



Perdaman Urea Project

Environmental Management Plan
Air Quality and Greenhouse Gas Emissions

Final
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Prepared for Perdaman Chemicals and Fertilisers Pty Ltd

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1 Overview

1.1 Summary

Title of proposal	Perdaman Urea Project
Proponent name	Perdaman Chemicals and Fertilisers Pty Ltd (Perdaman)
Purpose of the Environmental Management Plan (EMP)	Environmental Scoping Document requirement
Key environmental factors	Air Quality and Greenhouse Gas (GHG) Emissions
Key environmental objectives	Air Quality - To maintain air quality and minimise emissions so that environmental values are protected (EPA, 2016). GHG Emissions – To mitigate GHG emissions and consequently minimise the risk of contributing to climate change (EPA, 2019).
Key provisions in the plan	Outlined in Table 2-2 and Table 2-3

1.2 Proposal

Perdaman Chemicals and Fertilisers Pty Ltd (Perdaman) proposes to establish a Urea Production Plant on the Burrup Peninsula, Western Australia, to be located within the Burrup Strategic Industrial Area approximately 8 km from Dampier and 20 km north-west of Karratha (the Project).

Urea is an organic compound with the chemical formula $\text{CO}(\text{NH}_2)_2$, manufactured via the reaction of ammonia (NH_3) and carbon dioxide (CO_2) at high pressure and temperature. Natural gas from the nearby Woodside LNG plant will be used as feedstock to the process. The stages involved in ammonia synthesis and urea production are outlined below and depicted in the block flow diagram (Figure 1-1). Support utilities include onsite power generation and an air separation plant.

Gas reforming: Natural gas is catalytically reformed with oxygen and steam to form 'syngas', which is purified to a hydrogen rich and CO_2 stream.

Ammonia synthesis: The hydrogen and nitrogen mixture are compressed and reacted (with help of a catalyst) to form ammonia. This chemical reaction releases heat which is recovered as steam which improves the overall process thermal efficiency, and consequently lowers emissions.

Urea synthesis: Ammonia and CO_2 are reacted to form urea (solution) in a two-stage process which involves an ammonium carbamate ($\text{NH}_2\text{COONH}_4$) intermediate. The urea solution is concentrated to over 95 per cent.

Urea granulation: The concentrated urea solution is dried and granulated, suitable for storage before being conveyed to Dampier Port.

Power generation: Process power requirements will be met with a high efficiency combined cycle gas turbine (CCGT) that includes cogeneration of steam, and a steam turbine for excess steam. The gas turbine will be operated on natural gas under normal conditions.

Air separation: Air is compressed and separated into nitrogen (N_2) and oxygen (O_2) in a conventional cryogenic air separation unit.

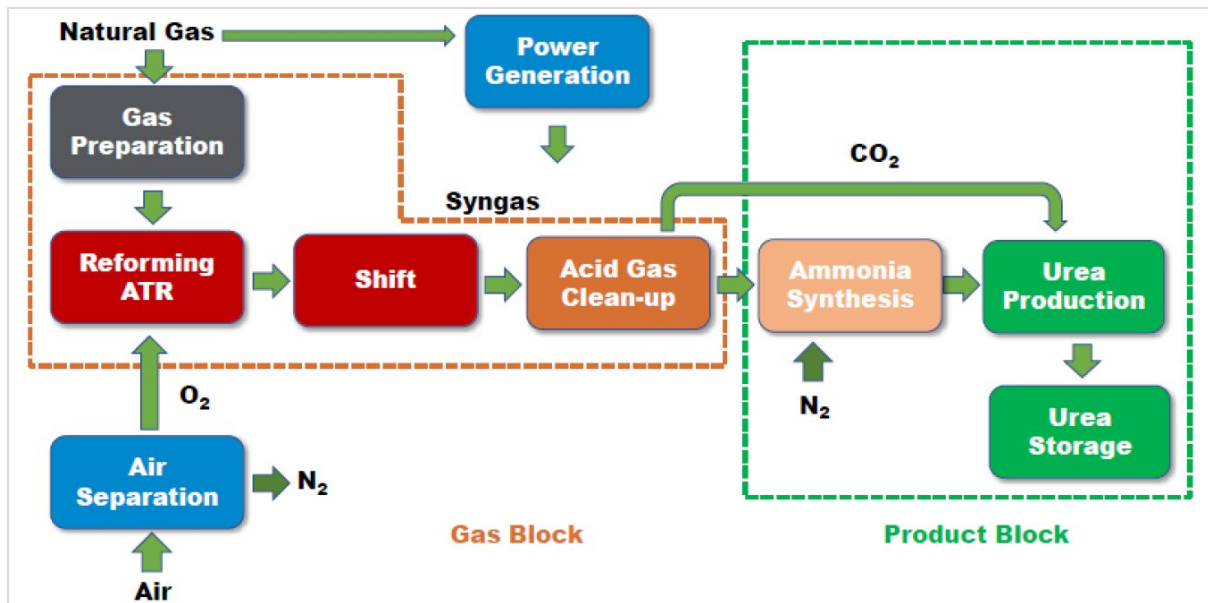


Figure 1-1 Block flow diagram of urea production

1.2.1 Atmospheric emissions

The atmospheric emissions from the Project are primarily derived from ammonia synthesis and urea production, and the combustion of natural gas for onsite power generation. Of primary concern with respect to air quality, on both the local and regional scale are:

Oxides of Nitrogen (NO_x): Consisting of nitric oxide (NO) and nitrogen dioxide (NO₂), these emissions come from combustion, both from the high temperature combustion where nitrogen in the air is oxidised and from nitrogen in the fuel, and from the production of urea.

Urea Particulates: Particulate Matter (PM) comprised of urea dust within the PM₁₀ (particulate matter with an aerodynamic diameter of less than 10 microns) and PM_{2.5} (particulate matter with an aerodynamic diameter of less than 2.5 microns) size ranges, is released to atmosphere from the urea manufacturing process. Particulate scrubbing equipment is incorporated into the Project design to collect urea particulate present in exhaust gases prior to discharge to atmosphere.

Ammonia (NH₃): Traces of ammonia are released from the urea manufacturing process. Acid gas scrubbing equipment is incorporated into the Project design to reduce ammonia present in exhaust gases prior to discharge to atmosphere.

Sulphur dioxide (SO₂), carbon monoxide (CO) and Volatile Organic Compounds (VOCs) (including methanol and formaldehyde) are also present in emissions, but at relatively lower levels in comparison to the pollutants of primary concern listed above.

Ozone (O₃) while not a direct emission from the Project, is formed through atmospheric photochemical reactions involving emissions of NO_x and photochemically reactive organic compounds. Given the complex nature of the reactions and the many variables, it is assumed that any project on the Burrup Peninsula emitting photochemically reactive pollutants will contribute to the process of ozone formation. The Project is estimated to contribute less than 5% of the estimated NO_x emissions in the airshed, based on current approved projects operations.

1.2.2 Greenhouse Gas emissions

The Project is a direct source of GHG emissions, also referred to as Scope 1 emissions, generated from the CO₂ formed as a by-product of gas reforming and the combustion of natural gas for onsite power generation. The CO₂ generated as a by-product of gas reforming is used as a reagent in the urea synthesis process, and hence accounts for a net reduction in emissions from the Project. An important feature of the Project design is that the production of ammonia is fully balanced to urea, such that no ammonia is produced for export as with typical plants, resulting in consumption of CO₂ generated from gas reforming within the urea synthesis process.

Combustion of natural gas for onsite power generation, process heating and steam generation comprise the key stationary energy emission sources.

Although minor, the leakage or loss of methane (CH₄) from the gas reforming and urea synthesis process circuits is also a direct source of GHG emissions.

1.3 Key environmental factors

Air quality and GHG emissions are identified as key environmental factors for the Project.

The Project is a source of atmospheric emissions comprised of NO_x, ammonia and urea particulate matter (as PM₁₀ and PM_{2.5}) of primary concern with respect to air quality on both the local and regional scale.

The Project is located within the Murujuga (the Dampier Archipelago and Burrup Peninsula) Airshed. Murujuga is recognised as a unique ecological and archaeological area containing one of the largest collections of Aboriginal engraved rock art (petroglyphs) in the world. Industrial air emissions are of importance within the context of regional air quality (human health and amenity) and concern over the potential risk of impacts to rock art.

The key issue of concern for the rock art is the potential for colour changes to occur due to natural weathering of the rock art being accelerated by industrial air emissions. An understanding of the weathering processes that are naturally affecting the rock art, and how anthropogenic emissions may alter these processes, is not yet clearly established. One theoretical premise for this is that an increase in acidity of rock surfaces through acid rain and organic acids from nitrate-stimulated microbial growth may alter the mineral composition, integrity and colour of the rock varnish (J. L. Black, *et al.*, 2017).

In this context, it should be recognised that ammonia and urea particulates are not acid forming pollutants. Further, urea dust can decompose rapidly to volatile gas phases in a hot, dry ambient terrestrial environment with little or no potential for regular rain, such that losses through volatilisation may be potentially significant (Cardno, 2020).

The Project is also a direct (Scope 1) emitter of GHG emissions. Total net GHG emissions for the Project are estimated to be equal to 0.65 Mtpa CO₂-e. As a proportion of national and state GHG emissions, the contribution of the Project is low, but still of significance within the context of an increasing trend in Western Australia's emissions of GHGs.

1.4 Rationale and approach

The relevant studies conducted by Perdaman in association with the environmental approvals for the Project have been used to inform the development of this EMP, as follows:

- *Perdaman Urea Project Air Quality Impact Assessment (Jacobs, 2020)*

The Air Quality Impact Assessment (Jacobs, 2020) applied air dispersion modelling to predict the potential ambient air quality impacts of the Project. The assessment considered the potential impacts of the Project (in-isolation) and the incremental cumulative impact of the Project based upon existing and possible future industrial emissions in the region. The air quality impacts are assessed in terms of potential human health and amenity. The overall conclusions of the assessment with respect to human health are that, based on modelling which showed compliance with the relevant air quality criteria, there is a low risk of air quality impact on human health from the Project. The modelling indicated the key pollutants of concern (predicted impacts most closely approach the relevant air quality criteria) to be dust (comprised of PM₁₀ and PM_{2.5} size fractions) and ammonia emitted under normal plant operations from the urea production process primarily.

- *Perdaman Urea Project Greenhouse Gas Assessment (ETA, 2020).*

The Greenhouse Gas Assessment (ETA, 2020) applied accepted methods to estimate the net GHG emissions from the Project to assess the contribution to state and national GHG emissions, and benchmark the Project's energy efficiency and GHG intensity compared to international best practice for the relevant industry sector. The net GHG emissions from the Project were estimated to be 0.65 Mtpa CO₂-e. Gas reforming is the largest single source of GHG emissions (1.72 Mtpa CO₂-e), however these emissions are almost entirely offset through the consumption of CO₂ within the urea production process (-1.5 Mtpa CO₂-e), such that net GHG emissions are estimated to be equal to 0.22 Mtpa CO₂-e, which represents 33% of Project emissions. GHG emissions from stationary energy sources are estimated to be equal to 0.43 Mtpa CO₂-e, which represents 67% of Project emissions. The assessment found that the Project meets the international best practice benchmark established by Fertilisers Europe (2000) for energy efficiency in ammonia production.

2 Environmental Management Measures

2.1 Air Quality Management Measures

The Project incorporates various design features and pollution control equipment to minimise emissions from the Project into the Murujuga airshed as far as reasonably practicable, such that the potential air quality impact on human health from the Project has been assessed as being low risk. Perdaman commits to confirm vendor specifications for key pollution control equipment are achieved, and Project emissions are consistent with estimates used as the basis for the modelling assessment.

The proximity of existing and possible future industry on the Burrup Peninsula and the potential for cumulative impacts necessitates a regional approach to the management of ambient air quality in the region. Perdaman commits to participate and contribute to monitoring and analysis and other relevant aspects of the Murujuga Rock Art Strategy (DWER, 2019).

The key air quality management measures that will be implemented for the Project are presented in Table 2-2.

2.2 Greenhouse Gas Management Measures

The GHG management measures have been developed consistent with the mitigation hierarchy (avoid, reduce, offset) such that GHG emissions from the Project are avoided or reduced, and residual emissions offset, in the planning, design and operations stages (EPA, 2019a).

Energy efficiency and GHG emission considerations during the design stage of the Project is critical to reducing emissions over the life of the Project, with the most significant opportunities to avoid and reduce emissions associated with technology selection and choice of feedstock. The selection of technology for the Project represents international best practice in terms of energy efficiency and GHG emissions, and the use of natural gas as a feedstock is considered the most energy efficient and least GHG intensive option. Opportunity for further significant improvement in energy efficiency and GHG emissions over the life of the Project is therefore expected to be limited, with continuous improvement focused on attaining optimal equipment performance and reliability. Perdaman commits to developing and implementing a comprehensive energy efficiency and GHG emissions monitoring and reporting system to track relevant performance metrics over the life of the Project, and to inform decisions on opportunities to implement practicable measures to improve energy efficiency.

The proposed co-location of ammonia-urea production allows for the CO₂ generated as a by-product of gas reforming to be used as a reagent in the urea synthesis process, and hence accounts for a net reduction in emissions from the Project. An important feature of the Project design is that the production of ammonia is fully balanced to urea, such that no ammonia is produced for export as with typical plants, resulting in consumption of CO₂ generated from gas reforming within the urea synthesis process. The resulting net reduction in GHG emissions from the Project is estimated to be 1.5 Mt CO₂-e per annum.

Perdaman has established interim and long-term targets to avoid, reduce or offset 32,500 tpa CO₂-e by 2035 and 65,000 tpa CO₂-e by 2050 from the Project (Table 2-1), and shown in Figure 2-1. Perdaman will seek continuous improvements in its operational procedures, plans, utilisation of installed plant and actions with the objective of attaining these aspirational targets.

Table 2-1: Interim and Long-term GHG Emission Targets

Scope	Base year annual emissions (t CO ₂ -e per annum)	Base year	Target year	Target year annual emissions (t CO ₂ -e per annum)	Percentage reduction from Base year (%)
1	650,000	2024 ¹	2035	617,500	5%
			2050	585,000	10%

Notes:

1. Indicative Project timeline for full production.

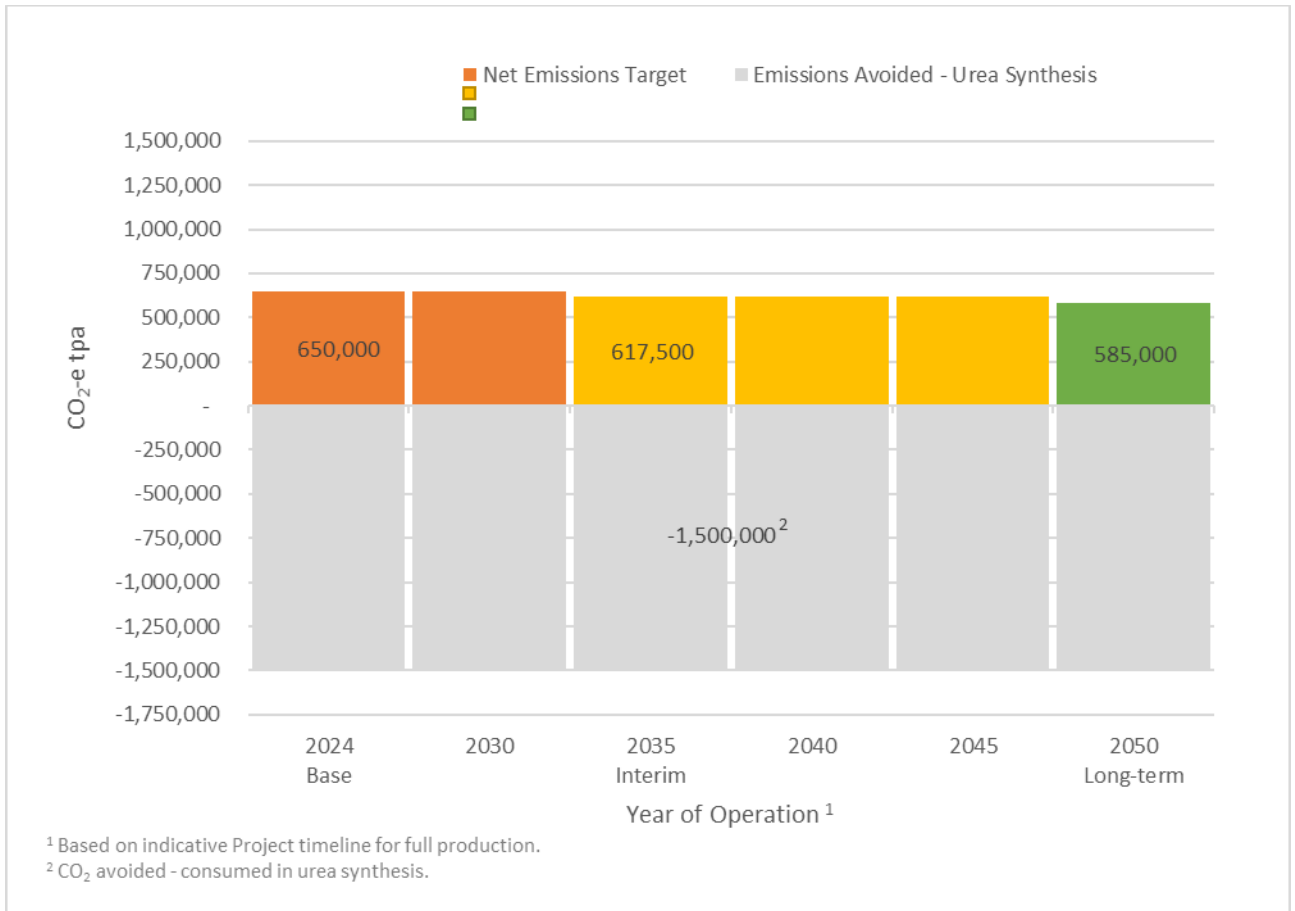


Figure 2-1 Interim and Long-term GHG Emission Targets

Perdaman commits to continue to evaluate further opportunities to develop and implement practicable GHG emissions reduction and offset initiatives in order to achieve these interim and long-term emission targets. Detailed engineering and feasibility studies will be required to identify potential cost-effective reduction and offset initiatives to ensure genuine and credible emission reductions are achievable and can be practicably implemented within the timeframe, without detriment to other key environmental values.

To ensure opportunities to develop and implement practicable GHG emissions reduction initiatives continue to be evaluated over the life of the Project, at 5 yearly intervals after the completion of Project commissioning, Perdaman will conduct a study to identify potentially applicable technologies for reduction of GHG emissions and assess the practicability of the application of those technologies to enhance the overall environmental performance of the Project. Where the study is able to demonstrate that the technology can be practicably implemented to provide a minimum GHG performance enhancement of at least 10% and not be detrimental to other key environmental values, in particular maintaining the integrity of rock art, Perdaman will liaise with the Environmental Protection Authority (EPA) with the objective of applying best practicable endeavours to implement the technology in an agreed timeframe.

Perdaman will also explore opportunities to foster and support the development of potential collaborative government and industry GHG offset initiatives, such as:

- local tertiary industry that could make use of the high-grade purity CO₂ produced as a by-product of the Gas Reforming plant;
- a common-user sequestration site for GHG emissions produced by regional industries, such as potential use of depleted oil and gas reservoirs; and
- fuel replacement for stationary energy production that may arise if large scale hydrogen production proves feasible in the Karratha region.

The key GHG management measures that will be implemented for the Project are presented in Table 2-3.

Table 2-2: Air Quality Management Measures

EPA factor and objective: Air Quality – To maintain air quality and minimise emissions so that environmental values are protected.			
Outcome: To minimise emissions as far as reasonably practicable over the project life and avoid contributing to adverse cumulative air quality impacts in the region.			
Key environmental values: Human health and amenity			
Key impacts and risks: Adverse impacts to human health and amenity			
Management-based provisions			
Management actions	Management targets	Monitoring	Reporting
<p>Incorporate Project design features and key pollution control equipment to minimise emissions, including (but not limited to) the following:</p> <ul style="list-style-type: none"> • ammonia scrubber (Urea Absorber vent) • particulate/ammonia scrubber (Urea Granulation) • Dry Low-NOx burners (Power Generation) 	<p>Vendor specifications to be achieved on all key pollution control equipment.</p>	<p>Confirmation through stack emissions testing and monitoring of other process control indicators.</p>	<p>Report outlining results of monitoring to be submitted within three months of commencement of Project operations (completion of commissioning).</p>
<p>Confirm Project emissions of key pollutants:</p> <ul style="list-style-type: none"> • oxides of nitrogen (NOx) • particulate matter (as PM₁₀ and PM_{2.5}) • ammonia 	<p>Consistent with estimates used as basis for the modelling assessment.</p>		

Management actions	Management targets	Monitoring	Reporting
<p>Verify the air quality impacts of the Project predicted in the Air Quality Impact Assessment by comparison to ambient air quality measurement results.</p>	<p>Relevant standards used in the Air Quality Impact Assessment, adopted from:</p> <ul style="list-style-type: none"> • National Environment Protection (Ambient Air Quality) Measure (NEPC, 2015) • New South Wales Environment Protection Authority (NSW EPA) impact assessment criteria (NSW EPA, 2016). 	<p>Support and contribute to the State government’s coordinated ambient air quality monitoring network that may be established under the Murujuga Rock Art Strategy (DWER, 2019).</p> <p>Alternatively, Perdaman will develop and implement an independent ambient air quality monitoring program to verify the predicted air quality impacts of the Project. The program will involve monitoring over a minimum 12-month period at a representative site for key pollutant(s), developed in consultation with the DWER.</p>	<p>Report outlining results of monitoring and verification of predicted air quality impacts of the Project to be submitted within three months of completion of the minimum 12-month monitoring period.</p>

Table 2-3: Greenhouse Gas Management Measures

EPA factor and objective: Greenhouse Gas Emissions – To mitigate greenhouse gas emissions and consequently minimise the risk of contributing to climate change.			
Outcome: To avoid, reduce and offset emissions of Greenhouse Gases (GHG) over the project life.			
Key environmental values: Global climatic conditions (beneficial use and ecosystem health)			
Key impacts and risks: Global warming and climate change			
Management-based provisions			
Management actions	Management targets	Monitoring	Reporting
Incorporate Project design features to optimise energy efficiency and minimise GHG emissions intensity.	<u>Ammonia Plant</u> Energy efficiency of 26.7 GJ _{LHV} /t NH ₃ GHG intensity of 0.44 t CO ₂ -e/t NH ₃	In accordance with obligations under the <i>National Greenhouse and Energy Reporting Act 2007</i> .	In accordance with obligations under the <i>National Greenhouse and Energy Reporting Act 2007</i> .
	<u>Urea Plant</u> Energy efficiency of 19.4 GJ _{LHV} /t urea GHG intensity of 0.32 t CO ₂ -e/t urea		In addition, relevant GHG emissions data will also be publicly disclosed by Perdaman to ensure accountability and public transparency.
Establish interim and long-term targets to avoid, reduce or offset GHG emissions from the Project.	<u>Interim</u> 617,500 t CO ₂ -e per annum by 2035		
	<u>Long-term</u> 585,000 t CO ₂ -e per annum by 2050		Findings of periodic review (every five years) of applicable technologies for reduction of GHG emissions.

3 Review of this Plan

This EMP will be progressively reviewed and developed to provide the framework for air quality and GHG management requirements as the Project proceeds through the design, construction, commissioning and operational phases.

Once operational, Perdaman commits to developing a periodic audit and review process to identify necessary amendments and improvements to the EMP based on progress in achieving stated environmental performance objectives, changes in Project operations and knowledge of associated environmental risk, and overall effectiveness of the EMP.

4 References

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