Ammaroo Ammonium Phosphate Fertiliser Project

Referral for Significant Variation

Verdant Minerals Pty Ltd

9 November 2022

Executive Summary

Introduction

Verdant Minerals Pty Ltd (Verdant) is a Darwin-based, developer of Australian fertiliser mineral projects, including the Ammaroo Ammonium Phosphate Fertiliser Project (hereinafter abbreviated to 'Ammaroo Phosphate Project' and referred to as the 'Project').

The Project is situated in the central region of the Northern Territory (Figure E-1), located in the western Georgina Basin approximately 220 kilometres (km) southeast of Tennant Creek, 125 km east of Barrow Creek and 270 km northeast of Alice Springs (Figure E-2).

In 2018, the Project was subject to and approved under an Environmental Impact Assessment, and comprised the development of the Ammaroo resource, by open-cut mining, crushing, beneficiation and drying to produce a phosphate rock concentrate for transportation via rail to the Darwin Port. The Project planned to export the rock concentrate to international markets as the essential feed stock for the production of fertiliser products. (For the purposes of clarity, the 2018 Project will hereafter be referred to as 'the Approved Project').

To expand the economic feasibility of the Project, Verdant now plan to include the onsite production of monoammonium phosphate (MAP) and diammonium phosphate (DAP) fertilisers. This will entail the construction of additional onsite plant and infrastructure, including a phosphoric acid plant, sulphuric acid plant, ammonia plant, granulation plant, and amenity and service infrastructure (collectively referred to as the "Proposed Project").

The Proposed Project has many similarities to the Incitec Pivot Phosphate Hill operation in Queensland that has sustainably produced approximately 900 ktpa of MAP and DAP for over 20 years. Phosphate Hill is located approximately 300 km east of Ammaroo on the eastern side of the same geological basin, the Georgina Basin.

Australia remains a significant importer of ammonium phosphate fertiliser produced primarily in China, the Middle East and Northern Africa, supply that could be at risk under a number of real scenarios. By value adding to the Ammaroo phosphate rock resource, through the development of Ammaroo Phosphate Project as an ammonium phosphate fertiliser production facility, the Proposed Project will have significant economic benefit to the region and the Northern Territory, and ultimately play a significant role in enhancing the resilience and self-reliance of Australia's domestic agricultural industry through security of fertiliser supply.

Environmental Regulatory Context

In 2014, the then Federal Minister for the Environment determined the Project to be a 'controlled action' and assessed the Approved Project under the *Environment Protection Biodiversity Conservation (EPBC) Act 1999*. EBPC approval was granted in January 2018 (EBPC 2014/7260). Having regard to the Environmental Impact Statement (EIS) and Supplementary Report (hereafter referred to as 'Approved EIS'), the Northern Territory Environment Protection Authority (NT EPA) assessed the Approved Project for its potential impacts and released Assessment Report 87 to be considered in decisions made by the Northern Territory Government. In 2018, the Project was approved under the Environment Assessment Act 1982.

Recommendation 2 of Assessment Report 87 requires Verdant Minerals to provide written notice to the NT EPA if it alters the Ammaroo Phosphate Project and/or commitments, safeguards, or mitigation measures in the Environment Impact Statement in such a manner that the environmental significance of the action may have changed. In June 2020, the *Environment Protection Act 2019* (EP Act) replaced the Environmental Assessment Administration Procedures. The EP Act has an equivalent requirement for referral to the NT EPA of significant variation prescribed in Section 52 of the EP Act.

This report details the referral of significant variation and describes the environmental impacts and mitigation measures for the Proposed Project.

It is noted the Proposed Project will require the following additional statutory processes:

– Major hazards facility (MHF) notification and licencing under the Occupational Health and Safety Regulations 2017. NT WorkSafe require the process to commence following financial investment (FID) on the Proposed Project.

– Referral under the *Environment Protection Biodiversity Conservation Act 1999*.
– A Native Title Mining Agreement for the project to conform with the *Native Title Act 1976 and Sacred Sites Act 1989*.
– Water licencing for groundwater extraction under the *Water Act 1992*.

Scope and Impact of Project Changes

The Proposed Project comprises a number of changes to the infrastructure that was required for the Approved Project. Table E 1 provides a high-level comparison of the scope for the Proposed Project to that for the Approved Project and is further illustrated in Figure E 3.

The plan of the overall Proposed Project and the design of the fertiliser plant are provided in Figure E 4 and Figure E 5, respectively.

Table E 1 Project comparison

Project Component	Approved Project	Proposed Project
Construction period	2 years	3+ years
Operation period	24 hours per day, 7 days per week for 25 years.	No change
Infrastructure	– The mine site, processing plant and tailings storage facility – 105 km of rail and 137 km gas pipeline – Materials and rail handling facility – Bore field and 12 km water pipeline – Roads, power station, water treatment, administration building and accommodation village – Realignment of about 12 km of Murray Downs Road. – Storage and materials handling facilities at Darwin Port	– All previously approved infrastructure, with the exception of the tailings storage facility – Phosphoric acid plant – Sulphuric acid plant – Ammonia plant – Darwin Port – Storage facility for fertiliser and solid sulphur at Site – Gypsum stacking area – Bulk chemical storage tanks – Power plant expansion – Airfield – Accommodation village expansion – Additional groundwater abstraction bores – Expansion of storage facilities for fertiliser and solid sulphur at the Darwin Port
Output	Phosphate rock concentrate, extracted from ore through crushing, flotation and drying, and transported by rail to Darwin Port for export.	Further processing of the phosphate rock concentrate on site to produce a final product of ammonium phosphate fertiliser as MAP and DAP and transported by rail to Darwin Port for export or local consumption or Southern Australia for local consumption.
Workforce	300 jobs during construction and 165 during operation	Approximate peak of 1,600 jobs during construction and 400 direct workforce during operation.

The key project changes are summarised in Table E 2, which outlines the key differences between the Approved Project and the Proposed Project. Table E 2 also provides detail of where the existing assessment conditions of the Approved Project are being met for the Proposed Project.

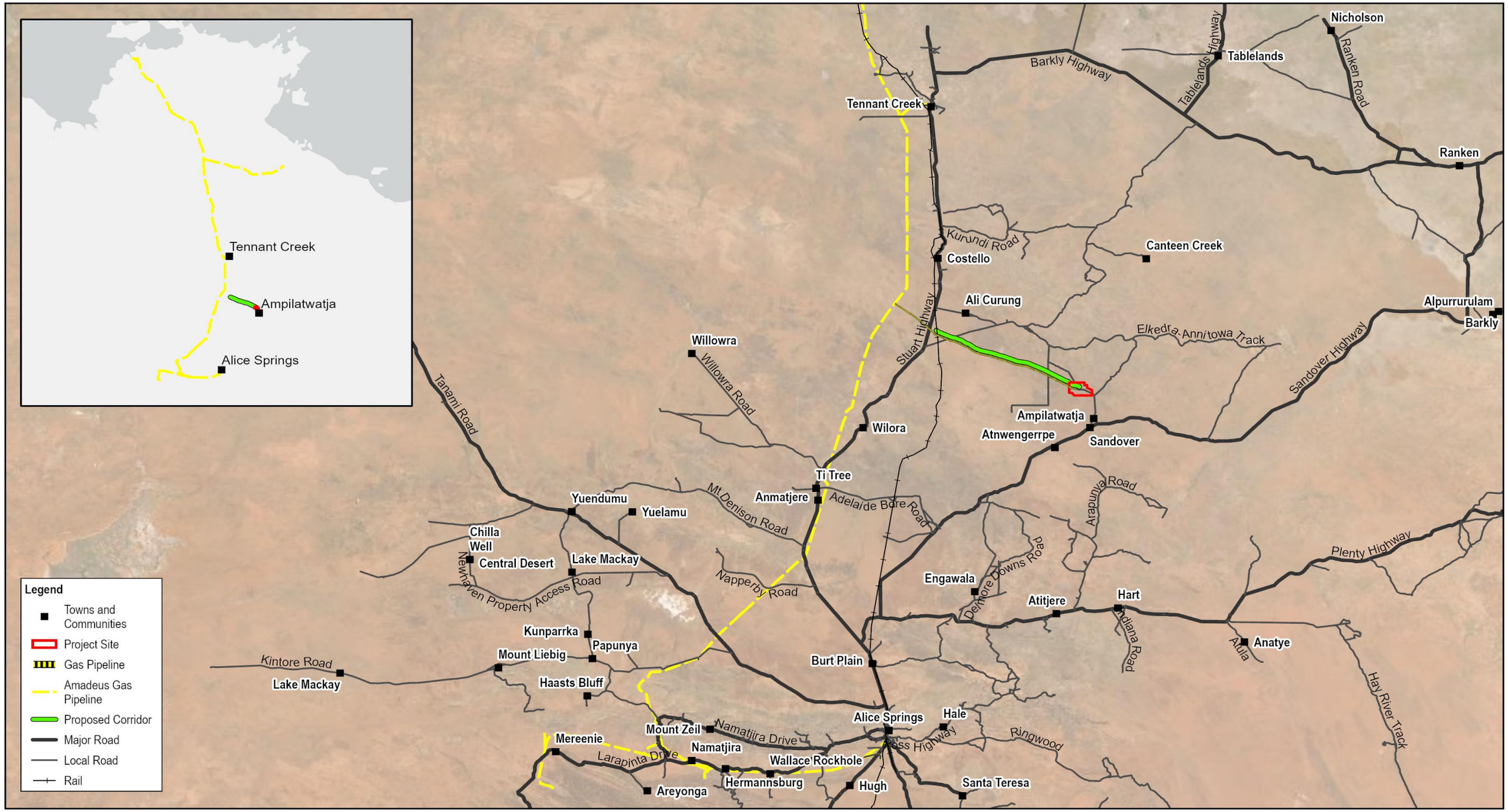
Table E 2 Summary of scope changes

Project change is significant	Project component	Characteristics of Approved Project	Characteristics of Proposed Project	Existing assessment conditions adequate	Comment
Project Life					
Yes	Construction period	2 years	3.5+ years due to increase in scope and complexity of the site.	Yes	Traffic study has confirmed manageability.
No	Operational period	25 years, operating 24 hours every day.	No change from Approved Project.	Yes	Increased economic activity providing increased benefit and employment opportunities to local communities, NT, and nationally.
Mine site Outputs					
No	Ore	115 Mt over Life of Mine (LOM)	160 Mt over LOM	Yes	Total material movements over LOM will vary with ROM grade and mining optimisation.
	Overburden	322 Mt over LOM	340 Mt over LOM		
	Tailings	69 Mt over LOM	40 Mt over LOM		
	ROM	Average 2.5 Mtpa in years 1-5, 5 Mtpa in years 6-25.	Average 6.4 Mtpa at nominal 17.0% P_2O_5		
Manufacturing Site Outputs					
No	Beneficiation	Up to 2 Mtpa of 32% P_2O_5 phosphate rock concentrate.	2.0 Mtpa of phosphate rock concentrate of 28% P_2O_5 as feed to the phosphoric acid plant (PAP).	Yes	No significant change from Approved Project. Feed rate will vary dependent on grade/recovery variability to meet PAP requirements to meet product specifications.
Yes	Phosphoric acid plant (PAP)	-	Phosphate rock concentrate will be fed from the beneficiation plant to the Phosphoric acid plant (PAP) and reacted with sulphuric acid from the (SAP) to produce: – 960,000 tpa of phosphoric acid (~52% P_2O_5) as feed to the granulation plant (GP). – 3 Mtpa of gypsum by-product to be stored in the gypsum stacking area (GSA).	Yes	See comments below in mining operation section.
Yes	Ammonia plant (AP)	-	The conversion of the phosphoric acid to ammonium phosphate fertilisers (MAP & DAP) requires ammonia. Natural gas will be used as the feed to the AP designed to produce 200,000 tpa of ammonia for the use in the granulation plant (GP).	Yes	Hydrogen production loop for the ammonia plant (AP) may change if alternative technology becomes economically viable.
			The ammonia plant (AP) will generate greenhouse gas (GHG) emissions of approximately 340,000 tpa CO_2 due to the consumption of approximately 8.7 PJ pa of natural gas.	No	The GHG emissions from the current technology adopted for the ammonia plant (AP) will trigger the NT EPA large emitter legislation.
Yes	Sulphuric acid plant (SAP)	-	The sulphuric acid plant (SAP) will convert 500,000 tpa of imported elemental sulphur to produce 1.5 Mtpa of 98.5% sulphuric acid as feed to the PAP and GP.	Yes	Steam from the sulphuric acid plant (SAP) will supply approximately 70% of power for the site, significantly reducing the requirement for gas fired power.
Yes	Granulation plant (GP)	-	The granulation plant (GP) will be fed with phosphoric acid and ammonia to produce approximately 1 Mtpa of ammonium phosphate fertiliser as finished MAP and DAP products.	Yes	See comments below in mining operation section.
Mining Operation					
No	Mine staging	Designed to produce 1 Mtpa of phosphate concentrate ore through years 1 to 5, and 2 Mtpa of 32% P_2O_5 phosphate concentrate through years 6 to 25.	The mine will produce an average of 2.3 Mtpa of 28% P_2O_5 phosphate concentrate throughout LOM. The additional feed tonnes are due to the quality of the feed needed for the onsite PAP being lower than commercial specifications for export phosphate concentrate, enabling more efficient mining and beneficiation.	Yes	The integration of the beneficiation circuit and PAP plant design has increased overall recovery of the resource.
No	Mine site	Open pits (23 m average depth,60 m maximum depth). Surface area of approximately 1500 ha over LOM. Mining by open cut strip mining using truck and shovel operations to remove overburden and transport to the ROM for feed to the beneficiation plant.	No change from Approved Project.	Yes	-
No	Mine waste	Removal of overburden and storage in waste dumps until ullage is available for direct placement in completed pits. Dumps and pits will be progressively rehabilitated during the LOM.	No change from Approved Project.	Yes	-

Project change is significant	Project component	Characteristics of Approved Project	Characteristics of Proposed Project	Existing assessment conditions adequate	Comment
Yes	Tailings storage facility (TSF)	Surface tailings storage facility (TSF) + in pit storage at later stage.	In pit tailings storage facility (IPTF).	Yes	TSF no longer required as early pre-strip mining will create ullage for an IPTF to be established.
Fertiliser Manufacturing Operations					
No	Beneficiation plant (BP)	Crushing, conveying, screening, milling, flotation, filtration systems required to beneficiate the ore from the ROM into a phosphate rock for export.	A new ore sorting technology stage has been added between the ROM and wet beneficiation plant to reject bulk silica minerals in feed rock. The beneficiation plant will produce a concentrate rock slurry as feed for the Phosphoric Acid Plant.	Yes	The inclusion of ore sorting technology has improved the overall mining and beneficiation processing. This has also reduced water consumption in the beneficiation and the volume of tailings generation.
Yes	PAP with continuous ion exchange (CIX)	-	The PAP will utilise well-established dihydrate phosphoric acid technology from a global licensor. The plant comprises a reaction section where phosphate rock concentrate slurry from the beneficiation plant is reacted with 98.5% sulphuric acid. This slurry then goes through a filtration stage using vacuum separation where streams of weak phosphoric acid and gypsum are produced. The weak phosphoric acid stream is then concentrated through evaporation of water using process steam, from the SAP. The concentrated acid stream then goes to storage before being feed to the granulation plant.	Yes	Design of the PAP will follow established engineering standards and will comply with all regulatory emission requirements. Engineering controls will be applied for management of onsite risks and hazardous materials.
		-	The gypsum acts as a filter media on the filtration stage vacuum filters to remove impurities from the weak acid stream. Several wash stages ensure that the gypsum discharge has a low acid content before being transferred dry to a gypsum stacking area (GSA) for storage.	Yes	The GSA will be designed for dry stacking of gypsum contained within large cells which will be HDPE lined to prevent any residual leaching of moisture from the dry gypsum or as a result of rain.
		-	The PAP plant will include a side stream continuous ion exchange (CIX) process which will enable the additional conditioning of the weak phosphoric acid from filtration circuit when increased purification of the acid is required to meet specification. The CIX comprises a series of continuous ion exchange columns, which remove unwanted minor elements (Fe, Mg, Al, Na, K) through absorption onto an ion exchange resin, and then eluted with a weak sulphuric acid. The elution products are evaporated and filtered to produce a mixed phosphate salt for disposal on the GSA. The CIX plant is contained entirely within the battery limits of the PAP.	Yes	The CIX uses established ion exchange technology in a new industrial application to improve phosphoric acid quality in an effective manner. Test work has been carried out to establish the application of this technology on phosphoric acid.
Yes	Ammonia plant (AP)	-	Ammonia will be produced by converting natural gas to hydrogen and carbon dioxide using a high temperature catalytic steam methane reforming (SMR) technology. The hydrogen is then reacted with nitrogen from the air through catalytic ammonia synthesis. The ammonia plant also produces excess steam from heat recovery systems which is used to generate power for the site in the central power plant. The SMR technology selected is the most viable at this time for a plant of the required size, using an established licensor and plant design. The project is working with the licensor to establish opportunities to optimise the design to enable more efficient conversion of natural gas and to enable the progressive introduction of green H_2 when economically viable.	No	Total scope 1 and scope 2 operational emissions of the Proposed Project per annum is estimated at 491,800 t CO_2-e emissions, or 2.84% of NT's total annual emissions and 0.1% of Australia's total current annual emissions. The majority of operational emissions are due to the ammonia plant, estimated to produce 340,000 t CO_2-e at peak capacity. Based on the estimated GHG emissions, the Proposed Project is considered a large emitter and would be required to fulfil obligations under the NT Large Emitters Policy and will trigger a GHG abatement plan (GGAP). This plan will be agreed in consultation with the Northern Territory Government (NTG) as part of the broader NTG approval process.
Yes	SAP	-	The design of the SAP will utilise well establish technology from a global Licensor and plant design. The sulphuric acid is produced from elemental solid sulphur which is fed as molten sulphur into a combustion chamber for burning in the presence of air. Sulphur dioxide is then converted to sulphur trioxide in presence of vanadium pentoxide catalyst. The sulphur trioxide is then absorbed in recycling sulphuric acid to form concentrated sulphuric acid. The SAP also produces significant quantities of high-pressure steam from waste heat recovery systems. This steam is used for power generation and process heating requirements thereby offsetting other traditional fossil fuel-based energy sources.	Yes	The SAP requires the import, storage, and transfer by rail of 500,000 tpa elemental prilled sulphur. High pressure steam from the SAP and AP generates approximately 58 MW of electrical power for the site, reducing the total energy consumption and carbon emissions of the Proposed Project.
Yes	Sulphuric acid plant (SAP)	-	The design of the GP will use well established licensor technology and plant design. The diammonium phosphate (DAP) and monoammonium phosphate (MAP) fertiliser products are produced through the controlled reaction of phosphoric acid and ammonia and	Yes	-

Project change is significant	Project component	Characteristics of Approved Project	Characteristics of Proposed Project	Existing assessment conditions adequate	Comment
			smaller quantities of sulphuric acid. The hot MAP and DAP slurry is then granulated, cooled, coated, and screened.		
Yes	Finished product	Rock concentrate storage and handling infrastructure to support loading of rail wagons for export via the Darwin Port.	A 60 kt MAP and DAP storage facility and handling infrastructure is required to support the efficient and timely loading of rail wagons. Product will be railed to either the Darwin Port or to South Australia depending upon markets and seasonality.	Yes	New infrastructure will be required at the Darwin Port for the receival, storage and out loading of MAP and DAP fertilisers.
Yes	Water treatment plant	A water treatment plant for the partial reduction in the total dissolved solids content of the raw water for use in the beneficiation plant and for potable water for the site.	Approximately 30% of the raw water from bore field will be treated in a water treatment plant to produce reverse osmosis (RO) water, potable water and demineralised water using a combination of filtration, reverse osmosis membrane filtration and mixed bed ion exchange.	Yes	The primary reject water from the water treatment plant water will be recycled within the processing facility.
Yes	General site/plant arrangements	-	All process plants will be located adjacent to each other and generally be connected directly or via tank or bin storage by pipelines or conveyers. There will be an increase in the surface area of the overall plant with appropriate installation of surface water diversion measures to avoid flooding. The plant will be fully located within the mining lease.	Yes	The integration of the various processing plants into a single chemical processing facility has enabled significant optimisation of infrastructure and energy and water conservation. The layout has considered management of hazards and health.
Yes	Air emissions	Dust from mining and processing operations and minor CO_2 emissions from 16 MW of gas/diesel generators and a final product fired dryer.	There will be a number of new emissions from the additional process plants including CO_2, SOx, NOx, and particulates. All process plants will be designed to meet or better legislative limits on emissions. Due to the remote location of the site, there will be no offsite impact to receptors, with the only potential receptors located in the site accommodation village.	Yes	Separation distance assessment and updated air quality dispersion modelling have demonstrated no impact on the closest sensitive receptor (accommodation village) or on regional communities. Existing management plans will be modified to ensure risks from dust and any other particulates are appropriately mitigated.
	Infrastructure Corridor				
No	Rail spur	105 km rail spur, connecting the site to the main Adelaide to Darwin railway line.	Minor modifications are included at the junction of the spur to main line south of Tennant Creek to accommodate the option to travel to the south as well as north to Darwin.	Yes	These changes improve the connectivity of the site to additional Australian markets and ports for exports and imports, and also as a mitigation to weather events impacting the main line.
No	Gas pipeline	A nominal 7-inch diameter 137 km long, buried gas pipeline connecting the site to the Amadeus gas pipeline south of Tennant Creek.	The pipeline will now be a buried steel pipeline of 10-inch diameter to meet the increased requirements for natural gas for the ammonia plant.	Yes	-
Yes	Borrow materials	An estimated 1.9 Mt of borrow materials (incl. ballast, substructure, and base materials) will be sourced for construction of the infrastructure corridor	Increased volumes will be managed from existing borrow pit locations and utilising pre-strip from mining areas for construction as far as possible.	Yes	Further, more extensive identification of sources for specific aggregates for concrete, structural fill, and rail ballast, including existing commercial sources, will be conducted and appropriate applications made should these be outside the existing lease boundary.
	Other Infrastructure and Facilities				
Yes	Power	Installed capacity of approximately 24 MW, supplying an average load of 16 MWh for 2 Mtpa production from year 6 onwards. The power plant will comprise multiple high efficiency gas engines.	The primary source of up to 53 MW of power for the site will be generated from steam turbine generators (STG) supplied by high pressure steam from heat recovery plants within the SAP and AP. This will vary given the operating status of each of these plants. Additional generation capacity will be provided from either gas fired auxiliary boilers to generate additional steam or gas engine generators to supply up to 24 MW. There will also be emergency back-up diesel generators for approximately 4 MW capacity to provide critical power in the event of loss of steam and gas to the site.	Yes	As an initial step in the GGAP, the project is evaluating the best mix of economically viable renewable technologies, with a base investment in solar PV, wind, and battery storage to offset natural gas consumed during periods of renewable energy availability.
Yes	Onsite storage and buffers	Rock concentrate storage facility for rail loading and transport to Darwin	To achieve efficient and reliable operations there will be buffer storage required for several intermediate process fluids and for final products. The nominal capacities will comprise; sulphuric acid storage – 48 kt; phosphoric acid – 12 kt; ammonia – 10 kt; fertilisers 60 kt; solid sulphur – 20 kt; molten sulphur – 12 kt; diesel storage 100 kl. Each of these storage facilities will be designed meeting relevant health, safety, and environmental regulations.	No	The ammonia storage tank will trigger Major Hazard Facility (MHF) requirements in terms of the safe design, operation, and maintenance of the storage facilities. The compliance documentation to meet these requirements will be submitted after project financial investment decision (FID).
Yes	Accommodation village	The village was designed to accommodate 300 FTE during construction and 165 FTE during operation.	The village will have overall capacity of 800 rooms to accommodate normal site operations with capacity for additional project and shutdown personnel.	Yes	Expansion of the accommodation village will require minor additional vegetation clearing, in an area not considered to be a sensitive habitat.

Project change is significant	Project component	Characteristics of Approved Project	Characteristics of Proposed Project	Existing assessment conditions adequate	Comment
			During construction, total site accommodation on site may have capacity for up to 1600 persons through the addition of more temporary style accommodation.		
No	Land clearing	Clearing of up to 3775 ha of native vegetation.	The total land area being cleared of native vegetation for the proposed site over the LOM will remain within the 3775-ha limit as per condition 1 of the EBPC approval that was granted in January 2018 (EBPC 2014/7260). Additional site features, including the airfield, expanded Accommodation Village, and access roads, also remain within the boundary of the ML. No allowance has been made for the installation of significant renewables infrastructure (solar PV, wind turbines, batteries) that may be required in the future to meet any requirements under a Greenhouse Abatement plan.	Yes	There may be significant additional land clearance required for installation of renewable (wind, solar and batteries) associated with meeting a full GGAP when economic to do so – This is yet to be defined.
Yes	Raw water bore field	The bore field will comprise three high flowing water bores equally spaced over 1.5 to 2.0 km run. The maximum raw water demand for 1 Mtpa phosphate rock concentrate production is approximately 220 m^3/h and approximately 440 m^3/h for 2 Mtpa equivalent to 4.6 GLpa.	The demands of the additional processing stages to make final fertilisers, has increased the total water demand for the site to approximately 8.5 GLpa. The application of Best Available Technology (BAT) throughout the design, including extensive water recycling, use of fin fan cooling as an alternative to cooling towers, and heat integration, has resulted in a significant reduction in overall potential water usage. There will be an additional 3 bores making a total of 6 to meet the demand together with associated pipeline, tankage, and pumping infrastructure.	Yes	Extensive groundwater modelling has demonstrated that the increased water consumption will have minimal long-term impact over the LOM. It is estimated that the total LOM extraction represents less than 0.13% of the estimated volume of the Georgina Basin aquifer and that LOM water drawdown at the closest at-risk community bores (2) would be between 10% to 20% of the available drawdown at the locations. In addition, modelling suggests the flow of water (flux) across the boundary between the Western Davenport Water Control District and the Georgina Basin will be less than 1% of the extracted volume.
Yes	Airfield	The Approved Project contemplated either the use of the Ampilatwatja Royal Flying Doctor airstrip or building of a new airstrip adjacent to the site.	The Proposed Project will build a new airfield adjacent to the site and accommodation village to enable efficient FIFO transfers during construction and LOM operations of the facility. The airfield will be capable of landing twin engine jet aircraft with a capacity of up to 200 passengers and freight. The airfield will also provide basic amenities for check-in, security and waiting. It is expected that the airfield will be available to assist with community transport needs in emergencies.	Yes	Given the distance of the site from major populations, it is essential to have safe and efficient transport. This will reduce worker fatigue and reduced the risk of serious vehicle incidents.
Yes	Offsite - Darwin Port	Facilities for offloading and loading rail and shipping plus 80kt storage for handling 1.8 Mtpa phosphate rock.	Darwin Port facilities will need to provide handling facilities for ship off-loading, covered storage for 60 kt and rail loading, for the transfer 500,000 tpa of solid sulphur prill from the port to the Ammaroo site. Further facilities will be needed for unloading of rail wagons, 80 kt of covered storage and ship loading to facilitate the handling at a rate of 1 Mtpa of fertiliser through the Port. To facilitate these material movements, it is likely the Port will have to upgrade the current rail handling capability of the port and local rail capacity and enable investment in significant storage capacity and load out facilities.	Yes	The use of the Darwin Port as the main import and export point for the project, aligns with the NT economic framework for both Rail (transport) and Port infrastructure hubs. With appropriate investment in these facilities, they will also contribute to increasing the overall capacity of the Port. Operations shall meet Port Authority Environmental Management System requirements including Environmental Management Plan, and Minimum Environmental Expectations.
	Workforce				
Yes	Construction	An estimated peak of 300 direct construction jobs on site plus access corridor construction activity	The Proposed Project will require a significant construction effort to deliver the overall project in the most cost effective and efficient manner. It is envisaged from current construction planning, the peak construction workforce on site may reach 1,600 with the average at closer to 830 over the 3-year construction period.	Yes	Experience has shown that these projects will require a significant construction workforce onsite which will need to be supported by many additional resources. The overall effort to deliver the Proposed Project will bring significant economic opportunities to communities throughout the region, the Northern Territory and Australia.
Yes	Operations	165 direct jobs when in full operations producing 2 Mtpa from year 6 onwards	Steady state operations and maintenance of the site will require approximately 556 FTE direct workers in each year of operation (>300 site-based, and 78 Darwin-based) with considerable services support in Darwin and locale as available.	Yes	The Proposed Project will bring significantly greater occupational and economic benefit to the region and Australia over the 25-year LOM.



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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

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VERDANT MINERALS PTY LIMITED
AMMAROO PHOSPHATE PROJECT

Project No. **12571099**
Revision No. **1**
Date **30 Sep 2022**

Locality Plan

FIGURE E-1

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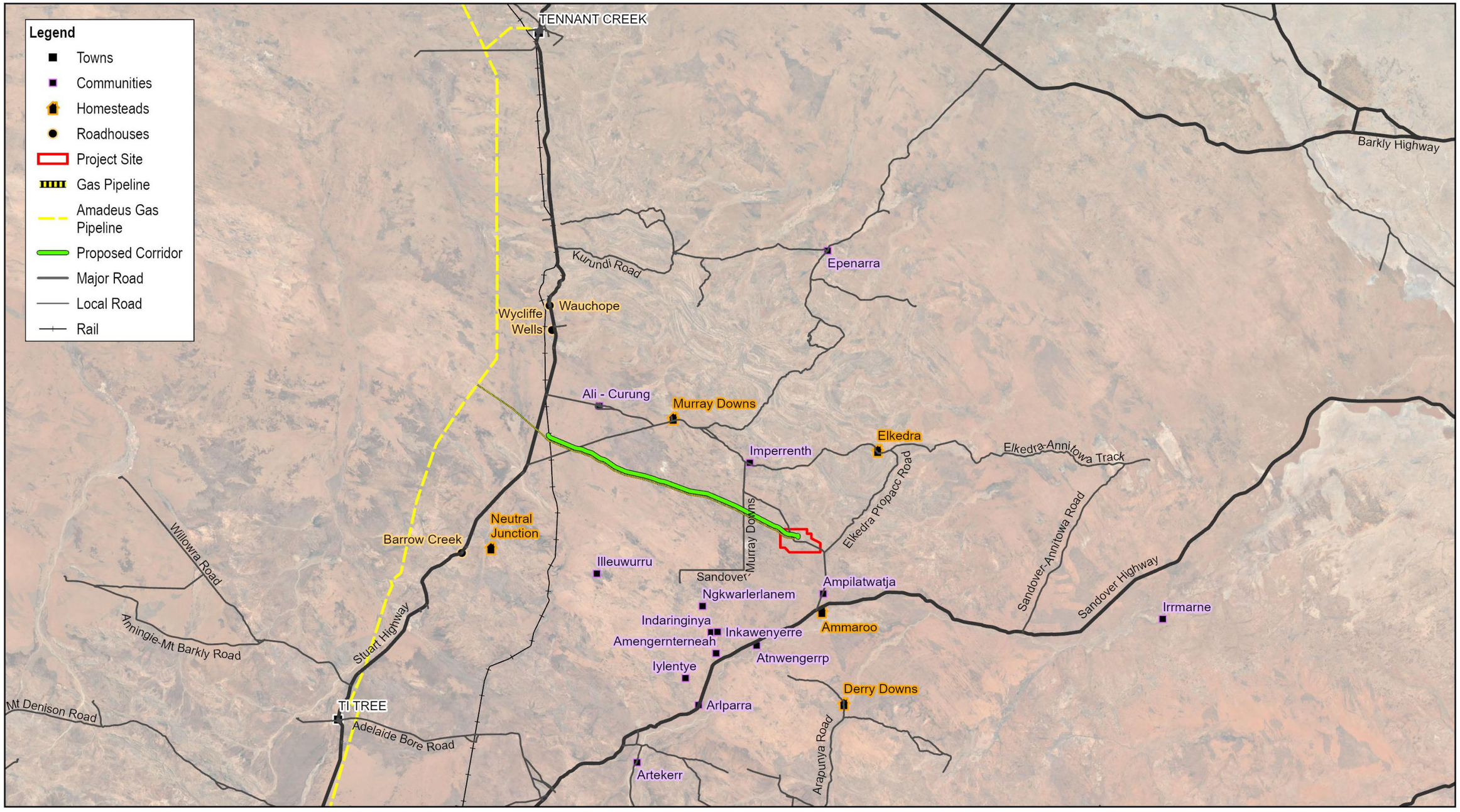
World Imagery: Earthstar Geographics
Light Gray Reference: Esri, Garmin, FAO, NOAA, USGS. Created by: nrama

Figure E 1 Locality of Ammaroo Phosphate Project



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

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VERDANT MINERALS PTY LIMITED
AMMAROO PHOSPHATE PROJECT

Community Context

Project No. **12571099**
Revision No. **1**
Date **19 Sep 2022**

FIGURE E-2

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Figure E 2 Community context

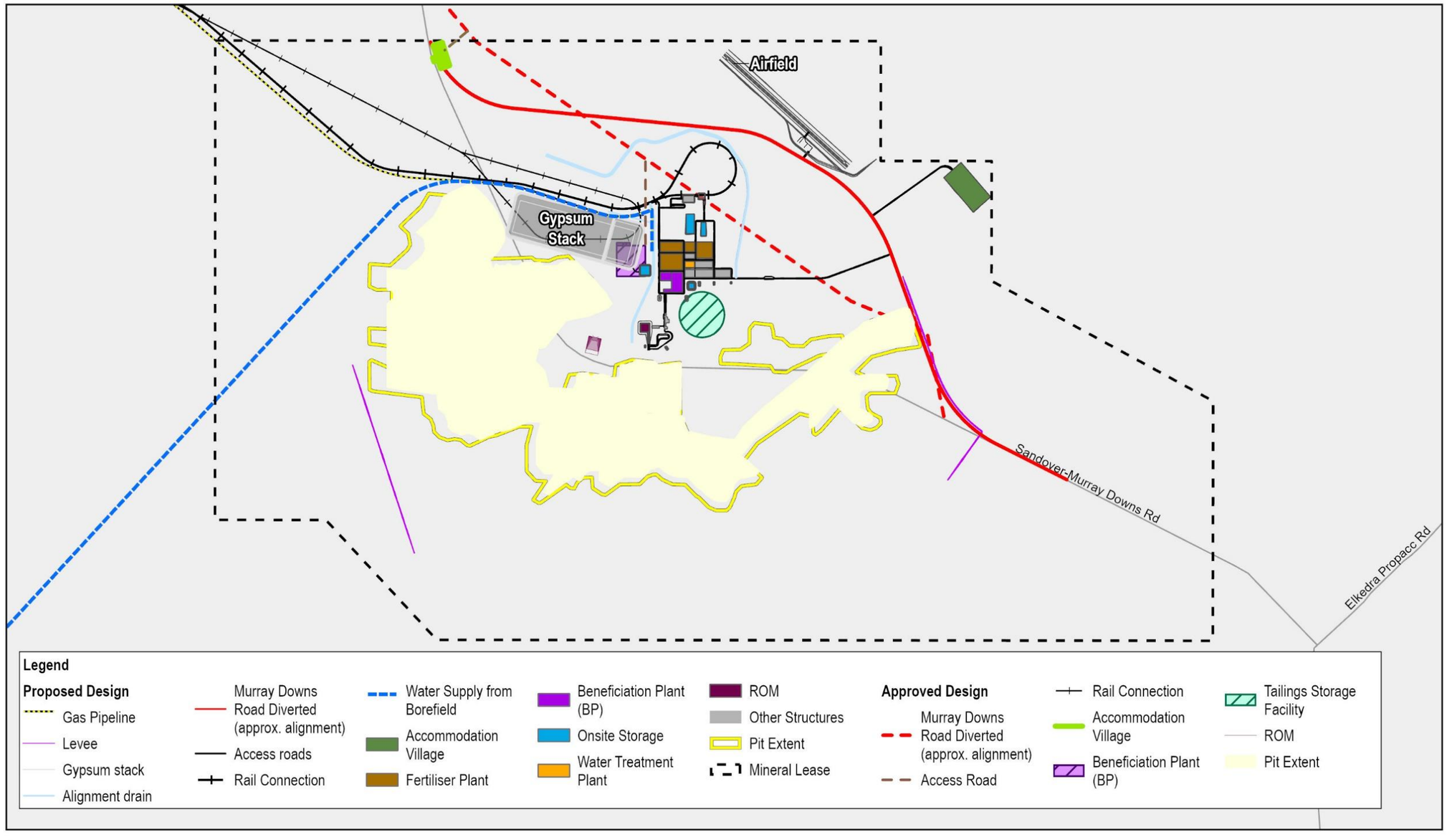
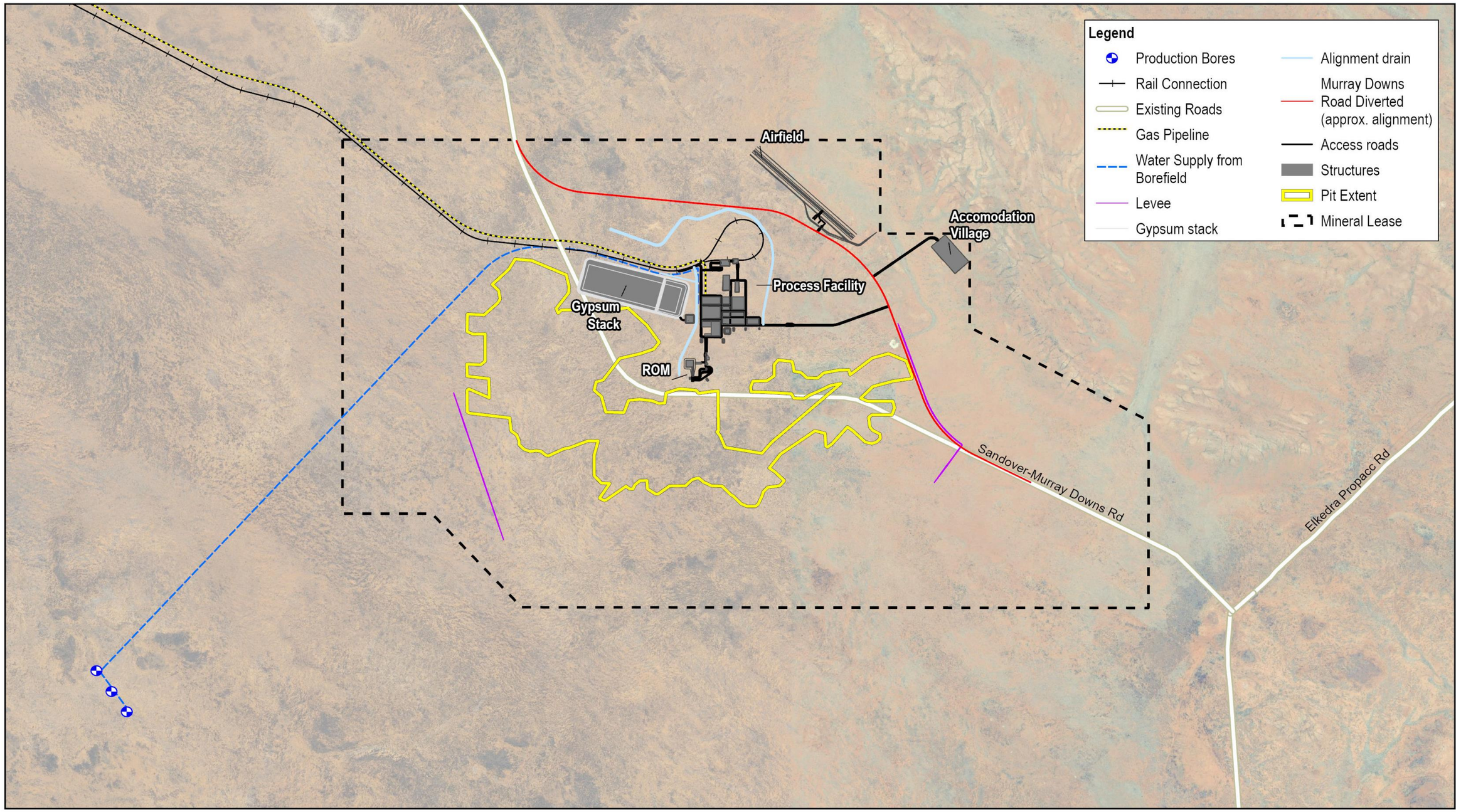


Figure E 3 Approved Project and Proposed Project footprints



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Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Australian 1984
Grid: AGD 1984 AMG Zone 53

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VERDANT MINERALS PTY LIMITED
AMMAROO PHOSPHATE PROJECT

Plan of Overall Ammaroo Phosphate Project

Project No. **12571099**
Revision No. **1**
Date **06 Oct 2022**

FIGURE E-4

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Figure E 4 Plan of overall Ammaroo Phosphate Project (Proposed Project)

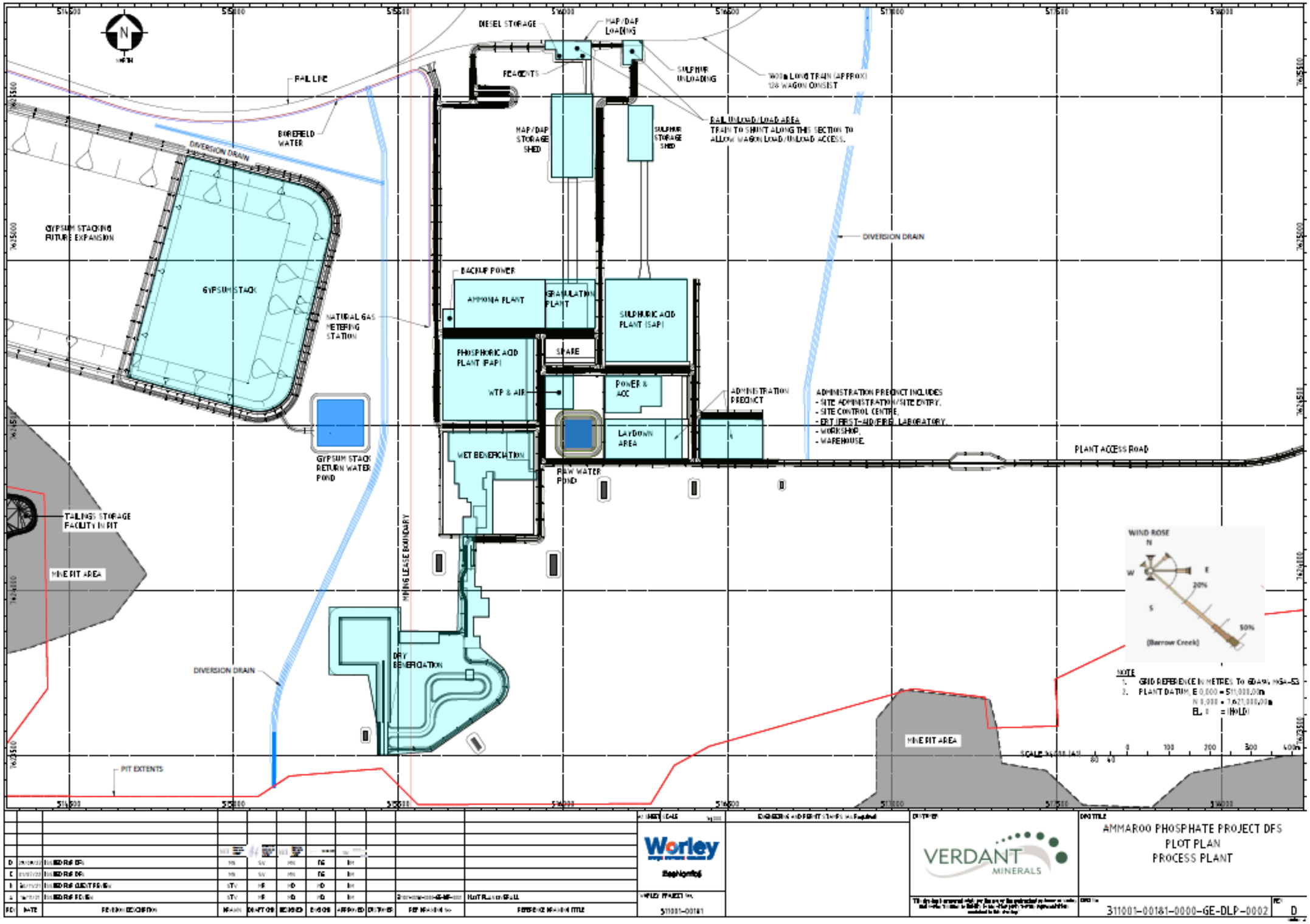

Figure E 5 Plan of fertiliser plant (Worley Parson 2022)

Risk and Impact Assessment Framework

In the preparation of this report, the environmental risk register developed for the Approved Project has been fully re-evaluated. Throughout this referral document, the term environment includes the natural, cultural, physical, and social characteristics of the environment.

All Proposed Project changes were considered in the context of the existing assessment conditions for the Approved Project, i.e., Assessment Report 87, to determine if those conditions would be adequate to manage the Proposed Project changes. The findings of that process have guided the preparation of this referral document, and the supporting appendices provide additional information in key areas, in support of those findings.

Where additional potential impacts were identified outside the scope of the Approved EIS, supplementary technical assessments have been undertaken and are summarised within this referral and with supporting reports in the Appendices.

A revised environmental risk register for the Proposed Project has been established to document the findings of the risk assessment process, and contains details of impact pathways, consequences, planned controls, additional controls, and the residual risk rating.

The environmental risk assessment identified twenty risk events in total, and of these there were no risks assessed to have a residual risk higher than medium, of which there were only six.

Community Consultation

For the Approved Project, extensive community consultation was completed gaining broad support for the Approved Project. Limited consultation occurred during 2020 and 2021 due to the COVID 19 pandemic and associated restrictions. At time of this referral, further consultation activities were conducted in June 2022 in Ampilatwatja, Tennant Creek, and Alice Springs, and involved engagement with a number of stakeholders including the Department of Chief Minister and Cabinet, NT Chamber of Commerce, Barkly Regional Council, Central Land Council, Arid Lands Environment Centre, Saltbush Social Enterprise, nearby pastoral stations, and services and community residents in Ampilatwatja. More recently, Verdant provided sponsorship to the annual AFL football and Softball carnival held in Ampilatawatja in late September 2022. This included the provision of team and individual trophies and ladies softball jerseys. It should also be noted that negotiation of the current draft Native Title Agreement, that predominantly occurred in 2018, also contemplated a downstream value adding project, at least as far as the production of phosphoric acid. The Central Land Council have received an updated draft of the Native Title Agreement from Verdant, incorporating the production of ammonium phosphate fertilisers. It is expected that there will be further discussions and consultations with the community and Native Title Holders during the remainder of 2022 and early 2023 regarding the project, its impacts and benefits and the conclusion of associated Native Title Agreement.

The purpose of these consultations was to inform the community of the Proposed Project and to understand their thoughts and concerns. Overall, stakeholders engaged in Ampilatwatja, and Tennant Creek were positive about the project, supportive of it proceeding, and did not report concern regarding the Proposed Project's description.

While support for the project is due to the employment opportunities from local community in Ampilatwatja, and the positive impact of access to benefit payments for the community, some concerns were raised regarding the potential for the Proposed Project to draw workforce from local businesses (particularly in Tennant Creek and Alice Springs). Other concerns centred around impacts of groundwater extraction (compared to Environmental and Social Impact Assessment (ESIA) 2018) and the potential for road traffic accidents or degradation of road conditions, due to construction and operation traffic. It was noted that the sensitivity to road incidents has increased, particularly for Ampilatwatja and Ammaroo Station.

Therefore, it is intended that a Community and Stakeholder Engagement Plan is developed for the project, to manage ongoing communication with key stakeholders, such as pastoral stations. Given the increased sensitivity of local businesses to workforce draw, more consultation with regional stakeholders and potential proponents in the region is recommended. Collaboration with key government agencies and stakeholders will be required to manage the attraction and retention of skilled workforce to backfill any positions created.

The community consultation has also informed the review of the social impact assessment for the Proposed Project.

Surface Water

The changes associated with the Proposed Project are considered unlikely to significantly impact surface water flows and quality around the site. The Approved Project included flood protection levees in strategic locations around the site to protect the mine, process areas, and built infrastructure including the accommodation village. The Proposed Project has modified the location of the eastern levee to meet the revised layout of the site and has retained the same level of protection from a 1 in a 100 annual exceedance probability design flood event. The access road to the revised accommodation village location crosses an area subject to flooding is not considered to adversely affect the potential impact to surface water flows or mine infrastructure.

The design of the gypsum stacking facility will include a drainage ditch to maintain freeboard in a 1% annual exceedance probability (AEP) design flood event. This control is considered sufficient to mitigate risks associated with surface water from the gypsum stack.

Additionally, the Erosion Sediment Management Plan (ESCP), Hazmat Management Plan, and Water Management Plan will be updated to outline the mitigation measures and monitoring required for the Proposed Project risks. As detailed in Section 14.1, human health and safety will be considered for the Proposed Project which would include additional controls to mitigate risks from storage and handling of hazardous substances and chemicals which may impact surface water.

Marine Water

The Proposed Project materials storage and handling operations at Darwin Port site shall be compliant with the Port Environmental Management System (EMS) with specific adherence to the Port Environmental Management Plan, and Minimum Environmental Expectations. The appropriate design of the planned Port facilities for the Proposed Project combined with existing controls at the Port are deemed sufficient to mitigate any environmental risks to marine waters from material storage and handling operations.

Groundwater

Water use for the Proposed Project will increase groundwater extraction from 4.6 to 8.5 GLpa. Based on the updated modelling conducted by IGS (2022), drawdown at Hagen's Bore and at Ampilatwatja bore field is likely to be 2.6 to 0.9 m (for the 50th percentile model), respectively, for the Proposed Project. This represents between 10% and 20% of the available drawdown at both locations. The proposed extraction therefore does not pose a significant risk of impact to other users with respect to reducing yields of adjacent bores (Hagen's bore) and community water supplies (Ampilatwatja).

Project water use is not within the Western Davenport Water Control District but is 20 km to the east of the boundary. Water table drawdown at the project bore field will induce flux across the Western Davenport Water Control District boundary. Groundwater flux across the boundary of the Western Davenport Water Control District is predicted to peak at 0.6 ML/d (for the 50th percentile model).

Peak flux across the Western Davenport Water Control District is considered small relative to the total volume extracted from storage (23.3 ML/d) with the most likely rate of 0.6 ML/d equating to only 3% of the rate extracted from storage. This indicates that the most likely extraction simulation sources 97% of its water from areas outside the Western Davenport Water Control District, within the Georgina Basin.

Biodiversity

The change in the Proposed Project footprint, including the airfield, accommodation village, and access roads, is not expected to significantly impact biodiversity as demonstrated in the Approved EIS. The Proposed Project is estimated to impact a total of ~1 ha of drainage habitat representing a relatively small area of habitat. Potential impacts to sensitive vegetation types are outlined in Section 6.3, Appendix J of the Approved EIS. It is not expected that the change to the road alignment (approximately 400 m east of previous alignment) and the small increase of area to be disturbed (approximately 0.5 ha) will cause any further potential impacts to sensitive vegetation. It is considered that the Proposed Project will not significantly impact biodiversity.

The environment management framework established in the Approved EIS will be updated for the Proposed Project to assist in minimising potential impacts to biodiversity values.

Protected Matters Under the EPBC Act 1999

The assessment undertaken as part of the Approved Project in 2017 noted that only vegetation clearance was likely to impact on Matters of National Environmental Significance (MNES), mainly threatened fauna and migratory species. In January 2018, the Approved EIS was granted EPBC approval (EPBC 2014/7260) with Condition 1 allowing for 3775 ha of clearance.

Following an updated search of protected matters under the EPBC Act carried out in August 2022, and a comparison of protected species identified from the Approved EIS and the Proposed Project, it is considered that the Proposed Project is unlikely to cause new or increased impacts to protected matters under the EPBC Act as the proposed alterations to the Project are not resulting in any additional clearance of native vegetation over the LOM to that assessed in 2017.

As such, the 2018 Approval (EPBC Act referral 2014/7260) would still be applicable as no variation to Condition 1 is planned by the Proposed Project.

Human Health and Safety

The health and safety management system that was established by Verdant, identifies health and safety risk and control measures to mitigate risks. The structure of the management system currently established for the Project uses guidance provided by WorkSafe Australia and AS/NZS 4801:2001 *Occupational Health and Safety Management Systems*. As part of the management system, Verdant's Risk Management Procedures require the maintenance of a site-specific risk register to identify and assess and minimise risks to human health and safety (i.e., accommodation village and wider community) over the life of the Project.

The Proposed Project adds health and safety aspects and operational complexity to the Project. During the design activities undertaken so far, the Proposed Project has completed formal Hazard Identification reviews (HazID's) for each of the major process plants and for the overall site layout. These have been independently chaired by each of the engineering service providers and licensors for each of the plants and have also incorporated lessons from existing operating plants.

All HazID's were formally recorded with actions either, closed out through changes during the Definitive Feasibility Phase (DFS), assigned to future engineering phases or assigned a management system mitigation, as appropriate.

Hazard Operability reviews (HazOP's) are not required at DFS level as they generally require a more detailed and frozen design. However, the Proposed Project has adopted a strategy to use existing reference process plants of the same capacity and design as those required and hence has benefitted from the knowledge, that any significant HazOP type issues associated with the process plants are inherently covered in the design.

From the five separate HazID's completed for the Proposed Project, the key high-risk Health and Safety hazards identified relate to:

1. Mining and Dry beneficiation
    - Release of silica containing dust from mining operations, crushing, and grinding, having the potential to expose personnel to silicosis with resultant health impacts.
2. Acid plants
    - Unintended release or leakage to atmosphere of process streams (liquid or gaseous) with the potential to expose personnel to a toxic chemical.
    - High pressure steam release, having the potential to expose personnel to injury from high pressure and temperature.
3. Ammonia plant
    - Ammonia release to atmosphere, with potential for fire and explosion and exposure to a toxic gas.
    - Hydrogen release to atmosphere, with potential for fire and explosion.
    - High pressure steam release, having the potential to expose personnel to injury from high pressure and temperature.
4. Granulation plant
    - Slurry release from the reactor with potential to expose personnel to hot slurry.

The hazards associated with the Proposed Project are well understood, and there are appropriate actions and processes in place to ensure they will be fully addressed and managed as part of the MHF licencing process. This MHF process is required following financial investment decision (FID) phase for the Proposed Project.

With respect to community health, including residents of the accommodation village, the likely impacts associated with air quality, groundwater, surface water, transport, and noise and vibration from the Proposed Project have been re-assessed considering the proposed project changes. Residual risks are generally ranked as medium with the majority as low after controls. The potentially impacts on human health and safety are discussed across several sections of the EIS Referral and captured in the risk register.

Social and Economic Impacts

Community consultation to support a review of the Social Impact Assessment (SIA) and preparation of an economic impact assessment was undertaken. The findings of these assessments have been provided in Appendix L. The aim of the revised SIA is to understand how the Proposed Project may impact stakeholders throughout the region. The scope of the revised SIA included re-engaging with key stakeholders and communities to provide updates on the status and proposed changes to the Project, review and gap analysis of the existing SIA, review of the project description and updated technical reports and preparation of a revised SIA.

The Proposed Project changes relevant to this SIA Addendum include:

– An increase in infrastructure required on site, including processing plant infrastructure, and an expansion to the workforce accommodation village.
– An airfield on site, (including associated infrastructure and roads) allowing workers to fly directly from Darwin, Alice Springs or other locations including capital cities to site.
– An increase in groundwater extraction for use in downstream processing.
– An increase in the construction and operation workforce.
– A longer construction period would be required to build the required infrastructure.
– The social impacts and opportunities identified and assessed as part of the updated ESIA would be managed and mitigated through a range of measures recommended in this report, and by other relevant mitigation measures recommended as part of the Approved Project (i.e., ESIA 2018), and other EIS Referral specialist studies.

These measures are generally focused on Verdant's commitments to continuously work with the Traditional Owners and Central Land Council to finalise the Native Title Agreement and governing structure, identify opportunities for community benefits (e.g., community benefit fund), updating the Local Industry Participation Plan to reflect increase in potential opportunities for local businesses, including avenues for training and upskilling support provided to the businesses, and preparing a Community and Stakeholder Engagement Plan to manage ongoing communication with key stakeholders (including pastoralists, NT Chamber of Commerce, local businesses, and government agencies), particularly regarding project updates, groundwater monitoring, and amenity impacts.

The Proposed Project will also bring significant direct and indirect economic benefits to economies of the local Barkly region (Barkly), the Northern Territory and Australia over the Project life from construction through operations. An Economic Impact Assessment for the Proposed Project by ACIL Allen Consulting (ACIL Allen) summarised the benefits in terms of employment both direct and indirect as a result of the construction and operation of the Proposed Project and also in terms of the economic benefits.

In terms of employment, the Proposed Project will require an average workforce of approximately 830 full time equivalents during the three years of construction, peaking at more than 1,600. During the 25-year operational phase, an average of approximately 556 full time equivalent direct workers in each year of operation will be required, with more than 300 engaged on roles at the Project site and a further 78 based in Darwin. It is expected up to 102 of these long-term roles could be from the Barkly region.

Additional benefits to the economy will be obtained through the indirect jobs resulting from the construction and operation of the Proposed Project. These indirect jobs result from the purchases made by Verdant during construction with commensurate increase in activity and income for Australian businesses.

Outside of the economic benefits, it is expected that the Proposed Project of Ammaroo will be strongly aligned with a number of core economic and social development policies committed by the NT Government with a range of benefits to the Territory.

The key metrics from the economic impact assessment highlight:

– The construction expenditure of the Ammaroo Project is estimated to have an Australian content approaching 76 per cent. Of the total spending in Australia, an estimated $932 million will be spent in the Northern Territory, including some $311 million in the local Barkly region.
– Over the following 25 years operation of the Project starting in 2027-28, there will be over $10.0 billion of operational spending, or an average of more than $400 million per year. This excludes rehabilitation spending, royalties, payroll taxes or Native Title compensation payments.
– Nearly $6.0 billion, or 45 per cent, of the total operations expenditure will be spent on goods and services purchased from the Northern Territory, or an average of more than $200 million a year of which a third will be spent in the local Barkly region.
– During the operations phase, it is expected the Proposed Project will inject a further $500 million into the Northern Territory economy by way of payroll taxes, royalties, and Native Title compensation.

Aboriginal and Historic Cultural Heritage

Based on the Project footprint, the Proposed Project is not considered to impact the archaeological sites present. The current exclusion zones present onsite will be maintained for the Proposed Project. At the time of the Proposed Project Referral preparation, consultation with Traditional Owners, and Central Land Council (CLC) were ongoing, with the intent of concluding the Native Title Mining Agreement which also incorporates the process for attaining a sacred sites clearance certificate from AAPA for the Proposed Project to conform with the Native Title Act and Sacred Sites Act. Subject to the granting of these approvals and certifications by these stakeholders and organisations, cultural heritage impacts of the Proposed Project have been adequately considered.

To mitigate any further potential impacts to cultural heritage, the site CHMP will be updated to include the Proposed Project construction and operation and any additional mitigation measures required.

Transport

As a result of the Proposed Project, the level of traffic generated to and from the site is expected to be greater than initially projected within the Approved Project. Nevertheless, due to the expanded program, increased from 12 months to three years, the change to daily traffic volumes is low in road capacity terms, noting the local road network has the capacity to accommodate the forecast additional traffic volumes.

Of note, the heavy vehicle trips will increase by more than 10 trips per day to the external road network and by more than 61 trips per day to the internal road network. While again these additional volumes are to be supported by the road network, the impacts will need to be managed. Mitigation measures for these additional volumes, include:

– Traffic management crews may be required to drive ahead of oversized vehicles during deliveries. The assistance crews will assist by providing warning of large vehicles ahead and holding traffic where required.
– Traffic controllers will be present as required to hold up any traffic where large heavy vehicles are required to occupy more than one traffic lane, drive over the road centre line or turn across oncoming traffic.
– Internal roads will be constructed and marked early on, to prevent construction vehicles driving across pedestrian areas.
– To increase awareness of the increased truck volumes and the presence of heavy vehicles, truck warning signage should be installed along the unsealed roads which make up the main delivery routes.
– All loading and unloading of materials will be limited to specific loading areas within the site. No loading or unloading is to occur on public roads.
– Any roads utilised for the construction of the Proposed Project will be maintained and repaired (if necessary) to an acceptable standard to be negotiated and agreed with the relevant Government Agency (Dept Infrastructure Planning and Logistics).

Air Quality

Compliance of the Proposed Project to meet air quality criteria was assessed for sensitive receptors, at the accommodation village (3.0 km) and nearby communities, including Ampilatwatja (20 km).

An assessment of the separation distances applicable to the Proposed Project based on NT EPA Recommended Land Use Separation Distances Guideline (NT EPA, 2017) was completed. From this assessment, it was found that separation distances did not extend to the nearest sensitive receptor location (i.e., accommodation village). The result of the separation distance assessment indicated there may be a low risk of residual emissions leading to off-site air quality impacts.

Updated air quality impact assessment modelling was also conducted as part of this EIS Referral to account for:

– Additional pollutant sources from the Proposed Project.
– Changes to the location of the accommodation village.
– Changes to some source locations.
– Additional emission sources associated with the Proposed Project.

The results of the air quality impact assessment show that compliance is predicted for all pollutants, including particulate matter (PM_{10}), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), fluoride (F), sulphuric acid (H_2SO_4) and ammonia (NH_3).

There is no change from the Approved Project in terms of air quality risk impact to human health. This is due to the pollutant of major concern being particulate pollution, specifically PM_{10}, related to dust generated by mining activity, which have not changed. Air quality impacts are predicted to be compliant with all relevant air quality criterion for the closest sensitive receptor at the accommodation village, provided that existing dust controls are implemented and maintained. A range of mitigation and management measures will be implemented including dust monitoring adjacent to the accommodation village.

Atmospheric Processes

Based on the estimated GHG emissions during operations, the Proposed Project is considered a large emitter and will be required to fulfil obligations under the NT Large Emitters Policy. This will trigger a GHG abatement plan (GGAP) for the Proposed Project to be agreed through consultation with the Northern Territory Government.as part of the overall NT Government approval process.

Total scope 1 and scope 2 operational emissions of the Proposed Project per annum is estimated at 491,800 t CO2-e emissions, which represents 2.84% of NT's total annual emissions and 0.1% of Australia's total current annual emissions. The majority of the operational emissions are due to the operation of the ammonia plant on natural gas, estimated to produce 340,000 t CO2-e per annum at full capacity.

During the construction phase of the Proposed Project, the quantity of scope 1 emissions are estimated to be approximately 384,450 t CO2-e. The majority of construction emissions are due to vegetation removal (i.e., lost carbon sink), accounting for 255,000 t CO2-e (approximately 66%) of scope 1 construction emissions. Annualised construction emissions are 0.62% of NT total annual emissions and 0.026% of Australia's total annual emissions.

The Proposed Project has already incorporated a number of design approaches to minimise the operational emissions, particularly through the extensive recovery and utilisation of waste heat and steam in power generation and process heating. Further abatement strategies will be explored for all phases of the Proposed Project to determine areas where further emission reductions can be made while maintaining Project economic viability and a high level of technical and operational reliability.

A number of potential pathways have been identified to align the Proposed Project with the Australian Federal and NT Government's goal of net zero by 2050. These pathways are based on the phased application of current renewable energy and green ammonia technologies to offset emissions. Verdant has studied the potential of green ammonia production from the project outset, however, these technology pathways are still evolving, are yet to be proven at scale and add significant cost to the production of ammonium phosphate fertilisers, in comparison to the traditional process. This is a trade exposed industry and markets willing to pay a premium for 'green' fertiliser products, have not yet emerged. The Company intends to closely monitor the evolution of green ammonia technologies and production going forward. Within the next decade, the Proposed Project is expected to integrate photovoltaics (PV) and industrial batteries into the energy mix to reduce and eventually replace the natural gas that consumed for base load power generation as battery technologies evolve and costs reduce.

The emissions inventory and GHG management plan is based on information available at the time of this Referral and is to be updated as the project progresses through the planning, detailed design, construction, and operational phases, as more information becomes available.

Noise

The existing noise environment within the vicinity of the project site is anticipated to be a typical rural noise environment setting, with potential local noise sources including fauna, wind, local neighbourhood activities and occasional local traffic. Sensitive receptors assessed for compliance against noise quality criteria include the accommodation village (~3.6 km) and communities along Murray Downs Road.

The noise impact assessment found that the Proposed Project activities during construction and operation should not exceed noise criteria. No additional mitigation measures are required however the noise management plan will be updated for the Proposed Project.

Consideration of Principles of Environment Protection and Management

In accordance with Part 2 of the EP Act, **Principles** of Environment Protection and Management are required to be considered within the referral of significant variation. In addition, under section 43 of the EP Act the general environmental duty must be considered. Based on the Proposed Project design and management systems under development, it is considered that these principles and duty have been adequately incorporated into the Proposed Project. Key principles considered within the Proposed Project include:

– Principle of evidence-based decision making:
  - Design of plant and gypsum stacking facility has adopted best available technology and ANCOLD design requirements, respectively.
– Principle of sustainable use:
  - The Proposed Project has been designed to reduce as far as practicable the consumption of energy and water wherever possible.
  - Future design and engineering phases will pursue further energy efficiency through optimising recycle and integration of heat and energy systems.
  - Adoption and integration of renewable energy strategies to reduce natural gas consumption in the power generation facilities.
  - Converting the general site fleet and mining fleet to electric vehicles (EV) as commercially viable technology becomes available.
  - Further the Proposed Project is committed to negotiating a viable greenhouse gas abatement plan to reduce emissions to net zero by 2050, based on available technology and economically viable commercial pathways, including potential external 3rd party renewables in the form of green energy or green H_2, should other investments in extensive renewable project be developed.
– Principle of conservation of biological diversity and ecological integrity:
  - the Proposed Project has demonstrated the application of this principle through the biodiversity considerations within the Section 13 and the control measures to be implemented as listed in Appendix F.
– Environmental decision-making hierarchy:
  - The impact assessment and identification of risks and control measures to mitigate risks demonstrates application of this principle. Where environmental impacts were identified to be avoidable, these have been avoided.
– Waste management hierarchy:
  - Plant design has allowed for reuse of reject reverse osmosis water from the water treatment plant in processing (reuse).
  - Steam recovery within the Proposed Project design for use in energy generation reduces overall energy consumption of the Proposed Project (recovery).

- Dry gypsum stacking has been integrated into the Proposed Project design. This is considered of lower environmental risk compared to wet stacking reducing generation of leachate (reduce).

– General environmental duty:

- Proposed Project is undertaking an extensive and on-going consultation process with stakeholders including aboriginal communities.

Summary of Key Residual Risks

The Proposed Project EIS has not identified key residual environmental risks with a high ranking. Key residual environment risks with a medium ranking associated within the Proposed Project are listed in Table E 3. The controls, listed in Appendix F, were considered adequate to reduce risk and the residual risk tolerable.

The remaining residual risks were assessed as low with controls reducing the likelihood of the impact occurring.

Table E 3 Key residual environmental risks

Environmental factor	Potential impact	Mitigation measures	Residual risk rating
Terrestrial ecosystems	Mortality of flora and fauna due to interactions with machinery used in land clearing.	– Implementation of an updated vegetation clearing procedure and site traffic management plan reduces likelihood of impact.	Medium
Terrestrial ecosystems	Loss of vegetation due to land clearing.	– Limit the disturbance of areas required for the airfield and associated access road, expansion of the accommodation village, and installation of additional boreholes in the bore field, within the overall disturbance area of Approved Project (although there is a small increase in the disturbance footprint in these localities). – Erosion and Sedimentation Control Plan will be updated for the Proposed Project and outline management of soil to minimise erosion and sedimentation. – On-going rehabilitation of cleared land from year 1. It is noted that the Proposed Project will result in no significant additional clearing compared to the Approved Project. There may be additional land clearance required for installation of renewable (wind and solar) associated with meeting a full GGAP when economic to do so. This to be defined at a later stage.	Medium
Atmospheric processes	Greenhouse gas from plant construction (mainly lost carbon sink from vegetation removal) and operation (ammonia plant) (Scope 1, 2 and 3 emissions).	– Greenhouse gas abatement plan (GGAP) to be developed in collaboration with Northern Territory Government outlining steps to reduce emissions to net zero by 2050.	Medium
Communities and economy	Project evokes negative perceptions towards the use of water by mining in an arid area that may have other beneficial users (e.g., stock, domestic bores), including concerns about cultural and aesthetic values of water.	– Updated water abstraction management plan. – Modelling for the Life of Mine, including recovery recharge time post mine. – Adherence to water license requirements. – Any new bores required will be drilled by a licensed driller under relevant legislation (e.g., Water Act). – Verdant would assist in extending community bores should significant drawdown occur. – Community and stakeholder engagement plan to manage key messaging around water use.	Medium
Human health and safety (accommodation village and public)	Aircraft arriving and departing from the airfield.	– Limit arrivals and departures to less sensitive time periods during operation of the airfield to minimise potential aircraft noise impacts.	Medium

Environmental factor	Potential impact	Mitigation measures	Residual risk rating
		– Schedule rostering of early arrivals/departures and late afternoon arrivals/departures so as to ensure sleeping times are not adversely impacted. – Aircraft type will change from construction to permanent operations when the manning requirements will be lower. – Airfield may be used for community / RFD flights in addition to Proposed Project.	
Human health and safety	Aircraft incident with FIFO from areas beyond road travelling distances (e.g., Mount Isa) potentially causing multiple fatalities.	– Proposed Project shall only use CASA approved air carriers with remote FIFO experience.	Medium

Conclusion

This **referral of significant variation** was prepared to assess the potential impacts of the Proposed Project on the environment. As detailed in this referral report, the Proposed Project has fully considered the impacts of the project on the environment, in accordance with a referral of significant variation under the Environment Protection Act 2019.

Where environmental risks have been identified, administrative, environmental management and monitoring control measures have been proposed to manage risks to acceptable levels. Potential impacts to cultural heritage, groundwater, atmospheric emissions, and health and safety will also be addressed through additional regulatory processes which are currently ongoing or planned for later phases.

The social and economic impacts of the Proposed Project have also been assessed, with increased potential benefits having been identified for the local Barkly area, the NT, and Australia as a consequence of the construction and long-term operation of the Proposed Project.

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Publication Statement

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	Bachelor of Environmental Science (Land and Water Management), Griffith University 2003
	Diploma of Environmental Technology, Torrens Valley Institute, 2000
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1. Introduction

Verdant Minerals Pty Ltd (Verdant) is a Darwin-based, developer of Australian fertiliser mineral projects, including the Ammaroo Ammonium Phosphate Fertiliser Project (hereinafter abbreviated to 'Ammaroo Phosphate Project' and referred to as the 'Project'). The Project is situated in the central region of the Northern Territory (Figure 1), located in the western Georgina Basin approximately 220 kilometres (km) southeast of Tennant Creek, 125 km east of Barrow Creek and 270 km northeast of Alice Springs (Figure 2).

In 2018, the Project was initially subject to and approved under an Environmental Impact Assessment, and comprised the development of the Ammaroo resource, by open-cut mining, crushing, beneficiation and drying to produce a phosphate rock concentrate for transportation via rail to Darwin Port and on to international markets as the essential feed stock for the production of fertiliser products. (For the purposes of clarity, the 2018 Project will hereafter be referred to as 'the Approved Project').

To expand the economic feasibility of the Project, Verdant now plan to include the onsite production of monoammonium phosphate (MAP) and diammonium phosphate (DAP) fertiliser. This will entail the construction of additional onsite plant and infrastructure, including a phosphoric plant, sulphuric acid plant, ammonia plant, granulation plant and amenity and service infrastructure (referred to as the 'Proposed Project').

The Proposed Project has many similarities to the Incitec Pivot Phosphate Hill operation in Queensland that has sustainably produced approximately 900 ktpa of MAP and DAP for over 20 years. Phosphate Hill is located approximately 300 km east of Ammaroo on the eastern side of the same geological basin, the Georgina Basin.

Australia remains a significant importer of ammonium phosphate fertiliser produced primarily in China, the Middle East and Northern Africa, supply that could be at risk under a number of real scenarios. By value adding to the Ammaroo phosphate rock resource, through the development of Ammaroo Phosphate Project as an ammonium phosphate fertiliser production facility, the Proposed Project will have significant economic benefit to the region and the Northern Territory and ultimately play a significant role in enhancing the resilience and self-reliance of Australia's domestic agricultural industry through security of fertiliser supply.

1.0 Purpose of this Report

This referral has been prepared by GHD Pty Ltd (GHD) on behalf of the proponent, Verdant Minerals Pty Ltd, for the purpose of a decision being made under the NT Environmental Protection Act.

The purpose of this report is to:

– Describe the Proposed Project's expanded activities and required infrastructure.
– Identify any substantial changes to the potential environmental impacts of the Proposed Project compared to the Approved Project and the additional mitigations that may be required to manage these impacts to acceptable levels.
– Be submitted as a **referral of significant variation** to the existing Approved Project approval to request formal approval of the Proposed Project.

1.1 Proponent Details

Verdant Minerals Pty Limited (Verdant) is a Darwin-based, developer of Australian fertiliser mineral projects, including the Ammaroo Phosphate Project.

The company name was changed from Rum Jungle Resources Ltd to Verdant Minerals Pty Ltd in December 2016.

Table 1 Proponent details

Characteristic	Details
Company name	Verdant Minerals Pty Ltd ABN 33122 131 622
Registered office	20 / 90 Frances Bay Drive, Stuart Park NT 0820
Postal address	GPO Box 775, Darwin NT 0801
Contact details	Chris Tziolis Managing Director T: +61 8 8942 0385 M: +61 437 021 415 E: ctziolis@verdantminerals.com.au

1.2 Assumptions and Limitations

This report has been prepared by GHD for Verdant Minerals Pty Ltd and may only be used and relied on by Verdant Minerals Pty Ltd for the purpose agreed between GHD and Verdant Minerals Pty Ltd as set out in section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Verdant Minerals Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring after the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

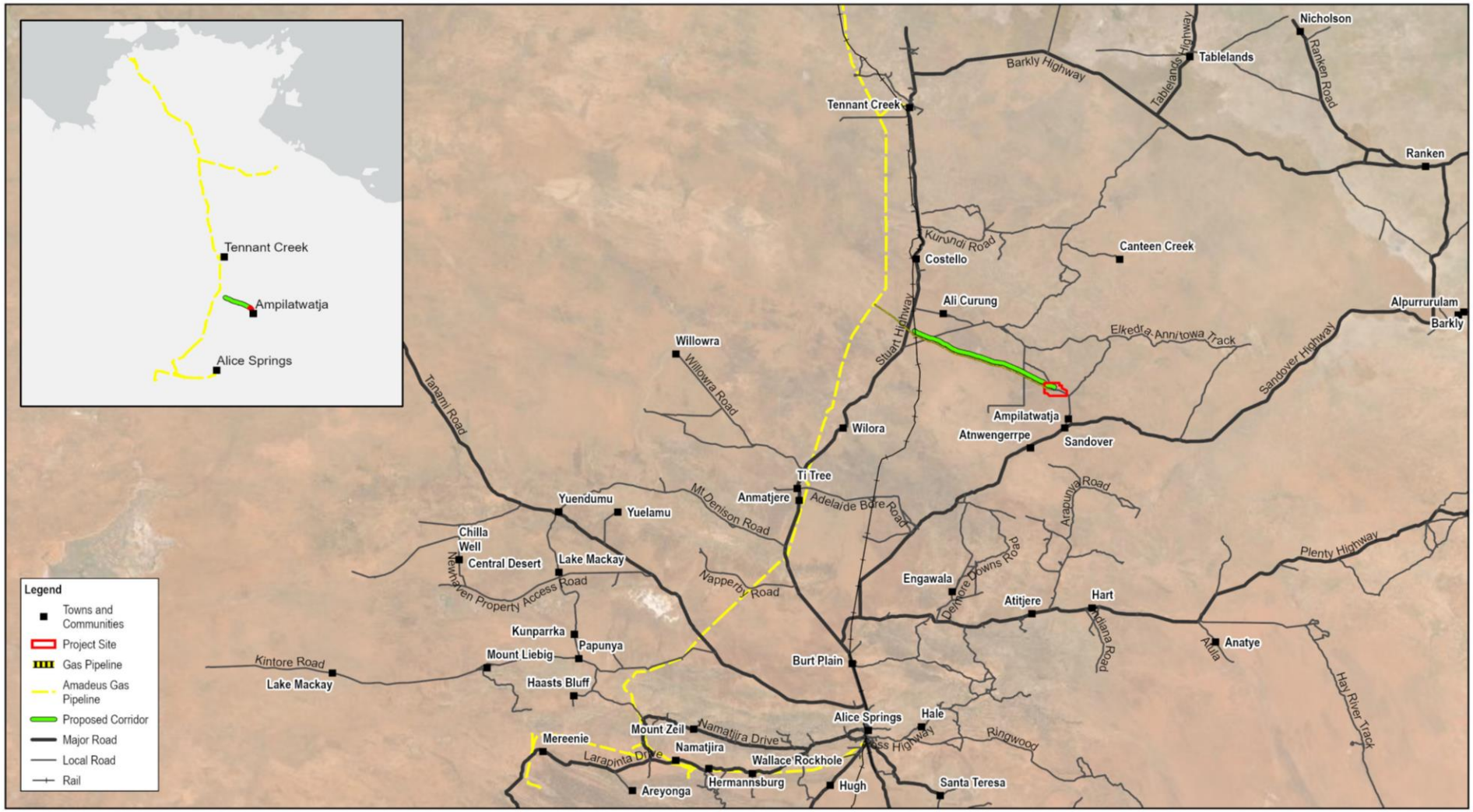


Figure 1 Locality of Ammaroo Phosphate Project

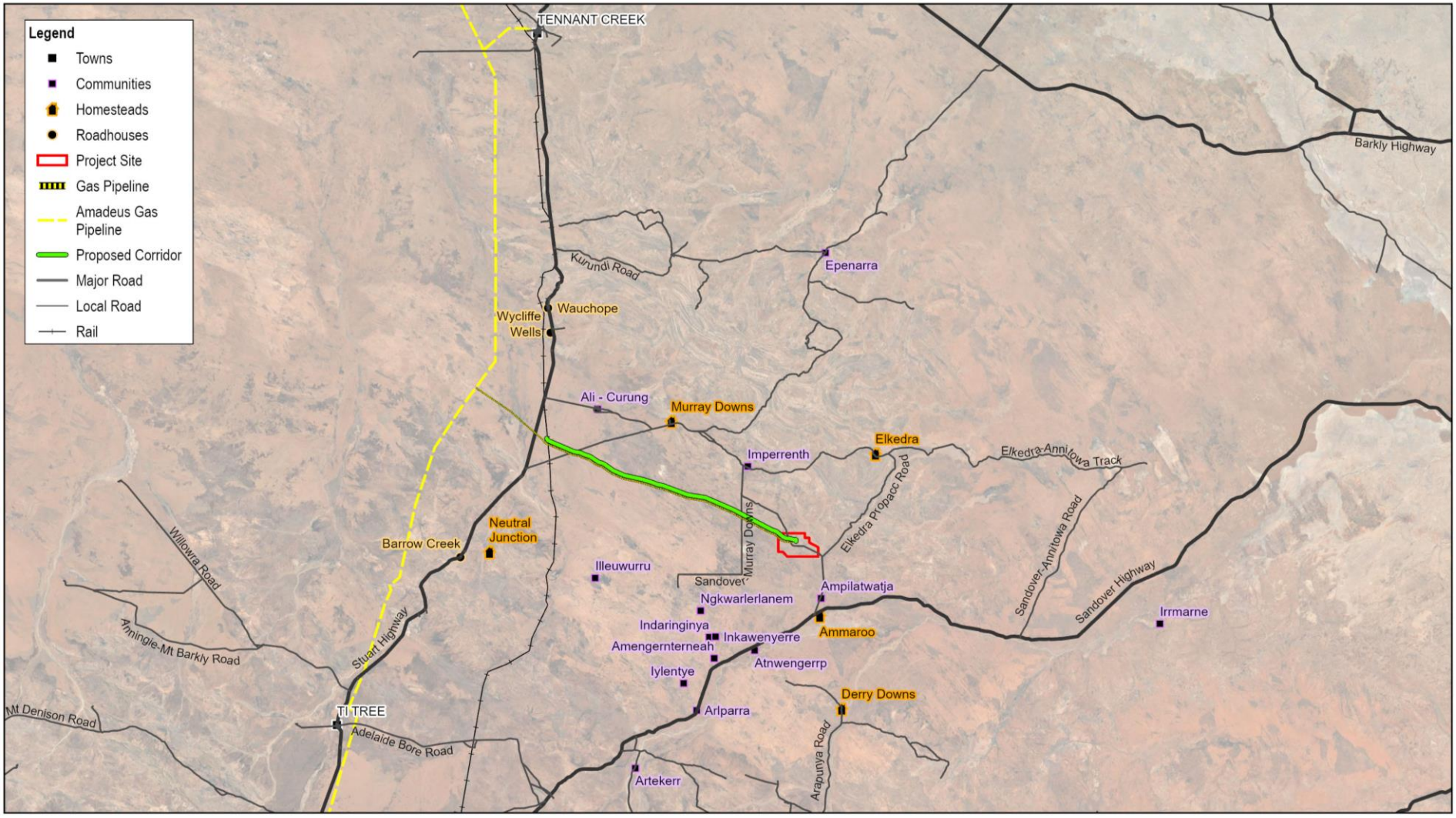


Figure 2 Community context

1.3 Abbreviations

Table 2 List of abbreviations

Abbreviation	Description
AAPA	Aboriginal Areas Protection Authority
ACM	Acid Consuming Material
AEP	Annual Exceedance Probability
AMD	Acid Metalliferous and Saline Drainage
Ar	Argon
ARI	Average Recurrence Interval
ASU	Air Separation Unit
NH_3	Ammonia
AP	Ammonia Plant
BAT	Best Available Technology
BOM	Bureau of Meteorology
BP	Beneficiation Plant
$CaCO_3$	Calcite
CCUS	Carbon Capture Utilisation and Storage
CH_4	Methane
CHMP	Cultural Heritage Management Plan
CIX	Continuous Ion Exchange
CO	Carbon Monoxide
CO_2-e	Carbon Dioxide Equivalent
CPA	Concentrated Phosphoric Acid
DAP	Diammonium Phosphate
dBA	Decibels
DCCEEW	Department of Climate Change, Energy, Environment and Water
DEPWS	Department of Environment, Parks, and Water Security
DFP	Definitive Feasibility Phase
DIDO	Drive In Drive Out
DMP	Dust Management Plan
DoEE	Commonwealth Department of the Environment and Energy
EC	Electrical Conductivity
EET	Emissions Estimation Technique
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EL	Exploration Lease
EP Act	Environment Protection Act 2019
EPA	Environment Protection Authority
EP regulations	Environment Protection Regulations 2020
EPBC Act	Environment Protection Biodiversity Conservation Act 1999

Abbreviation	Description
ESCP	Erosion and Sedimentation Control Plan
ESIA	Environmental and Social Impact Assessment
EV	Electric Vehicles
FID	Financial Investment Decision
F	Fluoride
FIFO	Fly In Fly Out
FTE	Full Time Equivalent
GDE	Groundwater Dependent Ecosystems
GHG	Greenhouse Gas
GGAP	Greenhouse House Gas Abatement Plant
GLpa	Gigalitres Per Annum
GP	Granulation Plant
GSA	Gypsum Stacking Area
H_2SO_4	Sulphuric Acid
ha	Hectare
HazOP	Hazard Operability
HDPE	High-Density Polyethylene
HPS	High Pressure Super-Heated Steam
HPSH	High Pressure Superheated Steam
HRS	Heat Recovery System
IAEA	International Atomic Energy Agency
IGS	Innovative Groundwater Solutions
ILUA	Indigenous Land Use Agreement
IPTF	In Pit Tailings Storage Facility
LGC	Large Generation Certificates
LLFC	Low Level Flash Coolers
LOM	Life of Mine
LPG	Liquefied Petroleum Gas
MAP	Monoammonium Phosphate
MHF	Major Hazards Facility
ML	Mineral Leases
MPag	Megapascal Gauge
MNES	Matter of National Environmental Significance
Mt	Million Tonnes
Mtpa	Million Tonnes Per Annum
MP	Medium Pressure
MW / MWh	Megawatt / Megawatt Hour
NAF	Non-Acid Forming
NEPM AAQ	National Environment Protection Measure (Ambient Air Quality)
NMP	Noise Management Plan
NO_2	Nitrogen Dioxide

Abbreviation	Description
NORM	Naturally Occurring Radioactive Materials
NPI	National Pollutant Inventory
NR	Natural Resource Maps
NT EPA	Northern Territory Environment Protection Authority
NTG	Northern Territory Government
OHS	Occupational Health and Safety Regulations
ORP	Oxidation Reduction Potential
P_2O_5	Phosphorus Pentoxide
PAP	Phosphoric Acid Plant
PM	Particulate Matter
PV	Photovoltaic
RGV	Reactor/Granulator/Vent
RNTBC	Registered Native Title Body Corporate
RO	Reverse Osmosis
ROM	Run of Mine
SAP	Sulphuric Acid Plant
SIA	Social Impact Assessment
SiO_2	Silicon Dioxide
SMR	Steam Methane Reformer
SO_2	Sulphur Dioxide
SO_3	Sulphur Trioxide
STG	Steam Turbine Generators
TIA	Traffic Impact Assessment
TMP	Traffic Management Plan
tpa	Tonnes Per Annum
TPWC Act	Territory Parks and Wildlife Conservation Act
TSF	Tailings Storage Facility
WDWCD	Western Davenport Water Catchment District
WMP	Water Management Plan
WPA	Weak Phosphoric Acid
WTP	Water Treatment Plant

2. Approved Ammaroo Phosphate Project

Verdant Minerals Pty Ltd (Verdant) submitted a Draft Environmental Impact Statement (EIS) (hereafter referred to as 'Approved EIS'), for development of a phosphate mine (hereafter referred to as the 'Approved Project') to the Northern Territory Environment Protection Authority (NT EPA) in 2017.

The Approved Project comprised an open cut mine of shallow phosphate deposits (average ROM grade of 15% P_2O_5), ore beneficiation (concentration to 32% P_2O_5 product), rock concentrate drying and site infrastructure for supporting the operation of the mine and loading rail wagons for transport of the rock concentrate to Darwin Port. The Approved Project would produce up to 2 million tonnes of phosphate rock concentrate each year, which would be exported to global markets via Darwin Port, for further processing into fertilisers overseas. The mine life was expected to last more than 25 years.

In 2018, the NT EPA approved the Approved Project, contingent on Verdant meeting a series of recommendations to reduce potential environmental impacts.

The key approved project components are summarised in

Table 3 and illustrated in Figure 3 and Figure 4.

2.0 Previous Approval Process

2.0.0 EPBC Act Approval

In 2014, the then Federal Minister for the Environment determined the Project to be a controlled action and assessed the proposed project under the Environment Protection Biodiversity Conservation (EPBC) Act 1999. EPBC approval was granted in January 2018. The approval document (EPBC 2014/7260), including approval conditions, has been provided in Appendix C.

GHD has considered the conditions of the EPBC approval and their application to the expanded scope associated with the Proposed Project. GHD has determined that if the Proposed Project fully complies with the existing EPBC approval conditions for the Approved Project, then the intent of those Approved conditions will adequately cover the expanded activities.

2.0.1 NT EPA Approval

In 2018, the Northern Territory Environment Protection Authority (NT EPA) assessed and subsequently approved the Project under the Environment Assessment Act 1982.

Having regard to the Project Environmental Impact Statement (EIS) and Supplementary Report, the NT EPA assessed the Project for its potential impacts and released Assessment Report 87 to be considered in decisions made by the Northern Territory Government. Assessment Report 87 states that, subject to the implementation of its 12 recommendations and the Project EIS commitments, the Project can be managed to avoid significant environmental impact.

Recommendation 2 of Assessment Report 87 requires Verdant to provide written notice to the NT EPA and the Responsible Minister, if it alters the Project and/or EIS commitments, safeguards, or mitigation measures in such a manner that the environmental significance of the action may have changed, in accordance with clause 14A of the Environmental Assessment Administrative Procedures.

It should be noted the Environment Protection Act 2019 replaced the Environmental Assessment Administration Procedures in June 2020. The same requirement for referral to the NT EPA is prescribed in Section 52 of the Environment Protection Act 2019.

GHD propose to use Assessment Report 87 to demonstrate that, subject to the implementation of the existing 12 recommendations and additional EIS commitments associated with the additional scope, the Proposed Project can be managed to avoid significant environmental impact. Assessment Report 87 identified the following key environmental factors that may be impacted by the Approved Project:

– Hydrological processes.
– Inland water environmental quality.

NT EPA's Assessment Report 87 has been provided in Appendix D of this referral. Appendix A and Appendix B provide a gap analysis summarizing the Proposed Project Impact on Approved Project EIS Conditions and Proposed Project comparison to NT EPA environmental factors, respectively.

Table 3 Summary of previously Approved Project components

Element	Characteristics
Project Life	
Construction period	2 years
Operational period	25 years, operating 24 hours every day
Production Estimates	
Ore	115 Mt over LOM
Overburden	322 Mt over LOM
Tailings	69 Mt over LOM
Plant feed	Average 2.5 Mtpa in years 1-5, 5 Mtpa in years 6-25
Production	1 Mtpa in years 1-5, 2 Mtpa in years 6-25, 45 Mt over LOM
Mine site	
Mine staging	Designed to produce 1 Mtpa of phosphate rock concentrate through years 1 to 5, and 2 Mtpa of phosphate rock concentrate through years 6 to 25
Pit	Pits to be excavated to average depth of 23 m, with a total surface area of approximately 1500 ha over LOM
Materials handling	Open cut strip mining using truck and shovel operations to remove overburden and transport ROM ore to the beneficiation plant
Waste	Removal of overburden and temporary storage in waste dumps and subsequent placement in completed pits as part of a continuous rehabilitation process
Tailings Storage Facility	Surface tailings storage facility for an initial 3-year period and then in-pit tailings deposition once depleted pits are available for tailings disposal
Process plant	Crushing, conveying, screening, flotation, filtration systems required to beneficiate the ore into a concentrate rock for export
Finished product	Finished product storage and handling infrastructure to support loading of rail wagons
Infrastructure corridor	
Rail spur	105 km rail spur, connecting the process plant to the main Adelaide to Darwin railway line
Gas pipeline	137 km low pressure, natural gas supply pipeline from the Amadeus Gas Pipeline to the site to provide gas
Borrow materials	An estimated 1.9 Mt of borrow materials (incl. ballast, substructure, and base materials) will be sourced for construction of the infrastructure corridor
Other infrastructure and facilities	
Power	Installed capacity of approximately 24 MW, supplying an average load of 16 MWh for 2 Mtpa production from year 6 onwards. Power plant will comprise multiple high efficiency gas engines.
Bore field	The bore field will comprise three high flowing water bores equally spaced over 1.5 to 2.0 km run. The maximum raw water demand for 1 Mtpa phosphate rock concentrate production is approximately 220 m^3/h and approximately 440 m^3/h for 2 Mtpa
Workforce	
Construction	Peak of 300 direct jobs
Operations	165 direct jobs when the project is producing 2 Mtpa i.e., from year 6 onwards

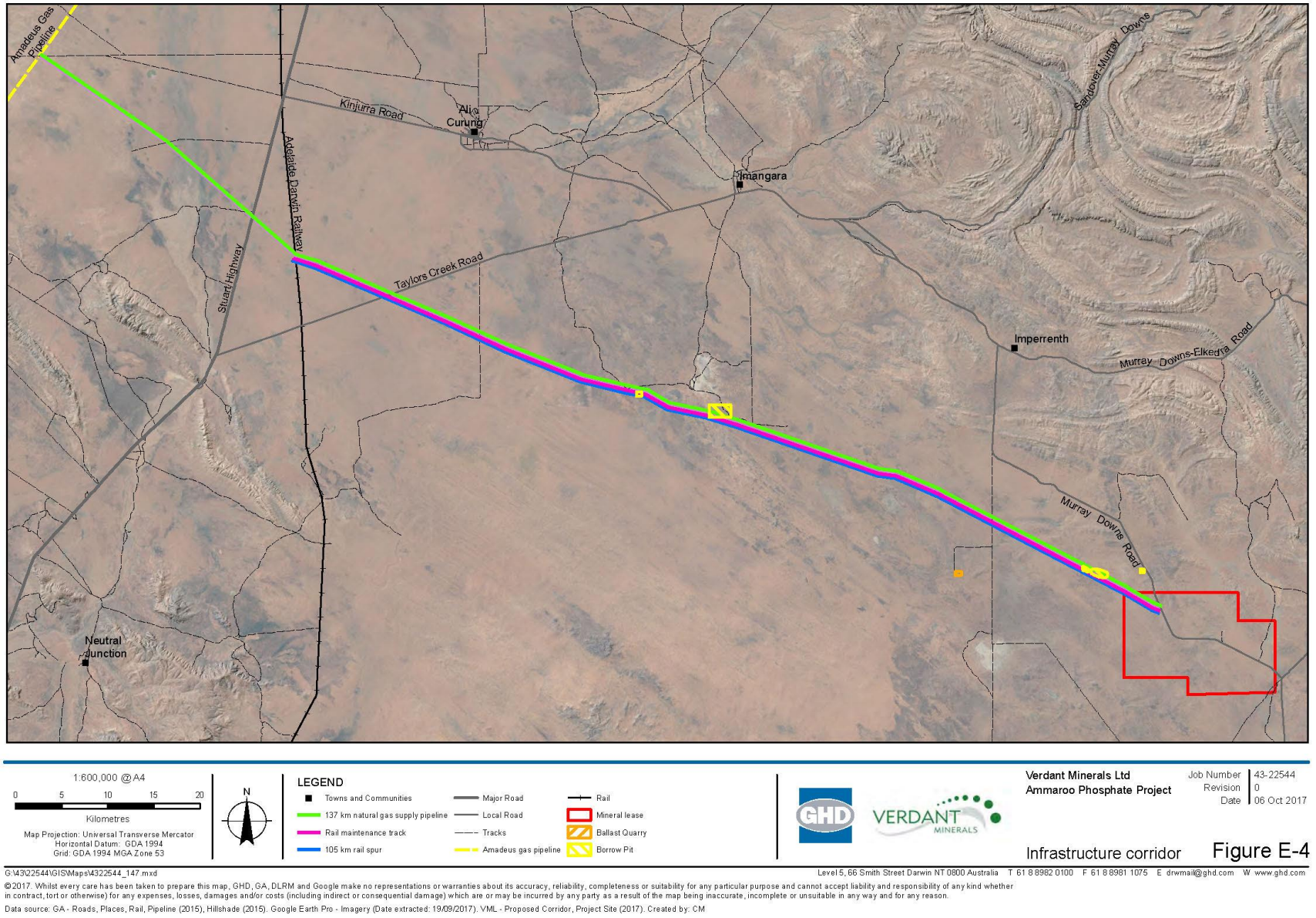


Figure 3 Site plan of Approved Project areas (figure adapted from Approved EIS, 2017)

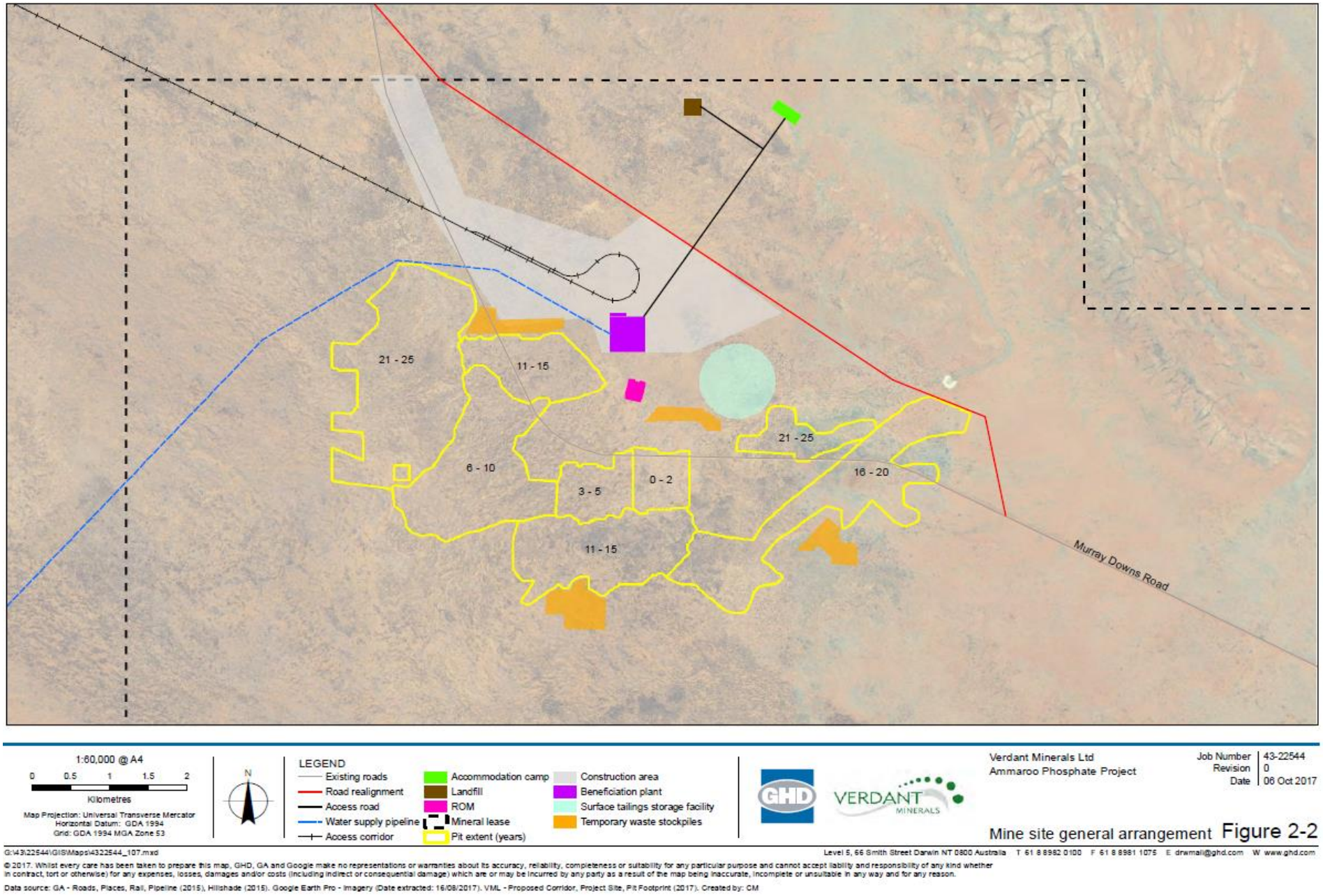


Figure 4 ***Approved Project plan - mineral lease area (figure adapted from Approved EIS, 2017)***

3. Current Regulatory Context

3.0 Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires a person not to take an action that has or will have a significant impact on a Matter of National Environmental Significance (MNES) unless that action is approved. An action means any project, development, undertaking or any activity or series of activities (Section 523).

The project will not significantly affect any of the following MNES:

– World Heritage properties.
– National Heritage places.
– Wetlands of international importance.
– Migratory species protected under international agreements.
– Commonwealth marine areas.
– The Great Barrier Reef Marine Park.
– Nuclear actions.
– A water resource in relation to coal seam gas development.

The Approved Project was previously referred to the Commonwealth Department of the Environment and Energy (DoEE). In August 2014, the then Commonwealth Minister for the Environment determined that the action was a "controlled action" and required assessment by Preliminary Documentation under section 95A. The Approved Project was deemed as having the potential to impact on listed threatened species and communities (sections 18 and 18A) including the following listed species:

– Greater Bilby (*Macrotis lagotis*).
– Southern Marsupial Mole (*Notoryctes typhlops*).
– Black-footed Rock-wallaby (*Petrogale lateralis* - MacDonnell Ranges race).
– Crest-tailed Mulgara (*Dasycercus cristicauda*).
– Great Desert Skink (*Liopholis kintorei*).

Listed threatened species and communities protected under the EPBC Act include species and communities that are considered to be extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent. Environmental approval under the EPBC Act, as well as Northern Territory approval from the responsible Minister, is required prior to commencement of the project. EPBC approval (EPBC 2014/7260) was granted for the Approved Project in January 2018 by federal department.

In August 2022, consultation with the Department of Climate Change, Energy, Environment and Water (DCCEEW) was conducted between Verdant and the department to determine whether referral of the Proposed Project is required for consideration by the Minister or whether it is a controlled action. The DCCEEW indicated that given that the Proposed Project does not exceed the already approved clearance, no additional action is required other than to formally request an extension to the Approved Project action timeline for commencement.

3.1 Environment Protection Act 2019 (NT)

In June 2020, the *Environment Protection Act 2019* (EP Act) was enacted within the Northern Territory. The EP Act requires the proponent of a proposed action or a strategic proposal (a proposal), to notify the Northern Territory Environment Protection Authority (NT EPA) of a proposed significant variation to a proposal.

The meaning of a significant variation of an action is defined under section 12 of the EP Act as a variation that:

– will alter the action to the extent that a referral trigger that did not previously apply to the action now applies.

– has the potential to have a significant impact on the environment; or
– will result in new or additional areas being subject to a potential significant impact on the environment.

Part 7 of the Environment Protection Regulations 2020 (EP regulations) details the processes for providing notice of significant variations through the following stages of the Environmental Impact Assessment process:

– Significant variations notified during the assessment process.
– Significant variations referred after an assessment report has been completed for a proposal.
– Significant variation after an environmental approval has been granted for a proposal.

The proposed addition of the Proposed Project requires Verdant to submit a referral of significant variation following process 3 as described above.

Division 3 of Part 7 of the EP regulations provides the process for significant variations that are referred by the proponent under section 52 of the EP Act, after an environmental approval has been granted for a proposal.

In determining whether the referral requires a new environmental impact assessment, the NT EPA will consider the following:

– Whether the potentially significant impacts on the environment of the significant variation are materially different from, or additional to, the impacts already identified in the original proposal.
– Whether the potential detrimental effects of the significant variation are indeed significant compared to the potentially significant impacts identified in the original proposal.
– Whether the objects of the Act and the purpose of the environmental impact assessment process set out in section 42 of the EP Act would be undermined if the matters raised in the significant variation were not assessed.

The EPA Guideline 'Referring a significant variation to the NT EPA - Environmental impact assessment guidance for proponents' prescribes the information required in an application for a variation to an approved project and the process that will be followed to determine the application. On receipt of a Notice of Variation, the NT EPA will determine which of the following pathways to direct Verdant to undertake.

– The environmental impacts of the variation can be managed through the existing conditions of the environmental approval.
– The environmental impacts of the variation can be managed through amendments to the existing conditions of the environmental approval, or
– The environmental impacts of the variation are such that a new environmental impact assessment of the variation is required.

The purpose of this report is to provide the information required for the NT EPA to determine the most appropriate pathway.

Consideration of principles of environment protection and management under the EP Act have been made for the Proposed Project. This has been presented in Appendix G.

3.2 Large Emitters Policy (NT)

The Northern Territory Government's policy 'Greenhouse Gas Emissions Management for New and Expanding Large Emitters' (the Large Emitters Policy) commenced on 1 September 2021. This policy requires that new projects and expansion of existing projects, considered to be 'large emitters' are required to obtain an environmental authorisation under Territory legislation and are required to meet the obligations of the Policy. The thresholds for a project to be considered a 'Large Emitter' are:

– *The industrial project threshold is 100 000 tonnes carbon dioxide equivalent (tCO2-e) (scope 1) in any financial year over the life cycle of a project.*
– *The land use project threshold is 500 000 tCO2-e (scope 1) generated from a single clearing action, or cumulatively from multiple land clearing actions on a property over time.'*

Projects covered by the Policy are required to develop a Greenhouse Gas Abatement Plan (GGAP) which demonstrates how Scope 1 and Scope 2 emissions (direct and indirect) will be managed and reduced to a default

expectation of net zero by 2050. A target and interim targets are required as part of a GGAP to establish a trajectory for achieving the long-term target. The GGAP forms part of the approving Minister's consideration of a project and may be captured by conditions of an environmental authorisation, making the GGAP enforceable.

3.3 Water Act 1992 (NT)

Under Part 6 and 6A of the *Water Act 1992*, Verdant will be required to submit an application to obtain a water extraction licence in order to extract the proposed 8.5 GLpa of groundwater from the Georgina Basin to the Department of Environment, Parks, and Water Security (DEPWS). In deciding whether to approve a water extraction licence application, the controller (i.e., DEPWS) must have consideration of:

– Availability of water in the area.
– Existing water license entitlements.
– Water allocation plan rules.
– Potential effects of water extraction and the condition of the water resource.
– Development and land use in the area.

The controller must also consider adverse effects on the supply of water to any designated bore (i.e., a bore used for beneficial uses including potable or stock water).

Under the Act a Water Control District can be declared. The Western Davenport Water Control District is located 30 km northwest of the Proposed Project.

3.4 Native Title Act 1993

The *Native Title Act 1993* (NTA) provides for the recognition and protection of native titles.

The grant of a mineral lease on an area where native title has been determined to exist (or where such area is subject to a registered native title claim) is a "future act" (Section 233) and will trigger the 'right to negotiate' process (Part 2, Division 3, Subdivision P).

The right to negotiate process requires good faith negotiations between the proponent, government party and native title party (together, the negotiation parties) with a view to obtaining the agreement of the native party to the doing of the future act or the doing of the future act subject to conditions (Section 31).

If agreement is reached, the negotiation parties will execute an agreement in accordance with Section 31(1)(b) of the NTA and the future act will be valid for the purposes of the NTA. A copy of such agreement is to be provided to the National Native Title Tribunal (NNTT) (Section 41A).

The NTA also provides for Indigenous Land Use Agreements (ILUA). An ILUA may provide for the non-application of the 'right to negotiate' process and include consents to the doing of future acts (or validate certain historical acts). An ILUA that has the effect of a contract between the parties and an ILUA that is registered in accordance with the NTA has the effect that all persons holding native title in relation to any area covered by the ILUA will be bound by the agreement (whether or not they are a party to the agreement) (Section 24EA).

The future act subdivision of the NTA also mandates certain processes of notification, consultation, and/or consideration of comments in relation to other types of future acts. Notification under Section 24MD of the NTA is likely to be relevant to the project in respect of infrastructure related mineral leases, extractive mineral permits, and access authorities.

Native title does exist over the project area. At the time of referral preparation, consultation with Traditional Owners, CLC and AAPA were ongoing, with the intent of obtaining a Native Title Mining Agreement and sacred site clearance certificates for the project to confirm with the Native Title Act and Sacred Sites Act.

The Project Area is within the administrative boundary of the Central Land Council (CLC) but is not located on Aboriginal land and therefore the *Aboriginal Land Rights (Northern Territory) Act 1976 (Land Rights Act)* does not exist over the project area.

3.5 Northern Territory Aboriginal Sacred Sites Act 1989 (NT)

The *Northern Territory Aboriginal Sacred Sites Act 1989* (Sacred Sites Act) protects sacred sites. It does this by establishing a procedure for the registration of sacred sites and establishing a procedure for the avoidance and/or protection of sacred sites in the development and use of land.

Under the Act, an Authority Certificate can be issued by the Aboriginal Areas Protection Authority (AAPA) that provides legal indemnity against possible prosecution in relation to damage to sacred sites resulting from the works or uses covered by the Certificate, so long as any imposed conditions are followed. AAPA administers Authority Certificates in consultation with the relevant custodians under the Act.

At the time of referral preparation, consultation with Traditional Owners, CLC, and AAPA were ongoing, with the intent of obtaining a Native Title Mining Agreement and sacred site clearance certificates for the project to confirm with the Native Title Act and Sacred Sites Act.

3.6 Major Hazards Facility Notification and Licencing (NT)

Major hazards facility (MHF) notification and licencing under the *Occupational Health and Safety Regulations 2017*. This is a Northern Territory WorkSafe process which is triggered when a facility is in excess of 10% of the major hazard threshold quantities set out in Schedule 14 of the OHS Regulations. The proponent must submit an application for MHF licence. Once registered as an MHF, the proponent would submit a safety case for the operations outlining the health and safety measures for the Proposed Project. The submission process is not required to start by NT WorkSafe until the final project investment decision has been made.

3.7 Mine Management Act 2001

The Mining Management Act 2001 (MM Act) and the Mining Management Regulations regulate mining activities and the management of mining sites. The legislation is administered by the Department of Industry Trade and Tourism. An operator of a mining site that proposes to undertake works that would cause “substantial disturbance” (as defined in the MM Act) requires an authorisation under the MM Act (Section 35). An application for an authorisation must include a Mining Management Plan (MMP) (Section 36). The MMP must describe the mining activities proposed and management systems to protect the environment, health and safety, details of ownership, plans for the mine workings and infrastructure, and a plan and costing of closure activities (Section 40).

4. Proposed Variation of Existing Approval

Verdant are now proposing changes to the Approved Project in order to create further economic and social value for the Project and the community by increasing the downstream processing of the rock concentrate envisaged in the Approved Project. The Proposed Project will produce higher value final fertiliser products as monoammonium phosphate (MAP) and diammonium phosphate (DAP) fertilisers for use within Australia and for export (denoted the 'Proposed Project'). This will entail the construction and operation of additional onsite processing plants and supporting infrastructure with significant increase in economic activity, offering additional short and long-term employment opportunities over a minimum of 25 years.

In terms of key environmental aspects, the Proposed Project will require an increase in water extraction from the Georgina Basin and an increase in CO_2, NOx, SOx, and GHG emissions compared to the Approved Project. The Proposed Project is likely to trigger Large Greenhouse Gas (GHG) Emitter status under the NT Office of Climate Change's Large Emitters Policy and will also need to meet the requirements of the Major Hazards Facility (MHF) legislation.

A comparison of the key components between the Approved Project and the Proposed Project is provided in Table 4 and illustrated in Figure 5. The plan of the overall Proposed Project and the design of the Fertiliser plant are provided in Figure 6 and Figure 7, respectively.

Table 4 Project comparison

Project component	Approved Project	Proposed Project
Construction period	2 years	3+ years
Operation period	24 hours per day, 7 days per week for 25 years.	No change
Infrastructure	– The mine site, processing plant and tailings storage facility – 105 km of rail and 137 km gas pipeline – Materials and rail handling facility – Bore field and 12 km water pipeline – Roads, power station, water treatment, administration building and accommodation village – Realignment of about 12 km of Murray Downs Road – Storage and material handling facilities at Darwin Port	– All previously approved infrastructure – Phosphoric acid plant – Sulphuric acid plant – Ammonia plant – Water treatment plant – Darwin Port – Storage facility for fertiliser and solid sulphur at site – Gypsum stacking area – Bulk chemical storage tanks – Power plant expansion – Airfield – Accommodation village expansion – Additional groundwater abstraction bores – Storage facility for fertiliser and solid sulphur at Darwin Port
Output	Phosphate rock concentrate, extracted from ore through crushing, flotation and drying, and transported by rail to Darwin Port for export.	Further processing of the phosphate rock concentrate on site to produce a final product of ammonium phosphate fertilisers as MAP and DAP and transported by rail to Darwin Port or South Australia for local or export consumption.
Workforce	300 jobs during construction and 165 during operation.	Approximate peak of 1,600 jobs during construction and 400 direct workforce during operation.

5. Proposed Project Description

A summary of the proposed additional process plant and infrastructure is provided in Table 5.

Table 5 Proposed project description

Item	Description
Fertiliser Manufacturing Infrastructure	
Phosphoric acid plant (PAP)	The PAP will utilise well established wet dihydrate phosphoric acid technology from a global licensor. The plant comprises a reaction section where phosphate rock concentrate slurry from the beneficiation plant is reacted with 98.5% sulphuric acid. This slurry then goes through a filtration stage using vacuum separation where streams of weak phosphoric acid and gypsum are produced. The weak phosphoric acid stream is then concentrated through evaporation of water using process steam, from the SAP. The concentrated acid stream then goes to storage before being fed to the granulation plant (GP). The PAP plant will include a side stream continuous on exchange (CIX) process which will enable the additional conditioning of the weak phosphoric acid from filtration circuit when increased purification of the acid is required to meet specification. The CIX comprises a series of continuous ion exchange columns, which remove unwanted minor elements (Fe, Mg, Al, Na, K) through absorption onto an ion exchange resin, and then eluted with a weak sulphuric acid. The elution products are evaporated and filtered to produce a mixed phosphate salt for disposal on the GSA. CIX plant is contained entirely within the battery limits of the PAP.
Sulphuric acid plant (SAP)	Sulphuric acid is produced from elemental solid sulphur which is imported to the site. Sulphur dioxide is first obtained by the burning of the molten sulphur in presence of air the sulphur dioxide is then converted to sulphur trioxide in presence of vanadium pentoxide catalyst. The sulphur trioxide is then absorbed in recycling concentrated sulphuric acid in an absorption tower to form concentrated sulphuric. The SAP also produces significant steam from waste heat recovery systems which provides process steam and power for the site offsetting other energy sources.
Ammonia plant (AP)	Ammonia is produced by converting natural gas to hydrogen and CO_2 through high temperature catalytic steam methane reforming (SMR). The hydrogen is then reacted with nitrogen from the air through catalytic ammonia synthesis. The ammonia plant also produces excess steam from heat recovery systems which is utilised to generate power for the site.
Granulation plant (GP)	DAP and MAP are formulated in a controlled reaction of phosphoric acid from the PAP plus ammonia from the AP and sulphuric acid from the SAP. The resultant hot slurry is then granulated, dried, screened, crushed, cooled, and coated to make final products of ammonium phosphate fertilisers, for market.
Non process infrastructure	
Gypsum stacking area (GSA)	Gypsum is produced as a by-product of the phosphoric acid plant process. Dry gypsum filter cake is discharged from the PAP filters and transported via a conveyor and stored within a membrane lined gypsum stacking area (GSA). An estimated 3 Mt of dry gypsum will be stored at the GSA per annum. Dry stacking will minimise water usage and evaporation compared with wet stacking. The Project will adopt "best practice" in the design of the GSA to minimise impact to environment.
Materials handling facility (Darwin Port)	Storage and handling facilities are proposed at the Darwin Port for the temporary under-cover storage of export fertilisers and imported sulphur: – Fertilisers – 80,000 tonnes. – Solid Sulphur - 60,000 tonnes. The Port will also require modifications and upgrade to rail and materials handling infrastructure to facilitate the required throughput of fertilisers and sulphur.

Item	Description
Chemical storage (Site)	To achieve efficient operations there will be buffer storage required for several intermediates and for final products. The nominal capacities will comprise: Sulphuric acid storage – 45,000 tonnes. Phosphoric acid – 20,000 tonnes. Ammonia – 10,000 tonnes. Solid sulphur -20,000 tonnes. Molten sulphur – 12,000 tonnes. Diesel storage – 100 KL Processing equipment with liquids/chemicals will be provided where necessary with suitable bunding/containment.
Finished product storage	A storage facility for 60,000 tonnes of MAP and DAP plus, out load facility to support loading of rail wagons.
Power plant expansion	Power generation from steam turbine generators (STG) powered from high pressure superheated steam (HPSH) from the sulphuric acid and ammonia plants to supply up to 58 MW of electrical power to the site. Additional power generation capacity from gas engines or equivalent to supply up to 24 MW intermittently, where the shortfall from power from steam cannot be supplied by renewables.
Airfield	An airfield is proposed to be constructed to enable FIFO workforce commuting and use as a regional emergency services resource. The airfield is proposed to be nominally 2100 m x 200 m and designated for Class 3 air operations. Together with the access road and associated airfield infrastructure the total area would be approximately 62.3 ha.
Accommodation village expansion	The permanent accommodation village capacity is increased to 800 rooms for normal operations which allows capacity to accommodate additional work force peaks for maintenance and shutdowns and any other project activities above normal operations. During the construction period there will be at least a further 800 rooms on site located within the construction area.
Water treatment plant	The water treatment plant (WTP) comprises filtration, reverse osmosis, and demineralisation processes. The WTP will be used to treat a proportion of the water supplied from the bore field to then use in the process plants.
Additional groundwater abstraction bores	An additional 3.9 GLpa (8.5 GLpa in total) will be required to be abstracted from groundwater within the Georgina Basin aquifer, via a 17 km pipeline. An additional 3 bores will be installed within the bore field southwest of the Mining Lease.
Rail spur	Minor modifications at the junction to main line to accommodate rail transport to southern Australia as an option.
Land clearing requirements	The total footprint of the Proposed Project at approximately 3,772 ha has not increased since the Approved Project.
Workforce	
People	A peak of approximately 1,600 people will be onsite during construction and an average of approximately 300 during normal operations although this will be supplemented for periods of activities beyond normal operations. The workforce will operate on a fly in fly out (FIFO) schedule, utilising the onsite airfield. Flights would likely operate between site and Darwin and/or other locations/capital cities. Local communities will also contribute to the workforce needs of the site and hence there may be some drive-in drive out (DIDO) for short commutes.

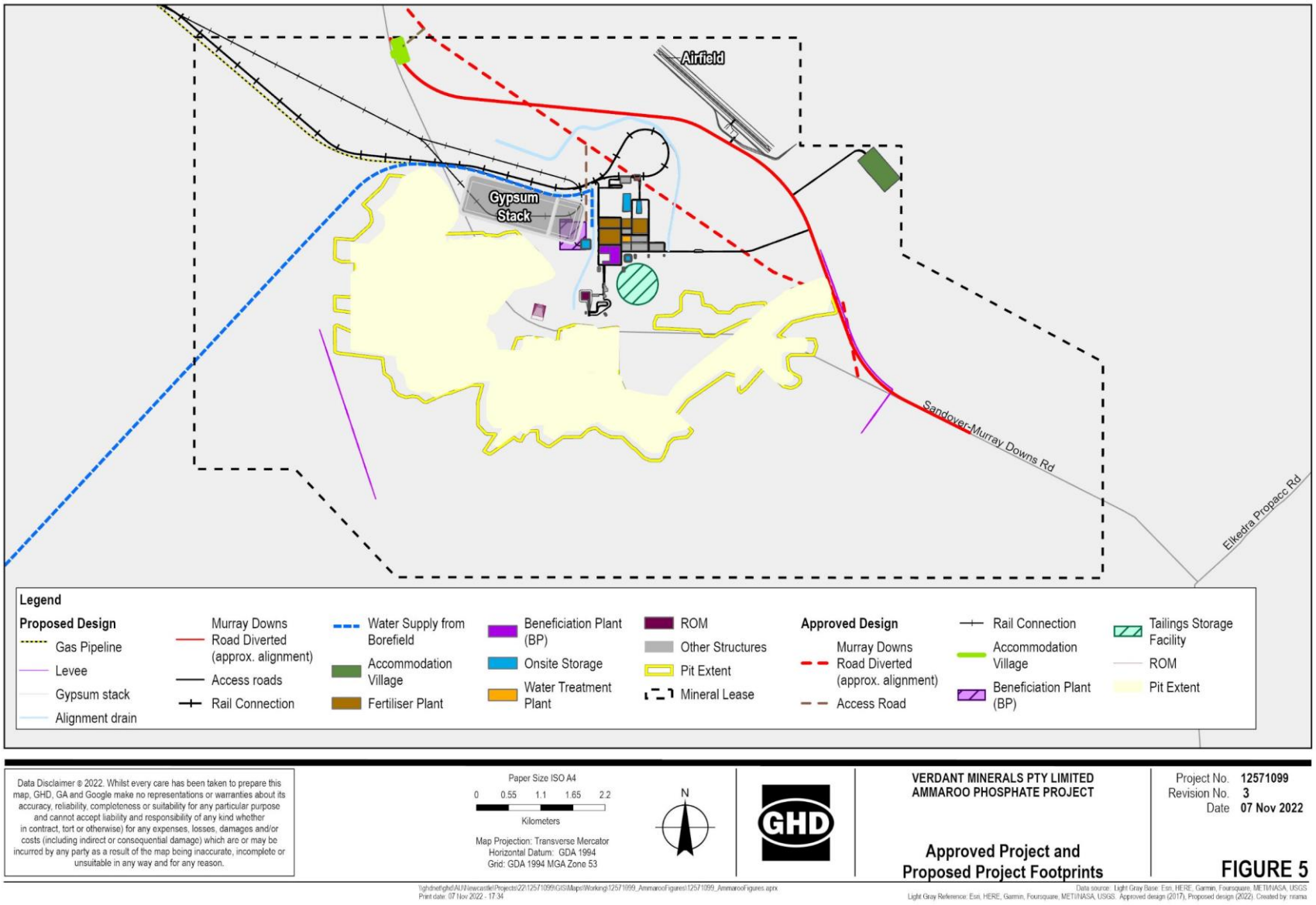


Figure 5 ***Approved Project and Proposed Project footprints***

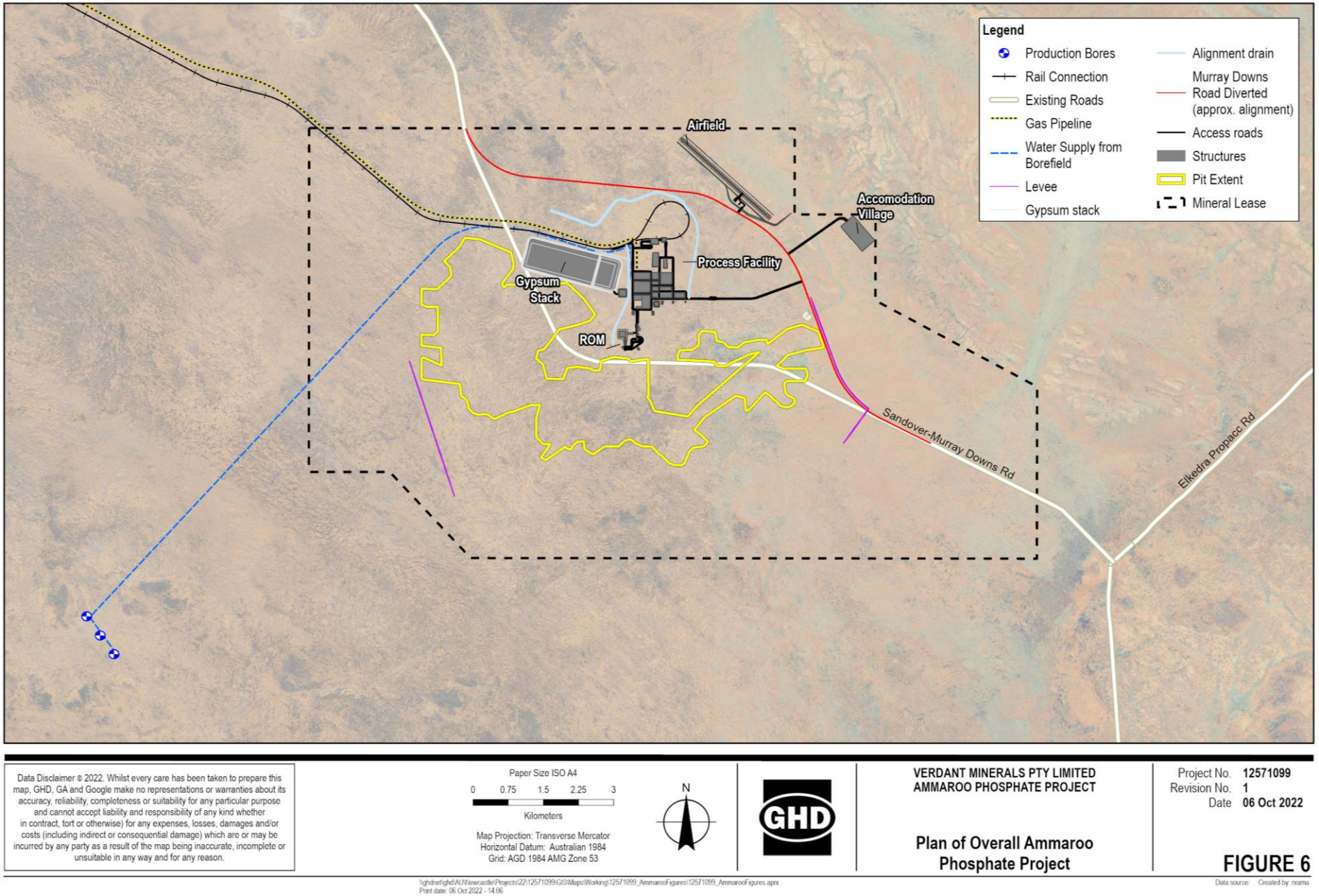


Figure 6 Plan of overall Ammaroo Phosphate Project

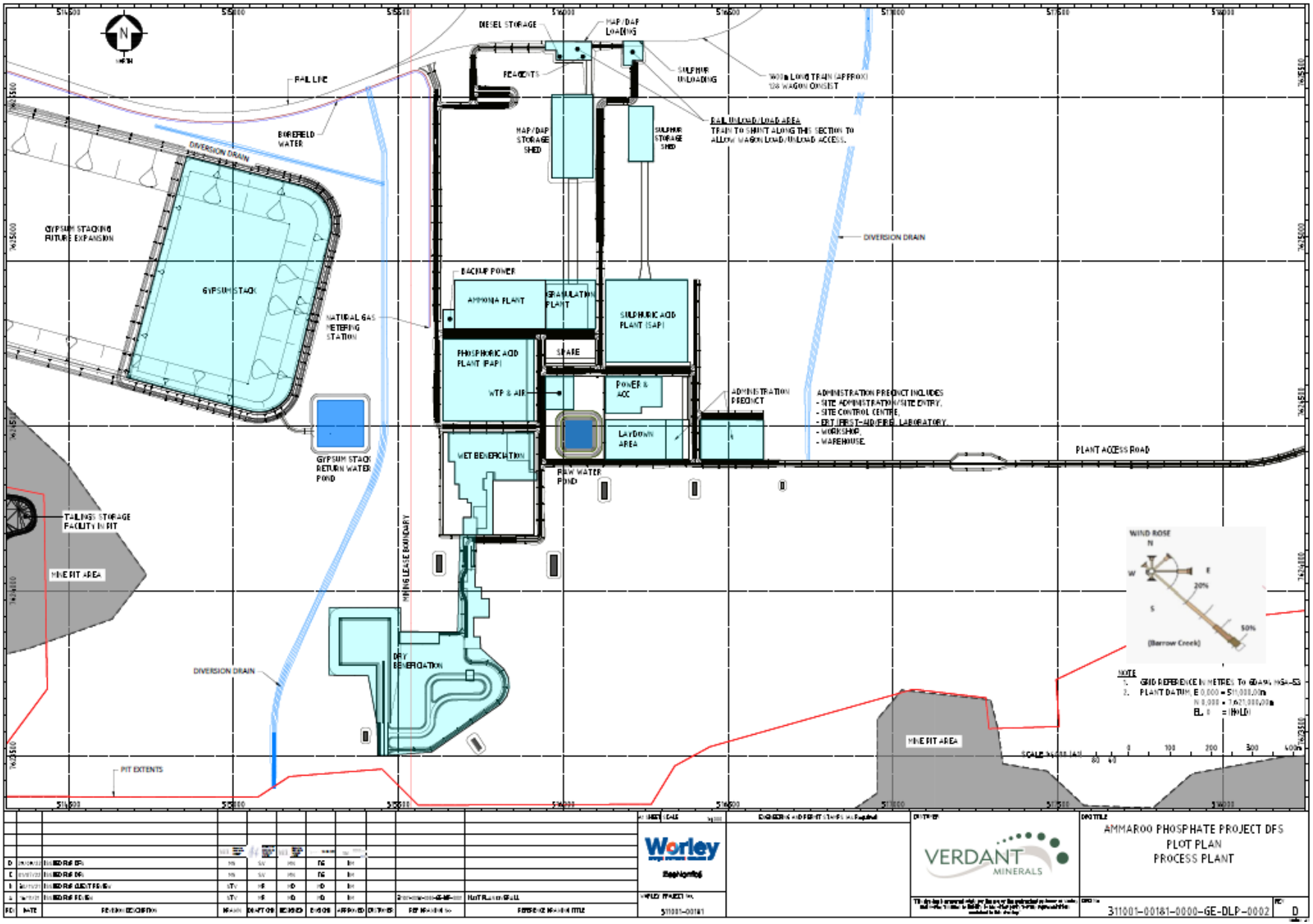


Figure 7 Plan of fertiliser plant (Worley Parson 2022)

5.0 Fertiliser Manufacturing Process

The additional processing infrastructure will allow the mined and beneficiated phosphate rock to be reacted with sulphuric acid in a phosphoric acid plant, to produce phosphoric acid, with gypsum being a by-product of the reaction. The phosphoric acid will then in turn be reacted with ammonia to produce ammonium phosphate fertiliser. The fertiliser manufacturing complex consists of a sulphuric acid plant, phosphoric acid plant, ammonia plant, granulation plant, and other associated infrastructure listed in Table 5, which is located on the mining lease (ML29463). A simplified flow diagram is shown in Figure 8 below.

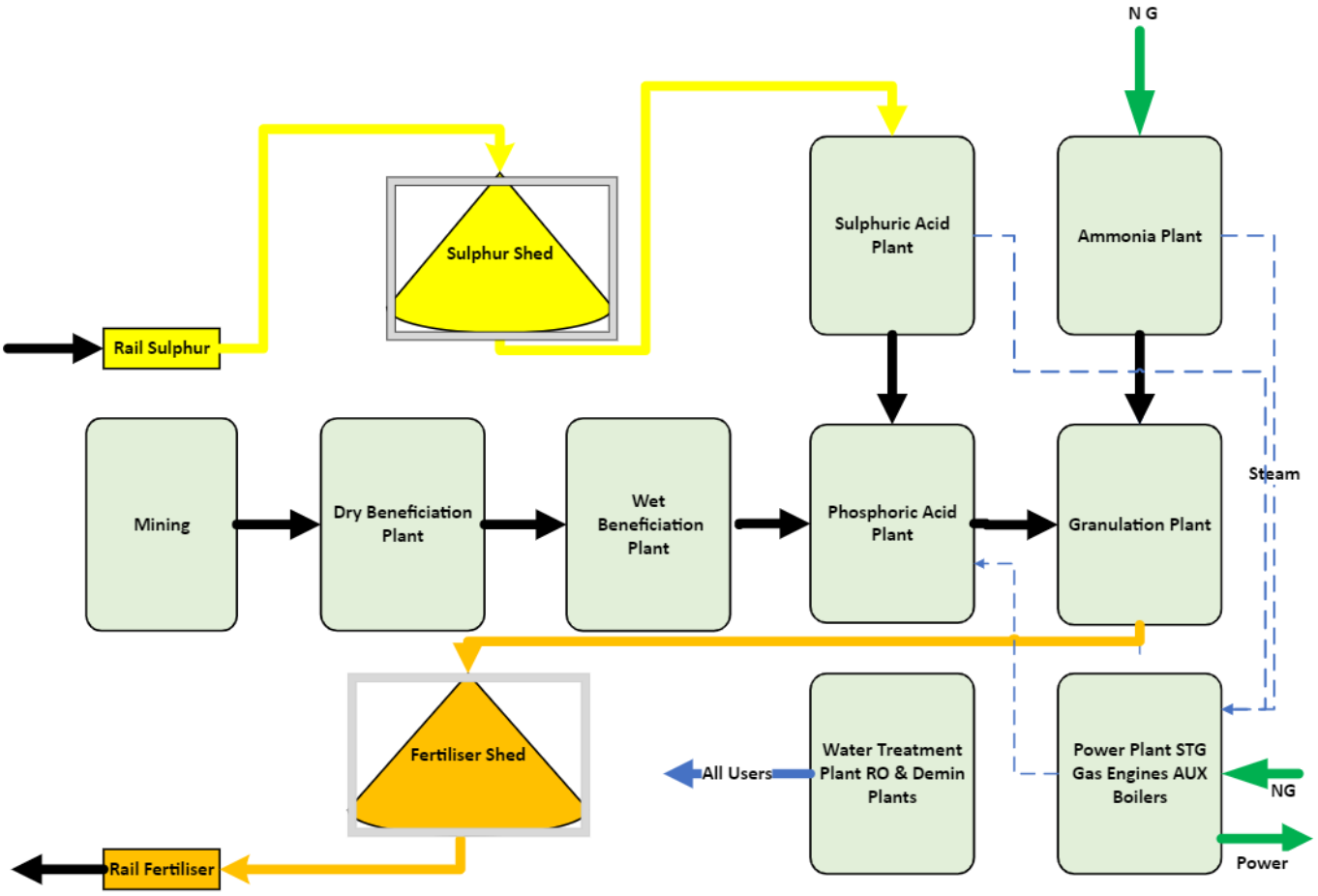


Figure 8 Fertiliser manufacturing flow diagram

The major inputs and outputs for the proposed fertiliser manufacturing complex are listed in Table 6. A process flow diagram for the proposed fertiliser plant is illustrated in Figure 8.

Table 6 Major fertiliser plant inputs and outputs

Input	Volume / Quantity	Output	Volume / Quantity
Sulphuric Acid Plant			
Sulphur (elemental solid)	500,000 tpa	Sulphuric acid	1.5 Mtpa
Phosphoric Acid Plant			
Phosphate rock Concentrate	2.0 Mtpa (28% P_2O_5)	Gypsum	3 Mtpa
Sulphuric acid	1.4 Mtpa	Phosphoric acid (P_2O_5) (100% equivalent)	500,000 tpa
Ammonia			
Natural gas	6.5 PJ pa	Ammonia	200,0000 tpa
Granulation Plant			
Phosphoric acid	500,000 tpa	MAP & DAP fertiliser product	1 Mtpa
Ammonia	180,000 tpa		
Natural gas	0.4 PJ pa		
Sulphuric acid	16,000 tpa		
Coating oil	3,000 tpa		

5.0.0 Beneficiation Plant

There is no significant change from the Approved Project. The Ammaroo geological resource contains phosphate of varying concentrations (average of approximately 14%) combined with chert and clay. The beneficiation process is designed to separate the (gangue) minerals of calcite ($CaCO_3$) and silica (SiO_2) from the phosphate mineral, thereby upgrade it to a higher concentration P_2O_5 (phosphorus pentoxide content) of greater than 28% that can be fed to the phosphoric acid plant (PAP).

The Proposed Project beneficiation plant is now divided into two processing components compared to the Approved Project:

1. Dry beneficiation plant: this involves the primary crushing, screening, and optical sorting at a dedicated facility near the ROM pad. The addition of optical sorting rejects dry waste rock from the mine feed prior to being fed to the wet beneficiation plant. This increases the feed quality to the wet plant thereby reducing wet plant capacity and hence reducing use of water, power etc and the volume of tailings.
2. Wet beneficiation plant: this involves the secondary crushing, milling, and flotation of the feed from the dry plant and then dewatering to produce the right quality feed for the PAP.

The overall function of beneficiation plant is not significantly different to the Approved Project but has improved efficiency and recovery through the system.

The beneficiation plant flowsheet is depicted in Figure 9.

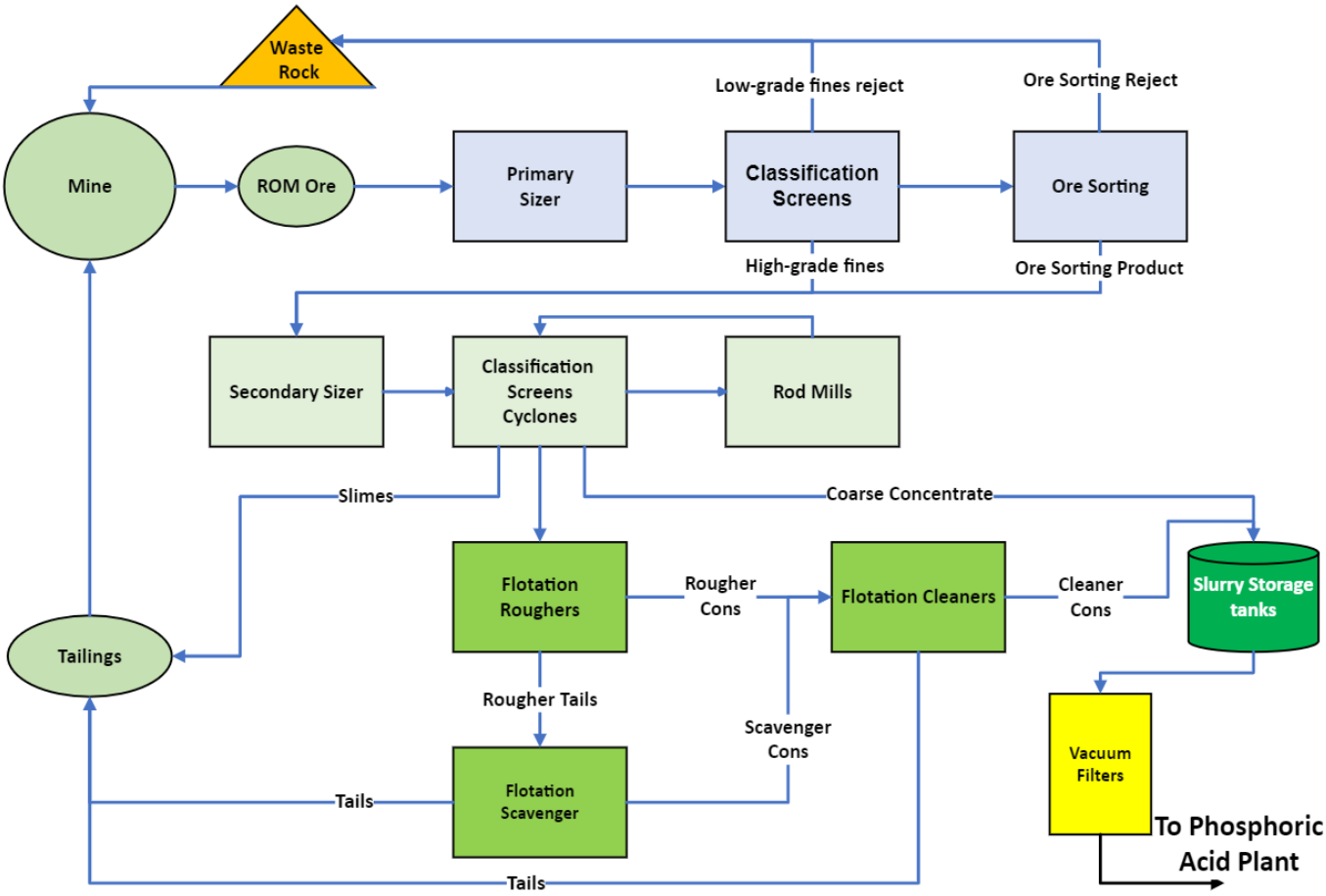


Figure 9 Beneficiation plant flow diagram

5.0.1 Sulphuric Acid Plant

The sulphuric acid plant (SAP) plant will be designed by an established global licensor and operated utilising established best available technology meeting all regulatory requirements. In addition, the SAP will provide a significant amount of the site wide energy requirements through the extensive integration of waste heat recovery systems to generate super-heated steam for feeding to the central power plant and steam for process heating. The general flowsheet for the SAP will follow the steps outlined in Figure 10 and is detail in the subsections below.

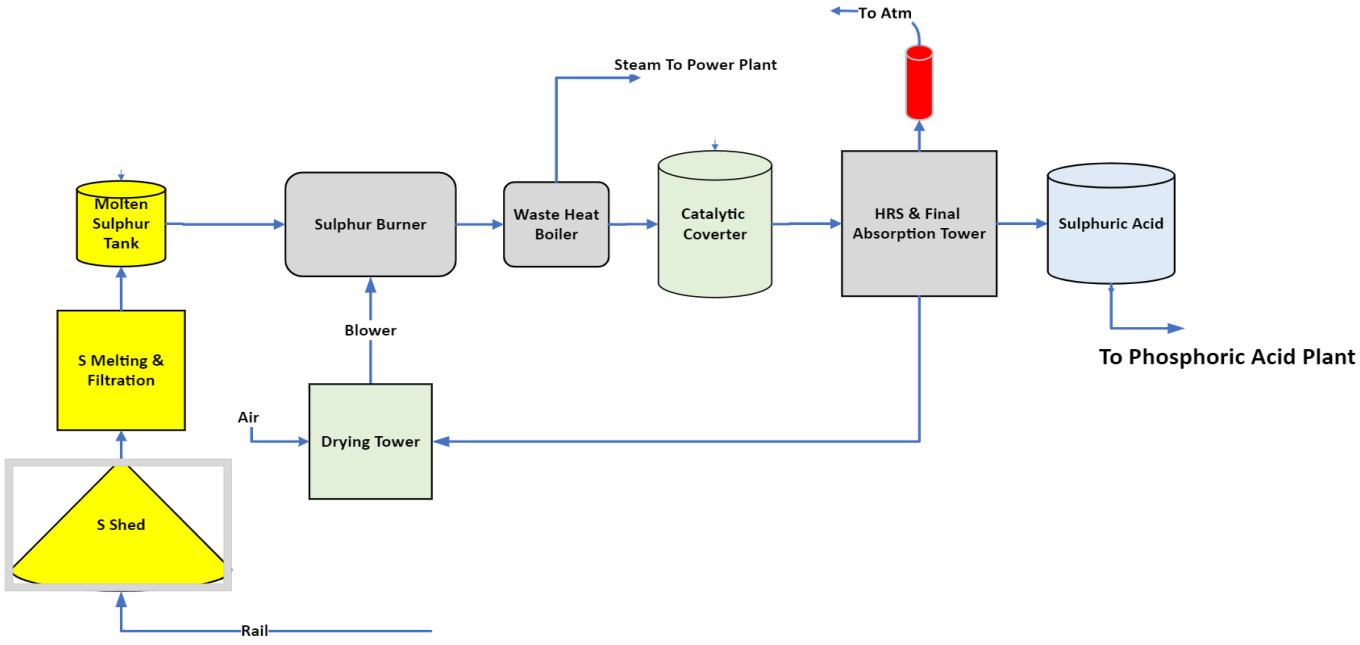


Figure 10 Sulphuric acid plant process diagram

5.0.1.0 Sulphur Receival, Filtering and Storage

The sulphuric acid plant (SAP) produces 98.5% sulphuric acid from solid elemental sulphur imported to the Ammaroo site by train from Darwin Port. The sulphur is unloaded from bottom dump wagons and directly conveyed to and stored in a 20,000 tonnes capacity shed. The sulphur is then conveyed into the sulphur melting system whilst being treated with lime to control the acidity (pH), where it is filtered to remove impurities and then fed to the molten sulphur tankage, with total capacity of 12,000 tonnes across two tanks.

5.0.1.1 Combustion, Conversion and Absorption

From storage, the liquid sulphur is pumped through a number of burners and is combusted in a combustion chamber with dry air to produce sulphur dioxide (SO_2). The air is dried by co-current flow with sulphuric acid in a drying tower. The dried air leaving the drying tower enters the sulphur furnace, where special sulphur burners are used to burn liquid sulphur. Natural gas is used to start up the sulphur furnace and heat up the convertor catalyst. When the desired temperatures are achieved, the natural gas heating is turned off and the liquid sulphur is sprayed at pressure into the furnace. Vanadium pentoxide is used as a catalyst for the reaction of sulphur dioxide with oxygen to produce sulphur trioxide. Sulphur dioxide is passed over four packed catalyst (converter) beds. An intermediate absorption tower is utilized to absorb sulphur trioxide (SO_3) from the process gas after the third converter bed. The final absorption tower is used to capture SO_3 following the final converter bed pass.

5.0.1.2 Sulphuric Acid Production and Heat recovery

A waste heat boiler and a network of heat exchangers (superheaters, economizers, and interchangers) is used to recover and exchange heat from the process gas from the combustion and the converter bed stages. This heat is used to produce superheated high-pressure steam which is sent to the power plant and used to generate electrical energy via steam turbine generators or converted to medium pressure (MP) steam for process heating. This heat recovery system and the production of steam reduces overall electricity consumption, reducing the greenhouse gas output for the Proposed Project, as described in Section 18.1

SO_3 gas from the converter is absorbed into sulphuric acid and water is added to achieve the desired final sulphuric acid strength (98.5%). This stage of the process with the reaction of the water releases further heat. This heat is recovered with a heat recovery system as MP steam and is used for process heating.

Further acid cooling is via an intermediate water circuit utilising fin fan cooler. Fin fan coolers have been selected on this duty as they eliminate water loss that would arise if a standard evaporative cooling tower were used for this final cooling stage. A small hybrid cooling tower is required for the final acid cooling as not possible with the fin fan circuit.

The sulphuric acid generated by the SAP is stored at approximately 35°C within the SAP plot in two tanks, with a total capacity of 45,000 tonnes, before being pumped to the end users.

5.0.2 Phosphoric Acid Plant

The Phosphoric acid plant (PAP) will be designed by a globally established licensor with experience in the design and operation of multiple plants to process phosphoric rock concentrate of a similar composition to the Ammaroo rock. Following extensive test work, the PAP will utilise a wet dihydrate process technology to ensure phosphoric acid of the required quality can be produced. As a unique feature of the Project, it will also incorporate the option to utilise a continuous ion exchange (CIX) process to further remove other potential contaminants from the phosphoric acid.

To manufacture phosphoric acid, phosphate rock is received from the beneficiation plant and reacted with sulphuric acid manufactured in the sulphuric acid plant (SAP). The Reaction slurry is then be filtered which separates 24% phosphoric acid (denoted weak phosphoric acid (WPA)) from the gypsum cake by-product. The WPA is then clarified and concentrated by evaporation of the phosphoric acid to produce 52% concentrated phosphoric acid (CPA). Figure 11 comprises a process flow diagram illustrating the process of phosphoric acid production. The processes within the PAP are also detailed in the subsections below.

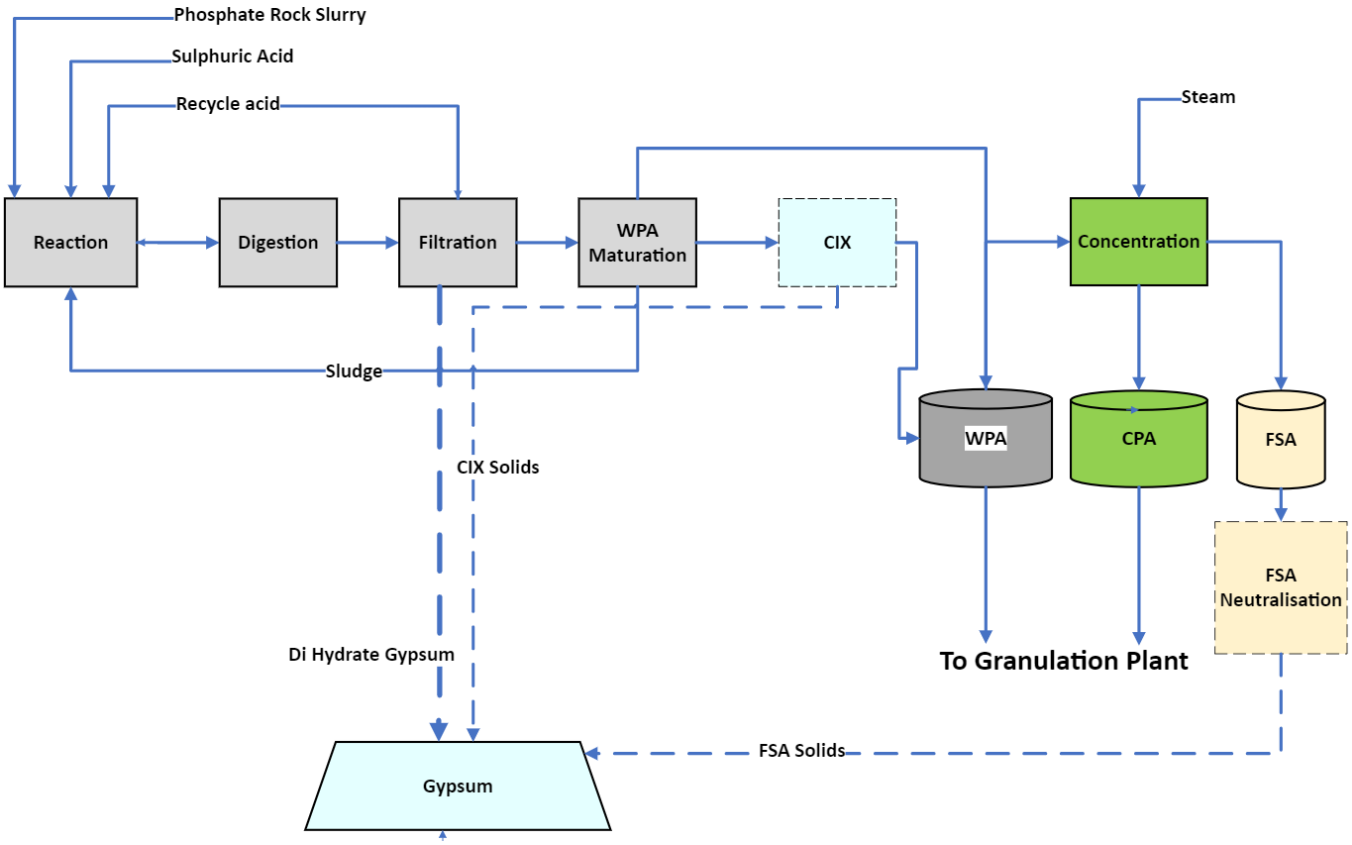


Figure 11 *Phosphoric Acid Plant Process Flow Diagram*

5.0.2.0 Reaction and Filtration

The process involves feeding phosphate rock slurry and sulphuric acid (98.5% H_2SO_4) into two identical rectangular multi compartment reactors trains, where they combine to form a slurry of phosphoric acid and calcium sulphate dihydrate gypsum ($CaSO_4$ plus $2H_2O$). The temperature is controlled by low level flash coolers (LLFC) which promotes the formation of dihydrate gypsum crystals and rock digestion by slurry recirculation and mixing. Reaction slurry from the reactor is transferred to the digestion compartments to allow increased crystal growth before being pumped to the two rotating vacuum tilting pan filters.

5.0.2.1 Gypsum By-Product Processing

During filtration, the reactor slurry is distributed onto two tilting pan filters. The gypsum cake is formed in the pans, allowing the liquid to filter through the cake, filter cloth, and connecting hoses to the appropriate collection compartments below the pans. After forming the initial cake in the filter pans, the gypsum solids are washed four times on the filter to reduce water soluble P_2O_5 in the solids to less than 1.0% P_2O_5. The dry gypsum cake is conveyed to a membrane lined gypsum stacking area (GSA).

5.0.2.2 Removal of Minor Element Cations

Filtered weak phosphoric acid (WPA) containing approximately 24% P_2O_5 is then pumped to the WPA settler for clarification, with the settled sludge being returned to the reactor and the overflow sent to either storage or further processing as outlined below. Some impurities found in the original phosphate ore remain. Therefore, a further WPA processing step is proposed, using continuous ion exchange technology (CIX). This CIX technology will remove the minor element cations. This step is important as minor element cations inhibit the manufacture of diammonium phosphate fertiliser (DAP) to specification grade of nitrogen and phosphate with a ratio of (18:46).

Reject elution products from the CIX process are evaporated and filtered to produce a mixed phosphate salt low grade fertiliser product either for sale or disposal. WPA treated by CIX is fed to the clean acid storage and onto the concentration section.

5.0.2.3 Concentration

Further concentration of the acid to create CPA is accomplished in the evaporator units, which removes water via boiling under vacuum. The evaporator system utilises five separate evaporators and have been designed to produce CPA of 52% P_2O_5 concentration.

The CPA is pumped to the storage tanks and then to the granulation plant for further processing into DAP and MAP fertilisers.

5.0.2.4 Emissions Control

During the reaction of sulphuric acid and phosphate ore fume released from the reactor and digestion compartments are vented to the fume scrubber.

The vapours leaving the evaporation stage contain fluosilicic acid (FSA) and are passed through an entrainment separator to two FSA scrubbers and FSA scrubber separator. The FSA recovered from the entrainment separator collected and sent to the FSA storage tank. From there it is pumped for neutralization with lime to produce CaF_2, or fluorspar, a stable form of fluorine. After clarification, the water is recovered, and the fluorspar is transferred to the gypsum conveyor for disposal at the gypsum stack.

The CPA is pumped to the storage tank and then as feed to the granulation plant for further processing into DAP and MAP fertilisers.

5.0.3 Ammonia Plant

Ammonia is produced by converting natural gas to hydrogen and CO_2 through high temperature catalytic steam methane reforming (SMR). The hydrogen is then reacted with nitrogen from the air through catalytic ammonia synthesis. The ammonia production is shown in the process flow diagram in Figure 12.

The ammonia plant (AP) involves several processes, including:

– Reforming the natural gas with steam
– CO conversion
– Methanation.
– Ammonia synthesis and.
– Ammonia conversion.

These processes in ammonia production are summarised in the subsections below.

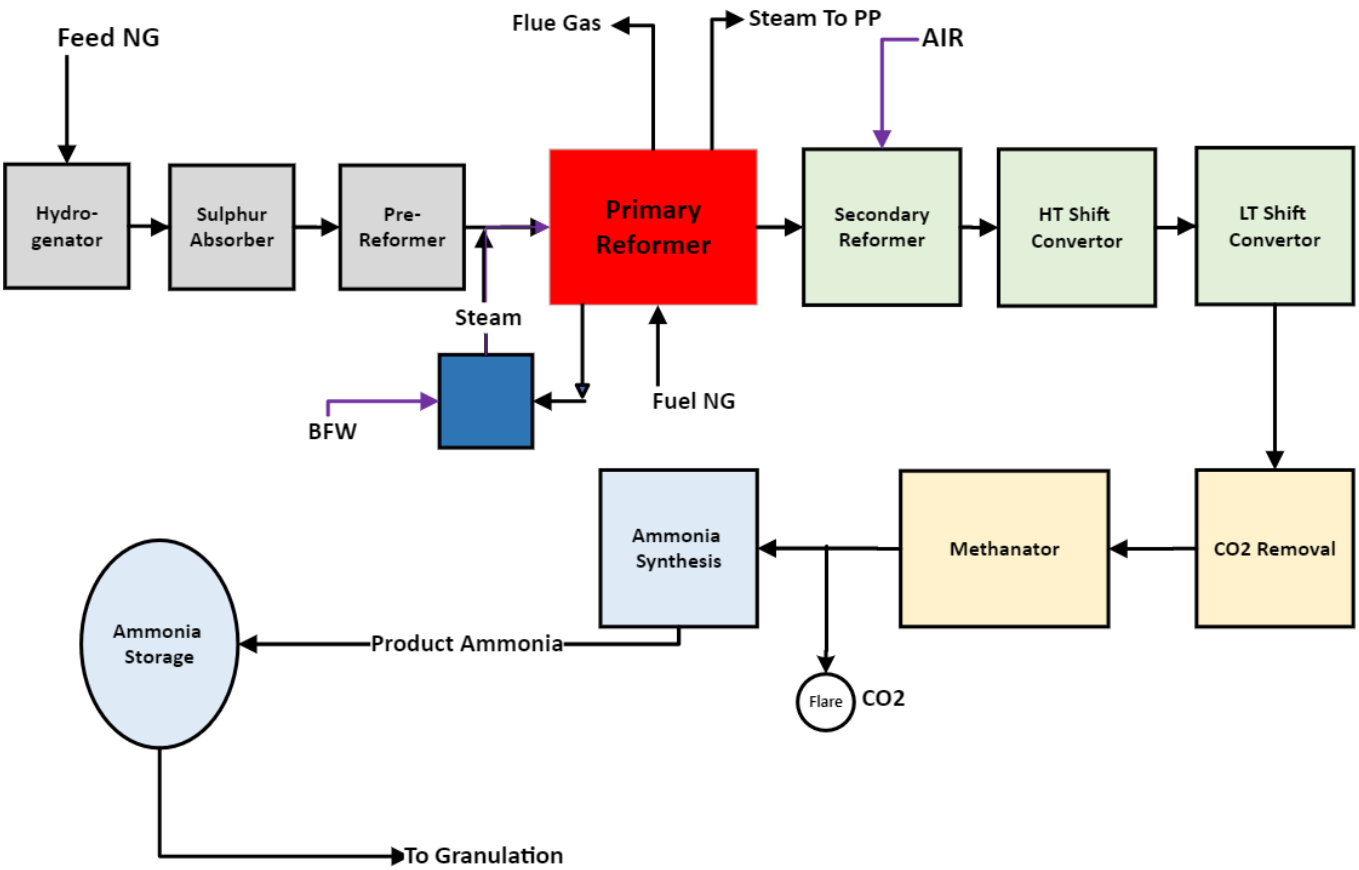


Figure 12 Ammonia Plant Process Diagram

5.0.3.0 Desulphurisation

Desulphurisation of the natural gas feed requires the removal of the sulphur compounds in the natural gas feed for the process. This process consists of a hydrogenation reactor and two sulphur absorber reactors positioned in series.

5.0.3.1 Steam Reforming

Steam reforming of the de-sulphurised natural gas is achieved in two steps by steam and air. The process gas from these steps contains hydrogen and nitrogen as well as carbon monoxide (CO), carbon dioxide (CO_2), methane and argon. Reactions take place in pre-reformer, primary reformer, and secondary reformer at a pressure range of 3.4 to 3.6 Pag.

5.0.3.2 Gas Purification

In the gas purification section, CO is first converted to CO_2 and H_2 with steam in order to increase the H_2 yield, then CO_2 is removed in the CO_2-removal section, and afterwards the remaining CO and CO_2 in the converted gas are removed in the methanation.

5.0.3.3 Ammonia Synthesis

The purified synthesis gas is compressed to a pressure of about 19.3 MPag and converted into ammonia by a catalytic reaction. In order to limit the accumulation of Ar and CH_4 in the loop, a purge stream is taken.

5.0.3.4 Waste Heat Recovery

Waste heat from some of the above reaction steps is utilised to produce high pressure steam. The main use of this HP steam is as feed to the steam reformer and for other process heating purposes inside battery limit. The excess steam is exported outside the battery limit and utilised in the power plant.

5.0.4 Granulation Plant

The role of the granulation plant (GP) is to produce diammonium phosphate (DAP) and monoammonium phosphate (MAP) fertilisers from the reaction of the phosphoric acid produced in the PAP, ammonia produced in the AP and small quantities of sulphuric acid produced in the SAP. The granulation process is illustrated in Figure 13.

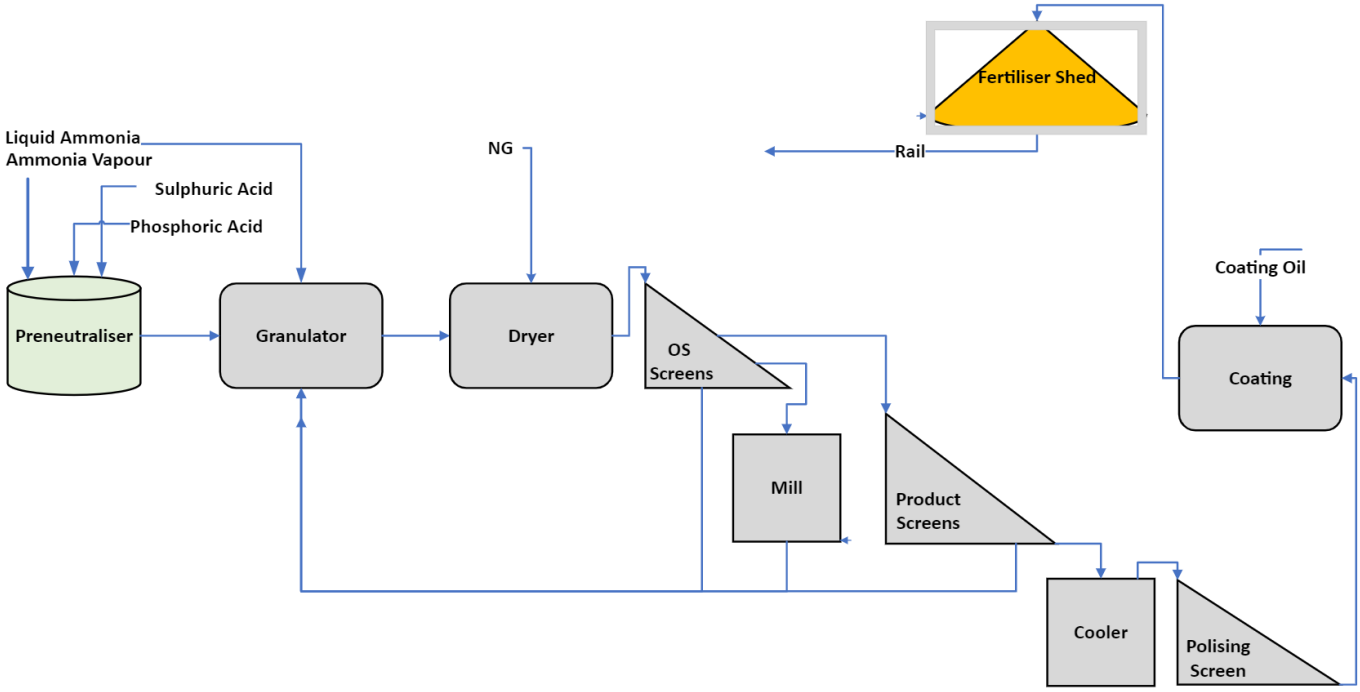


Figure 13 Granulation Plant Process Diagram

5.0.4.0 Reaction

The granulation process begins with a reaction in the pre-neutralizer, which is a dual diameter vessel with a large diameter for vapour release at the top, and a smaller diameter below to create a low residence time to minimize the harmful reactions that reduce available P_2O_5. Ammonium phosphate slurry is then pumped from the pre-neutralizer to the rotary drum granulator through the slurry spray header via two cross-connected, independent, parallel piping systems. The slurry pumps are variable speed pumps controlled by variable frequency drives, thus eliminating the need for control valves in this difficult application.

5.0.4.1 Granulation, Drying and Product Cooling

The granulation system transforms the pre-neutralizer slurry into a granular product of DAP and MAP fertilisers. Phosphate slurry is sprayed onto a bed of recycled dry material, which is rolled and distributed evenly on the surface of the granules. Ammonia is then introduced into the granulator via the ammonia sparger. to remove additional water and produce a uniform, hard, layered granule.

The granules are then dried at about 90°C. in a natural gas fired rotary drum dryer to reduce granule moisture without overheating the granules. The drying chamber is equipped with a quench air fan to provide temperature control to prevent melting, ammonia evolution, and fume formation as the hot gas encounters the solids from the granulator.

Air and gases containing dust and ammonia from the dryer flow to the dryer cyclone which removes a major portion of the dust that is returned as part of the recycle process via the fine's conveyor.

The dried product exits the dryer and passes through a series of sizing screens, which separates the material based on the desired particle size of the final product. Product that is oversized or undersized are either crushed or recycled back to the granulator. After screening, the product is then cooled by ambient air in either a fluidized bed or rotary drum and stored. Material leaving the cooler discharges into the polishing screens, where the oversize and undersize material is captured and recycles back to the granulator. Product is then fed to the coating drum, where it is sprayed with a coating oil. to suppress product dustiness and reduce product caking.

5.0.4.2 Emissions Control

A “dual-mole” scrubbing system will be used to remove particulates and gases that are generated from the reaction and granulation processes and is preferred over other systems as it uses less phosphoric acid. Gas streams are first scrubbed in the pre-scrubber where most of the ammonia and fluorine are removed. Then, exhaust emissions merge with the gases from pre-scrubber and flows to the dust and fume reactor/granulator/vent (RGV) scrubber where additional ammonia and dust are removed. The same solution also scrubs the fumes from the dryer in the dryer scrubber. Following pre-scrubbing, exhaust gases including those from the product cooler are finally passed through the tail gas scrubber, where a scrubber solution removes final traces of dust, ammonia, and fluorine emissions. The scrubber solution would be acidified with sulphuric acid to give a pH of 3.0 to 4.0, which is the optimum for ammonia and fluorine recovery. The scrubbers then feed into the reactor, resulting in no wastewater production.

The final DAP and or MAP product is conveyed into a storage shed to be reclaimed for rail load-out to port.

5.0.5 Additional Infrastructure

5.0.5.0 Gypsum Stacking Area

Dry gypsum filter cake is discharged from the PAP filters as a by-product of phosphoric acid production and transported by conveyor systems and stored within a membrane lined gypsum stacking area (GSA). An estimated 3 Mt of dry gypsum will be stored at the GSA per annum. The selection of dry stacking will minimise water evaporation compared with wet stacking and will minimise the potential for contamination outside of the GSA. The design and operation of the GSA will adopt "best practice" to minimise impact to environment.

The GSA will be progressively constructed over the life of the mine, ensuring sufficient capacity is always available to accommodate production. The initial GSA will be constructed for 2 years’ operation or 6 Mt of gypsum, over an area of approximately 325,000 m^2 (650 m x 500 m). The planned size of the GSA has a design capacity of 25 years storage of gypsum by-product, with the plant operating at full capacity. The GSA will be designed, constructed, and operated in accordance with ANCOLD Guidelines on tailings dams and include a lined HDPE membrane and other design features and operational management, monitoring and stacking procedures to prevent harm to the environment.

5.0.5.1 Materials Handling

5.0.5.1.0 Rail Operations

The Approved Project comprised the construction of a new dedicated rail spur connecting the Project site to the Tarcoola-Darwin railway with the transport of approximately 1 Mtpa of phosphoric rock concentrate to Darwin Port.

The Proposed Project will transport bulk ammonium phosphate fertiliser from the site primarily to Darwin Port via the new dedicated rail spur and the existing Tarcoola-Darwin railway and will rail bulk sulphur from Darwin Port to the Project area on return. An option will also be possible to rail fertiliser south to Southern Australia via a southern arm on the connection of the new spur to the Tarcoola to Darwin railway.

It is likely that a train consist will comprise approximately 128 wagons including 4 flatbed wagons and two or three locomotives. The same rail wagons will transport both the sulphur required on site and the fertiliser product for export. It is expected that a train will complete the cycle from Darwin Port to site, unload sulphur and general cargo, load fertiliser and return to Darwin Port and discharge every three days.

5.0.5.1.1 Sulphur

Sulphur will be imported in cape size bulk carriers into Darwin Port as solid prill granules. A new 60,000 tonnes capacity specialised storage shed will be required for receival, storage, and discharge in Darwin Port. From the storage shed the sulphur will be loaded on to rail wagons via a new outload facility for transport to site by rail, using top loaded, bottom dumping, covered rail wagons.

At site, the sulphur rail wagons will be bottom discharged into a covered receival facility and conveyed into a 20,000 tonnes specialised storage shed. The sulphur will be reclaimed from the shed and fed to the sulphur melting system, where it will be stored ready to be consumed in the SAP to produce sulphuric acid.

The sulphur storage sheds at site and Darwin Port will be fully enclosed with a concrete floor and concrete side barrier walls to prevent product from discharging outside of the storage area. In the event of a spill, any sulphur spill outside of the shed will be manually cleaned up.

5.0.5.1.2 Fertilisers (DAP and MAP)

The material handling facilities at the site will provide capacity for storing 60,000 tonnes of DAP and MAP fertilisers. This gross capacity will ensure sufficient capacity to ensure efficient rail operations without delay at site. Fertilisers will be reclaimed from the storage shed into a load bin and then top loaded into the rail wagons. Each wagon can transport 68 tonnes of fertiliser and each train consist will deliver 124 wagons totalling approximately 8430 tonnes per train. The annual fertiliser export from site will be up to 1 Mtpa.

The material handling facility at the Darwin Port will unload the fertiliser from the train wagons via a bottom dump facility and into a dedicated storage shed with a capacity of 80,000 tonnes. The fertiliser can then be reclaimed from the storage shed and loaded into ships. Ships will be scheduled to load fertiliser every 14 to 21 days to ensure ullage is maintained for further transfers from site. The system will operate 365 days per year other than during periods of site shut down for maintenance.

5.0.5.1.3 Chemical Storage

Provision is also made for the unloading of other raw materials that may be delivered to site by rail. These include large volume consumption chemicals such as Diesel, SOAK5, Sodium Silicate, and Lime. A central storage area has been allocated for these chemicals at site.

Other minor reagents arriving in various containers or packaging will be transported within the site to the end users.

Table 7 Consumables – annual requirements and storage quantities

Chemical	Use	Annual consumption
Diesel	Mining and Emergency power generation	4,000 tonnes
Coating oil	Granulation coating during MAP and DAP production.	3,000 tonnes
SOAK5	Beneficiation flotation	8,000 KL
Soda ash	Beneficiation plant	60 tonnes
Sodium silicate	Beneficiation plant flotation	1,200 tonnes
Defoamer	PAP and GP reactors	5,000 tonnes
Flocculant	Beneficiation and PAP thickener/clarifier	1,000 tonnes
Lime	Sulphur pH control SAP and FSA neutralisation PAP	70,000 tonnes
Filter aid	Molten sulphur filtration	30 tonnes
Water treatment chemicals	Boiler feed water and cooling towers	40 tonnes
Sodium Hydroxide	Demineralised water	128 tonnes
OASE	CO_2 removal in the ammonia plant	14 tonnes
Kaolin or Sand	Filler fertiliser production	93,000 tonnes

5.1 Energy Demand

The Ammaroo site will not be connected to an external source of electrical power and will therefore be considered an “island” facility in terms of meeting its own energy demands. Energy is required in the form of electrical energy to drive process and infrastructure equipment, steam to provide process heating, natural gas, and sulphur to provide chemical energy for the processes and chemical reactions. The site has been designed to integrate as many of the energy systems as possible, thereby maximising heat recovery and efficiency across the site. This approach has enabled a significant reduction in baseline GHG emissions compared with sites without such an approach.

The peak electrical power demand for the overall site prior to future investment in “green H_2” will be approximately 77 MW. Of this overall demand, up to 58 MW of power will be supplied from steam turbine generators (STG) supplied with high pressure steam generated from waste heat recovery in the sulphuric acid and ammonia plants. Depending on the specific operating modes of the various plants, additional power generation of up to 24 MW of electrical load will be supplied from gas engines generators or other renewable energy sources as described in Section 5.5.

Auxiliary steam boilers capable of using natural gas as fuel, will provide short term start up steam for the SAP, supplemental high-pressure steam, and essential process steam for other process plants for periods when the SAP is either curtained or not operational. These boilers will have capacity to run at up to 140 tph for intermittent periods as required. The Project will also have approximately 4 MW of diesel generators to provide critical back-up and black-start power for when the other sources of energy are not available.

As part of the greenhouse gas abatement planning, the Project is also considering the best mix of renewable energy sources and storage, with a base investment in solar PV and potentially wind turbines to partially offset some of the natural gas consumed in the gas engines during periods of renewable energy generation. This investment will also be supplemented by an industrial sized storage battery to provide system stability control and some additional stored renewable energy. There will also be discrete/standalone renewable energy facilities to provide power to the accommodation village and to supplement other remote energy consumers.

Direct investments in further renewable sources of energy and storage or other options for “over the fence” solutions through 3rd party investments are subject to the Greenhouse Gas Abatement Plan (GGAP) to be agreed with the NT EPA targeting a net zero pathway by 2050. Further information on potential options is provided in Section 18.1 and Appendix O.

5.2 Water Usage Requirements

Approximately 8.5 GLpa, or 970 m^3/h will be abstracted from the bore field that is located 7 km southwest of the Project site boundary and pumped via a 17 km dedicated HDPE pipeline to the site for treatment and use.

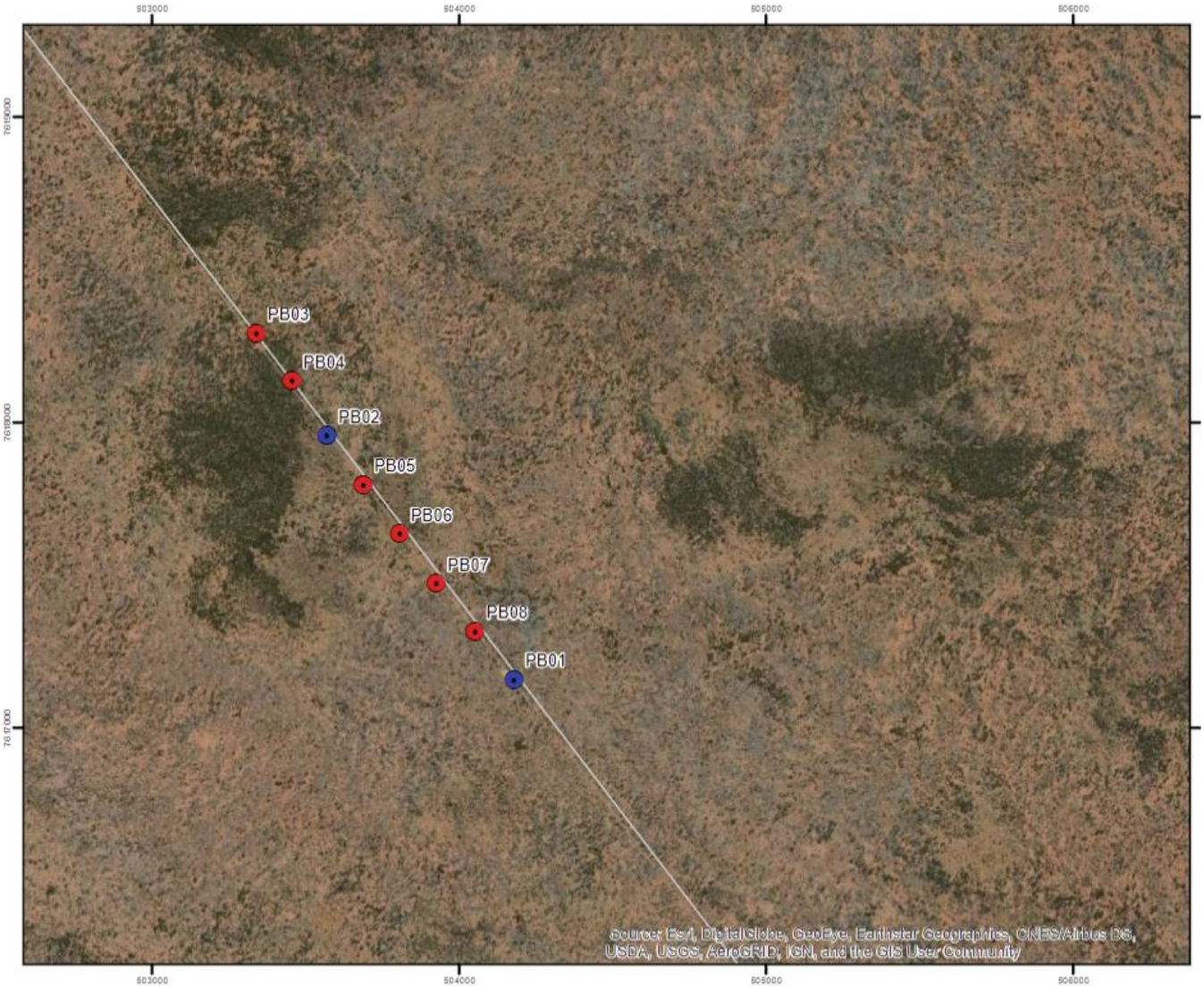


Figure 14 Existing and proposed bores (Source: Groundwater Science 2021)

The revised consumption for the Proposed Project represents an increase of 3.9 GJ on the previous water usage requirements in the Approved Project. This additional water is required to assist in the operation of the phosphoric acid, ammonia, granulated fertiliser, and steam plants, as shown in Table 8.

A larger water treatment plant (WTP) will be installed for the Proposed Project for the purposes of treating approximately 280 m^3/h (or approximately 30%) of the bore water make-up water. This treated water is required mainly for process use in the phosphoric acid, sulphuric acid, ammonia, granulation process plants and as feed for the demineralisation plant to make demineralisation water for the steam plants.

The plant has been designed to minimise overall water consumption and has adopted a number of features to ensure efficient first use and recycled use of water within the site. These features have included extensive use of; fin fan coolers in place of open cooling towers where the duty can be met; use of process heat integration to extract as much heat as possible to avoid the need for cooling towers; adoption of efficient hybrid cooling towers to minimise evaporative losses; recycle of reject process water streams for use within the plant and site where possible (i.e., for dust suppression).

The main consumption of water is to the intermediate product streams where concentration by evaporation is unavoidable, to the tailings although water recovery facilities are installed, and to the gypsum dry stack where

evaporation takes place. The remainder of the losses are due to dust suppression needs and general evaporative losses across the plant and site. A summary of the key consumers is provided in Table 8.

Table 8 Water requirements and reuse in mining and fertiliser operations

Plant Area	Raw Water Make-up m^3/h	Water consumption requirements	Included Water re-use	Water losses m^3/h	Water Losses Description
Mine site	0	Dust suppression		0	See WTP
Beneficiation plant	230	Dry and Wet beneficiation processing	Wastewater streams: Decant water from tailings storage pit Stormwater from first flush SW pond. Water from rock concentrate de-watering filters Wastewater from other processing plants	150 20	Tailings disposal after decant water is recovered. Process evaporation
Phosphoric acid plant	260	Phosphoric acid manufacture	The phosphoric acid plant is designed to be a 'zero' liquid effluent plant, therefore water from the plant processes is recycled into the various processing units.	85 170 235	Gypsum cake water of crystallisation Gypsum cake free moisture. Cooling towers evaporation losses
Ammonia plant	50	Ammonia manufacture		30 20	Cooling tower evaporation losses Steam reforming of NG to H_2 and CO_2
Sulphuric acid plant	0	Sulphuric acid manufacture		7.5	Cooling tower evaporation losses
Granulation plant	0	Ammonium phosphate manufacturing	The granulation plant is designed to be a 'zero' liquid effluent plant, therefore water from the plant processes is recycled into the various processing units.	5 80	Final product moisture Product drying
Water treatment plant	280	Site supply of RO demineralised and potable water	All RO reject water will be re-used on site	30	Dust suppression and washdown
Power plant	0	Site supply of power		7.5	Cooling tower evaporation losses
Ancillary services	25	Site supply		5	Miscellaneous e.g., potable water, safety shower water temp control
Contingency	125	Site wide design growth in consumption		**125**	
Total	**970**	**8.5 GLpa**		**970**	**8.5 GLpa**

5.3 Waste Generation

The waste generated from the operations of the Proposed Project have been detailed in Table 9.

Table 9 Waste generated from the Proposed Project

Area	Product	Type	Category	Disposal Method	Quantity
Beneficiation	Tailings	solid	non-hazardous	in pit storage	42 Mt over LOM
	Spent grinding media and wear parts	solid	inert	laydown yard/scrap sale	
Phosphoric acid plant	Gypsum	solid	slightly acidic	gypsum stacking area (GSA)	3 Mtpa
	Fluosilicic acid	solid	toxic 1B	GSA	90 tpa
		liquid	toxic 1B	re-cycle to process	
	Ion exchange	solid	acidic containing minor elements from phosphate ore (Fe Al Mg etc)	GSA	95 tpa
		liquid	acidic	re-cycle to process	n/a
Sulphuric acid plant	Spent filter cake (45-60% S content)	solid	non-toxic Class 4.1	GSA	±3500 tpa
	Contaminated sulphur spillages	solid	non-toxic Class 4.1	GSA	variable
	Spent catalyst V_2O_5	solid	acute toxicity (dust) containing heavy metal V_2 Category 4	specialist contractor	±150t per 2yr
	Boiler blowdown	liquid	containing high total dissolved solids (TDS)	dust suppression	n/a
Ammonia plant	Spent catalysts	solid	acute toxicity (dust) containing heavy metals (Ni Cr Co Mo Fe Zn etc)	specialist contractor screening and disposal	±90t per 4yr ±30t per 10yr
	Catalyst reduction wastewater	liquid	toxic containing catalyst dust +Cu	GSA or re-use in beneficiation plant	4600 + 7650 kg per 4yrs
	Spent condensate polisher resin	solid	non-hazardous	landfill	expected to be low
	Boiler blowdown	liquid	containing high total dissolved solids (TDS)	dust suppression	n/a
Granulation plant	Fertiliser spillages	solid	non-hazardous	re-cycled into the process	n/a
Water treatment plant	Spent filters and cartridges	solid	non-hazardous	landfill	variable
	Spent anion and cation resins	solid	non-hazardous	landfill	±200 tpa
	RO reject	liquid	category 2	re-use in process plants	1 GLpa
Site	Oily water + Waste oil	liquid	hydrocarbons	removal specialist contractor for re-cycling.	unknown expected to be low
	regulated waste	solid	various	landfill	±12 skips per yr.

5.4 Land Disturbance Requirements

The Approved Project had estimated the overall disturbance area for the mine, associated infrastructure, and access corridor (rail and pipeline) to be 3,775 ha over the LOM. The overall disturbance area of the Proposed Project has not changed. The main infrastructure for the Proposed Project including the additional fertiliser manufacturing plants and gypsum stacking area will be constructed within the previously allocated disturbance area. There have been numerous small changes between the Approved Project and the Proposed Project to the alignment and sizes of some of the infrastructure. This has included the removal of the surface tailings storage facility and the addition of the gypsum stacking area, an airfield, and a larger accommodation village (Figure 5).

All land disturbance is planned to be within the current nominated ML area. Of this, the disturbance area for the airfield and associated access road, expansion of the accommodation village, and installation of additional boreholes in the bore field, will all be accommodated within the overall disturbance area, although leading to a small increase in the disturbance footprint in these localities. As discussed in Section 12, these local increases are not considered a significant impact to biodiversity.

The Proposed Project has also made a nominal disturbance allocation of 350 ha for land to accommodate up to 100 MW of Solar PV / wind farms as an initial allocation to meet GHG abatement plans.

5.5 Closure and Rehabilitation

The Mine Closure Report (Appendix Q of the Approved EIS) will be updated to include the Proposed Development for submission with the Mine Management Plan (MMP), under the MM Act. This will include details of the closure and rehabilitation plans for the Proposed Project. Generally, the closure and rehabilitation will comprise the activities below in addition to the closure activities for the Approved Project:

– Capping of the GSA.
– Decommissioning and disassembly of plant and associated infrastructure.
– Re-profiling of the final surface.
– Subsoil and topsoil re-spreading and contour ripping.
– Revegetation and weed control.
– Ongoing monitoring.

5.6 Design Uncertainties

The Proposed Project is completing the Definitive Feasibility Study phase, where the level of technical definition has reached a stage where the understanding of the Ammaroo phosphate rock resource, and an overall process scheme for developing this resource to manufacture ammonium phosphate fertilisers, has been well established and significant technical risks are understood and mitigated. The overall level of engineering definition and execution planning has established a level of certainty and accuracy which will support evaluation for a business decision on the viability of the project. Further stages of engineering definition and execution planning will be required prior to a final investment decision (FID).

The Proposed Project has taken an approach to adopt established best available technology (BAT) with proven capability where applicable and as such has reduced the technical risk associate with developing new processes. The major process plants comprising, the sulphuric acid plant, phosphoric acid plant, ammonia plant and granulation Plant are all based on process designs from global licensors and engineered and built by global engineering service companies on plants of similar capacities and duties. The beneficiation plant process has been designed based on test work data specifically based on the Ammaroo phosphate rock resource. This design has then utilised established equipment components to achieve the desired process upgrades from ROM feed rock to meet the specifications to feed the phosphoric acid plant.

Other infrastructure required for the Proposed Project for integrating all the process plants, providing utilities, logistics and amenities to support the overall operation, have been specified and are also selected on best available technology, meeting the safety, environmental, operational, and financial objectives of the Proposed Project.

Notwithstanding this approach there remains a number of design aspects of the Proposed Project which will require further development in future phases to eliminate uncertainties prior to FID. The key areas where this will be required are:

- The ammonia plant process design is based on best available SMR technology, as available at this time. There is considerable focus within the broader industry on the technology to produce “greener” ammonia which may lead to alternative technology to reduce GHG impact. The current design adopts electrical drives throughout the plant to assist in future GHG reduction strategies. Any changes to the current ammonia plant technology will be assessed against overall impact on the environmental aspects of the Proposed Project.
- The overall plant adopts a high level of energy, heat, and water integration to reduce the overall GHG and water consumption of the operations. A more detailed review of these assumptions, and also further opportunities will be conducted in the frontend engineering design (FEED) stage. It is likely some variations will eventuate in specific streams as a result of these more detailed design processes however these are expected to be within an accuracy of +/- 10% overall.
- Each of the major process (chemical/acid) plants have adopted proven designs from global licensors and engineering service providers. Although it is the intent to continue with these parties, should this not be possible due to lack of availability and/or commercial drivers, the Proposed Project may engage alternative suppliers of similar technology. Should this be necessary, it is expected that the environmental commitments implicit in this EIS referral will still be complied with.
- The Proposed Project is committed to negotiating a GHG Abatement plan. As a result of this process, it is possible there will be changes to the Proposed Project technical scope in order to: integrate renewable technologies into the design; to accommodate advancements in available technology; and for “alternative over the fence” options that may arise with time.
- In development of the detailed routing for the access corridor during FEED, there may be opportunities to optimise the alignment of the corridor (within 100 m of the current corridor) in specific areas to reduce earthworks and potentially reduce the impact to surface flow. Final location will be identified in the MLP and will meet all commitments within the EIS Referral.
- A continuous ion exchange (CIX) plant has been incorporated in the Proposed Project to provide further confidence in meeting quality specifications for the fertiliser products. A final decision on the inclusion and capacity of this plant is still under evaluation. The environmental impact of the CIX has been included in the EIS Referral documentation.
- The rail and Port logistics for the Proposed Project are subject to final commercial agreements. As such, there is always uncertainty associated with the commercial and technical conclusion to these negotiations. There is potential for some of the current details of the logistics to be modified but it is unlikely these will impact the commitments within the EIS Referral.
- Detailed geotechnical surveying of the site will be required to confirm the most appropriate foundation design for the major items of equipment to be constructed on the site. This may change the type of foundation designs adopted for the plants using either piled or spread footings, and also the sourcing strategy for structured fill.
- Scope associated with the construction phase of the Proposed Project such as construction accommodation village capacity, numbers of workforce, transport, overall duration, and sequence may change with further detailed design and execution planning. These will be managed within the commitments within the EIS Referral.

6. Alternative Options

Verdant consider the development of the Proposed Project will provide advantages compared with the Approved Project. The key drivers and benefits of the Proposed Project are provided in sections below together with options which have been considered within the scope development to optimise the design to minimise the overall environmental impact.

The opportunity to develop the Ammaroo Phosphate Project is driven by the presence of one of the World's largest phosphate rock resources. Value will be extracted from this resource through the economic development and production of the resource for consumption in either global or Australian markets. The remote location of the Ammaroo site from a capital city and coastal infrastructure provides a particular challenge to the economic viability of a development.

Over more than a decade, Verdant (previously Rum Jungle) have endeavoured to create a viable economic option for the development of the resource. The most recent was in 2018 with the Approved Project based on the export of phosphate rock concentrate. Whilst this option remains viable, phosphate rock is a low value product and export market entry opportunities are constrained. Since the Approved Project, a concept was considered including further processing at site to produce merchant grade phosphoric acid (MGA). This MGA would be exported to overseas produces to turn into finished fertilisers. Again, this concept although adding some downstream processing also failed to extract full value for the product in a constrained market.

The concept was further refined into the Proposed Project, as defined in the EIS Referral. This represents the most viable option for the development of the Ammaroo resource at this time. The benefits and best available technologies selected for the Proposed Project are discussed in sections 6.0 to 6.3.

6.0 Ammonium Phosphate Fertiliser Project

The Approved Project represented the most basic development option for the Ammaroo phosphate project, comprising; mining; beneficiation; drying and export of phosphate rock concentrate (32 %P_2O_5) via a new rail spur to the Darwin Port, for export to overseas downstream processing companies to make final ammonium phosphate fertiliser products.

The Proposed Project retains the key mine, beneficiation, and infrastructure components and adds the downstream processing capability to make final quality ammonium phosphate fertiliser products for markets in Australia and / or for export. The development of the Proposed Project has been careful to ensure the scope of the project facilities meet the following broad objectives:

– Fit for purpose in terms of scale – 1 Mtpa of final fertilisers to meet likely market opportunities.
– Proven technology and equipment selection minimising technical risk and maximising reliability.
– Minimising health, safety, and environmental impact through application of Best Available Technology (BAT).
– Ensuring long term operating cost competitiveness and viability through advanced technology applications.
– Leveraging the downstream processing "value add".

The key drivers and benefits of the Proposed Project through the production of ammonium phosphate fertilisers on site are:

– Currently, Australia relies heavily on importation of fertilisers. Production of a ready to use fertiliser in Australia could substitute the importation of products from overseas producers and support self-sufficiency and resilience of Australia's vital agriculture industry.
– Add value to the Australian economy by developing downstream processing.
– Allow for additional Northern Territory and local employment and develop the Northern Territory's chemical processing and manufacturing skills and capacity.
– As indicated in Section 15.1, the Proposed Project will also:
    - Add additional investment in Central Australia and the Northern Territory.

- Increase gross domestic product.
- Increase Federal and Northern Territory tax revenues.
- Increase chemical processing and manufacturing skill capacity development.

The following sections outline some of the options considered in developing the full scope of the Proposed Project to meet the broad objectives above.

6.1 Water Usage Design Considerations

Minimising water consumption is recognised as a key component of the Proposed Project given the requirements to conserve water across the Northern Territory. BAT has been selected for process plant designs where there has been potential to reduce the water demand of the process compared to conventional designs where water resources are more abundant.

Through applying BAT and process optimisation focussed on water efficiency as outlined in Table 10, it is estimated that water savings of approximately 5 GLpa have been achieved thereby significantly reducing the overall groundwater extraction requirements of the Proposed Project to 8.5 GLpa.

Table 10 Water usage design considerations

Infrastructure	Water usage efficiency	Approximate water saved
Sulphuric acid plant	Two design considerations were made within the SAP which increase the water efficiency of the plant, including: – Fin fan coolers and a small hybrid cooling tower – these technologies eliminate the evaporative water losses that arise in traditional cooling towers through heat rejection. – Heat recovery system (HRS) – when SO_3 gas, from the converter, is absorbed into sulphuric acid, the reaction is exothermic releasing significant heat. This heat has been captured through the investment in heat exchangers to produce medium pressure (MP) steam which is subsequently used for process heating. By capturing this MP steam the plant avoids water losses through evaporation and blowdown from the cooling towers.	0.5 GLpa
Ammonia plant	The ammonia plant has been designed with fin fan coolers on the compressor interchange coolers and the ammonia chillers in preference to cooling towers.	0.25 GLpa.
Beneficiation plant	The design of the beneficiation plant has incorporated the ability to re-use the maximum available waste streams from the site. Additionally, recovery of tailings water and first flush rainwater will be used in the beneficiation plant and for other site needs such as dust suppression. The use of ore sorting leads to water savings, as it reduces the overall throughput by approximately 25%, and therefore the amount of water required in the wet bene process. The volume of wet tailings produced is reduced, and evaporation losses from tailings are therefore lower. Evaporation losses in the plant will also be lower as the equipment is smaller, so float cell and thickener surface areas for evaporation losses are reduced.	0.5 GLpa
Phosphoric acid plant and dry gypsum stacking **Dry gypsum stacking**	The design incorporates a “Zero” liquid approach which will allow for re-cycling of all of wastes streams back into the process. Additionally, reverse osmosis (RO) reject water will be used in the PAP cooling tower, saving approximately 0.5 GLpa of raw water make-up. Dry gypsum stacking avoids having to add water to allow slurry pumping. prior to dry gypsum stacking. This will result in savings of 2.0 GLpa through lower significantly less evaporative losses compared to wet stacking. A Fluosilicic acid (FSA) system has also been added to the acid concentration circuit and will reduce contamination of the cooling water circuit and thereby avoid blowdown losses of up to 2 GLpa.	2.5 GLpa
Granulation plant	The design incorporates a “Zero” liquid approach which will allow for re-use all of wastes streams back into the process. Additionally, raw water consumption to the scrubber has been substituted with wastewater from the SAP and water treatment plant.	0.3 GLpa
Power plant	The design has substituted traditional cooling towers with air cooled condensers and a small hybrid cooling tower to minimise evaporative losses to avoid evaporation losses.	1.2 GLpa

Infrastructure	Water usage efficiency	Approximate water saved
General	The site will require dust suppression within the process plant and mining areas. Wherever possible and safe and environmentally compliant, waste stream water will be used, avoiding further raw water consumption.	

6.2 Energy Consumption Considerations

The Proposed Project has adopted a number of BAT to increase the energy efficiency of the process plant and to reduce overall emissions. The application of BAT and their alternatives are summarised in the following subsections.

6.2.0 Sulphuric Acid Plant

The Proposed Project has incorporated an extensive integration of waste heat boiler and heat exchanger networks (i.e., superheaters, economizers, and interchangers) to be incorporated into the design of the SAP. These technologies are used to recover and exchange heat from the process gas (sulphur derived) combustion and the converter bed stages. The heat is then used to produce superheated high-pressure steam which is sent to the power plant and used to generate electrical energy via steam turbine generators. The superheated steam can also be converted to MP steam for process heating. This integrated steam recovery network reduces overall energy consumption of the SAP and provides the steam to generate approximately 57 MW of power for use across the site thereby reducing the greenhouse gas output for the Proposed Project.

As detailed in Table 10, the SAP design also incorporates a heat recovery system (HRS). The heat realised through the exothermic reaction during SO_3 gas absorption into sulphuric acid is captured as MP steam and is used for process heating. The inclusion of the HRS into the design will reduce power consumption by approximately 23 MW by capturing up to 109 tph of MP steam, which is used for process heating.

6.2.1 Ammonia Plant

The design of the ammonia plant will incorporate electrically driven compressors rather than the normal steam driven compressors. The ammonia plant is a net steam producer, that would normally use this steam to power these compressors. The selected design will now export this excess HP steam to the power plant to generate electrical power centrally. The benefit of this conversion will allow for greater flexibility across the site to substitute clean energy sources into the power distribution system and allow flexibility in the operation of the ammonia plant SMR hydrogen section to potentially introduce green hydrogen into the process in the future when this technology becomes economically viable.

6.2.2 Power Generation

The inclusion of the air-cooled condenser in the power plant (see Table 10) will also reduce cooling tower pumping requirements and is estimated to reduce power consumption within the power plant by approximately 1.2 MW.

6.2.3 Future Opportunities

The current design of the Proposed Project offers some further opportunities for future incorporation of technologies to reduce energy consumption. These opportunities would currently add significant capital to the project rendering it uneconomic and will ultimately have to be considered in light of their maturity and reliability and the overall safe and reliable operation of the plant. Some of these opportunities include:

– Incorporation of heat exchange in the PAP condensate return system with the weak phosphoric acid (WPA) feed prior to the evaporators. This could benefit through lower steam usage in PAP and more steam available for power generation.
– Site wide energy integration optimisation study.
– Opportunities to incorporate solar photovoltaic and wind as power sources to the plant, to reduce reliance on gas for power generation and reduce carbon emissions.

– Convert the granulation plant air dryer from NG to renewable electric power.
– Incorporation of thermal solar steam into the power mix to reduce natural gas consumption.

6.3 Dry Stacking

The incorporation of dry stacking into the Proposed Project design has been selected instead of wet stacking. Dry stacking also negates the need for an evaporation pond, which is required for wet stacking and produces fluoride emissions from the pond. Phosphogypsum (gypsum) is the by-product of phosphoric acid production for fertiliser manufacturing and is produced in significant quantities. Traditionally, there have been three methods of dealing with this substance.

– Wet stacking.
– Dry stacking.
– Disposal directly in the sea.

The only currently operating phosphoric acid plant (PAP) at a fertilizer production facility in Australia is in western Queensland, where the gypsum is stored using the wet stack method. In this case, the wet gypsum filter cake from the PAP is transported by conveyor to a mixing tank and then pumped as a slurry to the stack with discharge into a rim ditch surrounding the sedimentation pond on the top. Excavators remove gypsum solids from the rim ditch to continuously raise the perimeter dyke whilst the remaining solids form beaches in the central pond. The fluid from the slurry drains through the stack and is recovered and recycled through the PAP *via* an evaporation pond.

The Proposed Project will use dry stacking to store the gypsum. In this case, the gypsum filter cake will be sent via conveyor to the stacking area where smaller mobile conveyors and bulldozers will be deployed to place and shape the cake and create the gypsum stack.

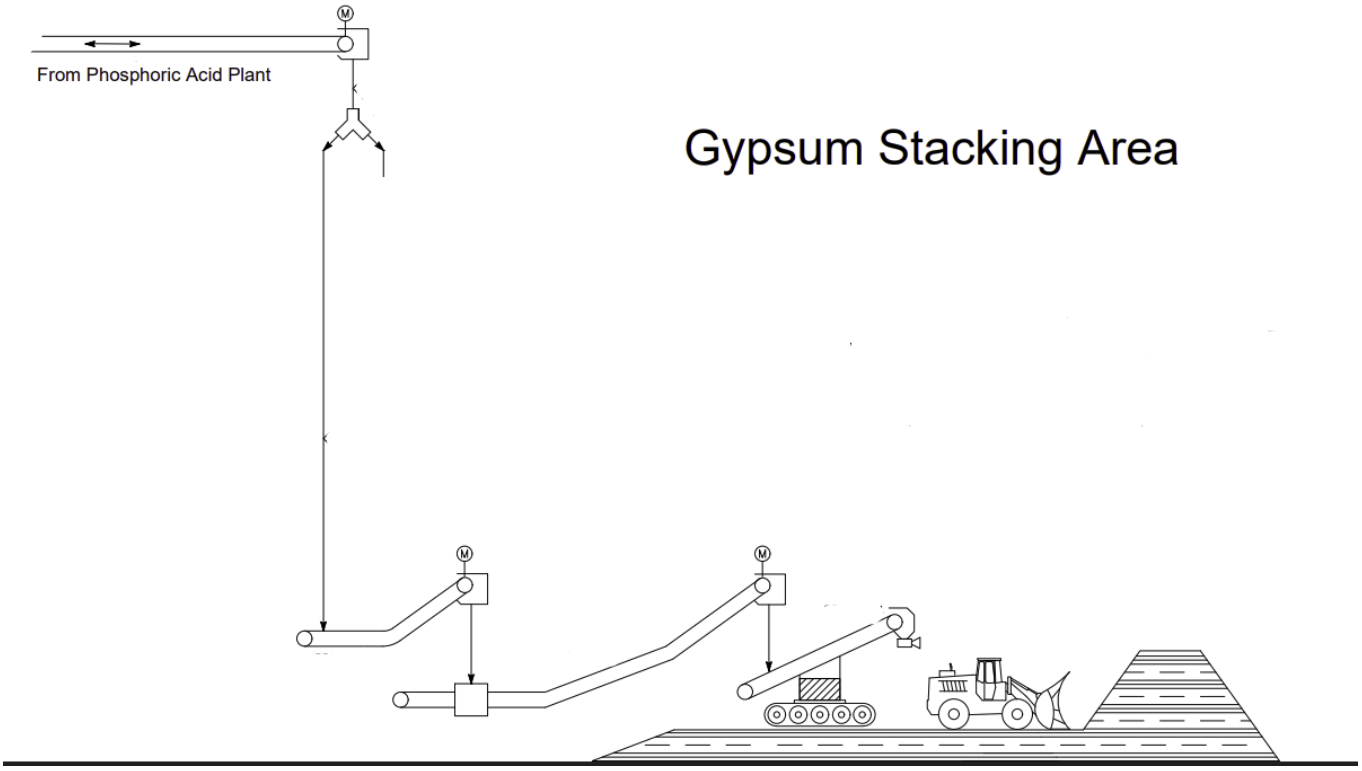


Figure 15 Gypsum stacking process

6.3.0 Advantages of Dry Stacking

Dry stacking has been chosen as it is more suitable for the arid Ammaroo site and offers significant benefits over wet stacking, as outlined below.

– Water use: the dry stacking method will allow the site to substantially lower its water use. Approximately 2 GLpa will be saved as a result of avoiding pumping a slurry for wet stacking.
– Drainage/leachate: dry stacking will avoid significant drainage of free water through the stack into traditionally, a large collection ditch around its toe. Minimal seepage is expected from a dry stack due to the inherently lower free moisture in the gypsum cake, thereby reducing the likelihood of contaminant mobilisation through leaching and runoff.
– Any minor seepage of pore fluid which may occur in time due to settling and compaction over the life of the dry stack, will drain into a collection ditch surrounding the stack. This small volume can either be left to evaporated or recovered and used for dust control by spraying on the stack.
– Part of the longer-term strategy for the site will be looking for opportunities to automate parts of the operations. Dry stacking will lend itself to these options more easily than wet stacking.

6.3.1 Environmental Management Measures

Gypsum is often perceived as an environmental hazard. The impacts are identified in the areas of soil, groundwater and surface waters, ecology, air quality, noise, and radioactivity. The Ammaroo project has adopted the following mitigation measures to manage these potential impacts:

6.3.1.0 Groundwater

The potential for any contamination of the groundwater from the gypsum stack is extremely low.

– Primarily, the proposed site of the gypsum will be on the igneous and sedimentary rocks of the Davenport Province, comprising the felsic volcanics, limestones, siltstones, shales and sandstones of the Tennant Creek Block and the limestones and sandstones of the Georgina Basin. The Davenport Province rocks hold only localised, poor-quality aquifers due to their low porosity and permeability.
– The Ammaroo gypsum stack is located on a site where there is no evidence of an aquifer. The boundary of the Regional-scale Georgina Basin aquifer, which underlies the mining area, is over 1.5 km south of the plant/stack area.
– In the mining area the standing water level of the Georgina Basin aquifer is approximately 60 m below surface, with the overburden being limestone, which would naturally neutralize any acidic seepage.
– The base of the stack will be lined with an impermeable membrane, resulting in almost no risk of leachate reaching any groundwater.
– A long-term groundwater monitoring program will be implemented across the site as part of the environmental management plan.

6.3.1.1 Surface Water

Potential risks to surface water are low due to:

– The area of the proposed site hosts only small, ephemeral drainage lines. There are no medium or large-scale creeks, lakes, springs, or soaks.
– The stack will be constructed with a drainage ditch of sufficient capacity to maintain freeboard in a 1:100-year design flood event so there will be no opportunity for leachate or stack runoff to impact the local environment.
– When the stack is complete, it will be capped with soil or mining waste ore, which will reduce the long-term influx of rain and further minimize the chance of leachate seeping out. At mine closure, there will be appropriate treatment put in place to deal with any relict leachate in the drainage ditch *in situ* – it will not be released into the environment.

6.3.1.2 Air Quality/Soil Impacts

Gypsum dust has been identified as a potential hazard as it can contain contaminants derived from the parent phosphate ore. Its greatest impact can be on soil but that is usually limited to within 30 to 50 m of the stack and tests completed in the USA have shown that contaminants derived from the stack dust are present only at very low levels and below their legislative limits. At Ammaroo the 'dry' material will have a fluid content of up to 25% and is not inherently dusty during initial transport and stack construction.

In the generally arid atmosphere, drying of the stack will occur and with the potential for high winds to cause some localized dusting. However, all parts of the gypsum transport and stacking mechanism will have controls implemented to reduce as far as practicable the emission of dust.

Dust monitoring stations will be placed around site for long term monitoring of the mine and production facilities and appropriate PPE will be available for workers as part of the Occupational Health and Safety (OH&S) plan, should there be short term occurrences.

Ecology

Any small potential for ecological damage to native flora and fauna from dust will be managed under the site biodiversity management plan.

Structural Integrity

Erosion and sedimentation on and around the stack itself will be controlled by meeting appropriate engineering standards and regular inspection to ensure slope stability for the stack to eliminate the chance of large-scale failures impacting the surrounding environment.

Radioactivity

There has been some concern around the world with the potential radioactivity associated with gypsum stacks formed from resources with higher radionuclides in the source rock. The amount of radiation likely to be associated with a stack is a direct result of the type of source rock used to feed the phosphoric acid process. The most common elements of concern are uranium and thorium, which can decompose to produce Radon222 gas and Radium226.

The source rock at Ammaroo has some of the lowest levels of uranium measured globally and thorium is within the usual range for phosphate rocks. Both elements also fall well below the safe exposure limit of 1 Bq/g (1,000/kg) for Naturally Occurring Radioactive Materials (NORM) set by the International Atomic Energy Agency (IAEA) (Figure 17 and Figure 18). As such, the potential for radiation impacts on workers and the environment is negligible and will be monitored and managed as appropriate, meeting all Legislative requirements. There is no threat to the public due to the site's remoteness.

A study of "Radiological Considerations for the Verdant Minerals Ammaroo Phosphate Deposit" (Appendix K in 2018 EIS) as part of the Approved Project in 2018 by JRHC Enterprises Pty Ltd, concluded: In accordance with the criteria for a radioactive material outlined by the IAEA (IAEA 2004), the Ammaroo ore is not considered to be radioactive and therefore not subject to regulatory control for the following reasons:

– Combined uranium and thorium concentrations are less than 1Bq/g, averaging approximately 0.3Bq/g
– Occupational doses (above natural background) are calculated to be less than 1mSv per year.

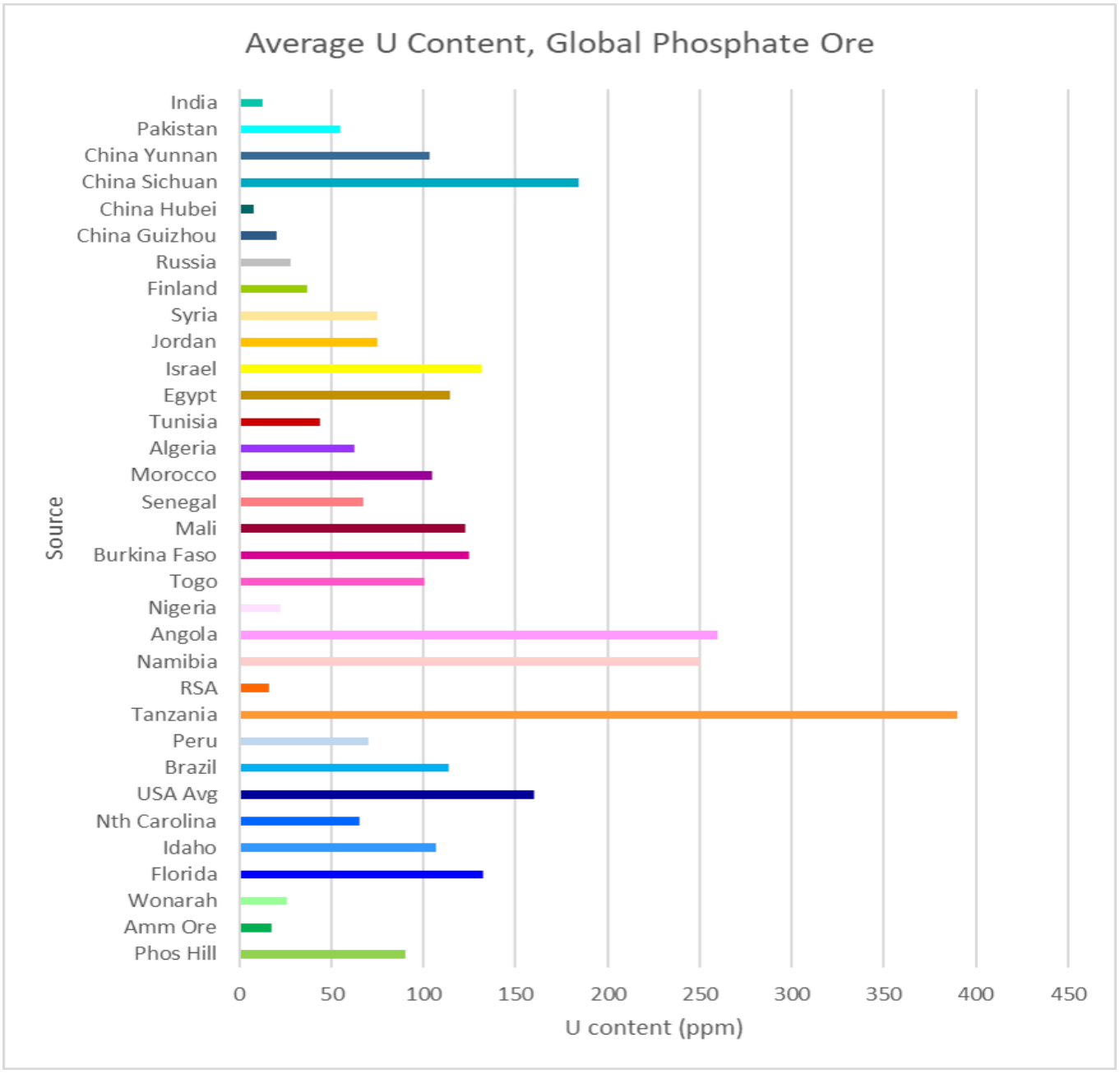


Figure 16 Phosphate ore average uranium content, global phosphate ore

(Sources: Abbott 2021, Adesanwo et al. 2010, Dethier et al. 2022, Dippel 2004, EGI 2009, Gaafar et al 2016, Haneklaus et al. 2017, Havelange 2021, Khan et al. 2022, Lopez et al. 2019, Russell & Trueman 1971, Sabiha-Javied & Ashgar 2010, Sattouf 2007, Saueia et al. 2005, Shang et al., Steiner et al. 2020, Sun et al. 2020, Tufail et al. 2006, Tulsidas et al. 2019, USEPA 2022)

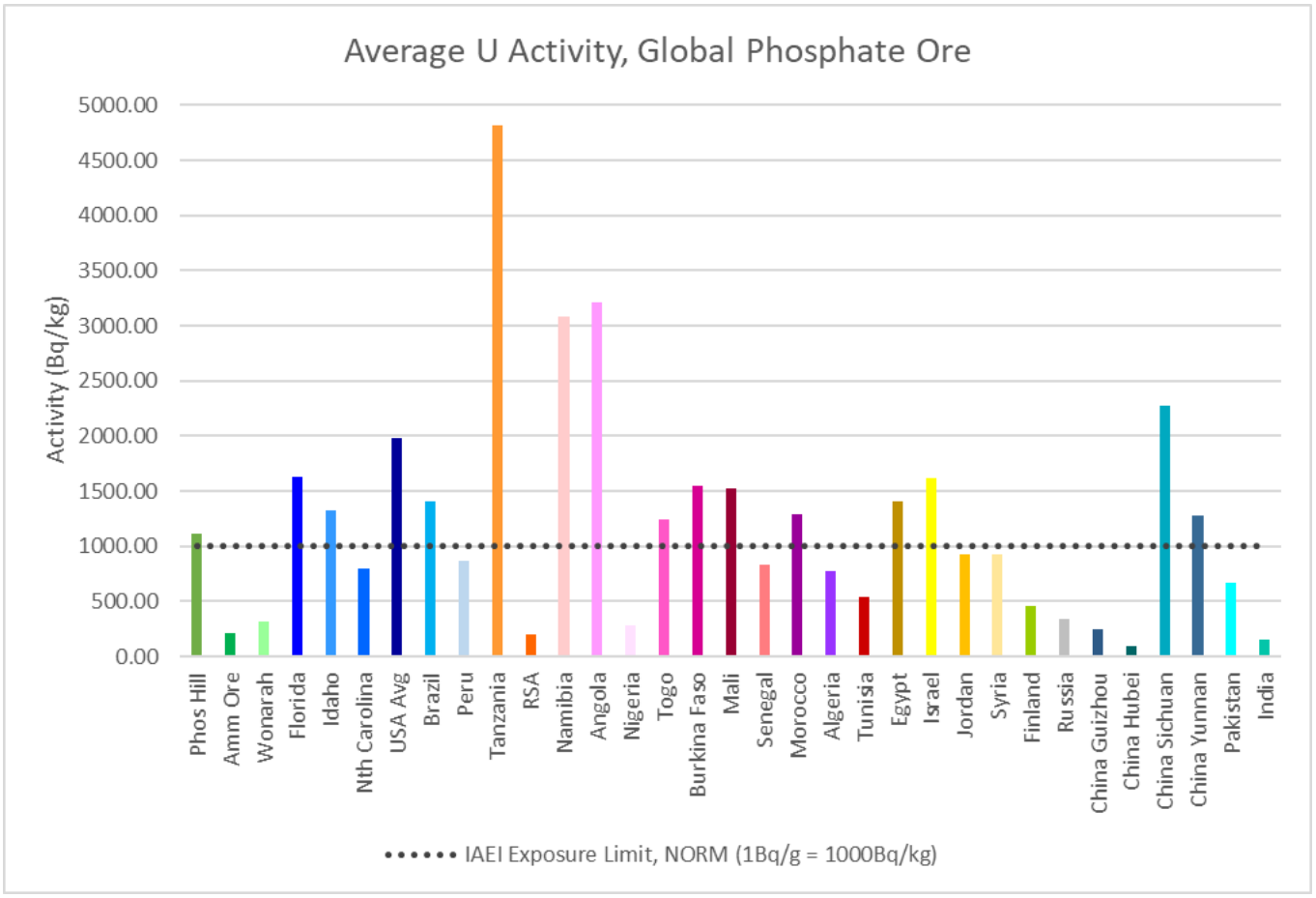


Figure 17 ***Average uranium activity in Bq/kg, Ammaroo and global phosphorites***

(Sources: Abbott 2021, Adesanwo et al. 2010, Dethier et al. 2022, Dippel 2004, EGI 2009, Gaafar et al 2016, Haneklaus et al. 2017, Havelange 2021, Khan et al. 2022, Lopez et al. 2019, Russell & Trueman 1971, Sabiha-Javied & Ashgar 2010, Sattouf 2007, Saueia et al. 2005, Shang et al., Steiner et al. 2020, Sun et al. 2020, Tufail et al. 2006, Tulsidas et al. 2019, USEPA 2022)

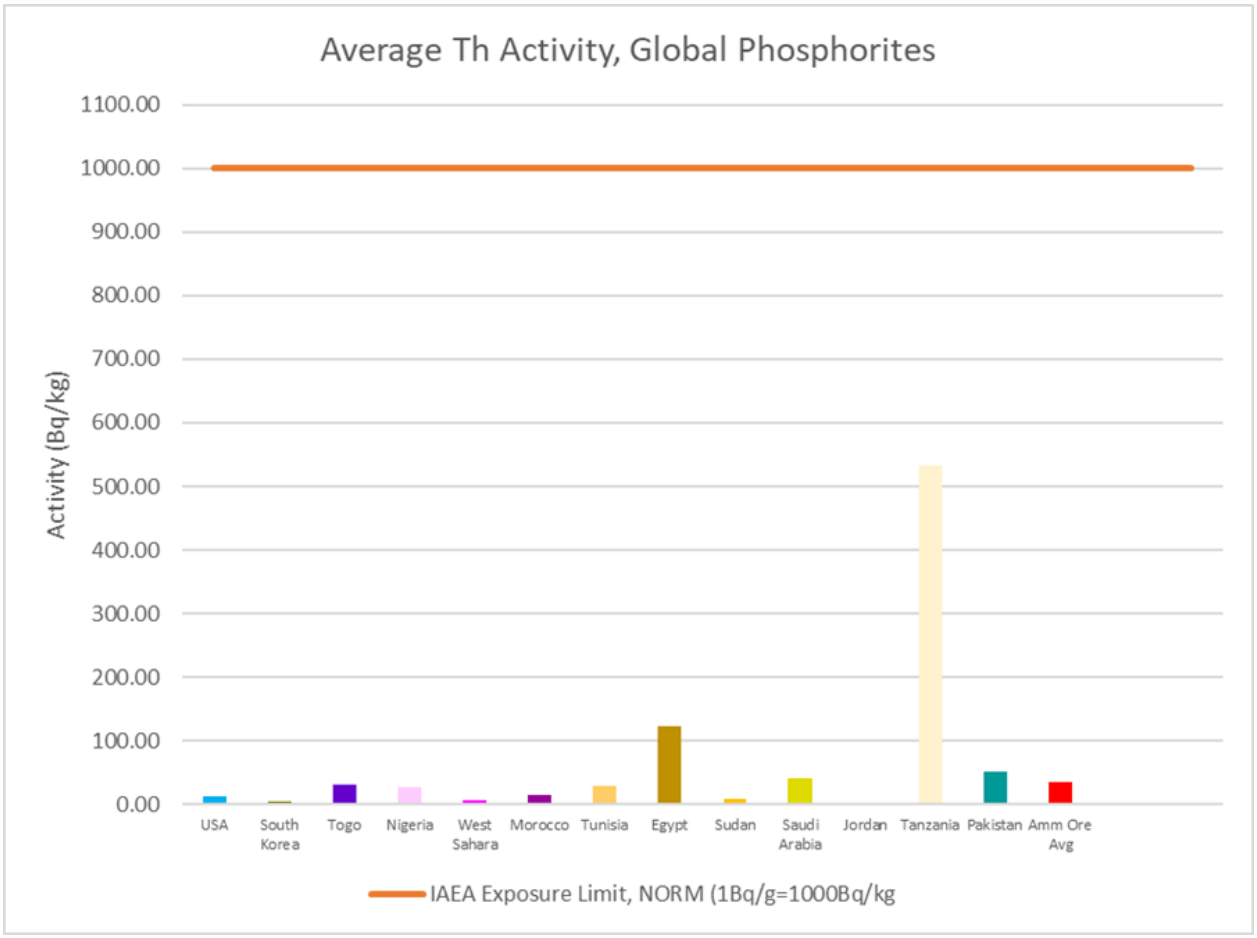


Figure 18 Average thorium activity in Bq/kg, Ammaroo and global phosphorites

(Sources: Abbott 2021, Adesanwo et al. 2010, Dethier et al. 2022, Dippel 2004, EGI 2009, Gaafar et al 2016, Haneklaus et al. 2017, Havelange 2021, Khan et al. 2022, Lopez et al. 2019, Russell & Trueman 1971, Sabiha-Javied & Ashgar 2010, Sattouf 2007, Saueia et al. 2005, Shang et al., Steiner et al. 2020, Sun et al. 2020, Tufail et al. 2006, Tulsidas et al. 2019, USEPA 2022).

In addition to the above management measures, there are opportunities for using gypsum, after suitable treatment, as a resource in addition to long-term safe storage of the material. There is potential in several areas:

– Fertiliser and soil conditioner: The gypsum can be used as a fertiliser in its own right as it contains available calcium, sulphate and phosphate and also has benefits as a soil conditioner to treat sodic and/or alkaline soils, in addition to breaking down clay soils to improve moisture and air input and root penetration. This may raise the possibility of local communities developing either market gardens or commercial cropping or assist local pastoralists in improving soil properties.
– Construction materials: gypsum is a suitable additive to concrete and concrete-based materials such as building blocks as it acts as a retardant and develops greater strength during the curing process than standard concrete. It is also suitable for use in plasterboard. Studies have shown that small-scale production facilities can be set up for minimal costs, which may provide another opportunity for an indigenous owned industry to be established in manufacturing building products for the Northern Territory's indigenous housing construction programs. As the process is exothermic research has suggested that the heat can be recovered and used to produce part of the power required for production.
– Road base: When utilized in a mix, gypsum has been shown to perform as well as, or better, than traditional road base, particularly under compaction. It may be possible that gypsum from the Ammaroo stack could be incorporated into regional road construction and repair initiatives.
– Other less well-known options include calcining the gypsum to produce clinker/aggregate, sulphur dioxide, lime, or sulphuric acid; treating it as a source for elemental calcium; lanthanide or fluorine recovery; and manufacture of calcium carbide, ammonium sulphate or sodium sulphate which will also result in CO_2 sequestration. It can also be used as backfill in open cut and underground mines.

7. Project Location and Regional Context

7.0 Location, Land Use and Tenure

The Ammaroo Project is in the Northern Territory and approximately 270 km northeast of Alice Springs, 220 km southeast of Tennant Creek, 95 km from the Adelaide to Darwin Railway as illustrated in Figure 2.

The main Ammaroo project resource is located on Ammaroo Station and is covered by Mineral Lease applications that have been in place since 2012 and 2013. The Mineral Leases (MLs) includes:

– ML29463
– ML29854

Verdant also have contiguous exploration leases (ELs) on nearby Elkedra and Derry Downs Stations.

The area surrounding the project is sparsely populated and contains pastoral activity with little development. Land use comprises cattle grazing, remote aboriginal communities and outstations, and pastoral station homesteads. The area supports an active beef and sustainable cattle industry, and stocking numbers vary seasonally.

All pastoral stations are on land under perpetual pastoral lease. There are smaller areas of aboriginal land in the region, primarily associated with established communities. Much of the area to the north and west of the main Ammaroo resource is under petroleum exploration title, but there are no petroleum exploration applications, or granted tenure, over the Ammaroo resource itself.

7.1 Environmental Context

The following sections provide a detailed description of the environmental, cultural, and socio-economic context in which the proposed variation occurs.

7.1.0 Bioregional Context

The Project lies within the Tanami bioregion, which is characterised by red sand plains with underlying rock strata occasionally exposed as hills and ranges. The eastern extent of the bioregion, within which the Project site occurs, only partially reflects this bioregional description, and is comprised of red earth soils dominated by Mulga or Gidgee plains, interspersed with red earth sandplains that support a mixture of hummock and tussock grass.

7.1.1 Climate

The climate is typical of the arid zone and is characterised as having hot days and cold nights, where rainfall is infrequent and unpredictable, and evaporation is high.

The nearest Bureau of Meteorology (BOM) rainfall gauge to the Project is located at Ammaroo Station (015585) approximately 30 km southeast.

The mean annual rainfall is approximately 309 mm. Regionally, most rainfall is associated with the monsoonal wet season and cyclonic activity. Over some drought years, there is minimal or no rainfall.

The BOM gauge at Alice Springs Airport (015590) is located about 280 km southwest of the Project and has monitored pan evaporation records since 1959. Evaporation is greatest during months of higher mean rainfall with the highest average daily evaporation peaking in January at 12.9 mm. Rates of evaporation are significantly lower from May to August corresponding with lower average rainfall.

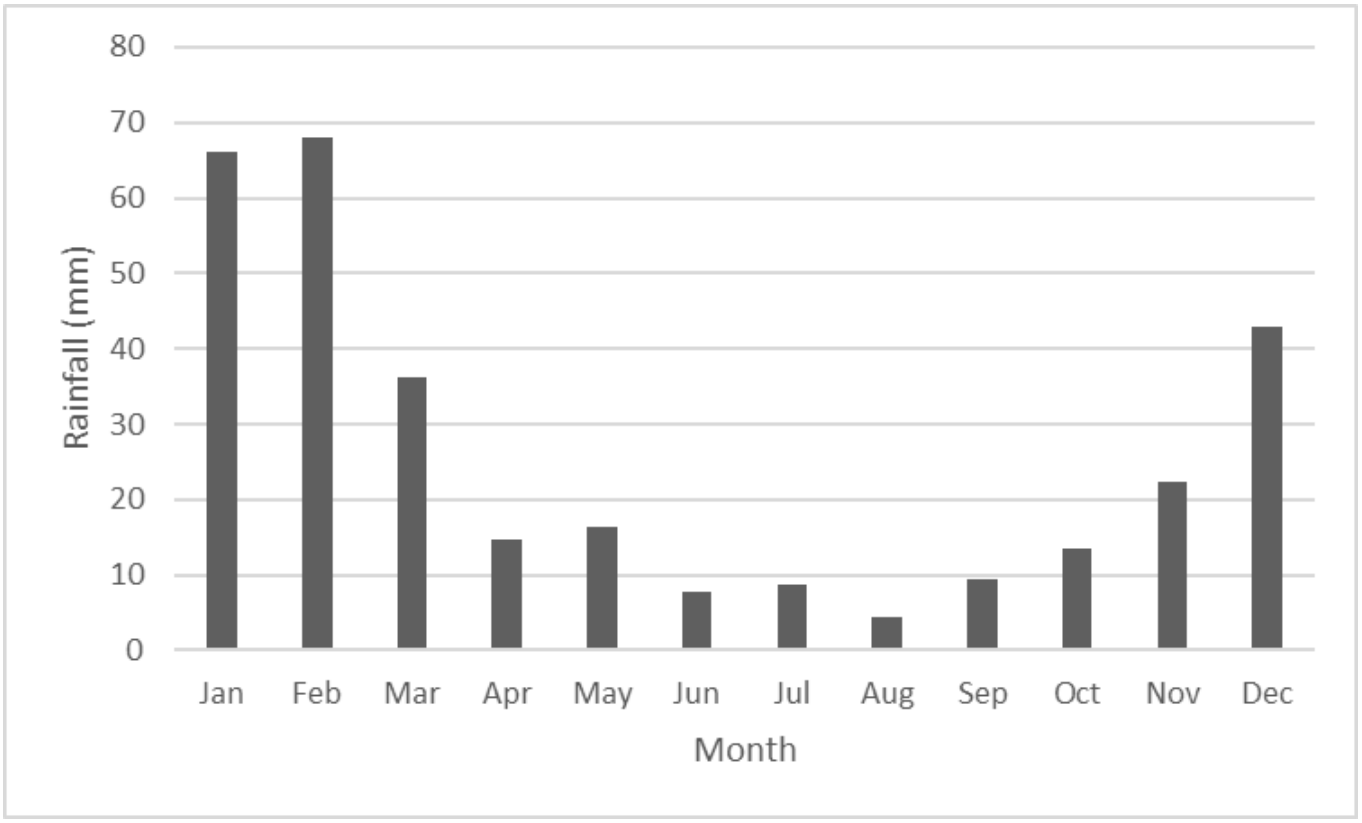


Figure 19 Mean monthly rainfall (Source: BOM (2022))

7.1.2 Temperature and Humidity

The nearest BOM station that collects up to date temperature data is located at Tennant Creek Airport (015135), approximately 220 km northwest of the project.

– Typical of central Australian arid climates, the hottest month is December with a mean maximum temperature of 37.3.

– The coolest month is July with a mean minimum temperature of 12.4. Sub-zero temperatures occur occasionally during July and August and there have been instances of surface water freezing at night.

– The average monthly relative humidity at 9:00 am typically ranges between 28% - 54% with an annual average of 41 %. The average monthly relative humidity at 3:00 pm typically ranges between 17 to 35% (with an annual average of 41%.

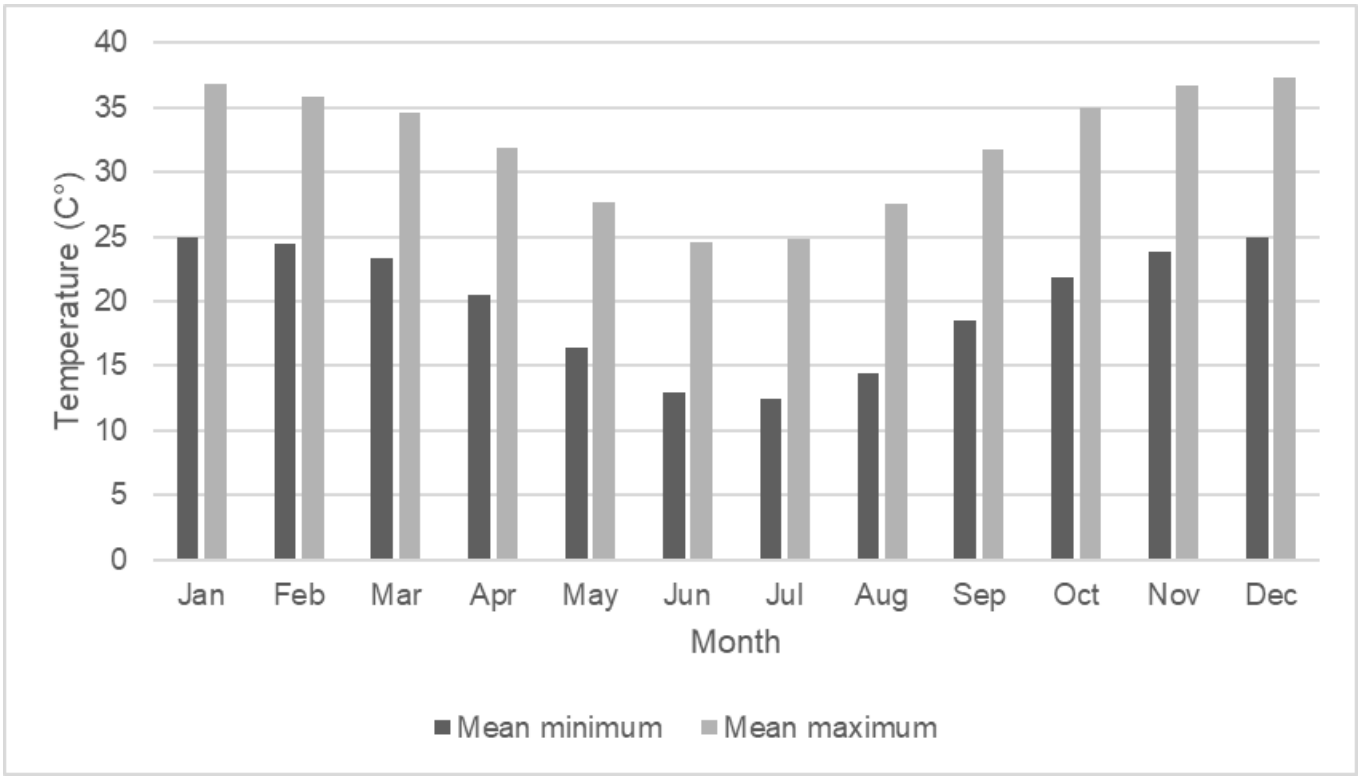


Figure 20 ***Average minimum and maximum temperature (Tennant Creek Airport - 220 km from Project)***

7.1.3 Wind

No data for wind directions and speeds was available in proximity to the study area. Instead, the Air Pollution Model (TAPM) (CSIRO) was used to develop a prognostic model of the wind conditions at the project site.

The winds at the project site primarily originate from the southeast throughout the year and are generally in between 2.0-4.0 m/s.

7.1.4 Geology and Physiography

The Project is located on the southwestern edge of Georgina Basin, which extends across the Northern Territory into Queensland. The Georgina Basin includes rocks of Neoproterozoic to Devonian age, with Cambrian platform carbonate rocks dominating the basin fill. The basin-edge Cambrian carbonates contain the largest sedimentary rock phosphate deposits in Australia and account for over 95% of Australia's economic demonstrated rock phosphate resources.

The Project overlaps the geologically older Davenport Province. Based on published mapping, the main Ammaroo phosphate deposit is hosted in Arthur Creek Formation, which is Middle Cambrian or approximately 500 Ma to 520 Ma years old. The host rocks are a mixed carbonate / silty siliciclastic shallow water facies mosaic that was deposited on a Cambrian shoreline as phosphatic waters upwelled from the depths.

The Cambrian rocks in the Project area are un-faulted and considered flat to gently undulating and very gently folded, with an overall 0.25% downward inclination towards the southwest as they dip into the basin. Outcrop of Cambrian aged sediments, comprising of dolomitic limestone and siltstone, is restricted to the north, along the flanks of the Davenport Ranges.

The northwest of the Project area also contains limited outcrop of Neoproterozoic and Paleoproterozoic arkosic sandstone and volcanic rocks. These have also been intersected in deeper drillholes beneath the phosphate deposit.

The Southern Georgina Basin carbonate sediments comprising the Arrinthrunga, Hagen, Chabalowe, Arthur Creek, and Red Heart Dolostone sequence are a very significant regional aquifer. The sandstone, limestone and

dolostone units host the aquifers that are the target water supply for the mine bore field (Jeuken, 2017). Regional geology is depicted in Figure 21.

The regional topography is dominated by the Davenport Ranges, which are located approximately 15 km to the north of the mine site and consist of a series of sandstone and siltstone hills rising to an elevation of approximately 100 m above the surrounding plains. Closer to the site a series of minor sandstone foothills form low isolated sandstone outcrops.

The Project site is located within the vicinity of a local low point that receives flows from a number of unnamed first, second and third order watercourses. The west side of the mining area generally drains to the north-west.

The Project site's surface geology consists predominantly of sediments from the Cenozoic era, comprising of residual alluvium, quartz sand sheets, calcrete, laterite, colluvium, silcrete and silt.

7.1.5 Land Systems

The region consists of four land systems, and only the Singleton, Alinga, and Sandover are present in the study area as described in the Approved EIS. The land system in which the proposed variation specifically lies is the Alinga land system. The latter is detailed below in Table 11 below.

Table 11 Land system descriptions

Land system	Bioregion	Land system description	Landscape class	Vegetation description	Acid sulphate soils
Alinga	Tanami	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Lateritic plains and rises	Mainly short grass-forb under mulga, some soft spinifex	No occurrence of acid sulphate soils

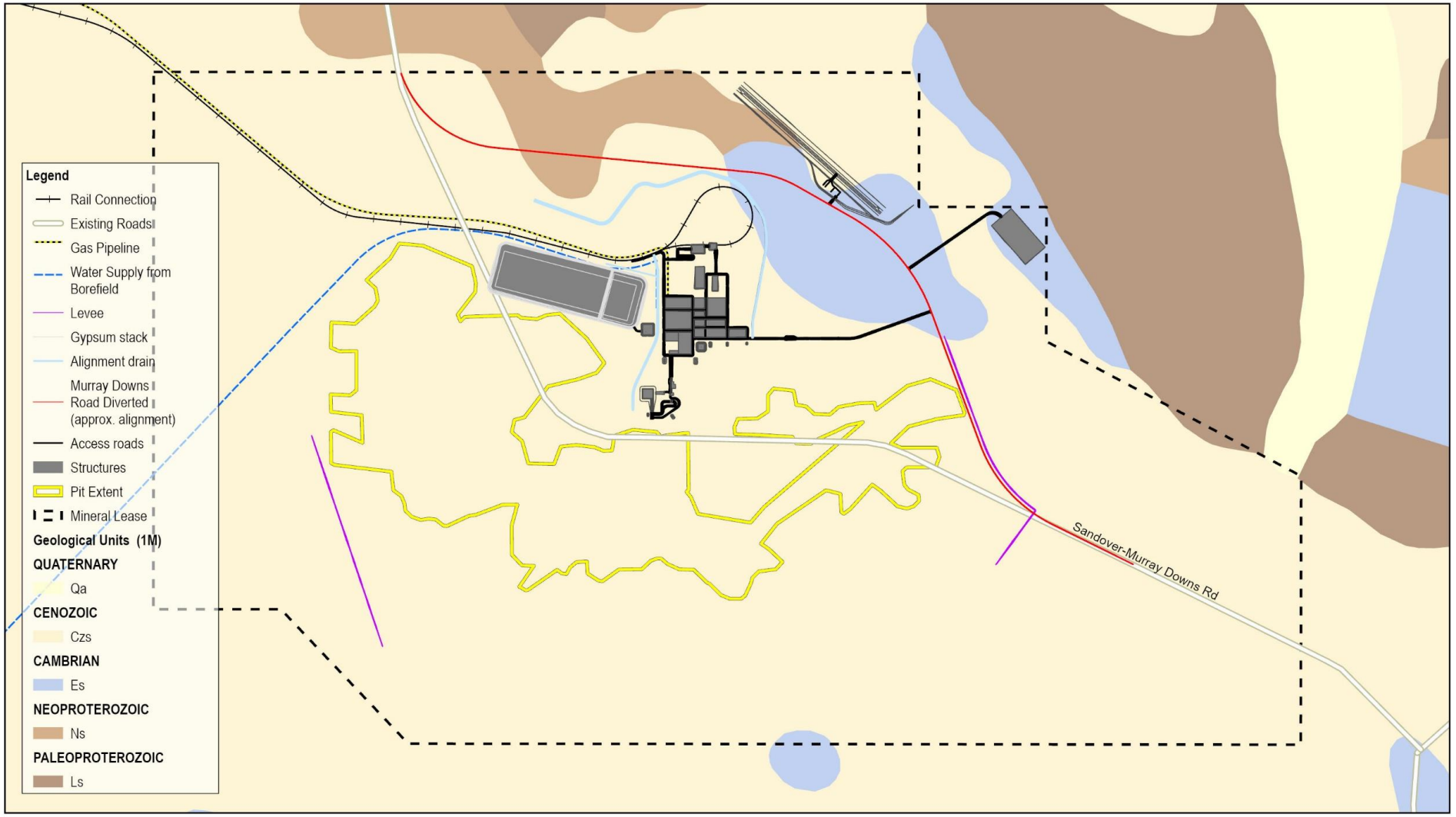


Figure 21 Regional geology

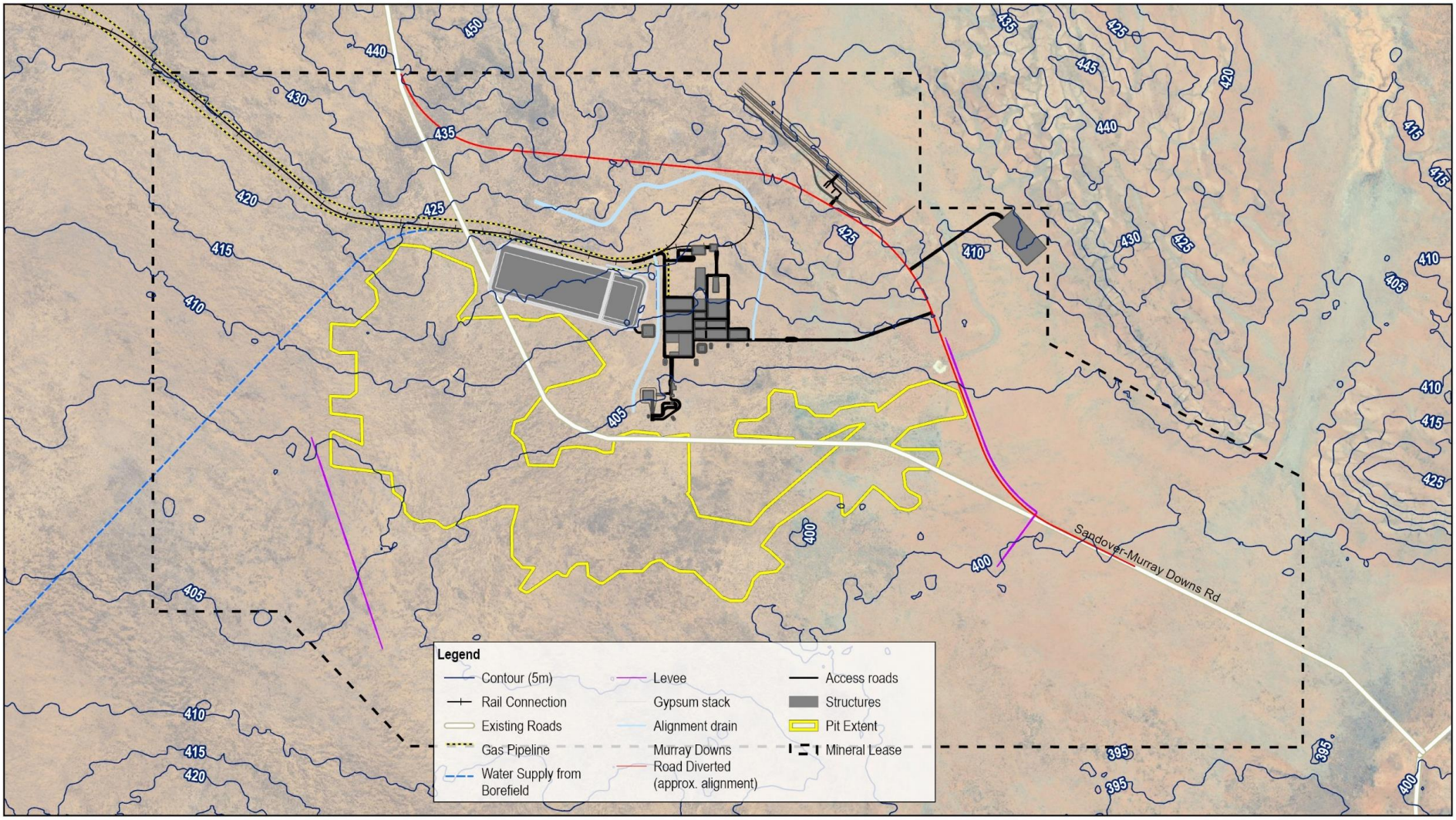


Figure 22 Topographic contour plan

7.1.6 Soils

The Northern Territory Geological Survey, 1:250,000 scale Elkedra map sheet indicates the materials present at the site comprise the following geological units:

– Quaternary age colluvium deposits comprising gravel, sand, silt, and clay.
– Quaternary age aeolian sand plains and dunes.
– Quaternary age red earth deposits / ferruginous gravel.

Results from test pits and boreholes at the process plant site locations have concluded a typical soil profile comprised of a surficial layer of silty sand and sandy silt of low plasticity between 0.5 to 1.0 m thick. Underneath this was found to be silty or clayey sand to an average depth of 2.0 m. A thick gravel layer approximately 0.5 m thick was found below the sand later at 75% of test locations. At some locations, a layer of clay up to 1.0 m thick was found between the sand and gravel layers.

Based on the results of the investigation for the project, the ground conditions in the general area are likely to be composed of sandy soil between 2 to 5 m deep, overlying extremely to moderately weathered sandstone, siltstone, and conglomerate rock. The weathering and strength of the rock are highly variable, with the consistency of the material varying between dense sand / very stiff clay and medium strength rock material.

7.1.7 Hydrology

7.1.7.0 Surface Water Drainage

The Project is located within the Diamantina-Georgina Rivers Basin. No surface water drainage exists within the proposed variation, however surface water surrounding the Project includes:

– Atcherie Creek, which passes about 26 km east of the project site and is a tributary of the Sandover River.
– George Creek, which passes about 34 km northeast of the project site and is a tributary of the Elkedra River, which feeds Boundary Dam (located about 100 km northeast of the project).
– Taylor Creek, which intersects the western end of the access corridor.
– Sandover River, which passes about 33 km south of the project site (a tributary of the Georgina River via Bybby Creek and the Sandover River Flood out).

Drainage features only occur within the eastern area of the site and do not intersect the proposed infrastructure. Drainage floors occur within the site, none of which fall within the new alignment.

7.1.7.1 Groundwater

The Project is located within the southern Georgina Basin, whose carbonate aquifer is the target water supply for the mine bore field. Aquifer testing at the bore field site indicates that the aquifer has the capacity to support well yields of over 75 L/s, based on recent test data and from the Approved EIS.

There are no wetlands or large Eucalypts that may indicate the presence of groundwater dependent ecosystems (GDEs) within the project site or in the surrounding area. Groundwater from the Georgina Basin carbonate aquifer is used for community water supplies, station water supplies and for stock watering. The closest external bore is Hagen's Bore (used for stock), 15 km southeast of the bore field, followed by the Ampilatwatja community bores, approximately 20 km southeast. A conservative estimate of the Approved Project's maximum use of ground water resources includes up to 4.6 GLpa, or 110 GL total during 25-year LOM operations. Impacts of groundwater extraction are discussed in Section 11.

Verdant have established an environmental management framework to ensure that groundwater values are protected; including annual model recalibration based on groundwater monitoring from seven monitoring bores.

7.1.8 Communities

The Project is located in remote, arid, and sparsely populated country surrounded by small Aboriginal communities and homelands and large pastoral stations. Surrounding communities include the Alyawarre communities of Imangara (Murray Downs), Ampilatwatja and other Alyawarre outstations; Arlparra, service centre for the Utopia Homelands to the south of the Sandover Highway, Ali Curung on Kaytetye land northwest of the project site (Figure 2). The communities surrounding the Project are detailed in Table 12.

Table 12 Surrounding communities

Communities	Approximate distance	Easting, Northing GDA 2020 / MGA Zone 53
Old mine camp	3.5 km northeast	517100.00 m E, 7627550.00 m S
Ampilatwatja	20 km southeast	523132.00 m E, 7605574.00 m S
Imperrenth	43 km northwest	495367.00 m E, 7655026.00 m S
Ngkwarlerlanem	33 km southwest	478416.00 m E, 7597321.00 m S
Imangara	69 km northwest	466869.00 m E, 7672211.00 m S
New mine camp (i.e., accommodation village)	3 km east-northeast	518803.48 m E, 7626721.50 m S

The Ammaroo resource lies on pastoral lease land under Native Title. The Native Title holding parties associated with the Project are the Kayetyre Alywarr Awenyerraperte Ingkerr-wenh Aboriginal Corporation RNTBC, Eynewantheyne Aboriginal Corporation RNTBC, and the Kaytetye Tywerate Arenge Aboriginal Corporation RNTBC.

Verdant are working with all title holders and the Central Land Council to develop a Native Title Mining Agreement which will include protecting cultural heritage and provide for financial benefits, commercial, training and employment opportunities for local people as part of the Project.

Pastoral properties surrounding the Ammaroo, Murray Downs, Elkedra and Neutral Junction Stations. More recently, the Barkly has emerged as a potential horticultural province, e.g., at Singleton station approximately 110 km to the northwest.

The populations within the Project area are serviced by regional centres including Tennant Creek, and Alice Springs.

8. Environmental Risk Assessment

8.0 Previous Assessment (Approved Project)

Section 6 of the Approved EIS provides a description of the whole-of-project risk assessment undertaken for the identification, assessment, and management of project environmental risks associated with the Approved Project. The scope of the risk assessment includes construction and operation, decommissioning, closure, and post-closure risks of the project in relation to environmental, social, and economic values on both a local and regional scale.

The risk assessment provides a framework for identifying components of the project with the potential for greater environmental risk, and highlights areas of focus for environmental impact assessment and project specific control measures to minimise the likelihood and consequence of these identified risks.

A risk register was established to document the findings of the risk assessment process. The risk register contains details of impact pathways, their consequences, planned controls inherent in the project description, an initial risk assessment, additional controls, and the residual risk rating.

The environmental risk assessment identified 101 risk events, which had potential impacts on environmental receptors. Nine events related to social and community aspects identified and assessed had potential positive impacts. Key risk areas that were subject to detailed impact assessment and risk management planning include the following:

– Road accidents from increased traffic during construction and operation activities.
– Health and safety of project personnel from interaction with equipment as well as mobile and fixed plant, during construction and operation activities.
– Dust fallout and deposition, including impacts to flora, fauna, and nearby sensitive receptors, from wind erosion of exposed operational surfaces and vehicle movement along haul roads.
– Flora, vegetation communities and fauna habitat impact from land clearing during construction.
– Flora, vegetation communities and fauna habitat impact from spread of weeds and feral animals due to vehicle movements and/or inappropriate waste management.
– Changes in hydrological characteristics from construction of linear assets (e.g., rail spur).
– Decline in availability of water to existing and/or future users, within the Southern Georgina basin from progressive water table drawdown arising from groundwater extraction rates.
– Disturbance and or damage to archaeological sites or cultural exclusion zones during construction and operation activities.
– Social and family tensions from increased disposable income and distribution of benefits payments in the local communities.
– Employment impacts to existing local businesses (e.g., retail, hospitality, council) due to recruitment of project personnel.
– Wellbeing of project personnel due to living away from home and lack of family / support networks.

The residual risk rating for over half of the risks was rated as low. Those rated medium or high were the subject of particular attention in the development of further control measures and management plans.

8.1 Additional Risk Assessment Completed (Proposed Project)

In the preparation of this EIS Referral, the environmental risk register developed for the Approved Project has been fully re-evaluated and updated.

All proposed project changes were considered in the context of the existing assessment conditions for the Approved Project, i.e., Assessment Report 87, to determine if those conditions would be adequate to manage the

Proposed Project changes. The findings of that process have guided the preparation of this referral document, and the supporting appendices provide additional information in key areas, in support of those findings.

Where additional potential impacts were identified outside the scope of the Approved EIS, supplementary technical assessments have been undertaken and are summarised within this referral and with supporting reports in the Appendices.

Environmental risks have therefore been determined based on the risks identified in the Approved EIS, together with recommendations coming from the additional technical investigations conducted on the Proposed Project.

A revised environmental risk register for the Proposed Project has been established (Appendix F) to document the findings of the risk assessment process, and contains details of impact pathways, consequences, planned controls, additional controls, and the residual risk rating.

The environmental risk assessment identified twenty risk events that have the potential to impact the existing environment in total, and of these there were no risks assessed to have a residual risk higher than medium, of which there were only six, after control measures are in place.

A review of the previous risk assessment methodology that was used for the Approved EIS was undertaken, and there are no changes to the risk assessment methodology that was used for this EIS Referral. The methodology along with the register for risks identified and mitigation measures for the Proposed Project are provided in Appendix F.

9. Community Consultation

This section summarises the community and stakeholder engagement conducted during the preparation of this Proposed Project Referral. This consultation built on extensive consultations undertaken by Verdant for the Approved Project.

9.0 Consultation Approach

9.0.0 Objectives

Consultation plays an important role in project development. It is undertaken to raise awareness of a project, understand community and stakeholder issues, and obtain feedback from community and other key stakeholders to inform project design, development, and future consultation requirements.

Effective communication and stakeholder engagement are fundamental to reducing risk, minimizing social and environmental impacts, considering the needs of the community and stakeholders, and understanding their concerns about the project.

The objectives of consultation for the Proposed Project included:

– Update communities and stakeholders about how the project has progressed.
– Build relationships with key stakeholders and the community.
– Inform the communities and stakeholders about the change to project description.
– Understand community and stakeholder issues and concerns.
– Inform project development, construction planning, environmental assessment, and future consultation requirements.

9.0.1 Methodology

Engagement tools

Engagement to inform this referral was undertaken face-to-face in June 2022. Engagement activities included:

– Phone and email communication.
– Project website.
– Distribution of information, including community update flyer.
– Face-to-face meetings and briefings.
– A video.

Stakeholder identification

A stakeholder is defined as a person, group, or organisation who has an interest in, and/or is directly or indirectly impacted by a project. Consultation was carried out with four key stakeholder groups to better understand their views, provide information about the project, and where possible, enable opportunities for collaboration on project design:

– Native Title Holders, community residents, and service providers in Ampilatwatja.
– Nearby pastoral stations.
– Regional stakeholders in Tennant Creek, and Alice Springs.

9.1 Summary of Feedback

A summary of the feedback received from each stakeholder group is provided in Table 13.

Table 13 Summary of feedback

Theme	Feedback	Where addressed
Residents and services in Ampilatwatja		
Project sentiment	– Overall support for the approved project – Overall support for the proposed project	*N/A*
Opportunities	– Employment opportunities for local community – Support for community events – Economic benefits from Native Title Agreement – Potential upgrades to local roads	*Social Impact Assessment* *Economic Impact Assessment* *Traffic Impact Assessment*
Concerns	Communities raised concern with: – Potential road safety risks for road users – Governance and implementation of the Native Title Agreement – Restrictions to Country for gathering resources – Use of groundwater	*Social Impact Assessment* *Economic Impact Assessment* *Traffic Impact Assessment* *Groundwater Impact Assessment*
Nearby pastoral stations		
Project sentiment	– Overall support for the approved project – Overall support for the updated project – Interest in continued future engagement between Verdant Minerals and pastoral stations	N/A
Opportunities	– Use of proposed infrastructure (such as bores and the airfield) – Potential upgrades to the local roads	*Social Impact Assessment*
Concerns	– Further degradation of the roads if they are not upgraded – Workforce accessing parts of the station without permission – Access for cattle to water sources	*Social Impact Assessment* *Groundwater Impact Assessment* *Traffic Impact Assessment*
Regional stakeholders		
Project sentiment	– Some support for the approved project – Some support for the proposed project	*Social Impact Assessment*
Opportunities	– Long term, sustainable employment opportunities for communities in the Barkly Region – Procurement opportunities for business across Alice Springs and the Barkly Region – Economic diversification	*Social Impact Assessment* *Economic Impact Assessment*
Concerns	– Meeting expectations for local employment and procurement – Collaboration with other proponents in the region – Attraction and retention of workforce to the region – Potential environmental impacts as a result of groundwater extraction and greenhouse gas emissions	*Social Impact Assessment* *Groundwater Impact Assessment* *Greenhouse Gas Assessment*

9.2 Future Consultation

The recommendations for future engagement with stakeholder and communities for the project are provided in Appendix L.

Table 14 Consultation recommendations

Recommendation	Detail
Prepare Community and Stakeholder Engagement Plan	A Community and Stakeholder Engagement Plan will guide engagement activities with stakeholders and communities potentially impacted by the Project in the long term. This will help to ensure the engagement process is consistent and tailored to the needs of each stakeholder group. The Community and Stakeholder Engagement Plan should be reviewed routinely, and as required to ensure it is up to date.
Collaboration with stakeholders and proponents	We recommend that Verdant continue to collaborate and coordinate with key regional stakeholders (such as Barkly Regional Council, NT Chamber of Commerce, and other proponents) to manage potential cumulative impacts of the Project, and to ensure adequate planning can take place for workforce requirements.
Finalise Native Title Agreement	Finalising the Native Title Agreement is being prioritised, in partnership with the CLC, and Native Title Holders.
Establish project governance	Establishment of a Project Liaison Committee to provide a voice for key communities and stakeholders in the project area is a key component of the current draft Native Title Agreement.

10. Surface Water

10.0 Surface Water Assessment

10.0.0 Previous Assessment and Impacts

Section 7 and Appendix G of the Approved EIS provide details on the scope and findings of surface water impact assessment conducted within the study area. The previous surface water impact assessment was conducted to assess the potential direct and indirect impacts of the Phosphate Mine Project on surface water resources within and around the project site, and mitigation measures that would be implemented to minimise those impacts.

The assessment described the surface water environment at the project, and outlined hydrological conditions, including catchments and watercourses, water users, water quality in surrounding water catchments and flood extents. The assessment also includes detail of impacts from surface water interception, dirty water discharge, process water discharge, erosion and scouring, and pit protection levees.

10.0.0.0 Flood Modelling

The surface water assessment identified potential impacts to surrounding water uses from a reduction in water quality and quantity, and on surrounding watercourses and flooding regimes. Flood modelling was conducted within the mining area for one percent Annual Exceedance Probability (AEP) and 0.1 percent AEP.

The maximum modelled flood depths and extents for the one per cent AEP (approximately equivalent to the 100-year average recurrence interval (ARI)) critical duration design storm events indicated that the proposed flood protection levees would be sufficient to protect the open cut pit from flood inrush for the one per cent AEP design flood event.

The modelling indicated that the maximum modelled flood depths and velocities for the 0.1 per cent AEP (1,000-year ARI) flood event for the design conditions were very similar to the one per cent AEP flood depths. The modelling indicated a similar result for the maximum modelled velocities for the 0.1 per cent AEP (approximately equivalent to the 1,000-year ARI) event and change in the maximum modelled flow velocities.

Modelling was also provided for the site incorporating the flood protection levee proposed east of the mine pit. With the levee constructed, the mine pit, infrastructure, and accommodation village were considered to be protected from a 1 per cent AEP flood event.

The impacts on hydrological regimes identified included:

– Loss of surface water resources due to interception and diversion of surface water.
– Erosion and scouring of local watercourses because of the concentration of flow paths by culverts along the access corridor, or the narrowing of the flow path to the east of the open cut pit as a result of the flood protection levees.

10.0.0.1 Surface Water Quality

Water quality impacts were identified, including:

– Discharges from sediment dams following high rainfall events. The discharges from the sediment basins would be mixed with similarly sediment-laden flood waters, resulting in an unappreciable change to water quality. This was considered to be an insignificant consequence.
– Contamination from discharge of process water during high rainfall events. The freeboard storage proposed was considered sufficient to manage potential risks to downstream water quality.
– Tailings storage facility failure or overflow. As detailed in Section 10.1, the tailings geochemical analysis was concluded to allow managed as non-acid-forming, non-saline, non-metalliferous and non-radioactive waste. The proposed in-pit facility was considered to have a low risk to surface water from a ‘failure of the TSF’.

– Contamination from spill of hazardous material or chemical. Surface water impacts for this were considered low, based on the well-regulated and managed nature of these activities.

10.0.0.2 Mitigation Measures

Mitigation measures were considered necessary to avoid, control, reduce or minimise impacts of project activities on surface water. Mitigation measures included:

– Dirty water from sediment dams would be minimised using suitable management and maintenance of the sediment dams.
– Process water discharge would be prevented by suitably designed freeboard capacity.
– Routine inspections of the culverts along the access following rainfall events and flood protection levees.
– Process water storages were constructed with a turkey's nest design (i.e., have no external catchment) in order to minimise intercepted external water volumes and were proposed to be managed to maintain a minimum freeboard equivalent to the total inflows expected during a 100-year ARI 72-hour design storm event.
– Flood protection levees were also proposed to be constructed on the west and east sides of the mine pit.

Additional controls to manage surface water impacts were detailed in Erosion and Sedimentation Control Plan (ESCP), Hazmat Management Plan, Water Management Plan (WMP). Residual risks associated with potential surface water impact for Approved EIS are detailed in Table 15.

Table 15 Qualitative risk – surface water

Potential event	Residual risk level
Alteration of hydrological regimes – mine pit	Low
Alteration of hydrological regimes – linear infrastructure	Medium
Erosion, sedimentation of watercourses	Low
Discharge of sediment laden water from sediment dams	Low
Discharge of process water	Low
Failure of the TSF	Low
Accidental spill of hazardous material and chemicals	Low

10.0.1 Proposed Project Potential Impacts and Assessment Required

10.0.1.0 Flood Modelling

An updated surface water assessment was undertaken as part of the Proposed Project EIS taking into account the following project changes:

– Airfield.
– Expansion and relocation of the accommodation village.
– Access roads to the airfield and accommodation village.
– Extension of the railway loop.
– Realignment of the flood protection levees.

As shown in Figure 23, Figure 24, and Figure 25, these components of the Proposed Project do not intercept the modelled one per cent AEP design flood extents, except for the access road to the accommodation village. It is understood that the road is designed to provide flood immune access for the 20% AEP design flood. The access road to the accommodation village results in higher peak water levels upstream of the road, however no impact to any sensitive receivers was identified. Similar to the previous assessment, the constriction of the natural flow path by the eastern levee is expected to result in increased velocity near the levee, however the locally increased is similar to nearby natural flow paths and is not expected to exceed the stability threshold of the natural channel lining and result in significant erosion or scour.

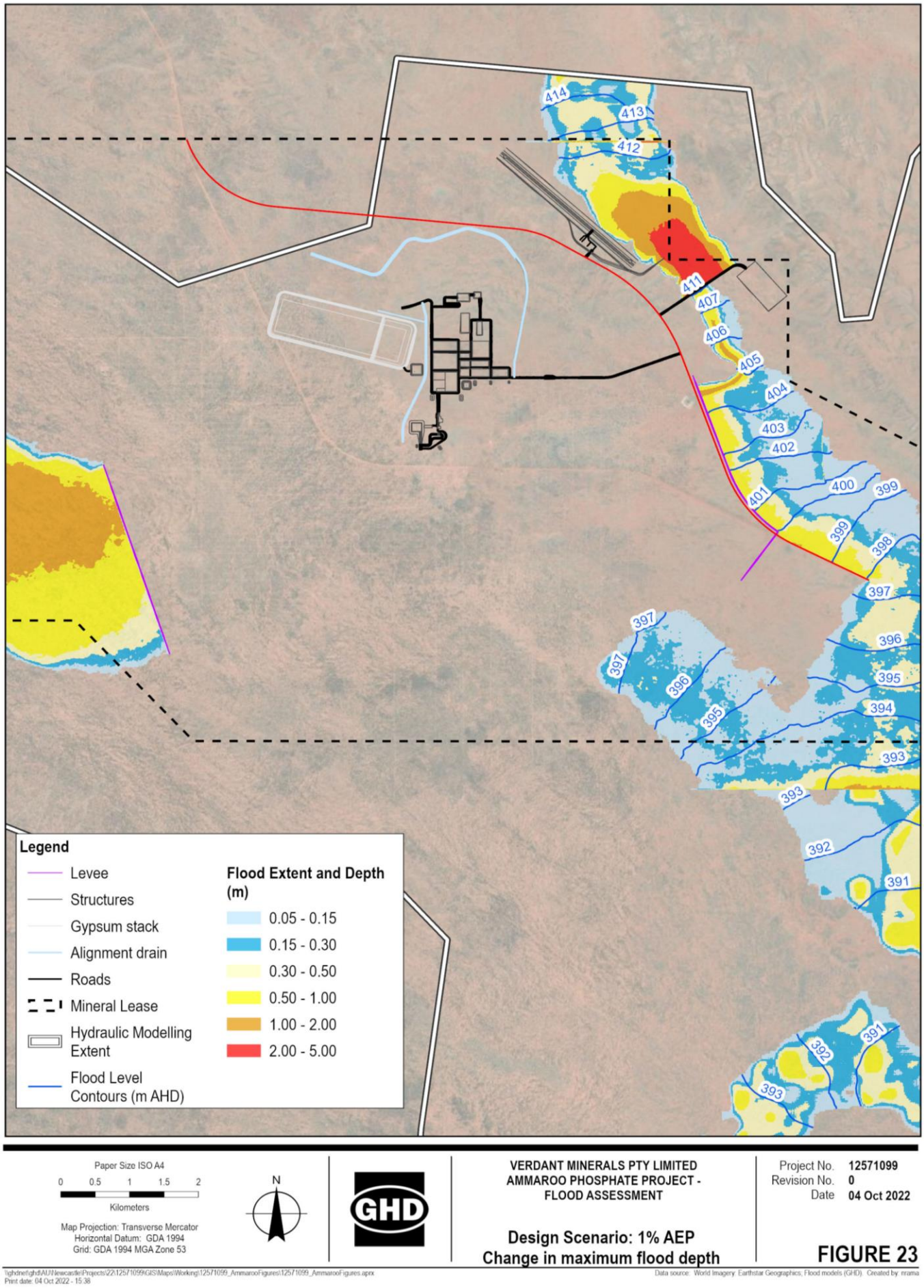


Figure 23 *Maximum modelled 1% AEP flood depths, proposed conditions with Proposed Project layout*

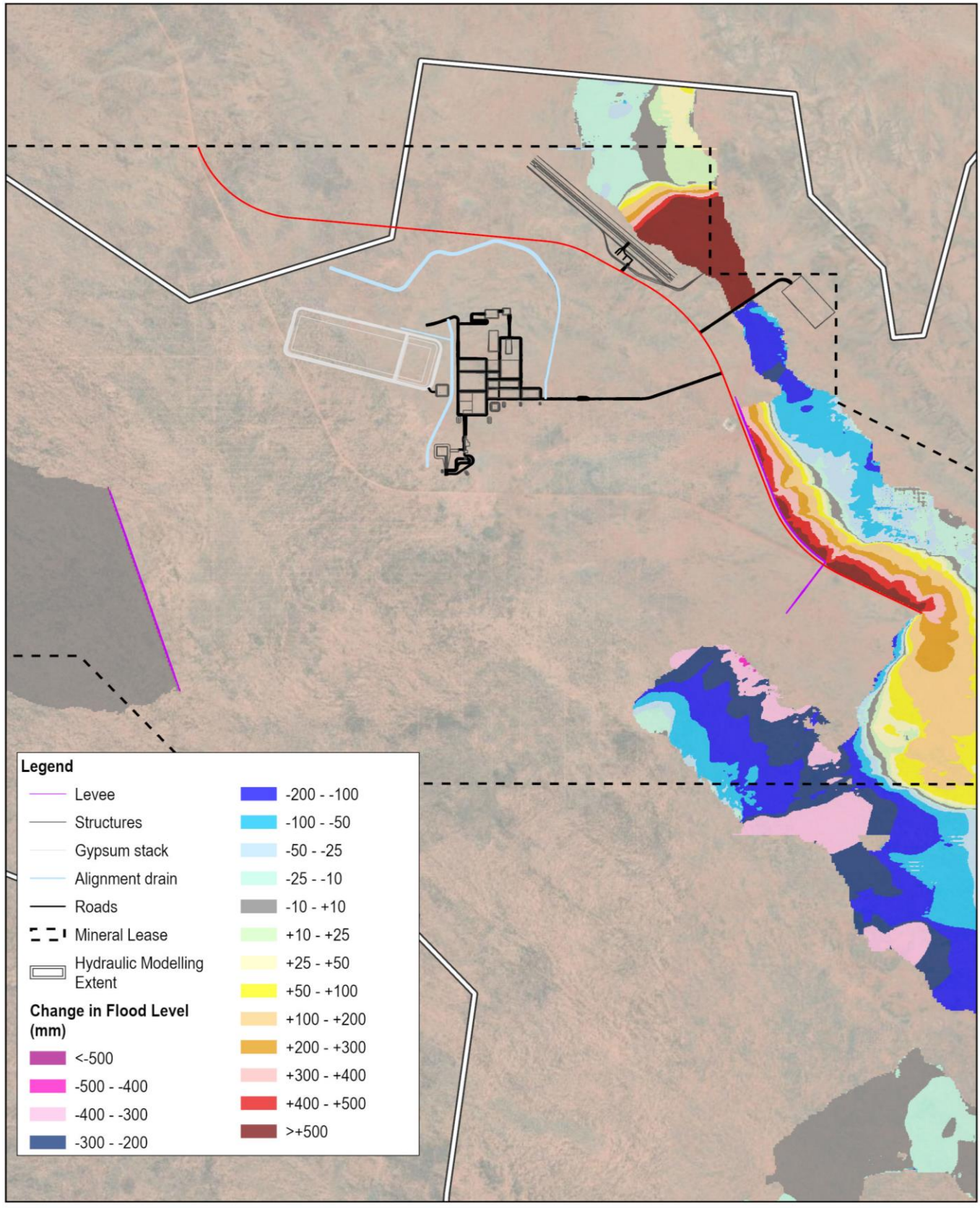


Figure 24 *Change in maximum modelled 1% AEP flood depths with Proposed Project layout*

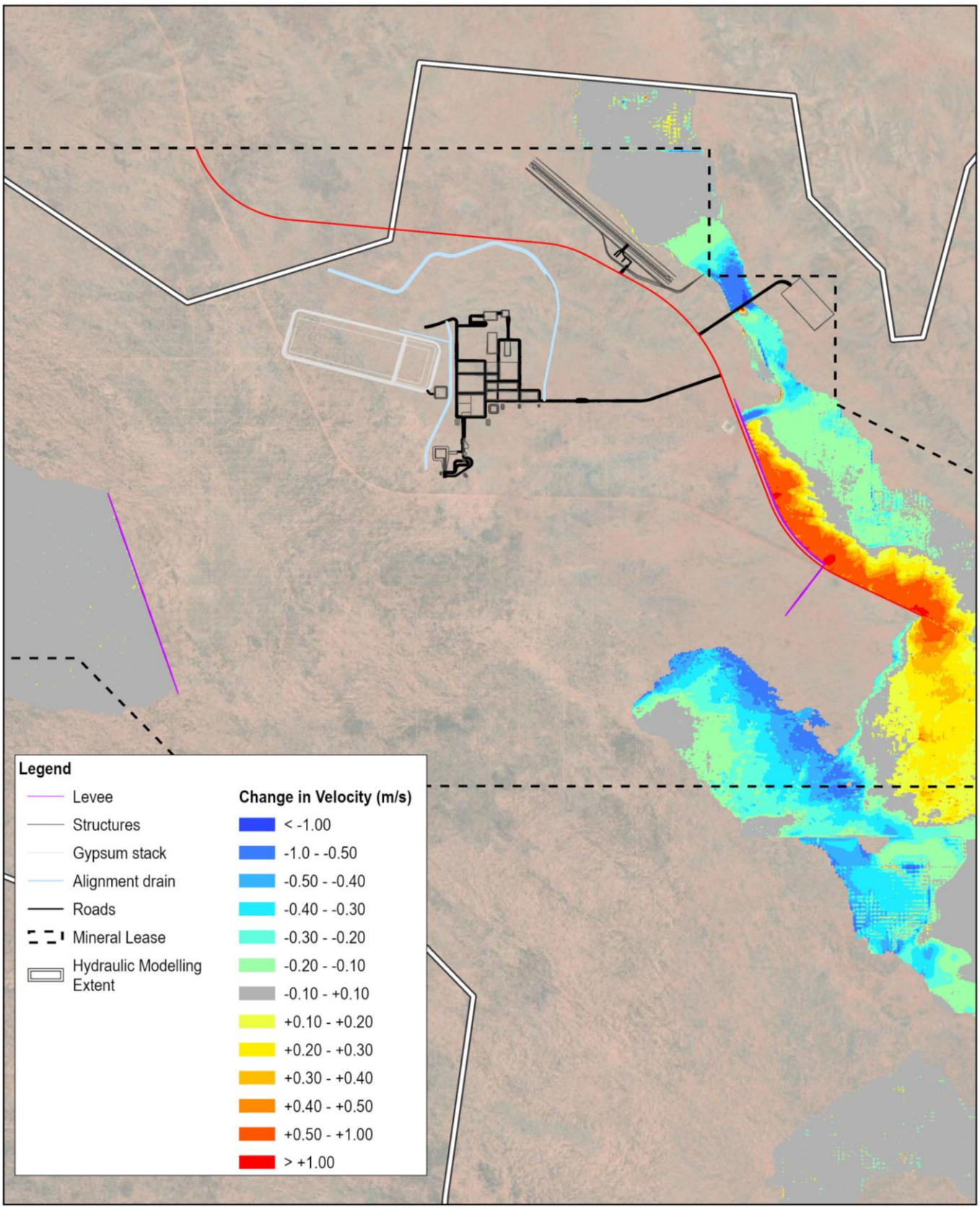


Figure 25 *Change in maximum modelled 1% AEP flood velocities with Proposed Project layout*

10.0.1.1 Surface Water Quality

The potential impacts to surface water quality from the Approved EIS also relate to the Proposed Project, including:

– Discharges from sediment dams following high rainfall events.
– Contamination from discharge of process water during high rainfall events or due to fertiliser processing failure.
– The gypsum stacking facility failure or overflow.

This is discussed further in Section 10.1. While these may represent potential impacts to surface water quality, it was considered that the current understanding of infrastructure processing and design, as described above, was sufficient to understand risks (i.e., Section 8) and to determine appropriate risk mitigation measures.

It is noted that the storage sheds at site and the Darwin Port will be fully enclosed with a concrete floor and concrete side barrier walls to prevent product from discharging outside of the storage area. In the event of a spill, any sulphur spill outside of the shed will be manually cleaned up.

10.0.1.2 Mitigation Measures

The impacts on surface water are not considered to be significantly changed for the Proposed Project compared to the Approved Project. The access road to the accommodation village is not considered to adversely affect the potential impact to surface water flows or mining infrastructure.

As described in 6.3.1.1, the design of the gypsum stack will include a drainage ditch to maintain freeboard in a 1% AEP design flood event so there will be no opportunity for leachate or stack runoff to impact the local environment. This control is considered sufficient to mitigate risks associated with surface water from the gypsum stack.

Additionally, the ESCP, Hazmat Management Plan, and WMP would be updated to outline the mitigation measure and monitoring required for the Proposed Project risks. As detailed in Section14, human health and safety will be considered for the Proposed Project which would include additional controls to mitigate risks from storage and handling of hazardous substances and chemicals which may impact surface water.

10.1 Waste and Gypsum Stack Management

10.1.0 Previous Assessment and Impacts

Gypsum waste management was not a component of the Approved Project EIS, as this is a by-product of phosphoric acid production within the Proposed Project. The acid metalliferous and saline drainage assessment completed is summarised below.

Section 8.6 and Appendix I of the Approved EIS provides detail on the acid metalliferous and saline drainage (AMD) assessment undertaken for the Approved Project. The AMD assessment was conducted for waste rock and tailings (synthesised) produced during mine operations and presents the findings of a review of historical resource geochemical data, an assessment of mine development information relating to the risk of development of AMD and detailed, specific geochemical analysis of potential for AMD.

Based on the findings of the AMD testing, an AMD ecological and human health risk assessment was undertaken to determine the AMD risk associated with the material identified at the Ammaroo Phosphate Mine. The risk assessment concluded that, given the low sulphur content, generally low metal toxicant content and low metal and salt leachability of waste rock and tailings, the initial risk of groundwater contamination from AMD is low (refer to the Approved Project AMD Assessment Report - Appendix I). The Approved Project AMD management Plan included an allowance for separate storage of all separable PAF material if encountered, blending of any minor PAF with non-acid-forming (NAF) and acid consuming material (ACM) and routine dust, sediment and erosion control, the residual risk was considered low.

The AMD Management Plan for the tailings and waste rock (see Appendix I of the Approved EIS). The Plan confirmed that ore and waste rock were suitable for management in unlined monofil waste rock dumps. Waste rock and tailings were considered suitable to be disposed in-pit before being rehabilitated progressively. Surface water and groundwater monitoring implemented as per the Water Management Plan (Appendix E of the Approved EIS) were considered sufficient for the on-going management of AMD risks.

10.1.1 Proposed Project Potential Impacts and Assessment Required

10.1.1.0 Waste Management

Previous tailings and waste rock storage management would remain the same as part of the Proposed Project. The additional waste stream that must be managed as part of the Proposed Project comprises the gypsum stacking facility located to the west of the proposed fertiliser plant. As specified in Section 5.0.2.1, the gypsum by-product of phosphoric acid production, is considered to be dry with a free moisture content of less than 10% prior to stacking in the gypsum stacking facility.

Water availability in arid climates like Australia is a significant factor favouring dry stacking because of water scarcity. The initial design capacity of the first gypsum stacking cell will store up to 2 years of material when the plant is operating at full capacity. The gypsum stacking facility will constructed to ANCOLD tailings dam specifications.

10.1.1.1 Acid Metalliferous and Saline Drainage

Potential impacts may occur as a result of leachate from the gypsum stacking facility breaching the facility. To understand these potential impacts, barrel leaching was undertaken on representative samples. The purpose of this was to simulate the AMD risk associated with long-term effects of rain percolation through gypsum stack and the leaching potential soluble deleterious elements, into the environment (detailed in Section 10.1.2.0). The subsection below summarises the findings of the additional geochemical assessments conducted.

10.1.2 Additional Assessment Completed

10.1.2.0 Gypsum Waste Stack Geochemical Assessment

Barrel leaching is used to simulate the AMD risk associated with long-term effects of rain percolation through the gypsum stack. This process included the presence of soluble potential deleterious elements, which may impact the environment.

A barrel leach test of gypsum was undertaken using two filter sizes (0.45 µm compared to 0.1 µm) (report provided in Appendix H). The assessment included construction of one 100 L barrel with 120 kg of sample in each, which was considered representative of the gypsum waste stack. Instead of simulating the low annual rainfall at the site, the rainfall is greatly accelerated by the addition of a large quantity of water to each sample each month. Each week the liquid leachate is tested for pH, electrical conductivity, and oxidation/reduction potential (ORP) with a calibrated meter. In addition, after each monthly leachate cycle, a set amount of water is collected from the bottom drain tap and sent to the laboratory for analysis. The tests were run for a minimum of 18 months.

The results of the barrel leach tests indicated that some of the analytes (listed in Table 16) are reporting stable concentrations and are at low risk of sudden changes. Based on these trends alone, it was considered appropriate to cease ongoing assessment. Additionally, analytes that consistently reported below detection limit for most of the tests were also considered to have their ongoing assessment discontinued. Some of these analytes with decreasing trends still report significantly higher than the ANZG FAE 95% guidelines, the monitoring of these will continue to see if over time they reduce in concentration to meet guidelines.

Table 16 Observed trends in the analysis

Observed Trends	PHG1	PHG45
Decreasing concentration or stability	Al, Sb, As, Ba, Be, Bi, B, Cd, Ce, Cs, Cr, Cr III, Co, Cu, Dy, Er, Eu, Gd, Ga, Hf, Ho, Fe, La, Pb, Lu, Mn, Mo, Nd, Ni, Nb, Pd, Pr, Re, Rb, Sm, Sc, Se, Sr, Ta, Tb, Tm, Sn, Th, Ti, Tl, U, V, W, Y, Yb, Zn, Zr, F and Li	Al, Sb, As, Ba, Be, Bi, Cd, Ce, Cs, Cr, Cr III, Co, Cu, Dy, Er, Eu, Gd, Ga, Hf, Ho, Fe, La, Pb, Lu, Mn, Mo, Nd, Ni, Nb, Pd, Pr, Re, Rb, Sm, Sc, Se, Sr, Ta, Tb, Tm, Sn, Th, Ti, Tl, U, V, W, Y, Yb, Zn, Zr, F and Li
Increasing concentration	Br	Br
At or below detection limit	Cr IV, Os, Ag, Au, Hg, In, Pt, Te	Cr IV, Os, Ag, Au, Hg, In, Pt, Te
Results have yet to stabilise		B

Based on the metal concentrations in the leachate within the report, the gypsum waste would pose a risk to the surrounding environment if not properly designed and managed. The current stack design includes a lined base and runoff collection and suggests that there is a low risk of contamination to the surrounding environment. Recommendation for gypsum management include:

– Monitoring of leachate will continue for pH, electrical conductivity, major ions, nitrogen suite, Al, As, B, Cd, Cr, Cu, Pd, Mn, Ni, Se, Br, B, F and P, all other monitoring can cease.
– Differing filtration sizes can cease as no observably significant difference was found between the two. It is recommended to continue with just the 0.1 µm filter size.
– While the previous recommendation of completing Cr speciation has been adopted, the detection limit of 0.025 mg/l for Cr VI is higher than the guideline of 0.001 mg/L. Future analysis should include a lower detection limit so the results can be effectively compared to the guidelines.

10.1.3 Acid Mine Drainage Management

The Approved EIS included an AMD assessment and management plan (AMDMP) for the Approved Project. The AMDMP will be updated and submitted with the mine management plan and to include management and monitoring requirements for the GSA, as specified in the subsection above.

11. Groundwater

11.0 Previous Assessment and Impacts

Section 8 and Appendix H of the Approved EIS describes the characteristics of the aquifer, groundwater quality and existing users within the project site and surrounding area, and impact assessment findings. Characteristics the targeted aquifer, where groundwater was extracted from, include:

– The target aquifer is the Hagen Member of the Chabalowe Formation, which infills the Georgina Basin. This is a regional scale aquifer system that extends many hundreds of kilometres through the Northern Territory.
– The groundwater storage within this formation is estimated to exceed 160,000 GL.

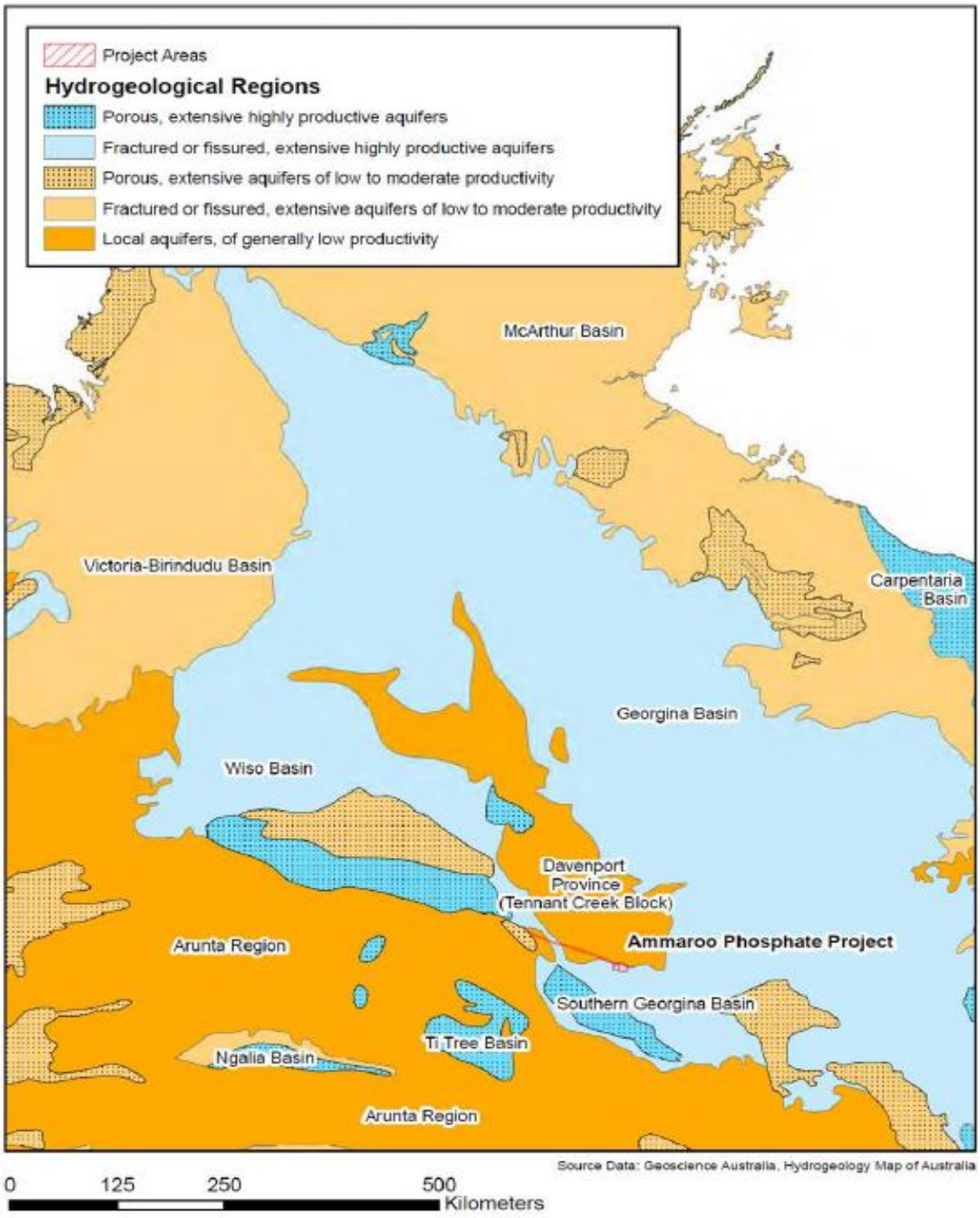


Figure 26 Location of the Ammaroo Phosphate project in the Southern Georgina Basin (IGS, 2022)

The Approved Project scope of groundwater extraction was 4.6 GLpa. Groundwater modelling was conducted for groundwater beneath the site, as per Appendix H of the Approved EIS (Groundwater Science, 2017). This report assessed impacts of groundwater extraction, groundwater flow and evaluated groundwater drawdown impacts. The modelling considered the estimated groundwater depth at the project site of 60 m below ground level (bgl), likely groundwater aquifer characteristics and the potential drawdown for water extraction at the bore field. The modelling showed that drawdown during the 25-year life of the mine would result in a maximum of 3.7 m at the closest pastoral bore (Hagen's Bore - RN010717), 2.7 m at the closest community bore (Ampilatwatja - RN011454) and 0.5 m within a 25 km radius of the project. The study concluded that drawdown would not affect water availability due to the extent and substantial vertical extent of the aquifer. The operating scenario reported the total extraction over the 25-year life of mine to be between 0.034 to 0.07% of the aquifer storage. This was within the Northern Territory's Water Allocation Planning Framework requires that "*total extraction over a period of at least 100 years will not exceed 80 per cent of the total aquifer storage at start of extraction".*

Potential direct and indirect impacts to groundwater detailed in the Approved EIS, included impacts during construction, operation and rehabilitation, and closure and are listed below:

– Drawdown of shared groundwater aquifers reducing availability and quality to existing users.
– Drawdown of groundwater levels reducing availability and quality to the environment (i.e., GDEs).
– Discharge or seepage of contaminated water (i.e., AMD seepage into groundwater aquifer).
– Process outputs (i.e., tailings) contaminating groundwater.
– Accidental spill of hazardous materials contaminating groundwater.

The highest residual risk identified was groundwater drawdown impacts to existing users. Drawdown was described to occur across multiple locations of the Project.

– Along the access corridor.
– At the mine site.
– At the bore field.

The impact assessment conducted considered that the impact to groundwater uses from water extraction could be managed by implementation of a Water Abstraction Management Plan which comprises monitoring of drawdown at sites of existing groundwater users within the region, baseline groundwater monitoring, regularly updating water balance calculations, reporting on continual improvement initiatives in water use efficiencies. These were recommendations as conditions of approval within NT EPA's Assessment Report 87 for Approved EIS.

To mitigate risks for AMD and contamination an AMD Management Plan and Hazmat Management Plan were recommended to be developed and implemented.

11.1 Proposed Project Potential Impacts and Assessment Required

It is proposed that the Proposed Project will require 8.5 GLpa of water to be extracted from groundwater (combined total for mining operation and fertiliser production). This is an additional 3.9 GLpa compared to the Approved Project. It is proposed that additional groundwater be extracted from 3 boreholes installed into the Georgina Basin carbonate aquifer. This may result in impacts to groundwater users, including:

– Drawdown of shared groundwater aquifers reducing availability and quality to existing users.
– Drawdown of groundwater levels reducing availability and quality to the environment (i.e., GDEs).

Revision of the groundwater modelling previously conducted is required to understand the potential impacts of the Proposed Project on groundwater and its users (IGS, 2022). This revised groundwater modelling also utilises updated the bore field testing and design conducted in February 2021 (Groundwater Science, 2021).

The assessment has also considered the impact to groundwater quality within and surrounding the Project area from potential spills from the fertiliser manufacturing plant, seepage to groundwater from the gypsum stack, and leak or spill of acidic water from the gypsum stack due to failure.

11.2 Additional Assessment Completed

11.2.0 Bore Field Testing

Groundwater Science (2021) undertook bore field testing in February 2021 to test the capacity of the target aquifer, and to establish the number and spacing of bores required to meet the increased extraction demand proposed (i.e., 8.5 GLpa). Three pilot holes were drilled at sites stepping out approximately 1 km each from the previously defined groundwater supply at PB1. The production bore PB02 was drilled to 114 m depth and cased with 323 mm steel casing. The bores installed are summarized in Table 17 and shown in Figure 27. Groundwater Science's report is provided in Appendix I.

Table 17 Bore field testing wells

Hole ID	RN	Easting	Northing	Depth	SWL	Yield
WI06	41710	504354	7617886	90	76.4	Lost Circulation – No yield data
WI07	41660	504995	7618572	96	77	Lost Circulation
WI08	41711	503556	7617972	168	81.9	Airlift Yield 2.2 L/s for 0.2 m drawdown
PB2	41712	503569	7617958	81.9	168	50 L/s

The testing comprised a constant rate pump test at the highest possible flow rate in production bore PB2, whilst monitoring water levels in PB2 itself and the 4 monitoring wells. To determine what flow rate would be sustainable, a step test was undertaken first. The step test indicated that the well could easily maintain the maximum possible flow rate achievable with the pump (~47 L/s). The pumping test was then set up to run at the 47 L/s for 7 days.

Observed drawdown in the observation wells was minimal, with all wells having less than 7 cm of drawdown after seven days of pumping. The pumped well, PB2, had a total drawdown of 3.18 m. The final drawdowns of each well are shown in Table 18.

Table 18 Drawdown observation

Well ID	Maximum Drawdown (m)	Radial Distance from PB2 (m)
PB2	3.18	0
WI08	0.06	19
WI06	0.06	788
WI03	0.06	1004
WI07	0.05	1553

The flow rate throughout the constant rate test was maintained at approximately 47 L/s. During the constant rate pumping test, the electrical conductivity (EC) along with pH was also recorded from PB2. EC was relatively consistent at 1,600-1,650 µS/cm, whilst the pH was stable at around 7.2.

Based on the results of the testing, the estimated aquifer parameters were calculated as:

– Transmissivity - 4,800 m^2/d.
– Specific Yield - 0.2 -0.05 v/v.

The parameters estimated were used for the groundwater drawdown modelling summarised in Section 11.2.1.

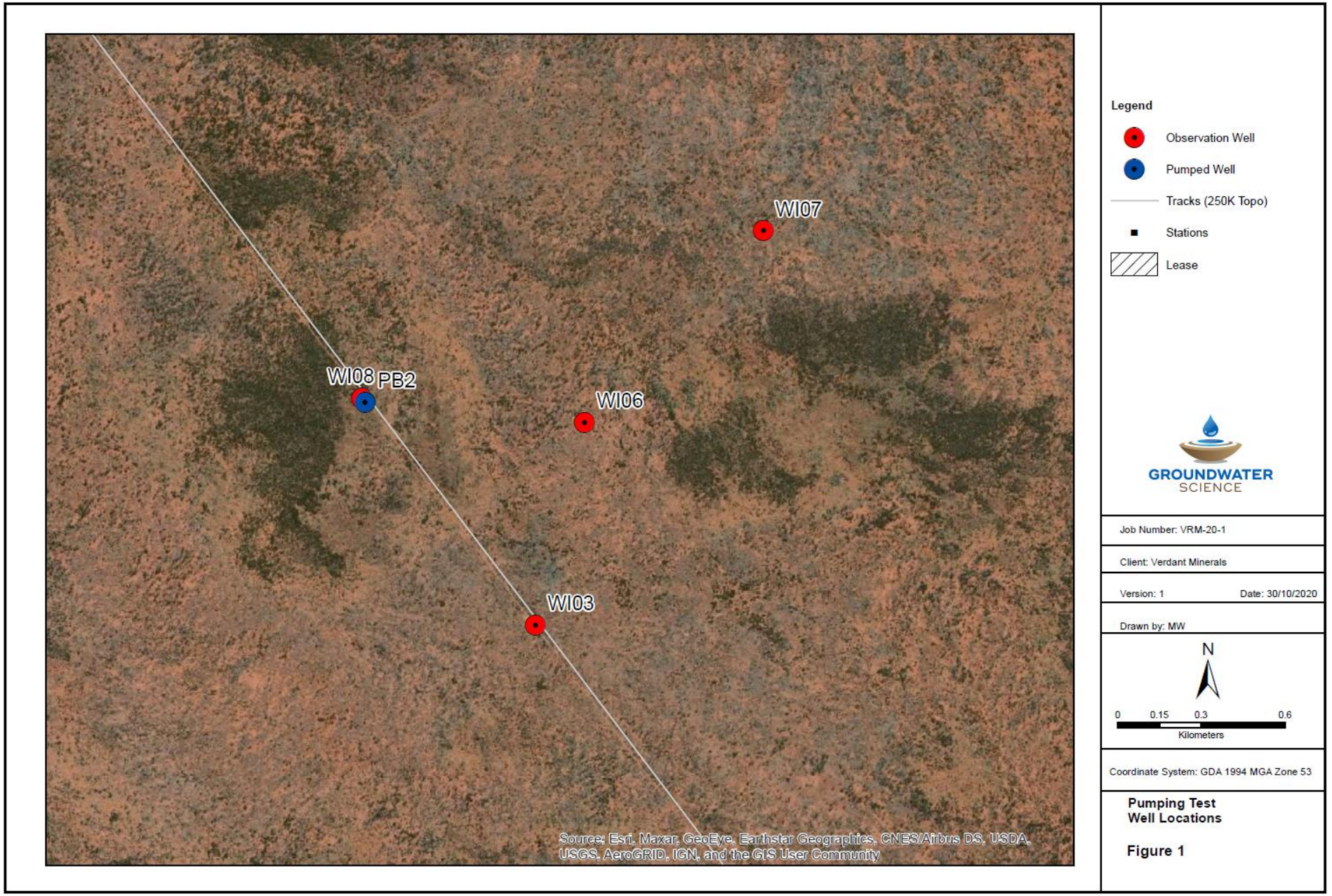


Figure 27 *Pumping testing well locations*

11.2.1 Updated Groundwater Modelling

In April 22, Innovative Groundwater Solutions (IGS) undertook updated groundwater modelling for the proposed 8.5 GLpa groundwater extraction for the Proposed Project (IGS, 2022). The report is provided in Appendix K and summarised below.

IGS's report aimed to assess the consequences of extraction of 8.5 GLpa from the proposed bore field, including:

– Groundwater drawdown impacts to existing users by simulating extraction at the nearest community bores.
– Changes to flux across the boundary of the Western Davenport Water Control District that results from the simulated extraction.

System properties used in the present study were derived from previous investigations conducted at the Project. Aquifer properties used in the current groundwater modelling investigation are presented in Table 19. Previous investigation by Groundwater Science (2017), precluded an assessment of the system heterogeneity option to simulate a homogenous aquifer of limit saturated thickness. IGS (2022) included a comprehensive uncertainty estimation of model forecasts, including aquifer heterogeneity.

Groundwater flow was simulated with MODFLOW-6 using Flopy and PESTPP-SEN. The groundwater extraction scenario was set at 8.5 GLpa and is distributed evenly among the three simulated production bores with extraction limited to 25 years. It is noted that IGS (2022) also include models simulating drawdown for 8.5 GLpa for 40 years.

Table 19 Systems property ranges obtained from previous investigation (IGS, 2022)

Property	Unit	Minimum	Maximum
Hydraulic conductivity	m/d	0.1	50
Specific yield	-	0.02	0.04
Recharge	mm/y	0.2	2.0
Connectivity (Conductance)	m^2/d	0.001	1000

The results of the updated modelling show that the drawdown after 25 years of extraction at the closest pastoral and community bores would be 2.6 and 0.9 m, respectively (P50). This does not represent a significant change from the drawdown predicted for the Approved Project. This because the previous model in IGS (2022) used updated specific yield and hydraulic conductivity parameters used for the IGS (2022) model. The parameters used in IGS (2021) are considered more representative than the Groundwater Science (2017) parameters as these were based on the aquifer testing conducted and the model system properties adopted.

A drawdown contour map for the P90 and P50 simulations in Figure 28 and Figure 29 gives an indication of the extent of the drawdown cone at the end of 25 years pumping.

Table 20 Comparison of simulated drawdown for 3.9 and 8.5 GL/year extraction models

Location	Well ID	Distance (km)	IGS 2022 8.5 GL/year extraction		Groundwater Science 2017 4.6 GL/year extraction		Year observed	Available drawdown (m)^
			P50	P10 – P90	P50	P5 – P95		
Ammaroo Well	WI04	0.0	-	-	8.6	5.2 – 17.9	25	N/A
Hagen's Bore (pastoral) - Peak Drawdown (m)	RN010717	11	2.6	1.5 – 4.9	1.9	1.5 – 3.7	25	N/A
Ampilatwatja Community Bore - Peak Drawdown (m)	RN011454& RN011455	20	0.9	0.4 – 3.0	1.2	0.6 – 2.7	25	9.1 & 13.7 (RN011454 & RN011455)
WDWCD - Peak Flux (ML/day)	-	20	0.6	0.2 – 4.0	1.45	0.44 – 2.5	25	-

^Groundwater Science 2017

Note: Direct comparison between the Groundwater Science (2017) and IGS (2022) models is not possible due to the differences in assumptions and designs of the models.

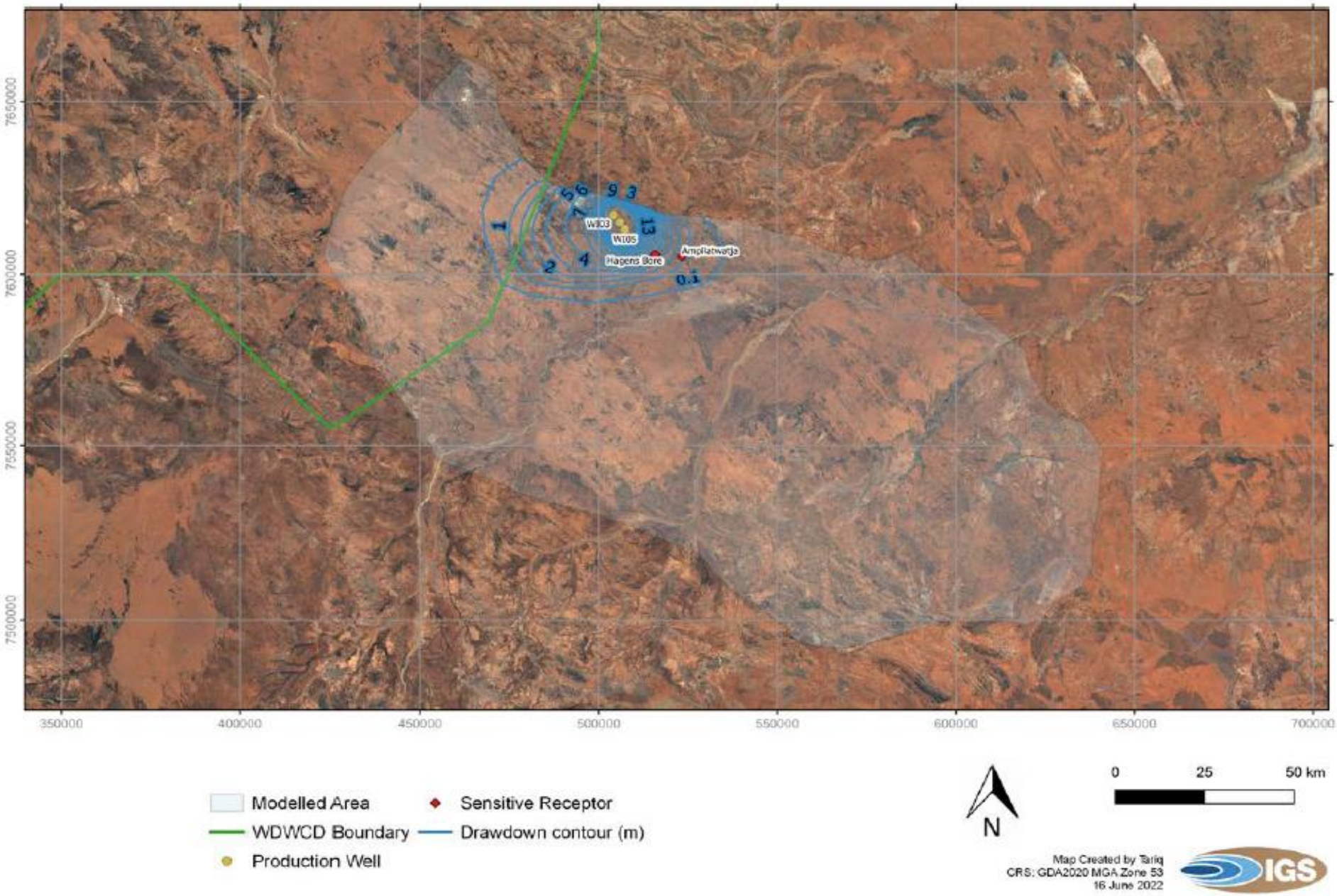


Figure 28 ***Drawdown contours at end of pumping at Hagen's Bore for P50 simulation (IGS, 2022)***

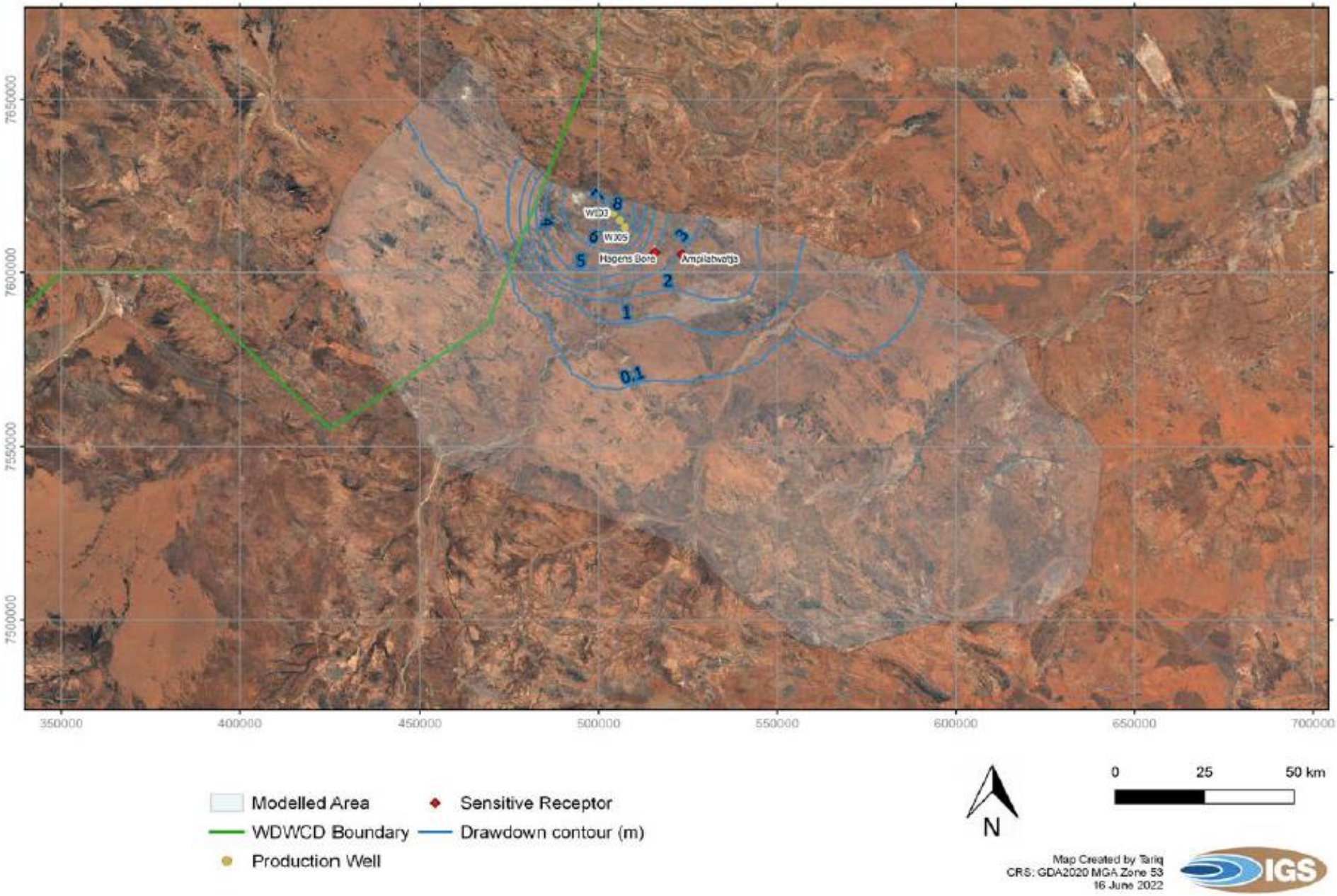


Figure 29 ***Drawdown contours at end of pumping at Hagen's Bore for P90 simulation (IGS, 2022)***

11.2.2 Peer Review of Groundwater Modelling

At the request of the NT EPA, Verdant also commissioned an independent Peer Review of the IGS 2022 Groundwater Model and Report. This Peer Review by HydroGeoLogic Pty Ltd (HydroGeologic, 2022) stated “It is my professional opinion that the hydrological modelling study (IGS 2022) has been undertaken consistent with best practice, notably in relation to the quantified uncertainty analysis methods applied...” and further “The (IGS) 2022 Ammaroo modelling study is commended for improving on the excellent previous modelling work ([Groundwater Science] 2017), and again confirms the low risk of significant drawdown at the existing user bores or material changes to the flux across the WCD boundaries

The full Peer Review Letter Report (HydroGeoLogic, 2022) is provided in Appendix J.

11.2.3 Proposed Project Impacts

11.2.3.0 Bore Fields

Based on the updated modelling conducted by IGS (2022), drawdown as a result of the proposed additional groundwater extraction (up to 8.5 GLpa) is probable (P10 to P90) to be:

– 1.5 to 4.9 m drawdown will be observed at the closest pastoral bore (Hagens Bore). This bore is located 15 km from the bore field.
– 0.4 to 3.0 m drawdown will be observed at the Ampilatwatja community. The Ampilatwatja bore field is about 20 km from the project bore field.

For the most likely groundwater extraction model (i.e., P50), it is unlikely that significant drawdown (i.e., more than 3 m) will result at existing user bores due to groundwater abstraction. Drawdown at Hagen’s Bore and at Ampilatwatja bore field being 2.6 and 0.9 m, respectively, which represents between 10% and 20% of the available drawdown at both locations. The proposed extraction therefore does not pose a significant risk of impact to other users with respect to reducing yields of adjacent bores (i.e., Hagen’s bore) and community water supplies (i.e., Ampilatwatja).

11.2.3.1 Western Davenport Water Control District

Project water use is not within the Western Davenport Water Control District (WDWCD) but is 20 km to the east of the boundary. Water table drawdown at the project bore field will induce flux across the WDWCD boundary. Groundwater flux across the WDWCD boundary is predicted to peak at 0.6 ML/d (i.e., for the P50 model).

The 10th and 90th percentile groundwater fluxes across the boundary of the WDWCD are predicted to peak at between 0.2 and 4.0 ML/d. Peak flux across the WDWCD is considered small relative to the total volume extracted from storage (23.3 ML/d) with the most likely rate of 0.6 ML/d equating to only 3% of the rate extracted from storage. This indicates that the most likely extraction simulation sources 97% of its water from areas outside the WDWCD.

11.2.3.2 Groundwater Dependant Vegetation

There are no GDEs located within the drawdown contour surrounding the bore field. No impacts to GDEs are therefore predicted.

11.2.3.3 Acid, Metalliferous and Saline Drainage

As specified in Section 10.1.2.0, AMD risks were assessed for the gypsum produced through the Proposed Project. The assessment concluded that metal concentrations in the leachate from gypsum waste would likely pose a risk to the surrounding environment, if not properly managed. However, the current stack design includes a lined base and runoff collection and suggests that there is a low risk of contamination to the surrounding environment (including groundwater).

11.2.3.4 Hazardous Material and Chemicals

Hazardous material, reagent, and chemicals such as diesel, oil and lubricants have the potential to impact groundwater. However, an accidental spill resulting in the contamination of groundwater is rare and would result in a minor impact due to the significant depth to the water table of 60 to 80 m providing a natural risk mitigation. As such, spills are considered a soil contamination risk rather than groundwater contamination. In addition, Verdant have established hazardous materials and chemicals handling procedures which reduce risk to groundwater (and soil).

12. Biodiversity

12.0 Previous Assessment and Impacts

In 2017, a Biodiversity impact assessment was conducted within the Project area. These findings formed the basis for the Flora and Fauna report for the Approved EIS (Flora and Fauna report – Appendix J) (EcOz, 2017). The scope of the assessment included the mining leases (ML 29463 and ML 29854), access corridor and gas pipeline (western extent of Project area), and water pertinent information from the assessment. Previous impacts detailed in Section 9 and Appendix J of the Approved EIS are summarised in the below subsections.

Matters of National Environmental Significance (MNES) and other matters protected under the EPBC Act are discussed separately in Section 13. This chapter provides bioregion context, habitat and sensitive vegetation, and potential impacts and mitigation measures previously established, which inform a discussion of the impact on MNES.

12.0.0 Bioregional Context

The Project area was identified to occur within the Tanami bioregion. This bioregion is comprised mainly of red sand plains with underlying rock strata occasionally exposed as hills and ranges. The sand plains are vegetated with mixed shrublands of *Acacia*, *Eucalyptus* or *Hakea* over spinifex hummock grasslands. In the ranges, *Acacia* shrublands occur over hummock grasses. However, the eastern extent of the Project area only partially reflects this bioregional description and is instead comprised of red earth soils dominated by Mulga or Gidgee plains, interspersed with red earth sandplains that support a mixture of hummock and tussock grass.

12.0.1 Vegetation and Flora

12.0.1.0 Habitat and Sensitive Vegetation

Previous habitat mapping conducted by EcOz identified forty habitat units within the Project area which fall within four landform and 11 habitat categories (Figure 30). Habitat categories include:

– Habitat category 1- red earth plains with tussock grass.
– Habitat category 2- sandy red earth plains with tussock and/or hummock grass.
– Habitat category 3 - red earth sandplains with hummock grass.
– Habitat category 4- desert sandplains with hummock grass.
– Habitat category 5 - low rises with tussock grass.
– Habitat category 6 - rocky rises with hummock grass.
– Habitat category 7 - rocky hills with hummock grass.
– Habitat category 8 - alluvial plains with tussock grass.
– Habitat category 9 - drainage floors or floodplains with tussock grass.
– Habitat category 10 - seasonal swamps.
– Habitat category 11 - drainage lines.

Habitat surveys conducted by EcOz (2017) identified one sensitive vegetation type, riparian vegetation, to occur within the Project area. Riparian vegetation was associated with tributaries of Taylor Creek, small ephemeral wetlands, drainage floors and claypans. Riparian vegetation identified along three tributaries to Taylor Creek occurred within the western end of the infrastructure/access corridor, with several claypans and small seasonal swamps within the infrastructure corridor, none which intersected the Project.

Habitat assessment further identified habitat features thought to have the potential to support sensitive riparian vegetation, which included drainage floors or floodplains with tussock grasses (habitat category 9), and seasonal swamps (habitat category 10). These areas become seasonally flooded and can support regionally important fauna (i.e., migratory birds). However, it concluded the habitat within the drainage floors did not have

characteristics typical of wetlands to support sensitive vegetation, and significant species were not identified. No groundwater dependent ecosystems (GDEs) were identified to occur within the Project survey areas.

12.0.1.1 Flora Species

The flora survey conducted in 2017 recorded a total of 348 flora species (EcOz, 2017). The Poaceae (grass family, 70 species), Fabaceae (pea family, 62 species), Malvaceae (29 species) and Amaranthaceae (24 species) were the most species-rich families recorded on the Project site. Flora species recorded comprised of:

- None that were threatened species under the EPBC Act and/or Territory Parks and Wildlife Conservation (TPWC) Act.
- None that were 'Near Threatened' species in the NT (under the TPWC Act).
- Three that were 'Data Deficient'.
- Five that were 'Not Evaluated'.
- Thirteen that were introduced, of which one is a declared weed under the *Weed Management Act 2001.*
- Three that have an unknown status (but are generally considered as introduced species).
- Four endemic species found only in the Northern Territory:
  - *Austrobryonia centralis.*
  - *Bonamia deserticola.*
  - *Corymbia deserticola.*
  - *Corymbia sphaerica* (Bloodwood).

  The endemic species are widespread within the region and have been recorded both within and outside of predicted Project disturbance areas.
- None that are considered to have a restricted range.
- The remaining are listed as 'Least Concern' under the TPWC Act.

12.0.1.2 Weeds

A review of the NT Weed Branch weed dataset as part of the biodiversity impact assessment of the approved EIS identified four declared weed species that have the potential to occur in the region of the Project site including:

- Parkinsonia (*Parkinsonia aculeata*) – Class B.
- Rubber Bush (*Calotropis procera*) – Class B.
- Athel Pine (*Tamarix aphylla*) – Class A.
- Castor Oil Plant (*Ricinus communis*) – Class B.

The most frequently reported species, with more than 1,300 records, was Parkinsonia.

The 2016 and 2017 field surveys identified 13 introduced flora species, of which one is listed under the *Weed Management Act 2001* as a Class B species (Rubber Bush*, Calotropis procera*). Previous surveys within the Project site and surrounding area recorded the presence of Buffel Grass (*Cenchrus ciliaris*) in low densities.

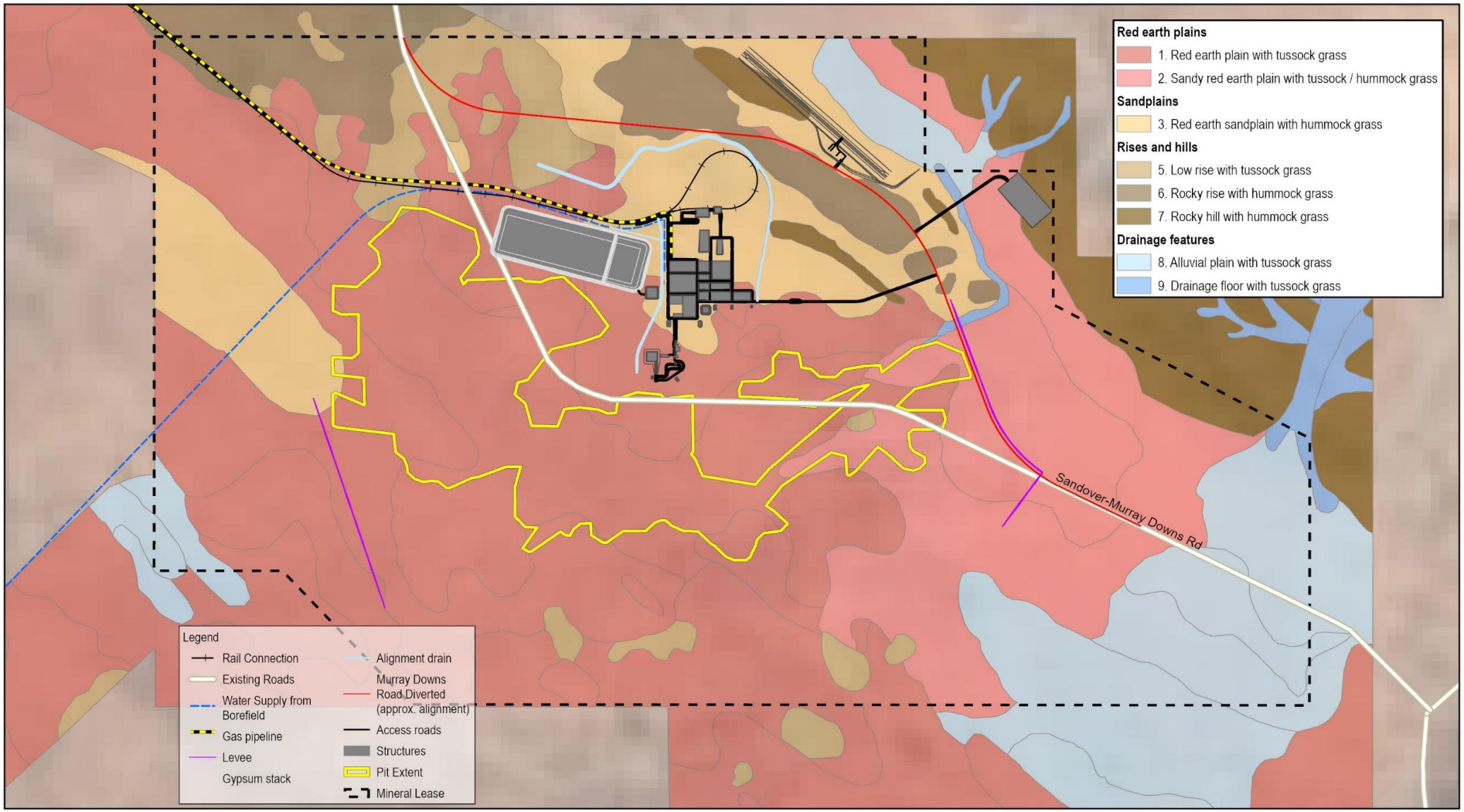


Figure 30 Vegetation communities within the study area (adapted from EcOz, 2017)

12.0.2 Fauna

12.0.2.0 Fauna Species and Introduced Species

A total of 133 fauna species were recorded during seven surveys within and surrounding the Project site between 2011 and 2017. These comprised 29 reptiles, 86 birds and 18 mammals. Sandplains and desert sandplains habitat areas recorded the highest activity and species richness.

Fauna assessments within the MLs conducted by EcOz (2017) recorded three near threatened species within the proposed alignments, including the Western Chestnut Mouse (*Pseudomys nanus*), Long-haired Rat (*Rattus villosissimus*) and the Northern Nail-tail Wallaby (O*nychogalea unguifera*). Two migratory species, the Rainbow Bee-eater (*Merops ornatus*) and the Glossy Ibis (*Plegadis falcinellus*), were recorded and are both listed as least concern.

Five introduced fauna species were recorded during the assessment, including the cat (*Felis catus*), rabbit (*Oryctolagus cuniculus*), house mouse (*Mus musculus*), fox (*Vulpes vulpes*), and cattle (*Bos taurus*).

12.0.2.1 Threatened Fauna Species

The following threatened species findings were identified during previous assessments:

– Grey Falcon (*Falco hypoleucos*) is considered likely to occur. Suitable foraging habitat exists within the Project sites.
– Two migratory species under the EPBC Act, namely the Rainbow Bee-eater (*Merops* ornatus) and the Glossy Ibis (*Plegadis falcinellus*) were present within the Project site.
– A total of 19 threatened species (Commonwealth and/or Northern Territory-listed) were determined to potentially occur within the region of the Project site. The likelihood of these species being present within the Project were assessed based on habitat requirements, distribution, and the quantity and dates of proximate records. The likelihood assessment concluded that five species were ranked as having a ‘high’ or ‘medium’ chance of occurring within the Project site. On completion of targeted field surveys for the five high or medium ranked species and/or habitat suitability assessment it was concluded that:
    - No threatened species were recorded within the Project site.
    - One threatened species (Grey Falcon) was considered likely to occur within the Project site.
    - Four threatened species considered by the preliminary assessment to have a medium chance of occurring within the Project area were revised to be considered as low likelihood of occurrence within the Project site.

The potential impacts to flora, fauna, and vegetation identified during the Approved EIS, are summarised in Table 21 below.

12.0.3 Potential Impacts and Mitigation Measures

Table 21 Approved EIS potential impacts and mitigation measures to flora, fauna, and biodiversity

Phase	Potential impacts	Description	Mitigation measures	Residual risk rating
Construction	Clearing vegetation and associated direct loss of vegetation, habitat, and limited fauna movement	Major impact on the integrity of the eleven habitat categories within the clearing footprint, and one that can only be gradually mitigated as rehabilitation progresses.	– Minimise amount of land clearance – Vegetation Clearing Procedure – Threatened species identification procedure – Biodiversity Management Plan	High
	Clearing of vegetation and soil disturbance resulting in erosion and/or sedimentation	Vegetation clearing and land disturbance, combined with rainfall run-off has the potential to cause erosion and/or sedimentation. Adherence to an Erosion and Sedimentation Control Plan would result in impacts no greater than a minor (i.e., small area) reduction in ecosystem integrity.	– Erosion and Sedimentation Control Plan (ESCP) – Water Management Plan	Low
	Introduction or spread of weeds resulting in habitat modification	Soil disturbance and movement of vehicles and machinery could lead to weed introduction or proliferation within the project site and adjacent areas. If weed management was not implemented consistently and effectively, it was considered possible that weed infestations would impact upon ecosystem integrity.	– Weed Management Plan – Bushfire Management Plan	Medium
	Machinery use and potential impact on individual fauna species via strike	There is the potential for interactions between the machinery used for vegetation clearing and fauna present in that vegetation. This could result in reductions in the local populations of some species that are less able to, or are reluctant to, evacuate their hiding places prior to them being cleared – such as nesting birds, nocturnal animals, and smaller reptile and mammal species that hide in burrows or tree hollows.	– Site Traffic Management Plan	Medium
	Trenching for the 137 km gas pipeline trapping fauna.	The establishment of linear infrastructure is unlikely to increase the distribution of the cat population.	– Trenching methods minimising open trenches	Medium
Operations	Alteration of hydrological regimes associated with mining in the pit. associated with linear infrastructure or other impediments altering surface flows	There were no permanent surface water impediments within the project site. Therefore, the likelihood of project activities impacting on surface water such that ecosystem integrity is compromised was considered rare, and any potential consequence would be insignificant.	– Water Management Plan	Low
	Introduction or spread of weeds resulting in altered fire regimes	Soil disturbance and movement of vehicles and machinery could lead to weed introduction or proliferation within the project site and adjacent areas.	– Weed Management Plan – Bushfire Management Plan	Medium

Phase	Potential impacts	Description	Mitigation measures	Residual risk rating
		If weed management was not implemented consistently and effectively, it was considered possible that weed infestations would impact upon ecosystem integrity.		
	Fragmentation of habitat resulting in an edge effect and reduction in habitat quality in uncleared areas	It was considered that the open, sparsely vegetated habitats within the project site will not experience any significant or substantial edge effects that will have a perceptible effect on ecosystem integrity. Consequence of fragmentation were considered minor in terms of areas of reduction in ecosystem integrity.	– Minimise amount of land clearance – Vegetation Clearing Procedure	Medium
	Machinery and vehicles resulting in soil compaction	Throughout the life of the project, the use of heavy vehicles could cause soil compaction. This could alter landscape character, reduce surface water quality, and cause difficulty in vegetation re-establishment. These impacts could lead to a reduction in habitat quality for flora and fauna.	– Site Traffic Management Plan	Low
	Groundwater drawdown from the bore field and/or changes to groundwater flows reducing environmental water	No groundwater-dependent ecosystems have been identified within the project survey areas. Therefore, although the project will be drawing upon groundwater to supply much of its water requirements, the impact of this on ecosystem integrity is expected to be insignificant.	– Water Management Plan	Low
	Noise from machinery disrupting roosting of foraging habitats and displacing fauna	There would be an impact of noise on the surrounding environment – during construction, the noise sources will be temporary and localised; during operations, the noise sources (i.e., plants and generators) will likely be some buffered by distance from the natural environment. The expected consequence was considered minor impact on ecosystem integrity.	– Noise Management Plan	Low
	Dust from mining and vehicle movement increased dust deposition on vegetation	The worst-case dust deposition rate was below the amenity criterion of 2 g/m^2/month (up to 12 grams of dust deposited over every square metre across an entire annual cycle), which is of the same order of magnitude that deposits naturally. The impacts associated with dust deposition on flora and fauna were expected to be insignificant.	– Dust Management Plan	Low
	Poor waste management increasing population of vertebrate pest species	With the implementation of a Waste Management Plan during construction and operations, it was considered unlikely that Project activities would cause an increase in vertebrate pest species, and so the effect on ecosystem integrity from that potential impact was considered insignificant.	– Biodiversity Management Plan – Threat Abatement Plans	Low
	Linear infrastructure facilitating the movement of feral fauna across landscape	Linear infrastructure has the potential to increase the area of habitat used by non-native predators (e.g., cats) through the creation of an easily traversed corridor. The establishment of linear infrastructure was unlikely to increase the distribution of the cat population, based on the already common presence of cats throughout the region.	– Biodiversity Management Plan – Threat Abatement Plans	Low

Phase	Potential impacts	Description	Mitigation measures	Residual risk rating
	Accidental chemical/hazardous material release contaminated surface or groundwater.	Potential for the accidental release of chemicals to impact upon flora and fauna, was considered low and the probable scale is small, resulting in, at worst, a minor reduction in ecosystem integrity.	– Hazmat Management Plan	Low
Closure	Inconsistent or inadequate rehabilitation reducing the quality of ecosystems in a post-closure landscape.	Topsoil will be stripped and laid out in windrows. Mining involves progressive rehabilitation over the life of the mine. Adherence to the Rehabilitation Plan would result in project activities not causing anything larger than a minor (i.e., small area) reduction in ecosystem integrity.	– Mine Closure Plan	Low

12.1 Proposed Project Potential Impacts and Additional Assessment

The Approved EIS outlines a range of potential sources of impacts that have a chance of occurring as a direct result of the Proposed Project.

Many of the potential impacts could be managed through updating management practices previously established. However, the alteration in the Proposed Project footprint (i.e., change in project positioning not the total project disturbance area) may impact flora, fauna, and vegetation not identified in the Approved EIS. Additional desktop assessment, detailed in Section 12.1, was undertaken to confirm the potential impacts on flora, fauna, and vegetation, including recently listed threatened species. The desktop assessment comprised a review of NR Maps and a review of previous biodiversity reports relating to the Project to understand the changes to infrastructure footprint on vegetation and habitat, and identification of changes in listed threatened species within the Project area and surrounding region.

12.1.0 Vegetation and Flora

12.1.0.0 Sensitive Vegetation Types

Based on the previous survey assessment, sensitive vegetation types of relevance to the Project area are associated with riparian areas and wetlands. One sensitive vegetation type will intersect the Project footprint, this includes:

– Wetlands – Habitat category 9 (drainage floors and floodplains).
– There is one weakly defined drainage line present within the north-eastern part of the mine lease. The Proposed Project proposes to intersect this habitat with reference to the planned access road footprint (Figure 30).

The 2017 survey confirmed this drainage line experiences sporadic and very temporary streamflow from the local rocky hills (habitat category 7). The field survey also confirmed that although aerial imagery suggests there to be a watercourse present, it was confirmed as a drainage floor due to the absence of defined channel, soil type and similar vegetation observed within other drainage floors in the area.

The Flora and Fauna report (EcOz 2017) in the Approved EIS has assessed the impacts from the works of the Approved Project potentially crossing the southern tip of the drainage line (previously assessed as the re-alignment of Murray Downs Road). The new alignment of Murray Downs Road has situated the road approximately 400 m east of the alignment that was previously assessed. The approximate area of potential impact to this habitat was assessed as around 0.5 ha. The Project also proposes to intersect the drainage line briefly on the access road to the accommodation village where an additional, 0.5 ha (approximately) of Habitat category 9 (drainage floors and floodplains) is proposed to be disturbed.

The Project is estimated to impact a total of ~1 ha of drainage habitat representing a relatively small area of habitat. Potential impacts to sensitive vegetation types are outlined in Section 6.3, Appendix J of the Approved EIS. It is not expected that the movement of road alignment (approximately 400 m east of previous alignment) and the small increase of area to be disturbed (approximately 0.5 ha) will cause any further potential impacts to sensitive vegetation.

No groundwater dependent ecosystems (GDEs) were identified to occur within the Proposed Project area.

12.1.0.1 Habitat within Project Footprint

Previous survey assessment conducted by EcOz in 2017 was used to identify broad vegetation communities within the Project site which are described in detail in Section 12.0.1. The habitat map is shown in Figure 30.

The new Project footprint can be classified within four vegetation types:

– Habitat category 1 – red earth plain with tussock grass.
– Habitat category 2 – sandy red earth plains with tussock and/or hummock grass.
– Habitat category 3 – red earth sandplains with hummock grass.

– Habitat category 6 – low rise with tussock grass.
– Habitat category 7 – rocky hills with hummock grass.
– Habitat category 9 – drainage floors or floodplains with tussock grass.

The proposed facility footprint crosses a variety of different landforms and associated vegetation. Facility structures occur between red earth plains (dominated by Mulga and/or Gidgee woodlands over tussock grass), sandy red earth plain with tussock/hummock grasses, red earth sandplains with hummock grass and rocky rise with tussock grass. The access corridors occur between all habitat categories outlined to occur within the Project footprint.

12.1.0.2 Flora Records

A review of the Natural Resource (NR) Mapping (DENR, 2022) desktop application of threatened flora species was conducted on 22 February 2022 and found no records of threatened flora species within the area of the Proposed Project. It is considered that the findings of the previous EcOz assessment are representative of the flora species present within the Project area.

12.1.0.3 Weeds

Previous comprehensive vegetation surveys (EcOz, 2017) identified the ML's had a very low weed presence with occurrences of isolated plants observed. An NR Maps search was conducted on 22 February 2022 and identified no introduced flora species within the Project area.

A Weed Management Plan was developed for the site which outlines strategies to limit the introduction of new weeds within the Project area and limit the spread of existing weed during project activities. Based on previous survey findings and the controls currently implemented onsite, it is considered that a very low weed presence is likely for the Project area.

12.1.1 Fauna

12.1.1.0 Fauna Species and Threatened Fauna Species Recorded within the Project Area

An updated assessment of the area was undertaken using the desktop application NR Maps on 22 February 2022 and identified no threatened or near threatened fauna species within the proposed Project area.

Previous assessment of threatened species likely to occur across the region of the Project area were conducted by EcOz (2017) and identified one species (Grey Falcon) as having a 'high' chance of occurring within the Project area and therefore were the focus of the field studies (GHD, 2017). The Grey Falcon is listed as Vulnerable under the TPWC Act and EPBC Act. There are several records of the Gray Falcon in the region. However, neither individual Grey Falcon nor potential nests were identified within the Project area during the field surveys (EcOz 2017). The assessment concluded the entire Project area constitutes suitable foraging habitat for the Grey Falcon. The assessment also concluded that the Grey Falcon could potentially nest within the Project area, however, the species' preference for tall trees means that the area does not provide optimal habitat. The floodplains adjacent to the Taylor Creek drainage systems are considered marginally suitable habitat for nesting, however, this habitat has not been identified within the Project footprint. The proposed access tracks traverse's floodplain habitat on two occasions, this floodplain habitat is considered marginally suitable for nest sites for Grey Falcon. The general occurrence of a Vulnerable species in the region within the Project area is not considered 'important' (as defined under the *EPBC Significant Impact Guidelines 1.1*) as assessed in the Approved EIS.

A desktop review (searched in July 2022) detailed one additional fauna species (Ghost Bat, *Macroderma gigas*) not assessed in the previous Approved EIS as potentially occurring within the Project area. However, there are no known historic records of this species within the Project area. The Ghost Bat is listed as Vulnerable under the EPBC Act and Near Threatened under the TWPC Act. Ghost Bats have not been identified in arid Australia and are considered regionally extinct in central Australia (Milne and Pavey, 2011), with only small, isolated populations in Northern Australia. During the survey undertaken in 2017, there was no suitable habitat present within the Project area to support foraging, breeding, or roosting of the species. The Ghost Bat's likelihood of occurrence has

been assessed in Section 12.1.1.2 below. Given that there are no previous records for the Ghost Bat within the Project area coupled with the lack of suitable habitat it is considered unlikely for the Ghost Bat to occur.

Potential land disturbance during the Proposed Project is not considered to significantly impact fauna species or threatened fauna species. Land disturbance has been minimised for the Proposed Project and will not increase the total area cleared from that estimated the Approved EIS (i.e., 3775 ha). Furthermore, the management measures previously established are considered adequate in reducing the potential impacts for the Proposed Project. These include:

– Minimise amount of land clearance.
– Vegetation clearing procedure.
– Threatened species identification procedure.
– Erosion and Sedimentation Control Plan (ESCP).
– Water Management Plan (WMP).
– Ongoing rehabilitation of cleared land during the mining process.

As outlined in the Approved EIS, if the Project is found to be disproportionally impacting upon near threatened species, it is recommended that species-specific management plans are devised in consultation with ecologist and relevant authorities.

12.1.1.1 Introduced Fauna Species

An NR Maps search conducted on 22 February 2022 found no records of introduced fauna species within the proposed Project area (DEPWS, 2022). Five introduced fauna species were recorded during the previous assessment, including the cat (*Felis catus*), rabbit (*Oryctolagus cuniculus*), house mouse (*Mus musculus*), fox (*Vulpes vulpes*), and cattle (*Bos taurus*).

The Biodiversity Management Plan and Threat Abatement Procedure developed for the Approved EIS are considered to reduce potential increases in introduced species since the Approved EIS. Therefore, the status of introduced species are considered to remain unchanged since the Approved EIS.

12.1.1.2 Likelihood of Occurrence and Potential Impact on Listed Threatened Species

The following assessment has been undertaken to examine the likelihood of occurrence and potential impact to listed threatened species not previously assessed under the Approved EIS. This assessment is based on desktop results, habitat requirements of the species, records and habitat values observed within the Project area including construction and operation activities that are sources of potential impact.

This analysis is used to provide greater detail for species with higher conservation status' under both the EPBC Act and TPWC Act i.e., those listed as 'threatened', 'endangered', and 'critically endangered'.

Table 22 Likelihood of occurrence and potential impacts

Species name Common (*Scientific*)	Conservation status		Data source	Records within and surrounding study area		Most recent	Likelihood of occurrence / potential impact within the Proposed Project footprint
	EPBC	TPWC		Project footprint	Within study area		
Mammals							
Ghost Bat (*Macroderma gigas*)	Vulnerable	Near Threatened	PMST	0	0	-	Occurrence: Unlikely, no previous records of the species exist within the Project area. Suitable foraging, breeding and roosting habitat for the species does not exist within the Project area Impact: Unlikely, suitable habitat does not exist within the Project footprint.

Key to table:

EPBC: Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999

TPWC: *Territory Parks and Wildlife Conservation Act* 1976

PMST: Information sourced from the Protected Matter Search Tool

NR Maps: Information sourced from the Department of Environment and Natural Resources (DENR) 2019 flora and fauna atlas (records not predictions).

Listing Codes: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Data Deficient (DD), Least Concern (LC)

Likelihood of occurrence of threatened species is assessed on a 4-tier scale: 1: Present – previously observed within 10 km of the development; 2: Possible - suitable habitat occurs within the development area, and site is within species' normal range; 3: Unlikely - suitable habitat does not occur within the development area, or suitable habitat present but substantially modified or degraded; 4: Highly unlikely – no suitable habitat within the development area and site is outside species' normal range.

12.2 Potential Impacts and Mitigation Measures

This section outlines the risk assessment summary associated with the Proposed Project impacts on the environmental values such as flora, fauna, and vegetation. The summary only captures the additional risks to biodiversity which were identified in relation to the changes in Proposed Project activities and/or events. It is noted that these activities which have the potential to impact the existing environment have a residual risk rating of medium to low, post control measures. These are included within Table 23 below along with their additional measures.

Table 23 Additional risks to biodiversity and mitigation measures

Activity	Recommended mitigation measures	Residual risk rating
Failure of gypsum stack closure resulting in erosion and seepage to the environment	– As part of the Mine Management Plan, an updated mine closure plan including gypsum stack area (GSA) will be submitted. – Construct to ANCOLD specifications, including liner. – Conduct regular inspections by accredited phosphogypsum stack auditors. – Update the Water Management Plan and Closure Plan to reflect the addition of the GSA. – A site-specific water management plan describing the procedures to be employed during closure of the system to manage the anticipated volume of process wastewater will be updated. – An estimate of all costs associated with closure of the system, including the costs of closing, any long-term care, and implementation of the site-specific water management plan. A description of all construction works necessary to properly close the system.	Low
Mortality of flora and fauna due to interactions with machinery used in land clearing	– Vegetation Clearing Procedure and Site Traffic Management Plan will be updated for the Proposed Project. *Note: The Proposed Development will not result in significant additional clearing compared to the Approved Project (i.e., small increase in the* disturbance *footprint in the localities of the airfield, access road, accommodation village, and bore field)*	Medium
Increased frequency and intensity of bushfires	– Bushfire Management Plan will be updated for the Proposed Project and include: – All construction activities, including establishment and operation of temporary camps, will occur within a cleared project footprint to minimise the risk of ignition sources coming into contact with flammable material (such as cleared vegetation). – Fire ratings and warnings in the area will be monitored and the proponent will liaise with Bushfires NT as required. – Fire breaks will be established.	Low
A reduction in habitat quality leading to a decrease in the diversity and/or abundance of flora and fauna species as a result of vegetation clearance	– Limit the disturbance of areas required for the airfield, associated access road, expansion of the accommodation village, and installation of additional boreholes in the bore field, within the overall disturbance area of Approved Project. Although there is a small increase in the disturbance footprint in these localities. – Erosion and Sedimentation Control Plan will be updated for the Proposed Project and outline management of soil to minimise erosion and sedimentation. – On-going rehabilitation of cleared land from year 1. It is noted that the Proposed Project will result in no additional clearing compared to the Approved Project. *Note: There may be additional land clearance required for the installation of renewables (wind and solar) associated with meeting a full GGAP when economic to do so. This however is to be defined at a later stage.*	Medium

13. Protected Matters under the EPBC Act

13.0 Previous Assessment and Impacts

Section 10 and Appendix J of the Approved EIS provides detail Protected Matters under the *EPBC Act 1999* conducted within the Project area. Appendix J of Approved EIS comprises the Flora and Fauna report which provides the findings of habitat biodiversity surveys conducted by EcOz Environmental Consultants (EcOz, 2017).

13.0.0 Threatened Species

Previous targeted EPBC listed threatened species surveys were carried out as part of the Approved EIS. EPBC listed threatened species previously assessed included the Greater Bilby (*Macrotis lagotis*) (Vulnerable) and the Great Desert Skink (*Egernia kintorei*) (Vulnerable). Targeted species surveys were undertaken, and a lack of evidence supporting the presence of the species indicated a low likelihood of the species occurrence within the Project area.

Additional threatened species that required an assessment of likely presence and habitat within the area as required by the then DEE included:

– Black-footed Rock-wallaby (*Petrogale lateralis*) (EPBC: Vulnerable, TPWC: Near Threatened).
– Brush-tailed Mulgara (*Dasycercus blythi*) (EPBC: Not listed, TWPC: Vulnerable).
– Southern Marsupial Mole (*Notoryctes typhlops*) (EPBC: Endangered, TPWC: Not listed).

These species were not included in the targeted survey effort and were determined to not be impacted by the Project.

13.0.1 Migratory Species

Other species protected under the EPBC Act that were assessed in the Approved EIS include namely the Rainbow Bee-eater (*Merops* ornatus) and the Glossy Ibis (*Plegadis falcinellus*), which are migratory species listed under bilateral international conventions, and have been confirmed to occur within the Project area during previous surveys.

The Rainbow Bee-eater is common and widespread, so habitats within the Project area are unlikely to be considered ‘important habitat’, and the individuals that occur are unlikely to be an ‘ecologically significant population’ (in accordance with the *EPBC Act*). The Glossy Ibis is a wetland species and generally found in wetlands and flooded grasslands. One sighting in the 2011 survey was recorded in close proximity to Woody’s Dam. This sighting is assumed to be of an opportunistic nature, as the dam supports neither a wetlands nor flooded grasslands habitat. The Glossy Ibis has not been recorded in subsequent surveys.

13.1 Proposed Project Potential Impacts and Additional Assessment

As noted in Section 12.1.1, an updated desktop search in July 2022 detailed one additional fauna species (Ghost Bat, *Macroderma gigas*) not assessed in the previous Approved EIS as potentially occurring within the Project area. However, there are no known historic records of this species within the Project area. The Ghost Bat is listed as Vulnerable under the EPBC Act. Ghost Bats have not been identified in arid Australia and are considered regionally extinct in central Australia (Milne and Pavey, 2011), with only small, isolated populations in Northern Australia. During the survey undertaken in 2017, there was no suitable habitat present within the Project area to support foraging, breeding, or roosting of the species. Given that there are no previous records for the Ghost Bat within the Project area coupled with the lack of suitable habitat, it is considered unlikely for the Ghost Bat to occur.

Based on the above, it is considered that the Proposed Project is unlikely to impact protected matters under the EPBC Act.

14. Human Health and Safety

14.0 Previous Assessment and Impacts

Section 11 of the Approved EIS provides a more detailed description of the scope and findings of the human health and safety study detailed below. Appendix K within the Approved EIS includes a Radiological Impact Assessment which evaluates specific risks to human health and safety associated with radiation exposure.

Verdant undertook a hazard identification and qualitative risk assessment workshop for the approved project. This workshop included the following scope:

– Identify potential hazards, including the hazards from naturally occurring radioactive material (NORM).
– Produce a qualitative risk assessment of these hazards.
– Assess the risks against the qualitative risk criteria.
– Discuss the management, prevention, treatment, and monitoring strategies used to minimise the impacts of the Project on human health and safety.

The study identified 30 hazards with potential human health and safety impacts, including 2 high risks, 23 medium risks and 5 low risks, as shown in Table 24.

Table 24 Qualitative risk – health and safety

Potential event	Residual risk level
Noise	Medium
Mosquito breeding	Low
Vehicle incident on-site	Medium
Falling from height or into depth	Medium
Confined space incident	Medium
Ground failure or rock fall	Medium
Contact with an electrical source	Medium
Struck by a dropped or swinging load	Medium
Tyre or rim incident	Medium
Flood	Low
Falling or dropped objects	Medium
Rotating or moving equipment	Medium
High-pressure release	Medium
Exposure to liquid / liquid bodies	Medium
Exposure to hazardous materials	Low
Engulfment	Medium
Poor slope stability following major rain event	Medium
Hazardous flora or fauna	Medium
Unauthorised site access	Medium
Vibration	Medium
Remote site location and / or undertaking lone and isolated work	Medium
Extreme climate	Medium
Manual handing	Medium

Potential event	Residual risk level
Radiation exposure on-site	Low
Fire or explosion	Medium
Bushfire from natural or human causes	Medium
Railway crossing incident off-site	High
Vehicle incident off-site	High
Increased worker traffic	Low
FIFO airplane accident (to offsite airport)	Medium

In the Approved EIS, transport related risks were assessed as high; however, a number of control strategies were identified to be implemented within the project, including design features to be incorporated in the facilities to reduce these risks so far as is reasonably practicable.

As part of the Approved Project, Verdant would also implement a health and safety management system that would be used as the basis for the management of all aspects of human health and safety. The project would also be developed in compliance with the relevant occupation health and safety legislation and applicable codes of practice. The health and safety management system would encompass an ongoing hazard identification program to identify any further hazards as the project progresses and where possible, these would be incorporated into the design of the facilities to eliminate, substitute, isolate or engineer human health and safety risks so far as is reasonably practicable. In the operational phase, the management system would incorporate operating procedures, systems, and processes to manage the identified risks. It would also include incident and emergency management systems, procedures, and resources to enable the effective response to an emergency and ongoing prevention of incidents through the incident investigation process.

Additionally, the risk management measures were adopted for the Approved Project, including for:

– Transport related risks.
– Ground control risks.
– Hazardous material exposure.
– Radiation exposure.
– Fire risks.
– Climate extremes.
– Remote area risks.

14.1 Proposed Project Potential Impacts and Assessment Required

14.1.0 Occupational Health & Safety (Accommodation Village)

A number of hazards associated with the Proposed Project will require consideration in Verdant's health and safety management system. Additional hazardous substances and dangerous goods handling and storage including ammonia, sulphuric acid, phosphoric acid, sulphur, molten sulphur, gypsum dust, silica dust, chemical vapours, FSA, SO_2 will need to be incorporated into occupational health and safety management procedures and controls.

The structure of the management system currently established for the site uses guidance provided by WorkSafe Australia and AS/NZS 4801:2001 Occupational Health and Safety Management Systems. As part of the management system, Verdant Minerals Risk Management Procedures require the maintenance of a site-specific risk register to identify and assess and minimise risks to human health and safety over the life of the Ammaroo project. Many of the risks associated with the Proposed Project were previous identified in the approved project. Nonetheless, identification of hazards, consequences, risks, and controls would be undertaken for the Proposed Project as part of the health and safety management system's ongoing risk identification process.

Furthermore, consideration of health and safety risk management will also be required as part of the MHF process, required following financial investment decision (FID) phase for the Proposed Project. Due to the likely status of

the Proposed Project as an MHF, NT WorkSafe would oversee operations and ensure Verdant are implementing health and safety measures for the risks onsite.

The health and safety management system that was established by Verdant, identifies health and safety risk and control measures to mitigate risks. The structure of the management system currently established for the site uses guidance provided by WorkSafe Australia and AS/NZS 4801:2001 *Occupational Health and Safety Management Systems*. As part of the management system, Verdant's risk management procedures require the maintenance of a site-specific risk register to identify and assess and minimise risks to human health and safety over the life of the Ammaroo project.

The Proposed Project adds health and safety aspects and operational complexity to the Project. During the design activities undertaken so far, the Proposed Project has completed formal Hazard Identification reviews (HazID's) for each of the major process plants and for the overall site layout. These have been independently chaired by each of the Engineering Service Providers and Licensors for each of the plants and have also incorporated lessons from existing operating plants.

All HazID's were formally recorded with actions either, closed out through changes during the Definitive Feasibility Phase (DFS), assigned to future engineering phases or assigned a management system mitigation, as appropriate.

Hazard Operability reviews (HazOP's) are not required at DFS level as they generally require a more detailed and frozen design. However, the Proposed Project has adopted a strategy to use existing reference process plants of the same capacity and design as those required and hence has benefitted from the knowledge, that any significant Hazop type issues associated with the process plants are inherently covered in the design.

From the 5 separate HazID's completed for the Proposed Project, the high-risk key Health and Safety hazards identified related to:

3. Mining and dry beneficiation
    - Release of silica containing dust from mining operations, crushing, and grinding, having the potential to expose personnel to silicosis with resultant health impacts.
4. Phosphoric acid plant
    - Fluoride fumes release to atmosphere, having the potential to expose personnel to a toxic chemical.
    - Acidic droplet discharge from the cooling tower, having the potential to expose personnel to skin irritation.
    - Sulphuric acid feed system leakage, having the potential to expose personnel to severe acid skin burns.
5. Sulphuric acid plant
    - Vanadium pentoxide catalyst dust, during shutdown catalyst screening, having the potential to expose personnel to carcinogenic materials.
    - Sulphur dioxide release to atmosphere, having the potential to expose personnel to sulphur dioxide inhalation.
    - Sulphuric acid release, having the potential to expose personnel to severe acid skin burns.
    - High pressure steam release, having the potential to expose personnel to injury from high pressure and temperature.
6. Ammonia plant
    - Ammonia release to atmosphere, vapourised ammonia resulting in an ammonia cloud. If ignited could cause a fire and explosion and having the potential to cause injury and exposure to a toxic gas. Natural gas release to atmosphere, a major gas leak can result in both a fire and explosion thereby having the potential for injury to personnel.
    - Hydrogen release to atmosphere, can result in both fire and explosion thereby having the potential for injury to personnel.
    - High pressure steam release, having the potential to expose personnel to injury from high pressure and temperature.

7. Granulation plant
    - Slurry release from the reactor (pre-neutraliser), having the potential to exposing personnel to hot slurry.
    - Ammonia release to atmosphere the consequences are the same as ammonia plant.
    - Natural gas release to atmosphere, the consequences are the same as ammonia plant.

The hazards associated with the Proposed Project are well understood, and there are appropriate actions and processes in place to ensure they will be fully addressed and managed as part of the MHF licencing process. This MHF process is required following financial investment decision (FID) phase for the Proposed Project.

14.1.1 Community Health (Accommodation Village and Wider Community)

With respect to community health, including residents of the accommodation village, the likely impacts associated with air quality, groundwater, surface water, transport, and noise and vibration from the Proposed Project have been re-assessed considering the proposed project changes. Residual risks are generally ranked as medium with the majority as low after controls. The potentially impacts on human health and safety are discussed across several sections of the EIS Referral and captured in the risk register (Appendix F).

15. Social and Economic Values

Section 12 and Appendix L of the Approved EIS provides a more detailed description of the scope and findings of the social and economic impacts of the Approved Project. At the time of referral preparation, a review of the social impact assessment (SIA) was undertaken, and preparation of an updated economic impact assessment is being prepared. The gap findings of the SIA assessments are described below, and in Appendix L.

15.0 Social Impact Assessment

15.0.0 Previous Assessment and Impacts

The ESIA for the Approved Project identified the following key benefits of the project during construction and operation:

- Improved community vitality in towns such as Tennant Creek due to increase in population and spending.
- Economic benefits for skilled workers, local businesses, and the broader region as a result of employment and procurement opportunities.
- Access to improved infrastructure for residents of Ampilatwatja, such as improved telecommunications and roads.
- Improved health outcomes through higher incomes and access to health promotion programs, drug, and alcohol testing.
- Community investment from the project contributes to cultural activities such as cross-cultural education of workers, arts, music, local festivals, and sports events.

The following key potential social impacts were also identified during construction and operation:

- Reduced community cohesion for residents in Ampilatwatja due to changed demographic composition and tensions over who received project benefits.
- Frustration and unmet expectations if local employment and procurement targets are not met due to lack of capacity or skills.
- Increased demand for local infrastructure and service providers, such as medical or emergency services.
- Increased demand and traffic on local road network, potentially leading to increase in road safety risk.
- Potential mental health issues for workers spending long periods away from home and family.
- Any loss of cultural heritage, such as damage to sacred sites, impacting on cultural and spiritual connections.
- Project evokes negative perceptions towards the use of water by mining in an arid area that may have other beneficial users, including concerns about cultural and aesthetic values of water.

A series of mitigation measures were recommended to maximise potential social benefits and mitigate potential social impacts.

15.0.1 Proposed Project Potential Impacts and Additional Assessment

The ESIA Addendum prepared for the Proposed Project provides a summary of how the existing environment has changed since the preparation of the ESIA for the Approved Project. A summary of these changes is provided in Table 25.

Table 25 Summary of change in existing environment – 2011 to 2016 and 2021

Area	Summary of changes
Tennant Creek (SA2)	Since ESIA 2017, Tennant Creek has changed through: – An increase in Aboriginal and Torres Strait Islander population from 52% in 2011, to 55.4% in 2021. – An increase in the proportion of people speaking a language other than English at home, from 39.7% in 2011, to 46% in 2016. – An increase in the proportion of the population who were born overseas, from 20.2% in 2011 to 25.6% in 2016. – A stable unemployment rate, which was stable between 2011 and 2016 (both 7.1%) – The largest industry of employment was local government in 2011, which became state government in 2016. – A greater rate of dwelling occupancy in 2021 (83.2%) compared to 2016 (70.3%).
Barkly (SA2)	Since ESIA 2017, the change in Barkly population can be characterised by: – A decrease in population between 2016 (2,539 people) and 2021 (2,203 people). – A decrease in the proportion of the population who identify as Aboriginal or Torres Strait Islander between 2016 (77.5%) and 2021 (72.4%). – An increase in the unemployment rate, from 11.5% in 2011 to 24.3% in 2016. – A reduction in housing occupancy, with 77.2% of dwellings occupied in 2011, compared to 64.7% in 2021.
Sandover-Plenty (SA2)	The change in the Sandover-Plenty population can be characterised by: – An increase in the median age from 28 years old in 2016 to 30 years old in 2021. – A decrease in the proportion of population who speak a language other than English at home, from 85% in 2016 to 80.9% in 2021. – An increase in unemployment, from 19% in 2011 to 42.6% in 2016.
Ampilatwatja (ILOC)	The population in Ampilatwatja and surrounding outstations has changed through: – A fluctuating population, which was 371 people in 2011, 462 people in 2016 and 425 in 2021. – An increase in the median age, from 20 years old in 2016 to 23 years old in 2021. – An increase in unemployment, from 43.9% in 2011 to 88.9% in 2016. – A fluctuation in the number of people per household, which increased from 5.8 people per house in 2011, to 6.3 in 2016. This decreased again to 6.1 in 2021, which aligns with the fluctuation in population. – An increase in the proportion of households who are renting, from 73.8% in 2016 to 82% in 2021.
Utopia and Arlparra (ILOC)	The population of Utopia and Arlparra can be characterised by: – A decrease in population, from 483 people in 201 to 372 people in 2021. – An increase in the unemployment rate, which was 26.8% in 2011 and was 72.4% in 2016.
Imangara (ILOC)	The population of Imangara decreased from 90 people in 2011 to 60 people in 2021. No other change was able to be identified due to the small size of the datasets.
Ali Curung (ILOC)	The population of Ali Curung can be characterised by: – A decrease in total population from 486 people in 2011 to 347 people in 2021. – An increase in the proportion of the population who spoke a language other than English at home, from 73% in 2011 to 83% in 2021. – An increase in unemployment, from 19% in 2011 to 37.9% in 2016. – A decrease in the average number of people per household, from 5.8 in 2011, to 5 in 2016, and 5.2 in 2021.

Source: ABS Census (2016 and 2021)

A complete summary of relevant demographic indicators is provided in the ESIA Addendum (Appendix L). This ESIA reviewed the impacts identified in the ESIA 2018, and the change to these social impacts as a result of the Proposed Project.

A summary of the key changes to potential benefits and impacts during construction and operation is provided below:

– A greater economic benefit to skilled workers, local businesses, and the region as a result of increase in expenditure on goods and services, and a larger workforce requirement.
– A greater risk of community and local businesses being frustrated if expectations for local employment and procurement are not met.
– The potential for the draw of skilled workforce from local businesses to work on the project during construction and operation.
– The potential increase of the chances of antisocial behaviour or safety incidents as a result of a larger construction and operation workforce on site, which may increase the demand for local emergency service providers.
– Presence of additional heavy vehicles on local roads may cause increased wear and tear of the road, which may cause inconvenience and be a safety concern for other road users.
– The extraction of more groundwater may concern some stakeholders, which could increase the negative perceptions and concerns about the project.

A number of additional mitigation measures were recommended in the ESIA Addendum to manage these potential social impacts and enhance potential social benefits. The additional measures recommended for the Proposed Project are listed in Table 26 below.

Table 26 Recommended mitigation measures

Impact category	Additional mitigation measures recommended for the Proposed Project
People and communities	– Continue to work with the Traditional Owners and Central Land Council to finalise the Native Title Agreement and governing structure. – Identify the opportunities for community benefits, that can be funded through the community benefit fund proposed in the Native Title Agreement.
Economy	– Update the Local Industry Participation Plan to reflect increase in potential opportunities for local businesses, including avenues for training and upskilling support provided to the businesses. – Prepare a Community and Stakeholder Engagement Plan to manage ongoing communication with key stakeholders (including pastoralists, NT Chamber of Commerce, local businesses, and government agencies), particularly regarding project updates, groundwater monitoring, and amenity impacts. – Verdant Minerals will work with pastoralists as per the conditions of the Approved Project, to monitor groundwater and any potential impacts to pastoral productivity (and in alignment with recommended mitigation measures made by Innovative Groundwater Solutions (2022)). – Ongoing collaboration with Traditional Owners and the Central Land Council to finalise the Native Title Agreement. – Continue to work with the CLC to provide support to Traditional Owners for governance arrangements. – Water bores constructed to support the construction of the rail spur will be left in place for use by pastoralists if desired.
Employment and education	– Verdant Minerals will prepare a Local Indigenous Employment Participation Plan to reduce barriers to employment and maximise employment opportunities for residents of the near region. – Develop partnerships with employment services and social enterprise services in Tennant Creek to maximise opportunities for long term employment for local people, particularly residents of Ampilatwatja (e.g., Saltbush).
Health, wellbeing, and safety	– The Project would have strict traffic management protocols to ensure the safety of all road users. This could include traffic safety awareness campaigns and notifying other road users of oversized vehicles approaching. – The Proposed project will discourage DIDO workforce unless meeting strict protocols and such journeys are unavoidable.

Impact category	Additional mitigation measures recommended for the Proposed Project
	– develop a Community and Stakeholder Engagement Plan that includes updates to the Ampilatwatja community and surrounding pastoral stations regarding potential amenity changes. – Establish an ongoing dialogue and avenue to capture potential issues and concerns with the operation of the airfield on surrounding stakeholders in the long-term.
Culture and heritage	– No additional mitigation measures are required for the Proposed Project
Environment	– Verdant Minerals will prepare a Community and Stakeholder Engagement Plan that includes key messaging and engagement with regional stakeholders on the increase in groundwater use, and ongoing reporting on groundwater monitoring results.
Human Rights	– No additional mitigation measures are required for the Proposed Project.

15.1 Economic Impact Assessment

Verdant commissioned ACIL Allen Consulting (ACIL Allen) to conduct an Economic Impact Assessment for the Proposed Project. A complete summary of the economic impact assessment is provided in Appendix Q.

The findings of the assessment are presented in the form of the direct and indirect economic impacts on the economies of the local Barkly region (Barkly), the Northern Territory, and Australia over the Project life from construction through to operations. The results consider what is meant by direct and indirect impacts.

In the case of employment, the direct jobs created by the Proposed Project fall into construction phase and operational phase. For the Proposed Project, the direct employment impact will average approximately 830 full time equivalent (FTE) construction jobs over each of the three years of construction, peaking at more than 1500. During the operational phase, an average of 556 FTE direct workers in each year of operation will be required.

Additional benefit to the economy will be obtained through the indirect jobs resulting from the construction and operation of the Proposed Project. These indirect jobs result from the purchases made by Verdant during construction with commensurate increase in activity and income for Australian businesses.

Outside of the economic benefits, it is expected that the Proposed Project of Ammaroo will be strongly aligned with a number of core economic and social development policies committed by the NT Government with a range of benefits to the Territory:

– $40 billion economy by 2030 – Development of the Ammaroo Project will increase annual GTP buy by an estimated $350 million and make a material contribution to the Northern Territory achieving an economy of $40 billion by 2030.
– Economic diversification – Once developed, the Proposed Project will be the first major downstream fertiliser project in the Northern Territory, and is complimentary to the development of the Agri-business, mining and manufacturing sectors which are targeted industries of the NT's economic development framework.
– Regional Development – The Proposed Project will provide a significant economic boost to Central Australia, which has suffered from minimal investment and has traditionally relied on tourism to drive economic opportunities for its residents.
– Population Growth – The Project will provide high quality, long-term sustainable jobs, which will increase the Northern Territory Population by attracting high skilled workers and their families.

The key metrics from the economic impact assessment highlight:

– The Proposed Project will create long term, sustainable job opportunities for local people, which will result in a more diversified jobs market in the currently narrow job market in the region, particularly for Indigenous people who currently experience a high level of unemployment. During an expected 25 years of operations, it is estimated the majority of the employees will be from the Northern Territory, with the potential for more than 100 employees sourced from the Barkly region.
– During construction, the Ammaroo Project will require an average of 830 FTE workers a year.
– During steady state operation, it is estimated that the Project will continue to directly employ 556 FTE workers in each year, with more than 300 of which will be engaged in site roles at the Project site and 78 in Darwin.

- The capital expenditure associated with the Project includes investment in construction of the manufacturing plant and also infrastructure to support the long-term mining and manufacturing operations, which will provide benefits to local industry and the community for the life of the mine operations.
- The construction expenditure of the Ammaroo Project is estimated to have an Australian content approaching 76 per cent. Of the total spending in Australia an estimated $932 million will be spent in the Northern Territory, including some$311 million in the local Barkly region.
- The Project will begin operating in 2027-28. Over the following 25 years there will be over $10.3 billion of operational spending, or an average of $413 million a year. This excludes rehabilitation spending, royalties, payroll taxes or Native Title compensation payments.
- Nearly $5.8 billion, or 45 per cent, of the total operations expenditure will be spent on goods and services purchased from the Northern Territory, or an average of around $231 million a year. Similarly, it is expected that 16 per cent of all operational expenditure will be spent in the local Barkly region. This is equivalent to a total of $2.0 billion over 25 years or $82 million a year.

During the operations phase, a further $508 million is expected to be spent on Northern Territory payroll taxes, royalties, and Native Title compensation.

16. Aboriginal and Historic Cultural Heritage

16.0 Previous Assessment and Impacts

Section 14 and Appendix N of the Approved EIS provides a more detailed description of the scope and findings of the desktop assessment and field investigations described below.

Verdant have established relationships with Traditional Owners and previously organised Indigenous stakeholder consultations in relation to the cultural heritage surveys, and to allow review and input opportunities for the Cultural Heritage Management Plan (CHMP).

A review of the Approved EIS was undertaken to identify registered sacred, natural, and historic sites, places, or objects. This review included a review of records from the Aboriginal Areas Protection Authority (AAPA) Authority Certificates, Central Land Council (CLC) cultural exclusion zone coordinates and a review of databases in October 2016 including Northern Territory Heritage Branch Archaeological Site Register, National Native Title Tribunal Register and the EPBC Act Australian Heritage Database.

The field investigations to identify additional Aboriginal archaeological sites were conducted from 29 October to 6 November 2016, and from 31 March to 2 April 2017, and identified:

– 29 artefact scatters.
– 2 artefact scatters/quarries.
– 3 artefact scatters/knapping floors.
– 76 isolated artefacts.

The sites in the Project Area ranged in size from 1 m^2 to an estimated 15,000 m^2. The sites with quarries were all found near surface rock outcrops associated with the Chabalowe Formation, confirming that local stone outcrops were used for sourcing raw materials. The main artefact types identified during the study include flakes, cores, broken flakes, tulas, and pounding and grinding stones. Raw material types present in the overall artefact assemblage within artefacts scatters include chert, silcrete, quartz and quartzite.

The archaeological significance of Aboriginal sites was assessed in the Approved EIS using the four criteria outlined in the Australia ICOMOS Burra Charter, 2013 (the Burra Charter); aesthetic, historic, scientific, and social or spiritual significance (Australia ICOMOS, 2013).

The mitigation measures established had consideration of the assessed scientific significance, legislative requirements and planning approval framework, and heritage best practice (in accordance with *The Australia ICOMOS Charter for Places of Cultural Significance, 2013.* It was also considered that surveyed archaeological sites identified were either low or moderate archaeological significance. There were no sites of high archaeological significance within the Project site and within the broader project area. Of the 110 archaeological sites recorded during field survey, 20 sites were located within the footprint of proposed infrastructure and would be directly impacted by the Project. An additional 61 sites have the potential to be indirectly impacted by the project. In addition, given that the field survey covered approximately 30% of the project site, it was also likely that additional, as yet unknown archaeological material was present.

The mitigation measures established to reduce potential impacts to cultural heritage included:

– Avoiding landscapes where archaeological sites were identified. A significant proportion of the archaeological sites were located in association with specific landscape features, in particular cobbles/pebbles and chert-bearing rock outcrops in the southwest of the Project area associated with the Chabalowe Formation. Avoiding these types of landscape features, where possible, reduces risk of impacting unknown archaeological resources.
– Where possible, options to avoid adversely impacting identified heritage items would be considered.
– A Cultural Heritage Management Plan (CHMP) be developed and implemented during project construction and operation.

The impact assessment found that the residual impacts of the Project are expected to be low to medium.

The provision of a CHMP to Indigenous stakeholders and Traditional Owners would occur for review purposes prior to implementation and following any significant revision or modification. Approval would be sought prior to submitting a work approval application for archaeological mitigation or permission to disturb Aboriginal archaeological places and objects within the Project site in accordance with relevant legislation.

16.1 Proposed Project Potential Impacts

The exclusion zones currently present onsite will also be maintained for the Proposed Project. At the time of referral preparation, consultation with Traditional Owners and CLC were ongoing, with the intent of obtaining a Native Title Mining agreement and sacred site clearance certificates for the Proposed Project to conform with the Native Title Act and Sacred Sites Act. Direct and indirect impacts to archaeological sites and artifacts will be recorded through this process. Subject to the granting of these approvals and certifications by these stakeholders and organisations, cultural heritage impacts of the Proposed Project will be adequately addressed and protected.

To mitigate any further potential impacts to cultural heritage, the site CHMP would be updated to include the Proposed Project construction and operation. The CHMP, in consultation with the custodians, is likely to include the following mitigation measures:

– Consultation and engagement with Traditional Owners and custodians.
– Measures to enable the Proponent to meet its duty of care to protect the cultural and heritage values of any places or items of significance, including, where necessary.
– Approval to carry out work on heritage place or object will be sourced from NT Heritage Branch prior to construction.
– Planning for an appropriate recording and salvage program if requested.
– Procedures to avoid sites and areas incl. appropriate signage, or sites clearly marked.
– Code of behaviour.
– On-going cross-cultural training as part of construction and operation for all employees.
– Procedures for the discovery of surface or sub-surface items during the course of the Project.

17. Transport

17.0 Previous Assessment and Impacts

Section 13 of the Approved EIS describes the potential traffic and transport impacts related to the Approved Project and appendix M of the Approved EIS providing the traffic impact assessment report conducted by GHD in 2017.

Due to the change of scope for the Proposed Project, the level of traffic generated to and from the site will be greater than projected within the TIA 2017. Nevertheless, due to the expanded period of construction of the Proposed Project, increased from 18 months to three years, the change to daily traffic volumes is estimated to be low in road capacity terms, given the local road network is considered to have sufficient capacity to accommodate the forecast additional traffic volumes.

The key impact will be the heavy vehicle trips will increase by more than 10 trips per day to the external road network and by more than 60 trips per day to the internal (Project boundary) road network. While these additional volumes can be supported by the road network, the impacts will need to be managed. Mitigation measures for these additional volumes have been outlined within the following section.

17.0.0 Background

The key roads within the area impacted by the project are Stuart Highway, Murray Downs Road (and Kinjurra Road) and Sandover Highway.

The Stuart Highway (National Route 1/National Route 87) is a national highway connecting Darwin, in Northern Territory, and Port Augusta, in South Australia, and linking the key rural population centres of Katherine, Daly Waters, Tennant Creek and Alice Springs. Within the nearest vicinity of the project site, it is generally a sealed two-lane, single carriageway road with one lane in each direction. The width of seal is approximately 7 m wide with unsealed shoulders and the posted speed limit is 130 km/h.

Murray Downs Road is a two-way, single carriageway road that connects from Ali Curung in the north-west to the Sandover Highway in the southeast. Murray Downs Road is used predominantly by road trains transporting cattle, tourism traffic associated with the Binns Track, and locals. The road consists of both unsealed formed road sections and gravel sealed sections. Near the project site, the road is approximately eight metres wide, and a default speed limit of 110 km/h applies.

Kinjurra Road is a sealed two-way single carriageway road with 8 km of two-lane seal and 14 km of single lane seal (formation varies from 7–9 m). The road connects with Murray Downs Road at Ali Curung (in the east) and connects with Stuart Highway in the west. A default speed limit of 110 km/h applies.

The Sandover Highway is an unsealed two-way, single carriageway road connecting the Queensland Border in the north-east to Plenty Highway in the south-west. Plenty Highway then connects to the Stuart Highway, approximately 70 km north of Alice Springs. A default speed limit of 110 km/h applies.

17.1 Proposed Project Potential Impacts and Assessment Required

Increases in traffic movement during construction and operation of the Proposed Project may impact road networks used for transport. Therefore, the traffic impact assessment (TIA) previously undertaken was revised for the increases in traffic volumes, as detailed below. The revised TIA focuses on the construction traffic as this is considered the largest potential impact. The findings of the revised TIA were that the net change in vehicle trips for the Proposed Project is not expected to have any undue impact on the road network. The Revised TIA addendum report is provided in Appendix M.

17.1.0 Construction Traffic

The total construction period of the Proposed Project is expected to be up to 3 years. However, it is considered that the peak construction period, where the majority of truck movements would occur, will be approximately 24 months. The light and heavy vehicle movements during construction have been detailed in the subsections below.

17.1.0.0 Light Vehicles

The light vehicle movements generated during construction will typically comprise of trips generated by:

– Workers being transported between the accommodation village and the airfield.
– Workers driving to the accommodation village by private vehicle.
– Workers being bused between the accommodation village and the job site.

For purposes of this assessment, it will be assumed that the construction workforce is comprised of 1,600 workers, in accordance with the projected construction peak. Furthermore, it will be assumed that 90% of the construction personnel fly in, while the remaining 10% will drive by private vehicle.

Application of this split to the peak workforce of 1,600 workers equates to 1440 workers travelling by plane and 160 travelling by car.

To/from the accommodation village by plane

Based on a typical FIFO roster whereby workers have three weeks on followed by one week off, with flights running at least twice per week, nominally 250 workers fly in and out on each flight day.

Buses travelling between the Airfield and the accommodation will be able to accommodate up to 50 workers each. As such, on flight days there will be between 5 and 9 bus trips per flight, with buses carrying passengers in each direction, equivalent to 18 movements in both directions.

It is assumed that 10% of bus movements will occur during the peak hour, equivalent to 2 movements in each of the peak hours.

To/from the accommodation village by car

With approximately 160 workers travelling to/from the site by private vehicle, based on the same 2- and 4-week turnovers, it will be assumed that approximately 53 workers arrive and depart the accommodation village each week.

Spread across the week, the workers travelling by private vehicle are expected to generate an additional 8 car trips to/from the accommodation village each day. It will be conservatively assumed that 50% of these movements will occur during peak hours.

To/from the job site

Each day the workforce will be bused between the accommodation village and the job site. Based on the use of 30- and 50-seater buses, everyday there will be between 27 trips (800 workers) and 54 trips (1600 workers) generated in each of the morning and evening peak hours. This equates to a total of 54-108 daily trips in both directions.

It is noted that trips between the accommodation village and the job site were not considered in the TIA 2017 as they did not utilise the public road network. However, for information purposes these trips have been included in this update.

Total light vehicle movements

A comparison of the traffic generation projections from the Approved Project TIA 2017 and the Proposed Project is included in Table 27 below.

Table 27 Light vehicle traffic generation

Trip type	AM peak		PM peak		Daily	
	Approved	Proposed	Approved	Proposed	Approved	Proposed
Airport shuttle bus	2	2	2	2	14	18
Other LVs	5	4	5	4	20	8
Work shuttle bus	-	54	-	54	-	108
Total	**7**	**60**	**7**	**60**	**34**	**134**

17.1.0.1 Heavy Vehicles

Heavy vehicle movements across the construction period will comprise:

– Material and equipment deliveries to the job site.

– Internal truck movements between the works areas and the borrow pit.

The heavy vehicle trip generation is outlined below. Heavy vehicle estimates have been estimated in Table 28. Within the 24-month peak construction period, approximately 5,750 truck movements transporting equipment and material will be required on public roads. It is expected that most heavy vehicles used to transport materials will be standard B-doubles, however over mass vehicles will be used to transport large equipment associated with the various processing plants. Heavy vehicle movements are anticipated to be approximately spread across the workday.

Most of the equipment and materials required for construction will originate from Darwin, with the remainder originating from Adelaide. In addition, gravel and concrete material will be extracted from borrow pits on site.

A further 122,150 truck movements are expected within the project site as local trips, primarily to and from borrow pits within the 12-month peak construction period. It is considered 104,150 of these truck movements are expected to be fully contained within the project site and will not affect the public road network (i.e., mass excavations).

It is noted that the haulage estimates in Table 28 are approximate values and may vary by plus or minus 15%. For example, there may be the opportunity to transport rail line components using the railway.

Heavy vehicle movements are anticipated to be approximately evenly spread across the workday. As such, a conservative assumption that only 10 per cent of daily trips will occur in the peak hour has been adopted.

Table 28 Construction heavy vehicle estimates

Description	Unit	Quantity	Type of package	Truck journeys -ex Darwin or Adelaide	Truck – from borrow pits	Comment
Railway above ground equipment	Te	11,100	Rail Line & components	925		Potential for most to be delivered by rail in 25 m Lengths
Buildings/ Accommodation/ Crib/Office	Modules	433	Bed units	210		Two building modules per truck journey 15 m by 3.5 m, 1,300 rooms
		130	Kitchen/Laundry/ units	65		
		10	Laundry units	5		
		10	Offices units	5		
		20	Misc. containers	10		
Culverts	EA	739	12 m x 0.6 to 2.1 m	10		
Fencing gates	LM	4,000	120 m rolls	5		Cattle fence with ring lock for TFS, CLC Sites, process areas
Gravel	CM	1,200,000			15,000	40 t loads B-doubles
Mass excavations	CM	4,660,352	Plant		70,600	Local dump and 40t loads B-doubles
	CM	1,300,000	Rail		19,700	
	CM	933,425	Airfield		14,150	
Concrete	Te	154,153		880	2,700	40 loads B-doubles, 23 kt Cement @15% Cement/m^3, Aggregate @70%
Structural steel, stairs, sheeting	Te	35,000	Sub-assemblies and loose	1555		Riser/ units 2*4m 8 per wagon, B-doubles
Piping	LM	145,964		500		Spools in 40 t loads B-doubles
Sub stations	Unit	50	Large loads - escorted?	40		Preassembled units
Electrical equipment	Units	Varies	Non packaged equipment, fittings, and bulks	220		Containers B-doubles
Process Equipment	EA	760	Large equipment not in modules; mill 360 t, crusher 100 t	280		120 large single loads, 65 B-doubles
Escorted Loads	Units	50	Pre-assembled units	80		Includes oversize and overweight modules subject to journey survey and construction strategy.
	Units	42	Heavy construction Equipment, cranes etc	170		
	Units	18	Mining Fleet	35		
Diesel, Oils & Chemicals	Units		Tankers and Iso packs	60		B-doubles

Description	Unit	Quantity	Type of package	Truck journeys -ex Darwin or Adelaide	Truck – from borrow pits	Comment
Camp consumables	Units		Containers - Refrig + Misc	450		B-doubles
Construction Equipment	Units		Misc construction tools and equipment	205		B-doubles
Contingency	Units		Nominal	45		
Total			**Combined loads of different types**	**5,750**	**122,150**	

Deliveries

Over the 3-year construction period there is projected to be approximately 5,750 truck movements transporting equipment and materials to the site, equivalent to 11,500 movements in both directions. It is expected the majority of equipment and materials will be sourced from the north (Darwin), with the remainder sourced from the south (Adelaide).

Noting deliveries are generally expected to occur on weekdays only, based on a five-day week with exceptions for public holidays, over the year there is expected to be approximately 8 deliveries per day being an equivalent to 16 heavy vehicle movements in both directions.

As a safety precaution, heavy vehicles will only be permitted to drive on sealed roads at night-time, with all trips on unsealed roads to be completed during daylight hours. Between Tenant Creek and the site, trucks will run through during daylight hours. To ensure traffic impacts are minimised, truck departures and arrivals will need to be staged. Due to the daylight requirements, it is expected that trucks will depart at any time from first light up until approximately 2:00PM.

With traffic departures to be dispersed over as little as 7 hours, it will be assumed that 15% of trips occur during the peak hours, noting all truck movements will be outbound in the morning peak, and inbound in the evening peak.

Based on the above, there may be up to 3 truck movements observed in any peak hour.

Internal trips

Within the site, it is estimated there will be approximately 122,150 truck movements, primarily to and from the borrow pits. As these will be internal on-site movements, these trips are not typically expected to utilise the public road network.

Total heavy vehicle movements

A comparison table of the heavy vehicle traffic generation projections from the TIA 2017 Approved Project and the Proposed Project is provided in Table 29 below.

Table 29 Heavy vehicle traffic generation

Trip type	AM peak		PM peak		Daily	
	Approved	**Proposed**	**Approved**	**Proposed**	**Approved**	**Proposed**
To/from external road network	2	3	2	3	6	16
Internal road network only	5	11	5	11	51	112
Total	**7**	**14**	**7**	**14**	**57**	**128**

17.1.1 Operational Transport

The primary transport method for bulk materials and products during operation of the Proposed Project will be via the constructed private railway spur line. A single train comprising approximately 124 bottom dump covered wagons plus general freight wagons will cycle between the site and the Darwin Port and Adelaide Port. The trains will be fully loaded when transporting MAP and DAP fertilisers (1 Mtpa) to either of the ports and will be approximately 50% loaded when transporting sulphur (500,000 tpa) to the site. Materials handling facilities at the Port will be provided to load and unload the train with the respective products and for the unloading of sulphur and loading of fertiliser products on to ships at the port. The port will also have storage facilities for the storage and reclaiming of fertilisers (80 kt) and sulphur (60 kt).

Provision is also made for the unloading of other raw materials that may be delivered to site by rail. These include large volume consumption chemicals such as Diesel, SOAK5, Sodium Silicate, and Lime. A few other minor reagents arriving in various containers or packaging may be transported to site via road transport.

During the operational phase, most of the workforce will primarily consist of FIFO workers, with drive in drive out (DIDO) workers being a small proportion, potentially being transported by company bus from designated pick-up points to minimise transport risks.

Based on the minimal use of roads for transport of material and workers, the on-going operation of the Proposed Project is considered unlikely to have significant impact on traffic in the region surrounding the project area.

17.2 Traffic Impact

As outlined within the preceding sections, due to the Proposed Project, the level of traffic generated to and from the site is expected to be greater than initially projected within the Approved Project. Nevertheless, due to the extended construction program, increased from 18 months to three years, the change to daily traffic volumes is low in road capacity terms noting the local road network has capacity to accommodate the forecast additional traffic volumes.

Of note, the heavy vehicle trips will increase by more than10 trips per day to the external road network and by more than 61 trips per day to the internal road network. While again these additional volumes are to be supported by the road network, the impacts will need to be managed. Mitigation measures for these additional volumes have been outlined below:

17.3 Mitigation

With due consideration of the traffic impacts that may be generated by the proposed development, particularly by the volume of heavy vehicles, the following mitigation measures have been proposed.

Table 30 Impacts and mitigation measures

Impact	Mitigation measures	Timing
B-double / B-triple vehicles on the public road network	**Assistance crews** Traffic management crews may be required to drive ahead of oversized vehicles during deliveries. The assistance crews will assist by providing warning of large vehicles ahead and holding traffic where required.	During construction
Increased truck volumes	**Traffic controllers** Traffic controllers will be present as required to hold up any traffic where large heavy vehicles are required to occupy more than one traffic lane, drive over the road centre line or turn across oncoming traffic.	During construction
	Internal access roads Internal roads will be constructed and marked early on, to prevent construction vehicles driving across pedestrian areas.	During construction
	Truck warning signage To increase awareness of the increased truck volumes and the presence of heavy vehicles, truck warning signage should be installed along the unsealed roads which make up the main delivery routes.	During construction
Loading areas	All loading and unloading of materials will be limited to specific loading areas within the site. No loading or unloading is to occur on public roads.	During construction
Damage to road infrastructure and pavement	**Road rehabilitation** Any roads damaged by the construction of the Ammaroo Phosphate project will be repaired to an acceptable standard, with all costs borne by Verdant Minerals.	During construction
Mud and debris tracking onto roads	**Vehicle wash down areas** Wash down areas will be provided within the site near the construction compound base to allow workers to clean construction vehicles on site.	During construction
	Dust suppression The dust impact along the roads will need to be monitored. If required, roads should be sprayed with water (potentially with a wetting or binding agent) to minimise dust in the air.	During construction
Bus and construction vehicle parking	All parking will occur within the site boundaries, in dedicated parking areas. All staff and drivers will be instructed not to park on public roads.	During construction

18. Air

18.0 Air Quality

18.0.0 Previous Assessment and Impacts

Section 15 and Appendix O of the Approved EIS provides detail on the scope and findings of air quality impact assessment conducted within the Project Area.

The Approved EIS included conducting dispersion modelling to predict ground level pollutant concentrations and impacts to the closest sensitive receptor (i.e., accommodation village). The model scenario selected for the previous assessment represented the worst-case scenario for air quality impacts at the nearest sensitive receptor, the accommodation village. This scenario occurred during pit operations during years 11-15, where the active pit is both proximate to the accommodation village and aligned with processing plant emission sources. Therefore, activity data and source locations presented in the Approved Project EIS reflect the likely conditions during years 11-15. The modelled sources in Approved Project included mining and beneficiation processes during construction and operation of the Approved Project.

Air emission rates were estimated using the National Pollutant Inventory (NPI) Emissions Estimation Technique (EET) Manuals. The Approved EIS identified particulate pollutants, specifically PM_{10}, as the pollutant of major concern which was related to dust generated by mining activity. Air quality impacts were predicted to be compliant with all relevant air quality criterion for all sensitive receptors with the accommodation village being the closest (geographically and) with worst-case concentrations compared to the assessment criteria.

The assessment recommended a dust management plan (DMP) be developed and implemented to avoid, minimise, and control dust impacts on air quality. The DMP established a monitoring site at the accommodation village to audit air quality, as part of the DMP.

18.0.1 Proposed Project Potential Impacts and Assessment Required

Additional air quality impact assessment modelling has been undertaken to assess the impacts of the Proposed Project of air quality. The additional assessment comprised:

– An update to the air quality model to include point sources associated with the additional process plants including minor changes to better reflect linkages between the beneficiation output, the fertiliser plants (i.e., phosphoric acid plant, sulphuric acid plant, ammonia plant, granulation Plant) and the outload facilities.
– Inclusion within the model to consider updated quality objectives and criteria of the 2021 National Environment Protection Measure (Ambient Air Quality) (NEPM AAQ).
– Emissions sources were relocated on the latest site plan layout, including updating locations of original emissions sources where these may have moved.

Since the previous air quality impact assessment, the power plant sources, and the rotary drier source have been removed from the model and replaced with a more representative source in appropriate locations. A summary of the changes made to sources modelled as part of Approved EIS is provided in Table 31.

Table 31 Changes to sources outlined in GHD's 2022 air quality impact assessment

Description	Change for the Proposed Project (2022 Air Quality Impact Assessment)
Dumping ore on ROM stockpile	Source moved to new ROM stockpile location
Front-end-loaders on ore on ROM stockpile	Source moved to new ROM stockpile location
Hauling ore to ROM stockpile	Location and distance of haul route updated in line with latest site plan
Haul trucks returning to pit	Location and distance of haul route updated in line with latest site plan
Screen	Sources moved to dry and wet beneficiation areas, respectively

Description	Change for the Proposed Project (2022 Air Quality Impact Assessment)
Conveyor	Sources moved to between the dry and wet beneficiation areas
Primary crusher	Source moved to dry beneficiation area
Secondary crusher	Source moved to wet beneficiation area
Loading stockpiles	Source moved to dry beneficiation area
Rotary drier	Source deleted and replaced with R_G1
Train load-out	Source moved to between the dry and wet beneficiation areas
ROM stockpile	Source moved to new ROM stockpile location
Beneficiation stockpile	Source moved to wet beneficiation area
Topsoil stockpile	Source re-shaped (same area) and moved slightly west
2.5 MW Diesel generators	Source deleted
2.5 MW Natural gas generators	Source deleted and replaced with P_PO1 – P_PO8
Natural gas fired rotary drier	Source deleted

18.0.2 Additional Assessments Completed

18.0.2.0 Separation Distance Assessment

A separation distance is a planning instrument used to provide separation of sensitive land uses (i.e., residential, schools, hospitals) from premises with the potential for off-site emissions that can cause dis-amenity. Under routine operations, any adverse impact is to be confined on-site so that an external buffer should not be required.

The purpose of the separation distance guidelines is to provide recommended minimum separation distances between industrial land uses with the potential for off-site emissions and sensitive land uses. Accordingly, the relevant uses for a buffer assessment involve the following:

– Provide clear direction on which land uses require separation.
– Inform and support strategic land use planning decisions.
– Prevent new sensitive land uses from impacting on existing industrial uses.
– Prevent new or expanded industrial land uses from impacting on existing sensitive land uses.
– Identify compatible land uses that can be established within a separation distance area.

The NT EPA Recommended Land Use Separation Distances Guideline (NT EPA, 2017) should be considered when preparing a planning proposal or amendments to existing development plans. The guideline defines a separation distance as the recommended distance to separate a source of emissions (offensive odour, noise, smoke, dust, or fumes) from sensitive land uses in order to avoid adverse impacts to human health and amenity. A sensitive land use is described as land use where people live or regularly spend time, and which require a particular focus on protecting the health and well-being of humans and amenity values from the emissions of an activity. Sensitive land uses may include, but are not limited to, residential premises, accommodation facilities such as hotels and nursing homes, hospitals, childcare centres, schools, and some outdoor recreation facilities.

Importantly, separation distances are not intended to replace effective source control technology and practices and are to be used in conjunction with best or leading practice environmental management.

Table 32 outlines the separation distances applicable to the Proposed Project. GHD has applied Method 2 to the application of separation distances, namely, the separation distance is measured from the activity boundary of a potentially impacting activity to the property boundary of the nearest sensitive land use.

Table 32 Separation distances applicable to the Proposed Project

Activity type	Activity description	Scale	Separation distance (m)	Drawn from
Fertiliser production	Production of inorganic fertilisers.	≥ 2,000 tonnes per year	1,000	Processing plant boundary
Mineral sands mining or processing	Premises on which mineral sands ore is mined, screened, separated, or otherwise processed.	≥ 5,000 tonnes per year	2,000	Mining and processing plant boundaries
Processing or beneficiation of metallic or non-metallic ore	Premises on which: – Metallic or non-metallic ore is crushed, ground, milled or otherwise processed – Tailings from metallic or non-metallic ore are reprocessed – Tailings or residue from metallic or non-metallic ore are discharged into a containment cell or dam	≥ 50,000 tonnes per year	2,000	Processing plant boundary
Electric power generation	Electrical power generation using natural gas as fuel.	≥ 20 megawatts (MW) in aggregate	1,000	Power plant boundary

The result of the separation distance assessment (Figure 31) suggests that:

– None of the relevant separation distances identified extend to the nearest sensitive receptor location, being the workforce's accommodation village.
– There is a low risk of residual emissions leading to off-site air quality impacts, including odour, smoke, dust, or fumes.

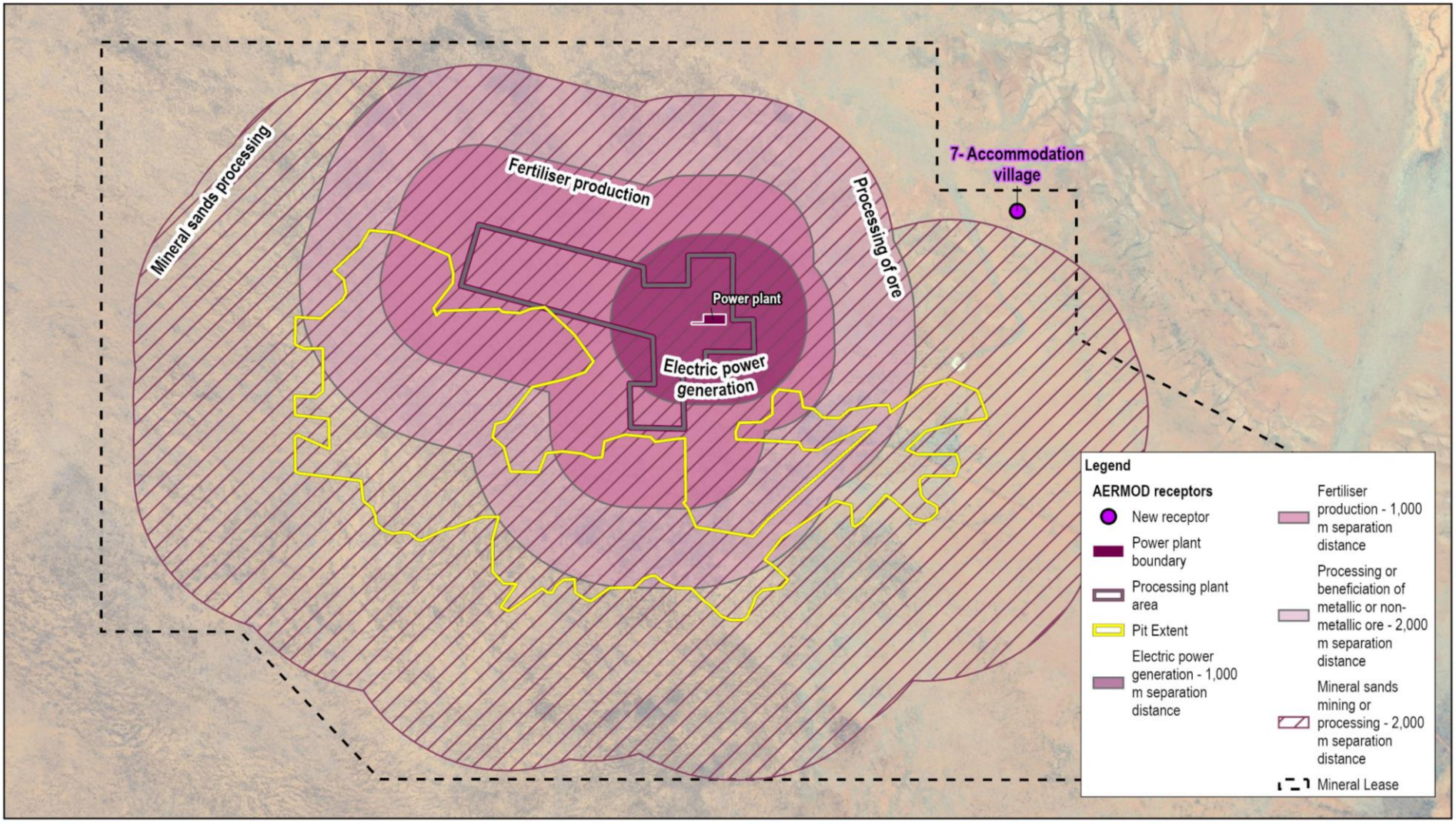


Figure 31 Separation distance assessment

18.0.2.1 Impact Assessment (Modelling)

The additional assessment considers the same sensitive receptors as per the Approved Project. These are shown in Figure 32. It is noted that the location of the accommodation village has changed from the Approved EIS. The accommodation village was originally located to the north-east of the project site and has been repositioned further east of the site.

Due to the remote location, background sources of gaseous products of combustion (such as oxides of nitrogen (NOx), carbon monoxide (CO), sulphur dioxide (SO_2), etc.) and background sources of ammonia (NH_3) and Fluorides (F) are considered to be negligible to non-existent. To determine background air quality in relation to dust (particulate matter), the Approved EIS used the baseline monitoring data collected at the Nolans project (135 km northwest of Alice Springs). A 24-hour average PM_{10} background value of 20 µg/m³ was deemed representative of the project area. This value was adopted for this assessment. These air emissions sources (Figure 33) were modelled for pollutants listed in Table 33.

Table 33 Air emission sources for Proposed Project

Area	Source description	PM_{10}	NO_2	SO_2	F	H_2SO_4	NH_3
Phosphoric Acid Plant	Reaction and Filtration Stack	X			X		
	Reaction and Filtration Stack	X			X		
Sulphuric Acid Plant	Conversion			X		X	
Ammonia Plant	Flue Gas Reformer Stack		X	X			
Granulation Plant	Granulation Plant Scrubber Stack	X	X	X	X		X
Power Plant	Power Plant Generator 1 to 8	X	X	X			
Gypsum	Gypsum stack (stockpile)	X					

The air quality impact assessment was completed using the AERMOD dispersion model, consistent with the Approved EIS. When a breakdown of the source emission rates is analysed, it can be seen that the majority of PM_{10} emissions are from the mining and beneficiation operations with a relatively small contribution from the sources associated with the production of MAP and DAP fertiliser in the granulation plant and the storage of fertilisers.

The results of the impact assessment show that compliance is predicted for all pollutants. The PM_{10} GLC's were predicted to be up to 85% of the air quality objectives at the accommodation village, which indicates that PM_{10} is the critical pollutant. The remaining pollutants were predicted to not be more than 50% of their relevant objective or criterion.

A contour plot for showing the predicted cumulative 24-hour average PM_{10} GLCs (the most critical pollutant) is provided in Figure 34 below. The contour plots show the spatial variability of the air quality impact surrounding the mine site and processing plant. As expected, due to the predicted wind direction, impacts are greatest to the northwest of the emission sources. A similar pattern of dispersion would be seen for the other air pollutants. From Figure 34, it can also be seen that the new location of the accommodation village is situated outside the 50 µg/m³ objective contour. This shows that PM_{10} compliance at the accommodation village is achieved.

As such, the following mitigation and management plan, as outlined in Approved EIS, are considered appropriate:

– Adhere to the dust control measures described in Section 4.5.2 of Approved EIS.
– A monitoring site is established at the new location of the mine accommodation village to audit the dust management plan. This would include PM_{10} in-air concentration and a dust deposition gauge (as part of a wider gauge network). If dust levels are found to approach the objective level, to further mitigate the risk of PM_{10} exceedances at the accommodation village, meteorology specific control measures should be considered. Where a meteorological forecast indicates that winds will be blowing towards the new location of the mine accommodation village or a reactive monitor reaches a predefined trigger level, measures such as reducing site activity or significantly increasing the intensity of dust controls (such as water sprays or chemical dust suppressants on major haul road links) should be carried out.
– An air quality management plan should be developed outlining:

- Air quality management practices.
- Emission control measures.
- Air quality monitoring strategies.
- Reactive dust monitoring program, if required.

18.0.2.2 Further Assessment during Detailed Design

The air emission rates, and source locations used for the new MAP/DAP plant were based on early-stage design information, and included:

– Some emission guarantees provided by Licensors.
– Emission estimates based on best available techniques.
– Source locations based on current plant layout maps.

As the design of the plant progresses, and as more detailed information emerges, the emissions and source locations used in the modelling exercise may be subject to change. However, given the margin of compliance with key pollutants from the MAP/DAP plant, it is expected that only major changes to the design would lead to changed impacts which would exceed the criteria levels.

It is recommended that an updated air quality assessment is completed during detailed design, to verify the progressed design's compliance with the relevant air quality objectives. The updated air quality assessment would:

– Consider updated modelling of point source emissions (fertiliser plant, power plant) based on updated vendor guarantees, source locations, and building layouts.
– Conduct dispersion modelling of additional mining stage scenarios, to reflect to most up to date mine planning capturing a range of pit locations and mining intensities.
– Inform the development of air quality management and monitoring plans.

In addition to completing an updated air quality modelling assessment, the following air quality plans should be developed:

– Air quality management plan – comprehensive document summarising all operational measures and procedures relating to the management of air emissions. The plan would include all control measures and ongoing management activities which would mitigate risk of air quality impacts. The plan would outline responsibilities, including for execution of any required air quality monitoring and reporting.
– Air quality monitoring plan – summary document, outlining methodology and reporting requirements for all relevant air quality monitoring activities. Details would be outlined for the following monitoring types, as appropriate; emissions sampling (routine or CEMS), compliance ambient air quality monitoring, reactive monitoring, visual monitoring, and meteorological monitoring.

18.0.3 Peer Review of Updated Air Quality Impact Assessment Study

At the request of the NT EPA, Verdant also commissioned an independent Peer Review of the GHD Updated Air Quality Impact Assessment Report (Appendix N) . This Peer Review by Etkimo stated "Based on the provided updated air quality assessment report, Ektimo are satisfied that our review points have been addressed at this time".

The full Peer Review Letter Report (Reference: R013261-2) is enclosed in Appendix N.

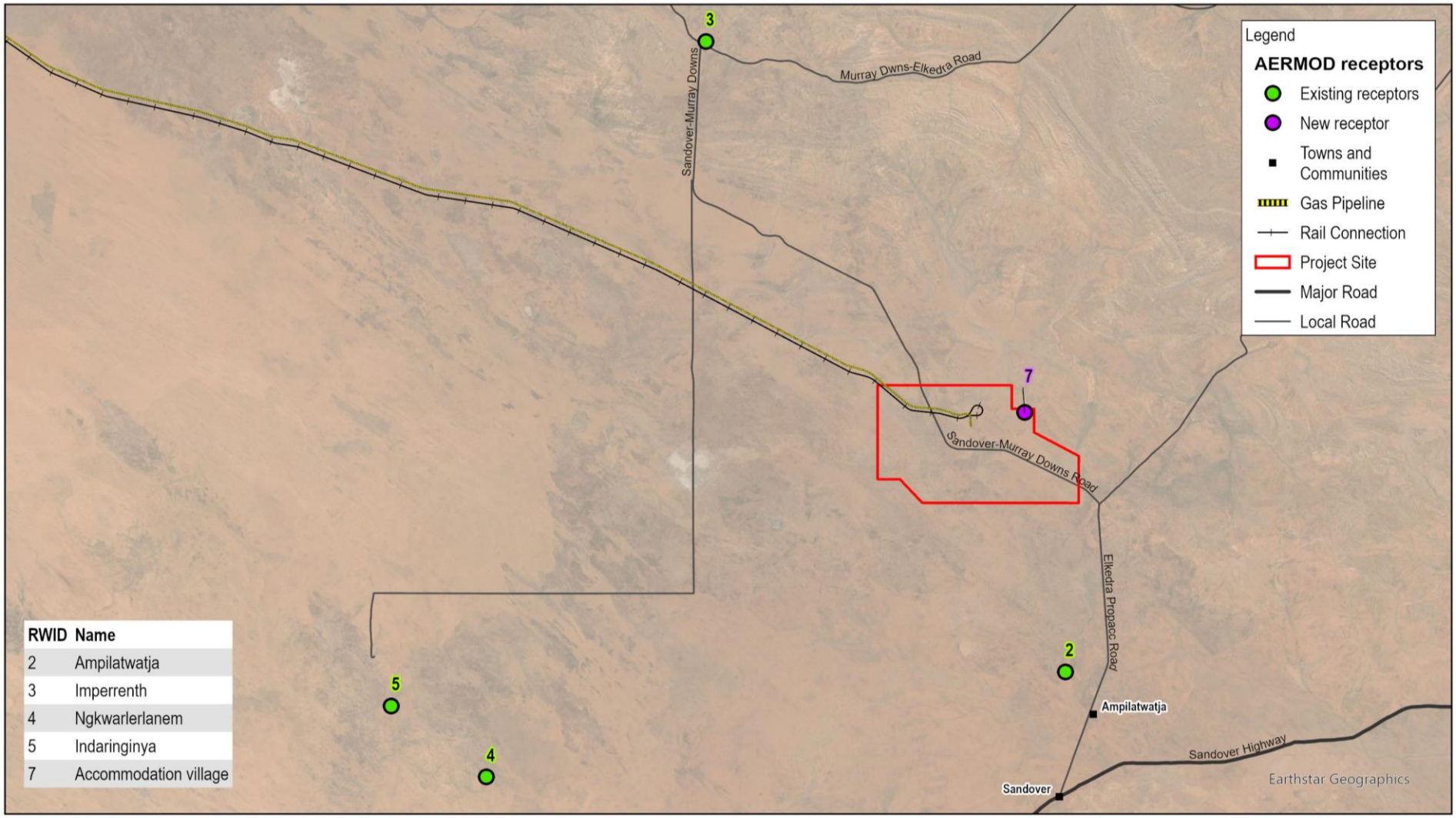


Figure 32 Air quality sensitive receptors

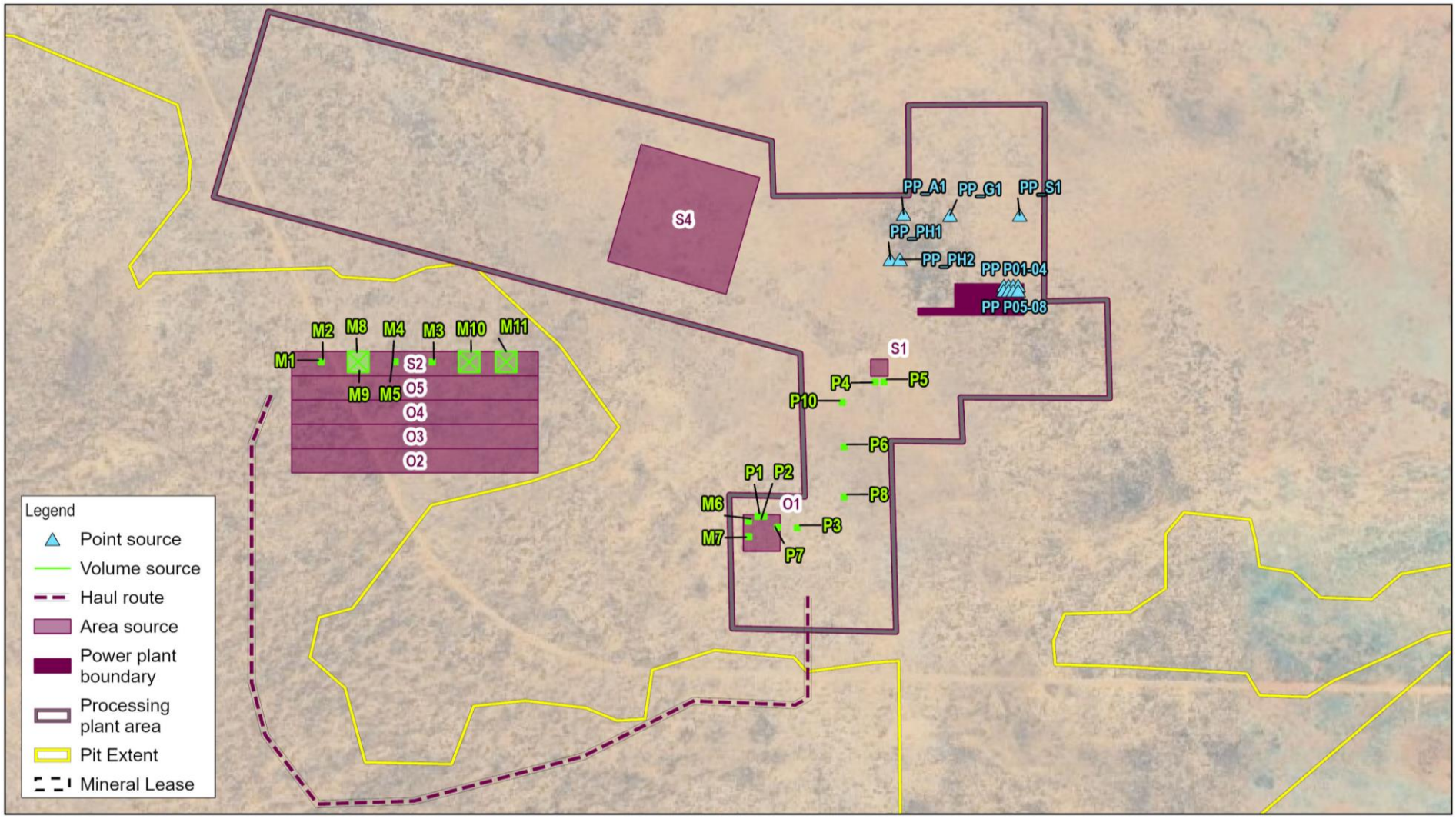


Figure 33 Air emission source locations

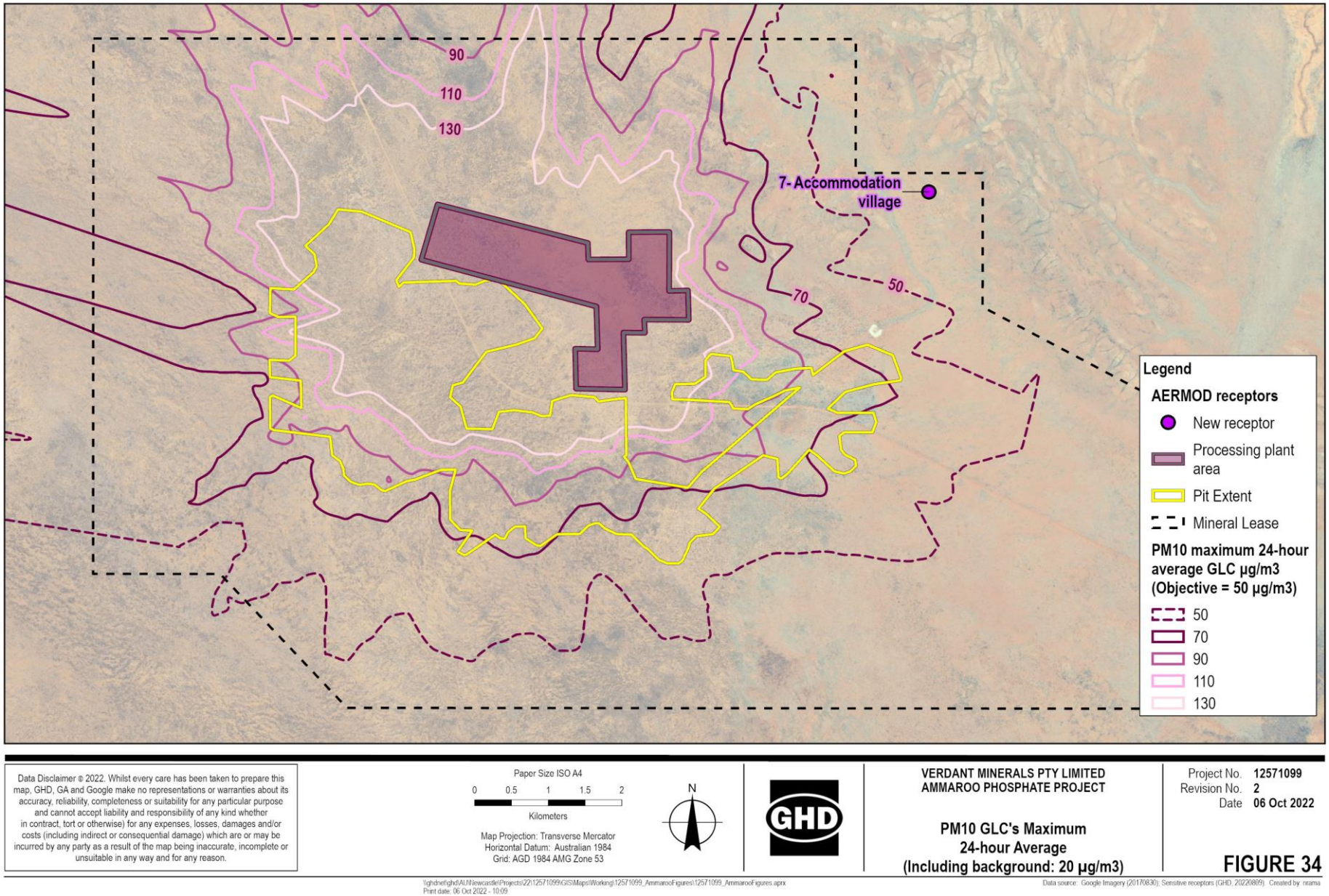


Figure 34 PM_{10} GLC's maximum 24-hour average (including background: 20ug/m³)

18.1 Atmospheric Processes

18.1.0 Approved Project Assessment

At the time of EIS preparation for the Approved Project, the Northern Territory Government's Large Emitters Policy (Large Emitters Policy) which required the reporting on construction and operational emissions, and development of a Greenhouse Gas Abatement Plan (GGAP) was not in effect. Therefore, this was not a consideration of the Approved Project.

18.1.1 Proposed Project Assessment

The NT's Large Emitters Policy commenced on 1 September 2021. This policy requires that new projects and expansion of existing projects, considered to be 'large emitters', are required to obtain an environmental authorisation under Territory legislation and are required to meet the obligations of the Policy. The thresholds for a project to be considered a 'Large Emitter' are *'The industrial project threshold is 100,000 tonnes carbon dioxide equivalent (tCO_2-e) (scope 1) in any financial year over the life cycle of a project.'*

The quantity of emissions for the Proposed Project are estimated to be approximately 384,450 t CO_2-e during construction, comprising scope 1 emissions only, over the duration of the entire construction period. The majority of construction emissions are attributable to vegetation clearance, accounting for a 255,100 t CO_2-e (approximately 66%) of scope 1 construction emissions. These annualised construction emissions would be 0.62% of NT total annual emissions and 0.026% of Australia's total current annual emissions.

The quantity of emissions estimated to occur during operations are estimated to be approximately 1,469,200 t CO_2-e per annum, comprising 491,500 t CO_2-e scope 1 emissions, 300 t CO_2-e scope 2 emissions, and 977,300 t CO_2-e scope 3 emissions per annum. Total scope 1 and scope 2 operational emissions of the Proposed Project per annum is estimated at 491,800 t CO_2-e emissions, or 2.84% of NT's total annual emissions and 0.1% of Australia's total current annual emissions. The majority of operational emissions are due to the ammonia plant, estimated to produce 340,000 t CO_2-e at peak capacity.

The emissions from the Proposed Project trigger the Large Emitters Policy and hence a greenhouse gas emissions (GHG) assessment of the emissions is required.

GHD prepared a Greenhouse Gas (GHG) Assessment Executive Summary Report for the Proposed Project as part of this EIS Referral (see Appendix O). This GHG Executive Summary report provides an overview of the construction and operational emissions associated with the Proposed Project and supports the basis for developing a pathway to net zero by 2050. A greenhouse gas abatement plan (GGAP) for the Proposed Project will be developed in consultation with the NT EPA as part of this EIS Referral process.

18.1.2 Scope of GHG Executive Summary Report

The scope of works, including inclusions, exclusions and assumptions are detailed in Table 34.

Table 34 Scope of inclusions, exclusions, and assumptions

Phase	Scope	Description
Inclusions		
Construction	1	– Diesel used in plant and equipment from construction and used at the workers' accommodation. – Water supply pumping, wastewater treatment. – Disposal of waste at on-site landfill. Emissions associated with the construction of facilities already approved, in line with the approach used for the Proposed Project. These include diesel use and vegetation removal for construction of: – The mine site, processing plant and tailings storage facility. – 105 km of rail and 137 km gas pipeline. – Bore field and 17 km water pipeline.

		– Roads, administration building, and accommodation village. – Airfield. – Fertiliser plant (granulation plant, sulphuric acid plant, phosphoric acid plant, ammonia plant) – Realignment of approximately 12 km of Murray Downs Road.
	2	Nil – all electricity to be generated on site using diesel generators
Operation	1	– Diesel used in plant and equipment during mining. – Natural gas in power gas engines and for process heaters (aux. boilers and driers). – Carbon dioxide process emissions generated during ammonia production. – Disposal of waste at on-site landfill.
	2	– Grid electricity consumption at the Darwin Port site only (all electricity to be generated on Ammaroo site using the on-site power plant or renewables).
	3	– Transport of raw materials and equipment to the site. – Transport of products from the site. – Worker commuting, including private transport to/from the site and fly in, fly out/drive in, drive out (FIFO/DIDO). – Embodied emissions from major raw materials and fuels (sulphur, diesel, natural gas, major chemicals, etc.). – Scope 3 emissions associated with fuel and electricity. – Scope 3 emissions associated with fertiliser use.
Exclusions		
All	-	Emissions associated with combustion of fuels used in minor quantities such as LPG, gasoline, solvents, oils, and greases during construction. Emissions associated with the leakage of hydrofluorocarbons or sulphur hexafluoride as these are likely to be negligible.
Construction	3	Scope 3 emissions including transport of plant equipment, worker commuting, and embodied emissions in materials such as concrete.
Operations	3	Scope 3 emissions from transport of raw materials, equipment and product to/from Australia and distribution of the fertiliser within Australia. Scope 3 embodied emissions of some propriety chemicals where emission factors were not available

18.1.3 Emission Sources and Discussion

A greenhouse gas inventory was prepared for the Proposed Project's construction, and life of mine operation emissions. The results of the inventory are shown in Table 35. All values are estimates, based on the best available information at the time and are subject to change as per final design, new information and equipment revisions.

Table 35 Estimated total emissions for Ammaroo Phosphate Project for construction and operational emissions

Project Phase	Scope 1 emissions	Scope 2 emissions	Scope 3 emissions	Total emissions
	(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	(t CO_2-e)
Construction	384,450			384,450
Operation (average per annum)	491,500	300	977,300	1,469,200
Operation (life of project)	12,335,100	7,100	24,439,800	36,782,100

18.1.3.0 Construction

Construction emissions are shown in Table 36 below and expected to be mainly lost carbon sinks from vegetation removal, diesel usage for construction equipment, earthworks, and power generation. Table 36 shows the

breakdown of emissions and total percent of scope 1 emissions. The Proposed Project will be remote from grid power; hence scope 2 emissions are not expected. Scope 3 emissions are not included in the construction inventory.

The majority of construction emissions are attributable to vegetation removal, accounting for 255,100 t CO2-e (approximately 66%) of scope 1 total construction emissions. Diesel used for earthworks are estimated to produce 41,000 t CO2-e (11% of total construction emissions).

Annualised construction emissions are approximately 128,100 t CO2-e per annum. Compared to Australia's and the NT's annual emissions, construction emissions would amount to 0.026% and 0.62%, respectively.

Table 36 Estimated construction emissions and breakdown for the Project

Construction - Emission source	Value		Scope 1 emissions	Total emissions	Emissions proportion of total
	Quantity	Units	(t CO_2-e)	(t CO_2-e)	%
Diesel use - main construction areas					
Diesel - Construction Earthworks	15,200	kL	41,100	41,100	10.7%
Diesel – Darwin Port	200	kL	400	400	0.1%
Diesel use - ancillary infrastructure					
Diesel - Airstrip	800	kL	2,100	2,100	0.5%
Diesel - Bore Drilling	20	kL	50	50	0.0%
Diesel - Gas & Water Pipelines	2,400	kL	6,400	6,400	1.7%
Diesel - Rail	22,600	kL	61,200	61,200	15.9%
Diesel - Realignment of Murray Downs Road	200	kL	500	500	0.1%
Other emissions					
Diesel - Water Pumping	100	kL	200	200	0.1%
Diesel - Accommodation village	4,700	kL	12,800	12,800	3.3%
Vegetation Removal - Lost Carbon Sink	2,300	ha	255,100	255,100	66.4%
Diesel - Vegetation Removal	900	kL	2,500	2,500	0.7%
Waste - MSW and C&D	1,800	t	2,100	2,100	0.5%
Total construction emissions over 3 years			**384,450**	**384,450**	**100%**
Annualised construction emissions (nominal)			**128,100**	**128,100**	**100%**

18.1.3.1 Operations

Operational (annual) emissions consist of scope 1 emissions from the ammonia plant (69% of scope 1 operation emissions) and natural gas used in power generation, intermittent steam generation, and for process drying as well as other minor sources of emissions include plant and equipment used during mining and scope 3 emissions from fertiliser use.

Estimated scope 2 emissions are negligible. The Darwin Port site will be the only site connected to grid electricity and is estimated to only emit 300 t CO_2-e (0.02% of operations emissions) scope 2 per year.

Scope 3 emissions sources include: the transport of raw material and equipment, worker commuting, embodied emissions from major raw materials and emissions associated with fuel/electricity and downstream fertiliser use. Table 37 is a summary of major and minor operation emission sources.

Table 37 Estimated operation (annual) emissions and breakdown

Emission source	Values		Scope 1 emissions	Scope 2 emissions	Scope 3 emissions	Total emissions	Proportion of scope 1 emissions	Proportion of total emissions
	Quantity	Units/a	(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	(t CO_2-e)	%	%
MAP/DAP granulation plant	1,000,000	t fertiliser	21,300	-	3,200	24,500	4.3%	1.7%
Sulphuric acid plant	3,451,700	m^3 NG	7,000	-	1,400	8,400	1.4%	0.6%
Phosphoric acid plant	500,000	t P_2O_5	4,300	-	0	4,300	0.9%	0.3%
Ammonia plant	200,000	t NH_3	340,000	-	73,100	413,100	69.2%	28.1%
Power plant	190,100	MWh	96,000	0	19,900	115,900	19.5%	7.9%
MAP fertiliser	500,000	t	-	-	279,800	279,800	-	19.0%
DAP fertiliser	500,000	t	-	-	503,700	503,700	-	34.3%
Summary of major operation (annual) emissions sources							95.3%	91.9%
Diesel mining	4,400	kL	11,900	-	600	12,500	2.4%	0.9%
Diesel (light vehicles, generator, Darwin Port, vegetation clearance)	800	kL	2,500	-	100	2,600	0.5%	0.2%
Vegetation removal (mining)	1,500	ha	6,600	-	-	6,600	1.3%	0.5%
NG pipeline fugitives	100	km	1,600	-	-	1,600	0.3%	0.1%
Waste disposal	200	t	300	-	-	300	0.1%	0.02%
Electricity Darwin Port	500	MWh	-	300	20	300	-	0.02%
Worker commuting	19,302,800	passenger/km	-	-	2,700	2,700	-	0.2%
Rail freight	2,235,100	kt/km	-	-	62,200	62,200	-	4.3%
Embodied emissions main materials	76,100	t	-	-	30,600	30,600	-	2.1%
Summary of minor operation (annual) emissions sources							4.6%	8.34%

Table 38 is a collation of NT and Australia's annual emissions published by the National Gas Inventories 2020 which will serve as a comparison for the Proposed Project's Scope 1 and 2 operation emissions; total annual operations emissions are also included in this table. Emissions calculated in the NGA do not include scope 3 emissions.

Table 38 Annual emissions of NT, Australia, and Ammaroo's projected operational emissions

Annual emissions	Value	
	Q	Units
NT (annual emissions)	17,300,000	t CO_2-e
Australia (annual emissions)	497,700,000	t CO_2-e
Scope 1 + Scope 2 (annual operations)	491,800	t CO_2-e

Source: National Gas Accounts (NGA) 2020

Table 39 compares NT and Australia's emissions with the Ammaroo annual operating emissions. The quantity of emissions estimated to occur during operations are estimated to be approximately 491,500t CO_2-e scope 1 and 300 t CO_2-e scope 2 per annum. Total scope 1 and scope 2 operational emissions of the proposed Project per annum is estimated at 491,800 t CO_2-e emissions, 2.84% of NT's total annual emissions and 0.1% of Australia's total annual emissions.

Table 39 Proportion of NT, Australia's emissions compared to Ammaroo's annual operational emissions

Emission source (operations)	Proportion (%)
Scope 1 + scope 2 (annual operations) compared with NT	2.84%
Scope 1 + scope 2 (annual operations) compared with Australia	0.1%

18.1.4 Abatement Strategy

Addressing the NT Large Emitters policy, strategies will be required to align the emissions from the Proposed Project with the NT's goal of net zero by 2050. Currently, several abatement strategies are under consideration. The abatement strategy will have to consider the impact on technical and operational reliability and safety of the operation and also be economically viable for the Proposed Project.

The following measures have so far been evaluated and considered to offer potential pathways to reduce GHG generation and energy use during operations and construction, where technically and commercially viable:

- Embed energy efficient plant design: designing processes that recycle heat and steam and selecting equipment with high energy efficiency. Preference for electric equipment (motors and heaters verses steam or gas) that enable supplementation with renewable energy.
- Continuous process design to improve capital, energy, and process efficiency.
- Progressively deploying levels of solar photovoltaic (PV), wind turbines and battery storage to substitute gas used in power generation.
- Converting or replacing the mining fleet and other site vehicles to electric vehicles (EV) as commercially viable technology becomes available.
- Progressively expanding investment in renewable energy (solar PV, wind, battery storage) and electrolysis and hydrogen storage to substitute natural gas as feed to the ammonia plant up to 5% intermittently and then up to 10% continuously of H_2 feed to the plant.
- Increasing investment in renewables, H_2 electrolysis, H_2 storage beyond 10% and installing an air separation unit (ASU), to reduce natural gas feed to the steam methane reformer (SMR) and combine with 50% green hydrogen (H_2) as feed to ammonia (NH_3) plant.
- Further extensive investment in renewables (including potentially solar thermal), H_2 electrolysis, H_2 storage to replace natural gas feed as the primary feed to the Ammonia plant. i.e., 100% green H_2.

Alternatively, external 3rd party renewables in the form of green energy or green H2 may be available should other investments in extensive renewable projects be developed. At the time of this referral, there are no such projects planned in the vicinity of the Proposed Project.

18.1.4.0 Efficient Design

The site has been designed to integrate as many of the energy systems as possible, thereby maximising heat recovery and efficiency across the site. This approach has enabled a significant reduction in baseline GHG emissions compared with sites without such an approach and will be continuously improved should new and more efficient processes/technologies become available. Examples of efficient design include:

– Waste heat recovery (in the form of high pressure super-heated steam (HPS)) from sulphuric acid and ammonia plants will be used to produce up to 54 MW of electrical power, with additional intermittent power generation of up to 24 MW obtained from gas engine generators.
– Design of the beneficiation plant utilising dry ore sorting technology to reduce waste being rock being fed to the wet beneficiation plant thereby reducing the capacity of the wet beneficiation plant, with comparably lower power consumption, compared to conventional design.
– The phosphoric acid plant may utilise continuous ion exchange technology (CIX) offering energy savings of up to 10% compared with conventional processes to remove impurities in the final weak acid streams.
– Extensive application of waste heat exchangers where possible to extract available process heat.
– Use of fin fan cooling and condensers, to reduce water losses and hence water handling power needs.
– Electrification of the major compressors within the ammonia plant to enable a central HPS power plant for the site and greater flexibility for the integration of renewable energy options in the ammonia plant.

18.1.4.1 Renewable Energy to Net Zero

The opportunities to progressively utilise renewable energy as a commercially and technically viable option to reduce the GHG emissions from the Proposed Project are currently under investigation by Verdant. This includes the phased installation of solar PV, wind turbines, and thermal solar energy generation schemes to meet the various operating conditions of the Project, together with a hydrogen electrolysis strategy.

Based on current technology developments, it is also likely that extensive energy storage in the form of industrial scale batteries and H2 storage, will be required to develop a safe and reliable pathway to achieving net zero operations. Based on current technology, this pathway will be at significant additional capital cost to the Project.

The Proposed Project is considering a combination of solar PV, wind generation and battery storage to be an initial stage to offset a proportion of the emissions from the gas engine generation. The pace of this investment will be determined in consultation with the NT EPA recognising the commercial impact of such investment and the desire to reach reduction targets, within certain timelines. From 2035, it is expected that greater than 80% of the emissions from the gas engines will be abated using renewables and a quantity of green hydrogen will be available either as fuel for the gas engines or feed to the ammonia plant.

18.1.4.2 Pathway to Green Ammonia (Net Zero) ASU and Other Investment

The substitution of natural gas feed into the SMR of the ammonia plant and the subsequent replacement of natural gas produced hydrogen with green hydrogen will be technically complex and capital intensive. Process limitations in the operation of the SMR and the feed requirements of the ammonia synthesis plant will initially limit the extent of direct green hydrogen substitution to approximately 10% of the total hydrogen made. After this point, additional nitrogen will be needed to be fed to the ammonia synthesis plant from a new air separation unit (ASU). The SMR will also become unstable at lower levels of natural gas feed and will require modification or total replacement to facilitate the substitution of natural gas feed with green hydrogen.

It follows that significant investment in renewables, hydrogen electrolysis and hydrogen storage will be required to substitute beyond 10% hydrogen in the feed, in addition to the investment in an ASU and other major modifications to the ammonia plant to adjust for operations without the inherent process steam which will no longer be generated in the SMR.

The total replacement of emissions from the ammonia plant through feeding 100% green ammonia using existing technology, including solar thermal applications, will require very significant capital investment.

Verdant will be working with technology providers to find more economically viable pathways to net zero ammonia production.

18.1.4.3 Conversion of Fleet to EV

It is unlikely electric vehicle (EV) fleets will be commercially available for the start-up of the Proposed Project. Verdant will propose to utilise conventional equipment whilst building knowledge of the mining process and then transition to an autonomous EV fleet when starting the first new pit once commercial application of the new technology is viable. Through such a planned transition to an autonomous EV fleet, Scope 1 emissions from mining equipment and heavy vehicle diesel will be abated. All site vehicles are planned to be converted to EV by 2050 to align with NT net zero goals.

18.1.4.4 Carbon Capture Utilisation and Storage (CCUS)

CCUS is not considered to be a viable abatement option at this stage due to the distance of the site from potential sequestration sites. CCUS may become a viable abatement option in the future if a cost-effective compression, pipeline transport and sequestration site become available and is a viable alternative to other options.

19. Noise and Vibration

19.0 Previous Assessment and Impacts

Section 16 and Appendix P of the Approved EIS provides detail on the scope and findings of noise and vibration impact assessment conducted within the study area. The scope of noise and vibration assessment assessed potential impacts to the closest sensitive receptors (i.e., accommodation village approximately 3 km northeast of the Site). The scope of the noise impact assessment was to:

– Identify significant noise generating sources within the proposed phosphate mine, beneficiation plant, power plant and train load out areas.
– Model operational noise levels using the identified operational noise sources.
– Identified sensitive receivers; and provided recommendations for noise and vibration mitigation measures.

Based on the noise model results, the predicted sound pressure levels at the sensible receptors were expected to be under the noise criteria. Vibration was not considered a significant impact at the closest sensitive receiver.

The noise and vibration assessment found that the project's activities during construction and operation should not exceed noise criteria. Therefore, no mitigation measures were recommended.

19.1 Proposed Project Potential Impacts and Required Assessment

During construction and operation of the Proposed Project, additional noise sources have the potential to impact the nearest sensitive receptor, which has moved further away from noise sources (3.6 km east north-east). Additional noise sources associated with the Proposed Project have been identified in Table 40.

Table 40 Construction and operational noise sources

Construction sources	Operational sources
Scrapper	Mining area (as per the EIS report)
Crane	Dry beneficiation plant
Backhoe	Wet beneficiation plant
Compressor	Phosphoric acid plant
Concrete pump	Gypsum handling
Dump truck	Granulation plant
Water truck	Rail – associated with loading and unloading operations
Compactor	Sulphuric acid plant
Concrete batch plant	Water treatment plant
Dozer	Power station
Grader	Auxiliary equipment and utilities
Loader	Ammonia plant
Excavator	Airfield
Aerodrome	

19.2 Additional Assessment Completed

Additional Noise Impact Assessment was conducted to understand the noise impacts from the Proposed Project on sensitive receivers (see Appendix P). The scope of the assessment included:

– Update of the assessment criteria in accordance with the *Northern Territory Noise Management Framework Guideline* (EPA, 2018).
– Assessment of the construction and operational noise levels associated with the changes from the Approved Project and identification of potential impacts.
– Provision of noise mitigation measures to minimise potential impacts where exceedances are identified.
– Preparation of an addendum report to supplement the existing report detailing the outcomes of this assessment.

The modelling conducted as part of the assessment considered construction and operational noise sources listed in Table 40, and considered 'worst-case scenario' noise conditions, with the exception of noise related to the airfield. This was excluded as the type of aircraft and frequency of movements were unknown at the time of this assessment. The airfield would produce intermittent noise, with modelling likely indicating impact to sensitive receivers at the accommodation village.

19.2.0 Construction Findings and Management Measures

The noise impact assessment found that the noise level contribution from each construction plant item would be below the assigned construction noise level of 45 dBA during standard hours of work. Outside the standard hours of work operation of a scrapers, dump trucks and dozers have the potential to generate noise emissions above the assigned construction noise level of 35 dBA.

The report recommended that a Noise Management Plan (NMP) should be developed for all construction projects. The NMP would detail the allowable hours for construction, details on construction noise and vibration management measures in addition to complaints handling procedures. The NMP would be submitted to NT EPA.

General noise and vibration management measures were also recommended, as detailed in Table 41.

Table 41 Construction noise and vibration management measures

Construction noise and vibration management measures
Community notification practices
Potential noise affected neighbours contacted at the earliest possible time before any site work begins. As a minimum it is expected that all potentially affected sensitive noise receptors be given 48 hours' notice prior to the commencement of construction activities
Potential noise affected neighbours informed about the nature of the construction stages and the duration of louder activities – for example, excavation and rock-breaking
Provide contact details on a site board at the front of the site, and maintain complaints register suited to the scale of works
Provide copies of noise management plans, if available, to potential noise affected neighbours.
Operational practices
Where practical, undertake the loudest works during the recommended standard hours
Haul truck movements on exposed haul routes or open ridgelines of the open cut mine should be prevented during the evening and night and should be along routes with a low gradient
Broadband reversing alarms (audible movement alarms) should be used for all site equipment, subject to meeting occupational health and safety requirements, and minimise reversing with beepers where practical.
Turn off plant that is not being used and where practical, operate machines at low speed or power and switch off when not being used rather than left idling for prolonged periods.
Examine and implement where feasible and reasonable, the use of silenced equipment and noise shielding around stationary plant (such as generators), subject to manufacturers' design requirements
All engine covers should be kept closed while equipment is operating

Construction noise and vibration management measures
Ensure plant is regularly maintained and all mobile equipment are selected, where possible, to minimise noise emissions and maintained in good repair. Machines found to produce excessive noise compared to normal industry expectations should be removed from the site or stood down until repairs or modifications can be made.
Arrange the work site to minimise the use of movement alarms on vehicles and mobile plant
Involvement of workers in minimising noise
Avoid dropping materials from a height
Talk to workers about noise from the works at the identified land uses and how it can be reduced
Use radios and stereos indoors rather than outdoors.
Handling complaints
Keep staff who receive telephone complaints informed regarding current and upcoming works and the relevant contacts for these works
Handle complaints in a prompt and responsive manner
Where there are complaints about noise from an identified work activity, review and implement, where feasible and reasonable, actions additional to those described above to minimise noise output
Providing all complaints to the NT EPA Pollution Hotline within 24 hours upon receiving a complaint.

19.2.1 Operational Findings and Management Measures

The predicted operational noise levels from the Proposed Project are detailed in Table 42 including the contributions from each plant area. Operational noise contours are shown in Figure 35.

Potential operational noise impacts occur when the operational noise levels exceed the project specific assigned noise levels (as outlined in Appendix P). The night-time project specific assigned noise level of 35 dBA has been adopted as operations during the day, evening and night-time periods are constant and the potential noise impacts would be highest during the night-time period.

No exceedances of the project specific assigned noise levels are predicted. The highest noise levels are anticipated at the accommodation village located 3.6 km east northeast of the project site. Noise at the accommodation village is expected to be dominated from the following plant areas:

– Ammonia plant due to steam drum operations.
– Mining operations primarily due to haul truck and grader movements.
– Sulphuric acid plant due to the steam vents.

The model is considered conservative due to the following factors:

– It does not include shielding from the operational plant and equipment and assumes propagation into the free-field.
– The propagation algorithm used takes into account noise enhancing wind conditions with source to receiver winds. Occurrences of source to receiver winds (south-westerly winds) for the accommodation village are negligible based on the wind rose (Appendix P).
– Mining operations have been modelled based on the existing terrain and do not account for shielding which would result from equipment operating within an open-cut mine.
– Mining operations are modelled in the pit located closest to the nearest sensitive receptor. This mining pit would not be operational within the first 10 years of operations. Advancement in mining technology, such as the use of electric motors, has the potential to provide additional noise benefits once this pit is operational.

The results indicate that there is the potential for low frequency noise as C-weighted noise levels are at least 15 dB above the A-weighted noise levels. The spectral contributions at the accommodation village were analysed to determine whether the octave band thresholds were exceeded. The spectral contributions within each octave band are below the thresholds therefore no adjustments to the predicted A-weighted noise levels are required.

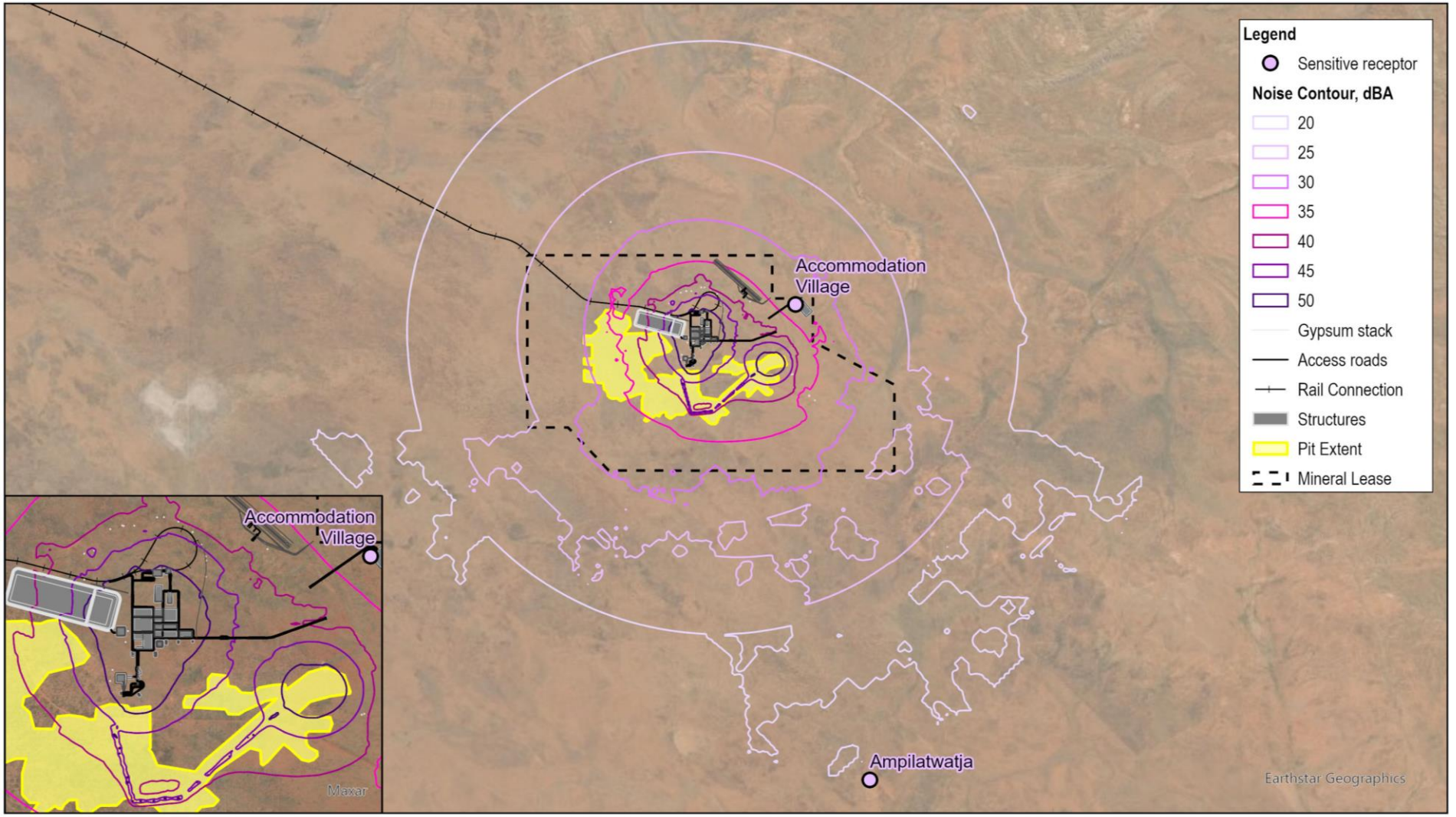
The construction noise and vibration management measures listed in Table 41 largely apply to the noise generation sources in the operation phase (i.e., haul truck movement, equipment operation and maintenance, etc.). Additional measures to minimise noise emissions during operations include:

– Where appropriate, selection of quiet equipment/system early in the design phase (e.g., conveyors) should be considered to minimise noise emissions. This would assist in minimising the off-site impact and help in preserving the hearing quality and reducing the potential health and safety impacts for on-site employees.
– Equipment shall be selected to have operating sound power levels compliant with the noise levels outlined in the Noise Impact Assessment report. Additional modelling shall be undertaken where the noise levels of the selected equipment are above these levels in order to confirm noise impacts.
– During operation of the airfield, arrivals and departures should be limited to less sensitive time periods to minimise potential aircraft noise impacts.

The full noise impact assessment report is provided in Appendix P.

Table 42 Predicted operational noise levels

Name	Plant area contribution, dBA												Total, dBA	Total, dBC
	Ammonia plant	Auxiliary	Dry beneficiation	Granulation plant	Gypsum	Mining	Phosphoric acid	Power station	Rail	Sulphuric acid	Wet beneficiation	WTP		
Accommodation village	29	< 10	14	11	< 10	30	19	16	< 10	16	15	< 10	33	61
Ali-Curung	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Ampilatwatja	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	10	40
Annerre	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Illeuwurru	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Imangara	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Imperrenth	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Indaringinya	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Ngkwarlerlanem	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Tara	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10



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Grid: AGD 1984 AMG Zone 53

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VERDANT MINERALS PTY LIMITED
AMMAROO PHOSPHATE PROJECT

Project No. 12571099
Revision No. 2
Date 06 Oct 2022

Operational Noise Contours

FIGURE 35

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Data source: Sensitive receptors (GHD, 20220809). Created by: nrama

Figure 35 Operational noise contours

20. Conclusion

To expand the economic feasibility of the Ammaroo Ammonium Phosphate Fertiliser Project, Verdant plan to include the onsite production of monoammonium phosphate (MAP) and diammonium phosphate (DAP) fertilisers. This will entail the construction of additional onsite plant and infrastructure, including a phosphoric acid plant, sulphuric acid plant, ammonia plant, granulation plant, and amenity and service infrastructure (collectively referred to as 'Proposed Project') within the boundary of the ML.

Australia remains a significant importer of ammonium phosphate fertiliser produced primarily in China, the Middle East and Northern Africa, supply that could be at risk under a number of real scenarios. By value adding to the Ammaroo phosphate rock resource, through the development of Ammaroo Phosphate Project as an ammonium phosphate fertiliser production facility, the Proposed Project will bring significant direct and indirect economic benefits to economies of the local Barkly region (Barkly), the Northern Territory, and Australia over the Project life from construction through operations and ultimately play a significant role in enhancing the resilience and self-reliance of Australia's domestic agricultural industry through security of fertiliser supply.

Outside of the economic benefits, it is expected that the Proposed Project of Ammaroo will be strongly aligned with a number of core economic and social development policies committed by the NT Government with a range of benefits to the Territory.

The environmental risk assessment identified potential environmental impacts from activities associated with the Proposed Project. Impacts assessed as having residual risk ratings of 'medium' include those related to terrestrial ecosystems and atmospheric processes consisting of loss of vegetation and loss of carbon sink; respectively, due to land clearance; and to communities and economy consisting of negative perceptions to groundwater abstraction.

With regard to risks to terrestrial ecosystems associated with land clearance, it is noted that the risk rating has not changed since the 2018 Approved EIS as it is considered that the Proposed Project is unlikely to cause new or increased impacts to protected matters under the EPBC Act given that the proposed alterations to the Project are not resulting in any additional clearance of native vegetation (beyond the approved 3775 ha) over the LOM to that assessed in 2017. Following consultation between Verdant and the Department of Climate Change, Energy, Environment and Water (DCCEEW) in August 2022, the department indicated that given there is no change to the clearance area, the 2018 Approval (EPBC Act referral 2014/7260) would still be applicable as no variation to Condition 1 is planned by the Proposed Project.

Specific mitigation measures for these potential impacts have been detailed throughout this referral. Based on this, it has been assessed that there are no residual significant impacts to NT EPA factors and objectives or matters of national environmental significance (MNES) associated with the Proposed Project.

Further, Verdant are committed to planning and conducting the Project in accordance with the environmental protection and management principals provided in this EIS Referral. Among the key aspects of these principals are:

– The careful and considered approach to limiting land clearance (which is unchanged since the Approved Project in 2018) to the area approved by the 2018 EBPC Approval conditions (EPBC 2014/7260), hence minimising, and reducing potential impacts to biodiversity values coupled with the progressive rehabilitation throughout the construction phase of the Project, and beyond, in order to restore pre-existing vegetation as quickly as possible upon completion of the works.
– Addressing the NT Large Emitters policy through GHG abatement strategies which align the emissions from the Proposed Project with the NT's goal of net zero by 2050.

21. References

Abbott, J. (2021). *Resource Estimation for the Ammaroo Phosphate Deposit, Northern Territory, Australia*. MPR Geological Consultants Pty. Ltd. internal report for Verdant Minerals Pty. Ltd.

ANCOLD (2019). Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure – Revision 1.

AS/NZ 2884. The Standard for Gas and Liquid Petroleum Pipelines.

Australia ICOMOS (2013). *The Burra Charter. The Australia ICOMOS Charter for Places of Cultural Significance. Available from Burra Charter 2013 (Adopted 31.10.2013) (icomos.org).*

Australian Radiation Protection and Nuclear Safety Agency (2017). *National Directory for Radiation Protection. Radiation Protection Series No.6. Available from National Directory for Radiation Protection (arpansa.gov.au)*.

Bureau of Meteorology (2022). *Climate Data Online.* Retrieved from Climate Data Online - Map search (bom.gov.au).

Department of Agricultural, Water and the Environment (DAWE) (2022). *Protected Matters Search Tool* [Accessed 22 February 2022] https://pmst.awe.gov.au/#/map?lng=131.52832031250003&lat=-28.671310915880834&zoom=5&baseLayers=Imagery

Department of Environment and Natural Resources (2019). *Declared Weeds in the Northern Territory. Available from: Declared Weeds in the Northern Territory*

Department of Environment, Parks, and Water Security (DEPWS) (2022). *Natural Resource Maps*, Accessed: January 2021. Available from http://nrmaps.nt.gov.au/nrmaps.html.

Dethier, T., Humblet, G., Robert, B. (2022). *Dihydrate pilot test – Preliminary Report Project 1047*. Confidential Report by Prayon Technologies, Belgium, for Verdant Minerals Pty. Ltd.

Dippel, S.K. (2004) Mineralogical *and geochemical characterisation of phosphogypsum waste material and its potential use as backfill at WMC Fertilisers' mine site, Phosphate Hill, NW Queensland*. M.Sc. Thesis, James Cook University.

EcOZ (2017). *Flora and Fauna Report for Ammaroo Phosphate EIS.* Prepared for Verdant Minerals.

Gaafar, I., El-Shershaby, A., Zeidan, I., Sayed El-Ahll, L. (2016). *Natural radioactivity and radiation hazard assessment of phosphate mining, Quseir-Safaga area, Central Eastern Desert, Egypt.* NRIAG Journal of Astronomy and Geophysics 5:160-172.

GHD (2017). *Ammaroo Phosphate Project – Draft Environmental Impacts Statement.* Prepared for Verdant Minerals.

GHD (2017). *Ammaroo Phosphate Project – EIS – AMD Assessment and Management Plan*. Prepared for Verdant Minerals.

GHD (2017). *Ammaroo Phosphate Project – Environmental Management Plan.* Prepared for Verdant Minerals.

GHD (2017). *Ammaroo Phosphate Project – Environmental Management Plan.* Prepared for Verdant Minerals.

Groundwater Science (2017). *Ammaroo Phosphate Project – Groundwater Study.* Prepared for Verdant Minerals.

Groundwater Science (2021). *Ammaroo Phosphate Project Borefield Testing and Design.* Prepared for Verdant Minerals.

Haneklaus, N., Bayok, A., Fedchenko, V. (2017). *Phosphate Rocks and Nuclear Proliferation.* Science & Global Security 25(3):143-158.

Havelange, S. (2021). *Verdant Minerals – HH Pilot Testing. Project No. 1027.* Confidential Report by Prayon Technologies, Belgium, for Verdant Minerals Pty. Ltd.

HydroGeoLogic Pty Ltd (2022). *Ammaroo Phosphate Project Mine Bore Field – Groundwater Model Peer Review*.

Innovative Groundwater Solutions (IGS) (2022). *Assessment of Groundwater Extraction from the Ammaroo Phosphate Project Mine Bore Field.* Prepared for Verdant Minerals

Jeuken (2017). *Ammaroo Phosphate Project groundwater study*. Prepared for Verdant Mineral Ltd, RJR-16-3-R001E, Groundwater Science.

Khan, S.A., Dar, S.A., Khan, K.F., Karim, Y. (2022). *Geochemical characteristics of Early Cambrian phosphate bearing sedimentary rocks from the Mussoorie Syncline, India: Implications for paleo-redox conditions*. Geosystems and Geoenvironment 1 (2022).

López, L., Castro, L.N., Scasso, R.A., Grancea, L., Tulsidas, H., Haneklaus, N. (2019). *Uranium supply potential from phosphate rocks for Argentina's nuclear power fleet*. Resources Policy 62 (2019):397-404.

Milne D.J. and Pavey C.R. (2011). The status and conservation of bats in the Northern Territory. *The Biology and Conservation of Australasian Bats*

Northern Territory Environmental Protection Authority. *Environmental Impact Assessment Guidance for Proponents – Referring a Significant Variation to the NT EPA.* Available from Referring a significant variation to the NT EPA.

Northern Territory WorkSafe (2020). Major Hazard Facilities. Available from Major hazard facilities | NT WorkSafe.

Russell, R.T. and Trueman, N.A. (1971). *Geology of the Duchess Phosphate Deposits, Australia*. Economic Geology 66(8):1186-1214.

Sabiha-Javied, M.T. and Asghar, M. (2010). *Hazard of NORM from phosphorite of Pakistan.* Journal of Hazardous Materials 176(1-3):426-433. (Abstract).

Sattouf, M. (2007). *Identifying the Origin of Rock Phosphates and Phosphorous Fertilisers Using Isotope Ratio Techniques and Heavy Metal Patterns.* Landbauforschung Völkenrode – FAL Agricultural Research, Special Issue 311. Die Deutsche Bibliothek.

Saueia, C.H., Mazzilli, B.P., Fávaro, D.I.T. (2005). N*atural radioactivity in phosphate rock, phosphogypsum and phosphate fertilizers in Brazil.* Journal of Radioanalytical and Nuclear Chemistry 264(2):445-448.

Shang, D., Geissler, B., Mew, M., Satalkina, L., Zenk, L., Tulsidas, H., Barker, L., El-Yahyaoui, A., Hussein, A., Taha, M., Zheng, Y., Wang, M., Yao, U., Liu, X., Deng, H., Zhong, J., Li, Z., Steiner, G., Bertau, M., Haneklaus, N. (2021). *Unconventional Uranium in China's Phosphate Rock: Review and Outlook.* Renewable and Sustainable Energy Reviews 140, April 2021, 110740.

Steiner, G., Geissler, B., Haneklaus, N. (2020). *Making Uranium Recovery from Phosphates Great Again?* Environmental Science and Technology 54:1287-1289.

Sun, Y., Amelung, W., Gudmundsson, T., Wu, B., Bol, R. (2020). *Critical accumulation of fertilizer-derived uranium in Icelandic grassland Andosol.* Environmental Sciences Europe (2020):32:92

The Northern Territory Government. (2021). Greenhouse Gas Emissions Management for New and Expanding Large Emitters. Available from Greenhouse Gas Emissions Management for New and Expanding Large Emitters

Tufail, M., Akhtar, N., Waqas, M. (2006). *Radioactive rock phosphate: the feed stock of phosphate fertilizers used in Pakistan.* Health Physics 90(4):361-370. (Abstract)

Tulsidas, H., Gabriel, S., Kiegiel, K., Haneklaus, N. (2019). *Uranium resources in EU phosphate rock imports*. Resources Policy 61 (2019) 151-156.

United States Environmental Protection Agency. (2022). *TENORM: Fertilizer and Fertilizer Production Wastes*. https://www.epa.gov/radiation/tenorm-fertilizer-and-fertilizer-production-wastes (Accessed 23 June 2022)

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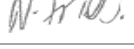
S4	0	K. Pechazis	K. Yale		N. Fries		09/11/2022

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