Stantec

# Memo

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| File: | lmka_memo_ghg_v2 | Date: | September 8, 2021 |

**Reference: Mackay Potash Project – Greenhouse Gas Assessment**

## 1. INTRODUCTION

Agrimin Limited (Agrimin) the Proponent proposes to build and operate the Lake Mackay Sulphate of Potash (SOP) Project (the Proposal) which is the subject of this assessment. Agrimin's proposal involves the development of a greenfield potash fertiliser operation. The potash operation will involve the extraction of brine from a network of shallow trenches established on the surface of Lake Mackay. The brine will be transferred into evaporation ponds for the precipitation of salt which will be harvested and then processed to produce a potash fertiliser product. The Proposal includes a processing plant and other associated site infrastructure, a haul road for transporting potash to Wyndham Port, as well as a water pipeline from a fresh borefield located to the south of Lake Mackay.

This report details the Greenhouse Gas (GHG) Assessment undertaken for the Proposal. It specifically addresses the following aspects:

- Provide estimates of scope 1, 2 and 3 emissions (a breakdown of GHG emissions by source inclusive of, but not limited to, stationary energy, fugitives, transport, and emissions associated with changes to land use), to inform the assessment process;
- Analyse the greenhouse gas intensity (i.e. quantity of $CO_2$-e generated per tonne of product produced) for the Proposal;
- Benchmarking against other comparable projects;
- Describe the greenhouse gas emission minimisation measures; and
- Demonstrate within the ERD how the EPA's objective for this factor can be met through appropriate avoidance and mitigation measures (Section 4.3)

This document has been prepared to inform and assist Agrimin in the preparation of supporting documents for the Environmental Review Document assessment process under the *Environmental Protection Act 1986* (EP Act) This submission uses and references the concept design work developed during the Definitive Feasibility Study (DFS) that forms the basis for finalising financing for the construction of the Proposal and in making a Final Investment Decision (FID).

## 2. Lake Mackay Potash Project Concept Design Energy Efficiency and Other Initiatives

### 2.1 PROJECT BACKGROUND AND OBJECTIVES

The Proposal includes a trench network consisting of 17 brine mining units (BMU's) which represent areas of the lakebed sediments that are similar in physical and chemical characteristics. The mine plan has an average brine extraction volume of 86 gigalitres per annum (GL/yr) with an average potassium grade of 2,820 milligrams per litre (mg/L). Throughout the life of mine, extraction and recharge processes are expected to gradually dilute the potassium grade from 3,280 to 2,560 mg/L. This grade dilution will be offset by increasing the annual brine extraction rate from 74 to 94 GL/yr in order to maintain a constant feed rate of SOP into the evaporation ponds.

The current life of the Proposal is 20 years, with an annual production rate of 450,000 tonnes of SOP.

Construction is expected to start mid-2022 for completion at the end of 2024. Approximately 1,500 ha of native desert spinifex and sparse scrubland will be cleared during this period including land for processing plant and associated infrastructure (500 ha) and haul roads (1,000 ha). Earthmoving and construction work will be undertaken by Agrimin's subcontractors.

### 2.2 POWER SUPPLY

The proposal will have an installed power supply of 22 megawatts (MW) and an average load of 16 MW utilising a hybrid gas, solar, wind and battery solution for a modelled renewables penetration of 57.6% (Agrimin Ltd, 2020). This power load will supply the processing plant, non-process infrastructure, offices and accommodation camp, as well as harvesting and pumping operations within the evaporation ponds. The power station and supply of trucked Liquified Natural Gas (LNG) are intended to be provided under separate Build-Own-Operate (BOO) contracts. The wind turbines are expected to be operational by the end of the first year of operations.

LNG has been selected as the preferred fuel option for power and heating requirements during operations with a total expected LNG consumption of 760,571 giga joules per annum (GJ/yr) from year 2 to 20. The first year will be slightly higher at 1,177,385 GJ/yr. Diesel will be used in mobile equipment at the site and as fuel for remote generators to power the process water borefield and remote pumping stations along the main brine feed canal and as a fuel for road trains transporting product to port. During construction, the electrical requirements will be met using temporary diesel generators.

### 2.3 PROCESSING PLANT

The processing plant is designed to receive 3.0 million Metric tonnes per annum (mMtpa) of raw potash salts, being fed from the evaporation ponds via two slurry pipelines (Agrimin Ltd, 2020). The salts will be crushed to ensure adequate liberation for the downstream unit operations of the plant to operate efficiently. The slurry from the crushing circuit will be fed into a thickener to minimise the amount of brine that moves forward into the next stages of the process. The salt slurry exiting the thickener will be transferred to a series of conversion vessels where the raw potash salts will be converted into a single potash-bearing salt mineral in the form of schoenite ($K_2SO_4.MgSO_4.6H_2O$). The resulting slurry exiting the conversion circuit will contain only schoenite and halite and will be transferred to the flotation circuit. The salt slurry exiting the conversion circuit will then be mixed with flotation reagents in the conditioning tanks then transferred to the flotation cells where the schoenite is preferentially floated from the halite. The combination of the flotation and leach reactors ensures that the concentrate is of the right schoenite quality and the recovery from the tails is achieved. The resulting schoenite concentrate will be de-brined and fed to the first stage SOP crystalliser to initiate SOP production. The SOP crystallisation step will take place at an elevated temperature to dissolve magnesium sulphate ($MgSO_4$) and crystallise SOP ($K_2SO_4$) within the SOP crystalliser vessels. The resulting SOP slurry will be transferred to a hydrocyclone followed by a centrifuge. The SOP will then be dried and stockpiled in a covered storage area ready for haulage to Agrimin's storage facility at Wyndham Port. A simplified process flow diagram is shown in Figure 2-1and a model of the processing plant is shown in Figure 2-2.

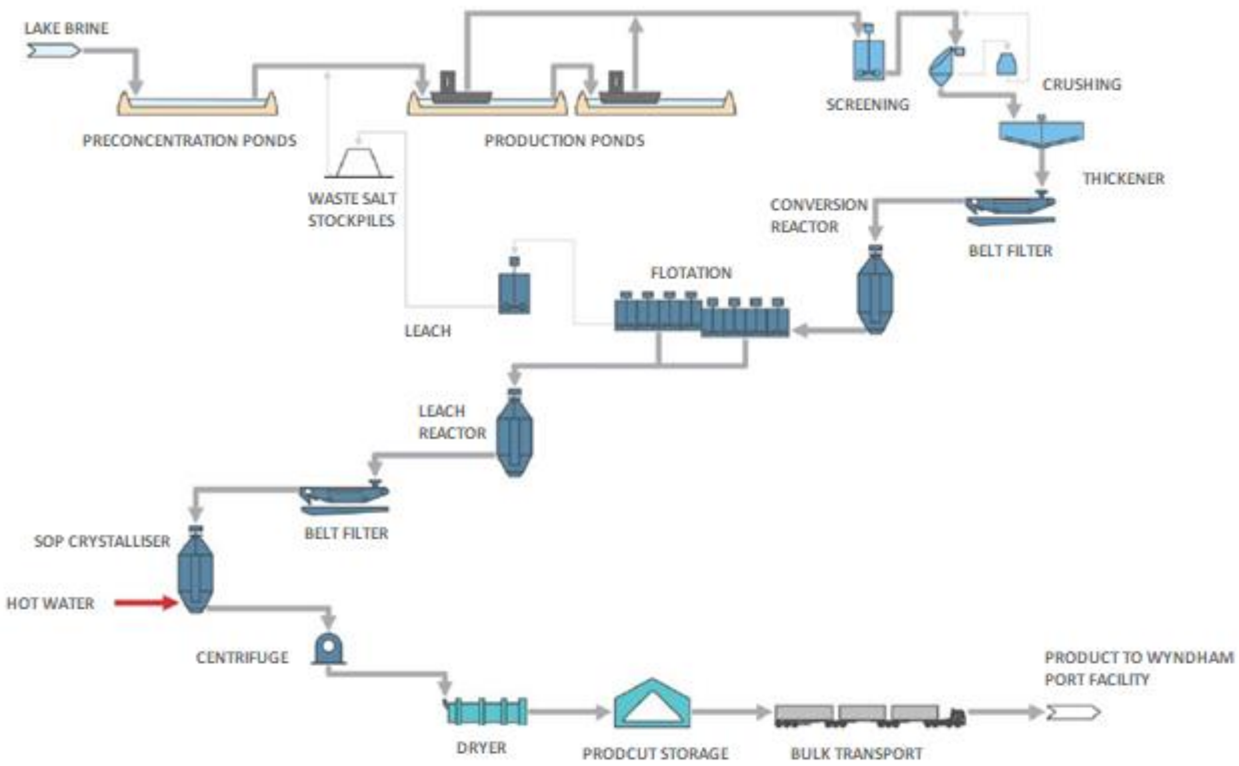


**Figure 2-1: Mackay Proposal Simplified Process Flow Diagram**

**Figure 2-2: Mackay Proposal Computer Generated Imagery of Processing Plant**

## 2.4 SITE INFRASTRUCTURE AND OFF-LAKE DEVELOPMENT ENVELOPE LAYOUT

Site infrastructure will include access roads, power plant and transmission lines, process water borefield, wastewater treatment facilities, 100 room accommodation camp, administration buildings, laboratory, medical treatment, vehicle and maintenance workshops, fire-fighting facilities and a sealed airstrip.

The DFS has estimated an on-site workforce of approximately 80 personnel, excluding off-site logistics personnel.

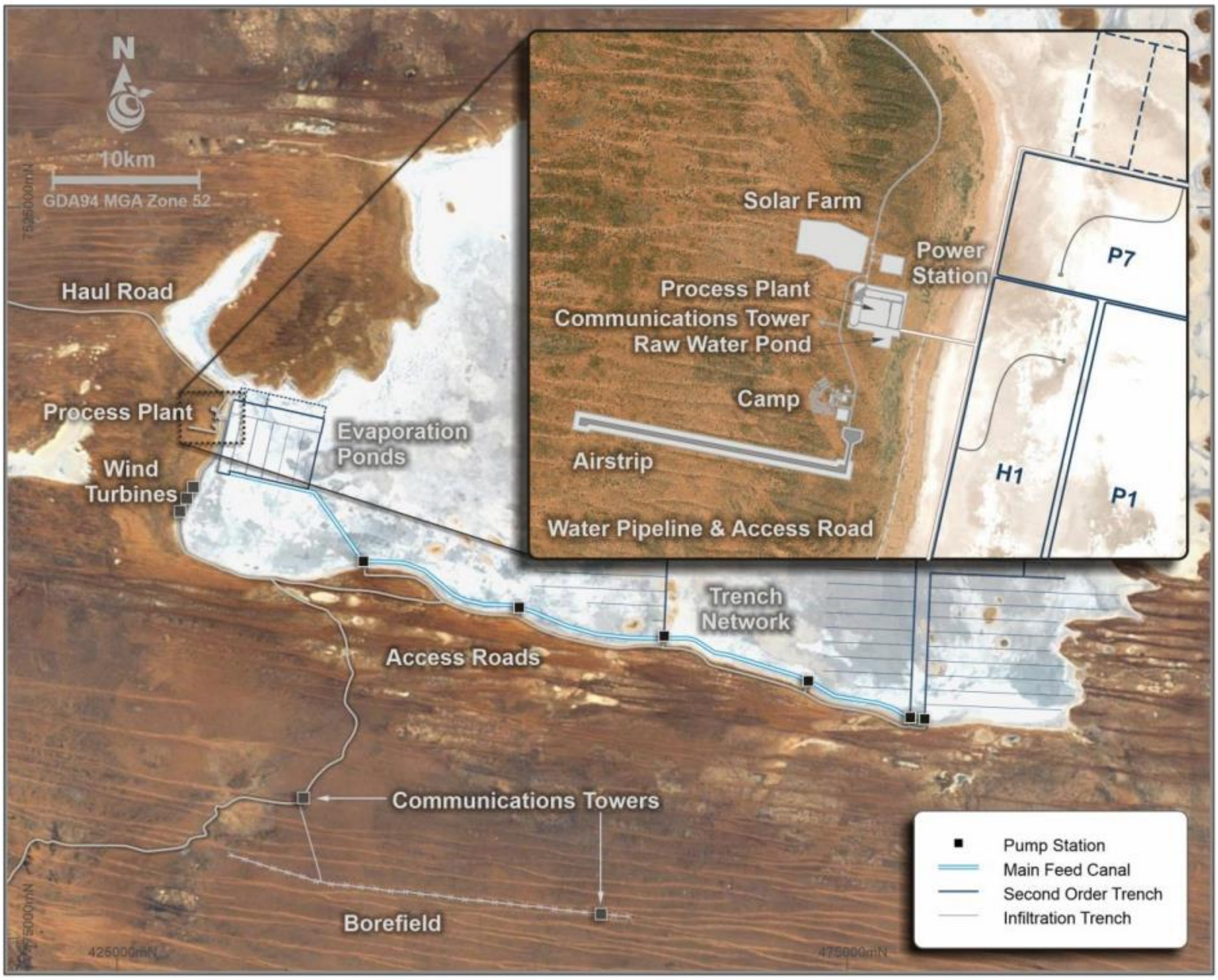


**Figure 2-3: Processing Plant and Site Infrastructure Layout**

## 2.5 HAUL ROAD AND PRODUCT HAULAGE

The haulage corridor from Lake Mackay to Wyndham Port comprises of 941km sealed single lane haul roads. including a new 346km sealed haul road to connect the site to the existing public road network. During operations, the corridor will also support the delivery of diesel, consumables and other supplies to the site.

The haul road is planned to be constructed over two years, primarily during the dry seasons. The route includes 346km along the new haul road, followed by 205km and 390km along the existing public Tanami Road and Great Northern Highway, respectively.

Agrimin will operate a joint venture with New Haul to truck the final product to the warehouse at Wyndham Port.

### 2.6 INCORPORATION OF RENEWABLE POWER SOURCES WITHIN DESIGN

Agrimin's vision is to establish the Mackay Potash Project as the world's leading seaborne supplier of Potash fertiliser, to develop the Project with sustainability principles at its core and to empower local Indigenous communities throughout the Project's long life (Agrimin Ltd, 2020).

Agrimin's commitment to a sustainable and Environmental, Social and Governance (ESG)-friendly development is embodied throughout the Project's DFS. This is demonstrated by Agrimin's high renewable energy targets, positive stakeholder engagement over the past six years and plans for maximising training and employment for local Indigenous people.

Agrimin is committed to developing the Mackay Potash Project sustainably and in alignment with the United Nations Sustainable Development Goals. The Company's commitment is embodied throughout the DFS and has been demonstrated through six years of positive stakeholder engagement with local communities, government agencies, special interest groups and the national mainstream media.

The proposal's power supply is designed to be generated utilising a hybrid gas, solar, wind and battery solution for a modelled renewables penetration of 57.6%.

## 3. GREENHOUSE GAS ASSESSMENT

### 3.1 ASSESSMENT OBJECTIVES AND SCOPE

The objective of this assessment is to identify the GHG emissions associated with the proposal and review and address the key components of requirements of the Environmental Scoping Document (ESD) (Stantec, 2020) endorsed on 10 September 2020 by the DWER-EPA as per the Western Australia (WA) EPA Greenhouse Gas Emissions Environmental Factor Guideline (EPA, 2020).

The GHG assessment scope includes review of the following emission types:

- Scope 1 – the emissions released to atmosphere as a direct result of the Proposal, from sources owned or controlled by Agrimin including but not limited to combustion from fuel used in processing plant, stationary and mobile combustion sources. Emissions from land clearing and construction also form part of this Scope.
- Scope 2 – the emissions from the consumption of an energy product at the Proposal, i.e. electricity. These emissions physically occur at the facility that generates the electricity, rather than the facility that uses it.
- Scope 3 – the indirect GHG emissions, that occur because of the activities of the Proposal, but from sources not owned or controlled by Agrimin. Examples of these emissions include upstream emissions associated with supply of fuels, or downstream emissions associated with the transportation of final product to user.

These emissions across the value chain are presented in **Figure 3-1**

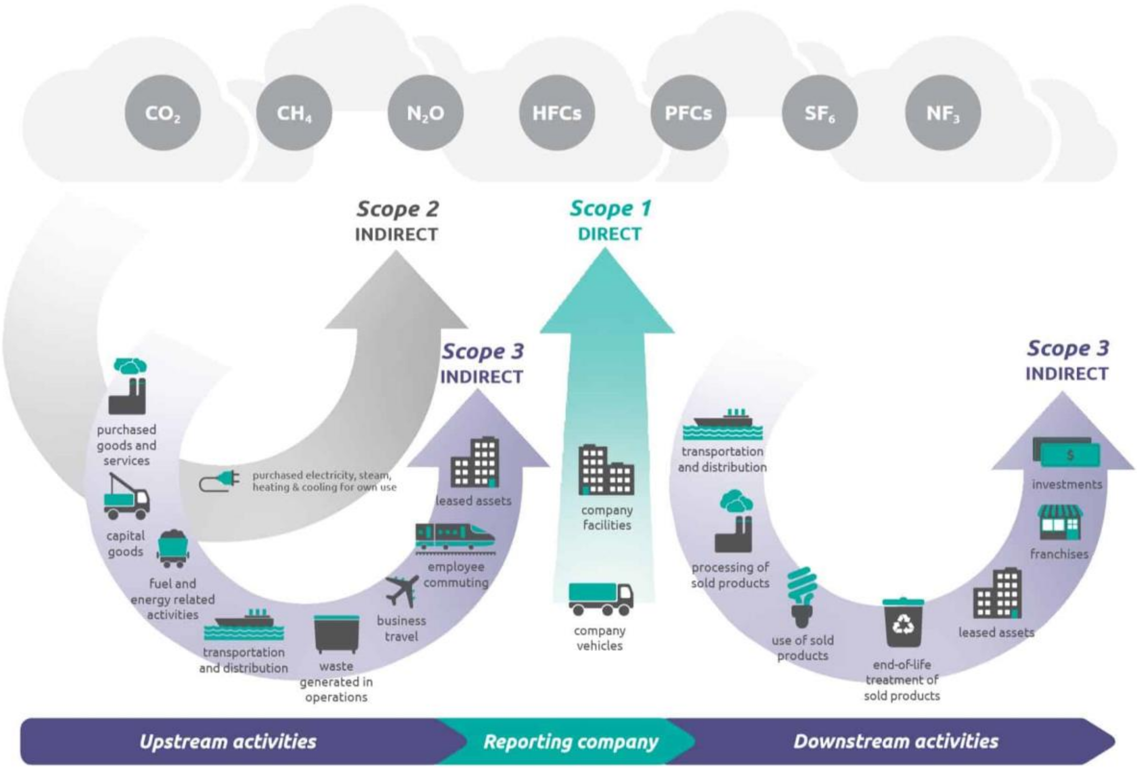


**Figure 3-1: Overview of Emissions and Scopes across a Value Chain (GHG Protocol, 2013)**

## 3.2 LEGISLATION, POLICY AND GUIDELINES

Under international climate agreements, Australia has two targets to reduce our greenhouse gas emissions:

- 5% below 2000 levels by 2020 (under the Kyoto Protocol) and
- 26-28% below 2005 levels by 2030 (under the Paris Agreement).

### 3.2.1 Emissions Reduction Fund

The Australian government's investment strategy in climate solutions includes the Emissions Reduction Fund (ERF). The ERF is a voluntary scheme provided by the Government which provides financial incentives to organisations and individuals to adopt new practices and technologies to reduce their GHG emissions. Under the scheme, participants can earn Australian carbon credit units (ACCUs) for emissions reduction. ACCUs can then be sold to generate income, either to the government through a carbon abatement contract, or in the secondary market.

The future implementation of energy reducing projects to achieve continuous improvement in energy efficiency during the life of the Proposal may present opportunities for Agrimin's participation in the ERF.

Within the ERF, there is a safeguard mechanism which is designed to ensure that emission reductions credited, are not offset through increases elsewhere in the economy. The mechanism works through setting baseline for emissions for facilities, which emit over 100,000 $tCO_2$-e annually (based on historical performance) and requiring facilities to keep their emissions below this baseline. The mechanism includes methodologies for dealing with growth and exceptional circumstances and came into operation on 1 July 2016.

### 3.2.2 National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) provides method and guidance for the reporting and dissemination of information related to GHG emissions from relevant organisations in Australia.

Reporting requirements under the NGER Act are triggered when the GHG emission and/or energy use of corporations and/or individual facilities owned and operated by constitutional corporations meet specific criteria. These threshold values are provided in Table 3-1. On a facility level, Lake Mackay Potash Project will be required to report under NGERS (Section 4.2). Agrimin's corporate will be subject to the thresholds detailed below. Methods for GHG accounting provided under NGER regulations are used within this report where relevant.

**Table 3-1: Current NGER Reporting Thresholds**

| Category | Facility | Corporate |
|---|---|---|
| Scope 1 and Scope 2 GHG emissions | 25kt or more $CO_2$-e per year | 50kt or more $CO_2$-e per year |
| Energy Consumption | 100 TJ/yr or more per year | 200 TJ/yr or more per year |
| Energy Production | | |

### 3.2.3 Western Australia Government's State Greenhouse Gas Emissions Policy

The WA Government's State Greenhouse Gas Emissions Policy for Major Projects (State Emissions Policy, WA Govt, 2019), commits the State Government to working with all sectors of the WA economy to achieve net zero GHG emissions by 2050. It also commits to working to achieve Australian Government's interim target of 26 to 28% emissions reduction by 2030. The State Emissions Policy encourages local innovation and the development of carbon offsets.

This policy is relevant to the Proposal as it sets the expectations for targeting best practice design and operation of the plant for energy efficiency.

### 3.2.4 WA EPA Greenhouse Gas Emissions Environmental Factor Guideline

The WA EPA Greenhouse Gas Emissions Environmental Factor Guideline (WA EPA, 2020), outlines the following components to be considered as part of a GHG assessment:

- Application of the mitigation hierarchy to avoid, reduce and offset emissions;
- Interim and long-term emissions reduction targets the proponent proposes to achieve;
- Adoption of best practice design, technology and management appropriate to mitigate GHG emissions; and
- Whether proposed mitigation is plausible, timely, achievable and is all that is reasonable and practicable.

These policies and guidelines have been used to guide the approach to the Proposal design and focus on the reduction of GHG emissions. The key components of the EPA's EFG have been used to develop the GHG assessment.

### 3.2.5 Agrimin's Commitment to Environmental, Social and Governance

Agrimin is committed to developing the Lake Mackay Potash Project sustainably and in alignment with the United Nations Sustainable Development Goals including the following specifically relating to emissions reduction:

- **Responsible Consumption and Production:** Agrimin have designed a sustainable and low impact production process to ensure that their operations minimise the consumption of water, energy and other materials.
- **Climate Action**: Agrimin aims to achieve a high penetration of renewable energy in their operations and are proud that their fertiliser will have one of the lowest carbon footprints associated with any major macro-nutrient fertiliser.

Agrimin is committed to protecting and improving the environments in which they work or influence and their Environmental Policy (Agrimin Ltd, 2021) is in alignment with objectives of the WA Government and EPA guidelines. One of the key objectives under their Environmental Policy is to achieve no net GHG emissions by

2050. These objectives provide the framework for the approach to the management of GHG emissions associated with the Proposal.

# 4. GHG EMISSIONS ESTIMATION

The GHG assessment addresses emissions from the Mackay Potash Project from construction, electricity generation, brine extraction and processing through to the transport of final SOP to Wyndham Port. The assessment also considers upstream and downstream emissions from operations.

Scope 1 emissions refer to emissions from the construction and operational phase of the Proposal and include:

- Construction phase
    - diesel combustion in stationary and mobile fleet undertaking earthworks, site support infrastructure, pumps and light vehicles;
    - diesel combustion in mobile fleet transporting supplies to site; and
    - Loss in carbon sequestration due to vegetation clearing;
- Operations phase
    - the use of Liquified Natural Gas (LNG) in the processing plant and for power generation;
    - the use of diesel fuel in stationary and mobile fleet; and
    - Downstream emissions associated with the NewHaul JV (Section 4.1.1.3) i.e., the use of fuel to transport final product to Wyndham Port.

Due to the remoteness of the facility, the Proposal generates its own electricity; thereby there are no Scope 2 emissions associated with the Proposal.

Scope 3 emissions from the Proposal includes emissions from upstream emissions associated with transportation of fuel and supplies to site and emissions associated with air transport of personnel to and from site:

- Upstream emissions associated with diesel combustion in mobile fleet transporting fuel (LNG, diesel) and other spare parts to site; and
- Air transport of personnel to and from site during construction and operational phases.

A detailed emission estimation is provided in subsequent sections.

### 4.1.1 Scope 1 Emissions

#### *4.1.1.1 Construction*

Construction is expected to start mid-2022 and last to the end of 2024. Prior to construction, about 1,500ha of vegetation comprising of desert spinifex and sparse scrubland will be cleared resulting in loss in carbon sink. Simulations created using Full Carbon Accounting Model (FullCAM) for complete removal (thinning) of above ground vegetation, in accordance with guidelines provided within Section 6 of NGA Factors. The model estimated 3.69 tonnes of carbon will be lost per hectare per year with the GHG emissions presented in Table 4-4). For the purposes of this assessment, it is assumed that the entire vegetation will be cleared during the first year of construction. While land clearing and construction activities will be undertaken by sub-contractors, these emissions have still been considered as Scope 1 based on the EPA's GHG Emission Key Factor Guideline (WA EPA, 2020). This guideline defines Scope 1 GHG emissions as emission's released to the atmosphere as a direct result of an activity, or a series of activities at a facility level. Activities considered under this factor includes developments that clear vegetation.

During construction, diesel will be used in stationary and non-road mobile equipment, temporary power generation, on-road vehicles and heavy vehicles transporting supplies to site. The relevant emission factors are presented in Table 4-1 to Table 4-3; associated fuel consumption and $CO_2$ equivalent emissions are presented in Table 4-4.

**Table 4-1: Energy content and emission factor for Diesel oil used in stationary combustion**

| Description | Value | Unit |
|---|---|---|
| Energy Content | 38.6 | GJ/kL |
| Emission Factor – $CO_2$ | 69.9 | $kgCO_2$-e/GJ |
| Emission Factor – $CH_4$ | 0.1 | $kgCO_2$-e/GJ |
| Emission Factor – $N_2O$ | 0.2 | $kgCO_2$-e/GJ |

**Table 4-2: Energy content and emission factor for Diesel oil for transport energy – post 2004 vehicles**

| Description | Value | Unit |
|---|---|---|
| Energy Content | 38.6 | GJ/kL |
| Emission Factor – $CO_2$ | 69.9 | $kgCO_2$-e/GJ |
| Emission Factor – $CH_4$ | 0.01 | $kgCO_2$-e/GJ |
| Emission Factor – $N_2O$ | 0.6 | $kgCO_2$-e/GJ |

**Table 4-3: Energy content and emission factor for Diesel oil for transport energy – Heavy Vehicles Euro IV or higher**

| Description | Value | Unit |
|---|---|---|
| Energy Content | 38.6 | GJ/kL |
| Emission Factor – $CO_2$ | 69.9 | $kgCO_2$-e/GJ |
| Emission Factor – $CH_4$ | 0.06 | $kgCO_2$-e/GJ |
| Emission Factor – $N_2O$ | 0.5 | $kgCO_2$-e/GJ |

**Table 4-4: Scope 1 Emissions – Construction phase – input used and emissions generated**

| Classification | GHG Estimation Methodology | Consumption | | | | Emissions (t $CO_2$-e/yr) | | |
|---|---|---|---|---|---|---|---|---|
| | | 2022 | 2023 | 2024 | Unit | 2022 | 2023 | 2024 |
| Loss in carbon sink due to vegetation clearing | Vegetation Clearing (FullCAM) | 1,500 | | | ha | 20,295 | - | - |
| Stationary and Non-road mobile equipment | Diesel consumption for stationary energy purposes | 1,740,116 | 7,534,770 | 7,727,890 | L/yr | 4,715 | 20,417 | 20,940 |
| Stationary energy - temporary | Diesel consumption for stationary energy purposes | 350,000 | 1,050,000 | 2,100,000 | L/yr | 948 | 2,845 | 5,690 |

| Classification | GHG Estimation Methodology | Consumption | | | | Emissions (t $CO_2$-e/yr) | | |
|---|---|---|---|---|---|---|---|---|
| | | 2022 | 2023 | 2024 | Unit | 2022 | 2023 | 2024 |
| power generation | | | | | | | | |
| Upstream emissions – haul trucks transporting supplies to Site | Diesel consumption for transport energy purposes - Heavy vehicles | 900,000 | 2,025,000 | 1,575,000 | L/yr | 2,448 | 5,508 | 4,284 |
| General transport - Light vehicles | Diesel consumption for transport energy purposes - road transport | 25,200 | 64,320 | 64,320 | L/yr | 69 | 175 | 175 |

#### *4.1.1.2 Electricity Generation*

The electrical power requirements for the Proposal will be met by a combination of gas fired power plants, solar photovoltaics (PV) and wind turbines. The gas generation platform will consist of 12 x 2,000kW Cummins reciprocating internal combustion engines with a N+1 redundancy. These are new, high speed engines with an improved step load capability, less greenhouse gas emissions, improved efficiency and higher ambient temperatures before the start of derating and lower rate of derating as temperature increases. In summary, these engines are far more robust for isolated applications compared to previous generation of high efficiency engines.

The solar PV system consists of 14MW on a single axis tracking system that can yield 62.5MWh per day. The wind turbines are 3 x 4.5MW. The battery system is 4MW at 2C & 2MWh.

The total electrical power demand of the Proposal is 139,504 MWh/yr. At its completion, 42.4% of the power requirements will be through LNG fuelled generators (59,169 MWh/yr); solar photovoltaics (PV) will supply 36,863 MWh/yr (26.4%) and wind turbines will provide 43,473 MWhr/yr (31.2%). In total, this accounts for 57.6% renewables in energy generation. Further to assist with grid startup and stability, Agrimin plans to install a 4MW Battery Energy Storage System (BESS) with a 2MWh storage capacity. The site will also house 3 units of 300kL LNG storage tanks.

It is expected that the wind turbines will become operational from the second year of operations. Therefore, during the first year of production, the LNG power plant will supply 102,641MWh (73.6%) of electrical power with the remaining requirement met by solar PVs. It is noted that the power plants will operate under BOO with Agrimin having no operational control; however, GHG emissions from this source have still been included within Scope 1 for sanity purposes.

Emissions of $CO_2$, $CH_4$, and $N_2O$ were estimated using methodology specified within Section 2.1.3 of NGA Factors (Equation 1). The emission factors are detailed in Table 4-5, fuel consumption and emission estimates are presented in Table 4-6. About 50,712 $tCO_2$-e and 29,233 $tCO_2$-e will be emitted during Year 1 and for the rest of the operational life of the Proposal respectively.

**Equation 1**

$$E = \frac{Q \times EC \times EF}{1000}$$

Where

E is the emissions of gas type ($CO_2$, $CH_4$, $N_2O$) ($CO_2$-e tonnes)

Q	is the quantity of fuel (kL)

EC	is the energy content of fuel (GJ/kL)

EF	emission factor for each gas type (kg $CO_2$-e / GJ)

**Table 4-5: Energy content and emission factor for LNG used in stationary combustion**

| Description | Value | Unit |
|---|---|---|
| Energy Content | 25.3 | GJ/kL |
| Emission Factor – $CO_2$ | 51.4 | kg$CO_2$-e/GJ |
| Emission Factor – $CH_4$ | 0.1 | kg$CO_2$-e/GJ |
| Emission Factor – $N_2O$ | 0.03 | kg$CO_2$-e/GJ |

#### *4.1.1.3 Operations*

In the processing plant, the boiler and dryer will use about 7,639kL/yr of LNG. Emissions of $CO_2$, $CH_4$, and $N_2O$ were estimated using methodology specified within Section 2.1.3 of NGA Factors (Equation 1). The emission factors are detailed in Table 4-5, fuel consumption and emission estimates are presented in Table 4-6. These emissions account to 9,959 t$CO_2$-e/yr.

Approximately, 5,911kL of diesel fuel will be used to power medium/heavy equipment including graders, dozers etc., stationary equipment such as portable light towers and air compressors, pumps and equipment for civil works. A detailed estimate of fuel consumption by equipment is provided in Attachment 1. Emissions were estimated using Equation 1 using emission factors presented in Table 4-1. These emissions account to 16,017 t$CO_2$-e/yr (Table 4-6).

Diesel (67.2kL) will be used as fuel in light vehicles including utility and maintenance trucks. Emissions were estimated using Equation 1 using emission factors detailed in Table 4-2. These emissions account to 183 t$CO_2$-e/yr (Table 4-6).

Agrimin will operate a joint venture with NewHaul to transport the finished powdered Potash in customised triple road trains each with 122 tonne capacity. Diesel (6,813kL) will be used to power the haul trucks transporting final product from site to Wyndham Port. Emissions were estimated using Equation 1 using emission factors detailed in Table 4-3. These emissions account to 18,531 t$CO_2$-e/yr (Table 4-6).

**Table 4-6: Scope 1 Emissions - Quantity of fuel and emissions generated**

| Classification | GHG Estimation Methodology | Consumption | Unit | Operational Emissions (t $CO_2$-e/yr) | Total for 20 years |
|---|---|---|---|---|---|
| LNG consumption in processing plant | LNG consumption for stationary energy | 193,262 | GJ/yr | 9,959 | 199,180 |
| LNG powered electricity generation - Year 1 | LNG consumption for stationary energy | 984,123 | GJ/yr | 50,712 | 50,712 |
| LNG powered electricity generation - Year 2 to Year 20 | LNG consumption for stationary energy | 567,309 | GJ/yr | 29,233 | 555,427 |
| Stationary and Non-road mobile equipment | Diesel consumption for stationary energy purposes | 5,910,787 | L/yr | 16,017 | 320,340 |
| Haul trucks transporting Potash to Wyndham Port | Diesel consumption for mobile energy purposes - Heavy vehicles | 6,813,542 | L/yr | 18,531 | 370,620 |

| Classification | GHG Estimation Methodology | Consumption | Unit | Operational Emissions ($t\ CO_2$-e/yr) | Total for 20 years |
|---|---|---|---|---|---|
| General transport - Light vehicles | Diesel consumption for mobile energy purposes - road transport | 67,200 | L/yr | 183 | 3,660 |

### 4.1.2 Scope 3 Emissions

As noted in Section 3.1, Scope 3 emissions result from activities not owned or controlled by Agrimin. These include emissions from upstream transportation of fuel and supplies and air transport of personnel.

#### *4.1.2.1 Upstream Emissions*

Scope 3 emissions result from the diesel oil combustion in trucks used for transporting LNG, diesel oil and other supplies to site. Emissions were estimated using Equation 1 using emission factors detailed in Table 4-3. Fuel consumption and emission estimates are presented in Table 4-7.

**Table 4-7: Scope 3 Emissions – Upstream- Fuel consumption and emissions**

| Classification | GHG Estimation Methodology | Consumption (L/yr) | GHG Emissions ($t\ CO_2$-e/yr) | Notes |
|---|---|---|---|---|
| Upstream - Transport of LNG fuel | Diesel consumption for transport energy purposes - Heavy vehicles | n/a | 3,089(Yr1)<br>2,460 (Yr2-Yr20) | Emissions estimates provided by Agrimin |
| Upstream - Transport of Diesel oil | Diesel consumption for transport energy purposes - Heavy vehicles | 413,600 | 1,125 | Fuel consumption calculated based on 220 truck load per year from Wyndham Port |
| Upstream - Transport of spare parts and supplies | Diesel consumption for transport energy purposes - Heavy vehicles | 450,000 | 1,224 | Fuel consumption calculated based on assumption of 2 trucks per week from Perth 4500km round trip at an average fuel consumption of 1 L/km |

#### *4.1.2.2 Operations – Air travel*

Scope 3 emissions result from air transport of contractors and site personnel from Perth airport. Input data and emission factors are presented in Table 4-8**Error! Reference source not found.** and Table 4-9 **Error! Reference source not found.** respectively. Emission estimates for air travel emissions during construction and operational phase of the Proposal is presented in Table 4-10.

**Table 4-8: Air travel – input data**

| Phase | Value | Unit | Notes |
|---|---|---|---|
| Flight distance from Perth to site | 1625 | Km | |
| Average no. of passengers per flight | 35 | | Aircraft will be dash 8-300 or equivalent, passenger capacity 50, assumed 70% full |

**Table 4-9: Emission factor for air travel – medium haul**

| Description | Value | Unit |
|---|---|---|
| Emission Factor – $CO_2$ | 82.7 | g $CO_2$-e /passenger-km |
| Emission Factor – $CH_4$ | 0.009 | |
| Emission Factor – $N_2O$ | 0.8 | |
| Reference: US EPA Center for Corporate Climate Leadership GHG Emission Factors Hub; US EPA (2018) | | |

**Table 4-10: Scope 3 emissions - Air travel – input data and emissions**

| Phase | Description | Value | Unit | GHG Emissions (t $CO_2$-e/yr) |
|---|---|---|---|---|
| Operational | Flight frequency per year | 104 | no. | 494 |
| Construction | | 33 (2022)<br>167 (2023)<br>167 (2024) | no. | 158 (2022)<br>791 (2023)<br>791 (2024) |

## 4.2 GHG EMISSIONS SUMMARY

A summary of the GHG emissions from the Proposal split by emissions type and scope is presented in Table 4-11. During the operational phase, higher Scope 1 emissions are noted in year 1 attributed to the higher usage of LNG for power generation. The same trend is noted for Scope 3 emissions, with year 1 generating higher GHG emissions associated with the increase in transportation needed to bring in LNG for power generation.

During construction phase, higher emissions (Scope 1) result from loss is carbon sequestration due to vegetation clearing and stationary combustion sources.

**Table 4-11: Summary of GHG emissions for the Proposal**

| Description | Emission scope | Annual Emissions (tCO -e/yr) | | | | |
|---|---|---|---|---|---|---|
| | | 2022 | 2023 | 2024 | Yr1 | Yr2 – Yr20 |
| Operations - Stationary energy | Scope1 | | | | 25,975 | 25,975 |
| Operations - Stationary Energy - power generation | Scope1 | | | | 50,712 | 29,233 |
| Operations - Transport Energy | Scope1 | | | | 183 | 183 |
| Operations (downstream) - transport of final product to Port | Scope 1 | | | | 18,531 | 18,531 |
| ***Sub-Total (Operations)- Scope 1*** | | | | | ***95,401*** | ***73,923*** |
| Construction - Vegetation Clearing | Scope 1 | 20,295 | | | | |
| Construction - Stationary Energy | Scope 1 | 4,715 | 20,417 | 20,940 | | |
| Construction - Stationary Energy (power generation) | Scope 1 | 948 | 2,845 | 5,690 | | |
| Construction - Transport Energy | Scope 1 | 69 | 175 | 175 | | |

| Description | Emission scope | Annual Emissions (tCO -e/yr) | | | | |
|---|---|---|---|---|---|---|
| | | 2022 | 2023 | 2024 | Yr1 | Yr2 – Yr20 |
| ***Sub-Total (Construction excl Land clearing) – Scope 1*** | | ***5,732*** | ***23,437*** | ***26,806*** | | |
| ***Sub-Total (Construction incl Land clearing)*** | | ***26,027*** | ***23,437*** | ***26,806*** | | |
| Upstream - Transport of fuel and supply | Scope 3 | 2,448 | 5,508 | 4,284 | 5,438 | 4,809 |
| Air Travel | Scope 3 | 158 | 791 | 791 | 494 | 494 |
| ***Sub-Total (Scope 3)*** | | ***2,606*** | ***6,299*** | ***5,075*** | ***5,075*** | ***5,302*** |
| ***Total Scope1 (excl Land clearing)*** | | ***5,732*** | ***23,437*** | ***26,806*** | ***95,401*** | ***73,923*** |
| ***Total Scope1 (excl Land clearing)*** | | ***26,027*** | ***23,437*** | ***26,806*** | ***95,401*** | ***73,923*** |

From Figure 4-1 it can be noted that 40% of the normal operational Scope 1 GHG emissions from the Proposal is from power generation followed by fuel combustion for stationary purposes such as boilers, and heavy equipment such as dozers, front end loaders etc., and 25% of emissions is due to the downstream transport of Potash to port.

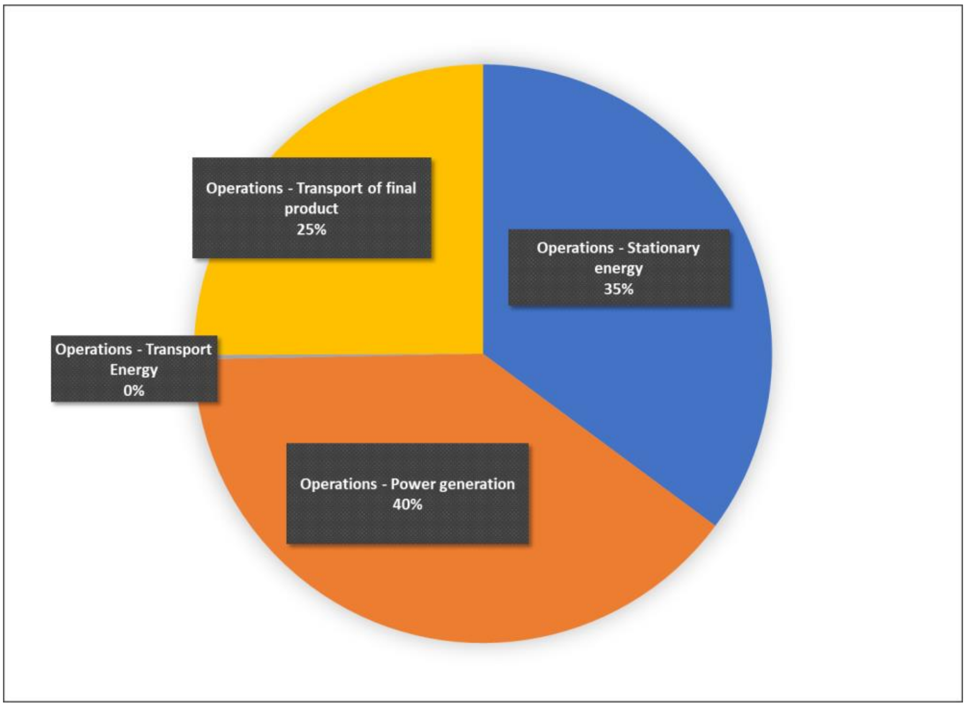


**Figure 4-1: Lake Mackay – Normal Operations – Scope 1 emissions contribution**

A plot of GHG emissions timeline for the entire life of the Proposal (Figure 4-2) shows higher emissions during operational year 1 as wind power generation is under construction . On a cumulative scale, the GHG emissions during construction phase is about 3% of the total operational life GHG emissions from the Proposal.

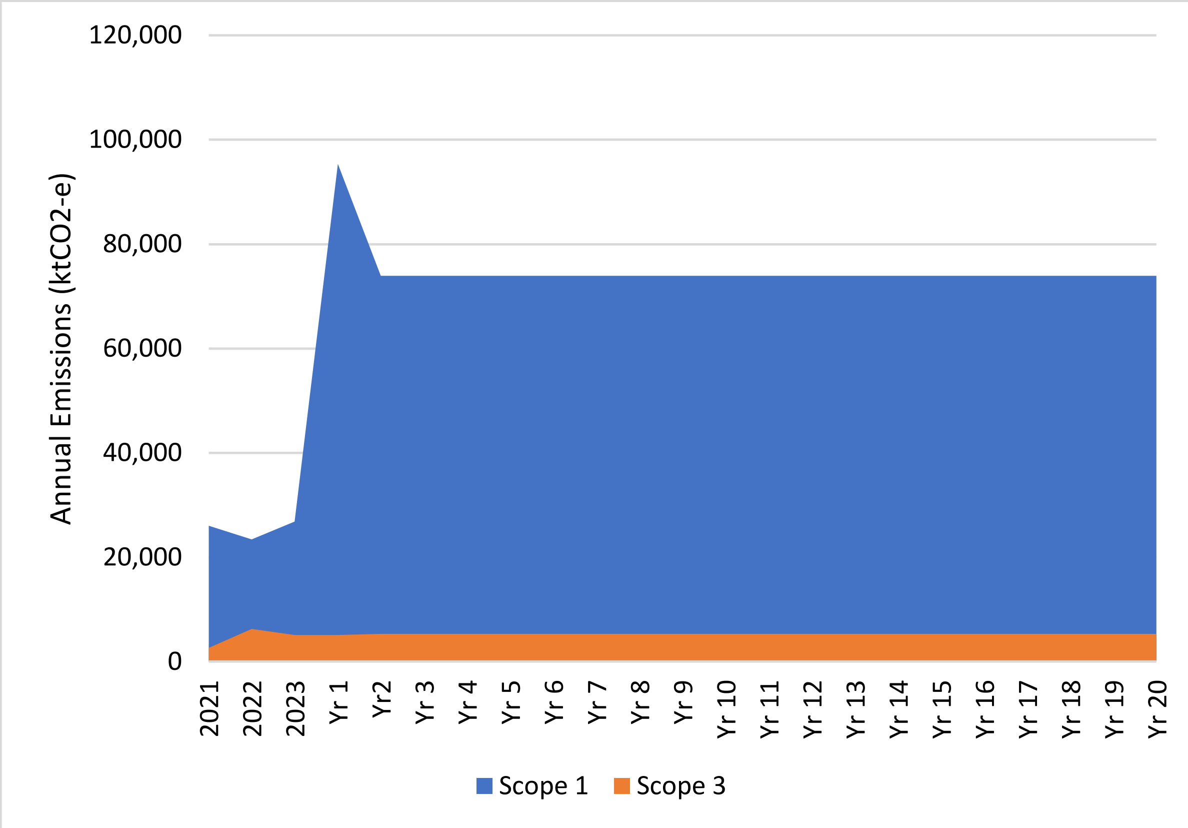


**Figure 4-2: Lake Mackay – GHG Emissions Timeline – All scopes**

### 4.2.1 Benchmarking of the Proposal GHG Emissions

Emission intensity of a project is expressed as the rate of (Scope 1 and Scope 2) emissions (t CO2-e) per unit of production. For the operational phase of the Proposal this accounts to 0.21t$CO_2$-e per tonne of SOP during year 1 of operations while wind power is still under construction and 0.16t$CO_2$-e / t SOP for the remaining life of the Mine.

A review of publicly available documents noted limited availability of GHG estimates related to SOP Projects. It is noted that the emissions intensity for the Kalium Lakes Project (DRA, 2018) is 0.3tCO2/t SOP, with the emissions from the Mackay Potash Project being (46%) lower. The lower energy intensity from Mackay Potash Project is attributed to the higher percentage of renewable penetration within the Proposal.

## 4.3 GHG MITIGATION OPTIONS

Majority of the scope 1 GHG emissions from the operational phase of the Proposal relate to the use of fuel in power generation, stationary combustion and haul trucks transporting the final product to Port. Agrimin has incorporated mitigation options into the design phase of the Proposal (Section 4.3.1 and Section 4.3.2) and will implement policies and procedures to minimise emissions during operations.

### 4.3.1 Approach to Best Practice Management and Mitigation

Agrimin have focussed on avoidance and minimisation of potential impacts of GHG through favouring sustainable design during options analysis. Renewable energy consultants (QGE) were engaged early to conduct an energy options study. This led to the selection of the power proposal by Contract Power Australia Pty Ltd who were able to provide the highest renewable energy fraction of 57.6% from a combination of photo voltaic and wind turbine technologies. Such a significant renewable penetration would reduce the dependency on LNG as a fuel for power generation while providing cost and emissions savings for the Proposal. As discussed previously, there are no Scope 2 emissions associated with the Proposal.

Construction impacts to vegetative carbon sinks will be minimised by reducing the haul road pavement width from 7.5m to 6.5m while utilising cleared areas (for example, existing tracks) where possible.

Management of greenhouse gas emissions will be in accordance with relevant legislation, State and National strategies relating to GHG emissions. This includes the establishment of procedures for annual reporting on energy production, energy consumption, emissions and updates on energy management projects in accordance with the NGER Act.

Agrimin will also investigate options for participation in the Emissions Reduction Fund (ERF).

Where options selection as discussed in the DFS were based primarily on financial costs, options that adopted energy efficient technologies and processes were at a significant advantage. For example, the trenching network has been proven to be the most efficient and cost-effective way of extracting brine by gravity and existing slopes.

### 4.3.2 Operational Energy Efficiency Measures

Operationally, the process plant and non-process infrastructure and equipment will be operated and maintained for optimal performance in accordance with manufacturer's specifications to minimise emissions. Agrimin will use customised triple road train configuration (rather than quad road train) for transporting final product to Port. This will reduce fuel consumption by 3-5% due to reduced drag, thereby minimising emissions.

Furthermore Agrimin will consider implementing the following energy efficiency measures:

- Building envelopes:
  - Selection of well-insulated building materials to minimise the heating and cooling requirements; and
  - Designing buildings according to the energy efficiency and heat conservation principles.
- Equipment design and selection:
  - Procurement of energy efficiency models; and
  - Optimise size selection for efficiency.
- Equipment maintenance:
  - Regular maintenance and service; and
  - Analyse downloaded engine use information to identify opportunities for improvement.
- Operator training:
  - Optimise machine usage; and
  - Using fuel efficient operating practices.
- Management practices:
  - Undertake audits on high energy use equipment to identify opportunities for improvement;

- Procurement policy that requires sub-contractors use energy efficient equipment and vehicles;
- Reduce fuel consumption including equipment selection, route and load optimisation, production scheduling and reduction in idle time;
- Process of continuous improvement through ongoing maintenance and reporting and identifying opportunities to reduce GHG emissions; and
- Identify and implement measures to progressively reduce or minimise emissions and maximise fuel and energy efficiency.

### 4.4 ASSESSMENT OF RESIDUAL GHG EMISSIONS IMPACTS

Considering the mitigation options proposed (renewables), there will still be some residual GHG emissions from the Proposal. At its peak, the Proposal contributes 173 $CO_2$ emission (kt) of GHG emissions per annum. Comparison of the Proposal emissions to state level GHG emissions (91.5Mt CO2-e for 2018, NGA, 2020) indicate that the Proposal contributes less than 0.2% of the WA GHG emission levels. Therefore, the residual impacts from the Proposal can be considered negligible.

## 5. ASSESSMENT LIMITATIONS

This report is intended to be solely used for the purposes of environmental review and approval. It is based on the concept design developed during the DFS for the Proposal. The report heavily relies on Agrimin's input data. This report would have to be revaluated if the intended operational or construction techniques change. The context of this report is to be read in full, with no excerpts to be taken as representative of the overall recommendations. The report has been written without reference to any specific timing, constructor preferences or alternative technologies which may become available. The report has been prepared exclusively for the Agrimin and no liability is accepted for any use or reliance on the report by third parties.

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## 7. ATTACHMENTS

Attachment 1: GHG Emissions – Input Data

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Attachment: Attachment

Cc. C.C.

## ATTACHMENT 1 – GHG EMISSIONS – INPUT DATA

**Table 0-1: Diesel Fuel consumption – Construction phase**

| | Fuel consumption (L/yr) | | |
|---|---|---|---|
| **Equipment** | **2022** | **2023** | **2024** |
| Four Wheel Drive Vehicle | 11,200 | 11,200 | 11,200 |
| Site Bus - 20 seater | | 4,410 | 4,410 |
| Site Bus - 50 seater | | 5,530 | 5,530 |
| Site Vehicles | | 17,787 | 17,787 |
| Traders - 7t (Complete with Tools) | | 11,393 | 11,393 |
| Mobile Maintenance Truck | 14,000 | 14,000 | 14,000 |
| Mobile Crane - 20T | | 46,872 | 46,872 |
| Mobile Crane - 100T | | 84,000 | 84,000 |
| Hydraulic Crane 200T - Wet Hire | | 45,325 | 45,325 |
| 300T Crawler Crane - Wet Hire | | 31,920 | 31,920 |
| EWP 18M/60FT | | 25,480 | 25,480 |
| EWP 24M/80FT | | 15,876 | 15,876 |
| Scissor lift 16M | | 3,247 | 3,247 |
| Fuel Carrier 1250L c/w Tank & Pump | | 2,205 | 2,205 |
| Telehandler 2.5t | | 7,056 | 7,056 |
| Articulating Boom | | 8,904 | 8,904 |
| Welding Plant (CSMPE) - Lincon 405 | | 7,168 | 7,168 |
| Welding Plant (CSMPE) - Vantage 575 | | 8,960 | 8,960 |
| 20 KVA Generator | | 39,060 | 39,060 |
| Compressor 195 CFM | | 5,292 | 5,292 |
| Poly Welder - Fast Fusion | | 26,434 | 26,434 |
| Fuel - Powerline subcon | | 60,000 | |

| Equipment | Fuel consumption (L/yr) 2022 | 2023 | 2024 |
|---|---|---|---|
| Portable Genset | 350,000 | 1,050,000 | 2,100,000 |
| Portable Light Tower | 6,000 | 8,000 | 8,000 |
| Portable Air Compressor | | 35,000 | 35,000 |
| Pump Station 1 | | 38,957 | 77,914 |
| Pump Station 2 | | 77,914 | 155,828 |
| Pump Station 3 | | 38,957 | 77,914 |
| Pump Station 4 | | 38,957 | 77,914 |
| Pump Station 5 | | 22,882 | 45,765 |
| Pump Station 6 | | 149,016 | 298,032 |
| Bore Pumps | 32,760 | 32,760 | 65,520 |
| 30t Excavators | 1,479,043 | 2,958,085 | 2,958,085 |
| Utility Vehicles | 24,811 | 74,433 | 24,811 |
| Vibrating Roller 12T | 1,544 | 1,544 | |
| Grader 140H | 14,112 | 14,112 | |
| Bobcat | 7,504 | 7,504 | |
| IT Loader | 11,872 | 11,872 | |
| 8T Excavator | 21,168 | 21,168 | |
| 20T Excavator | 30,800 | 30,800 | |
| Plate Compactor | 3,528 | 3,528 | |
| Water Cart 15kL | 6,174 | 6,174 | |
| Haul Road Construction | 100,800 | 3,545,308 | 3,545,308 |
| Supply and delivery truck | 900,000 | 2,025,000 | 1,575,000 |

**Table 0-2: Diesel Fuel consumption – Operations phase**

| Equipment | Fuel consumption (L/yr) |
|---|---|
| Utility Pickup Truck | 42,000 |
| Four Wheel Drive Vehicle | 11,200 |
| Mobile Workshop and Maintenance Truck | 14,000 |
| Grader | 25,000 |
| Dozer | 480,000 |
| FEL | 448,000 |
| Dump Truck | 14,800 |
| Fuel Tanker Truck | 28,800 |
| Water Tanker Truck | 72,000 |
| Telehandler | 7,200 |
| Boom Truck | 6,480 |
| Mobile Crane - 20T | 4,400 |
| Articulating Boom | 160 |
| Pond Service Boats | 3,000 |
| Mobile Crane - 100T | 2,640 |
| Fork Lift - 2T Elec | 2,800 |
| Skid Steer | 2,000 |
| Portable Genset | 28,800 |
| Welding Trailer - Genset | 7,500 |
| Portable Light Tower | 1,920 |
| Portable Air Compressor | 1,600 |
| Pump Station 1 | 149,016 |
| Pump Station 2 | 223,524 |
| Pump Station 3 | 149,016 |

| Equipment | Fuel consumption (L/yr) |
|---|---|
| Pump Station 4 | 149,016 |
| Pump Station 5 | 87,528 |
| Pump Station 6 | 298,032 |
| Bore Pumps | 917,280 |
| Transfer Pump | 386,400 |
| 30t Excavators | 1,440,000 |
| Utility Vehicles | 36,000 |
| Conveyors | 108,000 |
| Articulated Dump Trucks | 240,000 |
| Bobcats | 144,000 |
| Haul Road Maintenance | 285,000 |
| Trucking – New Haul JV | 6,813,542 |
| FEL | 160,875 |