slowly warm with the gaseous ammonia vented to a flare stack. With such double redundancy, it is anticipated that this will be a very unlikely frequency of occurrence, less than once in 100 years. In the event that such an occurrence happens and is not rectified by the time that the ammonia starts to vaporise, the maximum emissions would be as estimated in **Table 7-3**.

Maintenance Periods

Maintenance of the plant is anticipated to occur approximately yearly for a 10 day period. During this period the ammonia plant will be shutdown with power supplied by the package boilers which will be fired for this period by gas burners. For a period of around 12 hours within this maintenance period, these boilers will also be shutdown for maintenance with the power for the plant supplied by two diesel generators. Apart from this period the diesel generators will only potentially be used in emergency shutdowns and will be tested daily for a period of 10 minutes to ensure operability.

7.2.1.3 Existing Emission Sources

Existing major industrial sources of atmospheric emissions within the Dampier and Karratha region include the following:

- Woodside onshore treatment plant on the Burrup Peninsula including the Domestic gas (DOMGAS), LNG and LPG facilities; and
- Hamersley Iron's power station at Parker Point near Dampier.

Additionally, there are a number of emission sources that are proposed for the area including:

- Woodside's new train 4 and 5 LNG processing facilities;
- Plenty River's Ammonia/Urea plant; and
- Syntroleum's oil from gas plant.

Emissions from these plants are compared to the proposed Burrup Ammonia Plant emissions in **Table 7-4** for the pollutants of most concern, being nitrogen oxides and VOC.

Table 7-4 indicates that emissions of NO_X from the proposed Burrup Ammonia Plant are relatively small, at around 4% of the total emissions. The Burrup Ammonia Plant will not emit VOC.

Table 7-4 Existing and Proposed Emissions of NO_X and VOC from Industry in the Burrup/Dampier Area as Modelled in 1999 and Currently Proposed

Plant	Nitrogen Oxides (g/s)		VOC (g/s)	
	As Proposed in 1999	As proposed in 2001	As Proposed in 1999	As proposed in 2001
Woodside Facilities with additional trains 4 and 5 (1)	253.4	253.4	1320	1320
Hamersley Iron Power Station (1)	17.8	17.8	0.0	0.0
Proposed Syntroleum Oil from Gas Plant	73.7 (1)	46.6 (3)	5.3 (1)	9.1 (3)
Proposed Plenty River Ammonia/Urea plant (2)	37.8	37.8	15.3	15.3 (4)
Proposed Burrup Ammonia Plant	NA	16.4	NA	0
Total	**382.7**	**372.0**	**1340.6**	**1344.4**

Notes:

1) From HLA- Envirosciences Pty Limited (1999)
2) From Woodward Clyde (1998)
3) Revised Syntroleum emissions from DEP (2001)
4) Assumes that ammonia is classified as a VOC.
5) NA – Not applicable as the ammonia plant was not proposed in 1999.

7.2.1.4 Air Quality Criteria

Within Western Australia, the Environmental Protection Authority (EPA) assesses any new proposal in terms of emissions at stack and the resultant ambient ground level concentrations.

Emission Standards and Limits

For emissions from industrial sources, the WA EPA requires that "all reasonable and practicable means should be used to prevent and minimise the discharge of waste" (EPA, 1999a). For new assessments the EPA requires an assessment of the best available technologies for minimising the discharge of waste for the processes and justification for the adopted technology.

For best available technology the EPA has in the past used the AEC/NHMRC (1986) guidelines for new stationary sources as being indicative of what can be achieved as of 1985 (see **Table 7-5** for the guidelines relevant to this project).

Since the AEC/NHMRC guidelines have not been updated, the EPA has provided their own guidance for gas turbines (EPA, 2000a), and have referred to guidelines promulgated elsewhere for other Australian sources. In general, the most stringent are those from the NSW EPA (1997). Noteworthy emission limits that are lower than the AEC/NHMRC guidelines are:

- Particulate matter with an emission limit of 0.10 g/m^3

Table 7-5 AEC/NHMRC Guidelines for New Stationary Sources Relevant to this Project

Pollutant	Standard applicable to	Standard	Notes
Solid Particles	Any other trade, industry process, industrial plant or fuel burning equipment	0.25 g/m^3	
Nitric acid or oxides of nitrogen	Gas Fired Boilers	0.35 g/m^3	Nitrogen oxides calculated as NO_2 at a 7% oxygen reference level.

Note: Gas volumes expressed dry at zero degrees Celsius and at an absolute pressure equivalent to one atmosphere.

For an ammonia plant, the European Fertiliser Manufacturers Association (EFMA, 2000) also provides details on what it considers are the best available technologies (BAT) for the production of ammonia. This lists BAT guidelines for gas usage, greenhouse gas emissions and NO_X emissions from ammonia plant. For steam reforming process using natural gas, greenhouse gas emissions of 1.65 to 1.8 t CO_2/t NH_3 is considered best practice (see **Section 7.2.1.12**), whilst for NO_X emissions, 75 ppmv (3% O_2) or 0.45 kg/t NH_3 is considered best practice.

A summary of the emissions from this project for the substances with emission guidelines (NO_X and particulate) is presented in **Table 7-6**.

Table 7-6 Relevant Emission Standards and Guidelines for the Project

Emission Source	Units	NHRMC (1985)	NSW EPA (1997)	EFMA BAT Current Plants	EFMA BAT New Plants	Proposed Burrup Ammonia Plant
Nitrogen Oxides (expressed as NO_2)						
Reformer Flue Gas	(ppmv @ 3% O_2)	-	-	150	75	94
	(ppmv @ 7% O_2)	170.5	170.5	117	58	73
	(kg NO_X/ t NH_3)	-	-	0.9	0.45	0.61
Emergency Diesel Generator	(ppmv)	NA	NA	NA	NA	~ 600
Package Boiler	(ppmv @ 7% O_2)	170.5	170.5	NA	NA	104
Start Up Heater	(ppmv @ 7% O_2)	170.5	170.5	NA	NA	104
Solid Particles						
All Fuel Burning Plant	(mg/Nm^3)	250	100	NA	NA	<5
Dark Smoke						
Stationary Sources		Ringleman No. 1	20% Opacity	NA	NA	Negl

Notes:
1) Concentrations in mg/m^3 have been converted to ppmv using 1 mg/Nm^3 equal to 0.487 ppmv NO_X

Table 7-6 indicates that emissions of nitrogen oxides will be below the standard and guidelines for the package boilers and start up heater. For the reformer flue gas emissions, the proposed emissions of NO_X at 94 ppmv will be well below the Australian guidelines and also below the very stringent German guidelines of 97.5 ppmv (Appl, 1997). Emissions for this plant have been substantially reduced from standard plant (typically 150 ppmv) and are considered achievable by the plant vendors (Kellogg Brown & Root) based on their preliminary design data and

Management Commitment 7.2.1.1: *Burrup Fertilisers will investigate the feasibility of meeting the BAT for reformer gas emissions during the detailed engineering design phase.*

substantial operating experience worldwide. Even lower emissions may be achievable, but this will not be determined until detailed engineering design has been undertaken. The main contributor to the reformer flue gas NO_X emissions is the performance of the burners. The Proponent will investigate the feasibility of meeting the BAT for reformer gas emissions during the detailed engineering design phase.

Emissions of particulate would be negligible and also well below all guidelines.

The overall result of using low NO_X emission components (apart from the emergency diesel generator) is that the total NO_X emissions from this project are only 16.4 g/s. This is substantially less than the comparable Plenty River project (37.8 g/s) which indicates BAT for the reformer, but proposes standard burners for other components such as the gas turbines and the auxiliary boiler. As such, overall total emissions from the proposed plant would be substantially reduced compared to standard plants.

Ambient Ground Level Standards

For ambient ground level concentrations, the WA EPA does not have state-wide standards. For these, the EPA requires that pollutants meet the National Environmental Protection Measure (NEPM) standards (NEPC, 1998) as listed below in **Table 7-7.** These specify a maximum concentration and the goal that is to be achieved within 10 years.

Table 7-7 National Environmental Protection Measures – Standards and Goals

Pollutant	Averaging Period	Maximum Concentration	Goals within 10 years Maximum allowable exceedances
Carbon Monoxide	8 hours	9.0 ppm	1 day a year
Nitrogen Dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year none
Photochemical oxidants (as ozone)	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year 1 day a year
Sulphur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year none
Lead	1 year	0.50 ug/m^3	None
Particles as PM10	1 day	50 ug/m^3	5 days a year

These NEPM standards and goals have not been implemented in legislation throughout the state as yet, however the WA DEP intend to implement them through the development of a state wide Environmental Protection Policy (EPA, 1999b). Throughout Western Australia, these standards apply outside industrial areas and residence free buffer areas around industrial estates" (EPA, 1999b, pp3).

For other pollutants, the Department of Environmental Protection tends to reference the lowest standards that are in use throughout Australia. For this plant, the only other pollutant of concern is ammonia. For this project the Victorian State Environmental Protection Policy (CASANZ, 2000) design ground level concentration of 600 $\mu g/m^3$ for a 3-minute average has been adopted.

DEP's position (EPA 1999b) is that the ambient residential criteria should be applied outside industrial areas and residence free buffer areas around industrial estates.

On the Burrup there is no formally defined industrial buffer zone and therefore for the purposes of this air quality assessment we have elected to apply the NEPM outside the industrial zone (areas coloured purple on **Figure 1-1**).

Offsite receptors of particular interest for this study include the following:

- Hearson Cove and Cowrie Cove (beach recreation);
- Residential areas at Dampier and Karratha; and
- The industrial workforce at Mermaid Marine, Dampier Port Authority and Woodside facilities.

Onsite impacts are compared to occupational health criteria as listed in NOHSC (1995).

7.2.1.5 Existing Air Quality in the Region

The WA DEP has recently conducted an intensive survey of the air quality in the Dampier and Karratha region (DEP, 2001b). This study involved monitoring particulate below 10 µm (PM10), oxides of nitrogen and ozone at Dampier over three years and, for a period, ozone, oxides of nitrogen and sulphur dioxide at King Bay. Additionally, detailed meteorological data was collected with weather stations and atmospheric temperature and wind profiling equipment.

The results of the ambient monitoring showed that maximum 1-hour concentrations at Dampier from 1998-1999 were 0.021, 0.050 and 0.064 ppm for NO_2, NO_X and ozone respectively (DEP, 2000). These concentrations indicate that the major photochemical pollutants, NO_2 and ozone, are well below the NEPM standards (see **Table 7-7**).

Concentrations of PM10 were shown to vary widely from year to year, with the year 2000 having 18 exceedances of the standard. This high number is considered to be due to distant bush fires, with a small contribution from local iron ore stockpiling and ship loading operations.

7.2.1.6 Air Dispersion Modelling Approach

Using the detailed monitoring data obtained from the Pilbara Air Shed study (DEP, 2001b), the DEP evaluated a number of air dispersion models for assessing the impacts from existing and future industry. The models assessed were:

- DISPMOD, the WA coastal dispersion model that was specifically developed for Kwinana;
- TAPM, a numerical air quality model that can predict photochemical reactions such as the formation of ozone; and
- Ausplume, the Victorian EPA regulatory dispersion model that is commonly used in air quality assessments throughout Australia.

The results of this assessment (DEP, 2001b) indicated that DISPMOD was able to predict most accurately the NO_X levels in the region, whilst TAPM was shown to be able to best reflect the photochemistry with predictions of NO_2 and NO_X.

Based on the above, DISPMOD was selected for this assessment to predict the local impacts of pollutants such as NO_X and NO_2, SO_2 and NH_3. As DISPMOD does not have a rigorous treatment of the effects of building wakes on plume dispersion, Ausplume v5.1, the Victorian EPA regulatory model, was also used to verify the effects of building wakes on short stacks. For the assessment of photochemical smog and ozone and NO_2 on a regional scale, the results from previous modelling of ozone in the area using TAPM (HLA–Envirosciences, 1999) was utilised.

7.2.1.7 Nitrogen Oxides

Potential Impacts

Nitrogen oxide emissions from the plant occur from the primary reformer stack and, to a lesser degree, from the one package boiler operating during normal operation. Under start up conditions, nitrogen oxide will be emitted from the two package boilers and the start up heater.

Nitrogen oxides (NO_X) are produced through combustion at high temperature in air where the N_2 in the air is oxidised to NO and then to NO_2. Additionally, for fuels with nitrogen present, the nitrogen in the fuel can be oxidised to nitrogen oxides. From gas fired burners, typically around 90% of the NO_X is emitted in the form of NO, with the remainder as NO_2. After release this NO is then slowly oxidised to the more reactive NO_2.

NO_2 is a respiratory irritant which may contribute to bronchitis in infants, children and susceptible adults. For NO_2 the NEPC (1998) has set a 1-hour standard of 0.12 ppm.

Nitrogen oxides along with hydrocarbons are the basis for the formation of photochemical smog. This is discussed in more detail in **Section 7.2.1.11**.

For the assessment of nitrogen dioxide against the NEPM criteria, two approaches have been made:

- Firstly, to predict regional impacts using the results of a photochemical smog model (TAPM); and
- Secondly, to evaluate the local impacts of NO_X (within 5 km of the plant) using the models DISPMOD and Ausplume, with an estimation of the conversion of NO to NO_2 at this point.

TAPM Results

Using the dispersion model TAPM, CSIRO Division of Atmospheric Research (HLA –Envirosciences, 1998) predicted concentrations across the region. For the assessment with the present industry and proposed Woodside expansion, Plenty River plant, and Syntroleum plant, the maximum predicted concentration anywhere on the grid was 62 ppb, which is 51% of the standard (see **Table 7-8**).

Table 7-8 Predicted Maximum Concentrations from TAPM for Existing and Proposed Projects as at 1998

Location	Maximum NO_X Anywhere (ppb) (μg/m³)	Maximum NO_2 Anywhere (ppb) (μg/m³)	Maximum O_3 Anywhere (ppb) (μg/m³)
Anywhere	99	62 (127)	70
Dampier	53	19 (39)	33
Karratha	21	17 (35)	49
NEPM Standard		120 (247)	100

CSIRO was subsequently commissioned by Sinclair Knight Merz to assess the likely changes in ozone levels in the region with the proposed Burrup Fertiliser ammonia plant. Considering that the total NO_X emissions now proposed in 2001 have decreased from that assessed in 1998, CSIRO concluded that:

"It is our opinion that the operation of the ammonia plant on the Burrup Peninsula would lead to maximum hourly-averaged concentrations of ozone and nitrogen dioxide that are barely different from those estimated in a previous study for a very similar emissions scenario (ozone 70 ppb, nitrogen dioxide 62 ppb). Consequently, the resulting concentrations for all pollutants when existing industry, and the proposed industries considered in this Report, including the ammonia plant, are considered together, are estimated to be well below NEPM standards" (CSIRO, 2001).

As such, maximum concentrations on a regional scale and at Dampier and Karratha are predicted to be very similar to that presented in **Table 7-8** and will be at maximum 51% of the NEPM standard.

DISPMOD

To assess local impacts within several kilometres of the sources, DISPMOD was used to predict the concentrations of NO_X from the proposed ammonia plant and for the existing and previously proposed plants. To estimate maximum NO_2 concentrations, the data from the Dampier and King Bay sites were analysed to determine the maximum extent of NO_2 within the NO_X from the present Woodside facilities, (ie for northerly winds). The data for Dampier is presented in **Figure 7-1.** As a conservative relationship the line has been used to represent a realistic upper boundary of the ratio of NO_x to NO. In terms of relationship of NO_2 this is:

$[NO_X] < 20.56\ \mu g/m^3$ $\quad$ $[NO_2] = [NO_X]$

$[NO_X] \geq 20.56\ \mu g/m^3$ $\quad$ $[NO_2] = 0.3 \times [NO_X] + 14.39 \times [NO_X]$

Figure 7-1 Monitored NO and NOx Concentrations (ppb) from Dampier for Winds from Woodside

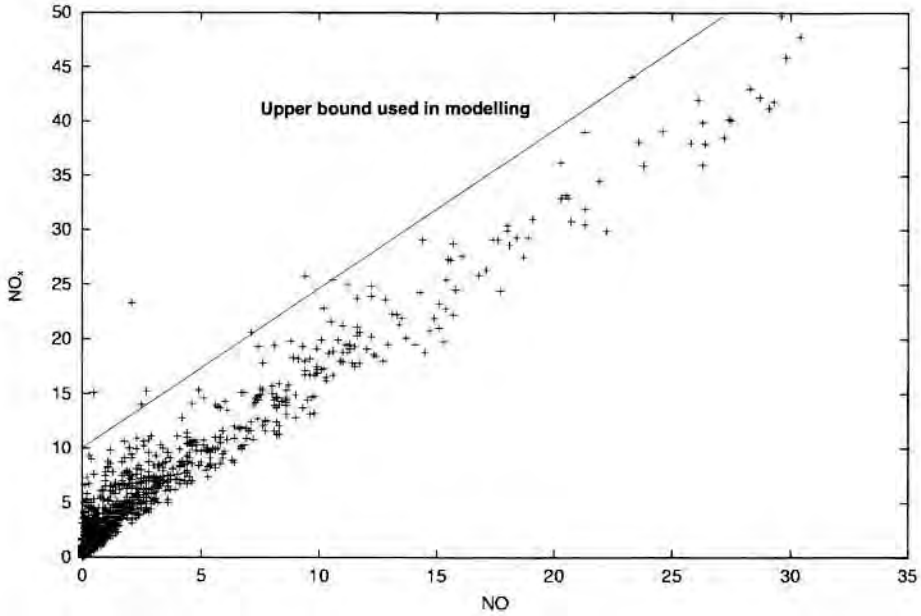


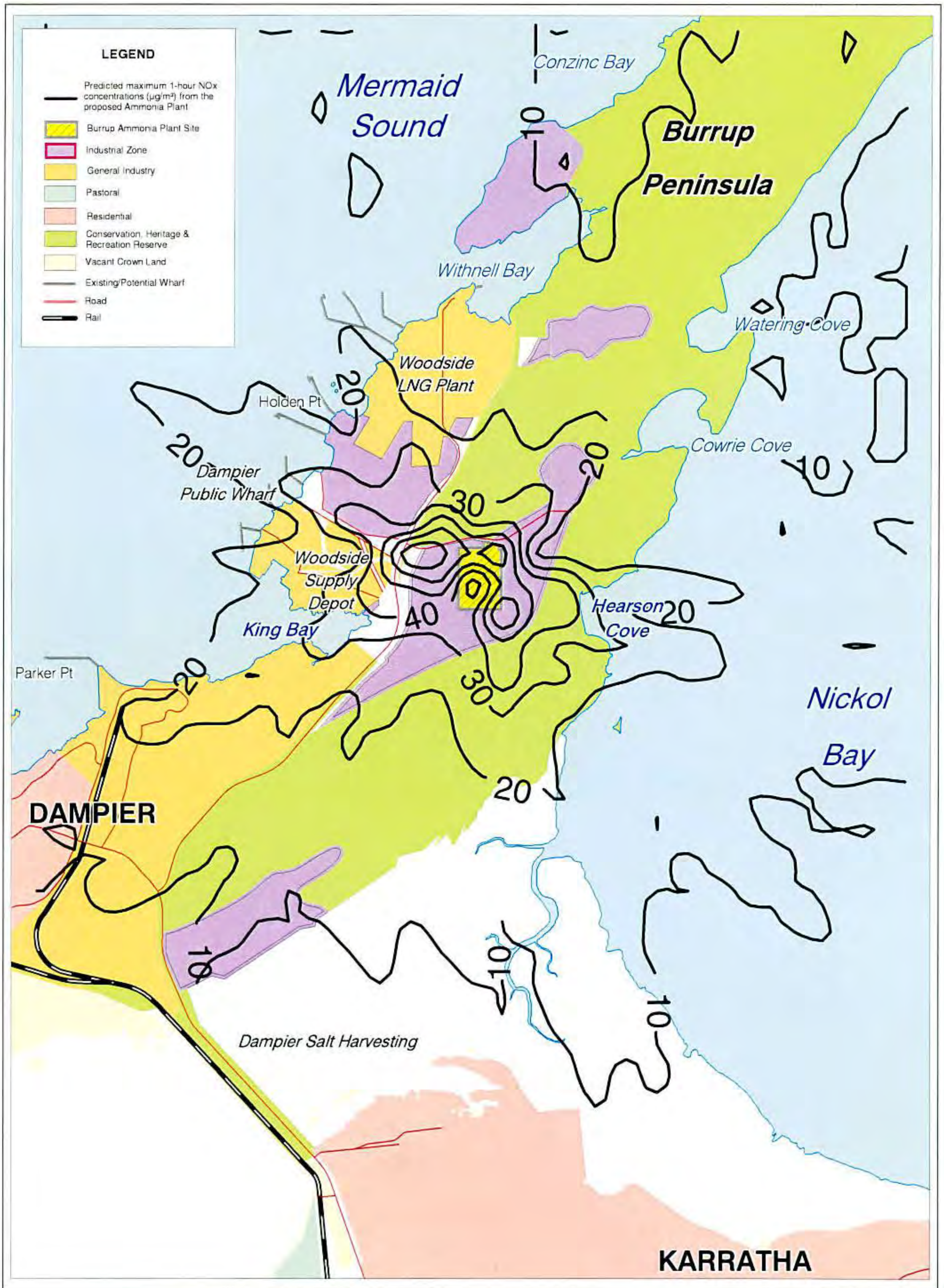
Figure 7-2 and **Table 7-9** presents the maximum 1-hour concentrations from the proposed Burrup Ammonia Plant in isolation under normal operation. This figure indicates that maximum NO_x concentrations close to the plant will be 70 $\mu g/m^3$ with concentrations of around 15 $\mu g/m^3$ in Dampier and 8 $\mu g/m^3$ in Karratha. Using the derived NO_X to NO_2 relationship, the maximum concentration anywhere on the grid will be 37 $\mu g/m^3$, which is 15% of the NEPM standard.

Table 7-9 Predicted Maximum Concentrations ($\mu g/m^3$) from the Burrup Ammonia Plant in Isolation

Operation	Frequency	Anywhere on Grid	King Bay	Hearson Cove	Dampier	Karratha
NO_2 (1 hour objective of 246 $\mu g/m^3$)						
Normal Operation	350 days per year	37 (78)	25 (23)	25 (20)	19	17
Maintenance/Startup	10 days per year	81 (163)	25 (41)	23 (38)	17	16
Plant Down Diesel Generator	12 hours per year	96 (196)	41 (44)	46 (41)	26	20
Storage Tank Flaring	1-in-100 years	87 (286)	44 (59)	43 (59)	28	22
SO_2 (1-hour objective of 570 $\mu g/m^3$)						
Plant Down Diesel Generator	12 hours per year	31 (71)	12 (12)	11 (11)	5	2
PM10 (24-hour objective of 50 $\mu g/m^3$)						
Normal Operation	350 days per year	(1.5)	(0.1)	(0.15)	Negl	Negl
Maintenance/Startup	10 days per year	(2.9)	(0.25)	(0.25)	negl	Negl
Ammonia (3-minute objective of 600 $\mu g/m^3$)						
Storage Tank Flaring	1-in-100 years	400 (1500)	165 (250)	165 (250)	75	41

Notes:

1) Values without brackets predicted by DISPMOD, within brackets predicted by Ausplume
2) Ausplume was used to investigate local impacts on hills and due to building downwash.
3) Maximum 1-hour NO_X concentrations occurred within 500 m by DISPMOD and within 1100 m to the NE with Ausplume. Maximum 24-hour PM10 concentrations occur on site boundary within 100 m of stacks.



SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

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BURRUP AMMONIA PLANT

PREDICTED MAXIMUM 1-HOUR NOX CONCENTRATIONS (µg/m³) FROM THE PROPOSED AMMONIA PLANT IN ISOLATION

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 7.2

Client: Burrup Fertilisers Pty Ltd
Project No. De01890
Date Drawn: 21 July 2001
File Name: odour_fig72.wor

Cumulative impacts from all existing and proposed sources are presented in **Figure 7-3**. The blue contours on **Figure 7-3** indicate that the existing maximum 1-hour concentrations of NO_X occur close to the Woodside facilities with a maximum of 406 $\mu g/m^3$. At the locations of Dampier and Karratha the maximum 1-hour concentrations are 80 and 75 $\mu g/m^3$ of NO_X respectively. With the addition of the proposed Burrup Fertiliser plant, the black contours on **Figure 7-3** indicate that there will be no change to the maximum concentrations, with only a small increase of several micrograms at most locations. Using the measured relationship described previously, the maximum 1-hour NO_2 concentrations would be 136 $\mu g/m^3$ near Woodside, whilst at Dampier and Karratha the NO_2 concentrations would be below 40 $\mu g/m^3$. This indicates that cumulative NO_2 levels would be well below the NEPM standard and the addition of the proposed Burrup Ammonia plant would have negligible impacts.

Aside from normal operations, NO_X will be emitted from the plant as follows:

- During startup, with emissions from the package boilers and start up heater;
- During the 10 day maintenance period from the package boilers when no steam is generated from the ammonia plant;
- During half day shutdown with emissions from the diesel generators when the ammonia plant and package boilers are down for maintenance; and
- In the event that ammonia is flared from the ammonia storage tank.

Maximum 1-hour ground level concentrations of NO_2 that could occur for the first three operations, assuming that these operations occurred at the worst case meteorological conditions are summarised in **Table 7-9**. These concentrations are well below the NEPM standard.

To assess the potential maximum impacts from flaring, DISPMOD and Ausplume were run with the flare stack parameters with the effective plume height calculated from the USEPA screening model SCREEN3. The predicted maximum 1-hour concentrations from flaring assuming that the flaring occurred at the worst case meteorological conditions are 87 and 286 $\mu g/m^3$ from DISPMOD and Ausplume respectively. For the more conservative of the models (Ausplume), the maximum concentrations occur 700 m to the north of the plant with only a small area to the north and south expected to potentially have an exceedance of the NEPM standard. This occurs under very stable light wind conditions (0.5 m/s and F class stability). At Hearson Cove or King Bay, the maximum concentrations would be 59 $\mu g/m^3$. Given the extreme unlikelihood that flaring will be necessary (less than 1-in-100 years) and assuming that flaring will only last for one day, the probability that the NEPM will be exceeded is predicted to be only once in 640 years.

Impact of Buildings and Terrain on Plume Dispersion – AUSPLUME
To assess the local impacts of the buildings on site and nearby terrain, AUSPLUME was used. Maximum concentrations using AUSPLUME, over a 200 m grid are summarised in **Table 7-9**. These show concentrations that are higher than from DISPMOD occurring on the small hills to the north of the plant. At the nearest sensitive receptor (Hearson Cove) the concentrations are the same as predicted by DISPMOD and are less than 20% of the NEPM.

7.2.1.8 Sulphur Dioxide

Potential Impacts
Sulphur dioxide emissions from normal operation will be negligible. This is due to the very low sulphur content in the natural gas. The only appreciable emissions of SO_2 will occur from operation of the diesel generators where a maximum emission of 0.7 g/s may occur.

On one day per year, during plant shutdown, there will be minor SO_2 emissions from the diesel generators. Assuming that these emissions occurred on the same day as the worst case dispersive conditions, modelling predicts maximum 1-hour concentrations of 71 $\mu g/m^3$ on the hills to the north of the plant. This is 12% of the NEPM standard. As such, impacts from the proposed plant in isolation are predicted to be negligible.

7.2.1.9 Dust and Particulate

Potential Impacts
During the construction of the plant there is the potential for dust impacts from the site works and vehicle movement on unpaved roads and wind erosion (refer to **Section 6.2.1**). During operation of the plant, however, there will be minimal dust emissions.

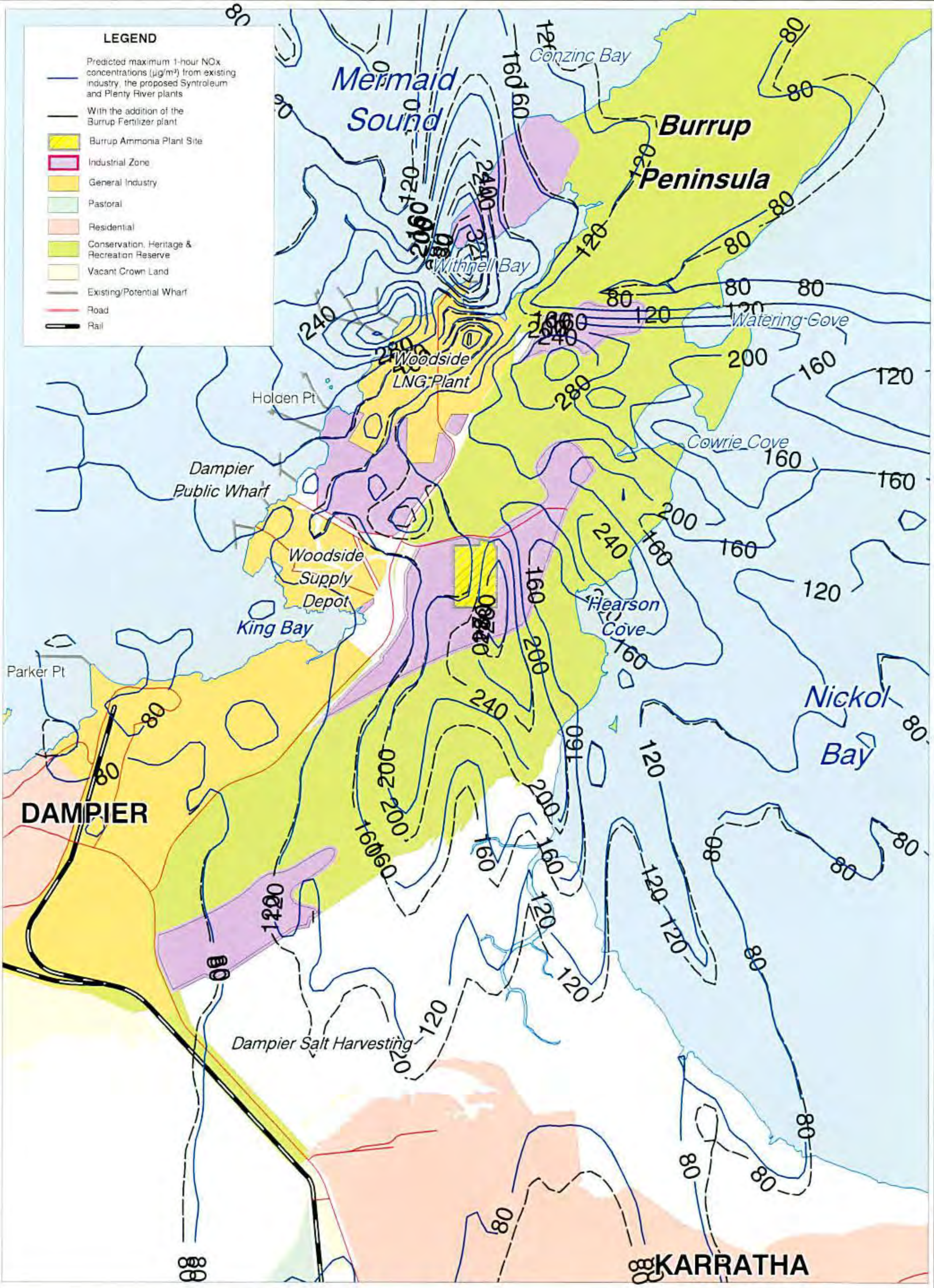
Stack emissions of particulate as detailed in **Section 7.2.1.1** are negligible, due to the firing of natural gas in a controlled burning environment. Modelling for the largest sources indicate that maximum impacts would be 2.9 $\mu g/m^3$ within the plant site, with concentrations at Hearson Cove or King Bay being 0.25 or 0.5% of the objective, respectively.

7.2.1.10 Ammonia

Potential Impacts
Ammonia will only be released in the event of failure of the refrigeration plant for the ammonia storage tanks. Under this circumstance (see **Section 7.2.1.2**) any gas released would be flared producing primarily combustion products such as water vapour, carbon dioxide and nitrogen oxides and some particulate, with a small amount of the gas being unburnt.

Ammonia is a colourless gas with a pungent, irritating odour. The Workplace exposure standard – short term exposure limit is 24,000 $\mu g/m^3$ for a 15-minute average. In lieu of any WA standard, the ambient standard adopted for this assessment is 600 $\mu g/m^3$ for a 3-minute average from the Victorian State Environmental Protection Policy (CASANZ, 2000). The odour threshold is 11,700 $\mu g/m^3$ (AIHA, 1989).

Assuming that flaring occurs at the worst case dispersive conditions, maximum 3-minute concentrations of 1500 $\mu g/m^3$ are predicted (see **Table 7-9**). This is 2.5 times the Victorian EPA guideline, but 13% of the odour guideline and around 6% of the occupational guideline. This maximum concentration is predicted to occur 700 m to the north of the plant with only a small area to the north and south expected to potentially have an exceedance of the Victorian EPA guideline. This maximum occurs under F class stability and 0.5 m/s winds. At Hearson Cove or King Bay, the maximum concentrations would be 250 $\mu g/m^3$ or 42% of the



SINCLAIR KNIGHT MERZ
Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT

PREDICTED MAXIMUM 1-HOUR NOX CONCENTRATIONS (µg/m³) FROM EXISTING INDUSTRY, THE PROPOSED SYNTROLEUM AND PLENTY RIVER PLANTS AND WITH THE ADDITION OF THE BURRUP AMMONIA PLANT

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 7.3

Client: Burrup Fertilisers Pty Ltd
Project No. De01890
Date Drawn: 21 July 2001
File Name: odour_fig72.wor

K:\DEVN\01800\De01890\maps\odour_fig7-3.wor guideline. Given the extreme unlikelihood that flaring will be necessary (less than 1-in-100 years) and assuming that flaring will last for only one day, the probability that the guideline would be exceeded is predicted to be once in 2800 years. Given that the predicted concentrations are below the odour threshold, are well below health limits for occupational workers and given that there is practically no probability that such an "exceedance" will occur, the potential impacts from flaring are considered negligible.

7.2.1.11 Photochemical Smog

Potential Impacts
Photochemical smog forms when pollutants such as nitrogen oxides and reactive organic compounds react together under the influence of sunlight and high temperature. The principal component of smog is ozone and consequently it is used to define smog levels. Ozone near the ground (as distinct from the "ozone layer" that occurs tens of kilometres up in the atmosphere) occurs typically in the range of 15 to 35 ppb and at such concentrations is a colourless gas. Ozone is a strong oxidant which reduces pulmonary function and can damage vegetation and susceptible materials at higher levels. To protect human health and welfare the NEPC has set a 1-hour standard of 100 ppb.

As detailed in **Section 7.2.1.5** present ozone levels in the Pilbara have been measured at a maximum at 0.064 ppb at the two monitoring sites. Using the dispersion model TAPM, CSIRO Division of Atmospheric Research (CSIRO, 2001) predicted that the maximum concentrations with existing plant and Woodside expansion, Plenty River and Syntroleum projects would be 70 ppb, or 70 % of the standard.

As stated in **Section 7.2.1.7** CSIRO undertook an independent study of the likely changes in ozone levels in the region with the proposed Burrup ammonia plant. The findings of that study, considering that there has been an actual reduction in the emissions proposed for the region, is that the maximum hourly-averaged concentrations of ozone will be very similar and therefore be well below NEPM standards" (CSIRO, 2001).

7.2.1.12 Greenhouse Gases

Potential Impacts
Greenhouse gases from the project have the potential to add to the greenhouse effect. The greenhouse effect occurs where certain gases in the atmosphere absorb outgoing infrared radiation from earth, therefore restricting the energy and heat loss from the earth's surface. This absorption by greenhouse gases is necessary for the maintenance of life as it maintains the average global temperature at around 15.5 °C.

With increased human activity in the last centuries there has been an increase in the levels of greenhouse gases and therefore the potential for changes in the energy balance in the atmosphere and to the climate.

Australia Governments Response
The following excerpt from EPA (1999b) summarises the Australian Federal and State Governments responses to the Greenhouse Gas issue.

"In response to the predicted impact of increasing levels of greenhouse gases, International and National targets limiting the increases in air emissions have been set. At the Kyoto Climate change conference in 1997, the developed countries agreed to a collective target of at least a 5% decrease in greenhouse gas emissions from the 1990 levels by the years 2008-2012. Australia has particular national circumstances whereby it has a high industrial growth rate. Within this agreement, Australia was to limit its increase to no more than 8% above 1990 levels by 2008 – 2012.

In the absence of any measures to reduce emissions of greenhouse gases, Australia's emissions in 2010 are expected to increase by 43% from the 1990 levels. It is also expected that companies producing greenhouse gases will accept the Greenhouse Challenge and implement 'no regrets' improvements in their emissions, which will reduce the increase to 28% from the 1990 levels. "No regrets" is a term used for measures that can be implemented by a company which are effectively cost neutral to the company. In other words, it provides the company with returns in savings which offset the initial capital expenditure that may be incurred.

In the Prime Minister's statement prior to the Kyoto meeting and with the approval of the Commonwealth Cabinet, he stated 'We are prepared to ask industry to do more than they may otherwise be prepared to do, that is, to go beyond 'no regrets', minimal cost approach where this is sensible in order to achieve effective and meaningful outcomes'. This can be achieved by taking action both on site and off site. The six greenhouse gases which are covered by the Kyoto Protocol are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

Australia as a whole is challenged to reduce greenhouse gas emissions by 24.5% from the predicted "Business as Usual" level in 2010 by implementing a combination of "no regrets" and "beyond no regrets" measures. This is equivalent to limiting greenhouse gas emissions in 2010 to 108% of Australia's 1990 levels".

Greenhouse Inventory

The major greenhouse gases emitted throughout the world are carbon dioxide and methane. Greenhouse gases of lesser importance are nitrous oxides, halocarbons and other gases. In this assessment, halocarbons and nitrous oxide emissions have not been estimated as there will be no usage or only negligible emissions of these gases respectively.

Emissions of greenhouse gases for the project have been estimated for the following sources:

- Clearing of vegetation during construction (loss of greenhouse sink);
- Combustion products from stationary sources (diesel generators, boilers and heaters);
- Venting of CO_2 from the CO_2 stripper; and
- Methane emissions from the anaerobic degradation of sewage in the wastewater treatment plant and sewage sludge disposal.

Other sources, such as the use of light vehicles on site (i.e. fork-lifts) or the transport of product to and from the Dampier Port are neglected as insignificant. Emissions to landfill from the decomposition of solid waste have also not been included, as this will be relatively small. Estimates of the greenhouse gas emissions where possible have been estimated using the methodologies developed by the National Greenhouse Gas Inventory Committee and are presented in **Table 7-10.**

Table 7-10 Estimated Annual Greenhouse Gas Emissions (Equivalent CO_2) from the Project

Source	$CO_{2\ E}$ (tpa)
Clearing of vegetation during construction	Negl
Waste Water Treatment Plant	9
CO_2 Stripper	1,053,000
Primary Reformer Stack	342,000
Diesel generator	83
Package Boilers and Start Up Heater	49,000
Total	1,444,000

Notes:

1) The above total includes emissions for the generation of 4 MW and 10 tph of steam of power for Water Corporation's thermal desalination plant. This is approximately equivalent to 33,000 of CO_2 emissions.
2) Vegetation clearing based on 28 ha cleared of spinifex rangeland including access roads and gradual decomposition of vegetation
3) Emissions from the CO_2 stripper and Primary reformer based on a plant availability of 350 days per year full time with 10 days of part operation of 20 hours.

Comparison Of Greenhouse Emissions with other Ammonia Plants

For the purpose of evaluating the greenhouse gas impact from a proposal, the DEP require the estimation of "no regrets" and "beyond no regrets" measures both considered and adopted for the Project. The greenhouse gas reductions from the adoption of these measures are then to be expressed as savings from the 1990 base case.

1990 Base Case

Energy Consumption

A summary of the energy consumption for the different ammonia production processes as at 2000 is presented in **Table 7-11**. This indicates that for the processes using gas, energy requirements are in the range of 28.4 to 32.0 GJ/ t NH_3. For the use of heavy fuel oil as a feedstock with a partial oxidation process the energy use is 1.3 times higher, whilst using coal as a feedstock with a gasification process requires an energy input around 1.7 times higher. Given that the carbon dioxide emissions for fuel oil and coal combustion per heat released are higher than from gas, indicates that the greenhouse emissions will be substantially higher. As such, in terms of greenhouse emissions for the ammonia manufacturing process, the use of natural gas and steam reforming process should be considered BAT.

Table 7-11 Comparison of Different Feed Stock Requirements for Different Gaseous Ammonia Processes

Fuel	Process	Feed Stock Requirements (GJ / t NH_3)	Fuel Requirements (GJ / t NH_3)	Total (GJ / t NH_3)
Gas	Conventional Steam Reforming	22.1	7.2 – 9.0	29.3 – 31.1
Gas	Excess Air Steam Reforming	23.4	5.4 – 7.2	28.8 – 30.6
Gas	Auto-thermal Steam reforming	24.8	3.6 – 7.2	28.4 – 32.0
Heavy Fuel Oil	Partial Oxidation	28.8	5.4 – 9.0	32.2 – 37.8
Coal	Partial Oxidation or Gasification			44.3 – 48.5
Gas	**Burrup Fertilisers (actual) (Corrected to standard conditions)**	-	-	**29.7** **28.8**

Notes:
1) Source – EFMA (2000), (Appl, 1997)
2) Energy requirements in GJ given at the lower heating value
3) Standard conditions are with a water inlet of 20 deg C and liquid ammonia product at 0 °C. The corrections applied are –0.7 GJ/ t NH_3 for every 10 degree increase over 20 °C and –0.3 for ammonia product at –33 °C (Appl, 1997).

For the gas process **Figure 7-4** presents what is considered BAT for energy consumption from steam reforming from 1960 to 2000 (KBR, 2001) and for 1995 and 2000 (EFMA, 1995 and 2000). The predicted energy consumption of the proposed Burrup Fertiliser plant is also plotted on this graph, along with reported values from other ammonia plants including:

- The original CSBP ammonia plant based in Kwinana, Western Australia (Dames & Moore, 1997);
- The new CSBP ammonia plant (Dames & Moore, 1997); and
- The proposed Plenty River ammonia urea plant (Woodward-Clyde, 1998).

Figure 7-4 Energy Consumption for Various Ammonia Plants

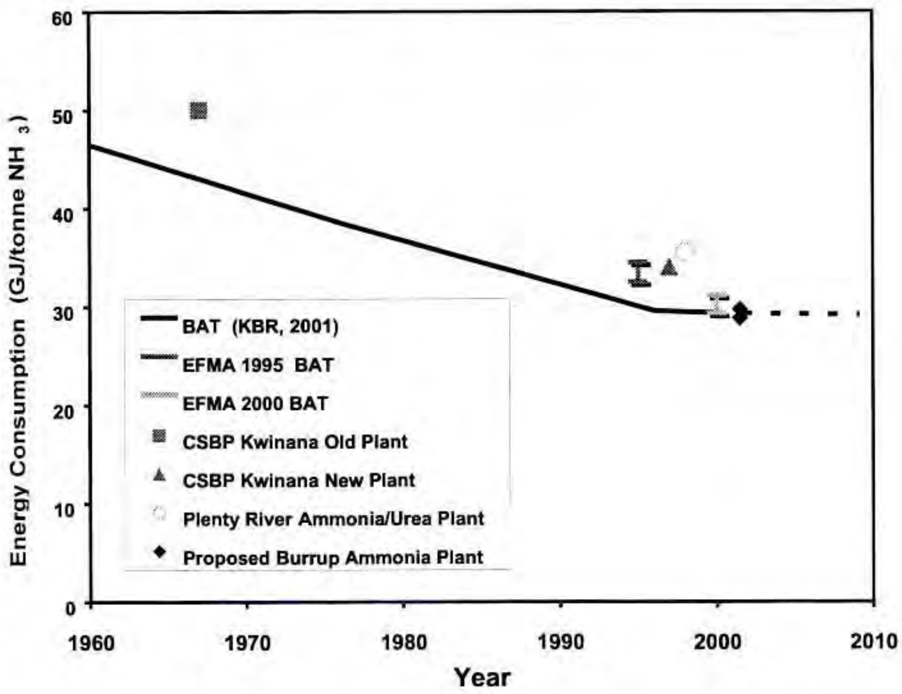


Figure 7-4 indicates that there has been a large decrease in the energy consumption from 1960 to the mid nineties. This decrease has been due primarily to the following (Appl, 1997):

- Use of waste heat to generate steam to drive steam turbine drives for the compressors etc;
- Replacement of the heat intensive carbon dioxide removal system using MEA with aMDEA or the Benfield process;
- Use of hydraulic turbines to recover energy when gas is depressurised;
- Improvement in boiler design to increase the energy efficiency. This use of waste heat wherever possible has resulted in ammonia plants changing from a net importer of steam/electricity to an exporter;
- Improvement in compressor efficiencies; and
- Increase in plant size and resultant increase in efficiencies of the plant.

From the mid nineties onward (Appl, 1997 and KBR, 2001a) it is anticipated that there will only be small increases in efficiencies in the near future with the energy consumption expected to fall to around 27 GJ/ t NH_3.

For a "business as usual" base case as at 1990 for the steam reforming process **Figure 7-4** indicates that a BAT energy consumption would be around 33 GJ/ t NH_3.

<u>Greenhouse Intensity</u>
Data on greenhouse intensity of older plants is not as readily available as that on energy intensity. For current plant, Appl (1997) and EFMA (2000) state that steam reforming plant based on natural gas produce 1.15 to 1.30 t CO_2/ t NH_3 from the process gas and 0.5 to 0.35 t CO_2/ t NH_3 from the flue gas depending on the degree of air reforming in the secondary reformer. Therefore, an overall emission of 1.65 to 1.8 t CO_2/ t NH_3 (average 1.73) is achievable. For plant as at 1990, based on the energy reduction figures from 33 to 29.3 GJ/ t NH_3, a greenhouse intensity of 1.95 t CO_2/ t NH_3 has been assumed for the "business as usual" base case.

Comparison to BAT and other Ammonia Projects
Comparison of the proposed ammonia project with other projects and the European Fertiliser Manufacturer's Association Best Available Technology guide is presented in **Figure 7-4** and **Table 7-12**.

It is noted that any comparison has a degree of uncertainty due to the reference conditions the figures are quoted to. In terms of energy consumption, Appl (1997) implies that the base case is for the use of cooling water at 20 deg °C and ammonia product produced at 0 °C. Other considerations that may be included, include the feed gas composition. For the above factors Appl (1997) quotes the following corrections:

- An increase of 0.7 GJ/ t NH_3 for every 10 °C rise in the cooling water from 20 °C;
- An increase of 0.3 GJ/ t NH_3 for producing NH_3 at –33 °C instead of 0 °C;
- A decrease of 0.1 GJ/ t NH_3 for gas with a Nitrogen content of 10%; and

- An increase of 0.2 GJ/ t NH_3 for natural gas with CO_2 content of 10%.

Table 7-12 Unit Energy Consumption and Greenhouse Intensities of Various Ammonia Projects

Project	Date	NH_3 Prodn (tpa)	CO_2 Emission (tpa)	Unit Energy Consumption (GJ/t NH_3)	Greenhouse Intensity (t CO_2 / t NH3)			
					CO_2 Stripping	Combust. Gases	Export	Overall
CSBP Old Plant	1967	70,000	-	50	-	-		2.9
CSBP Kwinana Expansion	1997	225,000	400,000	33 – 35	1.27	0.51	0.0	1.8
Plenty River	1998	620,000 (3)	1,367,500	35.5	1.27	0.93 (3)	0.0	2.2 (3,4)
Burrup Ammonia	2001	770,000	1,411,000(6)	29.7 (28.8) (5)	1.35	0.50	0.04	1.81 (1.76) (5)
BAT KBR	2000			29.3				1.65 - 1.8
BAT EFMA - CR - EAR	2000	-	-	 29.3 – 31.1 28.8 – 30.4	1.15 - 1.3	0.5	0.0	1.65 - 1.8

Notes:
1) Sources - Kwinana Ammonia Project (Dames and Moore, 1997), Plenty River Ammonia/Urea Plant (Woodward Clyde, 1998), EFMA (2000).
2) CR – Conventional Reforming, EAR Excess Air Reforming
3) Annual production of NH_3 for Plenty River based on 345 days production at 1,800 tpd.
4) The combustion gas emissions for the Plenty River plant will include some proportion used for powering the urea plant.
5) A correction factor of –2.9% has been applied for the cooling water inlet temperature and product temperature
6) Emission from the ammonia plant excluding 33,000 tpa emitted for providing electricity and steam to Water Corporation

As such, for the proposed ammonia plant with cooling water at an average of 28 °C and product produced at –33 °C the quoted energy consumption if referenced to the "base case" is actually 0.86 GJ/ T NH_3 lower; a correction factor of 2.9%.

Comparison of the energy consumption on a corrected basis to the listed BAT in **Table 7-12** indicates that, per unit of energy production, the proposed plant (28.8 GJ/ t NH_3) would achieve energy consumption better than BAT. Comparison on an uncorrected basis to other projects in WA indicates that the plant is around 15% and 18% more efficient than the new CSBP plant and proposed Plenty River plant respectively, though it is acknowledged that Plenty River's energy usage will include power for the Urea plant.

Comparison of the greenhouse intensity indicates that the plant emissions (1.81 t CO_2/ t NH_3) are at the upper range of the recommended BAT intensities (1.65-1.81 t CO_2/ t NH_3). This higher intensity is most likely due to the difference in reference conditions as listed by Appl (1997) previously. If a similar correction factor of –2.9% is applied, the greenhouse intensity of the proposed KBR technology would be 1.76 t CO_2/ t NH_3 indicating a truer picture that BAT is achieved for this project.

"No Regrets" Greenhouse Gas Emissions Adopted

The specific "no regrets" measures that have been adopted include:

Adoption of the Excess Air Reforming Process

The project has adopted the new KBR Purifier Process™. This is a low energy process using more excess air in the reforming process than the conventional reforming process. This use of excess air lowers the temperature in the primary reformer exit temperatures and provides additional reaction heat in the secondary reformer.

Recovery of Waste Heat

In the KBR Purifier Process waste heat is recovered wherever possible. This results in a high degree of waste heat recovery from the process as seen in the relatively low exit temperatures from stacks under normal operation in the plant.

No Fugitive Emission Plant

All potential fugitive fuel gases that are given off, such as methane and hydrogen in the carbon dioxide removal process, are recovered and sent to the fuel gas system. This results in no gases being flared under normal operating conditions unlike other ammonia processes.

Hydraulic Turbines to Recover Energy

Wherever possible, power is recovered from letting down high pressure gases to lower pressure by hydraulic turbine, reducing the power requirements of the system.

Export of Power and Waste heat to Water Corporation's Thermal Desalination Plant

Under normal operating conditions, the extraction of waste heat from the plant will generate 4 MW of electricity and 10 tph of low pressure steam for use by Water Corporation in the thermal desalination plant. The provision of such power and steam will potentially save around 33,000 tpa of greenhouse gases compared to if these were generated by alternative means.

Use of North West Shelf Gas

The use of Apache Energy Gas, with its low CO_2 content (around 2.5%), will result in lower greenhouse emissions than using other natural gas with higher CO_2 contents. Natural gases with high CO_2 content of around 20% such as from some gas fields in the Timor Sea and Indonesia will result in 1.4% higher energy usage and therefore higher CO_2 emissions than from relatively CO_2 free gas.

Based on a "business as usual" 1990 base case of 1.95 t CO_2/ t NH_3, the proposed Burrup ammonia plant emissions at 1.81 t CO_2/ t NH_3 represents a decrease of 7%. Given that the business as usual estimate is given at a corrected state, actual emissions for a plant built on the Burrup delivering –33 °C NH_3 would have been around 2.0 t CO_2/ t NH_3. Therefore, the adoption of "No Regrets" measures for this project associated with advances in technology are around 10%.

"Beyond No Regrets" Options Evaluated

Beyond no regrets options evaluated for this project have included:

- Potential use of the CO_2 by downstream industries;
- Reinjection of the CO_2 into gas or oil fields; and
- Establishment of tree farms as a means to offset the CO_2 emissions.

Use of the CO_2 stream by Downstream Industries

The removal of CO_2 from the process as 99.8% (on a dry basis) pure CO_2 stream provides a potential source of CO_2 for downstream uses, or a source for disposal, such as deep well injection. The other gas streams containing CO_2 (the exhaust flue gases) typically contain around 10% of CO_2 which will requires a much greater volume of gas to be either treated or disposed.

In both the new CSBP ammonia plant in Kwinana (Dames & Moore, 1997) and the proposed Plenty River Ammonia/Urea plant, the ammonia produced from the CO_2 stripping process has been used to varying degrees in downstream processing. For the CSBP ammonia plant, 100,000 tpa or 25% of the CO_2 produced is used in an adjacent air separation plant (Air Liquide) (Dames and Moore, 1997; CSBP, 2001) and effectively displaces CO_2 that would have to be produced. In the Plenty River proposal, 547,500 tpa of the 790,000 tpa CO_2 produced from the stripping process will be used as input to the urea plant. That is, 69% of the CO_2 from this gas stream or 40% of CO_2 from the plant is used and bound up in urea. Therefore, for these plants "effective" greenhouse intensities of 1.33 and 1.2 t CO_2/ t NH_3 could be claimed.

***Management Commitment 7.2.1.2:** The Proponent will continue discussions with potential downstream processing facilities on the Burrup to take CO_2 off gas.*

For the Burrup ammonia plant, discussions have been initiated with potential downstream processing facilities. In the event that such plant (eg urea plants, methanol plants or gas works) are built on the Burrup Peninsula, the Proponent will seek to have the CO_2 utilised in their processes. In the event that 100% of this gas stream can be used, the effective greenhouse emissions from this project will drop to 0.46 t CO_2/ t NH_3.

Deep Well Re-injection

Woodside Petroleum contracted CSIRO to evaluate the range of offsets available to reduce greenhouse emissions (Woodside, 1998). This study evaluated sink enhancement through a range of forestry options and the disposal through re-injection into a suitable aquifer of reservoir. Their study found that reinjection of gas from the onshore facilities was technically feasible, although significantly beyond the "no regrets" benchmark. A summary of the costing and estimated benefit of the reinjection for the two suitable oil/gas fields in the region are presented in **Table 7-13**.

Table 7-13 Scenarios for CO_2 Disposal Methods

Option	Mtpa CO_2e gas reinjected	Mtpa CO_2e produced from reinjection process	Lifetime on injection (years)	Cost ($ million)	$/ t CO_2e offset
Sulfinol vent gas to Tubridgi	0.6	0.08	6	270	86.5
Sulfinol vent gas to Wandoo	0.6	0.08	20	500	48
Flue gas to Wandoo	2.8	4.3	<1	>1400	No offset

Source: Woodside, 1998

Table 7-13 indicates that greenhouse gas offset costs will be in the range of $50 to $100 per tonne of CO_2 and that the lifetime would only be from six to 20 years.

Due to the very high costs, limited life time of injection for the fields and that the fields would not be available until after 2010 and 2013 respectively, this option was discounted.

In response to Woodside's assessment, the Australian Greenhouse Office recommended that the option of reinjection be pursued and requested that Western Australia look at a regional approach for reinjection of carbon dioxide, encompassing other proposed plants in the Pilbara region (EPA, 1999b).

With the proposed Burrup Ammonia project and Plenty River project there is now an additional 1.0 and 0.24 Mtpa of "pure" CO_2 that could be utilised. Notwithstanding the difficulties indicated in the Woodside report with regard to the cost and suitable well fields, the Proponent commits to participating in joint investigations into reinjection with other emitters of CO_2 in the Pilbara.

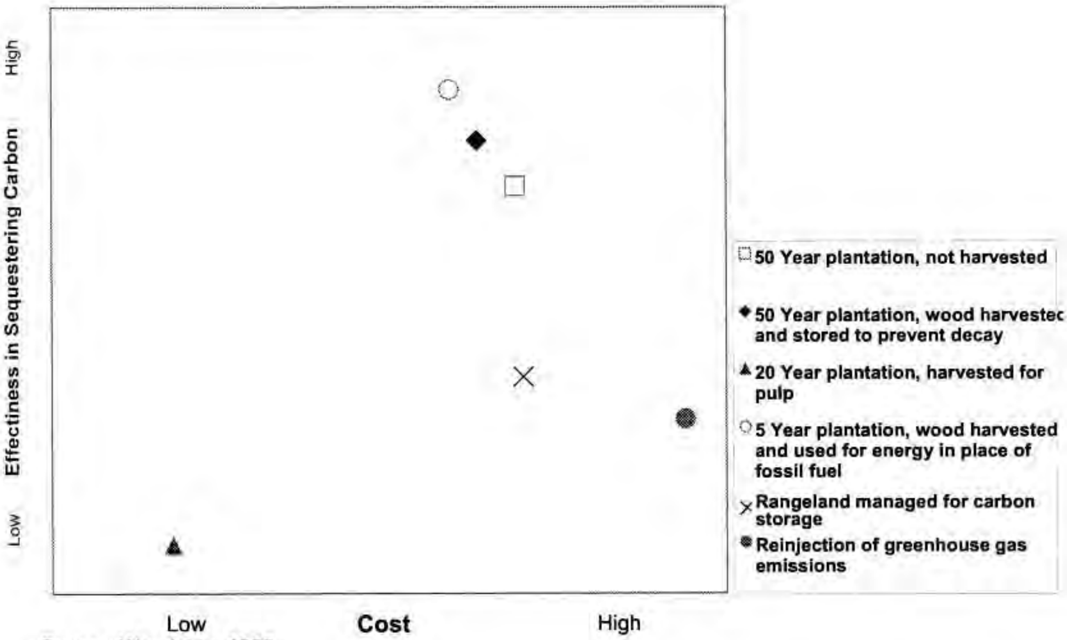
Management Commitment 7.2.1.3: *The Proponent is prepared to participate in joint investigations into re-injection of CO_2 gas into a suitable aquifer or reservoir.*

Establishment of Tree Farms

In the assessment conducted by Woodside (Woodside, 1998), a range of forestry options were evaluated. The cost effectiveness of these is presented in **Figure 7-5** and indicates that the option of five year plantation with the wood harvested and used for energy in place of fossil would be the most cost effective beyond "no regrets" option.

To this end, Woodside is considering participating in a tree planting scheme in the south west and establishment of a 5 MW biomass fired power station. Woodside (1998) concluded that a plantation of around 20,000 ha would have to be established to offset between 5-11% of the emissions from the present Woodside plant. An area of 250,000 to 500,000 ha would have to be planted for a 100% offset for the LNG expansion Project. Indicative costs per 1,000 ha of plantation for the establishment and maintenance are around \$2.5 million dollars.

Figure 7-5 Qualitative Cost Effectiveness Comparison of Sink Enhancement Options and Greenhouse Reinjection



Source: Woodside, 1998.

For the Burrup Ammonia project, based on annual emissions of 1.4 Mtpa CO_2 and assuming an average uptake of 20 tpa/ha, a tree farm of around 70,000 ha or an area the size of 70 by 100 km would be necessary. For a more realistic beyond "no regrets" reduction of around 5% for the project, plantings of 3,500 ha are required with estimated associated costs of $9 million.

Management Commitment 7.2.1.4: *The Proponent will undertake further investigations into the establishment of tree farms within Australia to sequester carbon dioxide from the atmosphere and/or to generate power to replace other non renewable fuels.*

Given that tree farms will provide a more cost effective beyond "no regrets" reduction in emissions, the Proponent commits to undertaking further investigations into the establishment of tree farms within Australia to sequester carbon dioxide from the atmosphere and/or to generate power to replace other non renewable fuels.

Commitment to Entering the Greenhouse Challenge

The Greenhouse Challenge is a co-operative agreement between industry and the Commonwealth Government. In it an industry undertakes an assessment of current emissions, develops action plans to reduce emissions, sets targets for future greenhouse gas reductions, and provides annual reports on their progress.

Management Commitment 7.2.1.5: *The Proponent will enter the Greenhouse Challenge upon project 'go ahead'.*

In line with the Proponent's goal to minimise energy usage and adopt best applicable technology (BAT), the Proponent commits to entering the Greenhouse Challenge upon project go ahead. This will ensure that the goal of minimising greenhouse gases is adopted within the detailed engineering design phase.

7.2.2 Noise

Management Objective – To ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the Environmental Protection (Noise) Regulations 1997 and to protect the amenity of visitors to Hearson Cove.

7.2.2.1 Noise Criteria – Operational Phase

The nearest residential receiver is identified as being in Dampier, approximately 6 kilometres to the south-southeast of the project site. The EPA has also identified Hearson's Cove as a location for which specific examination of the change in the quality and level of the ambient noise should be undertaken, recognising its use as a popular passive recreational area.

The criteria used to assist in determining the extent of any acoustical impacts from a project or development, is defined within the *Environmental Protection (Noise) Regulations 1997 (DEP, 1997)*. The regulations takes into account the zoning (and use) of the receiver location, and applies differing criteria for day, evening or night-time. **Table 7-14** presents the assigned noise levels in accordance with the EPA's regulations.

Table 7-14 EPA Assigned Noise Levels for all Premises

Type of premises receiving noise	Time of day	Assigned level (dB)		
		L_{A10}	L_{A1}	$L_{A,Max}$
Noise sensitive premises at locations within 15 metres of a building directly associated with a noise sensitive use	0700 to 1900 hours Monday to Saturday	45 dB(A) + influencing factor	55 dB(A) + influencing factor	65 dB(A) + influencing factor
	0900 to 1900 hours Sunday and public holidays	40 dB(A) + influencing factor	50 dB(A) + influencing factor	65 dB(A) + influencing factor
	1900 to 2200 hours all days	40 dB(A) + influencing factor	50 dB(A) + influencing factor	55 dB(A) + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 dB(A) + influencing factor	45 dB(A) + influencing factor	55 dB(A) + influencing factor
Noise sensitive premises at locations further than 15 metres from a building directly associated with a noise sensitive use	All hours	60 dB(A)	75 dB(A)	80 dB(A)
Commercial premises	All hours	60 dB(A)	75 dB(A)	80 dB(A)
Industrial and utility premises	All hours	65 dB(A)	80 dB(A)	90 dB(A)

$L_{A,Max}$ – The loudest noise level measured during the 15 minute sampling period

L_{A1} – The noise level exceeded for 1 % of the 15 minute period sampling period, equating to the loudest 9 seconds measured during the survey period;

L_{A10} - The noise level exceeded for 10% of the 15 minute sampling period or the loudest 90 seconds. This is frequently referred to as the average-maximum noise level;

L_{A90} - The noise level exceeded for 90 percent of the 15 minute sampling period. This is frequently referred to as the background noise level.

Part C, of Schedule 1 of the Regulations, defines *Noise Sensitive Premises* as being premises relating:

- Solely or mainly for residential accommodation purposes, including a caravan park or camping ground;
- A hospital (having accommodation for less than 150 in-patients) or sanatorium, home or institution for care of persons, a rehabilitation centre, home or institution for persons requiring medical or rehabilitative treatment;
- Educational building (school, college, university, technical institute, academy or other educational centre, lecture hall) or other premises used for the purpose of instruction;
- A place of public worship;
- A tavern, hotel, club premises, reception lodge or other premises which provides accommodation for the public;
- Aged care;
- Child care; and
- A prison or detention centre.

Specifically, however, for any other premises not referred above, it must be either:

- Industrial and utilities premises; or
- Commercial premises.

In terms of this assessment, the criteria for the more stringent "commercial premises" will be adopted for recreational users of Hearson Cove and Cowrie Cove. Also, the influencing factor will be conservatively taken as 0 dB (A). In summary, therefore, the noise emissions from the project site would be limited by the following criteria applicable under the *Environmental Protection (Noise) Regulations 1997 (DEP, 1997)*:

Table 7-15 Limiting Noise Criteria

Type of premises receiving noise	Time of day	Assigned level (dB)		
		L_{A10}	L_{A1}	$L_{A,Max}$
Nearest Residential dwelling(s)	Anytime – although criteria specifically applies to night-time operations	35 dB(A)	45 dB(A)	55 dB(A)
Hearson Cove	All hours	60 dB(A)	75 dB(A)	80 dB(A)
Industrial and utility premises	All hours	65 dB(A)	80 dB(A)	90 dB(A)

Based on the expected continuous operation of the facility, the limiting criterion would be compliance with the L_{A10} objective.

7.2.2.2 Noise Modelling Procedures

In order to quantify the noise emissions from the operation of the facility, a computer model was established using the Environmental Noise Model (ENM) software package. This computer program uses the following input parameters:

- Three-dimensional topography;

- The assigned octave band sound power level for the major plant items (based on the manufactures data, or data for similar plant obtained from the SKM acoustical database);
- The placement of the sources in 3-dimensional space;
- The absorption (or reflective) characteristics of the intervening ground type;
- Air absorption; and
- Dispersion, at the rate of 6dB per doubling of distance.

The following environmental parameters were used in the modelling, to ensure predictions are conducted in accordance with the "worst case" situation:

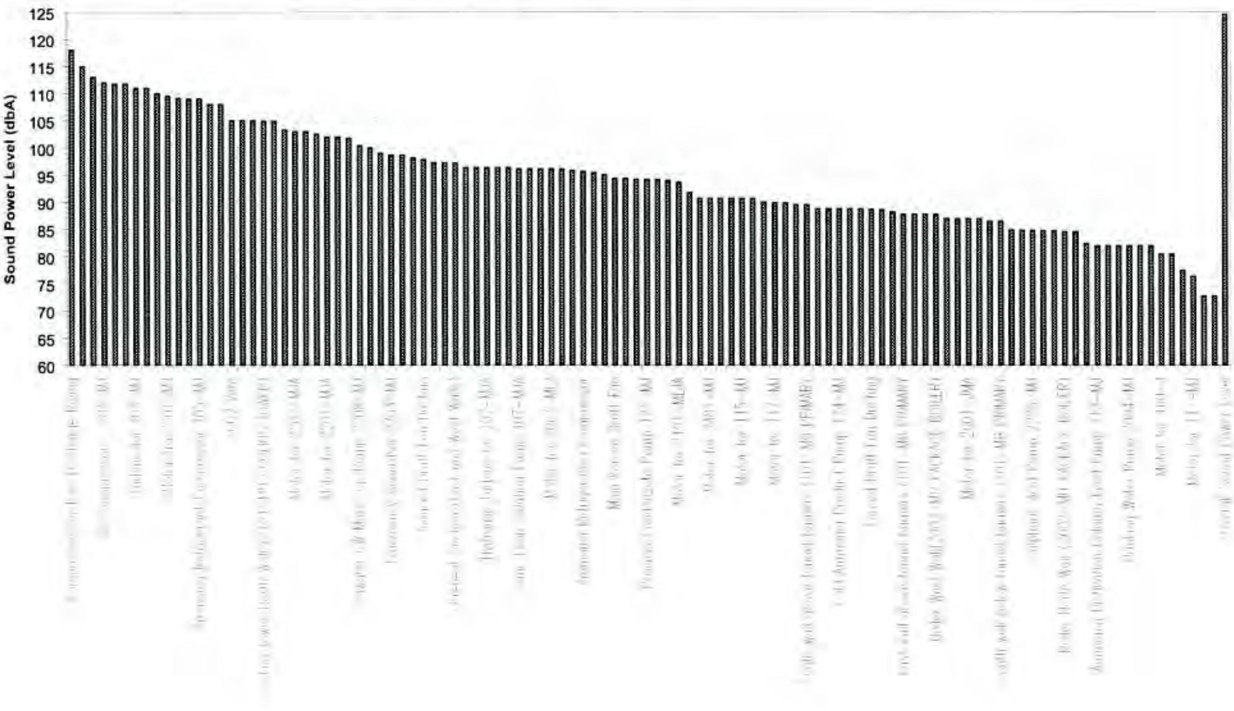
Table 7-16 Environmental Factors Used in Modelling

Time Period	Wind Speed	Temperature	Relative Humidity	Temperature Inversion
Day	4	20°C	50%	Nil
Night	3	15°C	50%	2°C/100 m

7.2.2.3 Predicted Noise Emissions

A graphical presentation of the plant items and the corresponding overall (A-Weighted) sound power levels for the facility is presented in **Figure 7-6**. It is recognised that these levels are preliminary and are subject to change as the design of the facility continues to be refined. They are however, sufficiently accurate to provide a good estimate of the noise emissions from the facility under normal operations.

Figure 7-6 Sound Power Level from Operational Facility



Using data from the Sinclair Knight Merz in-house acoustical database, octave band spectral shape were assigned to the noise sources detailed above, for input into the ENM noise prediction model.

Noise emissions from the facility were predicted in accordance with the procedures detailed in **Section 7.2.2.2**. Various scenarios were modelled for differing meteorological conditions, and the results are presented in the form of a noise contour (**Figure7-7**). The noise contour for the ammonia plant in isolation shows that noise levels around Hearson Cove beach would be in the order of 40 to 42 dB(A), and that noise levels in Dampier would be less than 20 dB(A). These noise contours are based on preliminary plant design, and do not reflect the noise attenuation strategies outlined in **Section 7.2.2.4**. The noise contours in **Figure 7-7** are provided to give an overall impression of the emissions from the project site, based on interpolation of predictions across a relatively coarse grid. When predicted noise levels at sensitive receptors are required, they should be based on "spot" or "single-point" calculations. Noise contours can show an apparent difference of 3 dB(A) (or more) when compared to single point calculations, based on the grid size used, and extent of interpolation.
Table 7-17 presents the predicted single point calculations noise levels in Dampier residential area and Hearson Cove recreational area, under various meteorological conditions.

Table 7-17 Summary of Single Point Predictions – Operational Phase

Meteorological Condition	Day/Night	Predicted Noise Level (dB(A)) Hearson Cove	Predicted Noise Level (dB(A)) Dampier
Non-enhancing	Day/Night	35 dB(A) to 37 dB(A)	<20 dB(A)
Wind – 4m/s source to receiver	Day	40 dB(A) to 42 dB(A)	<20 dB(A)
Wind 3m/s source to receiver plus 2°/100m temp inversion	Night	41 dB(A) to 42 dB(A)	<20 dB(A)
Assigned night time criteria	Night	60 dB(A)	35 dB(A)

Note: The range of noise levels at Hearson Cove represents the levels at the extremities along the beach frontage. These noise levels are conservative and are expected to be reduced by at least 8 to 10 dB(A) through noise attenuation strategies outlined in **Section 7.2.2.4.**

***Management Commitment 7.2.2.1:** During the detailed design phase of the project, the Proponent will situate plant components such that boundary noise levels do not exceed 65 dB(A).*

***Management Commitment 7.2.2.2:** The Proponent will adopt a number of noise attentuation measures to meet criteria for boundary noise levels and to reduce noise levels at Hearson Cove.*

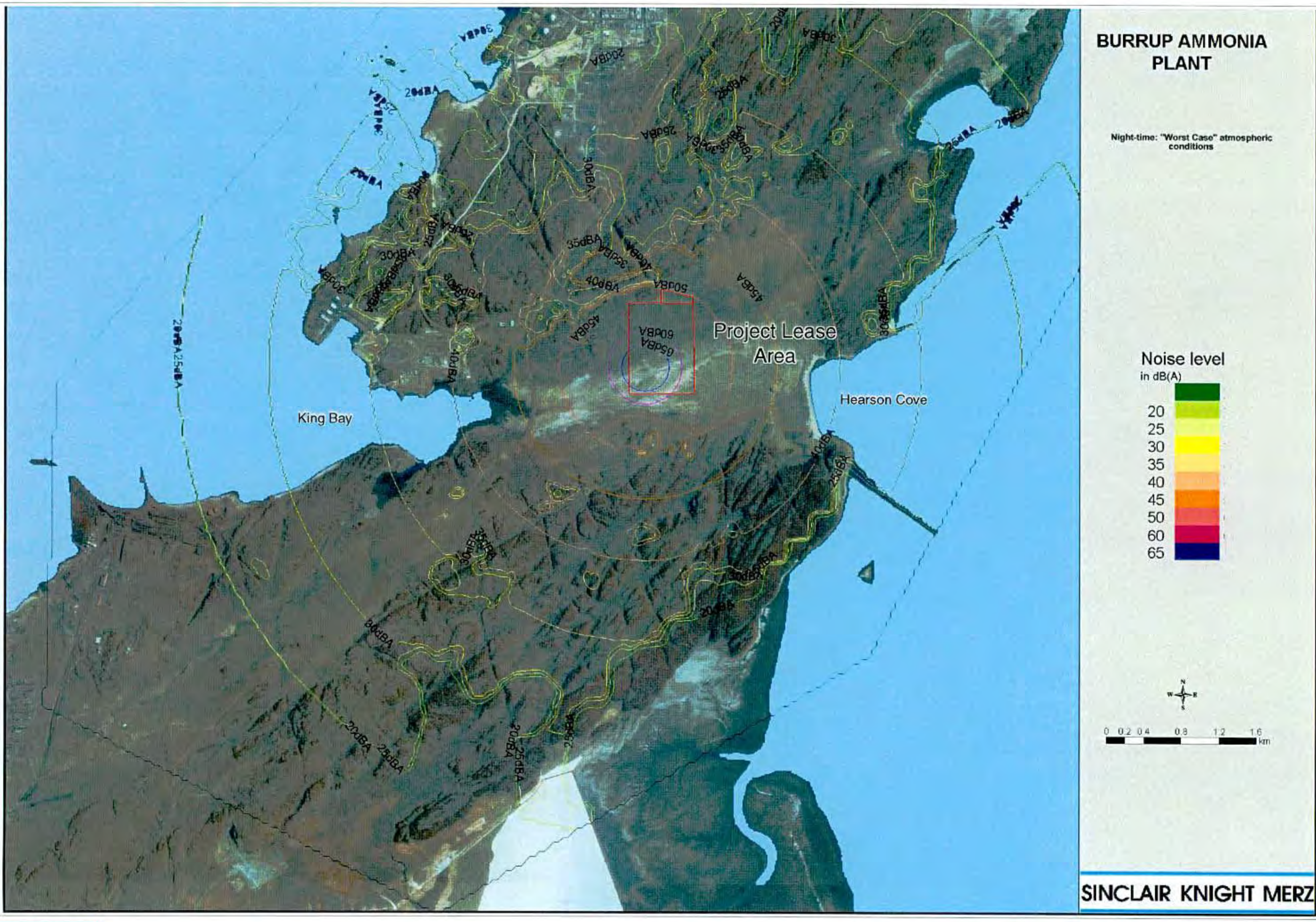
***Management Commitment 7.2.2.3:** During the detailed design phase of the project, the Proponent will ensure that no tonal or modulating characteristics are present.*

Based on the noise criteria defined in **Table 7-15**, the noise emissions from the facility would achieve the regulatory noise criteria at Dampier and Hearson Cove.

Notwithstanding the predicted level of compliance, these calculations are inherently conservative due to:

- No conversion adopted between the predicted emission and the L_{A10} index;
- No account of directivity from the various plant items within the facility, which would act to reduce the noise emissions, compared to the modelled values; and
- No account of noise attenuation provided by buildings or other structures within the development site.

In addition to the environmental noise criteria at residential and recreational receptors, the project will need to comply with a contributed noise limit of 65 dB(A) around the perimeter of the lease boundary. Based on the preliminary layout, and the assumed equipment sound power levels as per **Figure 7-6,** boundary noise levels up to 8 dB(A) above the 65 dB(A) criteria are predicted.



SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

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BURRUP AMMONIA PLANT

PREDICTED NOISE IMPACTS DURING OPERATION

Note: Noise contours show resultant noise levels at 'base case' without noise attenuation measures. Noise levels are based upon preliminary

FIGURE 7.7

Client: Burrup Fertilisers Pty Ltd
Job No: SW01198
Date Drawn: 21 July 2001
FileName: DE01890_01_Fig7_6.wor

However, careful optimisation of site and equipment layout during the detailed design phase and incorporation of additional noise attenuation measures during design and equipment selection will ensure that boundary noise criteria are achieved.

7.2.2.4 Noise Attenuation Strategies

The Proponent has considered a number of noise attenuation measures to achieve compliance at the lease boundary. Cost provisions for these measures have been incorporated into the Feasibility Study. Noise attenuation measures that will be considered in the detailed engineering design phase are as follows:

- Relocation of noise sources away from the boundary;
- Placement of buildings and sheds to afford acoustical shielding of noise sources;
- Building enclosures;
- Acoustic cladding on pipework; and
- Exhaust silencers on intake and discharge points.

These noise attenuation measures are expected to provide a noise reduction of at least 8 dB(A) which will ensure that boundary noise levels meet the regulatory criteria of 65 dB(A). Moreover, by reducing noise levels at the fenceline a noise reduction of a similar magnitude is expected at Hearson Cove.

During the detailed design phase of the works, other noise sources may be identified that also require treatment. The overall noise mitigation requirements would be revised in-line with final detailed sound power level data.

Some operational equipment may be tonal or impulsive. The characteristics of such equipment will be dependent upon, among other things, equipment selection, foundation design and piping design. Efforts to eliminate tonal or impulsive characteristics will be undertaken during the detailed design phase. Given that substantial noise attenuation measures will be adopted by the Proponent, it is unlikely that tonal and modulating characteristics will be audible at Hearson Cove.

7.2.2.5 Potential Impacts - Cumulative Noise at Hearson Cove

The EPA recognises Hearson Cove as an area used for passive recreational purposes. The existing background noise environment can, at times, be quite low, typically 25 dB(A) to 30 dB(A) based on the limited operator attended surveys that were conducted (refer to **Section 6.2.2**). These levels exclude the diurnal changes from tides, wind, surf and people noise that vary considerably during the day, and from day-to-day.

There are a number of other industrial facilities planned within the King Bay – Hearson Cove Industrial Area. As a result of the gradual change in landuse, the noise environment cannot be maintained at the existing levels, although "best effort practices" should be adopted by developers to ensure that the recreational amenity of Hearson Cove is not unduly compromised.

Table 7-18 presents a summary of the "worst-case" cumulative noise levels at Hearson Cove and Dampier, based on the noise predictions in **Section 7.2.2.4** and extracts from the environmental impact assessments of the two proposed nearby plants. The predicted noise levels from the proposed ammonia plant would be in the order of 5 dB(A) less than predicted noise levels from the approved syntroleum plant. On this basis the proposed ammonia plant would be an insignificant contributor at Hearson Cove.

Table 7-18 Cumulative Noise Levels

Project	Noise Levels at Dampier	Noise Levels at Hearson Cove
Ammonia Plant	<20 dB(A)	25 to 32 dB(A) [1]
Syntroleum Plant	31 dB(A)	37 dB(A)
Plenty River Plant	<20 dB(A)	33 dB(A) -nom
Future Cumulative Level	**31 dB(A)**	**39.3 dB(A)**

Note 1 – Assuming noise reduction at the lease boundary of at least 8 dB(A) through noise attenuation strategies outlined in **Section 7.2.2.4.**

The predicted (A-Weighted) spectra from the proposed ammonia plant has a maxima in the 500 Hz octave band, and does not contain a large amount of low-frequency energy, which can be perceived as more annoying to the general population. The spectral shape is typical for a large scale manufacturing process, and would not be expected to be noticeable or identifiable at the beach at Hearson Cove. Given that the Proponent will adopt substantial noise attenuation measures, it is unlikely that tonal or modulating characteristics will be audible at Hearson Cove.

7.2.2.6 Monitoring

Compliance noise monitoring will be undertaken, after the commissioning phase of the project. This monitoring will be undertaken by trained personnel, so as to distinguish between the noise levels from local environmental sources, and other industrial facilities operating in close proximity to the project site.

7.2.3 Waste Management

Management Objectives: Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on site or disposed of off-site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on site to prevent groundwater and surface water contamination or risk to public health.

7.2.3.1 Liquid Waste Management

Potential Impacts

The discharge of liquid waste to the environment has the potential to reduce the quality of surface, ground and marine waters. Potential changes in water quality could affect sensitive flora and fauna, such as mangroves and coral, which rely on the maintenance of existing conditions.

The sources, the estimated quantity and the general quality of liquid waste originating from the ammonia plant during operation are shown in **Table 7-19.** The characteristics of plant waste streams are preliminary estimates based on an ammonia plant similar to that proposed by Burrup Fertilisers, and will be confirmed during detailed engineering design.

The common user Burrup Peninsula seawater and brine disposal scheme is in the final stages of gaining environmental approval under application by the Water Corporation. This approval will be subject to several commitments that will have an impact on all users, including the Proponent.

The Proponent understands that the Water Corporation has made the following commitments with respect to the brine stream discharged into King Bay:

- The total dissolved solids concentration of the brine stream shall not exceed 53,000 mg/L.
- The temperature of the brine stream shall be within 2°C of the 24-hour average ambient seawater temperature.
- No industrial wastes shall be discharged into the brine stream without prior separate approval of the Department of Environmental Protection (DEP).
- No heavy metals shall be discharged into the brine stream.
- No biocides used in the process shall be discharged to sea.
- The use of process chemical additives that will be discharged in the brine stream is subject to approval by the DEP. The chronic toxicity of chemical additives to the process water will be tested on appropriate marine biota.

Table 7-19 Description of Process Liquid Waste Streams

Source	Flow m^3/hr	Temp. deg. C	Composition/ Contaminants	
Package Boiler Blowdown	2.0	100	Ca: 15.0 ppm Mg: 15.0 ppm Na: 160.0 ppm K: 12.5 ppm HCO_3: 2.5 ppm CO_3: trace Cl: 260.0 ppm	SO_4: 5.0 ppm PO_4: 15.0 ppm Fe: 2.5 ppm SiO_2: 2.5 ppm pH: 7-9 TDS: 500 ppm
Cooling Tower Blowdown	1,205	35[(1)]	Concentrated seawater. pH: 6-9	TDS: 53,000 mg/L
Neutralised Demineraliser Regenerant Wastewater	33.3 [(2)] (Intermittent) Approx. $400m^3$/every 12 hours. 57.0 (maximum)	38	Ca: 250 ppm Mg: 250 ppm Na: 5,000.0 ppm K: 250 ppm HCO_3: 5 ppm CO_3: trace Cl: 5,000 ppm	SO_4: 8,500 ppm PO_4: trace Fe: 5 ppm SiO_2: 5 ppm pH: 6-9 TDS: 15,000 ppm
Reformer Jacket Water Blowdown	4	100	CO_2: 300 ppm NH_3: 100 ppm Methanol: 100 ppm	Fe: trace pH: 6-9 TDS: 500 ppm

Source	Flow m^3/hr	Temp. deg. C	Composition/ Contaminants	
Air Compressor Intercoolers	4	41	CO_2: 100 ppm HCO_3: 100 ppm Fe: trace	pH: 6-9 TDS: 200 ppm
Process Condensate (See Note 3)	Normally 0.0 Max. 96.5	70	CO_2: 3,000 ppm NH_3: 1,000 ppm Methanol: 1,000 ppm	pH: 6-9 TDS: 100 ppm
Reformer Steam Drum Boiler Blowdown	2.5	100	Ca: 2.5 ppm Mg: 2.5 ppm Na: 30.0 ppm K: 2.5 ppm HCO_3: 0.5 ppm CO_3: trace Cl: 50.0 ppm	SO_4: 1.0 ppm PO_4: 10.0 ppm Fe: 0.5 ppm SiO_2: 0.5 ppm pH: 7 – 9 TDS: 100 ppm

1. 35°C represents the design condition. Actual temperature depends on seawater supply temperature and prevailing wet bulb temperature. Actual blowdown temperature is expected to range between 23°C and 34°C.
2. Flow is intermittent with approximately 400kL every 12 hours. The maximum flow is 57kL/hour.
3. The plant is designed to recycle 100% of process condensate and dumping of condensate would only occur if quality of condensate was unacceptable for recycling as boiler feedwater due to contamination or problems with the downstream treatment system. This is a very rare situation.

The Proponent will be bound by contract to the Water Corporation to uphold commitments made by the Water Corporation to the DEP. With respect to the proceeding six points, the Proponent advises:

- Brine return TDS will be controlled at 53,000 mg/L.
- Available data on seawater and wet bulb temperatures indicates the brine return temperature will naturally be within 2°C of the 24-hour average seawater temperature.
- The Proponent understands that the Water Corporation will seek separate approval from the DEP for the proposed discharges over and above their current approval.
- No heavy metals will be discharged over and above that occurring in the supplied seawater.
- The Proponent will treat the discharge brine stream to remove free chlorine, bromine and other biocides. The Vendor Wastewater Treatment Package responsible for this has not been selected at this stage of the project, but adequate cost allowances have been made.

Miscellaneous waste streams that will be generated at the ammonia plant include (**Table 7-20**).

Table 7-20 Miscellaneous Waste Streams

Source	Flow m^3/hr	Temp. deg. C	Composition/ Contaminants	Discharge
Domestic Wastewater [(1)]	Approx 40 m^3/day, Peak flow 15 m^3/h 1.7 kL/hr	38	BOD5 <20 ppm TSS < 30 ppm	Either to land or ocean in accordance with regulatory requirements.
Surface Runoff [(2)]	Variable	31	Treated as necessary to meet water quality criteria	Discharge off-site

1. Based on an operational (Karratha-based) workforce of 50 people.
2. Surface runoff from potentially contaminated areas will be collected separately to allow treatment to meet effluent discharge standards

All stormwater and sanitary wastewater released on or off site will satisfy the requirements of Water Corporation, Shire of Roebourne and DEP.

Management Strategies

The management of liquid waste on-site during the operating phase will comprise a number of individual systems with the overall objective to maintain the quality of surface, ground and marine waters.

Specific features that will be implemented as part of the design process will include:

- Separate fuel and oil storage system as outlined in **Section 7.2.4;**
- Stormwater from the site will be collected in two separate systems. Areas that have the potential to be contaminated by spillages, ruptures or overflows will be physically segregated by barriers from the reminder of the site. Stormwater from potentially contaminated areas will be collected by a contaminated stormwater system. Stormwater from the remaining plant area will be collected in a clean stormwater system.
- The clean stormwater drainage collection system will include open channels, pipes and sedimentation basin(s). Sedimentation basin(s) will be designed to collect stormwater from clean areas in the plant prior to its controlled discharge off-site.
- The contaminated stormwater collection system will include sealed and bunded collection areas and lined sedimentation basin(s). Lined sedimentation basin(s) will be designed to allow testing of water quality and to permit the controlled discharge off-site or allow for containment prior to further treatment before release off-site.
- The drainage system will be designed to transfer flows during a 1-in-50-year event and the sedimentation basin(s) will be designed to withstand a 1-in-100-year event.
- Process liquid wastes will be treated on-site in a Vendor Wastewater Treatment Package prior to being discharged into the Water Corporation's saline water outlet pipeline.

***Management Commitment 7.2.3.1:** Stormwater drainage system will be designed to separate potentially contaminated stormwater from clean stormwater.*

***Management Commitment 7.2.3.2:** All stormwater (from both systems) will be tested and confirmed as being of suitable quality before its release off-site.*

***Management Commitment 7.2.3.3:** Process liquid waste streams will be treated to meet Water Corporation and DEP acceptance criteria for discharge into the saline water outlet pipeline.*

Management Commitment 7.2.3.4: *Domestic wastewater during operations will be treated and effluent disposed in accordance with regulatory requirements.*

- Domestic wastewater will be treated to secondary standard (20mg/$L_{(BOD)}$ and 30mg/$L_{(SS)}$) prior to disposal either to land or ocean in accordance with the requirements of Water Corporation, Shire of Roebourne and DEP. Preferably, treated domestic wastewater will be transferred to the Water Corporation saline water outlet pipeline.

Monitoring

All treated wastewater discharged into the Water Corporation saline water outlet pipeline will be continuously monitored for flow rate and accumulated flow, temperature, conductivity, oxidation-reduction potential and turbidity. Other regular monitoring will include free chlorine, free bromine, metals, N, P and other parameters required by Water Corporation and DEP.

Stormwater will be monitored prior to discharge, with monitored parameters including TSS, pH, turbidity, total hydrocarbons and volumes.

Treated domestic wastewater will be monitored to confirm its suitability for disposal, with monitored parameters including TSS, pH, BOD, N, P and faecal contaminants.

In addition to the above management and monitoring strategies, the Water Corporation is also required to fulfill several commitments to manage the potential impacts from discharging brine wastewater to the marine environment. The commitments are summarised as follows (EPA, 2001):

- Preparation and implementation of a brine discharge quality plan to monitor and control emissions. This plan will include:
  - Continuous on-line monitoring of flow rate, temperature, conductivity, oxidation-reduction potential and turbidity;
  - Monitoring to control discharge levels of any process additives and other environmental contaminants;
  - The requirement for brine discharge temperature to be less than 2°C above the inlet seawater temperature for 80% of the time and not exceeding a maximum of 5°C above ambient temperature;
  - The requirement for the concentration of oxidising biocide in the brine discharge not to exceed 0.1mg/L; and
  - The requirement for the concentration of antiscalant in the brine discharge not to exceed 2mg/L.
- Development of a research program to determine the chronic toxicity of antiscalant on appropriate marine biota;
- Preparation and implementation of a monitoring program to monitor contaminants in the seawater, sediment and biota;
- Preparation and implementation of a water quality monitoring plan that includes the monitoring of caged "sentinel" organisms around the brine outfall; and
- Preparation and implementation of a coral management plan to ensure no adverse impacts on coral communities. The plan will include intensive monitoring of temperature at the outfall.

7.2.3.2 Solid Waste Management

Potential Impacts

The potential impacts from solid waste during the operating phase are similar to those during the construction phase as outlined in **Section 6.2.3.1**.

The sources, the estimated quantity and the general quality of solid waste originating from the ammonia plant during its operating life, are shown in **Table 7-21.**

Table 7-21 Solid Waste (Operating Phase)

Source	Quantity (m^3/period)	General Description	Disposal Route
Demineraliser Spent Cation/Anion Resin	27,000 / Every 3 years	Di-vinyl Benzene Polystyrene Resin	Disposed to offsite landfill
Primary Reformer Spent Catalyst	35 / Every 3 years	Nickel / Aluminium Oxides	Returned to catalyst vendor in sealed containers for metals recovery
Secondary Reformer Spent Catalyst	45 / Every 3 to 5 years	Nickel / Magnesium / Aluminium Oxides	Returned to catalyst vendor in sealed containers for metals recovery
High Temperature Shift Spent Catalyst	69 / Every 3 to 5 years	Iron / Copper Oxides	Returned to catalyst vendor in sealed containers for metals recovery
Low Temperature Shift Spent Catalyst	87 / Every 3 years	Copper / Aluminium / Zinc Oxides	Returned to catalyst vendor in sealed containers for metals recovery
Synthesis Converter Spent Catalyst	115 / Every 5 to 10 years	Promoted Iron Oxides	Returned to catalyst vendor in sealed containers for metals recovery
Methanator Spent Catalyst	39 / Every 3 years	Nickel / Alumina Oxides	Returned to catalyst vendor in sealed containers for metals recovery
Desulphuriser Spent Catalyst	33,200 / Every 3 years	Zinc Oxides	Disposed to offsite landfill
Desulphuriser Spent Catalyst	15,700 / Every 6 years	Cobalt / Molybdenum Oxides	Returned to catalyst vendor in sealed containers for metals recovery
Molecular Sieve Spent Dessicant	12.5 / Every 5 years	Sodium Alumino-silicates	Disposed to offsite landfill
MDEA Solution Spent Filter Media	2 / Every 3 years	Activated Carbon	Disposed to offsite landfill
Domestic & Commercial Waste		Municipal solid waste comprising recyclable, organic and residual materials	Disposed to offsite landfill
Biosolids		Stabilised biosolids from the domestic wastewater treatment plant.	Disposed to offsite landfill

Management Strategies

Solid waste management will be based around the hierarchy listed below:

- AVOID the use of certain materials (if possible) if they are difficult to manage;
- REDUCE the amount of waste produced;

- REPLACE the use of difficult to dispose of materials, with more environmentally acceptable ones;
- SEGREGATE waste for easier management;
- RECOVER/REUSE waste where feasible;
- RECYCLE waste by reprocessing where feasible; and
- DISPOSE of waste in an environmentally responsible manner.

Specific practices that will be employed during the operating phase of the project include:

Management Commitment 7.2.3.5: *Waste Management Plans will be developed around the waste management hierarchy.*

Management Commitment 7.2.3.6: *Spent catalyst will be returned to the manufacturer whenever possible.*

Management Commitment 7.2.3.7: *Solid waste disposed to landfill will comply with regulatory requirements.*

- Contractors will be required to prepare waste management plans that are based on the hierarchy above;
- Waste generated will be segregated into different categories as far as practicable;
- All recyclable materials that are feasible to recover will be segregated and periodically removed from site by a contractor;
- Spent catalyst will be recovered and returned to the manufacturer wherever possible;
- Domestic and commercial waste (food scraps, plastics, packaging materials, etc) will be periodically removed from site by a contractor and disposed to Dampier landfill;
- Catalysts and resins that are not returned to manufacturers (refer to **Table 7-21**) will be disposed to Karratha landfill in accordance with Shire of Roebourne and DEP requirements; and
- A licensed contractor will remove biosolids from the domestic wastewater treatment plant off site.

Monitoring

Management Commitment 7.2.3.8: *Waste plans will be audited.*

Waste plans prepared for each contract will be audited to confirm that work being undertaken complies with the established procedures.

Management Commitment 7.2.3.9: *Waste quantities will be documented and reported annually.*

Details of quantities of waste materials recycled, disposed to landfill and removed off site will be maintained for reporting purposes.

7.2.4 Hydrocarbon Management

Potential Impacts

The discharge of hydrocarbons to the environment has the potential to:

- Contaminate surface, ground and marine waters, the atmosphere and soil;
- Cause acute and/or chronic toxic hazards; and
- Cause flammable or explosive hazards.

The sources of hydrocarbon wastes (oils, grease, degreaser and fuels) include workshops, plant areas where rotating equipment and lube oil systems are located, liquid fuel storage and filling areas, waste oil storage and vehicle washdown facilities.

Management Strategies

Hydrocarbon management will be based around a framework that:

- Reduces the volume of hydrocarbon waste materials;
- Segregates hydrocarbons from stormwater to reduce the volume of waste materials;
- Ensures appropriate storage and handling procedures;
- Ensures appropriate clean-up procedures for spills; and
- Defines environmentally acceptable methods for the disposal of waste.

Specific features that will be implemented as part of the design process will include:

- The minimisation, segregation and containment of areas that can be contaminated with hydrocarbons by the use of appropriate bunding and drainage systems. This will include refuelling areas, storage areas, vehicle washdown areas and workshops.
- Storage of all liquid fuels and oils in accordance with the Australian Standard for The Storage and Handling of Flammable and Combustible Liquids (AS1940).
- The installation of oil interceptor traps / oil separators to remove hydrocarbons form areas that can be contaminated with hydrocarbons.
- The use of pipes and valves to prevent hydrocarbons from entering clean drainage waters.

Management Commitment 7.2.4.1: *Hydrocarbons will be minimised, contained and segregated from other areas.*

Management Commitment 7.2.4.2: *Hydrocarbons will be managed in accordance with Australian Standards.*

Management practices that will be implemented to minimise the generation of hydrocarbon waste and to manage it's clean up and disposal include:

- The use of absorbent materials to collect spillage;
- The use of spill capturing platforms for drum storage;
- The effective maintenance of all valves and piping systems installed to prevent the mixing of hydrocarbons with clean stormwater;
- The recycling of waste oil where possible;
- The storage of waste oil prior to its collection by an authorised waste contractor where it cannot be recycled; and
- The storage and subsequent collection for off-site disposal of oily rags, used absorbent and like materials.

These practices will be implemented during the construction phase of the project as well as during the operating life of the ammonia plant.

Monitoring

Regular inspections will be performed to ensure that hydrocarbon management systems are being used, are effective and are in compliance with regulations.

7.2.5 Hazardous Materials Management

Potential impacts associated with hazardous materials and proposed management strategies are variously addressed in **Sections 7.1 and 8.2**, and summarised below.

7.2.5.1 Potential Impacts

The operation of the ammonia plant will involve the transportation, storage and handling of hazardous materials which can have a serious impact on the environment and on human health.

Ammonia emissions from spills or leaks have the potential to impact aquatic ecosystems as it is toxic to fresh water and marine organisms.

MDEA solution is used in the plant to absorb carbon dioxide. Consumption is expected to be approximately 20t per year. MDEA is soluble in water, alkaline and toxic to aquatic organisms.

Small quantities of other hazardous materials including sulphuric acid and caustic for water treatment and liquid nitrogen have the potential to be toxic to aquatic organisms and to impact the quality of fresh and marine water.

7.2.5.2 Management Strategies

***Management Commitment** 7.2.5.1: The storage, handling and transportation of hazardous materials will comply with local and State Regulations.*

The storage, handling and transportation of hazardous materials will comply with all relevant local and State regulations, including:

- Mines Safety and Inspection Regulations 1995;
- Dangerous Goods Regulations 1992;
- Australian Standard for the Storage and Handling of Flammable and Combustible Liquids (AS 1940-1993);
- Environmental Protection (Liquid Waste) Regulations 1996; and
- Environmental Protection (Controlled Waste) Regulations 2001.

***Management Commitment** 7.2.5.2: A Hazardous Material Management Plan will be implemented.*

A Hazardous Material Management Plan will be implemented as part of the Environmental Management Plan and Safety Management Plan. Management strategies to be implemented in the Plan will include the following elements:

- A formal policy statement on hazardous materials;
- Designated responsibility for all elements of the Plan;
- Training of employees in handling and storage requirements;
- Training of employees in management of spills and leaks;
- Dissemination of information to employees;
- Establishment of purchasing and inventory controls; and
- Environmental monitoring and auditing.

***Management Commitment** 7.2.5.3: Ammonia will be stored in refrigerated and double walled double integrity tanks.*

Ammonia will be stored in refrigerated and double walled double integrity tanks on site. In the event of failure of the inner tank wall the ammonia will be contained within the outer tank wall. The tanks will be designed and equipped with appropriate pressure relief devices and a flare in the event of refrigeration failure. Instrumentation will be provided to detect failure of the inner tank wall.

A small amount of MDEA solution will be stored on site within a makeup storage tank. The MDEA solution in circulation will be contained within a closed pipeline loop. A separate MDEA solution sump is designed to drain MDEA solution from this pipeline loop should it fail.

Management Commitment 7.2.5.4*: MDEA solution will be contained within a closed pipeline loop that can be drained to a sump.*

All hazardous materials will be stored in compliance with their Material Safety Data Sheets and in accordance with local and State regulations (**Commitment 7.2.5.1**). Typically these storage areas will be fully bunded and sealed to contain any spills.

Bulk fuel will be stored in above ground tanks located in impermeable, bunded enclosures in accordance with local and State regulations.

7.2.5.3 Monitoring

Purchasing and inventory records will be maintained for all hazardous materials on site.

Monitoring will be conducted in accordance with the Department of Minerals and Energy Dangerous Goods licence.

7.2.6 Saline Water

7.2.6.1 Potential Impacts

Saline water will be required for cooling purposes and for desalination into plant water. Approximately 3,500kL/hr of seawater will be brought onto the site via a pipeline owned and operated by the Water Corporation.

The seawater cooling circuit consists of plate heat exchangers with various parts of the process plant including liquids containing MDEA and ammonia. A low risk of contamination of cooling water exists if leakage occurs on both sides of the heat exchanger.

Approximately 1,000kL/hr of saline water consisting of cooling water discharge and desalination plant reject stream will be discharged from the site via a return pipeline owned and operated by the Water Corporation.

Pipeline leakage or failure would result in saline water being discharged to the ground surface. This would have the potential to adversely affect vegetation over areas flooded by the saline water.

7.2.6.2 Management Strategies

Management strategies employed to minimise the risk of saline water contamination include:

Management Commitment 7.2.6.1*: Seawater cooling circuits will be continuously monitored for pressure, flow and temperature.*

- The seawater cooling circuit is operated at pressures above those of the contaminated material being cooled. In the event of leakage seawater will flow toward the contaminated stream rather than the contaminated stream entering the cooling water. Leakages will be automatically recognised by instrumentation.

- The seawater cooling circuit is continuously monitored by instruments to ensure pressure, temperature, flow rates and other variables are maintained at operating levels. Leakages will be automatically recognised by instrumentation.
- The circuits being cooled by the seawater are continuously monitored by instruments to ensure pressure, temperature, flow rates and other variables are maintained at operating levels.
- In the event of failure, instrumentation will automatically initiate management practices to contain the seawater and to allow remediation activities. These will depend on the nature, location and extent of contamination.

Management strategies employed to minimise the potential of adverse impacts of saline water discharge will include:

- Engineering and construction practices including the use of corrosion resistant materials and likely construction below ground.
- Following construction, the pipeline will be tested well above working pressures and will only be commissioned with saline water after it has been proven to be competent at these elevated pressures.
- A leak detection system will be designed into the pipeline that allows any leaks within the pipeline to be detected, located and isolated.

Further environmental issues associated with the saline water pipeline will be addressed by the Water Corporation in a separate environmental approval process.

7.2.6.3 Monitoring

All seawater cooling circuits and associated cooling circuits will be continuously monitored by Burrup Fertilisers for pressure, temperature and flow rate.

All seawater entering the site will be continuously monitored by Burrup Fertilisers for flow rate and accumulated flow.

All wastewater discharged into the Water Corporation saline water outlet pipeline will be continuously monitored by Burrup Fertilisers for flow rate and accumulated flow, temperature, conductivity, oxidation-reduction potential and turbidity. Other monitoring undertaken regularly will include free chlorine, free bromine, metals, N, P and other parameters required by Water Corporation and DEP.

8. Social Surroundings Impacts, Management and Monitoring

8.1 Community Issues

Preliminary consultations with numerous stakeholders based in Karratha and Perth raised a number of environmental and social issues relating to the proposed ammonia plant. These issues are summarised in **Table 1-3** in **Section 1.8**. Many of these issues have been addressed by the Proponent in preceding sections of this Public Environmental Review document. Strategies are also nominated to manage these issues. The awareness of environmental issues by stakeholders and community groups related to downstream processing industries is extensive as a result of experience and knowledge gained from the development and operation of the Woodside LNG plant and previous industry proposals issued to the public (Syntroleum gas to synthetic hydrocarbon (GTS) plant and the Plenty River ammonia/urea plant).

In additional to specific environmental and social issues, many technical and planning issues were raised by stakeholders regarding the following:

- The logistics of accommodating a series of piplelines and infrastructure for raw materials and waste products and the co-ordination of these pipelines within service corridors; and
- The need to co-ordinate the ammonia proposal with other proposed projects such as the Syntroleum GTS plant, the Plenty River ammonia/urea plant and the expansion of the Woodside LNG Plant to 4 trains to minimise their combined impacts on Karratha and Dampier.

Government authorities are currently investigating such regional co-ordination planning issues as the Peninsula continues to attract further potential downstream processing industries. As a commitment to participate wherever possible, the Proponent will assist the Department of Resources Development, local government and other industries to co-ordinate infrastructure and services on the Burrup Peninsula.

Management Commitment 8.1.1: *The Proponent will assist the Department of Resources Development, local government and other industries to co-ordinate infrastructure and services on the Burrup Peninsula.*

The following sections address the critical social factors including management strategies to ensure that:

- Public safety is maintained in terms of risk and traffic management;
- Accommodation requirements for this project are available and do not constrain the existing services in Karratha and Dampier;
- Potential impacts to visual amenity are minimised;
- Potential impacts on sites of cultural significance to Aboriginal and European heritage are minimised and appropriate management of significant sites is undertaken; and
- Potential impacts on Hearson Cove are minimised.

8.2 Public Safety

Management Objective – To ensure that the risk to the public is as low as reasonably practicable and complies with acceptable standards and to ensure that risk is managed to meet the EPA's criteria for off-site individual fatality risk and that ALARP is demonstrated and the DME's requirements in respect of public safety are met.

8.2.1 Risk and Hazard

Qest Consulting Group was engaged by Sinclair Knight Merz to conduct a Preliminary Risk Assessment (PRA) of the proposed development. A comprehensive report was provided to the Environmental Protection Authority and Department of Minerals and Energy as a supporting document to this Public Environmental Review (Qest, 2001). The following sections present a summary of this document.

8.2.1.1 Preliminary Risk Assessment

The objectives of the PRA were to demonstrate as far as reasonably practicable that:

- Offsite risks are minimised, firstly through elimination of hazards and secondly through control of remaining hazards; and
- The level of risk to persons located offsite as measured by defined criteria is within tolerable limits.

The scope of the PRA included:

- Hazard identification;
- Hazard and risk assessment; and
- Evaluation and selection of hazard and risk control measures.

The hazards that were considered are those associated with the operations of the Burrup ammonia plant that have the potential to extend beyond the boundaries of the plant area.

8.2.1.2 Risk Criteria

The risk criteria as stated in Bulletin 611 (EPA, 1992) are as follows:

- A risk level in residential zones of one-in-a-million per year (1×10-6) or less, is so small as to be acceptable to the Environmental Protection Authority.
- A risk level in "sensitive developments", such as hospitals, child care facilities and aged care housing developments of between one half and one-in-million per year (0.5 to 1×10-6) is so small as to be acceptable to the Environmental Protection Authority.
- Risk levels from industrial sites should not exceed a target of fifty-in-a-million per year (50×10-6) at the site boundary for each individual industry, and the cumulative risk level imposed on an industry should not exceed a target of one hundred-in-a-million per year (100×10-6).

- A risk level for any non-industrial activity located in buffer zones between industrial facilities and residential zones of ten-in-a-million per year (10×10-6) or lower, is so small as to be acceptable to the Environmental Protection Authority.

8.2.1.3 Methodology

The PRA addresses all aspects nominated in the EPA guidelines and specifically includes the assessment of the following risks:

- Leakage or failure of process equipment;
- Hazards of supply, process, storage operations proposed;
- Knock on effects process fires and explosions, and external events (cumulative risks);
- Ammonia export loading; and
- Shipping.

The method by which the proposed plant hazards were assessed includes the following steps:

- **Hazard Identification**
  The objective of the Hazard Identification process was to systematically examine the plant and facilities in order to identify all hazards with the potential to cause fatality to persons offsite. This was done using the analysts' experience, the design engineers' engineering knowledge, experience and a systematic review of the proposed plant and operations.

  Each functional area of the plant was reviewed and the hazards were documented. Hazards considered to have the potential to impact offsite were evaluated further.

- **Consequence Analysis**
  The objectives of the Consequence Analyses was to demonstrate that:
  - Toxic and flammable inventories have been identified;
  - A representative set of release cases have been chosen for analysis;
  - The effects of an unignited release have been evaluated (in terms of hydrocarbon and toxic gas concentrations);
  - The effects of an ignited release have been evaluated; and
  - The consequences of each release have been identified in terms of the potential for offsite fatalities, damage to structures and damage to inventory holders, such as vessels and pipework.

  To achieve these objectives the following was undertaken:
  - Identification of all inventories existing on the Ammonia Plant, either contained in storage or in 'live' plant;
  - Determination of release types and scenarios;
  - Determination of release sizes; and
  - Discharge rate modelling, toxic effects, fire and explosion scenario modelling to evaluate the effects of an ignited release in terms of radiation, overpressures, and the consequences of the release on other vessels.

- **Frequency Analysis**
  The objectives of the Frequency Analysis was to demonstrate that:
  - The event development is valid;
  - The failure data used are valid; and
  - The frequency of each of the hazardous events have been correctly determined.

  The achievement of these objectives is described as follows:
  - Initiating event frequencies were selected from a review of available data sources. A parts count of the plant was conducted.
  - Ignition probabilities for flammable releases were selected from a review of available data and expert judgement published for onshore plant.
  - Combining release frequency with ignition probabilities (and applicable mitigation measures) gave rise to a range of gas release, fire and explosion event frequencies.
  - Combining release frequency with wind direction and weather state probabilities gave rise to a range of flammable and toxic clouds.
- **Preliminary Risk Analysis**
  The objectives of the PRA were to:
  - Evaluate the frequency of each of the Hazardous Events and the associated consequences;
  - Produce individual risk and societal risk contours;
  - Identify major risk contributors;
  - Address the sensitivity of the results to key assumptions; and
  - Assess offsite risks.

  The PRA involves the determination of risks and related hazardous events by combining each event frequency with the event outcomes which are defined in the consequence analysis in terms of structural and human response. These were then cumulated for all events.
- **Assessment of Total Project Risks**
  The calculated risk levels were compared against EPA acceptance criteria defined in **Section 8.2.1.2.**

8.2.1.4 Safety Philosophy and Plant Design

History of Safety Performances of Similar Facilities & KBR Technology
KBR has developed technology to ensure safe operation of their plants with respect to the people on site, the greater community and the environment. Since 1944 the Kellogg and Braun plant designs account for 200 ammonia plants. KBR technology is incorporated in 50% of all ammonia plants.

The technology being used to design the proposed Burrup ammonia plant is the latest low energy Purifier Ammonia technology currently at the forefront of chemical manufacturing and engineering design. **Section 3.5** describes the alternative technologies that are available and demonstrates that the proposed ammonia plant is designed to Best Available Techniques (BAT) as recommended by the European Fertiliser's Manufacturing Association.

Safety Standards and Features to be Incorporated
Kellogg Brown & Root (KBR) are world leaders in ammonia based product technology and the selected processes are well proven. During all phases from

engineering through to procurement and construction, quality assurance systems will be in place to ensure that the designed plant safety features are implemented correctly.

Automatic shutdown of the plant, or parts thereof, will be initiated if certain limit values of operating parameters are exceeded. In addition, emergency manual trip initiation will be provided at strategic locations. The trip system will be designed to be fail safe, ie. failure of trip system elements or unintentional interruption of trip system signals will result in the plant or plant sections being automatically brought to a safe shutdown status.

To ensure that release sizes are minimised an Emergency Response Plan will be put in place. This will provide a plan for rapid response to identified releases, and would facilitate early manual isolation of any leaking equipment.

The shutdown system is a "3-phase" design. There are three stages; red alarm, yellow alarm and then trip.

Process Shutdown

The shutdown process of the Burrup Ammonia Plant, at worst, will result in the front end and back end of the plant being isolated and the inventory being vented via two stacks, one for each end of the plant. It must be noted that all sections of the process can be isolated.

Other emissions that would result from a process incident, are those from leaks due to pipe/equipment failure. When a pressure drop is detected the immediate isolation valves located upstream from the pressure drop are closed and the valves leading to the nearest vent point are opened. This ensures that the inventory, which could potentially leak near ground level, does so at an elevation of 60 or 45 m, for the front end vent stack and back end vent stack respectively.

Process Control

From a process control aspect, two KBR developments help to ensure the safety of personnel and the environment. The Advanced Process Control System (APC) helps to ensure the plant is running at optimum performance thereby minimising waste. The Operator Training Simulator (OTS) provides the operators with a training environment that completely replicates the plant. This also allows operators to train for emergency situations.

<u>Advanced Process Control System (APC)</u>

The primary objective of the APC system will be to operate the Burrup plant as close to its operating constraints as possible without sacrificing stability and safety. This is done by the use of state-of-the-art model predictive technology developed specifically for ammonia plants by KBR, the process licensor. The system automatically predicts the trajectory of the critical controlled variables, and provides optimised set points to the lower level DCS controllers. This allows consistent stable and optimal operation with minimal operator intervention.

The overall system is provided on a standard PC-NT connected to the DCS. Variables that are typical candidates for APC are:

- Steam to Gas Ratio;

- Desulphuriser Hydrogen to Feed Ratio Control;
- Secondary Reformer Exit CH_4 Composition Control;
- Reformer pass temperatures;
- Hydrogen to Nitrogen Ratio;
- Lean Amine to Feed Ratio Control;
- Converter Inlet and Bed Temperature Profile; and
- Ammonia Receiver Pressure Control.

Operator Training Simulator (OTS)
The primary objective of the OTS system will be to provide a standalone model based on a replica of the plant and control system for operator training. The system will be used to provide startup training for the operating crew, ensuring maximum familiarity with the plant and the knowledge of startup procedures. Beyond startup training, the system will be used to provide on-going refresher training to all operator staff, and potentially check out future process and control systems modifications prior to implementation.

The OTS system consists of several standard PC-NTs, and includes a customised version of the OTS specifically developed by KBR for ammonia plants. The system includes exact look-alike of the DCS consoles, and an Instructor Station. The heart of the system is a fundamental based dynamic model of the ammonia plant, which allows trainees to perform full startup from cold conditions, total shutdown from a normal operating state, and train on a variety of malfunctions and failures. Burrup Fertilisers hopes to realise quicker and incident free startup with the use of this system, in addition to well trained operating staff throughout the life cycle of the plant.

Process control for the Burrup Ammonia Plant will be a multi-faceted system. It will contain the following aspects:

- A Distributed Control System (DCS) will be used for basic process control loops.
- Programmable Logic Controllers (PLC) will be used for sequential control and other non-safety related process interlocks.
- Machine Protection Systems (MPS) will be implemented for all compressor control functions (anti-surge, speed, extraction, etc.). These controls can also be implemented in the DCS, if required.
- Safety shutdown functions will be implemented in a dedicated Safety Instrumented System (SIS). These functions will not be implemented in the DCS or PLC.

Each area/unit of the process will be analysed in extensive detail from a human safety, environmental hazards and economic loss point of view. Based on this detailed analysis, a Safety Integrity Level (SIL) will be determined for each process loop. The SIL for each loop will determine the redundancy of the field instruments and SIS.

The overall process control philosophy, from concept to actual plant operation, will be developed by the Controls Systems Engineering Division of KBR. The Control Systems Engineering Division will also develop the control strategy, control systems and operator interface as well as selecting the proper field instrumentation.

Plant Vent System
The plant will have two vent stacks where gases, excluding ammonia, will be vented with steam.

The following is a summary of how the venting may be used:

- In ESD situation, both vents will open for half an hour.
- After a shutdown and during start-up, venting will take place. The duration of the venting is dependent on the type and duration of shutdown.
- Every pressure vessel has been provided with a link to a vent or the flare.
- If the plant shuts down, the ammonia stays in the system and will not be vented.
- The vents open during commissioning and emergency shutdowns. During a shutdown induced by an inadvertent leak, such as a gasket failure, the valves upstream of the leak close and those downstream to next vent outlet open.

Ammonia Flare System
The plant will have a flare system which will be able to provide the ability to reduce the ammonia inventories should there be upset process conditions. Should there be a flare-out during a process upset, ammonia would be released from the flare tip which will be located some 35 m above the ground. Any such release will not result in a concentration of ammonia at the boundary that could cause fatalities.

It must be noted that the likelihood of a flare-out during a major upset is extremely remote, and no ammonia will be flared during normal shutdown.

A leak from the Refrigeration Compressor is the only scenario, as identified by Burrup Fertilisers, where ammonia may be sent to the flare. Other than this scenario only ammonia vapours will be flared as all liquid goes direct to the two storage tanks.

Nitrogen Purge Facilities
Liquid nitrogen storage and manufacturing facilities will be included as a plant utility used for cooling, inerting/purging flammable and other gases from process equipment and in process startup.

Fire Fighting Facilities
Facilities will be provided for the supply and distribution of fire fighting water for the whole plant.

Emergency Response
An emergency management plan will be developed as an integral part of the plant operating procedures.

Safety Management and Training

A safety management system and appropriate procedures will be developed and implemented via the education and training of operations personnel. To ensure the safe operation of the facility, this will also include emergency procedures.

Engineering Codes and Standards

The plants will be designed and constructed in accordance with relevant Australian codes and standards. Where suitable Australian standards do not exist, other internationally recognised standards such as German or U.S. standards will be applied.

8.2.1.5 Risk Assessment Results

Hazard Identification

The identified hazards considered as having the potential to impact offsite and therefore evaluated in the risk analysis studies are presented in **Table 8-1.**

Table 8-1 Potential Hazardous Events Examined in Risk Analysis

Location	Event	Release*
Natural Gas Feed Line	Major leak or rupture.	Methane
Ammonia Plant	Major leak or rupture.	Methane/Hydrogen Ammonia (l or g)
Refrigerated Ammonia Storage Tank	Major leak.	Ammonia (l or g)
Ammonia Export Pump	Major release from pump while operating.	Ammonia (l)
Ammonia Pipeline - Plant to Wharf	Major leak or rupture in pipeline.	Ammonia (l)
Ammonia Marine Loading Arm	Major leak or rupture.	Ammonia (l)
Shipping Channel	- Ship to ship collision. - Grounding. - Collision with fixed structure. - Fire/explosion onboard. - Tank material failure.	Ammonia (l)

* l – liquid; g - gas

Consequence Analysis

Toxic and flammable inventories were identified however as the plant was not at design stage, not all inventories were accurately determined. Nevertheless isolatable inventories were conservatively estimated based on a plant of similar capacity and technology.

The range of release sizes used for consequence analysis were 7mm, 22mm and 70 mm. Ruptures were considered for certain equipment such as process vessels. In assessing release durations for isolatable sections, consideration was made of the time taken to detect the release and effect ESD.

Release types and scenarios that were found to have the potential to impact on-site risk included:

- **High pressure gas jet fires:** There are two distinct sets of consequences. Firstly, personnel are directly affected by the radiation from the flame which can cause death or injury if persons are exposed for a sufficient length of time. Secondly, if the flame impacts on structure, pipework or adjacent inventories, then these may fail and give rise to additional releases, thus exacerbating the initial hazard.

- **Flash fires**: Flash fires may result from the ignition of a cloud of released material. The flash fire occurs due to the delay in ignition of the initial release which gives an opportunity for the development of a flammable cloud.
- **Explosions:** A flammable release may give rise to an explosion if the resulting flammable cloud forms in an area which is semi-confined. In these circumstances, if ignition were to occur then turbulence resulting from the movement of burning gases may result in flame acceleration to a point where combustion products may not be able to vent efficiently, resulting in an overpressure with the capability of damaging buildings or structure.
- **Toxic releases:** A release of ammonia will result in the development of a toxic cloud that will drift with the wind for potentially long distances. This can have fatal consequences for people enveloped in a cloud with ammonia concentrations of greater than 1000 ppm.

Frequency Analysis

Leak frequencies were estimated on a "parts count" approach using generic component failure frequencies. The number of equipment items in each process section was estimated in the absence of detailed design plans. Using generic failure frequencies, the leak frequency for the process section was taken as the sum of frequencies of the individual components.

A summary of release frequencies for the ammonia plant and associated infrastructure is provided in **Table 8-2.**

Table 8-2 Total Release Frequencies

Release Frequencies (per item per year)	Size of Release			
	7 mm	22 mm	70 mm	TOTAL
Feed & Desulphurisation	4.48×10^{-02}	1.16×10^{-02}	5.39×10^{-03}	6.18×10^{-02}
Reformer	1.03×10^{-01}	3.19×10^{-02}	2.11×10^{-02}	1.56×10^{-01}
CO_2 Conversion	7.88×10^{-02}	4.34×10^{-02}	3.78×10^{-02}	1.60×10^{-01}
CO_2 Absorber	1.69×10^{-02}	4.39×10^{-03}	1.99×10^{-03}	2.33×10^{-02}
Methanator	7.73×10^{-02}	3.59×10^{-02}	3.05×10^{-02}	1.44×10^{-01}
Cryogenic Purification	8.14×10^{-02}	2.62×10^{-02}	1.55×10^{-02}	1.23×10^{-01}
Synthesis Loop	6.86×10^{-01}	6.88×10^{-02}	3.52×10^{-02}	7.90×10^{-01}
Ammonia Refrigeration	6.89×10^{-01}	5.40×10^{-02}	2.07×10^{-02}	7.64×10^{-01}
Ammonia Distillation	2.18×10^{-02}	1.10×10^{-02}	8.78×10^{-03}	4.15×10^{-02}
Ammonia Scrubber	4.66×10^{-02}	1.21×10^{-02}	8.74×10^{-03}	6.74×10^{-02}
MDEA Loop	8.41×10^{-01}	8.27×10^{-02}	3.90×10^{-02}	9.62×10^{-01}
Storage tanks	$0.00 \times 10^{+00}$	$0.00 \times 10^{+00}$	2.00×10^{-06}	2.00×10^{-06}
Export Pipeline	8.21×10^{-06}	1.11×10^{-06}	2.00×10^{-06}	1.13×10^{-05}
Loadout facility	1.12×10^{-03}	2.78×10^{-04}	1.01×10^{-04}	1.50×10^{-03}
Loadout Pump	3.14×10^{-02}	2.87×10^{-03}	8.88×10^{-04}	3.51×10^{-02}

Quantitative Risk Analysis

The quantitative risk analysis was undertaken for each hazardous event by combining each event frequency with the event outcomes. The risk arising from these events was calculated using the Riskplot 11 calculation software package. This package calculates Individual Risk Per Annum (IRPA) and contours according to:

- Release scenario frequency (including releases initiated by escalation from an adjacent event);
- Location of release;
- Magnitude of consequence;
- Local meteorology; and
- Local topography.

The contours express the individual risk of fatality to the public at certain distances from an industrial facility.

The following risks were determined and are discussed below:

- Individual Risk
- Societal Risk
- Cumulative Risk
- Toxic Risks
- Flammable Risks

Individual Risk

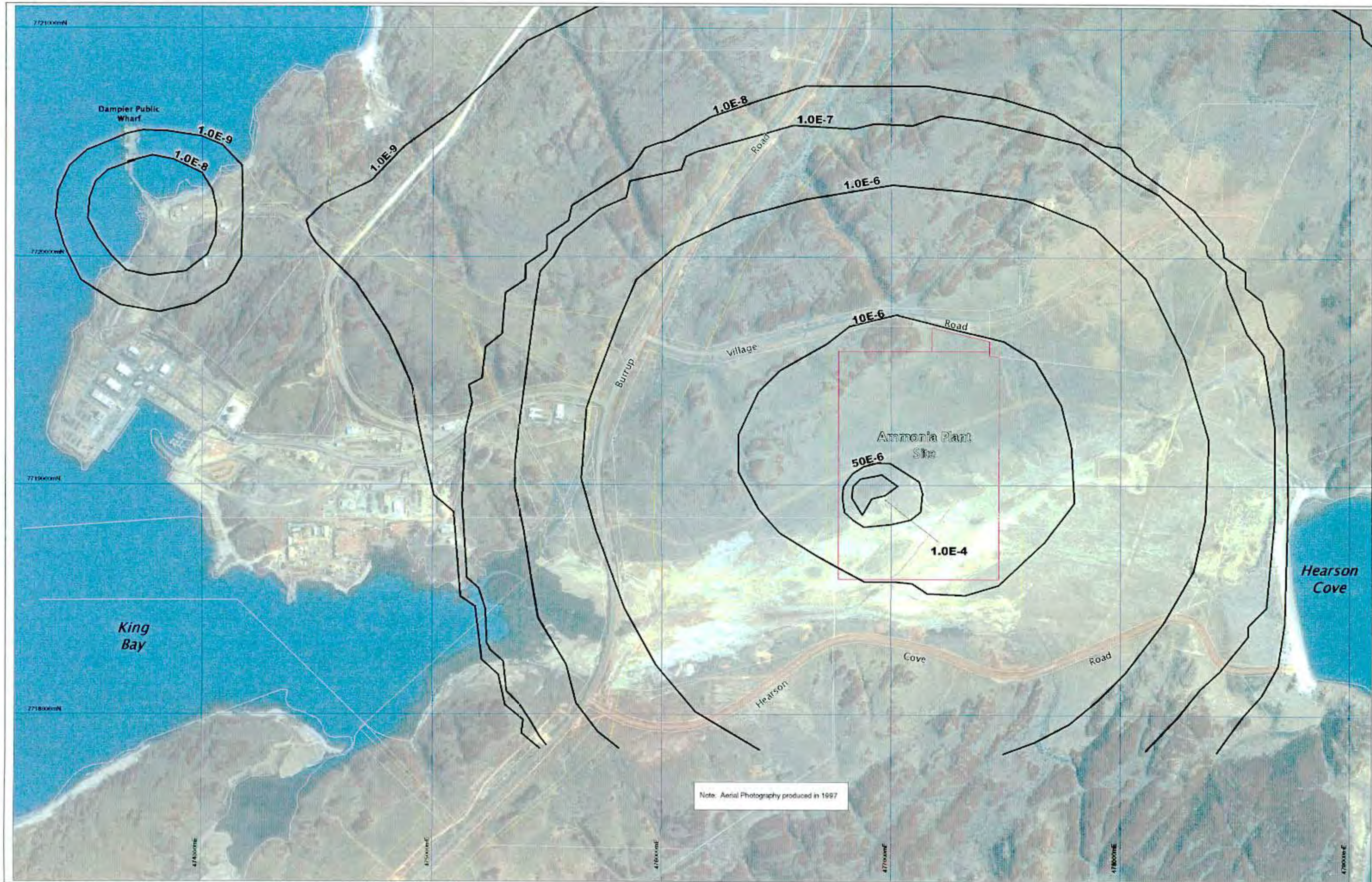
The calculated risk contours show the distance around the plant to the risk level of 50×10^{-6} fatalities per year. This is presented in **Figure 8-1**. The quantified risk at these locations represents the level experienced by a person present for 24 hours a day.

The 50×10^{-6} risk contour from the Burrup Ammonia Plant does not extend beyond the site boundary. The 10×10^{-6} contour extends west over the proposed Plenty River Ammonia/Urea Plant and south towards the proposed Syntroleum Synthetic Fuels plant. However, it does not extend far enough east to impact on the Hearson Cove recreational area. Therefore the plant is considered to comply with the EPA Criteria for individual risk.

The event with the potential to have the largest fatality risk is the catastrophic failure of one of the two ammonia storage tanks. However, the risk from this event can be considered negligible, as each tank will be designed as double-walled and double-integrity and will also be provided with shower curtains and/or sprays.

Societal Risk

The principal difference between individual risk and societal risk is that, whilst individual risk is a measure of the risk to a defined individual moving around a number of locations (or of any individual in a defined location - ie. risk contours), societal risk is a measure of the risk to a defined number of persons.



Photography supplied by the Department of Resources Development

Note: Secondary service corridors shown to Ammonia Plant Site are preliminary and subject to approval

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SINCLAIR KNIGHT MERZ
Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT
INDIVIDUAL RISK CONTOURS

0 250 500m

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 8.1
Client: Burrup Fertilisers Pty Ltd
Job No. SW01198
Date Drawn: 21 July 2001
FileName: DE01890_01_Fig8_1.wor

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The societal risk from the ammonia plant is presented in **Figure 8-2** and lies within the tolerable section of the WA societal risk criteria for new plants. This suggests that the risks are acceptable provided that risk reduction measures are considered.

Cumulative Risk
Plenty River's proposed Ammonia/Urea Plant is located to the west of the Burrup Ammonia Plant. From **Figure 8-3** the 10×10^{-6} risk contour from the Plenty River Plant extends marginally offsite on the eastern side of the boundary towards the Burrup Ammonia Plant. The 50×10^{-6} risk contour from the Plenty River plant extends offsite towards the west side. Neither contours will have a major impact on the Burrup Ammonia Plant Site. Both plants comply with individual risk criteria on their common boundary.

Syntroleum's proposed synthetic fuels plant is located approximately 1.4km to the south-west of the Burrup Ammonia Plant site. The contours provided by HLA-Envirosciences, consultants to Syntroleum, show that the 10×10^{-6} risk contour extends mostly to the west of the plant and will not impinge on the Burrup Ammonia Plant site. This is also shown on **Figure 8-3**. The Syntroleum plant is sufficiently removed from the other plants such that it will not be a significant contributor to the cumulative risk levels imposed on either of those industries.

Shipping Risks
There will be 26 export ship movements per year which will be monitored and controlled by the Dampier Port Authority. All vessels will be under the control of a local pilot and under radar surveillance from the Dampier Port Authority. Management procedures are in place for preventing major vessels from coming within one nautical mile of each other.

The only reasonable scenario in which vessels could come in contact with each other would be due to engine or steering failure. Should any of the large vessels (iron ore of LNG vessels) lose steering or power they would most probably run aground prior to colliding with the ammonia vessel since their draft precludes moving out of their channel.

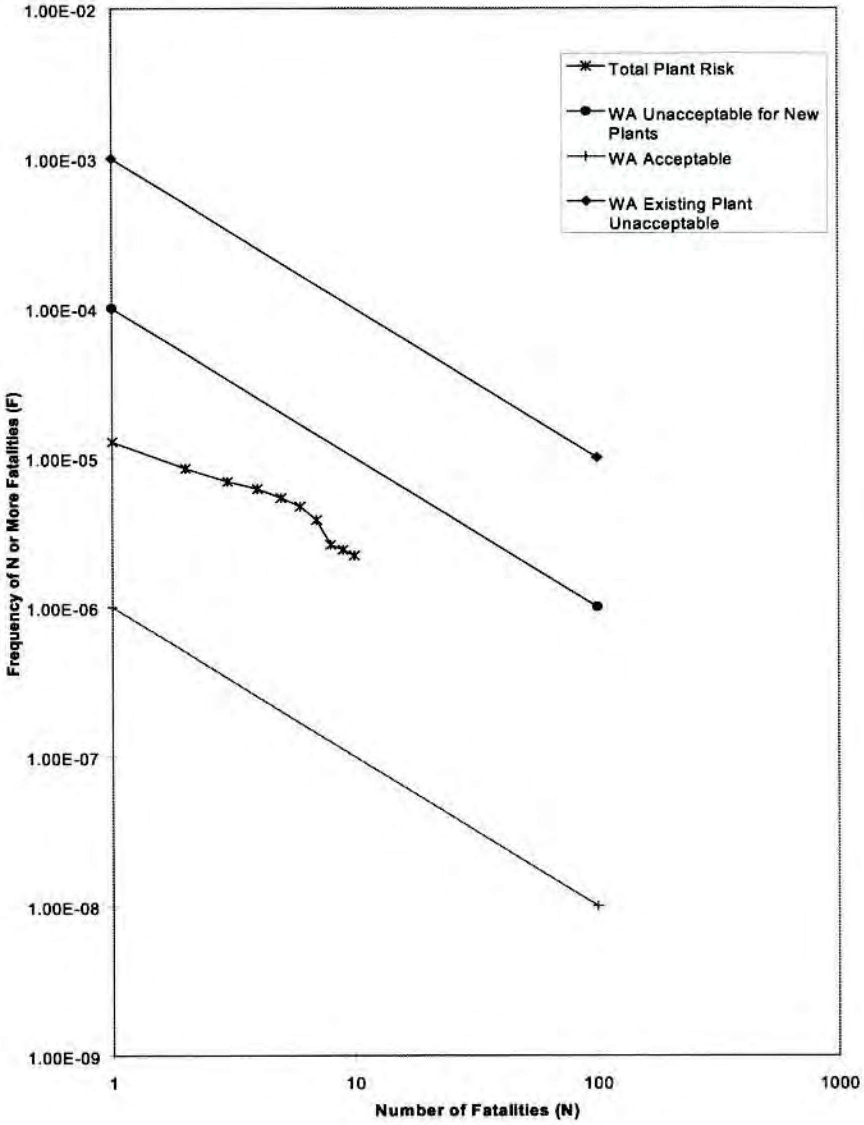
The risk of ammonia release due to ship collision is predicted to be 1.8×10^{-6} assuming that 20% of the collisions are severe enough to penetrate one of the tanks resulting in a significant release of ammonia. This release frequency is very low and will only effect the public under certain weather conditions.

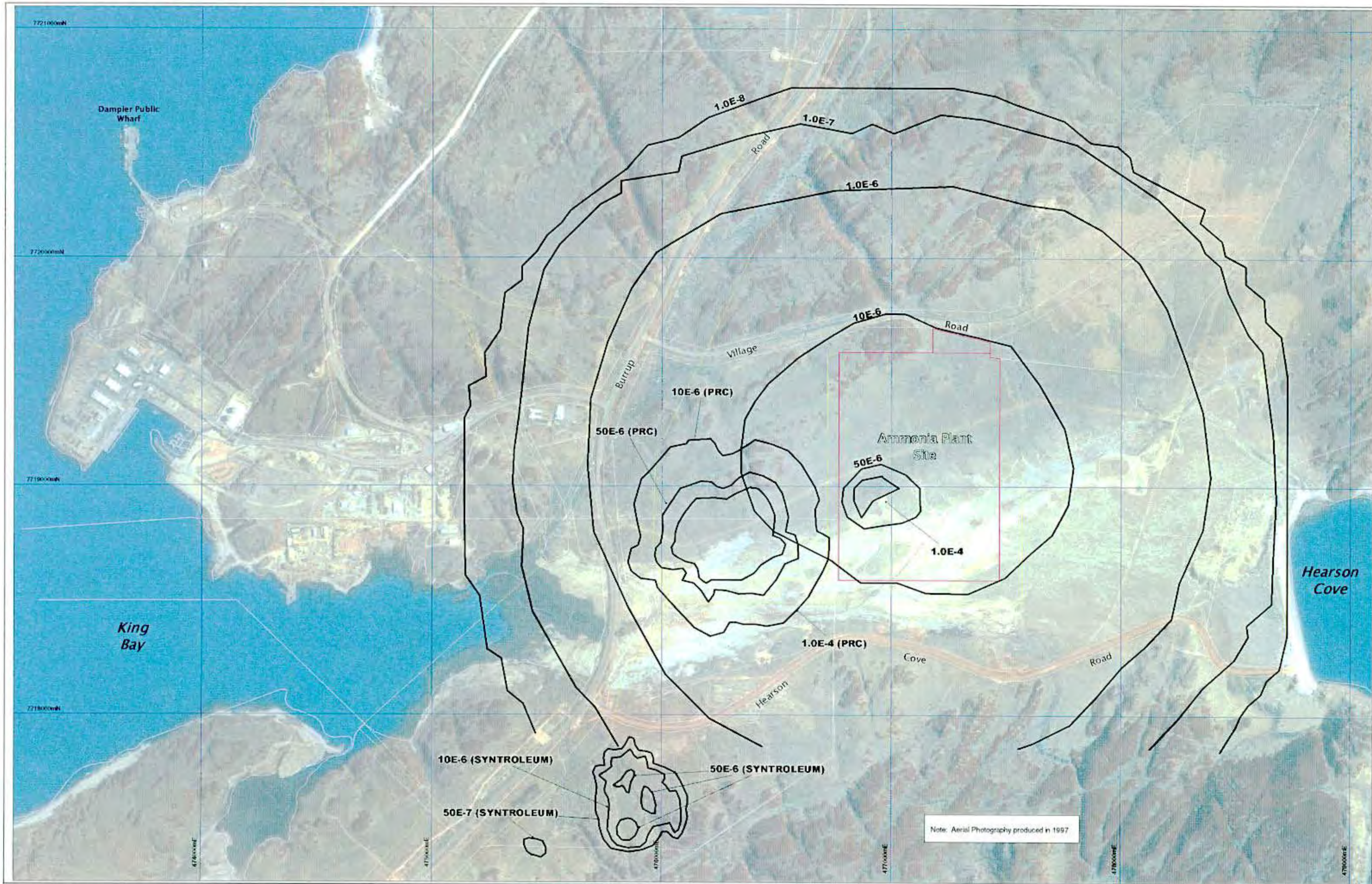
Toxic Risks
The major toxic risks from this plant are produced by process leaks in the ammonia synthesis and refrigeration sections.

Flammable Risks
There are no offsite fatal impacts predicted from methane or hydrogen releases.

A summary of the major risk contributors and their potential knock-on effects for the ammonia plant itself and also for existing and proposed operations in the surrounding area are provided in **Table 8-3** and **Table 8-4.**

Figure 8-2 Burrup Ammonia Plant – Societal Risks





Photography supplied by the Department of Resources Development

Note: Secondary service corridors shown to Ammonia Plant Site are preliminary and subject to approval

Quest Consulting Group

SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
P.O. Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT

PLENTY RIVER PLANT AND SYNTROLEUM FUELS PLANT CUMULATIVE RISK CONTOURS

0 250 500m

Vertical Datum: AHD
Horizontal Datum: AGD84
Map Projection: AMG84 Zone 50

FIGURE 8.3

Client: Burrup Fertilisers Pty Ltd
Job No: SW01198
Date Drawn: 21 July 2001
FileName: DE01890_01_Fig8_3.wor

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Table 8-3 Risk Contributions Including Knock-on Effects

Internal Event	Comment
Natural gas feed line release	Releases due to pipeline failure because of material of construction or maintenance faults or external impacts. The 37.5 kW/m2 contour extends for 29 m but will not impact on the storage tanks. No fatalities will occur beyond the site boundary.
Ammonia Process Plant - Flammable (methane, hydrogen or ammonia) release	No fatalities will occur beyond the site boundary due to on site fires. Risks from knock on effects from fires and explosions are minimal, as the fire and explosion frequency is significantly lower than the ammonia release frequency. The knock on release would have minimal impact as the process would be isolated and blown down / vented away from the process area before vessels would fail from heat.
Ammonia Process Plant - Toxic (ammonia) release	This is the major onsite and public risk contributor due to inventories of liquefied ammonia, high pressures and temperatures, the number of vessels and amount of pipework. However, the potential impact is minimised given the design and redundancy of the control and shutdown systems.
Refrigerated Ammonia Storage	Risk very low due to the low frequency at which double-walled double-integrity tanks fail. The likelihood of the inner and outer walls failing is very low. It would require a significant external impact. The failure of one of the tank walls would have no impact beyond the boundary. Water curtains for both tanks are also provided as a mitigating measure.
Export Pump	The likelihood of an event impacting beyond the boundary is very low due to the number of protection devices that would ensure any release was of short duration.
Pipeline from Plant to the Wharf	Risk very low due to the low frequency at which fully welded pipelines leak.
Marine Loading Arm	Risk very low due to the low frequency of the event (and minor consequences) due to there being many protection devices that would have to fail for an ongoing release. Protection includes: ❑ ESD system automatically activated on no-flow signal. ❑ All other activity on the wharf ceases throughout tanker loading operations. ❑ An operator to be stationed at the wharf throughout the entire loading operation.
Shipping Hazards Collision, Grounding, Or Onboard Incident	Risk very low due to the very low frequency of the event.

Table 8-4 External Knock-on Effects

External Event	Comment
LNG Plant and export jetties	The Burrup Ammonia Plant is at least 3.5 km from hydrocarbon inventories at the LNG plant and hence will be unaffected by any incidents.
Northern Boundary Pipeline Corridor	The corridor is almost 400 metres from the nearest section of the plant. The size and pressure of any pipeline in this corridor will not have a significant impact on this plant.
Plenty River Ammonia Urea Plant	The 10×10^{-6} risk contour extends marginally offsite on the east side of the boundary in the direction of the Burrup Ammonia Plant. The 50×10^{-6} risk contour extends offsite towards the west side. Neither contours are expected to have a significant impact on the proposed Burrup Ammonia Plant.
Syntroleum	The 10×10^{-6} risk contour crosses the boundary on the west side of the Syntroleum plant only. There will be no impact on the proposed Burrup Ammonia Plant.

8.2.1.6 Conclusions and Recommendations

Risks from the Burrup Ammonia Plant are considered conservative and acceptable for a PRA, provided risk reduction measures are undertaken.

The Risk Assessment of the Burrup Ammonia Plant was developed using generic failure frequencies. For these values to be valid the safety management must be of a standard at least equal to norm of the plants on which these frequencies are based.

To ensure this standard, a Safety Management System will be prepared prior to commissioning.

It should be noted that the basis of the PRA was conducted using preliminary drawings with limited access to information about the facility. It is therefore recommended that a thorough Quantitative Risk Assessment be completed prior to the commencement of construction and production operations.

Management Commitment 8.2.1.1: *The Proponent will establish a Safety Management System and Safety Management Plan prior to commissioning.*

Management Commitment 8.2.1.2: *The Proponent will prepare an Emergency Response Plan prior to commissioning.*

Management Commitment 8.2.1.3: *The Proponent will participate with other industries in the development of a Burrup Industrial Integrated Emergency Management Plan.*

Management Commitment 8.2.1.4: *The Proponent will iincorporate where practicable emergency release coupling to close wharf isolation valves.*

Management Commitment 8.2.1.5: *The Proponent will provide water curtains and/or sprays, where practicable, at the ammonia distillation, ammonia*

The following risk management measures will be implemented for the ammonia plant:

- Establish a Safety Management System and prepare a Safety Management Plan prior to commissioning. This Safety Management System should include the following elements: Policy and Objectives, Organisation and Responsibility, Employee Selection, Competency and Training, Contractors and Support Services, Management of Change, and Performance Audit and Review;
- Prepare an Emergency Response Plan prior to commissioning that provides a rapid response to identify releases that would facilitate early manual isolation of any leaking equipment;
- Develop a Burrup Industrial Integrated Emergency Management Plan to address events that impact across plant boundaries;
- Incorporate where practicable emergency release coupling to close wharf isolation valves;
- Provide water curtains and/or sprays, where practicable, at the Ammonia Distillation, Ammonia Scrubber and Ammonia Refrigeration sections (includes vessels 125-MD and 124-MD and 120-MC) in the Burrup Ammonia Plant.

8.2.2 Road Transport and Traffic

Management Objective – To ensure that roads are maintained and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements.

8.2.2.1 Potential Impacts

Construction Phase
All traffic will access the site from Village Road to the north of the site through the access road indicated in **Figure 4-1** during construction of the plant.

Pipe laying will occur underneath Burrup Road, Woodside's temporary quarry road and the MOF road in DRD's Burrup West service corridors pre-existing culverts. In the Village Road reserve, pipe laying will take place. The Proponent is currently the only dedicated user of Village Road. This road is infrequently used by the public to gain access to Cowrie Cove by which a four-wheel drive vehicle is required because Village Road becomes a track. Short delays may occur during these construction activities, however these will be conducted outside of peak traffic periods wherever practicable. Through traffic on the above mentioned roads will be maintained at all times during the construction phase.

All proposed traffic delays will be co-ordinated with Department of Main Roads and Shire of Roebourne.

Operational Phase

During the operational phase of the project, all access to the plant site will be via Village Road. Entrance to the site will be through a manned security gate located on the access road into the site. It is assumed that day shift employee numbers would be not more than 20 and night shift employee numbers would be not more than 10 resulting in up to 50 additional traffic movements per day. With minimal increase in traffic movement, the capacity of the roadways shall by no means be exceeded.

Sufficient employee and visitor parking spaces will be provided on site.

8.2.2.2 Management Strategies

As previously stated, any proposed traffic delays during the construction phase will be co-ordinated with Department of Main Roads and Shire of Roebourne.

Work requiring temporary closure of the roads will occur at times that are less likely to inconvenience the public.

Appropriate scheduling will attempt to minimise delays and road closure due to construction items that would obstruct regular traffic flow. For example, the construction of Burrup Fertiliser's ammonia pipelines and Apache's natural gas pipeline underneath Burrup Road would occur simultaneously.

Site traffic will be restricted to designated internal roadways and suitably sealed or gravelled areas to prevent disturbance of vegetated or natural areas.

A Traffic Management Plan will be prepared prior to construction which will include the following elements:

***Management Commitment 8.2.2.1:** the Proponent will prepare and enforce a Traffic Management Plan, prior to construction.*

- Undertake a study of the traffic flow patterns and schedule construction items at times of lowest interruption to road thoroughfare and the general public;
- Ensure the safety of the general public during construction;
- Monitor the effect of heavy vehicles on roads utilised during construction;
- Monitor movement of oversize vehicles to and from site;
- Truck haulage layup area to be constructed in site lease boundary;
- Creation of a one way loop road around the plant footprint; and
- Restrict access of vehicles on site to specific areas to reduce environmental impact.

8.3 Accommodation

There are approximately 240 homes available in the Shire of Roebourne (MfP, 2000), and it is likely that this housing stock will not be sufficient to meet the housing demand that has been generated by this proposal and other recent industry proposals. Existing resource companies such as Hamersley Iron and Woodside Energy have developed over 400 homes to the local housing market over and above those dwellings that are currently occupied by their own employees (MfP, 2000).

8.3.1 Potential Impacts

Construction Phase

The construction of the plant will occur over a period of about 20 months and will require an average workforce of about 150, peaking at 500. As discussed in **Section 4.6**, the construction workforce will be contracted from Western Australia with a number of specialists being supplied by Oswal Chemicals and Fertilisers Pty Ltd.

It is not possible for the Proponent to rely on the private housing market to accommodate the construction workforce. There is also a potential that other proposed projects may proceed at a similar time to this proposal resulting in an increased demand for construction accommodation.

The Proponent is investigating a number of available options with the assistance of the Department of Resources Development, Shire of Roebourne and the Department of Land and Administration.

Several temporary accommodation proposals in the Shire of Roebourne have recently been lodged. These proposals have the potential to meet the housing demand of this project and include (MfP, 2000):

- Proposed re-development of Peninsula Palms in Dampier to provide single persons quarters for approximately 700 people;
- Purchase of vacant land and a caravan park on the corner of Searipple and Mystery Roads by Weston Portables and Fleetwood. This area has the capacity to accommodate about 1800 persons;
- Development of a hotel on Sharpe Avenue, Karratha to accommodate at least 90 people by Entact Clough.
- Development of an accommodation village able to support about 320 persons on vacant land on King Way, Chiratta Road and Mooligan Drive by Gibraltar Properties;
- Development of an accommodation village or tourist accommodation for about 550 persons on The Esplanade, Dampier by Eurest Catering Services;
- Proposed release of 400 lots by the Department of Land and Administration subject to the resolution of Native Title; and
- The expansion of the residential suburb of Baynton.

***Management Commitment 8.3.1.1:** The Proponent will consult with the Department of Resources Development, the Shire of Roebourne and the Department of Land and Administration to establish suitable accommodation.*

Operational Phase

During the operational phase an estimated workforce of about 60 personnel will be employed with approximately 10 personnel being based in Perth and 50 personnel based in Karratha.

***Management Commitment 8.3.1.2:** The Proponent will comply with the Shire of Roebourne's Transient Workforce Accommodation Policy.*

Permanent housing in residential areas will be required to accommodate the operational workforce. The Proponent has already moved to secure housing that is required for its permanent workforce and are expected to purchase these shortly. This has been undertaken in consultation with the Department of Land and Administration and the Shire of Roebourne.

8.3.2 Management Strategies

In recognition that neither Karratha nor Dampier currently have the capacity to accommodate the proposed construction workforce, the Proponent will:

- Consult with the Department of Resources Development, the Shire of Roebourne and the Department of Land and Administration to establish suitable accommodation; and
- Comply with the Shire of Roebourne's Transient Workforce Accommodation Policy.

8.4 Visual Amenity

8.4.1 Landscape

Management Objective – To ensure that the visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse.

Suitable terrain for supporting the proposed ammonia plant is limited to only a portion of the project lease area, as a result of the significant rock piles to the north and low lying intertidal mudflats in the south. The plant will be constructed on the most level terrain available on the site. This area will be cut and filled to an elevation of about 4.9mAHD. The rockpiles in the north will form an attractive backdrop for the ammonia plant when viewed from Hearson Cove Road. These rockpiles contain sites significant to Aboriginal heritage and also support significant habitats and priority flora species, and as such will be protected to remain an important feature of the site.

The average height of the structures within the plant will be about 12 mAHD, although there will be several tall thin structures up to 65 mAHD (ammonia storage flare 30 mAHD; CO_2 stripper stack 65 mAHD; and vent stacks 30 mAHD). The ammonia storage tanks will also be prominent features of the ammonia plant and will have the general dimensions of 55 metres in diameter by 28 metres in height (33 mAHD).

- A three dimensional digital terrain model was developed to provide views of the ammonia plant from a series of vantage points surrounding the Project Area. These vantage points are referenced in **Figure 8-4**.

The visual impact of neighbouring proposed projects was also given consideration by including the gas to synthetic hydrocarbon plant proposed by Syntroleum. The ammonia/urea plant proposed by Plenty River was not included in the model, as visual information in sufficient detail for modelling was not available. It is known however, that the proposed ammonia/urea plant is to be located further south than the originally proposed location.

8.4.1.1 Potential Impacts

An aerial view of the proposed ammonia plant and the proposed gas to synthetic (GTS) hydrocarbon plant is illustrated in **Figure 8-5**. This view looks to the southwest (from view point 1) from Hearson Cove towards King Bay.

The model of the Syntroleum GTS plant was developed from readily available information and should not be considered as an exact illustration or model of the actual proposed plant. The GTS plant is much larger than the ammonia plant and occupies a footprint of about 50 hectares which is over double the area of the proposed ammonia plant.

From the north (view point 2), along Village Road, the proposed ammonia plant will be largely concealed by the tall rock piles with the exception of the emission stacks and ammonia flare. Only limited sections of the plant are visible in between these rock piles (**Figure 8-6**). The ammonia plant is visible (from view point 3) at a distance from the corner of Burrup Road and Hearson Cove Road (**Figuure 8-7**) given the surrounding vacant land is low lying. However, following the development of the ammonia/urea plant by Plenty River, Burrup Fertilisers' ammonia plant may be partially concealed.

The ammonia plant will also be clearly visible along the entire length of Hearson Cove Road (view points 4 and 5) as a result of the low lying mudflats that exists between the road and the Project Lease (**Figure 8-8** and **Figure 8-9**). Little can be done in terms of landscaping to conceal the plant from these view points, although various management strategies are proposed to maintain visual amenity (**Figure 8-10**.

From Hearson Cove (view point 6), the CO_2 stripper stack and vent stack of the plant will be visible however the majority of the plant will be concealed behind the sand dunes and vegetation upon the dunes. **Figure 8-10** illustrates the predicted view of the plant whilst standing on the top of the dunes of Hearson Cove. Considering that there is a significant drop of elevation from the dunes to the shoreline of the beach, the vent stack and CO_2 stripper are likely to be entirely concealed from an observer standing on the beach at the waters edge.

The proposed ammonia plant will not impact on the visual amenity of residents in Dampier or any other frequented sites south of Hearson Cove Road as several series of tall rockpiles, including the Pistol Ranges, exist in the southern portion of the Burrup Peninsula.

Management Commitment 8.4.1: *Where possible, buildings will be coloured to blend into the surrounding terrain.*

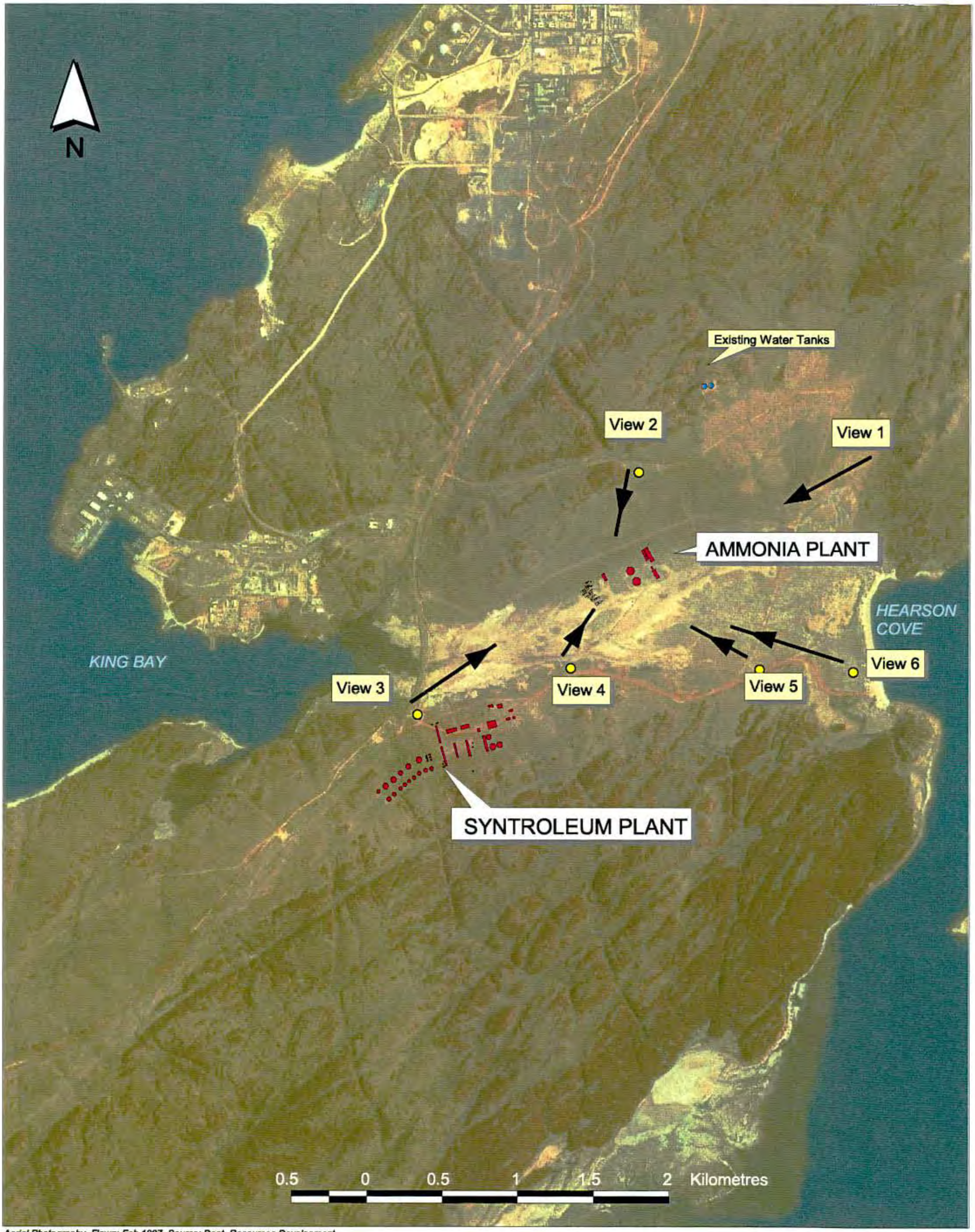
Management Commitment 8.4.2: *All temporary disturbances will be rehabilitated and revegetated with local species.*

Management Commitment 8.4.3: *A high standard of housekeeping will be maintained at all times.*

8.4.1.2 Management Strategies

To improve the visual amenity of the proposed ammonia plant the following management strategies will be undertaken:

- Where possible, buildings will be coloured to blend into the surrounding terrain;
- All temporary disturbances will be rehabilitated and revegetated with local species.
- All equipment and other tools will be housed or stored as required at all times;
- All solid waste will be housed or stored as required at all times prior to being disposed; and
- A high standard of housekeeping will be maintained at all times.



Aerial Photography. Flown: Feb 1997. Source: Dept. Resources Development.

SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
PO Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT
PHOTOGRAPH AND MODEL INDEX
SHOWING VANTAGE POINTS

FIGURE 8.4

Client: Burrup Fertilisers Pty Ltd
ProjectNo.: DE01890.010
Date Drawn: 30 July 2001
Map: A4-6920

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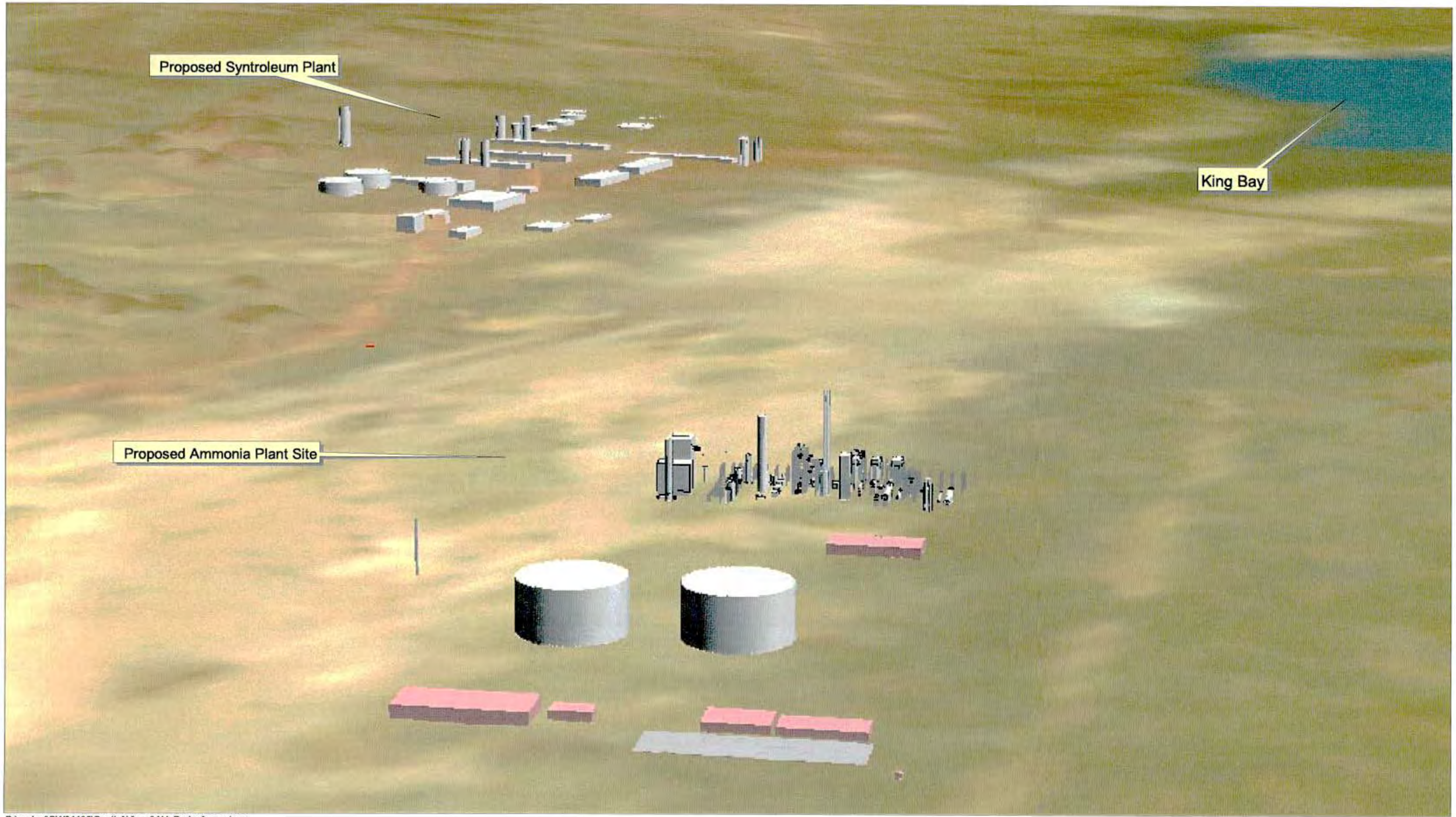

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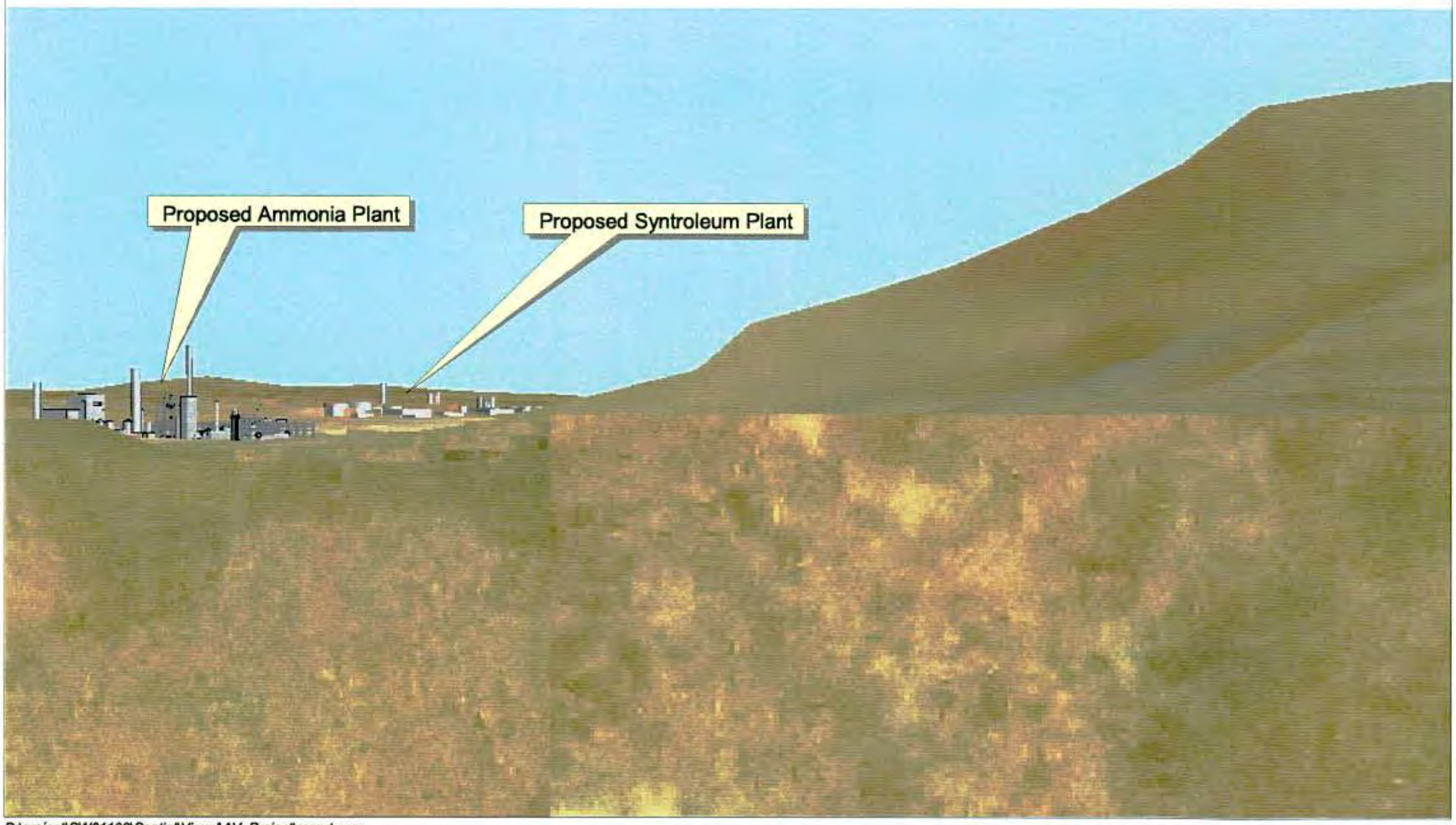
SINCLAIR KNIGHT MERZ

Sinclair Knight Merz
263 Adelaide Terrace
PO Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT
AERIAL VIEW OF PROPOSED AMMONIA PLANT
AND PROPOSED NEIGHBOURING DEVELOPMENTS
(FROM VIEW POINT 1)

FIGURE 8.5

Client: Burrup Fertilisers Pty Ltd
ProjectNo.: DE01890.006
Date Drawn: 23 July 2001
Map: A4-6925 Rev 2



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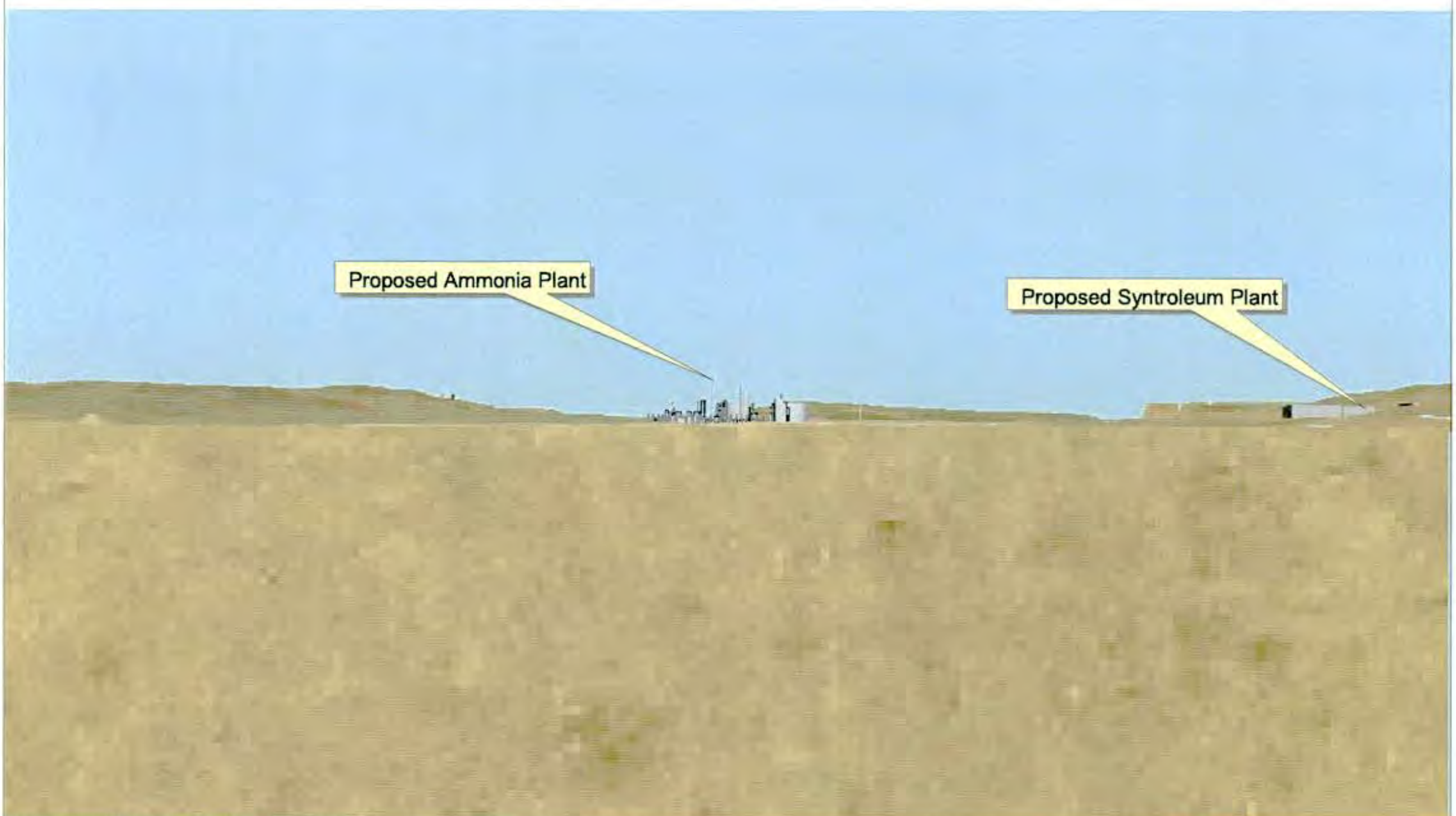
Sinclair Knight Merz
263 Adelaide Terrace
PO Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT
VIEW OF PROPOSED AMMONIA PLANT
FROM VILLAGE ROAD

(FROM VIEW POINT 2)

FIGURE 8.6

Client: Burrup Fertilisers Pty Ltd
ProjectNo.: DE01890.006
Date Drawn: 23 July 2001
Map: A4-6926 Rev 2



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Sinclair Knight Merz
263 Adelaide Terrace
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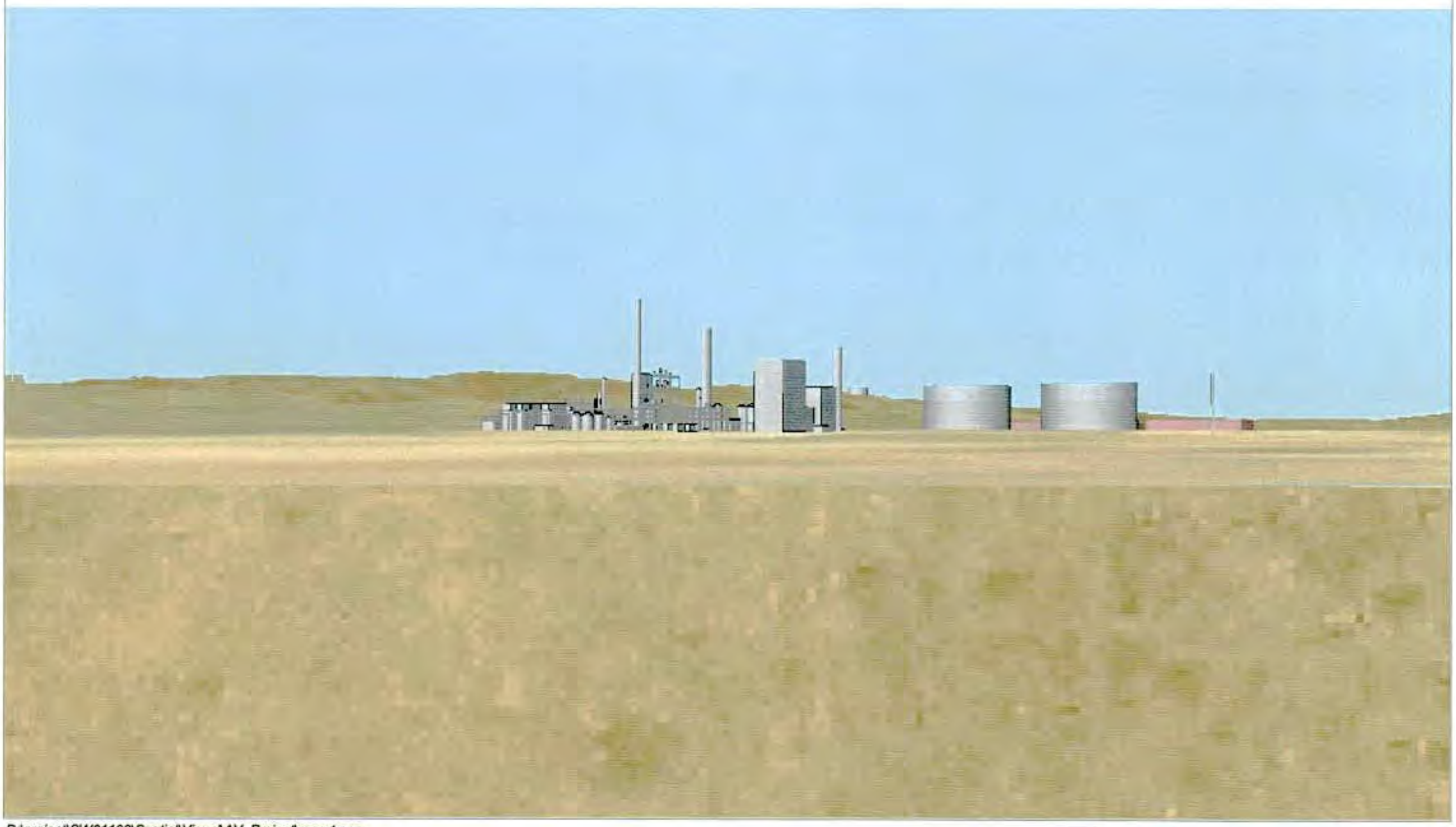
WA 6001 Australia

BURRUP AMMONIA PLANT
VIEW FROM INTERSECTION OF BURRUP ROAD AND HEARSON COVE ROAD

(FROM VIEW POINT 3)

FIGURE 8.7

Client: Burrup Fertilisers Pty Ltd
ProjectNo.: DE01890.006
Date Drawn: 23 July 2001
Map: A4-6927 Rev 2



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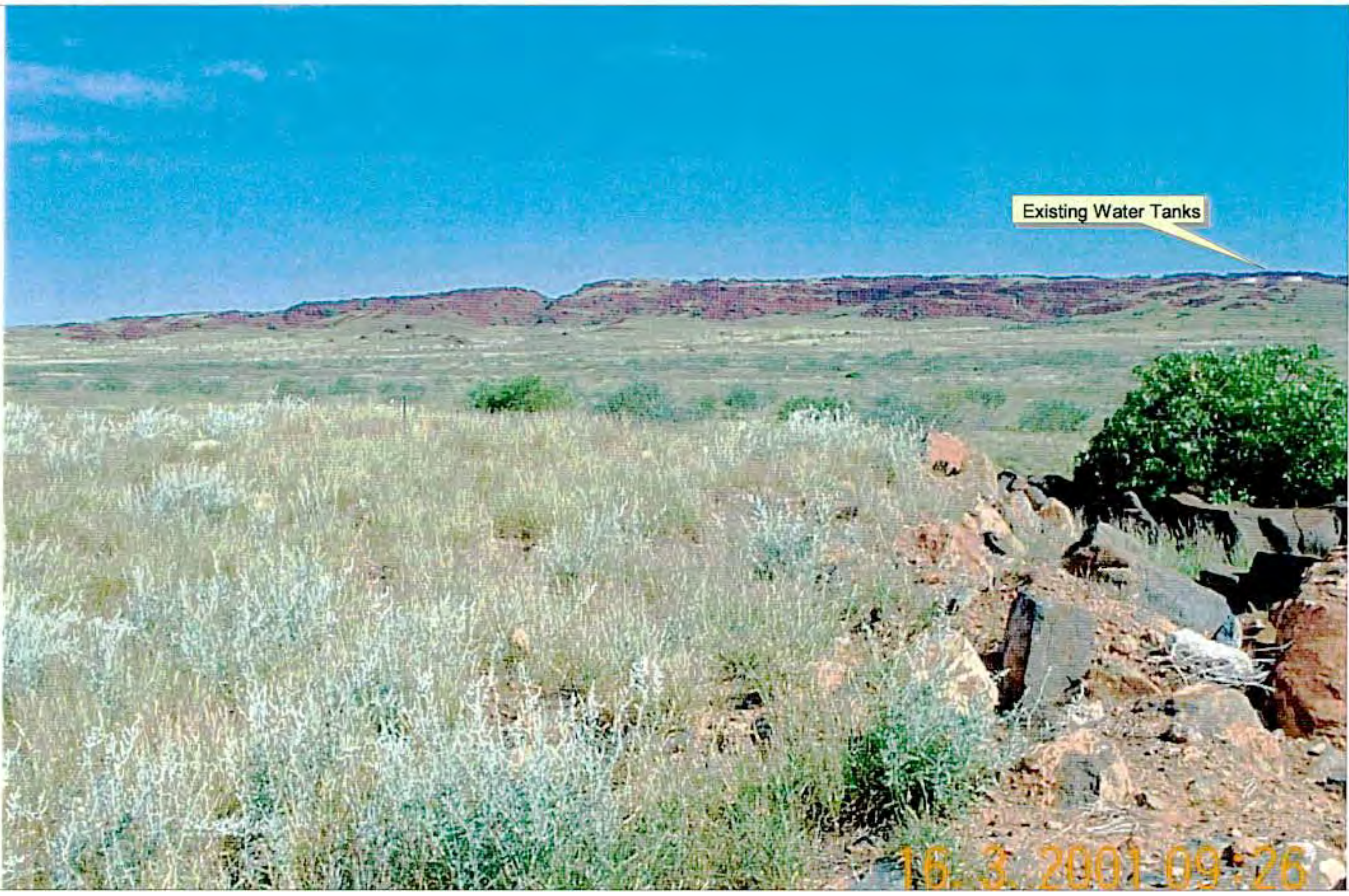
Sinclair Knight Merz
263 Adelaide Terrace
PO Box H615 Perth
WA 6001 Australia

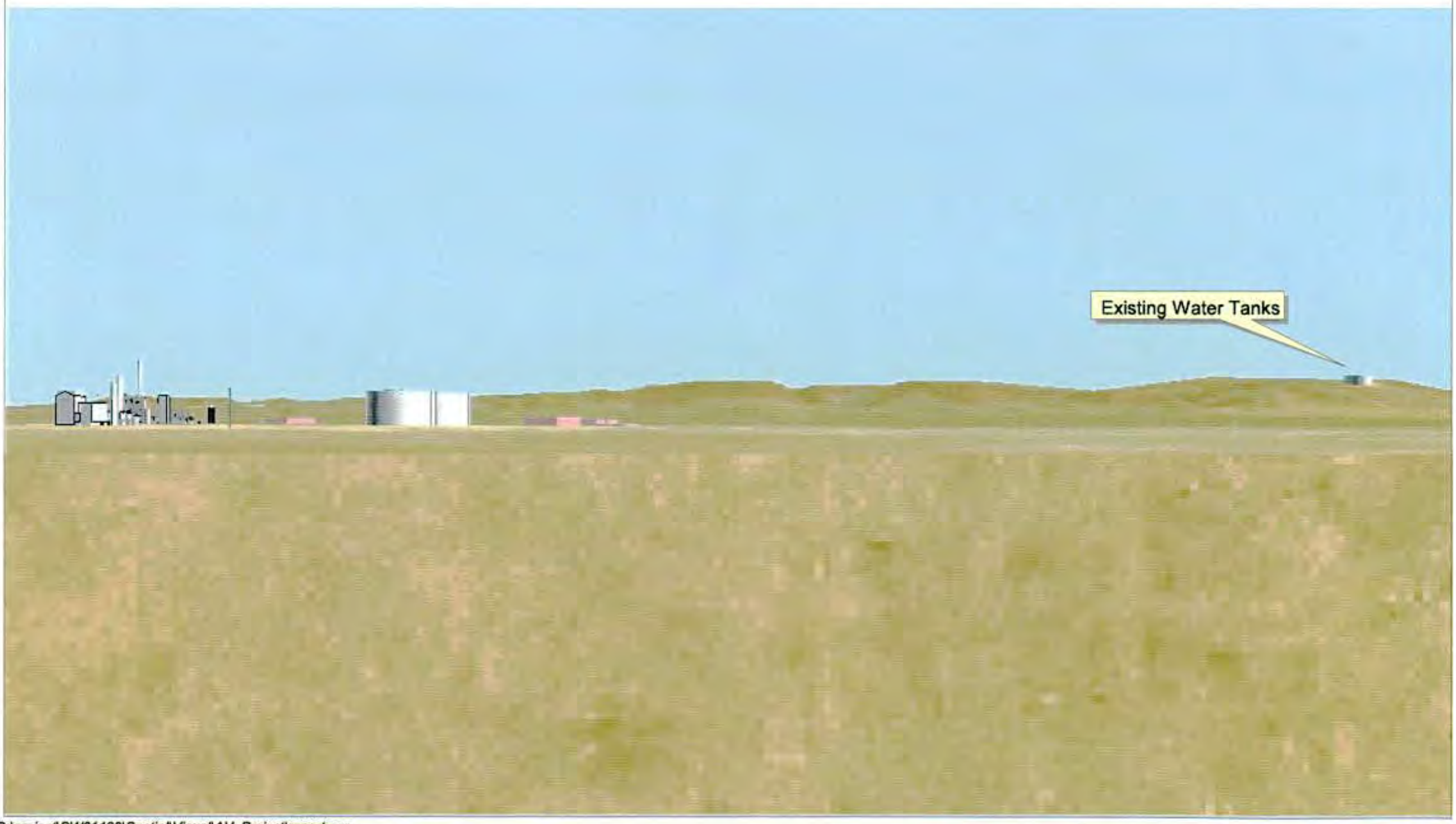
BURRUP AMMONIA PLANT
VIEW FROM HEARSON COVE ROAD
APPROX. 900m EAST OF BURRUP ROAD

(FROM VIEW POINT 4)

FIGURE 8.8

Client: Burrup Fertilisers Pty Ltd
ProjectNo.: DE01890.006
Date Drawn: 23 July 2001
Map: A4-6928 Rev 2





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SINCLAIR KNIGHT MERZ

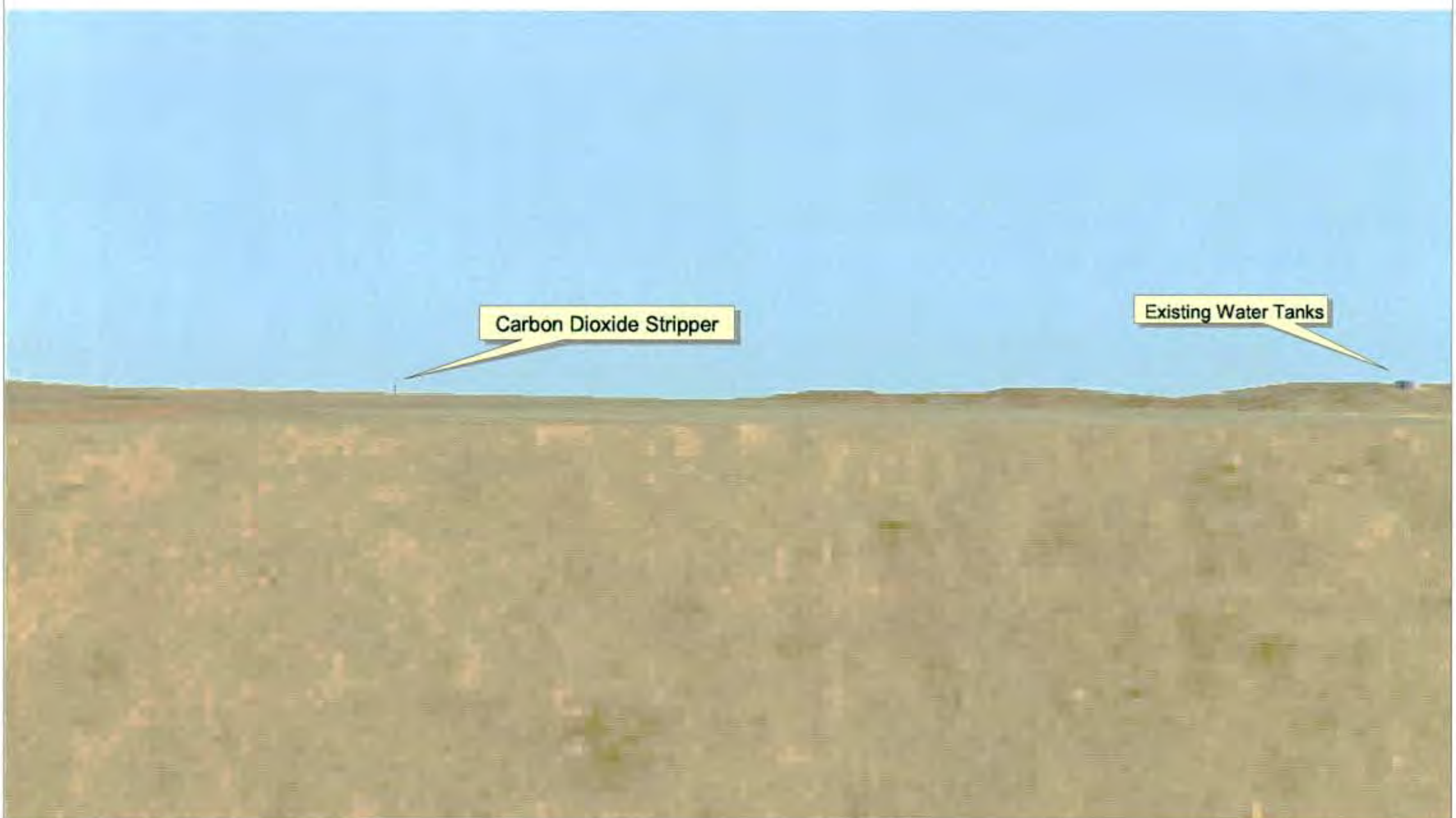
Sinclair Knight Merz
263 Adelaide Terrace
PO Box H615 Perth
WA 6001 Australia

BURRUP AMMONIA PLANT
VIEW FROM HEARSON COVE ROAD
APPROX. 2.3km EAST OF BURRUP ROAD

(FROM VIEW POINT 5)

FIGURE 8.9

Client: Burrup Fertilisers Pty Ltd
ProjectNo.: DE01890.006
Date Drawn: 23 July 2001
Map: A4-6929 Rev 2



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Sinclair Knight Merz
263 Adelaide Terrace
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BURRUP AMMONIA PLANT
VIEW FROM HEARSON COVE

(FROM VIEW POINT 6)

FIGURE 8.10

Client: Burrup Fertilisers Pty Ltd
ProjectNo.: DE01890.006
Date Drawn: 23 July 2001
Map: A4-6930 Rev 2

8.4.2 Light Spill

Management Commitment: To manage potential impacts from plant light overspill to visitors at Hearson Cove.

8.4.2.1 Potential Impacts

Light spill has the potential to impact marine environments and to also be of nuisance to nearby residents and recreational users of Hearson and Cowrie Coves. The determination of when light spill becomes obtrusive to others is difficult since physiological and psychological effects are involved. Extensive lighting is a common characteristic of chemical and industrial plants and is a mandatory safety feature. Residents of Dampier and Karratha and recreational users of Hearson and Cowrie Coves are well accustomed to industrial lighting of nearby industries such as the Woodside LNG plant. The flare from the Woodside LNG plant is a prominent feature of the night sky that is viewed as a tourist attraction.

It is unlikely that sensitive marine environments will be impacted by light spill as the plant is located approximately 1.2 kilometres from Hearson Cove and 1.5 kilometres from King Bay.

8.4.2.2 Management Strategies

To minimise the impacts of light spill the following management strategies will be undertaken:

***Management Commitment 8.4.4:** Lighting for the plant will be designed to best practice and will comply with relevant Australian Standards.*

- Lighting for the plant will be designed to best practice and will incorporate the guidelines of the Australian Standard AS 4282 (Int) 1997 *Control of the Obtrusive Effects of Outdoor Lighting.*

  This standard sets out guidelines for the control of obtrusive effects of outdoor lighting. It includes recommended limits for the relevant lighting parameters to control these effects. It also specifically refers to the potentially adverse effect of outdoor lighting on nearby residents (eg. dwellings such as houses, hotels and hospitals), users of adjacent roads (eg. vehicle drivers, pedestrians, cyclists) and transport signalling (eg. air, marine, rail), and on astronomical observations.

8.5 Aboriginal Heritage

Management Objective – To ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972 and to ensure that changes to the biological and physical environment resulting from the proposal do not adversely affect cultural associations with the area.

8.5.1 Aboriginal Heritage

Archaeological survey and ethnographic consultations were conducted during the months of June and July 2001 and results are presented in **Section 5.12**. Further ethnographic consultations are planned during the third quarter 2001. During the surveys, representatives including; engineering and geotechnical consultants; a municipal representative; surveyor; archaeologist and ethnographic consultant worked jointly with representatives from the Native Title claimant groups in an effort to ensure potential disturbance to Aboriginal heritage sites by project works would be minimised. This consultation work is continuing and is expected to be completed by late October 2001.

Each of the three main project areas, as listed above, were surveyed and wherever possible, the recommendations made by the Aboriginal representatives were adopted into the preliminary scoping documents that will become the basis of project design.

The Proponent has also undertaken a Preliminary Risk Analysis (PRA) of the ammonia plant site and associated gas supply and ammonia product delivery pipelines to ensure future safe access to existing Aboriginal heritage sites immediately to the north of the project lease. The PRA has established that project activities will not preclude the opportunity of controlled access by future visitors to these areas.

The results of the archaeology survey work have been compiled into a report entitled "Report on Archaeological Investigation of Aboriginal Sites: Burrup Fertilisers Ammonia Plant Project Area - Burrup Peninsula" (Quartermaine Consultants, June 2001). This report will be forwarded to the Aboriginal Affairs Department for their consideration.

In summary, the archaeological survey determined that, in reference to detailed site plans provided by the Proponent, the overall impact of potential project works on sites of Aboriginal heritage significance was minimal.

8.5.1.1 Archaeological Survey Results

Project Lease

Of the ten archaeological sites found within the project lease as presented in **Section 5.12**, the newly discovered Aboriginal heritage site (BF/FS1) and two existing but unregistered sites (DRD136 and DRD138) are likely to be disturbed during construction of the plant. These sites will be subject of an application to disturb sites pursuant to Section 18 of the *Aboriginal Heritage Act 1973.*

The three sites that will be impacted may be described as follows:

- **Site BF/FS1** - The new site is a shell midden with associated artefacts situated on the saline intertidal flats. Site dimensions are 5 by 10 metres. The site is considered to be of low archaeological significance because of the few artefacts present and the disturbed condition of the site.
- **DRD136** - A previously noted but unregistered site described as engravings and grinding patches is situated on the margin of the saline intertidal flats. No evidence was found at the reported site location although an occasional dolerite artefact was noted on the salt flat margins nearby. The site is considered to be of low archaeological significance because of the large number of such sites in the Burrup area together with the lack of any remaining archaeological material associated with the site.
- **DRD138** - A previously noted but unregistered site described as artefacts and shell accumulations measuring 100 by 30 metres is situated on the saline intertidal flats. No evidence was found at the reported site location and it was thought that this may have been due to recent floods that have scoured the area. The site is considered to be of low archaeological significance because

of the large number of such sites in the Burrup area together with the lack of any remaining archaeological material associated with the site.

Gas Supply, Ammonia Export and Water Pipeline Routes
Pipeline construction activities will be restricted to a 15 metre working width and therefore none of the registered sites presented in **Section 5.12** will be further disturbed by pipeline construction activities.

8.5.1.2 Management Strategies

Work undertaken to date in association with the Aboriginal custodians of the Burrup Peninsula, has determined that the development of the ammonia plant will have minimal effect on Aboriginal heritage sites existent within the project areas comprising the plant, product export pipelines, gas supply pipeline and water supply pipelines. Ethnographic consultation work continues with one other native title claimant group with a view to seek the group's consent for disturbance under Section 18 of the *Aboriginal Heritage Act 1973* of the three sites as described above.

To ensure that potential disturbance to documented Aboriginal heritage sites are minimised the following management strategies will be adopted by the Proponent:

***Management Commitment 8.5.1:** The Proponent is committed to the employment of Aboriginal representatives during project works to monitor all ground disturbances and earthworks.*

- Ensure that the ammonia plant footprint area and the associated water supply pipelines, are confined to areas of low lying salt pan to the south of the proposed lease area where heritage sites are less likely to be encountered as determined from the archival data;
- Ensure that the location of the plant site access road and associated infrastructure avoids heritage sites within the northern areas of the proposed plant lease area; and
- Consider the placement of the gas supply pipeline and ammonia product pipelines within established and previously disturbed road reserves, wherever possible, between the ammonia plant site and the Dampier public wharf precinct.

The above strategies are embodied by **Management Commitments 6.1.1.2 and 6.1.1.3**.

8.5.1.3 Monitoring

To ensure best management practice, the Proponent has given an undertaking to the Aboriginal custodians of land associated with the plant site and pipeline routes that, during earthworks on areas of ground that have not previously been disturbed, Aboriginal representatives will be employed to monitor the earthworks. In this context, earthworks have been defined as cut to a depth of 500 mm or fill to a depth of 500 mm.

During preparatory earthworks associated with the pipeline routes, Aboriginal representatives will also be employed to:

- Monitor ground disturbances;
- Ensure that ongoing consultation is maintained;

- Ensure that no disturbance to heritage sites adjacent to pipeline routes occurs; and
- Ensure inadvertent disturbance to Aboriginal heritage sites is avoided, especially in areas where the ground has not been previously disturbed.

8.5.2 Consultations

The Proponent has undertaken to engage representatives from each of the three Native Title claimant groups to assist in the Aboriginal heritage clearance work associated with the defined project areas. Preliminary discussion meetings and heritage clearance work undertaken to date have also served to identify general issues expressed by the claimant representatives which were not necessarily to do with heritage sites *per se* but were more related to perceived plant operations and project land use. The concerns may be summarised as follows.

- Water Courses: The placement of ammonia plant stormwater run-off systems should be designed to minimise land and marine environmental effects resulting from drainage flows particularly in the vicinity of King Bay (**refer to strategies and management commitments regarding marine ecology, hydrology and water quality summarised in Table 7-1**).
- Air Emissions: Ammonia plant air emissions should be demonstrably free of any adverse effect on the surrounding landscape and in particular to fresh water sources, heritage sites, medicinal plants, animals and traditional food sources (**refer to Section 7.2.1**).
- Plant Discharges: Plant discharges to ground and/or water should be demonstrably free of any contaminants that may adversely effect local flora and fauna. In particular, any adverse effects to Aboriginal engravings, wells and soaks are to be avoided (**refer to strategies and management commitments relating to waste, hydrocarbons and hazardous materials in Sections 7.2.3, 7.2.4 and 7.2.5**).
- Construction Concerns includes:
  - An approved project Environmental Management Plan should be implemented (**Commitment 6.02**).
  - Project personnel should undergo an Aboriginal cultural awareness program as part of the induction process prior to commencement of site work.
  - Aboriginal heritage sites adjacent to the lease area must be protected by restricting access to these sites during plant construction and operations.
  - Consideration should be given by the Proponent to assisting with protection and management of heritage sites adjacent to the proposed lease area.
  - The Hearson Cove beach should not be used for landing and transfer plant and/or equipment for use in project area. (**The Proponent will not require the use of Hearson Cove for the landing of equipment as the Dampier Public Wharf and Mermaid Marine provide sufficient capacity to land plant equipment**).

Management Commitment 8.5.2: *The Proponent will establish an Aboriginal cultural awareness program and will ensure that all project personnel undertake the program.*

Management Commitment 8.5.3: *The Proponent will ensure that access to Aboriginal heritage sites will be restricted during plant construction and operation.*

Management Commitment 8.5.4: *The Proponent will assist, where practicable, with the protection and management of heritage sites adjacent to the proposed lease area.*

The PER document has addressed these issues under various sections of this document as highlighted, and has made several specific management commitments related to Aboriginal heritage as shown.

8.6 Register of the National Estate

Management Objective – To identify any areas which are in close proximity to the proposal that are listed on the Register of National Estate or those areas on the Interim List, under the Australian Heritage Commission Act 1975.

A search of heritage places listed on the Register of the National Estate was undertaken in June 2001. The regions of Karratha, Dampier and the Burrup Peninsula were searched and revealed that nine places (**Table 8-5**) are registered under the National Estate as discussed in **Section 5.11**.

Table 8-5 Places Listed on the Register of the National Estate

Place Name	Location	Status
National Estate		
Coastal Margin Cape Preston to Cape Keraudren	Port Hedland	Indicative Place
Coastal Islands Mary Anne to Regnard	Mardie	Registered
Dampier Archipelago Marine Areas	Dampier	Indicative Place
Dampier Archipelago	Dampier	Registered
Grave Site on Dolphin Island	Dampier	Registered
Karratha Station Group	Karratha	Registered
Legendre Island Lighthouse	Dampier	Registered
Malus Island Whaling Site	Dampier	Registered
Pearling Relics Blackhawk Bay	Dampier	Registered

A definition of the 'status' names as they appear on the Register are:

- **Indicative Place:** The place is at some stage in the assessment process. The Australian Heritage Commission has not made a decision on whether the place should be entered in the Register.
- **Registered:** The place is in the register of the National Estate. Although some places may be legally registered because they are within a larger registered area, they may not necessarily possess intrinsic significance.

8.6.1 Potential Impacts

From the list of places registered under the National Estate (**Table 8-5**), the Dampier Archipelago is the only 'Place' that may be impacted by the proposed shipping of liquid ammonia. Potential impacts to the marine environment and habitats of the Dampier Archipelago may include:

- Spillage of ammonia at the load out or storage facility;
- Spillage of product from vessel collisions;
- Oil spills from vessel collisions;
- Disposal of stormwater potentially containing contaminants from the site to coastal areas;

- Impacts associated with disposal (by the Water Corporation) of cooling water, treated wastewater from the plant;
- Pollution of marine areas with TBT from antifouling on vessels;
- Introduction of exotic marine species from ballast water or on vessel hulls; and
- Impacts associated with dredging (by the Dampier Port Authority) to allow larger vessels to use the wharf.

These potential impacts have been previously addressed in **Section 7.1.1**.

8.6.2 Management Strategies

Management of the potential impacts on the marine environment of the Dampier Archipelago is discussed in **Section 7.1.1**. Management commitments that have been nominated by the Proponent are repeated below for ease of reference:

- **Management Commitment 7.1.1.1**: The Proponent will at all times carefully control the transfer of ammonia from the plant to the ship.
- **Management Commitment 7.1.1.2**: In the vent of a ship emergency, leak, blown line or failed connection with the vessel, the flow of ammonia to the ship will be terminated and ammonia will be recycled back to the plant.
- **Management Commitment 7.1.1.3**: The Proponent will prepare an Ammonia Spill Contingency Plan as part of the Operation Management Plan.
- **Management Commitment 7.1.1.4**: The Proponent will offer to join the committee of Technical Operators under Dampier Port Authority jurisdiction (to assist in the implementation of the Marine Pollution Contingency Plan).
- **Management Commitment 7.1.1.5:** During detailed design phase, the Proponent will ensure that adequate design features are in place to manage the quality of stormwater discharges such that the receiving environment is not adversely affected.
- **Management Commitment 7.1.1.6:** The Proponent will design the ammonia plant to meet the requirements of the DEP with respect to discharge of wastewater into Water Corporation's pipeline.
- **Management Commitment 7.1.1.7**: All vessels carrying Burrup Fertiliser products will be required to meet AQIS guidelines.
- **Management Commitment 7.1.1.8**: All vessels carrying Burrup Fertiliser products will meet the ballast water requirements of the Port of Dampier Environmental Management Plan.
- **Management Commitment 7.1.1.9:** The Proponent will ensure that all vessels comply with relevant legislation concerning antifoulants (TBT).

8.7 Recreation

Management Objective – To ensure that recreational users of the Hearson Cove area are not compromised.

8.7.1 Existing Conditions

The Burrup Peninsula consists of many protected coves which are used by the community for recreational purposes such as swimming and fishing. Hearson Cove, which is located approximately 1.2 kilometres to the east of the project lease, is the nearest recreational area to the project lease. Access to Hearson Cove can be readily made by two wheel drive vehicles as Hearson Cove Road has recently been sealed.

Further to the north of this cove and approximately 4 kilometres from the project lease is Cowrie Cove. Cowrie Cove is accessible only by four wheel drive vehicles and is therefore a less frequented destination for recreation.

8.7.2 Potential Impacts

Potential impacts on Hearson and Cowrie Coves that may occur as a result of the proposed development include:

- Impacts on visual amenity, including light spill from the operations during the evening (**Section 8.4);**
- Occurrence of nuisance odorous emissions (**Section 7.2.1.10**);
- Occurrence of nuisance noise emissions (**Sections 6.2.2 and 7.2.2);** and
- Issues related to public safety and traffic (**Section 8.2**).

The potential impacts have been previously addressed in this Public Environmental Review document and reference is made above to the relevant sections.

8.7.3 Management Strategies

Visual Amenity
The visual amenity of the plant and associated facilities from Hearson Cove will not be unduly impacted. From Hearson Cove, standing at the waters edge, it is unlikely that the plant will be seen (**Figure 8-7** illustrates the view of the plant whilst standing on the sand dunes of Hearson Cove).

Lighting of the plant is required for safety purposes however, to minimise the overspill of light, the Proponent will ensure that lighting for the plant will be designed to best practice and will comply with relevant Australian Standards (**Commitment 8.4.4**).

Atmospheric Emissions
Atmospheric emissions of nitrogen and sulphur oxides and ammonia are well within nominated standards and guidelines and will not require specific management strategies to further reduce proposed emissions of these gases.

As predicted in **Section 7.2.1**, air dispersion modelling predicts that maximum NO_2 concentrations at Hearson Cove would be well within the standards of the National Environmental Protection Measure (NEPM). Cumulatively, including the Syntroleum plant and the Plenty River plant, nitrogen oxide levels are also predicted to be well below the NEPM standard.

Sulphur dioxide and particulate emissions from normal operations will be negligible and will not impact on recreational users of Hearson Cove, Cowrie Cove or King Bay. Odorous emissions of ammonia may occur on extremely rare occasions where there is a failure of the refrigeration plant of the ammonia storage tanks. In the rare event that this may occur the maximum concentration at Hearson Cove or King Bay is predicted to be 42% of the Victorian EPA guideline of 250 $\mu g/m^3$. Given the extreme rarity of such an event occurring, the probability of the guideline being exceeded is predicted to be only once every 2800 years (**Section 7.2.1.10**).

Noise
The engineering feasibility study has included substantial provision for noise controls in the Bankable Feasibility Study to ensure compliance with boundary criteria. Allowing for at least 8 dB(A) reduction in noise emissions by the adoption of noise attenuation controls, the resulting noise level at Hearson Cove is predicted be in the order of 25 dB(A) to 32 dB(A). This is 5 dB(A) less than predicted noise levels from the approved Syntroleum plant. On this basis the proposed ammonia plant will be an insignificant contributor of noise at Hearson Cove.

Public Safety
Public safety at Hearson Cove and Cowrie Cove will not be compromised by the proposed development. The assessment of risks and hazards associated with the project indicated that recreational standards at Hearson Cove will not be compromised. The individual risk at Hearson Cove has been estimated to be less than 1×10^{-8} which is well within EPA acceptance criteria of 10×10^{-6}.

Management Commitment 8.7.1: *The Proponent will maintain a register of public complaints and investigate any substantiated complaints to the satisfaction of the Department of Environmental Protection.*

To ensure that recreational users of Hearson Cove and Cowrie Cove and other nearby recreational areas, including King Bay, will not be impacted by the proposed development, the Proponent will maintain a register of public complaints, and investigate any substantiated complaints to the satisfaction of the Department of Environmental Protection.

9. Public Consultation

The environmental review process is designed to provide information to the Environmental Protection Authority (EPA) and the public about proposed developments which have the potential to generate significant environmental impacts. An important element of the assessment process is the public exhibition of the PER document to enable members of the public, government agencies and other parties to evaluate the proposal and to make informed submissions to the EPA.

The statutory time requirement for the public review of the PER document is four weeks. Further to this requirement, the Proponent has recognised that a public open day will be required during the four week review period to ensure that local issues and concerns are addressed and to facilitate public and Government participation in environmental impacts of the proposal.

The public open day will be advertised in the North West Telegraph and where possible, Government bodies and community groups will be formally notified.

During the course of the PER preparation, the Proponent undertook preliminary consultations with a range of Government bodies and community groups based in Karratha and Perth including:

- Aboriginal Affairs Department
- Apache Energy
- Dampier Archipelago Preservation Association
- Dampier Port Authority
- Department of Conservation and Land Management
- Department of Environmental Protection
- Department of Land Administration
- Department of Minerals and Energy
- Department of Resources Development
- Main Roads Western Australia
- Karratha Chamber of Commerce and Industry
- Mermaid Marine
- Ministry for Planning
- Nickol Bay Naturalists Club
- Office of Energy
- Pilbara Development Commission
- Roebourne Shire Council
- Water and Rivers Commission
- Water Corporation
- Western Power
- Ngaluma-Injibandi Native Title claimant group;
- Wong-Goo-Tt-Oo Native Title claimant group;
- Yaburara and Coastal Mardudhunera Native Title claimant group

The environmental and social issues that were raised by the government bodies and community groups during preliminary consultations are summarised in **Table 1-3 .**

Following the project feasibility study potential synergies and sharing of services and equipment will be discussed with Woodside, Syntroleum and Plenty River Corporation. This may include items such as co-ordination of housing requirements and emergency response plans.

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10. Conclusion and Management Commitments

The proposed ammonia plant will have the design capacity to produce 2,200 tonnes of liquid ammonia per day from natural gas. At least 80% of the plant capacity will be exported to meet the captive needs of the phosphate complex of the Oswal Group at Paradeep in Orissa State, India. Significant benefits of the project would be value-added processing, export revenues as well as increased employment and multiplier effects at the local, regional, state and national levels.

The ammonia plant is designed using the latest low energy Purifier Ammonia technology available from Kellogg Brown Root. The ammonia plant utilises Best Available Techniques as recommended by the European Fertiliser's Manufacturing Association which ensures that emissions to the environment are minimised as far as practicable.

Further to meeting these standards, the Proponent is committed to ensuring that the development of the ammonia plant will be undertaken in a manner to minimise impacts on the surrounding biophysical and social environments. Accordingly, the Proponent has proposed numerous management commitments. These commitments are summarised in **Table 10-1**.

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Table 10-1 Summary of Proponent Management Commitments

No.	Commitment	Objective	Timing	Advising Agency
Environmental Management				
6.0.1	The Proponent will commence to prepare an Environmental Management System for the proposed ammonia plant within six months of project approval.	Manage all relevant environmental factors. Minimise environmental impacts. Comply with legal obligations. Continually improve environmental performance.	Within six months of project approval.	N/A
6.0.2	The Proponent will prepare an Environmental Management Plan for the construction and operational phases of the plant.	Manage all relevant environmental factors associated with the construction and operational phases of the project. Outline responsibilities and obligations. Enforce compliance.	The Construction Management Plan will be completed prior to commencement of construction. The Operations Management Plan will be completed prior to the commencement of operations.	DEP
Terrestrial Flora and Fauna				
6.1.1.1	Removal of vegetation will be kept to minimum by considering the layout of plant components and laydown areas during the detailed engineering design phase and providing adequate guidance in the Construction EMP.	Minimise the loss and impact to vegetation. Maintain the abundance and species diversity of flora and vegetation assemblages.	During detailed engineering design and construction phases of the project.	DEP
6.1.1.2	Disturbance to rockpiles, drainage lines and samphire communities will be avoided where practicable.	Minimise disturbance to areas considered to be significant in terms of vegetation communities and Aboriginal heritage.	During detailed engineering design and construction phases of the project.	N/A
6.1.1.3	The Proponent will develop a Rehabilitation Plan prior to construction to rehabilitate areas of temporary disturbance.	Maintenance of biodiversity and ecosystem integrity. Minimise impacts on visual amenity.	Prior to construction.	DEP CALM

No.	Commitment	Objective	Timing	Advising Agency
6.1.1.4	The Proponent will commence seed collection as soon as possible.	Collect an adequate stock of seed for rehabilitation	As soon as possible.	DEP
6.1.1.5	The Proponent will commence germination trials at a local nursery for several prominent flora species, including the Priority 1 species *Terminalia supranitifolia*, prior to construction.	Develop suitable techniques for the re-establishment of native vegetation on disturbed areas of the project lease.	Prior to construction.	DEP CALM
6.1.1.6	Where practicable, the Proponent will attempt to replace the Priority 1 flora species, *Terminalia supranitifolia*, that will be disturbed as a result of this proposal.	Maintenance of species abundance of Priority 1 flora.	Rehabilitation stage following the completion of plant construction.	DEP
6.1.1.7	A Weed Management Plan will be developed by the Proponent and included in the Environmental Management Plan for construction.	Prevent the spread of weeds and the introduction of new weed species. Protection and maintenance of native flora.	Prior to construction.	DEP CALM
6.1.1.8	The Proponent commits to undertake a second vegetation survey whereby the potential impacts from the proposed project will be reassessed in light of any further information that becomes available from the Burrup Vegetation Survey.	Determine the significance of the potential impacts from the project. Maintenance of species abundance and ecosystem integrity.	August-September 2001	DEP
6.1.1.9	The Proponent will assist government and nearby industries in the co-ordination and implementation of a local management plan for the King Bay-Hearson Cove Valley.	Minimise the impacts of industry on the environmental attributes of the King Bay – Hearson Cove Valley.	During operation	DEP DRD CALM
6.1.2.1	Disturbance of important fauna habitats including those of non-marine molluscan fauna, such as rockpiles and low lying grassed slopes and areas of marine influence will be minimised where practicable.	Minimise impacts on fauna and maintain abundance and species diversity.	Detailed engineering design and construction phases of the project.	DEP CALM
6.1.2.2	The Proponent will undertake a trapping survey in September/October and the results of the survey will be made available to the DEP prior to the conclusion of the EPA's assessment.	Further investigate the potential occurrence of the Pebble Mound Mouse and *Rattus tunneyi*, and other mammal and reptile species that are currently undescribed.	During September/October and prior to the conclusion of the EPA's assessment.	DEP CALM

No.	Commitment	Objective	Timing	Advising Agency
6.1.2.3	The Proponent will be prepared to contribute alongside industry and government bodies to a co-ordinated regional survey of molluscan fauna.	Increase knowledge base of existing status and distribution of molluscan fauna.	During operation.	DEP DRD CALM
6.1.2.4	The presence and quantity of mounds and burrows made by the Pebble Mound Mouse and *Rattus tunneyi* will be catalogued prior to construction and updated on a regular basis.	Maintenance of species abundance. Monitor the presence of significant fauna.	Complete catalogue prior to construction then update on a regular basis thereafter.	DEP CALM
6.1.2.5	Approved procedures for evacuating fauna will be followed if active mounds and burrows are identified.	Minimise the disturbance and loss of significant fauna.	Prior to construction and ongoing throughout operation.	DEP CALM
Topography and Landforms				
6.1.3.1	Disturbance to landforms will be minimised where practicable.	Minimise impacts on landforms and the significant environmental attributes they support.	During detailed engineering design and construction phases of the project.	DEP
6.1.3.2	Disturbance to rockpiles and high scree slopes will be avoided, where practicable.	Avoid disturbance of areas considered to be significant in terms of Aboriginal heritage and vegetation communities.	Detailed engineering design and construction phases of the project.	DEP
6.1.3.3	All planned disturbances will be marked on maps and pegged prior to the commencement of earthworks.	Ensure that all disturbances are minimised and that no unnecessary clearing is undertaken.	Prior to construction and the commencement of earthworks.	N/A
6.1.3.4	Vegetation and topsoil will be stockpiled for rehabilitation of areas of temporary disturbance.	Enhance the re-establishment of native vegetation.	Prior to construction.	N/A
6.1.3.5	Fill and gravel will be sourced during the detailed engineering design phase and as approved by the Shire of Roebourne.	Ensure that no potential adverse impacts occur as a result of the introduction of unsuitable fill and gravel.	Prior to construction.	Shire
6.1.3.6	All excavations will be backfilled following construction.	Restore disturbed surfaces to a condition that is suitable for rehabilitation. Prevent excavations from forming potential fauna traps.	During rehabilitation stage following the completion of construction.	N/A
6.1.3.7	All vehicles will be kept to designated tracks.	Minimise unnecessary disturbances of vegetation, fauna and the generation of dust.	During construction	N/A

No.	Commitment	Objective	Timing	Advising Agency
Hydrology and Site Drainage				
6.1.4.1	Surface water flows will be diverted around the construction site.	Prevent the contamination of surface water.	During construction.	N/A
6.1.4.2	Runoff from potentially contaminated areas will be collected treated, treated and tested prior to discharge.	Maintain the quality of surface water and marine water.	During construction.	N/A
6.1.4.3	A water quality monitoring program will be developed, prior to construction.	Maintain the quality of surface water and marine water.	Prior to construction.	DEP
6.1.4.4	An Erosion Control Plan will be developed prior to construction.	Maintain the quality of surface water and marine water and to prevent the off-site deposition of sediment.	Prior to construction.	DEP
Dust				
6.2.1.1	Dust control strategies will be implemented for all dust generating activities being carried out during the construction phase.	Ensure that dust does not cause an environmental or human health problem or adversely impact on amenity.	Prior to construction	DEP
6.2.1.2	The performance of the dust control strategies will be monitored and maintained during the construction phase.	Ensure that dust does not cause an environmental or human health problem or adversely impact on amenity.	During construction.	DEP
Noise				
6.2.2.1	The Proponent will prepare a Noise Management Plan to the satisfaction of the Department of Environmental Protection, as part of the Environmental Management Plan for construction.	Ensure that noise emissions comply with the Regulations and minimise impact on amenity of Hearson Cove.	Prior to construction.	DEP
6.2.2.2	The Proponent will formally respond to noise complaints during construction by preparing a report detailing monitoring results and proposed mitigation measures.	Ensure that noise emissions comply with the Regulations and minimise impact on amenity of Hearson Cove.	During construction	DEP

No.	Commitment	Objective	Timing	Advising Agency
7.2.2.1	During the detailed design phase of the project, the Proponent will situate plant components such that boundary noise levels do not exceed 65 dB(A).	Ensure that noise emissions comply with the Regulations.	During detailed design phase.	DEP
7.2.2.2	The Proponent will adopt a number of noise attenuation measures to meet criteria for boundary noise levels and to reduce levels at Hearson Cove.	Ensure that noise emissions comply with the Regulations and minimise impact on amenity of Hearson Cove.	During detailed design phase.	DEP
7.2.2.3	During the detailed design phase of the project, the Proponent will ensure that no tonal or modulating characteristics are present.	Ensure that noise emissions comply with the Regulations and minimise impact on amenity of Hearson Cove.	During detailed design phase.	DEP
Marine Ecology				
7.1.1.1	The Proponent will at all times carefully control the transfer of ammonia from the plant to the ship.	Minimise potential for spillage of ammonia and potential impact on surface water quality and public health.	During operation.	N/A
7.1.1.2	In the event of a ship emergency, leak, blown line or failed connection with the vessel, the flow of ammonia to the ship will be terminated and recycled back to the plant.	Minimise the potential impacts from spillages, leaks and other emergency events on water quality, the marine environment and public health.	During operation.	N/A
7.1.1.3	The Proponent will prepare an Ammonia Spill Contingency Plan as part of the Operation Environmental Management Plan.	Minimise the potential for spillage of ammonia and potential impacts on water quality, the marine environment and public health.	Prior to operation.	DEP DPA
7.1.1.4	The Proponent will offer to join the committee of terminal Operators under Dampier Port Authority jurisdiction.	To assist in the implementation of the Dampier Port Authority's Marine Pollution Contingency Plan.	Prior to operation.	DPA
7.1.1.5	During the detailed design phase, the Proponent will ensure that adequate design features are in place to manage the quality of stormwater discharges such that the receiving environment is not adversely impacted.	Minimise potential for contamination of marine waters and maintain marine ecological diversity and integrity.	During detailed design phase.	N/A

No.	Commitment	Objective	Timing	Advising Agency
7.1.1.6	The Proponent will design the ammonia plant to meet the requirement of the DEP with respect to the discharge of wastewater into Water Corporation's pipeline.	Minimise potential for contamination of marine waters and maintain marine ecological diversity and integrity.	During detailed design phase.	DEP Water Corporation
7.1.1.7	All vessels carrying Burrup Fertiliser products will be required to meet AQIS guidelines.	Minimise potential for contamination of marine waters and maintain marine ecological diversity and integrity.	Import of plant components and shipping of liquid ammonia.	AQIS
7.1.1.8	All vessels carrying Burrup Fertiliser products will meet the ballast water requirements of the Port of Dampier Environmental Management Plan.	Minimise potential for contamination of marine waters and maintain marine ecological diversity and integrity.	Import of plant components and shipping of liquid ammonia.	DEP DPA
7.1.1.9	The Proponent will ensure that all vessels comply with relevant legislation concerning antifoulants (TBT).	Minimise potential for contamination of marine waters and maintain marine ecological diversity and integrity.	During operation.	N/A
Water Quality				
7.1.2.1	All erosion and sediment control features of the plant will be inspected regularly and after each rainfall event.	Maintain or improve the quality of surface and groundwater to ensure that existing and potential uses and ecosystem maintenance are protected.	During operation.	N/A
7.1.2.2	All plant, equipment and storage vessels on site will be maintained and regularly inspected for leaks of fuels, oils and chemicals.	Maintain the quality of surface and groundwater to ensure that existing and potential uses and ecosystem maintenance are protected.	During operation.	DME
Atmospheric Emissions				
7.2.1.1	The Proponent will investigate the feasibility of meeting Best Available Techniques for reformer gas emissions during the detailed engineering design phase.	Minimise the potential impacts on the environment, human health and amenity from gaseous emissions.	During detailed design phase.	DEP
7.2.1.2	The Proponent will continue discussions with potential downstream processing facilities on the Burrup to take CO_2 off gas	Minimise emissions of greenhouse gas to atmosphere in accordance with Commonwealth and State policies.	Ongoing.	N/A

No.	Commitment	Objective	Timing	Advising Agency
7.2.1.3	The Proponent is prepared to participate in joint investigations into re-injection of CO_2 gas into a suitable aquifer or reservoir.	Minimise emissions of greenhouse gas to atmosphere in accordance with Commonwealth and State policies.	During operations.	N/A
7.2.1.4	The Proponent will undertake further investigations into the establishment of tree farms to sequester carbon dioxide form the atmosphere and/or to generate power to replace other non renewable fuels.	Minimise emissions of greenhouse gas to atmosphere in accordance with Commonwealth and State policies.	During operations.	N/A
7.2.1.5	The Proponent will enter the Greenhouse Gas Challenge upon project 'go ahead'.	Minimise emission of greenhouse gases to atmosphere in accordance with Commonwealth and State policies.	Upon project 'go ahead' with ongoing participation, thereafter.	DEP
Solid and Liquid Wastes				
6.2.3.1	All waste will be disposed in accordance with regulatory requirements.	Minimise potential for groundwater and surface water contamination or risk to public health.	During construction and operational phases.	DEP Shire
6.2.3.2	Solid waste quantities will be reported annually.	Minimise potential for groundwater and surface water contamination or risk to public health.	During operation.	DEP
6.2.3.3	Domestic wastewater during construction will be disposed in accordance with Health Department and local authority guidelines.	Minimise potential for groundwater and surface water contamination or risk to public health.	During construction.	Health Department Shire
7.2.3.1	Stormwater drainage system will be designed to separate potentially contaminated stormwater from clean stormwater.	Minimise potential for groundwater and surface water contamination or risk to public health.	During detailed design phase.	DEP
7.2.3.2	All stormwater (from both systems) will be tested and confirmed as being of suitable quality before its release off-site.	Minimise potential for groundwater and surface water contamination or risk to public health.	During operation.	DEP
7.2.3.3	Process liquid waste streams will be treated to meet Water Corporation and DEP acceptance criteria for discharge into the saline water outlet pipeline.	Minimise potential for groundwater and surface water contamination or risk to public health. To meet Water Corporation and DEP acceptance criteria.	During operation.	DEP Water Corporation

No.	Commitment	Objective	Timing	Advising Agency
7.2.3.4	Domestic wastewater during operations will be treated and effluent disposed in accordance with regulatory requirements.	Minimise potential for groundwater and surface water contamination or risk to public health. To meet regulatory requirements.	During operation.	Health Department Shire
7.2.3.5	Waste Management Plans will be developed around a waste management hierarchy.	Minimise potential for groundwater and surface water contamination or risk to public health.	Prior to construction or commissioning as appropriate.	DEP Health Department Shire
7.2.3.6	Spent catalyst will be returned to the manufacturer whenever possible.	Minimise potential for groundwater and surface water contamination or risk to public health.	During operation.	N/A
7.2.3.7	Solid waste disposed to landfill will comply with regulatory requirements.	Minimise potential for groundwater and surface water contamination or risk to public health.	During operation.	DEP Shire
7.2.3.8	Waste plans will be audited.	Minimise potential for groundwater and surface water contamination or risk to public health. To ensure that waste plans are being followed and that they are continually approved.	During construction and operation as appropriate.	N/A
7.2.3.9	Waste quantities will be documented and reported annually.	Minimise potential for groundwater and surface water contamination or risk to public health.	During operation.	N/A
Hydrocarbon Management				
7.2.4.1	Hydrocarbons will be minimised, contained and segregated from other areas	Maintain the quality of surface and groundwater and protection of ecosystems or risk to public health.	During detailed design phase and operation.	DME
7.2.4.2	Hydrocarbons will be managed in accordance with Australian Standards.	Maintain the quality of surface and groundwater and protection of ecosystems or risk to public health.	Detailed engineering design and operation.	DME
Hazardous Materials Management				
7.2.5.1	The storage, handling and transportation of hazardous materials will comply with local and State regulations.	Maintain the quality of surface and groundwater and protection of ecosystems or risk to public health. Comply with local and state regulations.	During operation	DME

No.	Commitment	Objective	Timing	Advising Agency
7.2.5.2	A Hazardous Material Management Plan will be implemented.	Minimise potential for groundwater and surface water contamination or risk to public health and to maintain the protection of ecosystems.	Prior to construction.	DEP DME
7.2.5.3	Ammonia will be stored in refrigerated and double walled double integrity tanks.	Minimise potential for groundwater and surface water contamination or risk to public health and to maintain the protection of ecosystems.	Detailed engineering design.	DEP DME
7.2.5.4	MDEA solution will be contained within a closed pipeline loop that can be drained to a sump.	Maintain the quality of surface and groundwater and protection of ecosystems or risk to public health.	Detailed engineering design.	DEP
7.2.5.6	Purchasing and inventory records will be kept for all hazardous materials.	Maintain the quality of surface and groundwater and protection of ecosystems or risk to public health.	During operation.	DME
Saline Water				
7.2.6.1	Seawater cooling circuits will be continuously monitored for pressure, flow and temperature.	Minimise potential for groundwater and surface water contamination or risk to public health.	During operation.	DEP
Infrastructure and Services				
8.1.1	The Proponent will assist the Department of Resources Development, local government and other industries to co-ordinate infrastructure and services on the Burrup Peninsula.	To create synergies with other industries and to ensure that infrastructure and services are not constrained.	On a continual basis throughout the life of the project.	DRD Shire
Public Safety				
8.2.1.1	The Proponent will establish a Safety Management System and Safety Plan prior to commissioning.	To ensure that the risk to the public is as low as reasonably practicable and complies with acceptable standards.	Prior to commissioning.	DME
8.2.1.2	The Proponent will prepare an Emergency Response Plan prior to commissioning.	To ensure that the risk to the public is as low as reasonably practicable and complies with acceptable standards.	Prior to commissioning.	DME
8.2.1.3	The Proponent will participate with other industries in the development of a Burrup Industrial Integrated Emergency Plan.	To ensure that the risk to the public is as low as reasonably practicable and complies with acceptable standards.	Ongoing as appropriate.	DME

No.	Commitment	Objective	Timing	Advising Agency
8.2.1.4	The Proponent will incorporate where practicable, emergency release coupling to close wharf isolation valves.	To ensure that the risk to the public is as low as reasonably practicable and complies with acceptable standards.	During detailed design phase.	DME
8.2.1.5	The Proponent will provide water curtains and/or sprays, where practicable, at the ammonia scrubber and ammonia refrigeration sections.	To ensure that the risk to the public is as low as reasonably practicable and complies with acceptable standards.	During detailed design phase.	DME
8.2.2.1	The Proponent will prepare and enforce a Traffic Management Plan, prior to construction.	To minimise potential traffic impacts and ensure safety of public during construction.	Prior to construction.	MRWA Shire
Social Surroundings				
8.3.1.1	The Proponent will consult with the Department of Resources Development, the Shire of Roebourne and the Department of Land and Administration to establish suitable accommodation.	To co-ordinate accommodation requirements and minimise potential for accommodation shortages in Karratha and Dampier.	Prior to construction and during commissioning.	DRD Shire DOLA
8.3.1.2	The Proponent will comply with the Shire of Roebourne's Transient Workforce Accommodation Policy.	To minimise potential constraints on existing accommodation facilities.	Prior to, and during construction.	Shire
8.4.1	Where possible, buildings will be coloured to blend into the surrounding terrain.	Minimise potential impacts on visual amenity.	Detailed design phase.	N/A
8.4.2	All temporary disturbances will be rehabilitated and revegetated with local species.	Minimise potential impacts on visual amenity	Rehabilitation stage following construction	CALM
8.4.3	A high standard of housekeeping will be maintained at all times.	Minimise potential impacts on visual amenity	During construction and operation	N/A
8.4.4	Lighting for the plant will be designed to best practice and will comply with relevant Australian standards.	Ensure employee safety and minimise potential impacts on visual amenity.	During detailed design phase.	N/A

No.	Commitment	Objective	Timing	Advising Agency
8.5.1	The Proponent is committed to the employment of Aboriginal representatives during project works to monitor all ground disturbances and earthworks.	Ensure that changes in the biological and physical environment resulting from the proposal do not adversely affect cultural associations of the project lease.	During construction	N/A
8.5.2	The Proponent will establish an Aboriginal cultural awareness program and will ensure that all project personnel undertake the program.	Ensure that changes in the biological and physical environment resulting from the proposal do not adversely affect cultural associations of the project lease.	Prior to construction and during operations.	N/A
8.5.3	The Proponent will ensure that access to Aboriginal heritage sites will be restricted during plant construction and operation.	Ensure that changes in the biological and physical environment resulting from the proposal do not adversely affect cultural associations of the project lease.	During construction and operations.	N/A
8.5.4	The Proponent will assist, where practicable, with the protection and management of heritage sites adjacent to the proposed lease area.	Ensure that changes in the biological and physical environment resulting from the proposal do not adversely affect cultural associations of the project lease.	During construction and operations.	N/A
8.7.1	The Proponent will maintain a register of public complaints and investigate any substantiated complaints to the satisfaction of the Department of Environmental Protection.	Maintain a good relationship with the community and to ensure that the environmental performance of the plant is maintained and continually improved.	Construction and Operation	DEP

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12. Abbreviations

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AQIS	Australian Quarantine Inspection Service
BAT	Best Available Technique
BFW	Boiler Feed Water
CO_2	Carbon Dioxide
CW	Cooling Water
DAP	Di-ammonium Phosphate
DBNG	Dampier to Bunbury Natural Gas Pipeline
DEP	Department of Environmental Protection
DMW	Demineralised Water
DOLA	Department of Land and Administration
DPA	Dampier Port Authority
DRD	Department of Resources Development
EFMA	European Fertiliser Manufacturer's Association
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Environmental Protection Authority
EPBC	Environmental Protection and Biodiversity Conservation Act
HAT	Highest Astronomical Tide
HT	Haldoe Tapsoe
IRPA	Individual Risk Per Annum
KBR	Kellogg Brown Root
LAT	Lowest Astronomical Tide
LHV	Low Heating Value
LNG	Liquefied Natural Gas
MP	Medium Pressure
NEPM	National Environmental Protection Measure
NH_3	Ammonia
NHMRC	National Health and Medical Research Council
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NPI	National Pollutant Inventory
NPK	Nitrogen-Phosphorus-Potassium
NO_x	Oxides of Nitrogen
NTT	Native Title Tribunal
OPL	Oswal Projects Limited
PER	Public Environmental Review
PM	Particulate Matter (PM $_{50}$ particles , 50μm diameter. PM_{10} particles , 10μm)
SO_2	Sulphur Dioxide
TDS	Total Dissolved Solids
USEPA	United States Environment Protection Agency
VOC	Volatile Organic Compound

UNITS

dB(A)	decibels 'A' weighted
kJ/h	kilojoule per hour
TJ/d	terajoule per day
kPa	kilopascal
km	kilometre
kV	kilovolt
μg/m^3	microgram per cubic metre
g/s	grams per second
m	metre
mg/Nm^3	milligrams per Normal metre cubed
m^3	cubic metre
MW	megawatt
W/m^2	watts per square metre
ppm	part per million
ppb	parts per billion
t	tonne
tpa	tonne per annum
tpd	tonne per day
Tcf	trillion cubic feet

UNIT CONVERSION

1t	= 1000kg
1kg	= 1000g
	= 1000 000mg
	= 1000 000 000μg

13. Study Team

Burrup Fertilisers Pty Ltd

- Pankaj Oswal – Managing Director
- Vikas Rambal – Project Director

Sinclair Knight Merz (Lead Consultant)

- Lorie Jones – Environmental Project Manager, Executive Environmental Engineer
- Gary Layton – Engineering Project Manager
- Jenny Lazorov – Technical Writer, Environmental Scientist
- Dr Owen Pitts – Senior Atmospheric Scientist
- Rowena Bird – Environmental Engineer
- Hendry Young – Senior Environmental Engineer
- Dr Peter Morrison – Senior Marine Scientist
- Geordie Clapin – Marine Scientist
- Dr David Lindsey – Acoustics Manager
- Dr Lisa Pollard – Senior Planner
- Sylvia Lawrence – Mechanical Engineer
- Shawn Ryan - Mechanical Engineer
- Ian Jackson – GIS/IT Project Manager
- Brett Plummer – GIS/IT Officer
- Casey Bates - Cartographer

Kellogg Brown Root (Process Plant Design Engineers)

- Stephen Gallagher – Project Manager
- David Malley

Qest Consulting Group (Risk Sub-consultant)

- Richard Keys – Managing Director
- Melissa Monaghan – Project Manager, Senior Risk and Safety Consultant
- Philip Doray – Safety Consultant
- Jason Muirhead – Risk and Safety Consultant
- Michael Sheehy - Risk Consultant
- Stewart Olney - Principal Risk and Safety Consultant

Astron Environmental (Flora and Fauna Sub-consultant)

- Vicki Long – Project Manager, Senior Botanist
- Jenny Mcilwain – Zoologist
- John Nicholson – Zoologist

- Shirley Slack-Smith – Zoologist WA Museum
- Peter Chalmers – GIS/Cartographer

Wyeth and Associates Pty Ltd (Aboriginal Heritage Sub-consultant)

- Harry Wyeth – Director
- Gary Quartermaine – Consultant Archaeologist

Environmental Protection Authority Guidelines for Preparation of the Public Environmental Review Document (*Part A: Specific Guidelines*)

APPENDIX A

Environmental Protection Authority

Mr Vikas Rambal
Project Director
Burrup Fertilisers Pty Ltd
Level 8, St Georges Square
225 St Georges Terrace
PERTH WA 6000

Our Ref 150/01, 166557
Enquiries Keith Collins
Email keith.collins@environ.wa.gov.au

Dear Vikas

AMMONIA PLANT, BURRUP PENINSULA (ASSESSMENT NO 1370)

Thank you for making yourself available to brief me on the ammonia plant proposed for the Burrup Peninsula. Please find attached the final guidelines specifying the scope and content of the environmental review document for the above proposal.

During the preparation of the environmental review document you are encouraged to consult with Mr Keith Collins, the Department of Environmental Protection's assessment officer for the project, who can be reached by telephone on 9222 7181.

Yours sincerely

Bernard Bowen

Bernard Bowen
CHAIRMAN

Westralia Square, 141 St Georges Terrace, Perth, Western Australia 6000. Telephone: (08) 9222 7000. Facsimile: (08) 9222 7155.
Postal Address: PO Box K822, Perth, Western Australia 6842.

Environmental Protection Authority
Guidelines

AMMONIA PLANT, BURRUP PENINSULA

(Assessment Number 1370))

Part A	Specific Guidelines for the preparation of the Public Environmental Review document
Part B	Generic Guidelines for the preparation of an environmental review document

Attachment 1	Example of the invitation to make a submission
Attachment 2	Advertising the environmental review
Attachment 3	Project location map
Attachment 4	Air quality and air pollution modelling Guidelines
Attachment 5	Scope of Work for a Preliminary Risk Assessment

These guidelines are provided for the preparation of the proponent's environmental review document. The specific environmental factors to be addressed are identified in Part A. The generic guidelines for the format of an environmental review document are provided in Part B.

The environmental review document must address all elements of Part 'A' and Part 'B' of these guidelines prior to approval being given to commence the public review.

Part A: Specific Guidelines for the preparation of the Public Environmental Review (PER)

1. The proposal

Burrup Fertilizers Pty Ltd proposes to construct an export orientated ammonia production plant on the Burrup Peninsula in the King Bay/Hearson's Cove area. The proposed location of the plant is indicated on the attached plan (Attachment 3).

The proposed plant will convert natural gas into liquid ammonia at a design capacity of 2 200 tonnes per day. Ammonia is used in the manufacture of chemicals and fertilizers, and it is expected that at least 80% will be exported to the Oswal Group in India.

The project will use the existing Dampier Public Wharf, but will require dredging of the seabed to extend the berthing pocket for the ammonia ships. This will be the subject of a separate referral to the EPA. Seawater cooling water supplies and discharges will be via a contract with the Water Corporation, as part of the desalination plant proposal. As a result, the Guidelines do not include the marine impacts from both the foregoing activities.

Could you please supply the project officer with an electronic copy of the document for use on a PC (Microsoft Word 2000), along with any scanned figures. Where possible, figures should be reproducible in a black and white format.

2. Objectives of the PER

The objectives of the PER are to:

- describe the alternative locations and technology reviewed for the plant, and the reasons behind the final proposed site at King Bay/Hearson Cove and the technology and plant configuration chosen;
- communicate clearly with the public (including Government Agencies) the environmental factors and impacts involved with the proposal, so that the EPA can obtain informed public comment to assist in providing advice to the Minister for the Environment and Heritage; and
- allow the provision of detailed environmental management commitments, demonstrating that the environmental impacts of the proposal can be managed to achieve best practice.

The PER and commitments will form the legal basis of the Minister's approval of the proposal. Hence the PER should include a description of all the main and ancillary components of the proposal. The PER should be simple and concise, as the readership will include non-technical people. Any extensive technical detail should be referenced or appended to the PER.

The PER should clearly explain the impacts, management strategy and predicted outcomes of the proposal in terms of the marine, terrestrial, atmospheric and social environments. The PER should also address cumulative impacts from other industry in the area.

Contents of the PER

The contents of the PER should include, inter alia:

- synopsis of the proponent, the proposal, location, project benefits, objectives and justification for the project and possible future expansions;
- a clear overlay of a suitably scaled aerial photograph, which clearly indicates the nature and extent of the major elements of the proposal, including gas and product pipeline routes;
- an outline of alternatives and indication of the consequences of not proceeding with the proposal;
- a map showing the proposal in a regional context;
- a detailed process flow diagram showing the process steps and unit operations. Diagrams showing mass, water and energy balances, indicating inputs, outputs, emissions and waste streams (either separately or combined);
- information on 'materials intensity per unit of service'. This relates to the material inputs necessary for production, distribution and use to the end-user service provided by any good. This information will provide comparative data for sustainability.
- a summary table that describes the key characteristics of the proposal. This should show a description of the components of the proposal, including the nature and extent of works proposed;
- the legal framework, decision-making authorities and involved agencies;
- description of the components of the proposal and particularly those aspects likely to involve environmental effects;
- description of the receiving environment which may be impacted, including relevant quantitative data and biological information;
- identification of the environmental factors and potential impacts, including short-term, long term, and cumulative impacts on the environment; site selection criteria for the onshore land requirements and discussion and evaluation of the advantages and disadvantages of feasible and prudent alternatives and reason for the final choice.
- discussion of the relevant environmental factors, including an assessment of their significance as related to objectives and standards which may apply; and consideration of relevant government requirements which may apply (eg Burrup Land Use Plan, EPA Guidance Statements);
- details of consultation with Woodside, Syntroleum and Plenty River Corp, and any other companies likely to be involved or affected by this proposal, with respect to project services, synergies, safety, risks and environmental matters (cumulative impacts);
- details of consultation with the Dampier Port Authority as to export of the product and shipping impacts; and the Shire of Roebourne as to road access and impacts at Hearson Cove;
- a summary of the environmental management program, safety management system including the key commitments, monitoring work and auditing of the program.

2. Environmental factors relevant to this proposal

The PER should focus on the relevant environmental factors for the proposal for both the construction and operation phases. A description of the project component and the receiving environment should be included with, or referred to, the discussion of the factor. The technical basis for measuring the impact and any specifications or standards for assessing and managing the factor should be provided. The environmental factors and their corresponding environmental management objectives, impacts, strategies for minimising impacts, and outcomes, should be set out under the following categories:

- biophysical;
- pollution; and
- social surroundings.

Further factors may be raised during the preparation of the PER. Regular consultation with the DEP and other relevant agencies will be necessary. Minor issues which can be readily managed as part of normal operations for any existing operations or similar projects may be briefly described.

Information used to reach conclusions should be properly referenced, including personal communications. Assessments of the significance of an impact should be soundly based and preferably comparatively quantified, rather than based on unsubstantiated opinions. The assessment should lead to a discussion of the management of the environmental factor.

At this preliminary stage, the Environmental Protection Authority (EPA) believes the relevant environmental factors, objectives and work required are as detailed in the table below:

CONTENT		SCOPE OF WORK	
Factor	**Site specific factor**	**EPA objective**	**Work required for the environmental review**
BIOPHYSICAL			
Terrestrial flora	vegetation communities	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	Undertake a suitable field survey to determine the existing abundance, species diversity, geographic distribution and significance of vegetation communities. (See Preliminary EPA Position Statement No.3 'General Requirements for Terrestrial Biological Surveys') Provide details of potential impacts from the proposal, including infrastructure corridors, and how they will be addressed. Proposed measures to manage impacts, including details of weed management.
	Declared Rare and Priority Flora	Protect Declared Rare and Priority Flora, consistent with the provisions of the *Wildlife Conservation Act 1950*.	Undertake a suitable field survey to determine the presence of Declared Rare and Priority Flora Provide assessment of potential impacts from the proposal, including infrastructure corridors(including impacts on vegetation communities) and how they will be addressed. Proposed measures to manage impacts.

Terrestrial fauna	specially protected (Threatened) fauna	Maintain the abundance, species diversity and geographical distribution of terrestrial fauna. Protect Specially Protected (Threatened) Fauna, consistent with the provisions of the *Wildlife Conservation Act 1950*.	Undertake a suitable field survey to determine the existing abundance, species diversity and geographic distribution of terrestrial fauna including Specially Protected (Threatened) Fauna. Provide an assessment of potential impacts from the proposal, including infrastructure corridors, and how they will be addressed. Proposed measures to manage impacts.
Marine ecology including sea floor, marine flora and fauna		Maintain marine ecological integrity and biodiversity and ensure that any impacts on locally significant marine communities are avoided.	The proposal has the potential to cause marine impacts through its shipping activities, from introduced marine pests in ballast water, wastewater discharges, the use of TBT anti-fouling agents, and spills. Provide details of potential impacts from proposal, and how the risks of introduction of unwanted marine organisms consistent with the AQIS Guidelines for ballast water management, and ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance, will be minimised.
Landform, drainage and site hydrology		Maintain the integrity, functions and environmental values of landforms and natural surface water drainage.	Provide details of potential impacts from proposal and pipeline corridors, on landform, natural surface water drainage, sediment transport and how they will be addressed. (Draft Guidance No.26 'Management of Surface Run-Off from Industrial and Commercial Sites) Include details of requirements for and sourcing of raw materials for fill in levelling of the site for construction. Proposed measures to manage impacts.

	Impact of high tide flow events	To protect the hydrological role of the flood plain so that any changes do not result in unacceptable environmental impact.	Provide details of potential impacts from flood events and how these will be addressed.
Water quality	Surface and groundwater quality	Maintain or improve the quality of surface and groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the National Water Quality Management Strategy-Australian and New Zealand Guidelines for Fresh and Marine Water Quality (*draft* October 2000).	Provide a detailed explanation of wastewater discharge from the site, options considered, assessment of options and steps taken to avoid or minimise impacts on the environment. Provide details of potential impacts on surface and groundwater quality and how they will be addressed with a specific emphasis on management of downstream impacts. Details of chemical storage and management on site should be included.

POLLUTION MANAGEMENT			
Atmospheric emissions	Applies to all gaseous and particulate emissions. Additional guidelines for specific pollutants appear below.	(i) Ensure that gaseous emissions, from this proposal in isolation and in combination with emissions from neighbouring sources and background concentrations, do not cause ambient ground level concentrations to exceed appropriate criteria, (including the NEPM for Ambient Air Quality, with advice sought from the DEP on specific pollutants as necessary), or cause an environmental or human health/ amenity problem; and (ii) Use all reasonable and practicable measures to minimise the discharge of significant atmospheric wastes such as NOx, SOx, greenhouse gases, toxic gases, particulates and smoke.	The proponent is responsible for identifying and quantifying all emissions to atmosphere from the proposal with a potential to have non-trivial impact on the environment (including impact on human health, nuisance, amenity, vegetation or fauna). Note: The proponent should refer to the Air Quality and Air Pollution Modelling Guidelines in Attachment 4 for a discussion of identification and modelling required. Provide details of any potential impacts (including cumulative impacts) and how they will be minimised and managed.
	NOx	As above Ambient NOx levels from the proposal should be compared with the NEPM for Ambient Air Quality, and may be compared to other standards recognised in Australia. If gas turbines are to be used then the EPA's Guidance for the Assessment of Environmental Factors relating to oxides of nitrogen should be met.	Provide a detailed explanation of NOx emissions and steps taken to minimise emissions of NOx. Provide justification of the ratio of NO to NO_2 used in modelling (as outlined in Attachment 4). Compare levels of NOx emitted from the proposed plant with levels from other ammonia plants. Provide details of any impacts (including cumulative impacts) and how they will be addressed and managed.

	Photochemical smog	As above Predicted ambient ozone levels from the proposal should be compared with the NEPM for Ambient Air Quality.	Provide details of any impacts (including cumulative impacts) and how they will be addressed.
	Odour	As above. No unreasonable impacts at boundary of the plant and Hearson Cove.	Provide details of odorous emissions and how these will be controlled. If necessary and appropriate, undertake an odour assessment in accordance with the EPA draft Guidance No.47 'Assessment of Odour Impacts'. Proposed measures to manage impacts.
	Dust	Ensure that dust generated during construction and operation does not cause any environmental or human health problem or significantly impact on amenity; and (ii) Use all reasonable and practicable measures to minimise airborne dust.	Provide details of dust emission sources during construction and operation and how these will be managed. Provide details of any potential impacts and measures to minimise impacts of dust.

Greenhouse gases		To minimise greenhouse gas emissions in absolute terms and reduce emissions per unit product to as low as reasonably practicable. To mitigate greenhouse gas emissions in accordance with the Framework Convention on Climate Change 1992, and in accordance with established Commonwealth and State policies. Proponents are required to: take all "no regrets" measures in construction and operation; take "beyond no regrets" measures which are reasonable and practicable; and commit to a programme of investigation, research and reporting of and progressive implementation of "no regrets" and "beyond no regrets" measures.	Provide details of greenhouse gas emissions, and using annual CO^2 equivalent quantities, provide a comparison with other plants producing similar products (considering the full life cycle). Provide details of efforts to reduce greenhouse gas emissions to best practice levels. Quantify the greenhouse emission levels which would be considered "business as usual", "no regrets" and "beyond no regrets". Investigate the feasibility of other measures. Provide details of any Greenhouse management agreements to be adopted, such as the Commonwealth Government's voluntary Greenhouse Challenge.
Waste	Liquid and solid waste disposal	Where possible, waste should be minimised, reused or recycled. Liquid and solid wastes should be treated on site or disposed of off site at an appropriate landfill facility. Where this is not feasible, contaminated material should be managed on site to prevent groundwater and surface water contamination or risk to public health.	Provide details of all liquid and solid wastes that will be produced by the proposal and how they will be disposed of, and rationale for chosen options, any potential impacts and how they will be addressed and managed.

Non-chemical emissions	Noise	Ensure that noise impacts emanating from the proposed plant comply with statutory requirements specified in the Environmental Protection (Noise) Regulations 1997. Protect the amenity of visitors to Hearson Cove.	Provide details of noise emissions. Determine existing background noise levels and quality at Hearson's Cove. Undertake modelling to determine impacts from the plant to Hearson Cove, including cumulative impacts from other existing or proposed plants, as to both noise levels and quality. Provide details of any potential impacts and how they will be managed, including community consultation.
	Light	Manage potential impacts from plant light overspill to visitors at Hearson Cove, as to the loss of amenity.	Provide details of any potential impacts of light spill and how they will be addressed.
SOCIAL SURROUNDINGS			
Public safety		Ensure that risk to the public is as low as reasonably practicable and complies with acceptable standards.	Provide details of any potential impacts from operation of the plant, pipeline corridors and shipping on public safety (including public roads and recreation areas) and how they will be addressed.
	Risk and hazard	Ensure that risk is managed to meet the EPA's criteria for off-site individual fatality risk (Interim Guidance Statement No.2), and that ALARP is demonstrated, and the DME's requirements in respect of public safety are met.	Undertake a preliminary risk assessment in accordance with the attached scope of works, to provide details of any potential risks and hazards associated with the proposal, associated pipelines and shipping. Include cumulative risks due to other existing or proposed hazardous facilities, and how they will be managed to meet the EPA's criteria. Demonstrate compliance with the Worksafe Australia Standard for the Control of Major Hazard Facilities.

	Road transport and traffic impacts	Ensure that roads are maintained or improved and road traffic managed to meet an adequate standard of level of service and safety and MRWA requirements.	Provide details of how road traffic will be managed and construction materials transported during construction, and future maintenance of proposed pipelines and roads to prevent potential impacts on existing levels of service, safety and public amenity.
Culture and heritage	Aboriginal culture and heritage	(i) Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and (ii) Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Provide details of archaeological and ethnographic surveys and consultations with Aboriginal communities, and of any potential impacts on Aboriginal culture, heritage and archaeological sites. Provide details of how impacts will be addressed and managed both during construction and operation.
	Register of the National Estate	Identify any areas which are in close proximity to the proposal that are listed on the Register of the National Estate or those areas on the Interim List, under the Australian Heritage Commission Act 1975.	Provide details of potential impacts on any such areas and how the impacts will be addressed and managed both during construction and operation.
Aesthetic	Visual amenity and recreation	Visual amenity of the plant and facilities from adjacent public areas should not be unduly adverse. Not to compromise recreational uses of the Hearson Cove area, as developed by local authority and planning agencies.	Provide details of any potential impacts on visual amenity resulting from the construction and operation of the plant and required infrastructure, possibly through the use of two dimensional silhouette images, overlay on ground level photographs or drawings. Demonstrate how these impacts will be minimised through landscaping. Provide views of impacts on the users of the Burrup Access Road and Hearson Cove beach area. Include cumulative impacts from other existing or proposed plants.

These factors should be addressed within the environmental review document for the public to consider and make comment to the EPA. The EPA expects to address these factors in its report to the Minister for the Environment and Heritage.

The EPA expects the proponent to fully consult with interested members of the public and take due care in ensuring any other relevant environmental factors, which may be of interest to the public, are addressed.

3. Availability of the environmental review

3.1 Copies for distribution free of charge

Supplied to DEP:

	Library/Information Centre	9
	EPA members	6
	Officers of the DEP (Perth)	6

Distributed by the proponent to:

Government departments	Department of Environmental Protection (Pollution Prevention Division, Pilbara Regional Office)	2
	Department of Minerals and Energy	1
	Department of Resources Development	2
	Dampier Port Authority	1
	Department of Conservation and Land Management	1
	Aboriginal Affairs Department	1
	Pilbara Development Commission	1
	Department of Land Administration	1
	Ministry for Planning	1
	Fire and Emergency Services Authority of WA	1
	Water Corporation	1
	Commissioner for Soil and Land Conservation`	1
Local government authorities	Shire of Roebourne	2
Libraries	J S Battye Library	2
	The Environment Centre	2
	Karratha Community Library	2
	Wickham Community Library	2
	Roebourne Library	2
Other	Conservation Council of WA	1
	Friends of the Burrup Peninsula	1

3.2 Available for public viewing

- J S Battye Library;
- Karratha Community Library
- Wickham Community Library
- Roebourne Library;
- Department of Environmental Protection Library; and
- Proponent website.

Correspondence from the Commonwealth Minister for the Environment and Heritage

APPENDIX B

Senator the Hon Robert Hill
Leader of the Government in the Senate
Minister for the Environment and Heritage

- 2 APR 2001

Ms Lorie Jones
Sinclair Knight Merz
PO Box H615
PERTH WA 6001

Dear Ms Jones

Burrup Fertilisers Pty Ltd/Industry/Burrup Peninsula/WA/Ammonia Plant
(Our Reference: 2001/199)

Thank you for the above referral, for decision on whether or not approval is needed under Chapter 4 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The referral documentation nominated Mr Vikas Rambal as the person proposing to undertake the action.

The referral has now been considered under the EPBC Act and I have decided that the action is not a controlled action. Approval is therefore not needed under Part 9 of the EPBC Act for the action to proceed.

The instrument of decision is attached for your information. This letter, and attached instrument, constitutes notice of the decision in accordance with section 77 of the EPBC Act.

Thank you for your assistance in this matter.

Yours sincerely

Robert Hill

Robert Hill

COMMONWEALTH OF AUSTRALIA

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

DECISION THAT ACTION IS NOT A CONTROLLED ACTION

Pursuant to section 75 of the *Environment Protection and Biodiversity Conservation Act 1999*, I, ROBERT MURRAY HILL, Minister for the Environment and Heritage, having taken into account the relevant matters specified in section 75, decide that the proposed action, set out in the Schedule, is not a controlled action.

SCHEDULE

The proposed action by Burrup Fertilisers Pty Ltd to construct and operate an export oriented liquid ammonia complex, Burrup Peninsula, WA, and associated facilities as described in the referral received under the Act on 5 March 2001 (EPBC 2001/199).

Dated this 2nd day of April 2001

Robert Hill

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MINISTER FOR THE ENVIRONMENT AND HERITAGE

Detailed Ammonia Process Description

APPENDIX C

APPENDIX C – Detailed Ammonia Process Description

Feed Gas Desulphurisation

Natural gas for feed and fuel is provided at 25°C and 5740 kPa(a). Natural gas is initially directed to a feed gas knockout drum where most entrained liquids (or solids) are removed. Upon exiting the drum the various fuel and feed streams are taken. Part of the natural gas is then sent to the package boiler and primary reformer furnace as fuel. Rest of the natural gas is feed gas to desulphurisation unit.

The feed natural gas is mixed with a recycle stream of hydrogen-rich synthesis gas, producing a mixture containing about 2.0% by volume hydrogen. The feed gas is heated to 371°C in the convection section of the primary reformer prior to desulphurisation. The heated gas then enters the CoMox vessel where organic sulphur compounds are hydrogenated to form hydrogen sulphide over a cobalt/molybdenum oxide catalyst bed prior to being passed to the desulphuriser vessels. Each of these two vessels contains a bed of zinc oxide catalyst. Hydrogen sulphide reacts with the zinc oxide and is retained by the bed of zinc oxide producing an effluent stream containing less than 0.1ppmv sulphur. The two vessels are arranged in a series "lead-lag" configuration such that either vessel can be taken off-line for catalyst change out while the other remains in service. Each vessel contains enough zinc oxide for one year service at the maximum sulphur inlet of 10 ppmv (as H_2S).

The reactions in the desulphurisation section are as follows:

$RSH + H_2$ ---------> $H_2S + RH$ + heat (reaction 1)
$COS + H_2$ ---------> $CO + H_2S$ + heat (reaction 2)
$H_2S + ZnO$ <-------> $ZnS + H_2O$ + heat (reaction 3)

High partial pressures of CO_2 and water could inhibit the absorption of sulphur on the zinc oxide by reacting with the zinc oxide to form hydrates, while high concentrations of ammonia could also restrict the activity of the Co-Mo catalyst. However at the expected temperatures and conditions no adverse reactions are foreseen.

Primary Reforming

The desulphurised feed is mixed with medium pressure steam prior to reforming. A portion of the process is used to strip the process condensate beforehand and therefore the steam is cooler than the MP steam header temperature by about 29°C. The process steam is added to achieve a 2.7 steam to carbon molar ratio in the feed gas. The mixture is preheated to 621°C in the convection section of the primary reformer. The hot mixed feed is distributed to the primary reformer catalyst tubes, which are suspended in the radiant section of the furnace. The feed gas passes down through the reforming catalyst and is reacted to form hydrogen, carbon monoxide and carbon dioxide. The primary reforming reactions as well as water-gas shift reactions will occur on the catalyst and are as follows:

$C_nH_m + nH_2O$ + heat -------> $nCO + (2n + m)/2\ H_2$ (reaction 4; endothermic)
$CH_4 + H_2O$ + heat <-------> $CO + 3\ H_2$ (reaction 5; endothermic)
$CO + H_2O$ <-------> $CO + H_2$ + Heat (reaction 6; exothermic)

Reaction (4) goes to completion but reaction (5) and (6) are equilibrium restricted. Overall the combination of reactions is endothermic (ie requires and absorbs heat), with the duty supplied by fuel gas burners located between the rows of tubes. The furnace burners operate with down firing and develop a reformed gas temperature near 716°C at the outlet of the catalyst tubes. The pressure at the outlet of the catalyst tubes is 4068 kPA(a). The effluent gas contains about 28 mole percent, dry basis, un-reacted methane.

The reforming furnace incorporates the use of internal manifolding at the outlet of the catalyst tubes for heat conservation of the reformed gas. The reformed gas continues to pick up heat in these risers and collector pipes while exiting the radiant section. The gas temperature at the riser exit is expected to be approximately 733°C. Flue gases leaving the radiant section will be at approximately 1000°C.

The reforming furnace is designed to attain maximum thermal efficiency (approximately 92%) by recovering heat in the convection section from the flue gases. Flue gases consist of combustion products from the radiant section of the reformer, tunnel burners and steam super-heat burners.

Keeping within Best Available Techniques (BAT), as defined by EFMA (2000), the convection heat is recycled for the following services:

- Steam/gas mixed feed preheat
- Process air/steam preheat
- High pressure steam superheating
- Natural gas feed preheat for desulphurisation
- Combustion air preheating

The Primary Reformer is also provided with tunnel burners for adjustment of convection coil outlet temperatures. A steam attemperator is provided between the HP Steam Superheater and the Primary Reformer steam superheat coil to prevent high superheat temperatures.

Process Air Compression

The process air compressor, provides air for the secondary reformer and requirements for instrument air etc. for the ammonia unit and offsite facilities. Ambient air is filtered and compressed to about 4310 KPa(a) in an integrally geared, six stage centrifugal compressor. Inter-stage cooling and condensate separation is provided. The air compressor driver is a medium pressure to condensing steam driven, Steam Turbine, which also provides power for an electric generator. With this arrangement the turbine will be kept at the near constant speed and control of the process air will be by a combination of suction inlet guide vanes and discharge venting.

At the Air Compressor discharge, a small quantity of medium pressure steam is continuously added. This protects the process air preheat coil in the reformer convection section and ensures forward flow in the event of emergency shutdown of the air compressor. Process air is then heated to 621°C in the convection section of the primary reformer and sent to the secondary reformer.

Secondary Reforming

The process gas contains about 52.3% hydrogen and 28% methane (dry volume basis) as it leaves the Primary Reformer furnace and enters the Primary Reformer Effluent Transfer Line, leading to the Secondary Reformer. In a conventional non-purifier plant, the quantity of air is controlled to produce a three-to-one ratio of hydrogen to nitrogen in the synthesis gas. With the Purifier process, about 50 percent extra air is normally used. This results in a hydrogen/nitrogen ratio at the feed to the cold box of 2.0. The extra air provides additional reaction heat in the secondary reformer and helps to keep the temperature of the gas exiting the primary reformer as low as possible. In addition, the methane leakage of the purifier process is much higher than the 0.25-0.30 dry volume percent in other designs. This further relaxes the reforming severity and lowers the required secondary reformer outlet temperature.

All the methane, together with the surplus nitrogen and most of the argon, are removed as waste gas in the cryogenic purifier later in the processing sequence and sent to the fuel.

During secondary reforming the oxygen in the air combusts part of the process gas from the Primary Reformer, leading to a high temperature (approx. 1353°C) in a special mixing and combustion chamber above the catalyst bed. The hot gas from this combustion passes down through a bed of nickel reforming catalyst where it reacts to produce more hydrogen in a similar manner to the Primary Reformer, but without outside heat transfer. Due to the overall endothermic nature of the reforming reaction, the gas temperature leaving the secondary reformer is reduced to approximately 912°C.

The Secondary Reformer effluent passes directly to the Secondary Reformer Waste Heat Boiler, where high pressure steam is generated in a vertical, natural circulation boiler. The partially cooled gas then passes through the H.P. Steam Super-heater, cooling it to the high temperature shift inlet temperature of 371°C. The H.P. Steam Super-heater provides only part of the steam superheat requirements, with the remaining portion fulfilled by the coils in the primary reformer convection section. A process gas bypass arrangement is provided amongst these two exchangers that allows to control the division of boiling and superheating duty according to the various operating demands of the steam system, while also controlling the high temperature shift feed temperature.

Carbon Monoxide Shift Conversion

In the shift conversion step, carbon monoxide (CO) reacts with steam to form equivalent amounts of hydrogen and carbon dioxide (CO_2). As indicated for primary reforming (reaction 6), the shift reaction is reversible and exothermic. The CO shift reaction rate is favoured by high temperatures, but the maximal conversion of CO to CO_2 (equilibrium) by low temperatures. There are two shift reaction stages in this unit, the High Temperature Shift Converter (HTS), and the Low Temperature Shift Converter (LTS). In the two stages of shift conversion provided, the HTS operates with a 371°C inlet and the LTS with a 211°C inlet. Each stage of shift utilises a different catalyst with its own distinct advantages.

In the high temperature shift, a relatively cheap and more durable iron oxide catalyst produces the bulk of the shift conversion, to 3.18% CO. For the relatively low steam to gas ratio used for this plant, the HTS also contains a copper promoter to prevent unwanted side reactions that could harm the catalyst.

A more favourable equilibrium concentration (lower CO) is attained with the low temperature shift copper based catalyst. The CO leakage obtained from this combination is 0.3 %. LTS catalyst permits a considerable reduction in the quantity of steam required for the overall shift conversion, but it is more expensive and susceptible to poisoning from process impurities, especially sulphur and chlorides. A reduction in CO content of process gas results in a reduction in plant feed requirements.

As a means to moderate the gas temperature between the high and low temperature shift, high pressure steam is generated in the HTS Effluent Boiler Feed Water Preheater/Steam Generator. Approximately 25% of the Boiler Feed Water (BFW) entering this exchanger is vaporised to steam. The exchanger is provided with a water-side by-pass around the cold shell with which to control the LTS feed temperature.

Heat is recovered from the LTS effluent gas in three exchangers. It is first used to preheat high pressure BFW in the LTS Effluent/BFW Exchangers, then to provide reboiling heat for the aMDEA03 CO_2 removal section in the CO_2 Stripper Reboiler, and finally to preheat deaerator feed water in the Methanator, the LTS Effluent/LP BFW Exchanger. The water condensed from the process gas is knocked out in the Raw Gas Separator, and pumped to the process condensate stripper by the Process Condensate Pump. The LTS effluent gas, now at 70°C, then enters the CO_2 Absorber.

Carbon Dioxide Removal

The CO_2 contained in the shifted process gas is next reduced to 500 ppmv by washing in a two – stage activated amine based system that utilises the aMDEA03 process licensed by BASF, a large company well recognised in the chemical industry.

The process gas first enters the bottom section of the CO_2 Absorber where the bulk of its CO_2 content is removed by absorption into semi-lean aMDEA solution. The gas then passes to the top section of the Absorber where most of the remaining CO_2 is removed by absorption into lean solution. The purified gas passes through a demister at the top of the Absorber, and to the CO_2 Absorber Overhead Knockout Drum to remove any traces of entrained aMDEA solution.

The rich aMDEA solution from the bottom of the Absorber is first passed through the Hydraulic Turbine where power is recovered from letting down the high pressure solution. This power is used to drive one of the semi-lean solution pumps.

The solution pressure at the exit of the hydraulic turbine is set to allow the major portion of the hydrogen dissolved in the solution to be flashed off. The bottom section of the HP Flash Drum allows full disengagement of the gas from the solution. The flashed gas contains a substantial amount of CO_2. This is recovered by washing it with a small amount of lean aMDEA solution in the top section of 163-MD. The hydrogen-rich off gas is sent to fuel gas system.

The rich solution from the bottom of HP Flash Drum is then flashed to 170 kPa(a) in the LP Flash section of the CO_2 Stripper. Most of the semi-lean solution is then pumped back to the middle of the Absorber by the Semi-lean Solution Pumps. The rest of the semi-lean solution is pumped by the Semi-Lean Solution Circulating Pumps through the Lean/Semi-Lean Exchanger where it is heated to 110°C, before it goes to the top of the stripping section.

Heat for the stripping action is provided by the CO_2 Stripper Reboiler. The stripped, lean aMDEA solution is then cooled by first by exchange with the semi-lean solution Lean/Semi-Lean Exchanger and then by exchange with two exchangers in parallel; the Lean Solution BFW Exchanger, which is used to preheat deaerator feed water, and the Lean Solution Cooler, which uses closed circuit cooling water. The lean solution is then pumped back to the CO_2 Absorber by the Lean Solution Pumps.

A small side stream of lean solution from the Lean Solution Pumps is sent to the top of the HP Flash Drum wash section. Approximately 20% of the lean solution is sent through a mechanical filter (aMDEA Solution Filter).

The CO_2 stream from the top of the stripper is cooled to 45°C in a pump around system and is vented. The aMDEA water balance is designed to have a slight deficit. To hold water balance, a continuous make-up stream of about 1,000 kg/hour is required. It is designed this way to eliminate a discharge of condensate which would require treatment.

Methanation

The overhead gas from the carbon dioxide absorber is preheated from 70°C to 316°C in the Methanator Feed/Effluent Exchanger and Methanator Start-up Heater. The Methanator Feed/Effluent Exchanger recovers the high temperature heat in the methanator effluent by heat exchange against the feed gas. A gas by-pass is provided around the Methanator Feed/Effluent Exchanger to permit adequate control of the feed temperature when the oxide content of the feed gas is high. The gas then flows through the methanator where remaining carbon oxides combine with hydrogen over a nickel catalyst to form methane and water.

Heat addition by the start-up steam heater is essential when the shift catalyst is new and the amount of carbon monoxide leakage from the shift converters will be significantly less than design, and therefore the methanator temperature rise will also be less than design. During this period, heat from the start

up heater supplements the low heat of reaction to keep the methanator inlet temperature above 290°C, which is ample to ensure the initiation of reaction.
The Methanator contains a bed of nickel catalyst that promotes the reaction of carbon dioxide and carbon monoxide with hydrogen to form methane and water.

$CO + 3H_2$ -----> $CH_4 + H_2O$ + heat (reaction 7)
$CO_2 + 4H_2$ -----> $CH_4 + 2H_2O$ + heat (reaction 8)

While some equilibrium restrictions apply, these extremely exothermic (ie produces heat) reactions will go to near completion. Thus despite the low amounts of reactants in the gas, a fairly large temperature rise will result. The total amount of carbon oxides leaving the methanator will normally be less than 5 ppmv (maximum 10 ppmv), and the methane content at design conditions 2.3% (dry basis).

Drying
In preparation for drying, the methanator effluent is cooled by heat exchange with methanator feed and cooling water to 43°C. The methanator effluent then combines with recycle synloop purge gas from the High Pressure (HP) Ammonia Scrubber and is further cooled with ammonia refrigerant in the Methanator Effluent Chiller, to about 4 °C. Condensate is separated in 144-MD and pumped by 122-MJ to the Raw Gas Separator.

The chilled gas from the knockout drum goes to the syngas driers containing solid desiccants. Exiting these driers the water content is reduced to less than 0.1 ppmv and the $CO+CO_2$ content of the gas to below 1 ppmv by adsorption on a type 4A Zeolite (aluminosilicate) bead.

The regeneration facilities are designed for a 12-hour cycle to provide a comfortable safety margin. Regeneration and cooling of the driers are done with dry vent gas from the purifier, heated to 287 °C in the syngas drier regeneration heater by HP steam. After use as the regeneration medium, the offgas stream is rejoined is directed to the Primary Reformer fuel system. During start-up or when purge gas is unavailable, a 2-3% side stream of the fresh makeup gas is used for the regeneration of the molecular sieve adsorbent.

Cryogenic Purification
Dried raw synthesis gas is cooled to about minus 130°C in the cryogenic purifier by heat exchange with make-up syngas and with purifier vent gas in the Upper Plate Fin Exchanger. The gas then flows through a Turbo Expander where energy is removed to develop the net refrigeration required for the purifier. Expander energy is recovered by generating electricity in the Purifier Expander Generator. The expander effluent is further cooled to minus 171°C and partially condensed in the Purifier Feed/Effluent Exchanger No. 2 and then enters the purifier rectifier column. Liquid from the bottom of the rectifier is partially evaporated at reduced pressure in the shell side of the rectifier overhead condenser. This cools the rectifier overhead and generates reflux for the rectifier.

The rectifier bottoms contain the excess nitrogen, all of the methane and about 61 percent of the argon. The partially evaporated liquid leaving the shell side of the rectifier overhead condenser is reheated and vaporised by exchange with purifier feed and then leaves as purifier vent gas. The vent gas is used to regenerate the syngas drier and then burned as fuel in the primary reformer.

The make-up syngas from the top of the rectifier overhead condenser is reheated by exchange with purifier feed to about plus 1°C and sent to the syngas compressor. The operation of the purifier is controlled by a hydrogen analyser on the syngas, to maintain the exact ratio of three-to-one hydrogen to nitrogen. The only remaining contaminant in the make-up syngas is about 0.27 percent argon.

Compression

The purified syngas is compressed in two stages to about 14,744 kPa(a) in a steam turbine driven Syngas Compressor. Recycle gas is added to the syngas before the last wheel of the second stage, and the combined flow leaves the compressor at 15,487 kPa(a). This combined gas is preheated and then fed directly to the synthesis converter. The syngas compressor is controlled to maintain the suction pressure. During turndown operation, cold recycle gas can be spilled back to the suction of the first stage to prevent the compressor from going into surge.

Ammonia Synthesis

Ammonia is produced in a fixed-bed, horizontal converter. The converter is a three stage, intercooled design. The third stage is divided into two beds in series, so the converter contains a total of four beds. Each bed is filled with 1.5-3mm iron promoted conventional catalyst. The first bed will be filled with pre-reduced catalyst. Make-up and recycle gas from the syngas compressor is preheated by exchange with the converter effluent in the feed/effluent exchanger. It then flows to the converter. Ammonia concentration in the feed to the converter is 1.8% by volume.

The effluent from the first bed containing about 10.4% ammonia is cooled by heat exchange with the feed to the converter. Heat is recovered from the second bed effluent by preheating the feed to the first bed. Ammonia concentration in the effluent from the second bed is about 15.8% by mole. Final ammonia concentration leaving the converter is 19.3%.

The ammonia synthesis reaction is equilibrium governed, and proceeds with a significant exothermic temperature rise across the catalyst. The reaction step is as follows:

$3H_2 + N_2 \longleftrightarrow 2NH_3 + \text{heat}$ (reaction 9)

The heat of reaction from the ammonia synthesis is recovered by the steam system in the Ammonia Converter Effluent/Steam Generator and Ammonia Converter Effluent 2nd BFW Preheater.

After heat recovery in the Ammonia Converter Effluent, the converter effluent is cooled from 202°C to 43°C. This is done by exchange with fresh make up syngas from the syngas compressor discharge in the Ammonia Converter Feed/Effluent Exchanger and by cooling water in the Ammonia Converter Effluent Cooler. Because of the high conversion obtained in the ammonia converter, the dew point of the converter effluent is several degrees above the exit temperature of the cooler.

The synthesis gas is further cooled and condensed in the Ammonia Unitised Chiller. This specially designed exchanger provides cooling of the converter effluent through interchange of heat with synthesis gas returning from the Ammonia Separator and boiling ammonia liquid at four different temperature levels (16.7°C, -2.2°C, -17.8°C and –33.3°C). By its unitised design it replaces four separate exchangers and four refrigerant drums.

Mechanically, the Ammonia Unitised Chiller consists of multiple concentric tubes, which run through the boiling ammonia compartments. Synthesis gas recycle vapours from the downstream Primary Separator pass through the centre tubes counter-currently to the converter effluent as it flows through the annular space between tubes. Thus the synthesis gas is being cooled, from the larger outside tube by boiling ammonia and from the inside tube by cold recycle vapour from the primary separator. The condensed gas exit temperature of the unitised chiller is -18°C, with the liquid ammonia product disengaged from the synthesis gas in the ammonia separator immediately downstream of the exchanger.

Approximately two percent of the vapour from the ammonia separator is removed from the synthesis loop to purge it of argon, which is contained in the makeup gas. This high pressure purge gas flow is adjusted to maintain the inert gas level in the ammonia converter feed gas to approximately 3.5% and is directed to the ammonia recovery section.

Recycle vapour from the ammonia separator containing nearly 2.63% ammonia is reheated in the Unitised Chiller to 38°C as described above. The reheated recycle vapour is directed to the synthesis gas compressor and recirculated for reuse as feed to the converter.

The purge gas stream from the ammonia separator is directed via Purge Gas Ejector to the HP Ammonia Scrubber for recovery and removal of the ammonia it contains down to a level near 25 ppmv (50 ppmv maximum). The essentially ammonia free gas is recycled upstream of the Purifier for recovery of the hydrogen and nitrogen.

Liquid ammonia from the ammonia separator is depressurised and flashed to a pressure of 1862 kPa(a) in the Ammonia Letdown Drum. The flashed vapour, primarily dissolved synthesis gas, is mixed with the refrigeration system purge gas and sent to the Purge Gas Ejector. The remaining liquid ammonia product is then split into streams leading to the ammonia refrigeration system in Unitised Chiller and the ammonia Refrigerant Receiver.

Loop Purge Ammonia Recovery

The loop purge gas is used as the driving stream for an ejector which pulls up inerts from the ammonia accumulator, 149-MD and flash vapour from the Letdown Drum. The ejector discharge stream is fed to the HP Ammonia Scrubber where ammonia is recovered as an aqueous ammonia solution. The aqueous solution is fed to the Ammonia Distillation Column which is reboiled by MP steam. The recovered ammonia vapour is combined with the ammonia stream going to the Ammonia Condenser. The ammonia free purge gas is divided into two streams. Part of the scrubbed purge gas is recycled to the front end of the plant to provide hydrogen to react with organic sulphur compounds in the Desulphuriser. The rest is combined with methanator effluent.

Ammonia Refrigeration

Ammonia is condensed from the converter effluent stream by chilling with ammonia refrigerant at four levels in the previously described Unitised Chiller. The ammonia vapours from the four refrigeration levels are routed to Ammonia Refrigeration Compressor. The refrigeration compressor also processes the ammonia vapour from the Methanator Effluent Chiller. The ammonia vapour is ultimately compressed to about 1841 kPa(a). The compressed ammonia is condensed in a water-cooled Ammonia Condenser and goes to the warm section of the ammonia accumulator.

The small amount of non-condensable gas in the ammonia accumulator goes to the suction of the ejector, which is driven by synthesis loop purge gas. The ejector discharge stream goes to the ammonia recovery system where ammonia is washed out with water.

The liquid ammonia from the cold section of the ammonia accumulator is used as a refrigerant. The refrigeration system is designed to produce all cold ammonia product at minus 33°C at design capacity. The cold ammonia product is drawn from the cold section of the Unitised Exchanger and is sent to the ammonia storage via the Ammonia Product Pump.

Process Condensate Stripper

Process condensate from the carbon dioxide absorber feed knockout drum is combined with the condensate from the methanator effluent separator. The condensate is preheated by feed effluent exchange and sent to Process Condensate Stripper where dissolved carbon dioxide, methanol and ammonia are removed. The stripped condensate leaves the bottom of the stripper and is cooled by Feed Effluent Exchanger. The stripped condensate is further cooled to 460°C by cooling water in the Stripped Condensate Cooler before treatment in the polisher unit.

The stripping medium for the process condensate stripper is process steam on its way to the primary reformer. The steam leaving the stripper is mixed with the feed gas upstream of the primary reformer. The stripped condensate in the bottom of the stripper column is acidic. To prevent corrosion, a metered amount of aqueous ammonia is injected into the bottom of the stripper.

Steam System
The steam system of the ammonia plant is shown in (Error! Reference source not found.**).** The ammonia plant uses three steam levels (**Table C-1**). The medium pressure header is connected to the overall plant steam system, which includes the package boiler and the urea plant.

- **Table C-1 Ammonia Plant Steam Levels**

Header	Pressure	Temperature
High Pressure	120-bar-g	510°C
Medium Pressure	45.5 bar-g	387°C
Low Pressure	3.45 bar-g	181°C

The ammonia plant produces high-pressure superheated steam, which is admitted to the syngas and refrigeration compressor turbines. The syngas turbine is a combination extraction and condensing machine, and the refrigeration compressor turbine is a condensing machine. In the syngas turbine, medium pressure steam is extracted to supply process steam and the requirements for the process air compressor, the high-pressure boiler feed water pump turbine, the turbogenerator, primary reformer ID and FD fans.

Low-pressure steam is generated from the back pressure turbine driver for the primary reformer ID and FD fans and by LP Steam Generator. It is used as deaeration steam. Excess LP steam is admitted to the turbogenerator to make electric power.

Polished condensate from the storage tank is preheated to 113°C against MDEA solution and carbon dioxide absorber feed gas. The preheated water flows to the deaerator. The deaerator pressure is maintained at 1.7 bar-g, which results in a saturation temperature of 130°C. The deaerated water is pumped by a turbine driven boiler feed water pump and is preheated in the LP Steam Generator to 191°C. After leaving the convection coil, the boiler feed water splits and is heated in parallel by HTS effluent and ammonia converter effluent. About 25 percent vaporisation of BFW takes place in each exchanger.

High-pressure steam is generated by process heat recovery in three steam generators, one at the outlet of the secondary reformer and the other two at the outlet of the HTS reactor and the synthesis converter. Steam generation is at 124 bar, which allows 4 bar pressure drop in the superheaters.

High-pressure steam is superheated to 348°C in the Steam Superheater and then to 510°C in the reforming furnace convection section. The high-pressure superheated steam is sent to the turbines driving the syngas compressor and the refrigeration compressor.

During start-up and emergency, MP steam is available from the package boiler rated at 100,000 kg/hour.

A key feature of the steam system is the turbogenerator set, which are located in the outside battery limit of the ammonia plant. Excess MP steam is admitted to the turbine. About 18.4 MW of power are generated during normal operation. The benefits of the turbogenerator are two-fold. It permits the ammonia plant to generate all its own power needs, which increases reliability.

Package Boiler
The package boiler is capable of producing 100 metric tons per hour of medium pressure steam at 45.5 bar-g and 387°C. The boiler will be located in the outside battery limit but will be serviced by the ammonia plant deaerator and boiler feed water pumps. Natural gas fuel is fired in the boiler.

Turndown Operation
The ammonia unit can be turned down to about 70 percent of design capacity while operating at essentially the design energy consumption per ton of ammonia produced. Below this capacity, compressors begin to require spill back to avoid surge. To keep a compressor out of surge, some of the discharge stream is spilled back to the suction, or in the case of the air compressor, vented to atmosphere. This increases the energy consumption per ton of ammonia produced, but it permits the unit to operate at rates below 70 percent. The lower limit of operation is about 60 percent of capacity. One advantage of the KBR Purifier Process™ during turndown operation is the ability to use more air in the secondary reformer to keep steam production higher.

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List of Flora Species found within the Project Lease

APPENDIX D

- **Table D1 Species List for the Project Lease proposed for the Development of the Burrup Ammonia Plant**

	FAMILY	GENUS SPECIES
31	POACEAE	**Cenchrus ciliaris* *Chrysopogon fallax* *Cymbopogon ambiguus* *Cymbopogon bombycinus* *Eragrostis falcatta* *Eriachne mucronata* *Panicum decompositum* *Paspalidium clementii* *Paspalidium tabulatum* *Sporobolus virginicus* *Themeda triandra* *Triodia angusta* *Triodia epactia* *Whiteochloa airoides*
32	CYPERACEAE	*Bulbostylis barbata* *Fimbristylis dichotoma*
47	COMMELINACEAE	*Commelina ensifolia*
87	MORACEAE	*Ficus platypoda var. lachnocaulon*
90	PROTEACEAE	*Grevillia pyramidalis* *Hakea lorea*
105	CHENOPODIACEAE	*Enchylaena tomentosa* *Halosarcia ?pruinosa* *Halosarcia halocnemoides subsp. tenuis* *Halosarcia indica* *Neobassia astrocarpa* *Rhagodia preissii subsp. preissii* *Threlkeldia diffusa*
106	AMARANTHACEAE	**Aerva javanica* *Amaranthus pallidiflorus* *Gomphrena cunninghamii* *Hemichroa diandra* *Ptilotus obovatus*
107	NYCTAGINACEAE	*Boerhavia burbidgeana* *Boerhavia gardneri* *Boerhavia replete* *Boerhavia schomburgkiana*

	FAMILY	GENUS SPECIES
108	GYROSTEMONACEAE	*Codonocarpus cotinifolius*
110	AIZOACEAE	*Trianthema turgidifolia*
110A	MOLLUGINACEAE	*Mollugo molluginis*
113	CARYOPHYLLACEAE	*Polycarpaea longifolia*
122	MENISPERMACEAE	*Tinospora smilacina*
131	LAURACEAE	*Cassytha filiformis*
137A	CAPPARACEAE	*Cleome viscose* *Cappans spinosa*
152	PITTOSPORACEAE	*Pittosporum phylliraeoides*
163	MIMOSACEAE	*Acacia ampliceps* *Acacia bivenosa* *Acacia colei* *Acacia coriacea* *Acacia inaequilatera* *Acacia orthocarpa* *Dichrostachys spicata*
164	CAESALPINIACEAE	*Senna glutinosa subsp. glutinosa* *Senna glutinosa subsp. pruinosa*
165	PAPILIONACEAE	*Alysicarpus rugosus* *Crotalaria medicaginea* *Crotalaria novae-hollandiae* *Crotalaria trifoliastrum* *Cullen pustulata* *Erythrina vespertilio* *Indigofera colutea* *Indigofera linifolia* *Indigofera monophylla* *Rhynchosia cf. Minima* *Rhynchosia sp. Burrup (821C)* *Swainsona Formosa* *Swainsona pterostylis* *Tephrosia aff. supina* (MET 12357) *Tephrosia leptoclada* *Tephrosia rosea*
173	ZYGOPHYLLACEAE	*Tribulus occidentalis*

	FAMILY	GENUS SPECIES
183	POLYGALACEAE	*Polygala isingii*
185	EUPHORBIACEAE	*Adriana tomentose* *Euphorbia coghlanii* *Euphorbia sp* *Euphorbia tannensis* *Flueggia virosa* *Leptopus decaisnei* *Phyllanthus maderaspatana*
207	SAPPINDACEAE	*Alectryon oleifolius*
220	TILIACEAE	*Corchorus walcottii* *Triumfetta appendiculate* *Triumfetta clementii*
221	MALVACEAE	*Abutilon fraseri* *Abutilon lepidum* *Gossypium australe* *Hibiscus sturtii grandiflorus* *Lawrencia viridigrisea* *Sida fibulifera*
223	STERCULIACEAE	*Brachychiton acuminatus*
236	FRANKENIACEAE	*Frankenia ambita*
272	COMBRETACEAE	*Terminalia supranitifolia* (P1)
273	MYRTACEAE	*Corymbia hamersleyana*
281	APIACEAE	*Trachymene oleracea*
294	PLUMBAGINACEAE	*Muellerolimon salicorniaceum*
301	OLEACEAE	*Jasminum didymum subsp. lineare*
305	ASCLEPIADACEAE	*Cynanchum floribundum*
307	CONVOLVULACEAE	*Bonamia pannosa* *Evolvulus alsinoides* *Ipomoea costata*
310	BORAGINACEAE	*Ehretia saligna* *Heliotropium ?tenuifolium* group

	FAMILY	GENUS SPECIES
		Trichodesma zeylanicum
315	SOLANACEAE	*Solanum cleistogamum* *Solanum lasiophyllum* *Solanum phlomoides*
316	SCROPHULARIACEAE	*Stemodia grossa*
325	ACANTHACEAE	*Dicliptera armata*
331	RUBIACEAE	*Heydotis couchiana*
337	CUCURBITACEAE	*Mukia maderaspatana* *Trichosanthes cucumerina*
341	GOODENIACEAE	*Goodenia microptera* *Scaevola cunninghamii* *Scaevola spinescens* *Scaevola aff. spinescens*
345	ASTERACEAE	*Pterocaulon sphaeranthoides* *Streptoglossa bubakii* *Streptoglossa decurrens*

Mammals, Birds and Reptiles recorded on the Burrup Peninsula

APPENDIX E

Table E1 Fauna Species Recorded on the Burrup Peninsula and Surrounding Areas

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
Tachyglossidae (Echidna)	*Tachyglossus aculeatus*	Short Beaked Echidna	
Dasyuridae (Dasyurids)	*Dasyurus hallucatus*	Northern Quoll	
	Dasykaluta rosamondae	Little Red Antechinus	
	Ningaui timealeyi	Pilbara Ningaui	
	Planigale maculata	Common Planigale	
	Pseudantechnius roryi		
	Pseudantechinus woolleyae		
	Sminthopsis macroura	Stripe-faced Dunnart	
Macropodidae (Kangaroos)	*Macropus robustus*	Common Wallaroo	
	Macropus rufus	Red Kangaroo	
	Petrogale lateralis	Black-footed Rock Wallaby	VU
	Pterogale rothschildi	Rothchild's Rock Wallaby	
Pteropodidae (Fruit Bats, Flying Foxes)	*Pteropus scapulatus*	Little Red Flying Fox	
	Pteropus alecto	Black Flying Fox	
Rhinolophidae (Horse-shoe Bats)	*Rhinonicteris aurantius*	Orange Horse-shoe Bat	VU
Emballonuridae (Sheathtail-bats)	*Saccolaimus flaviventris*		
	Taphozous georgianus	Common Sheath-tail Bat	
Molossidae (Mastiff Bats)	*Chaerephon jobensis*	Northern Mastiff Bat	
	Mormopterus beccarii		
	Mormopterus loriae	Little Northern Mastiff Bat	P1
	Tadarida australis		
Vespertilionidae (Ordinary Bats)	*Chalinolobus gouldii*	Gould's Wattled Bat	
	Chalinolobus morio		
	Eptesicus pumilus	Little Cave Eptesicus	
	Nyctophilus arnhemensis	Arnhem Land Long-eared Bat	
	Nyctophilus bifax	Northern Long-eared Bat	
	Nyctophilus geoffroyi		
	Nyctophilus rimoriensis		
	Scotorepens greyii		
	Vespadalus finlaysoni		

Table E1: (continued)

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
Muridae	*Hydromys chrysogaster*	Water Rat	P4
(Mice & Rats)	*Mus musculus*	House Mouse	I
	Notomys alexis	Spinifex Hopping-mouse	
	Pseudomys chapmani	Pebble Mound Mouse	P4
	Pseudomys delicatulus	Delicate Mouse	
	Pseudomys hermannsburgensis	Sandy Inland Mouse	
	Rattus rattus	Black Rat	I
	Rattus tunneyi	Pale Field-rat	
	Zyzomys argurus	Common Rock Rat	
Canidae	*Vulpes vulpes*	Fox	I
(Dogs)	*Canis familaris*	Dog	I
Felidae (Cats)	*Felis catus*	Cat	I

Taxonomy – According to Australian Museum
Notes: 1. Conservation Status Code.
S1: Species protected under Schedule 1 (fauna that is rare or likely to become extinct) of the *Wildlife Conservation Act* (1980, amended 1994).
R: Species listed on the Department of Conservation and Land Management's *Reserve List*.
I: Introduced Species.

- **Table E2 Birds Recorded on the Burrup Peninsula and Surrounding Areas**

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
Pelecanidae (Pelicans)	*Pelecanus conspicillatus*	Pelican	
Sulidae (Gannets, Boobies)	*Sula leucogaster*	Brown Booby	
Phalacrocoracidae (Cormorants, Shags)	*Phalacrocorax varius*	Pied Cormorant	
Fregatidae (Frigate Birds)	*Fregata ariel*	Lesser Frigate Bird	
Ardeidae (Herons, Egrets, Bitterns)	*Ardea novaehollandiae* *Ardea alba* *Ardea sacra* *Butorides striatus* *Nycticorax caledonicus*	White-faced Heron Great Egret Eastern Reef Egret Mangrove Heron Rufous Night Heron	
Ciconiidae (Storks)	*Ephippiorhynchus asiaticus*	Black-necked Stork	
Panionidae (Kites, Goshawks, Eagles, Harriers)	*Pandion haliaetus* *Elanus notatus* *Hamirostra melanosternon* *Haliastur Indus* *Haliastur sphenurus* *Accipiter fasciatus* *Haliaeetus leucogaster* *Aquila audax* *Aquila morphnoides* *Circus assimilis* *Circus aeruginosus*	Osprey Black-shouldered Kite Black-breasted Kite Brahminy Kite Whistling Kite Australian Goshawk White-Breasted Sea-Eagle Wedge-tailed Eagle Little Eagle Spotted Harrier (nesting) Swamp (Marsh) Harrier	
Falconidae (Falcons)	*Falco berigora* *Falco cenchroides* *Falco longipennis*	Brown Falcon Australian Kestrel Australian Hobby	
Turnicidae (Button-Quails)	*Turnix velox*	Little Button-quail	

Table E2 (continued…)

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
Burhinidae	*Burhinus grallarius*	Bush Thick-knee	
(Thick-knees)	*Esacus magnirostris*	Beach Thick-knee	R
Haematopodidae	*Haematopus ostralegus*	Pied Oystercatcher	
(Oystercatchers)	*Haematopus fuliginosus*	Sooty Oystercatcher	
Charadriidae	*Charadrius leschenaultii*	Large Sand Plover	M
(Lapwings, Plovers, Dotterels)	*Charadrius mongolus*	Mongolian Sand Plover	M
	Charadrius ruficapillus	Red-capped Plover	
	Elseyornis melanops	Black-fronted Plover	
	Pluvialis squatarola	Grey Plover	M
Recurvirostridae	*Recurvirostra novaehollandiae*	Red-necked Avocet	
(Stilts, Avocets)	*Himantopus himantopus*	Black-winged Stilt	
Scolopacidae	*Actitus hypoleucos*	Common Sandpiper	M
(Curlews, Sandpipers, Snipes, Godwits)	*Arenaria interpres*	Ruddy Turnstone	M
	Calidris acuminata	Sharp-tailed Sandpiper	M
	Calidris alba	Sanderling	M
	Calidris canutus	Red Knot	M
	Calidris ferruginea	Curlew Sandpiper	M
	Calidris ruficollis	Red-necked Stint	M
	Limosa limosa	Black-tailed Godwit	M
	Limosa lapponica	Bar-tailed Godwit	M
	Numenius madagascariensis	Eastern Curlew	P4, M
	Numenius phaeopus	Whimbrel	M
	Tringa brevipes	Grey-tailed Tattler	M
	Tringa nebularia	Greenshank	M
	Xenus cinereus	Terek Sandpiper	M
Glareolidae (Pratincoles)	*Stiltia Isabella*	Australian Pratincole	
Laridae (Gulls, Terns)	*Larus novaehollandiae*	Silver Gull	
	Chlidonias leucoptera	White-winged (Black) Tern	
	Sterna bengalensis	Lesser Crested Tern	
	Sterna bergii	Crested Tern	

Table E2 (continued...)

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
	Sterna caspia *Sterna nereis* *Sterna nilotica*	Caspian Tern Fairy Tern Gull-billed Tern	 R
Columbidae (Pigeons, Doves)	*Columba livia* *Geopelia cuneata* *Geopelia humeralis* *Geophaps lophotes* *Geopelia placida* *Geophaps plumifera*	Feral Pigeon Diamond Dove Bar-shouldered Dove Crested Pigeon Peaceful Dove Spinifex Pigeon	I
Sub-Family Cacatuineae (Cockatoos)	*Cacatua pastinator* *Cacatua roseicapilla*	Little Corella Galah	
Sub-Family Platycercinae ('Broad-tailed' Parrots)	*Barnardius barnardi* *Melopsittacus undulatus*	Ringneck Budgerigar	
Cuculidae (Parasitic Cuckoos, Coucals)	*Cuculus pallidus* *Chrysococcyx basalis*	Pallid Cuckoo Horsfield's Bronze-cuckoo	
	Chrysococcyx osculans	Black-eared Cuckoo	
Strigidae (Hawk Owls)	*Ninox novaeseelandiae*	Southern Boobook	
Tytonidae (Barn Owls)	*Tyto alba*	Barn Owl	
Podargidae (Frogmouths)	*Podargus strigoides*	Tawny Frogmouth	
Aegothelidae (Owlet-nightjars)	*Aegotheles cristatus*	Australian Owlet-nightjar	
Caprimulgidae (Nightjars)	*Eurostopodus argus*	Spotted Nightjar	R
Apodidae (Swiftlets, Swifts)	*Apus pacificus*	Fork-tailed Swift	M
Alcedinidae (Kingfishers)	*Dacelo leachii* *Halcyon chloris* *Halcyon pyrrhopygia* *Halcyon sancta*	Blue-winged Kookaburra Collared (Mangrove) Kingfisher Red-backed Kingfisher Sacred Kingfisher	 R

Table E2 (continued...)

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
Meropiae	*Merops ornatus*	Rainbow Bee-eater	M
Alaudidae (Old World Larks)	*Mirafra javanica*	Singing Bushlark	
Hirundinidae (Swallows, Martins)	*Hirundo ariel* *Hirundo neoxena* *Hirundo nigricans*	Fairy Martin Welcome Swallow Tree Martin	
Motacillidae (Old World Pipits, Wagtails)	*Anthus novaeseelandiae*	Richard's Pipit	
Campephagidae (Cuckoo-shrikes, Trillers)	*Coracina novaehollandiae* *Lalage tricolor*	Black-faced Cuckoo-shrike White-winged Triller	
Muscicapidae (Thrushes, Flycatchers and allies)	*Eopsaltria pulverulenta* *Pachycephala lanioides* *Pachycephala melanura* *Pachycephala rufiventris* *Rhipidura fuliginosa* *Rhipidura leucophrys*	Mangrove Robin White-breasted Whistler Mangrove Golden Whistler Rufous Whistler Grey (Mangrove) Fantail Willie Wagtail	
Sylviidae (Old World Warblers)	*Cinclorhamphus cruralis* *Cinclorhamphus mathewsi* *Eremiornis carteri*	Brown Songlark Rufous Songlark Spinifex-bird	
Maluridae (Fairy Wrens)	*Malurus lamberti* *Malurus leucopterus*	Variegated Fairy-wren White-winged Fairy-wren	
Acanthizidae (Bristlebirds, Scrubwrens, Gerygones, Thornbills)	*Gerygone tenebrosa* *Smicrornis brevirostris*	Dusky Gerygone Weebill	
Meliphagidae (Honeyeaters)	*Acanthagenys rufogularis* *Lichmera indistincta* *Lichenostomus keartlandi* *Lichenostomus virescens* *Lichenostomus penicillatus* *Manorina flavigula*	Spiny-cheeked Honeyeater Brown Honeyeater Grey-headed Honeyeater Singing Honeyeater White-plumed Honeyeater Yellow-throated Miner	
Ephthianuridae (Chats)	*Ephthianura tricolor*	Crimson Chat	

Table E2 (continued...)

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
Dicaeidae (Flowerpeckers)	*Dicaeum hirundinaceum*	Mistletoebird	
Pardalotidae (Pardalotes)	*Pardalotus rubricatus* *Pardalotus striatus*	Red-browed Pardalote Striated Pardalote	
Zosteropidae (White-eyes)	*Zosterops lutea*	Yellow White-eye	
Ploceidae (Weavers, Waxbills, Grass Finches, Mannikans)	*Emblema pictum* *Taeniopygia guttata*	Painted Firetail Zebra Finch	
Paradisaeidae (Bowerbirds)	*Chlamydera maculata*	Spotted Bowerbird	
Artamidae (Woodswallows)	*Artamus cinereus* *Artamus leucorhynchus* *Artamus personatus* *Artamus minor*	Black-faced Woodswallow White-breasted Woodswallow Masked Woodswallow Little Woodswallow	
Grallinidae (Magpie-larks)	*Grallina cyanoleuca*	Australian Magpie-lark	
Cracteicidae (Magpies, Butcherbirds & Currawongs)	*Cracticus mentalis* *Gymnorhina tibicen*	Pied Butcherbird Australian Magpie	
Corvidae (Crows)	*Corvus bennetti* *Corvus orru*	Little Crow Torresian Crow	

Taxonomy – According to Pizzey 1985

Notes: 1. Conservation Status Code.

R: Species listed on the Department of Conservation and Land Management's *Reserve List*.

P4: Species listed by the Department of Conservation and Land Management as taxa in need of monitoring

M: Species protected under the Japan/Australia and/or China/Australia Migratory Birds Agreement.

I: Introduced Species.

Source:

Astron Environmental (2000), *Natural Gas to Synthetic Oil Project: A Vertebrate Survey of the Plant Site on the Burrup Peninsula*, Unpublished report prepared for HLA- Enivrosciences, June, 2000.

Astron Environmental (1999b), *Natural Gas to Synthetic Oil Project: Plant Site Vegetation, Flora and Fauna Survey*, Unpublished report prepared for HLA- Enivrosciences, October, 1999.

Butler, W.H., & M.A., (1987), *Burrup Peninsula Fauna Survey* for Woodside Offshore Petroleum Pty Ltd.

- **Table E3 Reptile Species Recorded on the Burrup Peninsula and Surroundings Areas**

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
Amphibians			
Hylidae	*Cyclorana maini*	Burrowing Frog	
(Tree Frogs)	*Litoria rubella*	Desert Tree Frog	
Leptodactylidae	*Notaden nichollsi*		
(Southern Frogs)	*Uperoleia russelli*		
Reptiles			
Geckonidae	*Crenadactylus ocellatus hornii*	Clawless Gecko	
(Geckos)	*Diplodactylus ciliaris aberrans*	Spine tailed gecko	
	Diplodactylus conspicillatus		
	Diplodactylus elderi	Jewelled Gecko	
	Diplodactylus jeanae		
	Diplodactylus mitchelli		
	Diplodactylus savagei	Tree Dtella	
	Diplodactylus stenodactylus	Fat-tailed Gecko	
	Gehyra pilbara		
	Gehyra punctata	Spotted Dtella	
	Gehyra purpurascens		
	Gehyra variegata	Tree Dtella	
	Heteronotia binoei	Bynoes Gecko	
	Heteronotia spelea	Desert Cave Gecko	
	Nephrurus levis pilbarensis	Smooth Knob-tailed Gecko	
	Rhynchoedura ornata	Beaked Gecko	
	Oedura marmorata	Marbled Velvet Gecko	
Pygopodidae	*Delma borea*		
(Legless Lizards)	*Delma fraseri*		
	Delma nasuta		
	Delma pax		
	Delma tincta		
	Lialis burtonis	Burton's Snake Lizard	
	Pygopus nigriceps	Hooded or Black-headed Scaly-foot	
Agamidae	*Ctenophorus caudicinctus caudicinctus*	Ring-tailed Dragon	
(Dragon Lizards)	*Ctenophorus inermis(cf C. nuchalis)*	Central Netted Dragon	
	Ctenophorus isolepis isolepis	Military Dragon	
	Ctenophorus reticulates	Western Netted Dragon	
	Gemmatophora gilberti gilberti	Gilbert's Dragon	
	Gemmatophora longirostris		
	Pogona minor minor	Western Bearded Dragon	
	Tympanocryptis cephalus		
Varanidae	*Varanus acanthurus*	Ridge-tailed Monitor	
(Monitor Lizards)	*Varanus brevicauda*	Short-tailed Monitor	

Table E3 (continued…)

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
	Varanus eremius	Desert Pygmy Monitor	
	Varanus giganteus	Perentie	
	Varanus gouldii	Sand Monitor (Bungarra)	
	Varanus panoptes rubidus		
	Varanus tristis tristis	Black-headed Monitor (Racehorse Goanna)	
Scincidae (Skinks)	*Carlia triacantha*		
	Carlia munda		
	Cryptoblepharus carnabyi		
	Cryptoblepharus plagiocephalus		
	Ctenotus duricola		
	Ctenotus grandis titan		
	Ctenotus helenae		
	Ctenotus leonhardii		
	Ctenotus pantherinus ocellifer		
	Ctenotus saxatilis		
	Ctenotus serventyi		
	Cyclodomorphus melanops		
	Egernia depressa		
	Egernia formosa		
	Egernia pilbarensis		
	Glaphyromorphus isolepis		
	Lerista bipes		
	Lerista muelleri		
	Menetia greyii		
	Menetia surda		
	Morethia ruficauda exquisita	Fire-tailed Skink	
	Notoscincus butleri		
	Notoscincus ornatus ornatus		
	Omolepida branchialis		
	Sphenomorphus isolepis		
	Tiliqua multifasciata		

Table E3 (continued...)

FAMILY	GENUS SPECIES	COMMON NAME	CONSERVATION STATUS [1]
Snakes			
Typhlopidae	*Ramphotyphlops australis*	Worm Snake	
(Blind Snakes)	*Ramphotyphlops diversus ammodytes*	Worm Snake	
	Ramphotyphlops grypus	Worm Snake	
Boidae	*Aspidites ramsayi*	Woma	P1
	Aspidites melanocephalus	Black-headed python	
(Pythons)	*Morelia olivacea barroni*	Olive Python	VU
	Morelia perthensis	Pygmy Python	
	Morelia stimsoni	Stimson's Python	
Homalopsidae	*Fordonia leucobalia*	White-bellied Mangrove Snake	
(Water Snakes)			
Elapidae	*Acanthophis pyrrhus*	Desert Death Adder	
(Elapid Snakes)	*Acanthophis wellsi*		
	Demansia psammophis cupreiceps	Yellow-faced Whip Snake	
	Demansia rufescens	Rufous Whip Snake	
	Denisonia fasciata	Rosen's Snake	
	Furina ornate	Moon Snake	
	Pseudechis australis	Mulga Snake	
	Pseudonaja modesta	Ringed Brown Snake	
	Pseudonaja nuchalis	Gwadar	
	Rhinoplocephalus punctatus	Spotted Snake	
	Suta fasciata		
	Suta punctata		
	Vermicella approximans	Northwestern shovel-nosed Snake	
	(cf Simoselaps approximans)		
Hydrophiidae	*Ephalophis greyi*	Southern Mud Snake	
(Sea Snakes)	*Hydrelaps darwiniensis*	Black-ringed Mud Snake	
	Hydrophis major	Olive Headed Sea Snake.	

Taxonomy according to Storr *et al* 1981
Notes: 1. Conservation Status.
VU = Species protected under Schedule 1 of the *Wildlife Conservation Act* (1980, amended 1994). Fauna that is Vulnerable to extinction
P1 = Priority one Taxa with few, poorly known populations on threatened lands.

- **Table E4 Significant Bird Species that may occur on the Burrup Peninsula**

Scientific Name	Common Name	Conservation Status [1]
Burhinus grallarius	Bush Stone-curlew	R
Esacus neglectus	Beach Stone-curlew	R
Eurostopodus argus	Spotted Nightjar	R
Falco hypoleucos	Grey Falcon	R
Falco peregrinus	Peregrine Falcon	S4
Hamirostra melanosterna	Black-breasted Buzzard	R
Tringa hypoleucos	Common Sandpiper	M
T. nebulari	Greenshank	
T. brevipes	Grey-tailed Tattler	
T. terek	Terek Sandpiper	
Calidris acuminata	Sharp-tailed Sandpiper	
C. ferruginea	Curlew Sandpiper	
C. ruficollis	Red-necked Stint	
C. canutus	Red Knot	
C. tenuirostris	Great Knot	
C. alba	Sanderling	
Pluvialis squatarola	Grey Plover	
P. dominica	Lesser Golden Plover	
Apus pacificus	Fork-tailed Swift	
Numenius minutes	Little Whimbrel	
N. phaeopus	Whimbrel	
N. madagascariensis	Eastern Curlew	R
Hirundo rushca	Barn Swallow	
Charadrius mongolus	Mongolian Plover	
C. veredus	Oriental Plover	
C. leshenaultii	Large Sand Plover	
Arenaria imterpres	Ruddy Turnstone	
Limosa lomosa	Black-tailed Godwit	
L lapponica	Bar-tailed Godwit	
Limicola falcinellus	Broad billed Sandpiper	
Glareola maldivarium	Oriental Pratincole	M
Hydroprogne caspia	Caspian Tern	
Stern albifrons	Little Tern	R
S. bengalenisis	Lesser Crested Tern	
Sterna neresis	Fairy Tern	
Egretta alba	Great Egret	M
E. sacra	Eastern Reef Egret	
Haliaeetus leucogaster	White-breasted Sea-eagle	
Merops ornatus	Rainbow Bee-eater	M

Notes:1. Conservation status

S4: Species protected under Schedule 4 of the WA Wildlife Conservation (Specially Protected Fauna) Notice 1998. Schedule 4 lists those fauna species in need of special protection and includes uncommon birds with a cosmopolitan distribution and species whose breeding areas are threatened by habitat destruction and other causes.

R: Species included on CALM's reserve list. The reserve list comprises fauna which have recently been removed from the list of threatened fauna; have a restricted distribution; are uncommon, declining in range and/or abundance; or for which there is insufficient information to make an assessment of their status. Reserve List Species are described as fauna for which the impacts of any proposed development should be carefully considered, as there is a risk that such activities may result in the taxa meeting the criteria for listing as a threatened species.

M: Species protected by the Japan/Australia and/or China/Australia Migratory Bird Agreements

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Marine Environment Background

APPENDIX F

APPENDIX F – Marine Environment Background

The proposed loadout facility at the existing Dampier Public Wharf extends into the nearshore waters of Mermaid Sound. The Dampier Port Authority has responsibility to protect the environment of the port and minimise the impact of port activities on that environment.

The Dampier Port Authority has developed an Environmental Management Plan to provide a framework to ensure that operations under its direction and control are managed to protect the Port environment. The following broad description of the marine and near-shore environment in the area is largely extracted from the Port Dampier Environmental Management Plan (Bowman Bishaw & Gorham, 1994). The major environmental features in the region are divided into shoreline habitats and nearshore habitats.

F.1 Shoreline Habitats

Shoreline or intertidal habitats are extensive and well developed in the Dampier Archipelago and adjacent coastlines. The intertidal communities have been the subject of various studies (eg. Woodside Offshore Petroleum Ltd's ongoing studies) and have been mapped by the (then) Department of Conservation and Environment (now DEP) in 1985 and by Woodside in 1992. The main intertidal habitats present in the Port area are:

- Mangals;
- Sand and mud flats;
- Rocky shores;
- Beaches; and
- Reef flat.

F1.1 Mangals

Of the seventeen mangrove species found on the Western Australian coast, six occur in the Dampier Archipelago. The most common species are *Avicennia marina* and *Rhizophora stylosa*. Less common are *Bruguiera exaristata, Ceriops tagal, Aegialitis annulata,* and *Aegiceras corniculatum*.

Mangrove communities are ecologically important. They are net exporters of nutrients and are important habitats for, among other things, juvenile fish, crustaceans and turtles (CALM, 1990).

Mangals support an extensive infauna of burrowing and foraging invertebrates, the bioturbating activities of which act to condition the mud favourably for mangrove growth. Burrowing crustaceans found in Dampier mangals include Fiddler Crabs (*Uca spp*), the Mud Crab (*Scylla serrata*) and the Mud Lobster (*Thalassina anomala*). The most abundant burrowing invertebrate however, is the peanut worm (*Phascolosma* sp.) with densities of 400-500 m^2 recorded from the area (Woodside Petroleum Development Pty Ltd, 1980). Various gastropods also inhabit the mangroves; some feeding on the trees while others graze on the algae and diatoms occurring in the mud and on *Avicennia* pneumatophores (mangrove aerial roots).

Fish surveys undertaken by the CSIRO in 1983 – 1984 (Blaber *et al*, 1985) found lower fish abundancies in the Pilbara mangals than occur in tropical-wet mangals of Northern Australia. This was ascribed to the clearer water conditions associated with the lack of freshwater runoff in the Pilbara, which favours high predation upon juvenile fish. Although the fish biomass is reduced, productivity is high.

The organic content of sediments within Pilbara mangals was high by Indo-Pacific standards, favouring detrital feeders such as mullet (*Valamugil buchanoni*). A total of 113 fish species were found, of which 48 were encountered as fry.

The most extensive mangal in the Dampier area occurs in the Maitland River delta. A large area of this community was lost in the 1970s with the construction of Dampier Salt's solar salt production ponds. The remaining Maitland River mangal extends from the western limit of Dampier Salt's lease along the coast to the Maitland River, and around West Intercourse Island.

Smaller mangrove assemblages occur on the western side of Mid Intercourse Island, the sheltered bays of the Burrup Peninsula (King, Withnell and Conzinc) and in a land-locked intertidal depression on Enderby Island.

F1.2 Sand and Mud Flats

Intertidal sand and mud flats are a feature of protected areas of the Pilbara coastline. Mangals are generally backed by mud flats and fronted by intertidal flats of a more sandy nature. These generally support a large infauna of burrowing organisms, which provide an important food source for other organisms. The muddy sediments near the mangroves also have large populations of Fiddler Crabs (*Uca spp.*), while Soldier Crabs (*Hictyris longicarpus*) and Bubbler Crabs (*Scopimera inflata*) populate many of the sand flats. A variety of burrowing molluscs (*Anomalocardium sp., Garfarium sp.* etc) inhabit the sand and mud flats seaward of the mangroves. Other species, notably *Donax faba*, are prevalent within intertidal sandy beaches. These flats are feeding zones for shore birds and waders during low tides, and for fish and stingrays (e.g. *Himantura uarnak*) when inundated.

The mud flats which back mangroves are also important habitats. These are only inundated on spring high tides, and the salinity of near surface water usually exceeds 70% (Gordon, 1983), thus precluding the growth of mangroves. The mud flats support blue-green algal mat communities which fix atmospheric nitrogen and contribute to the primary production of the area. Paling (1986) reported a periodic flux of significant organic matter and nutrients from mud flat algal mat to coastal waters at Dampier.

The most extensive mud flats in the area occurred between what was then Dampier Island (now Burrup Peninsula) and the mainland and which are now developed as Dampier Salt's brine ponds and salt evaporator. The largest existing mud/sand flats in the area occur between Dampier Salt's lease and the Maitland River, incorporating West Intercourse Island. Smaller sand flats occur in the sheltered bays of the Burrup Peninsula (King, Withnell and Conzinc), on the southern side of Legendre Island, and in sheltered bays of Enderby and West Lewis Islands.

F1.3 Rocky Shores

The igneous nature of the majority of the islands of the Archipelago has provided extensive rocky intertidal foreshores and shoals. These are colonised by invertebrate communities typified by oysters (*Saccostrea spp.*), barnacles (*Chthamalus sp.* and *Tetraclita sp.*), whelks (*Morula sp.*) and chitons (*Aconthopleura sp.*). Population densities range from very low (individuals scattered over intertidal boulders) to very high (total blanketing of the substrata by oyster-barnacle sheets). These habitats are active feeding zones for fish which move in on rising tides, and shoreline birds such as the oyster catchers (*Haemotopus spp.*) on low tides.

Rocky shore occurs on all of the islands (except Keast which is a sand island), but is most extensive on the granophyre islands and the Burrup Peninsula. The exposed northern shoreline of Legendre Island also has a predominantly rocky intertidal shoreline, though of an eroded limestone nature.

F1.4 Beaches

Sandy beaches in the Port of Dampier are not extensive in area. They occur mostly as small deposits where sand is concentrated in embayments between rocky headlands.

The sand is generally coarse and consists of calcareous and siliceous material.

The resident biota of the sandy beaches consists largely of infauna such as polychaete worms, bivalve molluscs and amphipod crustaceans. Ghost crabs (*Ocypode*) are also present. The beaches are used as feeding and nesting grounds by wading birds and are important as turtle nesting sites.

F1.5 Intertidal Reef-flat

Extensive areas of intertidal reef-flat occur within the Dampier Archipelago. They support diverse assemblages of plants and animals and provide feeding areas for wading birds during low tide and for fish during high tide.

Intertidal pavements at mid-to low-tidal levels are generally colonised by algal turf and a cryptic fauna of rock crabs, other small crustaceans and gastropod and bivalve molluscs. Desiccation during periods of emersion limits the diversity of animals and plants able to inhabit this tidal range.

The most extensive and productive reef-flat within the Dampier Archipelago occurs in the protected waters bounded by Legendre Island, Collier Rocks and Keast Island. This reef-flat is only emergent during low spring tides and supports diverse macroalgae/seagrass and coral communities. The very abundant plants and animals provide food for large populations of turtles and pelagic fish, and for occasional Dugong.

F.2 Nearshore Habitats

There is a high diversity of nearshore or marine habitats in the Dampier Archipelago, due to the wide range of environmental conditions. For example, water turbidity increases from the clear oceanic waters near the outer reefs and islands into the silty inner waters. Water depths range from broad expanses of shallow reef-flat to deep (to 18m) channels between islands.

The wide range of habitats results in a diverse fauna that is acknowledged in the current consideration to have an area of the archipelago gazetted as a marine park/marine nature reserve.

The main habitats present are discussed under the following headings:

- Coral reefs;
- Macroalgal/seagrass beds;
- Invertebrate filter feeding communities;
- Sediment substrates; and
- Open waters.

F2.1 Coral Reefs

Well developed coral reefs are the most obvious of the marine habitats of the Dampier Archipelago, with at least 209 species of scleractinion corals from 57 genera recorded (Simpson, 1988). This high species diversity is attributed to the wide range of habitats available under varying physical conditions (Marsh, 1978). Simpson (1988) lists four main coral habitats:

- Intertidal and subtidal limestone pavements;
- Intertidal and subtidal igneous rocks;
- Intertidal and subtidal sands/gravels; and
- Intertidal muds.

The most extensive coral reefs occur as barrier and fringing reefs along the limestone submarine escarpment on the oceanic boundary of the archipelago. These reefs have relatively low diversity and high abundance, due apparently to the high energy regime and low rate of sediment deposition, conditions which favour the robust fast growing *Acropora* species and the robust pocilloporids. Inshore reefs are typified by low diversity and abundance, probably due to the inability of many species to survive high rates of sediment deposition that occur in this area. The mid-shore area of Mermaid Sound has the highest species diversity, reflecting a degree of biological overlap of these two extremes.

Coral communities are susceptible to wave damage from cyclones in summer and intense southern gales in winter. Another source of damage to corals is from natural predators such as the Crown-of-Thorns Starfish (*Acanthaster planci*) and the corallivorous whelk, *Drupella cornus*.

The coral reefs of the Dampier Archipelago are the only recorded area of Western Australia where the Crown-of-Thorns is relatively common (Wilson and Stoddart, 1987). Population studies of this starfish have been conducted in the archipelago by the Western Australian Museum in 1972-1974 (Wilson and Marsh, 1974; 1975), the DEP in 1985 (Simpson and Grey, 1989), and the Australian Institute of Marine Science in 1987 (Johnson and Stoddart, 1988). These studies found highest numbers of adult and juvenile *Acanthaster* in the western side of the archipelago.

Live coral cover in the affected area was less than comparable areas located on the eastern side of the archipelago, where there were lower *Acanthaster* populations.

To the north of Rosemary Island, Sailfish Reef supported flourishing corals before 1974 but was devoid of corals in 1985. It has been suggested that cyclone Trixie (in 1975) caused the initial gross damage with the *Acanthaster* then inhibiting recovery by predation of coral recruits (Simpson and Grey, 1989).

The corallivorous mollusc, *Drupella cornus*, which has caused extensive damage to Ningaloo Reef coral communities, is uncommon at present in the Dampier Archipelago. However there have been an increasing number of reports of large *Drupella* populations occurring between Ningaloo Reef and Dampier, and a further northward trend of *Drupella* recruitment could affect the corals of the archipelago sometime in the future.

Tropical coral reefs typically support a diverse and abundant fish population. Information from the Dampier coral reefs is limited to surveys conducted by the Museum of Western Australia undertaken in conjunction with the *Acanthaster* surveys of 1971-1974. These identified 408 species of bony fishes (teleosts) from 82 genera (WA Museum, unpublished data). However, coral reefs provide a wide range of habitats and many more fish species would be expected to be identified amongst the reefs of the archipelago if more extensive surveys were undertaken.

F2.2 Macroalgae/Seagrass Beds

The most prolific of the macroalgae present in the area are the *Sargassum* species. These plants exhibit a pattern of annual growth followed by senescence, with individual plants attaining lengths of 3m by late summer before breaking off above the holdfast in early winter. The detached *Sargassum* form large floating rafts, some of which drift ashore while others are carried offshore by tidal and wind induced surface currents. Minor seagrasses, notably *Halophilia spp.* And *Halodule sp.* occur within the macroalgal meadows, and are the dominant plants of some shallow sand flat areas of the Dampier Archipelago (eg. West Conzinc Island).

Principal areas of macroalgal occurrence are the shallows on the southern side of Legendre Island and the expansive flats near to the submarine limestone escarpment between Rosemary Island and Nelson Rocks. Smaller assemblages occur on hard shallow substrates around Eaglehawk, Malus, Enderby and Angel islands.

Seagrasses are the principal food of Dugongs (*Dugong dugon*). They are also consumed by other herbivores such as the Green Turtle (*Chelonia mydas*), which also grazes on macroalgae. Dugong, which are a classified Schedule 2 species (in need of special protection), occur within the archipelago, although they are much less common than in some other parts of the Pilbara (notably Exmouth Gulf). Green Turtles are common throughout the archipelago, but occur particularly in large numbers across the southern Legendre Island macroalgal beds.

F2.3 Invertebrate Filter Feeding Communities

Quantitative information on the occurrence, diversity and abundance of invertebrate filter feeding communities in the Dampier Archipelago is sparse. Communities dominated by sponges, gorgonians and sea whips were observed by Department of Conservation and Environment (DCE) researchers during 1982–1985, coincident with hydrodynamic studies. These occupy deeper hard substrates in channels between islands, particularly around Goodwyn Island, and less so between Malus and West Lewis Island (M. Forde, pers. comm). Less dominant fauna include ascidians, hydroids and bryozoans. Further areas of hard substrates encountered below the photic zone have communities dominated by molluscs, most notably the Bastard Oyster (*Pinctada albina*) and the Hammer Oyster (*Malleus malleus*).

F2.4 Sediment Substrates

Unconsolidated sediments comprise the bulk of the marine subtidal substrate of the Dampier Archipelago. Spot dives undertaken by the DEP throughout Mermaid Sound and Mermaid Strait have found sediments ranging from silty muds in the inner Sound region to coarse sands and gravels near Gidley Island (Talbot, 1991). These support a range of burrowing organisms (obvious by signs of bioturbation in the soft sediments), and solitary corals on the gravel flats. An infauna of photosynthetic organisms (diatoms, algae and dinoflagellates) occupy the surface sediments, being particularly obvious in winter when light penetration is highest. The ecological importance of these organisms is unknown, although Masini (1990) estimated potential gross productivity to be in the order of 300g of carbon/m^2/a. Additionally, the algae acts to bind the sediment, thus reducing re-suspended sediment load and increasing light penetration. This is particularly obvious in winter when sediments can have a visually discernable green/brown covering of microalgae.

F2.5 Open Waters

The tropical open waters of the archipelago support an abundance of plankton and pelagic fish, mammals and reptiles. During summer huge blooms of blue-green algae of the genus *Trichodesmium* occur along the entire Pilbara coast. Blooms from the Dampier Archipelago have been recorded to extend at least 140km seawards (Creagh, 1985), however their importance to primary production has not as yet been determined. Creagh (1985) concluded that they may provide an important food source for a variety of fish and invertebrates within the Dampier Archipelago.

The offshore waters support dense schools of Herring (*Herkolotsichthys* spp.), Sardine (*Sardinella* spp.) and Anchovy (*Stolephorus* spp). Pelagic fish, particularly the Tuna (*Thunnus tanggol*), and the

Mackerel (*Scomberomorus commerson*) feed on these small fish. Schools of Pelagic sharks (*Carcharhinus limbatus*) and Billfish (*Istophorus platypterus*) are less common predators. The baitfish also support the bulk of the shearwater and tern species which roost or breed on the islands.

Mammals are represented by the Dugong (*Dugong dugon*), Humpback Whale (*Megaptera novaeangliae*), False Killer Whale (*Pseudorca crassidens*), Southern Bottle-Nosed Whale (*Hyperoodon plenifrons*), Bottle-Nosed Dolphin (*Tursiops truncatis*), Indo-Pacific Humpbacked Dolphin (*Sousa chinensis*) and Risso's Dolphin (*Crompids griseus*). Dugong mainly frequent the seagrass beds located in shallow bays and areas between islands. Humpback whales regularly pass the archipelago on their annual northern and southern migrations while the other whales are occasional visitors. The Bottle-Nosed and Humpbacked Dolphins are relatively common while Risso's Dolphin is less common.

Marine reptiles occurring in the open waters include four species of turtles and up to twelve species of Sea Snakes. The Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*), Flatback Turtle (*Natator depressus*) and Loggerhead Turtle (*Caretta caretta*) occur in the area and all are recorded as nesting on archipelago beaches. The Green Turtle is the most common and, because it is a herbivore, it is often observed near macroalgae/seagrass beds. In contrast, the Hawksbill Turtle eats sponges and the Loggerhead Turtle eats crustaceans and molluscs.

Of the twelve species of marine snake that occur in the Dampier Archipelago, the Olive Sea Snake (*Aipsysurus laevis*) is the most common. Little is known about these animals in the Dampier Archipelago.

Draft Environmental Management Plan

APPENDIX G

1. Background

Burrup Fertilisers Pty Ltd, Burrup Fertilisers, proposes to develop a 2,200 tonne per day ammonia plant on the Burrup Peninsula. To do so Burrup Fertilisers is required to obtain environmental approvals from the Minister for Environment through the approval process of a Public Environmental Review. This draft Environmental Management Plan has been prepared in accordance with Burrup Fertiliser's commitment in the Public Environmental Review to prepare an Environmental Management Plan. The development of this document will also satisfy Ministerial Conditions that are expected to be placed on Burrup Fertilisers as a result of project approval.

In summary, the key characteristics of the Project are defined in **Table 1-1**.

- **Table 1-1 Key Project Characteristics**

Characteristic	Description
Project Purpose	To produce liquid ammonia from natural gas using advanced production technology for sale mostly to international markets.
Project Life	25+ years
Project Value	Approximately A$630 million
Plant Capacity	2,200 tpd (design case); 770,000 tpa
Area of Project Lease	72 ha
Area of Disturbance	*Item* — *Area (ha)* Ammonia plant and lay-down — 24.0 Desalination plant proposed by Water Corporation — 1.0 Access road and product pipeline to plant — 2.4 Total — 27.4 say — 28 (maximum)
Plant Facilities	Administration, maintenance and warehouse unit Ammonia storage unit Pumps and refrigeration unit Utility unit Control room Ammonia process unit Cooling tower
Plant Operation	24 hours per day, 350 days per year (design case)
Shutdown Time	Planned shutdown – 10 days per annum Emergency shutdown – 5 days per annum for 4 hrs/day
Ammonia Storage	2 x 40,000 tonne cryogenic, double-walled, double integrity tanks
Potable Water	7-10m^3/hr
Seawater	Approximately 2000m^3/hr; 48ML/day
Power Generation	Internal generation. Two (1 x operating 100% capacity and 1 x operating 25% capacity) 20 MW steam turbine generators. Supply of energy (approx 4MW of electricity) to the desalination plant.
Power Export	None
Emergency Power	Two emergency diesel generators (2.0MW) for start-up power. May also provide power for construction.

Characteristic	Description		
Steam Generation	Two (1 x operating and 1 x standby) 100t/hr of medium pressure steam for plant start-up		
Low Pressure Steam Export	Capacity for about 10 t/hr		
Energy Efficiency	Approximately 29.7 ~ 29.9 MJ/ t NH_3 (ammonia plant); Approximately 32.6 MJ/t NH_3 (entire project including shipping, transport of product, cooling etc.)		
Natural Gas Input	Approximately 74 TJ/day		
Natural Gas Pipeline	Approximately 1.3 km; below ground; from DBNG pipeline to the plant; to be constructed by Apache Energy.		
Seawater Pipeline	Approximately 1.2 km; likely to be below ground; from desalination plant to connect to brine discharge line along Burrup Road, to be constructed by Water Corporation.		
Ammonia Pipeline	Approximately 4.3 km; above ground; from the plant to the Dampier Public Wharf.		
Catalysts	Aluminium, cobalt, copper, iron, magnesium , molybdenum and nickel oxides		
Approximate Gaseous Emissions under Normal Operations:	Daily Load (kg/day)	Per tonne NH_3 (kg/t NH_3)	Annual Load (t/yr)
NO_x	1439	0.65	503
CO_2	4.03×10^6	1832	1,411,000
CO	295	0.13	103
SO_2	1.7	0.0008	0.6
NH_3	Nil	Nil	Nil
VOC	Nil	Nil	Nil
Liquid Wastewater Discharges:			
Package Boiler Blowdown Cooling Tower Blowdown Demineraliser Regenerant Wastewater Reformer Jacket Blowdown Reformer Boiler Blowdown Intercooler Waste Process Condensate Sanitary Wastewater Surface Runoff	The quantity and quality of liquid wastewater discharges will meet the requirements of the water Corporation as per their licence conditions stipulated by the DEP.		
Solid Waste:	Approximate quantities of solid wastes produced:		
Demineraliser Spent (Cation/Anion Resin)	27,000 kg every 3 years (Di-vinyl Benzene, Polystyrene Resin)		
Desulphuriser Spent Catalyst	33,200 kg every 3 years (zinc oxides); 15,700 every 6 years (cobalt and molybdenum oxides)		
Biosolids	Stabilised biosolids from wastewater treatment plant		
Domestic Waste	Variable quantity disposed to landfill weekly.		
Construction Period	Approximately 20 months		
Workforce	Construction: 500 (peak) Operation (on-site): 50 (peak to accommodate two shift changes) (off-site): 10		

2. Scope

This Environmental Management Plan (EMP) is in draft form and has been prepared for the purposes of the Public Environmental Review to provide the public the opportunity to comment. The EMP provides a mechanism whereby the Proponent is able to manage potential environmental impacts, identified in the Public Environmental Review document, and continually improve environmental performance on a long term basis.

The development of the EMP will satisfy the following nine management commitments made in the Public Environmental Review document:

- **Management Commitment 6.01**: The Proponent will commence to prepare an Environmental Management System for the proposed ammonia plant within 6 months of project approval.
- **Management Commitment 6.02:** The Proponent will prepare an Environmental Management Plan for the construction and operational phases of the plant, prior to the commencement of construction.
- **Management Commitment 6.1.1.3**: The Proponent will develop a Rehabilitation Plan prior to construction to rehabilitate areas of temporary disturbance.
- **Management Commitment 6.1.1.7:** A Weed Management Plan will be developed by the Proponent and included in the Environmental Management Plan for construction.
- **Management Commitment 6.1.4.3**: A water quality monitoring program will be developed, prior to commissioning.
- **Management Commitment 6.1.4.4**: An Erosion Control Plan will be developed, prior to construction.
- **Management Commitment 7.2.3.13**: A Hazardous Material Management Plan will be implemented.
- **Management Commitment 8.2.2.1:** The Proponent will prepare and enforce a Traffic Management Plan, prior to construction.

Notwithstanding the above management commitments, the environmental management plan will also include tasks and procedures to satisfy several additional management strategies stated in the PER.

This Environmental Management Plan provides environmental guidance for all major construction and operational activities and includes management plans for the following key components:

- Construction of the Plant and Loadout Facilities;
  - Erosion control plan
  - Rehabilitation plan
  - Traffic management plan
  - Weed management plan
- Operation of the Plant and Loadout Facilities;
  - Erosion control plan
  - Hazardous materials management
  - Traffic management plan
  - Water quality monitoring programme

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3. Environmental Legislation and Guidelines

Following the approval of the project by the Minister for the Environment, management commitments made in the Public Environmental Review document will be formalised as legally binding Ministerial Conditions. These conditions will be incorporated into the final EMP. The Proponent will also be required to obtain a Works Approval and a Pollution Prevention Licence under Part V of the *Environmental Protection Act 1986.* These approvals and licences will contain conditions that will have to be met during the construction and operational phases of the ammonia plant. These conditions will also be incorporated into the final EMP.

In addition to the above mentioned conditions, the Proponent is required to comply with other legislation and regulations. A summary of key legislation and regulations include and are not limited to (**Table 3-1**):

- **Table 3-1 Key Environmental Legislation**

Legislation/Regulation	Application	Administrator
Aboriginal Heritage Act 1972-1980	Protects Aboriginal sites from disturbance	Aboriginal Affairs Department
Agriculture and related Resources Protection Act 1976	Management of weeds and pests	Agriculture Western Australia
Australian Heritage Commission Act 1975	Identifies areas of national heritage significance	Australian Heritage Commission
Bush Fires Act 1974	Manages fire safety	Bush Fires Board
Conservation and Land Management Act 1984	Protection and management of nature reserves, state forest, marine parks etc	Department of Conservation and Land Management
Clean Air Regulations 1967	Regulates air borne emissions.	Department of Environmental Protection
Dampier Port Authority Act 1985	Protects marine waters within the boundaries of the Dampier Port Authority	Dampier Port Authority
Dangerous Goods Regulations 1992	Regulations for management and handling of dangerous goods	Department of Minerals and Energy
Environment Protection and Biodiversity Conservation Act 1999	Protects matters of national environmental significance	Environment Australia
Environmental Protection (NEPM-NPI) Regulations 1998	Requires industries to estimate emissions to air, land and water on an annual basis.	Environment Australia
Environmental Protection (Noise) Regulations 1997	Noise limits, methods for noise assessment and control.	Department of Environmental Protection
Environmental Protection (Liquid Waste) Regulations 1996	Control and abatement of liquid waste	Department of Environmental Protection
Environmental Protection (Sea Dumping) Act 1981	Permits for dumping dredge spoil at sea	Environment Australia
Environmental Protection Act 1986	Prevention, control and abatement of pollution and conservation protection and enhancement of environment.	Department of Environmental Protection
Explosives and Dangerous Goods Act 1961-1986	Regulates the manufacture, use and storage of explosives & dangerous goods	Department of Minerals and Energy

Legislation/Regulation	Application	Administrator
Fisheries Resources Management Act 1984	Conservation and development of fish resources within the State	Fisheries WA
Health Act 1911	Provides regulation for the protection of public health eg sewage disposal	Department of Health
Marine and Harbours Act 1981	Provision of safe and efficient shipping and boating	Transport WA
Native Title Act 1993	Handles Aboriginal claims for land ownership	Aboriginal Affairs Department
Ozone Protection Act 1989 (Federal)	Controlling the manufacture of ozone depleting substances	Environment Australia
Pollution of Waters by Oil and Noxious Substances Act 1987	Protection of sea and certain waters from pollution by oil and other pollutants. Inspection of vessels and infrastructure.	Department of Environmental Protection
Port Authorities Act 1999	The control, management and operation of ports	WA Ports
Shipping and Pilotage Act 1967	Shipping and Pilotage in and about the Ports, Fishing Boat Harbours and Mooring Control Areas of the State	Transport WA
Soil and Land Conservation Act 1945	Prevents disturbance to soil without authority	Agriculture Western Australia
State Planning Commission Act 1985	Controls land development in the state	Ministry for Planning
Waterways Conservation Act 1976	Conservation and management of waters and the associated land and environment	Water and Rivers Commission
Western Australian Marine Act 1982	Regulation of Navigation and Shipping	Transport WA
Wildlife Conservation Act 1950	Protection of rare and endangered flora and fauna	Department of Conservation and Land Management

4. Environmental Management

4.1 Environmental Management System (EMS)

An Environmental Management Systems (EMS) approach provides for industry to continually improve environmental performance. The EMS represents a structured system through which Burrup Fertilisers will be able to implement its Environment Policy, establish and assess it's commitment, objectives, plans and procedures, compliance to legislative requirements and improved performance. All levels of personnel will be required to implement the EMS and its effectiveness will depend on the commitment of these personnel.

The development of the EMS will be consistent with the following:

- AS/NZS ISO14001 Environmental Management Systems – Specification with Guidance for Use; and
- AS/NZS ISO14004 Environmental Management Systems – General guidelines on principles, systems and supporting techniques.

These standards are based on a continuous cycle of improvement containing the five main principles of Policy, Planning, Implementation, Measurement and Review (**Figure 4-1**).

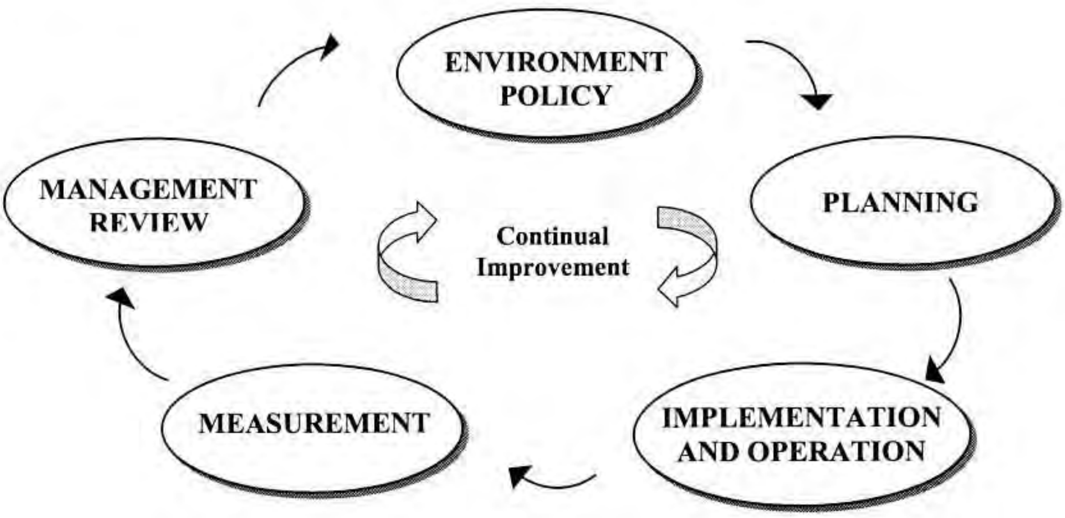

Figure 4-1 Environmental Management System Principles

An EMS using the ISO 14001 standard consists of seventeen elements which are embodied within the five main principles identified in **Figure 4-1**. The elements of an EMS are outlined in **Table 4-1**. Burrup Fertiliser's EMS will be developed using these elements as a guide.

- **Table 4-1 EMS Elements**

Principle	Element
Policy	*Environmental Policy Statement:* A statement of the company's commitment to the environment. The policy provides the framework for the development of the EMS.
Planning	*Environmental Aspects:* Identify and evaluate the environmental 'attributes' of the company's activities, products and services.
	Legal and Other Requirements: Identify and ensure access to relevant environmental laws, regulations, and other requirements of statutory authorities.
	Environmental Objectives and Targets: Develop environmental objectives and targets, relative to the organisation's Environment Policy, environmental aspects and impacts, legal requirements, views of stakeholders etc.
	Environmental Management Plans: Prepare Environmental Management Plans, which specify actions, responsibilities and timeframes in which to implement the Environment Policy, and environmental objectives and targets.
Implementation	*Organisational Structure and Responsibility:* Define clear roles and responsibilities for environmental management within the organisation. Provide the necessary human, physical and financial resources for personnel to conduct their responsibilities effectively.
	Training and Awareness: Provide the necessary training and skills for personnel to manage their environmental responsibilities capably.
	Communication: Establish clearly defined internal and external communication and reporting pathways.
	EMS Documentation: Establish and maintain documented information on the EMS and establish links to related documents. EMS documentation includes the EMS Manual, procedures, environmental management plans, schedules etc.
	Document Control: Ensure the effective management of EMS documentation.
	Operational Control: Identify, plan and manage the organisation's operations and activities in accordance with the Environment Policy, as well as environmental objectives and targets.
	Emergency Preparedness and Response: Develop procedures for preparing for, and responding to, environmental incidents and emergencies.
Measurement and Evaluation	*Monitoring and Measurement:* Develop and maintain monitoring of activities which entail a significant environmental risk.
	Corrective and Preventative Action: Establish a method of identifying and correcting actual and potential deficiencies in the EMS.
	EMS Records: Establish and maintain records of the EMS to assess environmental performance.
	EMS Auditing: Periodically audit the EMS to assess the performance of the system.
Review and Improvement	*Management Review:* Periodic management review of the EMS is the vital concluding stage in the feedback loop of the EMS. The review is conducted with a view to setting new benchmarks in environmental performance and therefore establishing continual improvement in the EMS.

4.1.1 Benefits of an EMS

There are several benefits for developing and implementing an EMS and these include and are not limited to the following:

- Improved environmental performance;
- Reduced liability;
- Documented evidence of 'due diligence';
- Improved compliance;
- Prevention of incidents;
- Improved public image;
- Reduced costs;

- Reduced insurance premiums; and
- Avoiding unnecessary involvement with regulators.

To ensure that the EMS is an effective tool for managing the environment, the EMS will be integrated as far as practicable into the company's other management systems including the Safety Management System.

4.2 Environment Policy

Burrup Fertilisers will develop a Safety, Environment and Social Responsibility Policy in a similar manner to the draft policy illustrated below. The company's policy will be included in the final EMP and the company's EMS to provide a framework and objectives for environmental management.

Burrup Fertilisers Pty Ltd

SAFETY, ENVIRONMENT & SOCIAL RESPONSIBILITY POLICY

(draft for discussion)

VISION

Burrup Fertilisers, as a Company, is committed to environmental protection and the health and safety of its people, contractors and the public.

MISSION

- Provide leadership, coordination and support with respect to environment, health and safety management in all operations and administrative functions and undertake the appropriate due diligence consistent with Burrup Fertilisers' shareholders' best interest.

BELIEFS

We believe that:

- Management and staff commitment to safety, environment and social responsibility is essential to ensuring a safe and environmentally acceptable operating environment.
- Safety shall be uppermost in the minds of all personnel at facilities which we operate.
- All personnel have a responsibility to perform their jobs in a safe and environmentally acceptable manner.
- Excellence in the performance of our environmental, health and safety responsibilities adds value, and is critical to our business.
- Public perception and attitudes are a valuable component to the successful management of our business.
- The environment and the economy can co-exist.
- Community consultation is the preferred mechanism to resolve safety, environment and social responsibility issues of concern to the public.

VALUES

We value:

- Our people are our most important asset and we will not compromise our safety standards to achieve other corporate goals.
- The experience and professionalism of our people.
- The commitment, leadership and accountability of all personnel for safety, environment and social responsibility performance.
- On-going and open dialogue with our stakeholders.
- The health, welfare and safety of our people, contractors and the public.
- The concept of "sustainable development": a balance of environment, economy and social responsibility.
- The commitment of our people to a safe operating environment and protection of environmental quality.
- Prompt, open, frank and complete communication on safety, environment and social responsibility issues.

PRINCIPLES

We will:

- Maintain high standards of environment, health and safety performance consistent with the well being of Society.
- Meet or exceed regulatory compliance.
- Strive to meet industry codes, guidelines and practices.
- Proactively participate in the formulation of public policy.
- Integrate environment, health and safety planning and management into our day-to-day activities, and define individual responsibilities, authority and accountability.
- Ensure that emergency response capability is in place and periodically tested for all company operations and facilities.
- Establish measurable performance targets and assess, document, report and continuously improve our environment, health and safety performance.
- Apply science-based assessment and cost-benefit analysis to safety, environment and social responsibility decision-making.
- Recognize and reward environment, health and safety excellence.
- Strive to optimise the safety of all work sites by hiring only contractors who have superior safety performance and management systems.
- Adopt a "Pollution Prevention" approach to project planning and strive towards the reduction of emissions and wastes.
- Strive to prevent injury to people and damage to equipment, material and the environment.
- Inform stakeholders of our safety, environment and social responsibility performance.
- Address stakeholder concerns when examining risk.

Pankaj Oswal
Managing Director

4.3 Organisation Structure

The proposed organisational structure for the implementation of the Environmental Management System is provided in **Figure 4-2.**

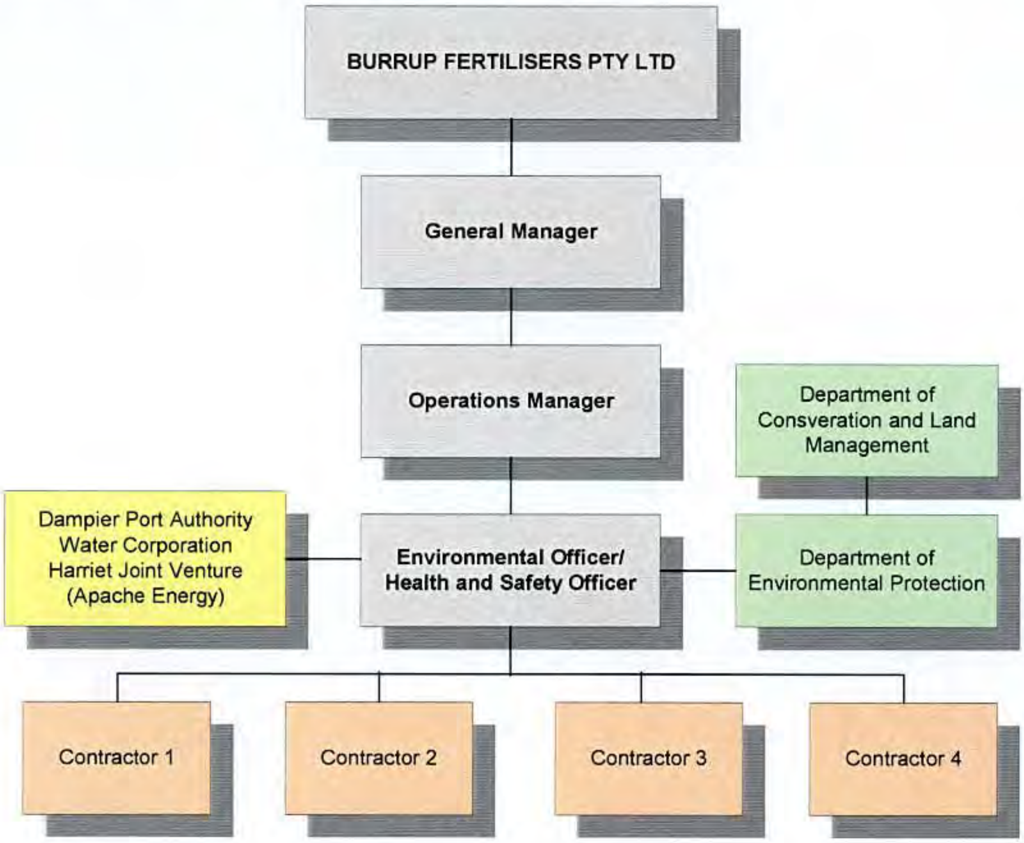

Figure 4-2 Proposed Organisation Structure

4.3.1 Responsibilities

The environmental responsibilities of personnel as illustrated in **Figure 4-2** will be:

General Manager: The general manager is responsible for:

- The implementation and improvement of the EMS;
- Ensuring compliance with legal requirements and other obligations;
- Allocating sufficient resources for implementation of EMS;
- Ensuring management is responsible and accountable for environment performance with their respective areas of responsibility;
- Monitoring environmental performance and driving continual improvement in environmental performance;
- Annual environmental review of the EMS and improvement process; and
- Demonstrating commitment and leadership in environmental management.

Operations Manager: The operations manager is responsible for:

- Implementation and improvement of the EMS;
- Ensuring compliance with legal requirements and other obligations;
- Ensuring significant environmental risks are managed to minimise environmental impact and liability;
- Ensuring employees have the required skills, knowledge and competence levels in their roles to achieve environmental objectives; and
- Demonstrating commitment and leadership in environmental management.

Environment Officer: The Environment Officer is responsible for:

- The development and implementation of the EMS and associated EMPs;
- Day to day management of environmental issues associated with the plant and loading facilities;
- Providing advice on awareness of environmental management requirements;
- Monitoring and advising management on environmental compliance, systems and performance;
- Providing advice and assistance to management to achieve their environmental objectives; and
- Liaising with the Department of Environmental Protection, Dampier Port Authority, Water Corporation and/or Apache Energy when environmental issues are raised.

Health and Safety Officer: The Health and Safety Officer is responsible for:

- The development and implementation of the Safety Management System (SMS) and associated management plans;
- Day to day management of safety issues associated with the plant and the loading facilities;
- Providing advice on awareness of safety management requirements;
- Monitoring and advising management on health and safety compliance, systems and performance;
- Providing advice and assistant to management to achieve their health and safety objectives; and
- Liaising with the Health Department, Department of Minerals and Energy, Dampier Port Authority, Water Corporation and/or Apache Energy when health and safety issues are raised.

Contractors: Appointed contractors will be instructed by the Environment and Health and Safety Officers in regards to their compliance to the EMS and SMS. The contractors will be required to:

- Undertake their activities in accordance with specified procedures and requirements;
- Seek environmental, health and/or safety advice and assistance when required; and
- Be responsible for the environmental outcomes of their activities.

4.3.2 Contact Details

The contact details for personnel will be included in the EMP as shown in **Table 4-2**. These details will be confirmed prior to construction.

- **Table 4-2 Contact Details for Communication**

Organisation	Role	Contact Person	Telephone	Mobile
Burrup Fertilisers	General Manager	TBA	TBA	TBA
Burrup Fertilisers	Operations Manager	TBA	TBA	TBA
Burrup Fertilisers	Environment Officer	TBA	TBA	TBA
Burrup Fertilisers	Health and Safety Officer	TBA	TBA	TBA
Department of Environmental Protection	Environment Officer	TBA	9143 1499	TBA
Department of Conservation and Land Management	Regional Ecologist	TBA	9143 1488	TBA
Dampier Port Authority	Chief Executive Officer	TBA	TBA	TBA
Water Corporation	TBA	TBA	TBA	TBA
Apache Energy	TBA	TBA	TBA	TBA
Contractor 1	Contractor	TBA	TBA	TBA
Contractor 2	Contractor	TBA	TBA	TBA
Contractor 3	Contractor	TBA	TBA	TBA
Contractor 4	Contractor	TBA	TBA	TBA

TBA – to be advised

5. Project Environmental Controls

Implementation of the Environmental Management Plans for the construction and operation phase of the project will be verified by:

- Auditing;
- Monitoring; and
- Reporting.

These mechanisms will also form part of the EMS which will facilitate the continual improvement of environmental management.

A detailed description of the auditing, monitoring and reporting requirements will be provided in the final EMP with particular attention given to:

- Purpose;
- Responsibilities;
- Frequency; and
- Methodology.

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6. Training and Environmental Awareness

All construction and operation personnel will be inducted to ensure that they are aware of tasks and procedures that will need to be followed to comply with the Proponent's commitments made in the Public Environmental Review document and to minimise the impacts to the environment.

Personnel will be required to sign an attendance record and a declaration that they agree to comply with tasks and procedures outlined in the Environmental Management Plan.

(This page has been left blank intentionally)

7. Environmental Management Plans

This Environmental Management Plan provides environmental guidance for all major construction and operational activities and includes management plans for the following key components:

- Construction of the Plant and Loadout Facilities;
  - Erosion control plan
  - Rehabilitation plan
  - Traffic management plan
  - Weed management plan
- Operation of the Plant and Loadout Facilities;
  - Erosion control plan
  - Hazardous materials management
  - Traffic management plan
  - Water quality monitoring programme

The requirement for a noise and blasting management plan will be determined following the result of the geotechnical survey and detailed design phase of the project. In the event that these management plans are required, this EMP will incorporate these plans under the construction phase of the plant.

7.1 Structure and Scope of EMPs

Environmental Management Plans are an integral component of the EMS and provide procedures and tasks that need to be completed to minimise the impact of the ammonia plant on the surrounding environment.

In summary each EMP will contain, though may not be limited to, the following:

- Specific environmental objectives and commitments;
- Statutory and other legal requirements;
- Organisation Structure and management responsibilities;
- A brief description of the existing environment;
- A brief description of the proposed project or process;
- Environmental management activities including monitoring;
- Contingency plans;
- Emergency response procedures and emergency contact numbers;
- Auditing; and
- Reporting (including non-conformance and corrective action reporting, incident reporting, and compliance reporting).

Each EMP will flowchart major processes including the following:

- Organisation structure and management responsibilities;
- Project activities;
- Monitoring programs;
- Contingency plans; and
- Emergency response procedures.

Flowcharting the major processes, provides an effective tool that is clear and simple to understand for all levels of personnel. These charts can be utilised on a stand-alone basis, separate from the EMP, as each chart will capture the major processes. The EMP will provide further guidance and information.

Draft structures and contents of the construction and operation EMPs are provided in the following sections.

7.2 Construction EMP

The proposed structure of the Construction EMP is illustrated in **Figure 7-1**. As an introduction/background to the Construction EMP the following information will be provided:

- A summary of the key environmental characteristics of the project lease to highlight the important environmental values of the project lease;
- A summary of environmental issues as identified in the Public Environmental Review document; and
- A list of activities (management commitments) that need to be fulfilled prior to the commencement of construction.

As part of the construction EMP the following management plans (**Figure 7-1**) will be provided to fulfil management commitments made by the Proponent in the Public Environmental Review document:

- Weed management plan (**Management Commitment 6.1.1.7**)
- Rehabilitation plan (**Management Commitment 6.1.1.3**);
- Erosion control plan (**Management Commitment 6.1.4.4); and**
- Traffic management plan (**Management Commitment 8.2.2.1**).

Each management plan for the environmental factors shown in **Figure 7-1** will consist of a list of tasks and procedures, a process flow chart and contingency plans.

7.2.1 Tasks and Procedures

Specific tasks and procedures that will need to be carried out to manage each environmental factor will be listed in a table format with reference to the responsible person and the commitment number. This table will also serve as a checklist whereby compliance to the task and/or procedure can be signed off by the responsible person. A typical example of such a checklist is provided by **Figure 7-2**.

7.2.2 Process Flow Chart and Contingency Plans

The process flow chart provides an illustrative, easy to follow guide to the processes involved with the construction of the plant. A chart and associated contingency plans will be developed to manage the environmental factors shown in **Figure 7-1**. A typical example of such a flow chart is provided by **Figure 7-3**.

Contingency plans will be provided in a flow chart format to manage impacts that are associated with the construction processes. A typical example of such a plan is provided by **Figure 7-4.**

- **Figure 7-1 Proposed Structure of the Construction Environmental Management Plan**

Contents

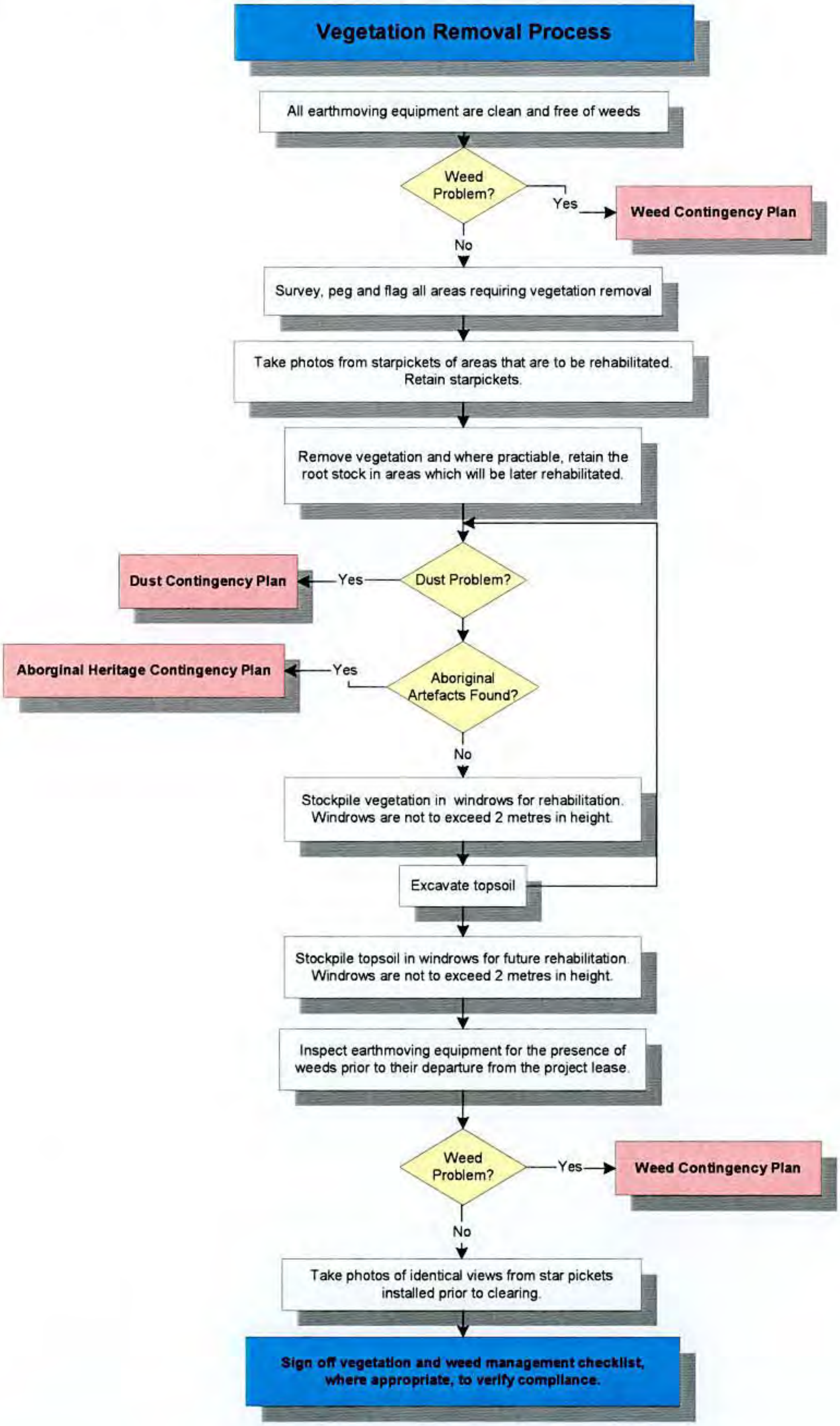
- **Figure 7-2 Typical Example of a Task/Procedure Checklist**

Table 1: Vegetation and Weed Management Checklist

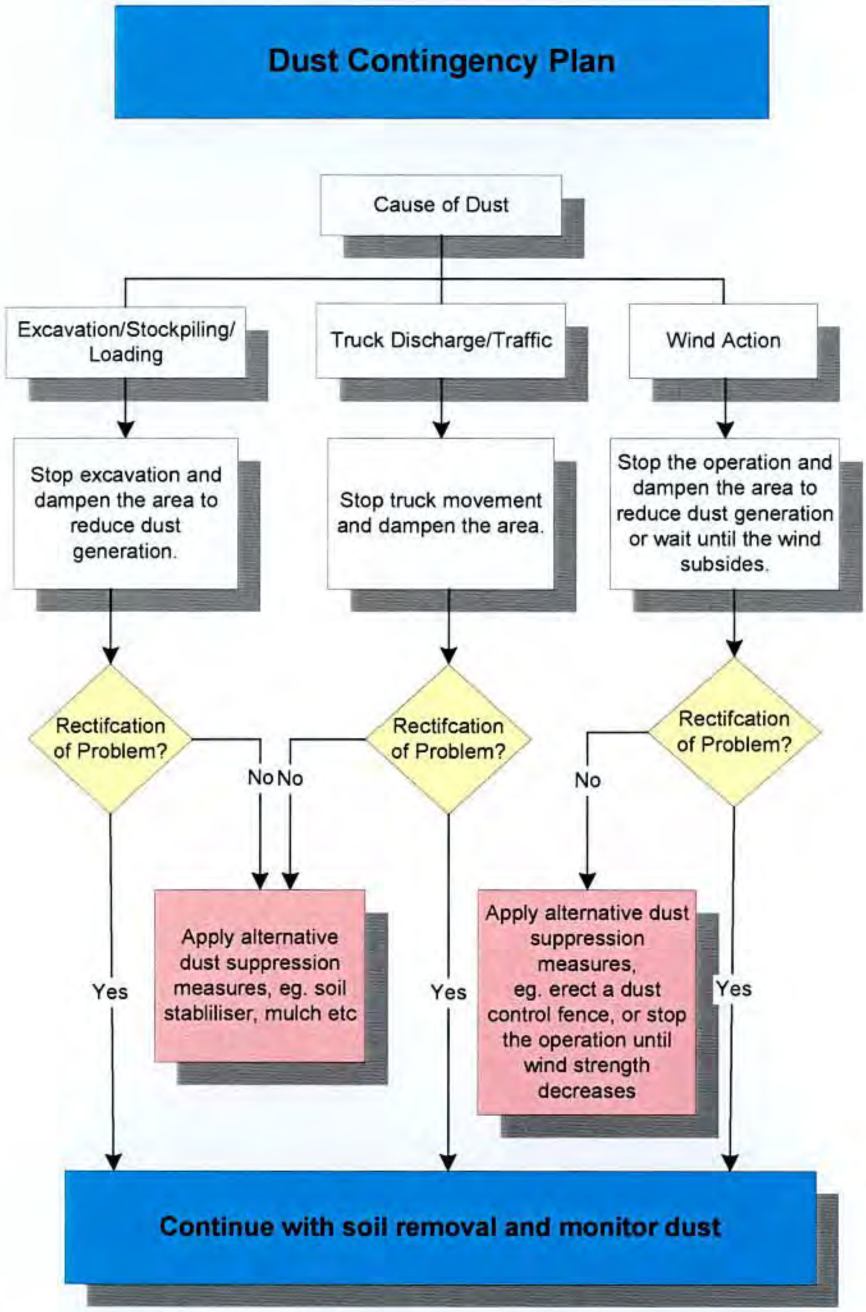
Task/ Procedure	Commitment No. *	Responsible Person	Completed by: [Name, sign & date]	Checked by Project Manager [Name, sign & date]	Comments
Removal of vegetation will be kept to a minimum: ■ Survey areas that require clearing; ■ Peg and flag all areas that require clearing; ■ Ensure all clearing is undertaken within flagged areas; and ■ Stockpile topsoil and vegetation for future rehabilitation.	P 6.1.1	Construction Contractor			
Disturbance to rockpiles, drainage lines and samphire communities will be avoided where practicable: ■ All clearing is be kept within surveyed areas as per design plans; ■ Ensure that access to the site avoids, where practicable, rockpiles, drainage lines and samphire communities; and ■ Ensure traffic through the project lease is kept to designated tracks.	P 6.1.2	Construction Contractor			

* Note: P – Proponent Commitment; M – Ministerial Condition; A – Audit Code

Figure 7-3 Typical Example of a Process Flow Chart



■ **Figure 7-4 Typical Example of a Contingency Plan**



7.3 Operational EMP

The proposed structure of the Operation EMP will follow the structure of the proposed Construction EMP. As part of the Operation EMP the following management plans will be provided to fulfil management commitments made by the Proponent in the Public Environmental Review document:

- Water Quality Monitoring Programme (**Management Commitment 6.1.4.3**)
- Erosion Control Plan (**Management Commitment 6.1.4.4);**

- Hazardous Materials Management (**Management Commitment 7.2.3.13**); and
- Traffic Management Plan (**Management Commitment 8.2.2.1**).

The Operation EMP will address the following environmental factors (**Figure 7-5**):

- Shipping;
- Atmospheric and Greenhouse Gas Emissions;
- Noise Management;
- Waste Management;
- Hazardous Materials Management;
- Erosion Control;
- Water Quality;
- Traffic Management; and
- Social Impact Management.

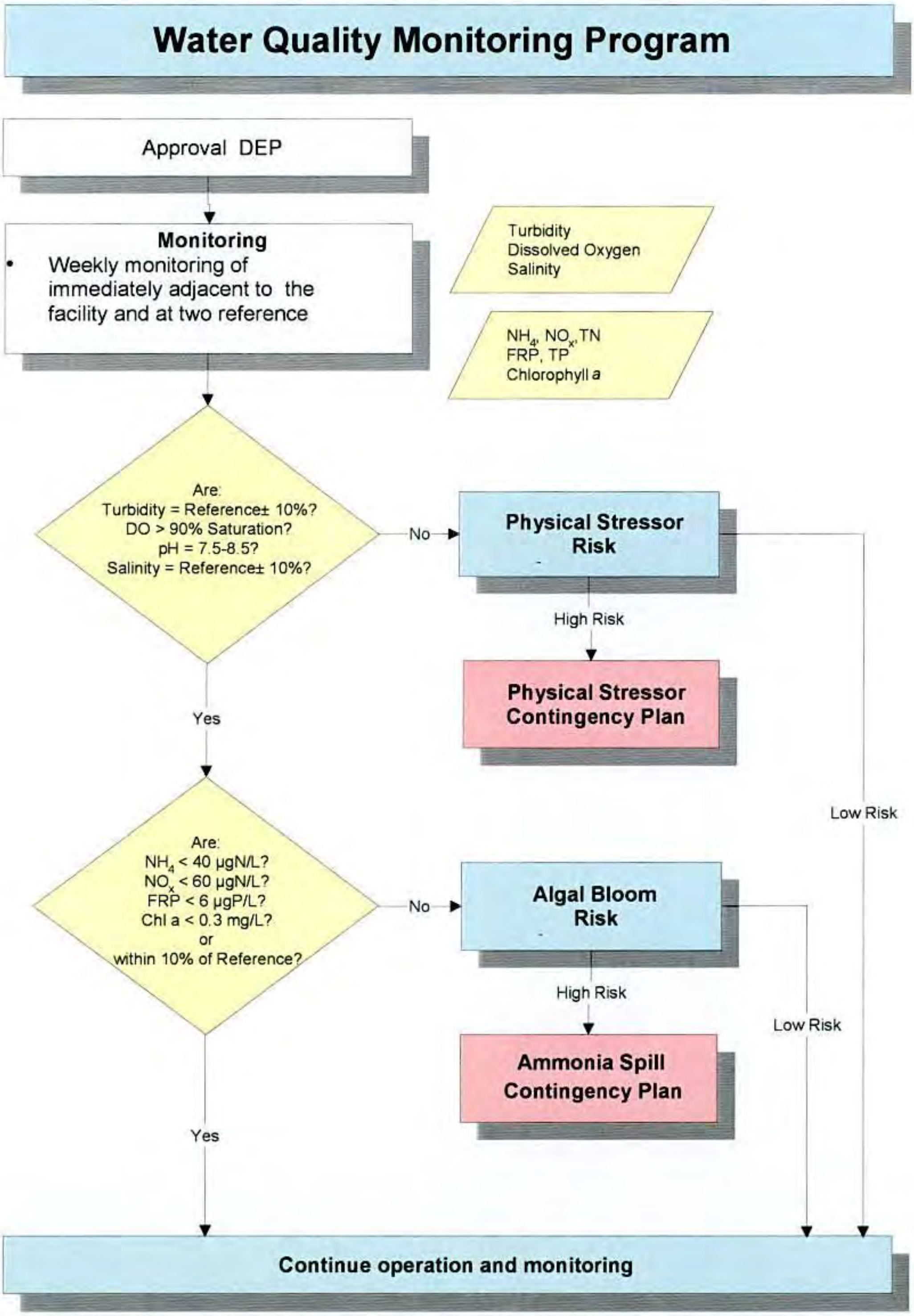
Under each of these environmental factors a list of tasks and procedures, process flow charts and contingency plans will be included in a similar format to that proposed for the Construction EMP.

A draft process flow chart for the management and monitoring of water quality at the loadout facility is provided in **Figure 7-6** as a typical example of how each environmental factor will be addressed in the Operation EMP. A part of this flow chart is the algal bloom risk assessment flow chart and the ammonia spill contingency plan which are also provided in **Figures 7-7 and 7-8**, respectively.

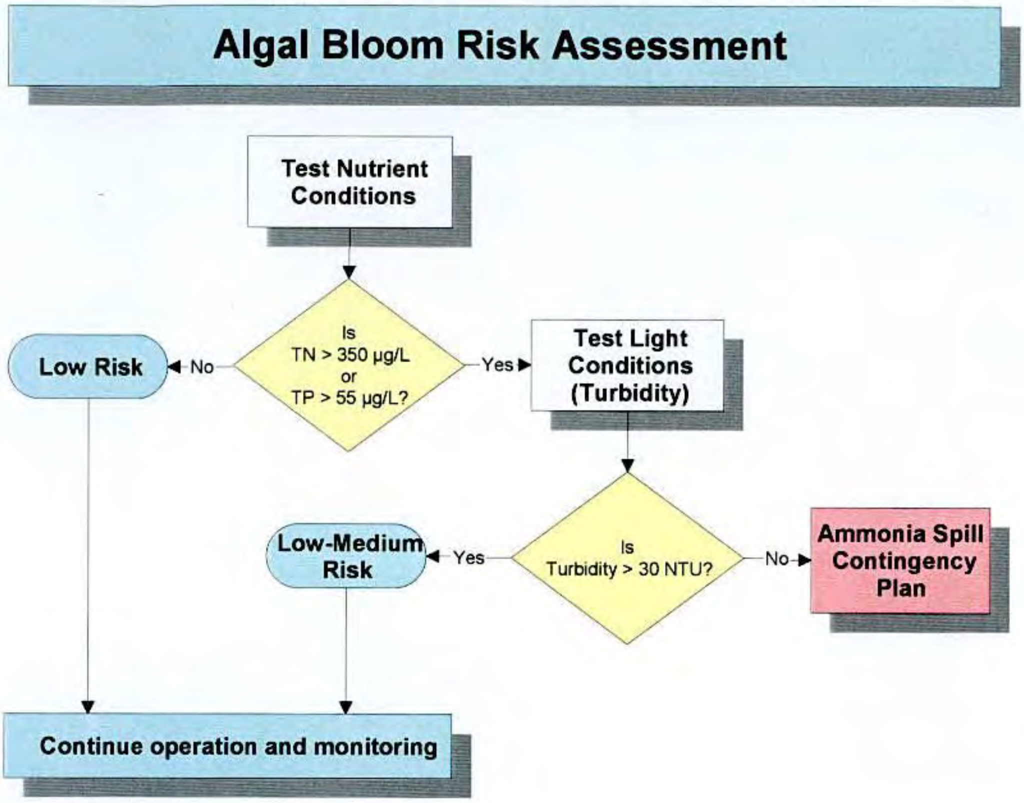
- **Figure 7-5 Proposed Structure of the Operation Environmental Management Plan**

Contents

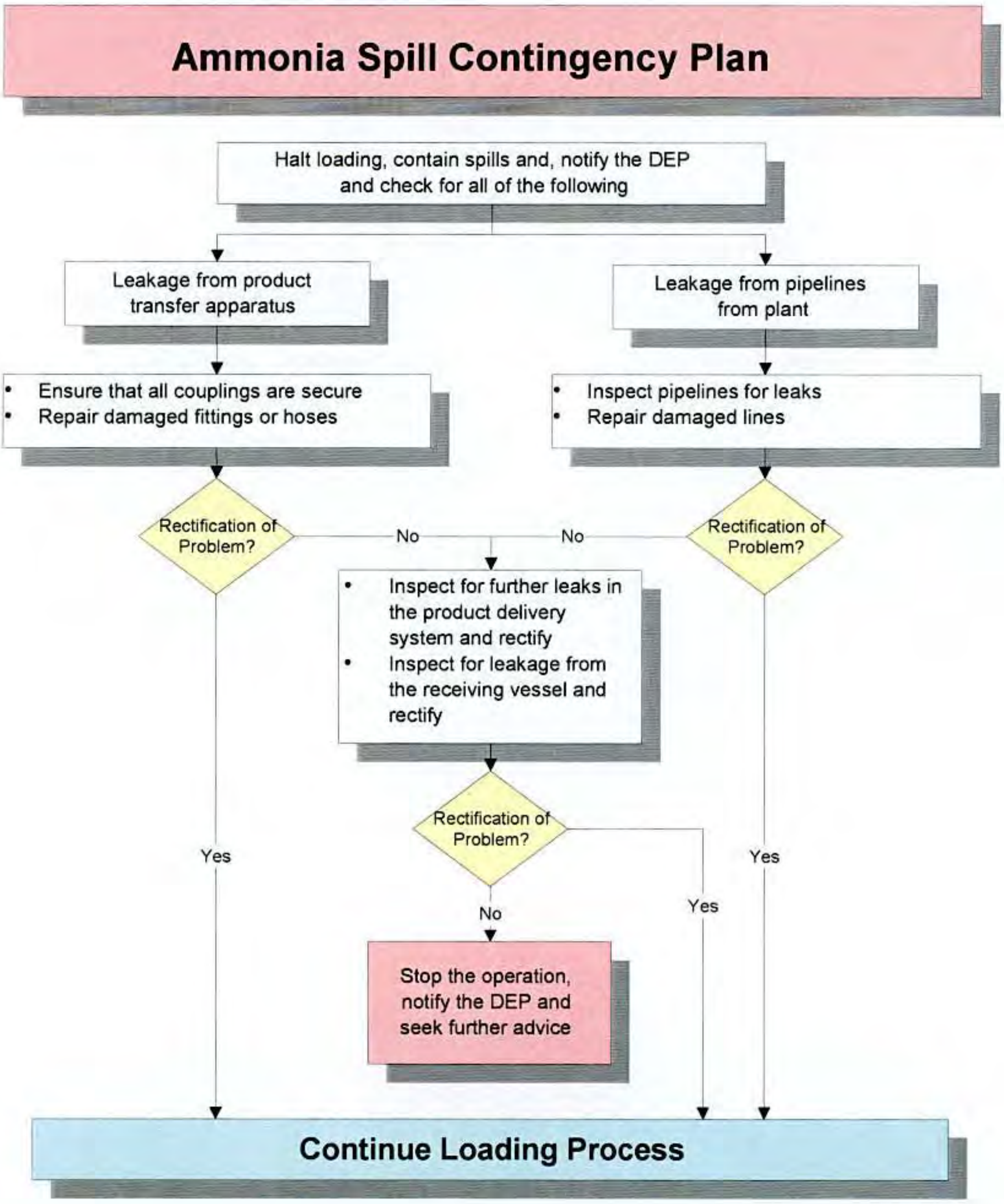
- **Figure 7-6 Water Quality Monitoring Process Flow Chart**



- **Figure 7-7 Algal Bloom Risk Assessment Flow Chart**



- **Figure 7-8 Ammonia Spill Contingency Plan Flowchart**



7.4 Complaints Register and Response

Burrup Fertilisers will register and investigate all substantiated complaints. A summary report, including monitoring results and proposed mitigation measures will be prepared and submitted to the Department of Environmental Protection.

Burrup Fertilisers will establish a complaint recording system and register. A generic complaint log is shown below as an example:

Burrup Fertilisers Pty Ltd **Complaint Log Sheet**	
Date of Complaint:………………… Time of Complaint:…………………	Reported By:………………… Phone Number:…………………
Location:……………………………………………	
Nature of Complaint:	
Immediate Action Taken:	
Further Action Proposed: Monitoring – Yes/No To be reported to Department of Environmental Protection – Yes/No	
Environment Officer Comments: ***Signed***………………………………….	Date:
Operations Manager Comments: ***Signed***……………………………………	Date:
General Manager Comments: ***Signed***………………………………….	Date:
Date reported to Department of Environmental Protection:………………………………… Reported to whom of the Department of Environmental Protection:………………………………	