ALBEMARLE KEMERTON PLANT

GREENHOUSE GAS MANAGEMENT PLAN

8 OCTOBER 2021

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EXECUTIVE SUMMARY

Albemarle Lithium Pty Ltd (Albemarle) is currently constructing the Albemarle Kemerton Plant (AKP), a lithium hydroxide monohydrate (LHM) product manufacturing plant and associated infrastructure. The AKP is located at 109 Kemerton Road, Wellesley, within the Kemerton Strategic Industrial Area (KSIA), approximately 17 kilometres (km) north-east of Bunbury (Figure 1).

Environmental approval was granted under the *Environmental Protection Act* 1986 (EP Act) on 26 October 2018 via Ministerial Statement (MS) 1085. MS 1085 requires the implementation of four Condition Environmental Management Plans, including a Greenhouse Gas (GHG) Management Plan (GHGMP; this document). A summary of the Project details and GHGMP are provided in Table 1.

Table 1: Summary

Proposal title	Albemarle Kemerton Plant
Proponent	Albemarle Lithium Pty Ltd
Ministerial Statement number	1085
Purpose of this GHGMP	To fulfil requirements of condition 9 of MS 1085. To provide management and monitoring measures to demonstrate that GHG emissions will be reduced over the life of the Project, in accordance with the EPA's objective outlined in the GHG Emissions Key Environmental Factor Guidelines.
Key environmental factor	GHG Emissions
EPA's environmental objective	To reduce net GHG emissions in order to minimise the risk of environmental harm associated with climate change.
Condition clauses	Condition 9 of MS 1085.
Key provisions	The key provisions of this GHGMP include avoiding, minimising and reducing the GHG Emissions of the Project by: • Considering alternative power options during the planning phase; • Incorporating alternative power options (and power sources) throughout the life of the Project; • Partnering with the ENERGY STAR program; • Incorporating an Environmental Management System; • Ongoing plant optimisation; • Using the best available technology; • Replacing infrastructure once they reach their end of life with new technology Over time, renewable energy technologies such as solar power, wind power, hydrogen and bulk energy storage are intended to supplement and eventually replace power generation at the Power Station. This approach will provide ongoing opportunities for reductions in total GHG emissions for the life of the Project.

The Environmental Protection Authority's (EPA) objective for Greenhouse Gases is to "reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change". A previous version of the GHGMP was prepared and submitted to the EPA in 2018. The purpose of the previous GHGMP was to satisfy Condition 9 of MS 1085.

Albemarle has recently identified that maintaining a reliable connection to the existing Western Power-owned and operated South West Interconnected System will require ongoing major capital investment by Western Power and is likely to be less economically viable than the construction of

a separate stand-alone power station at the AKP site. To address this, Albemarle has proposed a change to the original Proposal to include the development of the AKP Natural Gas Power Station (Power Station) which will be comprised of a series of gas-powered generators located within the existing development envelope authorised under MS 1085. Power sourced from the Power Station will be more environmentally friendly than power sourced from the SWIS (given the current high carbon intensity of the SWIS fuel source). In October 2019 Albemarle applied for approval under a Section 45c (S45c) of the EP Act to make changes to the original Proposal, these changes included the incorporation of the Power Station and a reduction in the size of the development envelope.

This revision of the GHGMP includes changes that reflect the change to the Proposal applied for under S45c of the EP Act detailed above and minor updates to ensure it aligns with the EPAs current guidance on the development of environmental management plans (EPA, 2020a) and the GHG Emissions Key Environmental Factor Guidelines (GHG Factor Guideline; EPA, 2020b).

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1 PROPOSAL

Albemarle Lithium Pty Ltd (Albemarle) has been granted approval for the development of the Albemarle Kemerton Plant (AKP), a lithium hydroxide monohydrate (LHM) product manufacturing plant and associated infrastructure, within the Kemerton Strategic Industrial Area (KSIA), approximately 17 kilometres (km) north-east of Bunbury, Western Australia (WA) (referred to as the Proposal) (Figure 1).

The Proposal was assessed by the WA Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act) and approved by the WA Minister for Environment via Ministerial Statement (MS) 1085 on 26 October 2018. Since approval of the original proposal, Albemarle identified that the construction of a separate stand-alone power station at the AKP may be more reliable and economically viable than establishing a suitable and available long term connection to the South West Interconnected System (SWIS). Albemarle has submitted an application under Section 45c (S45c) of the EP Act to change the original Proposal to include the development of the AKP Natural Gas Power Station (Power Station) and to reduce the extent of the Development Envelope. The details of this change are provided in Section 1.1.

Development of the Proposal commenced in late 2018 and the first process train is expected to be operational in 2021.

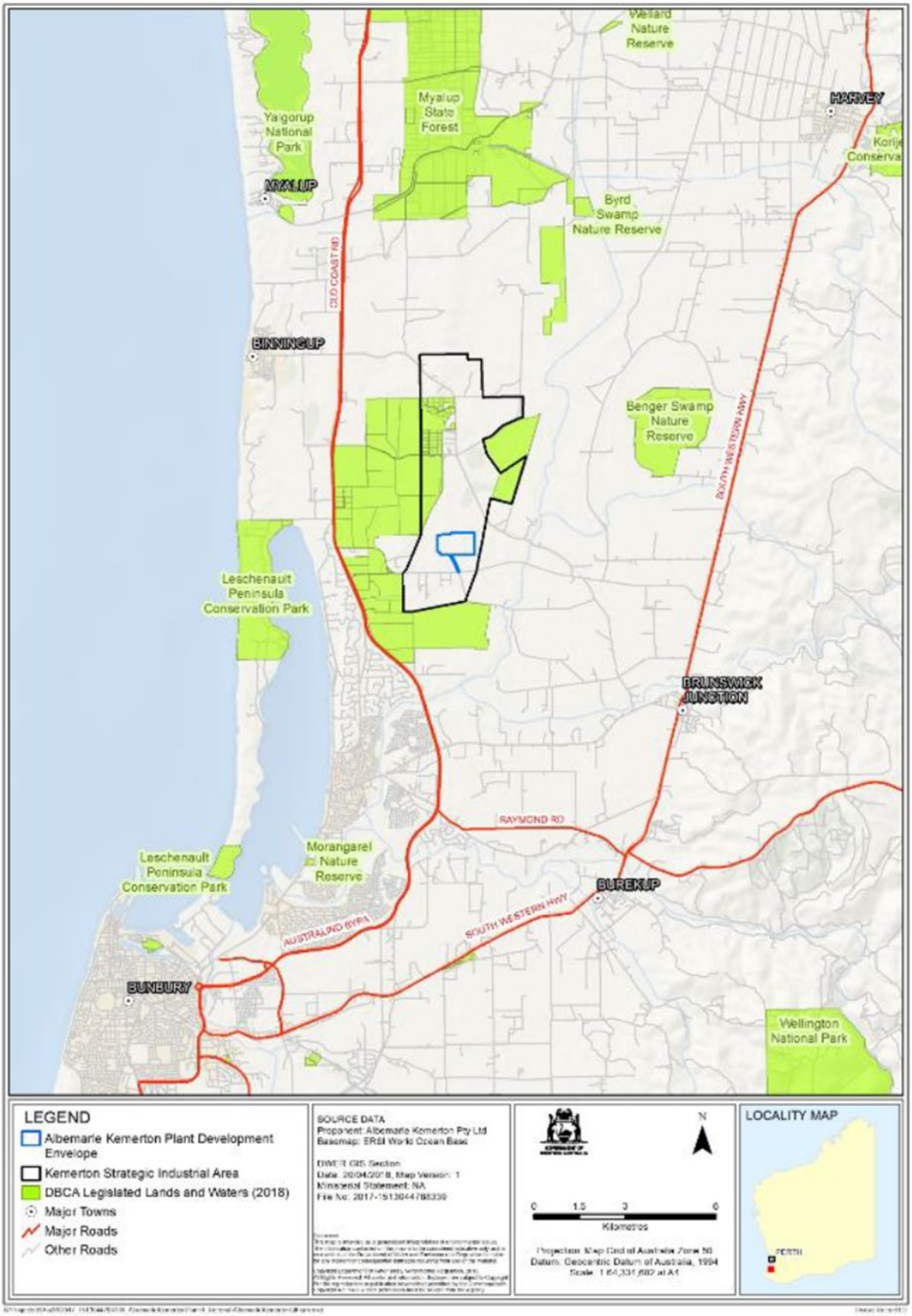
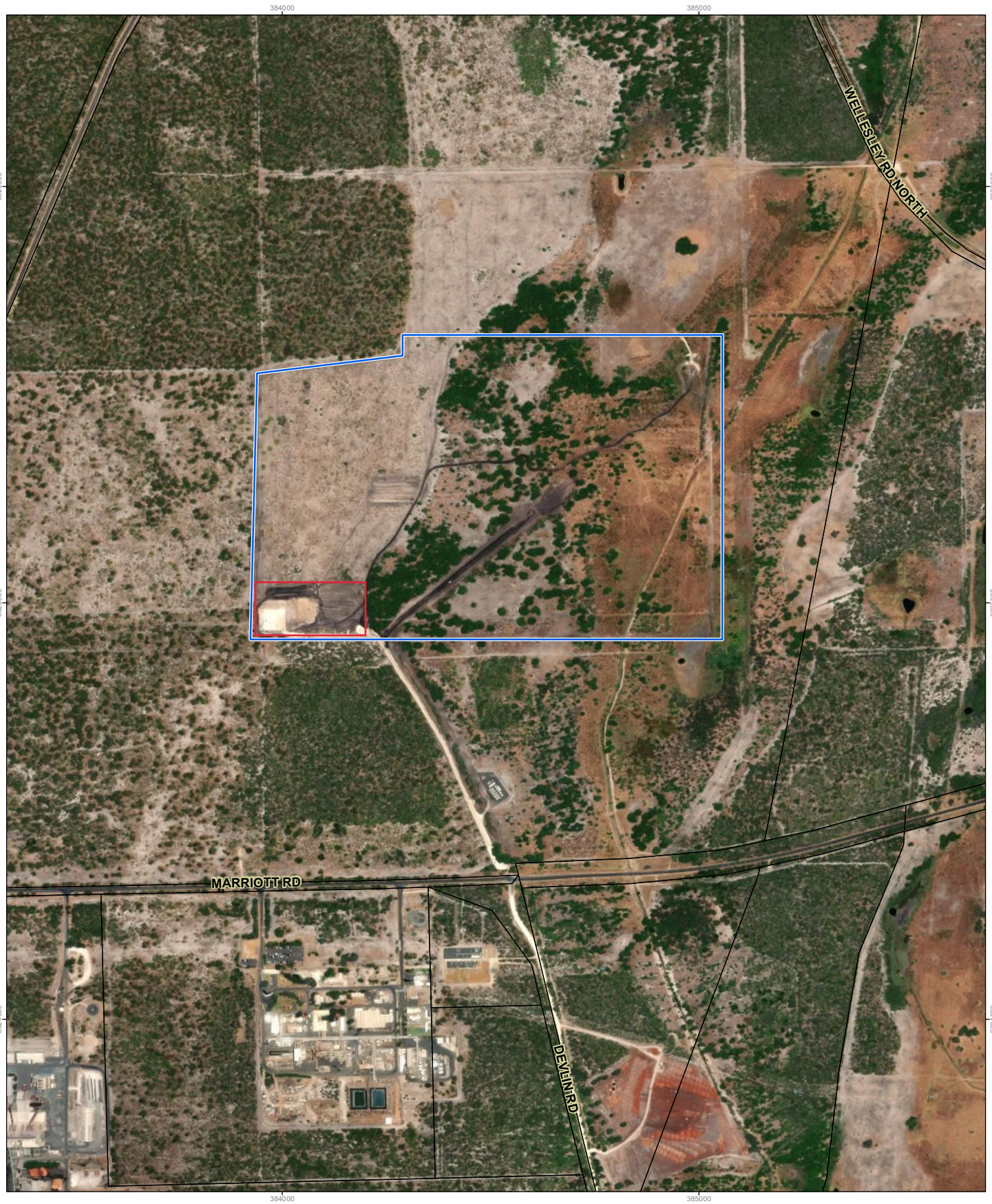


Figure 1: Regional location of the Proposal



Legend

- Project Development Envelope
- Indicative Power Station Area

0 100 200 400 N

Metres

Scale: 1:12,500 @ A4

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY

Preston Consulting

CREATED	JOB	DATE	REVISION
ENVIRONMAPS	MS1085	3/09/2020	0

Client: ALBEMARLE®

Figure 2: Proposal development envelope (revised) and indicative Power Station area

Source: Cadastre - Landgate, 2019 Orthophoto - Open Source

C:\GIS\Jobs\Preston Consulting\MS1085 - Albemarle Kemerton Lithium Plant\Figures\MS1085_BASE_200903.mxd

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1.1 CHANGES TO THE ORIGINAL PROPOSAL

Since approval of the original Proposal Albemarle has explored various power supply options for the AKP. Albemarle submitted an application under S45c of the EP Act seeking approval to construct and operate a modular power station with the potential to generate up to 73 MW of electrical power. The peak output of the power station is designed to be a maximum 69 MW (from gas generators only). The remaining 4 MW capacity is produced by diesel generators that are only intended to operate during start-up or maintenance of the gas generators.

1.2 SCOPE OF THIS REVISION

Albemarle has consulted with the EPA regarding the change to the original Proposal and the subsequent change in Scope 1 GHG emissions. This revision of the GHGMP includes changes to the predicted Scope 1 GHG emissions resulting from the construction and operation of the Power Station. It also includes minor updates to ensure it aligns with the latest EPA guidance on the development of Environmental Management Plans (EPA, 2020a) and the GHG Emissions Key Environmental Factor Guidelines (GHG Factor Guideline; EPA, 2020b).

2 PURPOSE OF THIS MANAGEMENT PLAN

This GHGMP provides management and monitoring measures for GHG emissions. It has been prepared to satisfy Condition 9 of MS 1085 for the construction and operation of the AKP and Power Station, and to demonstrate Albemarle's commitment to reducing their GHG emissions.

2.1 CONDITION REQUIREMENTS

Table 2 lists the MS 1085 conditions relevant to the GHGMP and how they are addressed.

Table 2: Relevant approval conditions

Condition and requirement	Reference
9 Greenhouse Gas Reporting	
9-1 Subject to condition 9-3, the proponent shall take measures to ensure that PS Net GHG Emissions do not exceed:	
(1) 956,000 t CO2-e for the period 1 January 2021 to 31 December 2024;	Section 5.1 and 5.2
(2) 1,195,000 t CO2-e for the period 1 January 2025 to 31 December 2029;	
(3) 1,186,000 t CO2-e for the period 1 January 2030 to 31 December 2034;	
(4) 1,110,000 tCO2-e for the period between 1 January 2035 and 31 December 2039;	
(5) 960,000 tCO2-e for the period between 1 January 2040 and 31December 2044;	
(6) 700,000 tCO2-e for the period between 1 January 2045 and 31 December 2049; and in any event;	
(7) zero tonnes of CO2-e for every five year period from 1 January 2050 onwards.	
9-2 Subject to condition 9-3, the proponent shall take measures to ensure that Plant Net GHG Emissions do not exceed;	
(1) 1,240,000 tCO2-e for the period between 1 January 2021 and 31 December 2024;	
(2) 1,550,000 tCO2-e for the period between 1 January 2025 and 31 December 2029;	
(3) 1,000,000 tCO2-e for the period between 1 January 2030 and 31 December 2034;	
(4) 1,000,000 tCO2-e for the period between 1 January 2035 and 31 December 2039;	
(5) 1,000,000 tCO2-e for the period between 1 January 2040 and 31 December 2044;	
(6) 740,000 tCO2-e for the period between 1 January 2045 and 31 December 2049; and in any event;	
(7) zero tonnes of CO2-e for every five year period from 1 January 2050 onwards.	
9-3 Where the time between the Commencement of Operations and the end of a period specified in condition 9-1 and 9-2 is less than 5 years, the PS Net GHG Emissions or Plant Net GHG Emissions limit for that period is to be determined in accordance with the following formula: Reduced Net GHG Emissions limit = $\frac{A}{B} * C$ Where: A is the relevant Net GHG Emissions limit for the periods as specified in condition 9-1 or 9-2 B is the time (in days) in the relevant period C is the days remaining between the Commencement Date and the end of the relevant period	Section 5.2
9-4 The proponent shall implement the Albemarle Kemerton Plant Greenhouse Gas Management Plan (Final Version, TBC) which includes the following:	

Condition and requirement	Reference
(1) is consistent with the achievement of the PS Net GHG Emissions and Plant Net GHG Emissions limits in condition 9-1 and 9-2 subject to the adjustment provided for in condition 9-3 (or achievement of emission reductions beyond those required by those emission limits);	Section 5.1
(2) estimated Proposal GHG Emissions and Emissions Intensity for the life of the proposal;	Section 5.1 & Section 5.2.1
(3) compare estimated Proposal GHG Emissions and Emissions Intensity for the life of the proposal against other comparable facilities;	Section 5.2.1
(4) identify and describe any measures that the proponent will implement to avoid, reduce and/or offset Proposal GHG Emissions and/or reduce the Emissions Intensity of the proposal; and	Section 5.1
(5) provide a program for the future review of the plan to: (a) assess the effectiveness of measures referred to in condition 9-4(4); and (b) identify and describe options for future measures that the proponent may or could implement to avoid, reduce, and/or offset Proposal GHG Emission and/or reduce the Emissions Intensity of the proposal.	Section 6
9-5 The proponent:	Section 6
(1) may revise and submit to the CEO the Confirmed Greenhouse Gas Management Plan at any time;	
(2) must revise and submit to the CEO the Confirmed Greenhouse Gas Management Plan if there is a material risk that condition 9-1 and 9-2 will not be complied with, including but not limited to as a result of a change to the proposal;	
(3) must revise and submit to the CEO the Confirmed Greenhouse Gas Management Plan by the date that the first five yearly consolidated report is required to be submitted under condition 9-10(1) and every five (5) years after that date; and	
(4) must revise and submit to the CEO the Confirmed Greenhouse Gas Management Plan as and when directed to by the CEO.	
9-6 Within one month of receiving confirmation in writing from the CEO that:	Section 5.4.3 and 5.4.4.
(1) the Greenhouse Gas Management Plan referred to in condition 9-4 satisfies condition 9-4; or	
(2) any subsequent version of the Confirmed Greenhouse Gas Management plan submitted under condition 9-5 satisfies condition 9-4,	
the proponent must submit a separate summary of the relevant plan to the CEO for public disclosure, which must:	
(3) include a summary of the matters specified in conditions 9-4(1) to 9-4(4); and	
(4) be published as required by condition 9-11(2).	
9-7 The proponent shall implement the most recent version of the Confirmed Greenhouse Gas Management Plan until the CEO has confirmed by notice in writing that it has been demonstrated that the Net GHG Emission limits in condition 9-1 and 9-2 have been met.	Section 5.4.3 and 5.4.4.
9-8 The proponent shall submit an annual report to the CEO each year by 31 March, commencing on the first 31 March after the Commencement of Operations, or such other date within that financial year as is agreed by the CEO to align with other reporting requirements for GHG, specifying for the previous calendar year:	Section 5.4.3
(1) the quantity of Proposal GHG Emissions and lithium hydroxide produced; and	
(2) the Emissions Intensity for the proposal.	
9-9 The proponent shall submit to the CEO by 31 March 2030 or such other date within that financial year as is agreed by the CEO to align with other reporting requirements for GHG, and every fifth year thereafter:	Section 5.4.3 and 5.4.4

Condition and requirement	Reference
(1) a consolidated report specifying: a. for each of the preceding five (5) calendar years, the matters referred to in conditions 9-8(1) and (2); b. for the period specified in condition 9-1 and 9-2 that ended on 30 June of the year before the report is due: i. the quantity of Proposal GHG Emissions; ii. the Net GHG Emissions, PS Net GHG Emissions and Plant Net GHG Emissions; iii. the type, quantity, identification or serial number, and date of retirement or cancellation of any Authorised Offsets which have been retired or cancelled and which have been used to calculate the Net GHG Emissions, PS Net GHG Emissions and Plant Net GHG Emissions; referred to in condition 9-9(1)(b) ii, including written evidence of such retirement or cancellation; and iv. any measures that have been implemented to avoid or reduce Proposal GHG Emissions.	
(2) an audit and peer review report of the consolidated report required by condition 9-9(1), carried out by an independent person or independent persons with suitable technical experience dealing with the suitability of the methodology used to determine the matters set out in the consolidated report, whether the consolidated report is accurate and whether the consolidated report is supported by credible evidence.	
9-10 A consolidated report referred to in condition 9-9(1) must be accompanied by:	Section 5.4.3 and 6
(1) a revision of the Confirmed Greenhouse Gas Management Plan under condition 9-5(3); and	
(2) a separate summary report, for the period specified in condition 9-1 and 9-2 that ended on 30 June of the year before the report is due and any previous periods specified in condition 9-1 and 9-2, and which includes: a. a graphical comparison of PS Net GHG Emissions with the Net PS GHG Emissions limits detailed in condition 9-1 and 9-2 (subject to the adjustment provided for in condition 9-3); b. a graphical comparison of Plant Net GHG Emissions with the Plant Net GHG Emissions limits detailed in condition 9-2 (subject to the adjustment provided for in condition 9-3); c. proposal Emissions Intensity compared to comparable facilities; d. a summary of measures undertaken by the proponent to avoid or reduce Proposal GHG Emissions for compliance periods detailed in condition 9-1 and 9-2; and e. a clear statement as to whether limits for PS Net GHG Emissions and Plant Net GHG Emissions set out in condition 9-1 and 9-2 have been met, and whether future PS Net GHG Emissions and Plant Net GHG Emissions limits are likely to be met, including a description of any reasons why those limits have not been, and/or are unlikely to be met.	
9-11 The proponent shall make the Confirmed Greenhouse Gas Management Plan, the summary of that plan, and all reports required by this condition 9 publicly available on the proponent's website within the timeframes specified below for the life of the proposal, or in any other manner or time specified by the CEO:	Section 5.4.4
(1) any Confirmed Greenhouse Gas Management Plan, within two (2) weeks of receiving written confirmation from the CEO as referred to in condition 9-6;	
(2) the summary of any Confirmed Greenhouse Gas Management Plan referred to in condition 9-6 and the reports referred to in conditions 9-8, 9-9 and 9-10 within two (2) weeks of submitting the document to the CEO.	

2.2 RATIONALE AND APPROACH

The management approach used in this GHGMP is conservative and is demonstrated through Albemarle's emphasis on managing impacts through planning, organisation and controlling

aspects of the AKP during design and operation. A hierarchical approach to manage potential impacts from the Proposal has been used:

- Avoidance: measures used to avoid or prevent GHG emissions from the Proposal;
- Offset: measures taken to reduce the GHG emissions of the Proposal by offsetting power sourced from the SWIS or Power Station with renewable energy sources.

Results from surveys, study findings and the EPA's assessment of the Proposal (EPA, 2018; Report Number 1618) inform Albemarle's management approach for meeting the EPA's environmental objective and condition requirements. The identified management actions, management targets and proposed review and revision of management actions are provided in Section 5.1, 5.2 & 6 (respectively).

2.2.1 Greenhouse Gas and Global Warming Potentials

The GHG considered in this assessment and the corresponding global warming potential (GWP) for each GHG are listed in Table 3. GWP is a metric used to quantify and communicate the relative contributions of different substances to climate change over a given time horizon (100 years). GWP accounts for the radiative efficiencies of various gases and their lifetimes in the atmosphere, allowing for the impacts of individual gases on global climate change to be compared relative to those for the reference gas carbon dioxide. The GWPs from the Intergovernmental Panel on Climate Change Fourth Assessment report and Section 2.02 of the NGER Regulations 2008 were used in this assessment.

Table 3: 100 year global warming potential of GHGs

Greenhouse gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298

2.2.2 State and National Greenhouse Gas Emissions

Australia's national GHG emissions, by sector, for the year to March 2018 are presented in Table 4. Total annual emissions are 536.7 Mt $CO_{2\text{-}e}$. Annual emissions from the Proposal, at peak capacity, would account for approximately 0.1% of Australia's annual GHG emissions.

The most recently published state-based emissions inventory is for 2016. WA's GHG emissions, by sector, for the 2016 year are also presented in Table 4. Total annual emissions for WA are 82.2 Mt $CO_{2\text{-}e}$. Annual emissions from the Proposal would account for approximately 0.8% of WA's annual emissions.

Table 4: Impact of AKP emissions on national and state totals

Emissions Source	March 2018 Australian Emissions (Mt CO_{2-e})[1]	2016 WA Emissions (Mt CO_{2-e})[2]
Energy – Electricity	181.5	25.4
Energy – Stationary Energy excluding electricity	98.3	25.4
Energy – Transport	100.6	14.5
Energy – Fugitive Emissions	57.3	8.5
Industrial processes and product use	36.1	5.0
Agriculture	73.7	8.9
Waste	12.6	1.7
Land Use, Land Use Change and Forestry	-23.3	-7.2
Overall Total	536.7	82.2

1. Table 3, DotEE "*Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2018*", June 2018 (Commonwealth of Australia 2018b)
2. Table 12: DotEE "*State and Territory Greenhouse Gas Inventories 2016*" February 2018 (Commonwealth of Australia 2018c)

2.2.3 CUMULATIVE GHG EMISSIONS

The design of the AKP allows for a staged approach in the construction and operation of the LHM production trains. Albemarle propose to construct and operate two trains (capable of producing 50,000 t LHM/ year), with the design of the AKP allowing for expansion up to five trains (capable of producing 125,000 t LHM/ year; MS 1085 limits LHM production form the AKP to 100,000 t / year). The timing of the construction and operation of additional trains is dependent on ore supply, operational costs and market conditions. Therefore, when quantifying the cumulative GHG emissions (the sum of GHG emission from the AKP and the chosen Power Option) it is practical to consider the cumulative GHG emission intensity only.

Albemarle proposes two power options for the AKP, purchased power from the SWIS and power produced from the on-site Power Station, both of which result in different cumulative GHG emission intensities. Cumulative GHG emission intensities for each power option are shown in Table 5.

Table 5: Total GHG emission intensity for each power option

Emissions Source	Emissions Intensity (t CO_{2}-e / t LHM)	
	Purchased Power SWIS (Mixed Source)	Generated Power Power Station
Power Option	3.11	2.39
AKP Operations	2	2
Total Emissions Intensity	**5.11**	**4.39**

3 ALBEMARLE KEMERTON PLANT

3.1 GREENHOUSE GAS ASSESSMENT

GHD (2018) provides a GHG inventory of the original Proposal (without the Power Station). The rationale for determining the GHG emissions of the original Proposal are detailed in the following sections.

3.1.1 REVISED OPERATIONAL LOAD

Albemarle has conducted additional internal investigations into the effects of infrastructure load on the energy consumption of the AKP. It is predicted that infrastructure required to run the AKP will operate at a lower energy demand than first thought (approximately 65 - 80% of maximum for most equipment). This will result in a change to the emissions intensity and overall predicted GHG emission for the AKP than what was originally reported to the EPA. The revised emissions intensities are summarised in Table 6. Note that in the first years of operation Albemarle will be fine tuning and optimising the operation of the AKP. The revised operational load listed in Table 6 is expected to occur after this initial reduction in Total GHG emission intensity (refer to the blue line in Figure 3).

Table 6: Emissions intensity after revising the operational load of the AKP

Emissions Source	Emissions Intensity (t CO2-e / t LHM)	
	Original Reported to the EPA	Revised Operational Load
AKP Operations (Scope 1)	3.10	2
Purchased Power - SWIS (Scope 2)	3.52	3.11
Generated Power - Power Station (Scope1)	2.96	2.39

3.1.2 METHODOLOGY

This assessment has been undertaken in accordance with the principles of ISO 14064-2 and the general principles for estimating emissions in the National Greenhouse and Energy Reporting (NGER) (Measurement) Determination 2008. Relevant sections of the following documents were used for the purposes of defining appropriate methods for quantification of emissions from individual sources:

- NGER (Measurement) Determination 2008 (as amended) and *National Greenhouse and Energy Reporting Act 2007* (NGER Act), Department of the Environment and Energy (DotEE); and
- National Greenhouse Accounts Factors, DotEE, July 2018.

These guidelines are considered representative of good practice GHG accounting in Australia and are applicable to the Proposal.

Condition 9 of MS 1085 did not mandate a specific standard, protocol, or methodology for the GHG assessment. The GHG Factor Guideline also does not indicate how the GHG assessment is to be conducted.

3.1.3 ASSESSMENT BOUNDARY

Emissions Boundary

The following GHG emissions have been considered:

- Scope 1 emissions from direct energy use during construction and operation;
- Scope 1 emissions from loss of carbon due to the removal of vegetation; and
- Scope 2 emissions from indirect energy use from the import of electricity.

The following emission sources were included in the assessment boundary:

- Fuel consumption during construction activities (including electricity generation, use of mobile plant and equipment);
- Energy (fuel/ electricity) consumption during operation of the facility including:
    - Grid electricity use;
    - Fuel (natural gas) used for stationary purposes including steam generation, and kiln operation;
    - Fuel (diesel) used for stationary purposes including front end loaders, forklift trucks, etc. around the site; and
- Consumption of raw carbonate materials (i.e. calcium carbonate) in the form of limestone sand consumed in the calcining process, per annum.

Emissions Scopes

Emissions have been separated into Scope 1 and 2 in accordance with the NGER (Measurement) Determination. These scopes are defined as follows:

- Scope 1 emissions are GHG emissions created directly by a person or business from sources that are owned or controlled by that person or business;
- Scope 2 emissions are GHG emissions created as a result of the generation of electricity, heating, cooling or steam that is purchased and consumed by a person or business. These are indirect emissions as they arise from sources that are not owned or controlled by the person or business who consumes the electricity; and
- Scope 3 emissions, i.e. GHG emissions that are generated in the wider economy as a consequence of a person's or business's activities, are not required to be estimated for this Proposal (such as upstream emissions attributable to the extraction and processing of spodumene ore or the extraction, production and transport of fuels consumed in the course of the construction and operation of the facility).

3.1.4 EXCLUSIONS

Specific exclusions from the GHG assessment includes:

- Scope 3 emissions including:
    - Transmission and distribution emissions of electricity imported to site;
    - Embodied emissions of construction materials;
    - Embodied emissions of spodumene ore and reagents used at the facility;

  - Emissions from extraction and transport of fuels;
  - Transport of materials. All transport will be by contractors, including spodumene ore and reagents to the facility, and products and tailings from the facility;
- Emissions associated with personnel travelling to and from the facility, during construction or operational stages;
- Emissions associated with the disposal of waste streams;
- Emissions associated with wastewater handling. Wastewater will be held in an on-site storage tank for a short period prior to pumping to the Kemerton Wastewater Treatment Plant. Residence times in the holding tank will be insufficient to generate methane or nitrous oxide emissions;
- Emissions which are likely to be negligible compared with the other emissions from the Proposal were excluded from the assessment, including:
  - Emissions associated with the decommissioning and rehabilitation of the Proposal site at the end of its life;
  - Emissions associated with combustion of fuels used in minor quantities such as LPG and oils and greases;
  - Emissions associated with the leakage of hydrofluorocarbons. The Proposal may use negligible quantities of hydrofluorocarbons for refrigeration and air conditioning during construction and operation;
  - Emissions from the storage or use of sulphur hexafluoride which may be used as an electrical insulator within the switchgear. It will be used in small quantities (kilograms) and will be carefully controlled, inventoried and only handled by licenced operators. Hence, emissions from leakage of sulphur hexafluoride are expected to be negligible;
  - Emissions associated with transport purposes for plant operations and maintenance vehicles; and
- Emissions from the generation, storage, or use of perfluorocarbons – these substances are unlikely to be stored, generated, or used at the facility.

3.1.5 ASSUMPTIONS

Assumptions used in estimating GHG emissions for the construction and operation of the AKP are listed in Table 7. The assessment was based on emission factors available at the time and future changes in emission factors were not considered. Emissions factors used in preparation of this inventory are also described in Table 7.

Data used for the GHG assessment was provided by Albemarle. The inventory is based on an assessment period of one year, being for operations the year of peak production. For construction, it was assumed that emissions would peak in the initial construction period.

Table 7: Greenhouse gas assessment assumptions by source

Parameter	Assumptions
Construction	
Diesel combustion - transport purposes	No emissions from transport diesel have been estimated for the construction phase. It was assumed that 100% of the diesel consumed for construction was for stationary energy purposes as these are likely to contribute the majority of diesel consumption.

Parameter	Assumptions
Diesel combustion - stationary energy purposes	Estimated diesel use for the initial stage of the construction phase was 2,500 kL. This includes diesel consumed in construction mobile plant and equipment and generators used for supplying electricity to construction operations. Emission factors (EF) were from the NGER (Measurement) Determination.
Grid electricity	Albemarle are currently reviewing options to use grid electricity during construction. For the purpose of this GHG plan, it has been assumed that no grid electricity will be used during construction, with all electricity generated by diesel-fired mobile generators.
Lost carbon sink due to land clearing	The Transport Authorities Greenhouse Group (TAGG) GHG Assessment Workbook for Road Projects was used to estimate the quantity of lost carbon sink associated with land clearing. The use of this method is inherently conservative in that it assumes all carbon pools are removed, and all carbon removed is converted to carbon dioxide and released to the atmosphere (TAGG, 2013). The estimate was prepared using vegetation survey information from the Environmental Referral (Albemarle Lithium, 2017a). The coverage of individual vegetation classes in the survey area was used, with a clearing area of 88 ha of grassland and woodland vegetation types. Since the 2018 GHD GHG assessment, Albemarle discovered that the extent of clearing required for the development of the AKP was 5.51 ha less than what reported in the original Proposal. Therefore, the GHD's estimation of the GHG emissions of the AKP is an over estimation. It was assumed that diesel consumption associated with vegetation clearing is captured in the diesel consumed for stationary energy purposes above.
Operations	
Diesel combustion - stationary purposes	Estimated diesel consumed for stationary purposes at the facility was 2,962 kL/a (source: Albemarle). EF were from the NGER (Measurement) Determination.
Grid electricity	Estimated electricity sourced from the grid used during production was 503 GWh/a (source: Albemarle) EF were from the NGER (Measurement) Determination.
Natural gas combustion- Kiln firing and boilers	Estimated natural gas consumption for the firing of gas burners was 92,418 tpa (source: Albemarle). An energy density value of 53.6 GJ/t (International Gas Union, 2012) was applied to the estimate to determine the energy consumed from this emission source, equating to 4,953,605 GJ/annum. EF were from the NGER (Measurement) Determination.
Use of carbonates	Estimated calcium carbonate consumption in the form of limestone sand was 118,260 tpa (source: Albemarle). The NGER (Measurement) Determination, section 4.22, requires the fraction of the raw carbonate material consumed in the industrial process during the year. If the information is not available the fraction is assumed to have the value '1' for the purposes of estimating emissions using Method 1. The value '1' has been applied to the estimate of emissions from this source.

3.2 BENCHMARKING

3.2.1 LITERATURE REVIEW

The GHG Factor Guideline indicates that an analysis of GHG intensity should be undertaken (i.e. quantity of CO_2-e generated per tonne of product produced) with comparison against published benchmarked practice for equivalent plant, equipment and operations.

Australian Equivalent Plants

The only Australian lithium plant (approved under development) is the Tianqi Lithium Australia Hydroxide Process Plant (Tianqi), located in Kwinana, WA. Tianqi could be considered as having equivalent plant, equipment and operations to the Albemarle plant for the following reasons:

- Similar capacity 24,000 tpa lithium hydroxide plant, compared with 20,000 tpa for each process train for Albemarle;
- Similar lithium mineral conversion process;
- Similar source material – spodumene ore concentrate (from the same Talison Greenbushes mine); and
- Natural gas is used for the kiln operations and steam generation.

The 2016 Works Approval for the first stage of the Tianqi operations indicates that specific detail regarding the process is the subject of an exemption from publication claim on the basis of commercial-in-confidence (Tianqi Lithium Australia, 2017). No details of fuel/ electricity use or GHG emissions are included.

GHG emissions data for Tianqi Lithium Plant shows the production of 43,735 mt of LHM resulted in the produced 180,582 mt $CO_{2\text{-}e}$ Scope 1 and 146,770 mt $CO_{2\text{-}e}$ Scope 2 emissions (Tianqi Lithium Corporation, 2020). This gives the Tianqi Lithium Plant a GHG emissions intensity of 4.19 t CO_2-e / t LHM for Scope 1 emissions and 3.35 t CO_2-e / t LHM for Scope 2 emissions (a total of 7.48 t CO_2-e / t LHM).

Published benchmarks for other mineral processing plants are not available in Australia for comparison. When available, these will be published by the Minister for Environment in 'Schedule 1 Benchmark Emissions-Intensity Index' of the *NGER (Safeguard Mechanism) Rule 2015*. Even if benchmarks were available for other types of mineral processing, it may not be possible to compare across different industries as benchmarks are expressed as t CO_2-e/ tonne specific product.

International Equivalent Plants

International Mineral Conversion Plants (either lithium hydroxide or lithium carbonate) are located in China, with one additional small plant located in Minas Gerias, Brazil (Hatch, 2017). Published English-language data on GHG emissions from these sources was not available.

A number of projects are also under development worldwide. Feasibility studies contain some information, but not complete information to enable a comparison. For example:

- The proposed 24,500 tpa lithium hydroxide plant for Nemaska Lithium, Shawinigian plant, Canada, indicates 430 GWh/a electricity but does not specify natural gas use quantities, so total GHG cannot be determined;
- The proposed 14,000 tpa lithium hydroxide plant for Sayona Mining Limited in Quebec, Canada, gives a preliminary estimate of 66 GWh/a electricity, 500 TJ/a gas and 10,000 tpa calcium carbonate. This equates to an approximate emissions intensity of 5.5 t$CO_{2\text{-}e}$/ tonne product. However, it is unclear whether the process and assumptions are comparable. The emissions intensity was not published, but estimated by GHD based on the preliminary information; and

- Feasibility and concept studies for a number of lithium hydroxide and lithium carbonate producers were examined however, there is insufficient data available on estimated fuel / electricity use and carbonate consumption to estimate comparative GHG emissions.

Lithium carbonate can be produced from brines via solar evaporation. However, this process cannot be considered equivalent to the AKP, equipment and operations. Emissions are much lower for production of Lithium carbonate from this process.

3.2.2 Albemarle's International Plants

Albemarle owns and operates LHM production operations in the Peoples Republic of China. The Jiangxi plant operations have an LHM production process and output rate similar to what is predicted for the AKP. The reported emissions intensity for the Jiangxi plant operations (excluding energy consumption) is 2.71 t $CO_{2\text{-}e}$ / t LHM.

The Jiangxi plant operations represent a significantly lower GHG emissions intensity (1.42 t CO_2 e / t LHM less) compared to the Tianqi Lithium Plant. It is not possible to determine the cause of this difference without detailed plant performance information.

Based on the above, Albemarle has determined that the GHG emissions performance of Jiangxi plant is suitable as representative GHG emission baseline for the AKP (AKP Baseline).

3.3 Potential GHG Emissions

The potential GHG emissions are from the GHG Inventory conducted by GHD for the original Proposal (GHD, 2018) and only considers GHG emissions from the AKP.

GHG (2018) estimated the peak annual GHG emissions resulting from the operation of the AKP to be 310,116 t CO_2-e (Scope 1) while producing 100,000 t LHM / year, this equates to an emissions intensity of 3.1 t CO_2-e / t LHM. A summary of the estimated Scope 1 emissions from the operation of the AKP is shown in Table 8.

Table 8: Scope 1 emission from the AKP (producing 100,000 t LHM / year)

Activity	Scope 1 GHG Emissions (t $CO_{2\text{-}e}$ / year)
Diesel combustion – stationary	8,026
Natural gas – Kiln firing and boilers	255,259
Use of carbonates	46,831
Total	**310,116**

After considering the revised operational load of the AKP (Section 3.1.1), the estimated peak annual GHG emissions resulting from the operation of the AKP is 200,000 t CO_2-e (Scope 1) while producing 100,000 t LHM / year, this equates to an emissions intensity of 2 t CO_2-e / t LHM.

4 POWER STATION

4.1 GREENHOUSE GAS ASSESSMENT

GHD (2019b) was commissioned to provide a GHG assessment of the power station; the details of this assessment are provided in the following sections.

4.1.1 METHODOLOGY

The NGER Act was established to provide for the reporting and dissemination of information related to GHG emissions (Government of Australia, 2007). The Regulations under that Act and the National Greenhouse and Energy Reporting (Measurement) Determination 2008, establish the legislative framework for a national greenhouse and energy reporting scheme.

The National Greenhouse and Energy Reporting Scheme Measurement – Technical Guidelines for the estimation of emissions by facilities in Australia 2017-18 (the Technical Guidelines) embodies the latest methods for estimating emissions and is applicable for the 2017-18 reporting year.

The GHG assessment of the Power Station has been undertaken in accordance with methodologies provided in the Technical Guidelines, which are considered representative of GHG accounting in Australia and are applicable to the Proposal.

GHG emissions were considered for the gas reciprocating engines and the diesel generators. It was assumed that each gas reciprocating engine would operate every hour of the year, and each diesel generator would operate 8 hours per year plus 1 hour per quarter.

4.1.2 EMISSIONS SCOPE

GHG emissions considered in this assessment constitute as Scope 1 as the electricity generation at the Power Station occurs on site and is the direct result of an activity that constitutes the facility.

Emissions calculation

GHG emissions for gas reciprocating engines and diesel generators were calculated using the following method:

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

Where:

- E is the emission of GHG released from the operation of the Power Station during the year, measured in tonnes of $CO_{2\text{-}e}$
- Q is the quantity of fuel combusted from the operation of the Power Station during the year, measured in gigajoules (GJ) for gas and kilolitres (kL) for diesel
- EF is the emission factor measured in kg $CO_{2\text{-}e}$/GJ of fuel. This variable is not required for estimating emissions from gas when the units are already in GJ.

Assumptions

The following was assumed in the emissions calculations:

- Diesel generators use 285 L of fuel per hour equating to 6.84 kL per year, taking into account the anticipated operating schedule.
- The gas reciprocating engines use 2,663 TJ (32 MW peak load) of power annually in Scenario 1 and 5,742 TJ (69 MW peak load) of power annually in Scenario 2.

4.2 BENCHMARKING

With forecast Scope 1 GHG emissions from the Power Station greater than 100,000 t CO_2-e during a financial year, the Power Station will trigger the *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015* (Safeguard Mechanism). As a result, Albemarle will apply for a Benchmark-Emissions Baseline under the Safeguard Mechanism based on the following production variable, defined in Schedule 2 of the Safeguard Mechanism:

- Electricity Generation.

The Benchmark-Emissions Baseline will be supported by a Default Emissions Intensity for electricity generation (currently set at 0.538 t CO_2-e / MWh) Scope 1 GHG emissions from the Power Station will be benchmarked against the Default Emissions Intensity, and under the Safeguard Mechanism, Albemarle will be required to offset any emissions in excess of the Benchmark-Emissions Baseline.

The Default Emissions Intensity of 0.538 t CO_2-e / MWh equates to an emissions intensity of 2.39 t CO_2-e / t of LHM for the Power Station.

4.3 POTENTIAL GHG EMISSIONS

The estimated annual GHG emissions resulting from the production of 100,000 t LHM / year while consuming electricity purchased from the SWIS (energy generated predominantly from coal) is 311,000 t CO_2-e (Scope 2), this equates to an emissions intensity of 3.11 t CO_2-e / t LHM.

The estimated annual GHG emissions resulting from the production of 100,000 t LHM / year while consuming electricity produced from the Power Plant is 239,000 t CO_2-e (Scope 1). This equates to an emissions intensity of 2.39 t CO_2-e / t LHM.

5 GREENHOUSE GAS REDUCTION MANAGEMENT MEASURES

Management measures are based on meeting the condition requirements provided in MS 1085, the EPA's *Environmental Factor Guideline: Greenhouse Gas Emissions* (EPA, 2020b) and Albemarle's GHG emission reduction aspirations.

Management objectives have been developed to address the key potential impacts associated with the Proposal. Management actions have also been developed to enable Albemarle to achieve the objectives.

5.1 OBJECTIVES AND ACTIONS

Table 9 presents the environmental management objectives and actions that Albemarle will implement during operation and closure. These actions are focused on avoiding, minimising and reducing GHG emission from the Proposal.

Table 9: Management objectives and actions

Management Objective	Management Action	Timing for Implementation	Description	Project Phase
Avoid, minimise and reduce GHG emissions	Alternative Power Options	Alternative power options were considered during the Proposal design. Albemarle will continue to explore alternative power options as new technologies become available.	Other power station designs were considered when power supply for the AKP was analysed. The Power Station was selected as the best option due to its high energy efficiency, modular configuration, low GHG emissions and cost (GHD, 2019).	Construction
	Proposed Power Options	Implementation of the Power Station will be considered throughout the life of the Proposal however, it is only likely to be implemented once the third and fourth trains are constructed (potentially 2030, but dependant on market conditions).	**Purchased Power from SWIS** Purchasing Power from the SWIS is deemed a suitable option for the AKP. Despite the higher total emissions and emissions intensity, it serves as an economically viable option for the early stages of the AKP due to a low capital cost and currently available capacity. **Power Station** Considering the lack of disturbance required for development of the Power Station, lower total emissions and reduced emission intensity (even before solar and battery integration), the Power Station compares very favourably with the alternative power option (purchased power from the SWIS). This option will be used to satisfy the higher reliability and maximum power demand of the AKP as LHM production increases.	Construction and Operation

Management Objective	Management Action	Timing for Implementation	Description	Project Phase
	Energy Source	Energy sourced from natural gas will be considered throughout the life of the Proposal however, it is only likely to be implemented once the third and fourth trains are constructed (potentially 2030, but is dependent on market conditions). Renewable energy sources will be considered throughout the life of the Proposal and are likely to be implemented in the early stages (i.e. 2030 onwards).	Natural gas has a lower emissions intensity than other fossil fuel energy sources (eg, coal), which reduces the GHG emissions produced by the Project. Renewable energy sources can be used to reduce the emissions intensity of energy needed to be produced for the AKP and from the Power Station or the SWIS. For example, solar PV energy may displace daytime energy sourced from the SWIS or produced at the Power Station. GHG emissions generated from the power purchased from the SWIS (power is generated largely from the combustion / burning of coal; Scope 2) is 311,000 t CO_{2-} e/ annum for a LHM production rate of 100,000 t / annum. The GHG emissions (Scope 1) generated from the Power Station is 239,000 t CO_{2-} e/annum for a LHM production rate of 100,000 t / annum. Switching to electricity sourced from the Power Station equates to an annual reduction in GHG emissions of 72,000 t CO_{2-} e for a LHM production rate of 100,000 t / annum.	Construction and Operation
	Environmental Management Systems and Processes	Currently implemented.	Albemarle Corporation is an ENERGY STAR Partner and has made a fundamental commitment to protect the environment through the continuous improvement of energy performance. Albemarle implements an organisation-wide energy management approach. The Albemarle Corporate Environmental Management System (EMS) includes a commitment to minimising the footprint of operations by actively pursuing opportunities to reduce emissions and energy usage. Continuous improvement to plant and process will be facilitated through Albemarle's EMS.	Construction

Management Objective	Management Action	Timing for Implementation	Description	Project Phase
	General GHG minimisation measures (AKP)	During the Proposal design phase, construction and throughout the life of the Proposal.	Potential measures to minimise Scope 1 emissions during the construction and operation of the facility are: • Maintenance of vehicles and equipment in accordance with manufacturer's specifications • Selection of low emissions producing plant and equipment • Steam boilers – economiser specified for high energy efficiency • Heat recovery from roaster kiln flue gas • Hot milling process – selection of energy efficient process • Incorporation of kiln chains as a superior heat transfer mechanism to improve heat efficiency by stabilising kiln burner operation • Plant control / monitoring system will monitor critical process and performance parameters • Plant and equipment will be maintained in accordance with manufacturer's specifications to minimise fuel consumption • Use of electric forklifts in product warehouse – displacement of other fuels • Use of ammonia as a refrigerant – this has a zero GWP and zero ozone depleting potential properties • Double trailer truck haulage – maximises tonnage per trip and minimises number of trips • Internal road layout design – designed to smooth the trucking speeds to minimise stop/start • Vehicles will be maintained in accordance with manufacturer's specifications to minimise fuel consumption. • Provision of electric vehicle charging car bays	Construction and Operation
	Optimisation of the AKP	Optimisation of the AKP will occur for the life of the Proposal however the greatest reductions from optimisation are expected to occur before 2030.	Albemarle's AKP expands on knowledge gained from the operation of their existing LHM plants in China and has resulted in an increase in efficiency in the design and operation of the AKP. As a result, the predicted Total GHG emissions of the AKP is 200,000 t CO2-e / annum for a LHM production rate of 100,000 t / annum, a reduction of 71,000 t CO2-e / annum (26.2 %) in Total GHG emissions from the Jiangxi plant.	Operation

Management Objective	Management Action	Timing for Implementation	Description	Project Phase
	Employing Best Available Techniques (AKP)	Implemented in the Proposal design and will be implemented as infrastructure is replaced.	During the environmental approvals process, a benchmarking assessment was carried out against Best Available Techniques (BAT) (Albemarle Lithium 2017b). Part of the BAT study assessed the facility against the European Commission Industrial Emissions Directive BAT Reference Document for the Non-Ferrous Metals Industries BAT 2 – Energy Management. A number of BAT 2 energy efficiency techniques were not applicable to the Albemarle process. Applicable energy efficiency techniques, to minimise grid electricity use, and hence Scope 2 emissions include: • Resizing of equipment to reduce the number of electrical drives • Use of variable speed drive for electric motors where applicable • Internal recuperative heat transfer within each evaporative system – maximises heat efficiency of each individual system • Further large recuperative heat transfer systems – maximises heat efficiency between individual systems • Plant control/ monitoring system will monitor critical process and performance parameters • Equipment will be maintained in accordance with manufacturer's specifications • Double-glazed windows on north and east facing windows – reduces solar heat input • Nominated LED energy efficient luminaries across majority of the site • Zoning of office lighting to maximum 100 sqm and individual motion sensors for each zone	Operation
	Energy Efficiency Improvement Opportunities (AKP)	Implemented in the Proposal design phase and optimised throughout the life of the Proposal.	Some of the possible opportunities for minimisation of net emissions of the AKP, within the existing design are: • Recovery of low-grade heat resources within the plant to further improve energy and water usage efficiencies • Further optimisation of recuperative heat exchange within the process streams by pinch analysis • Improved water balance control to reduce evaporation loads • Cascading of cooling water systems to further improve the efficiency of the higher powered refrigeration circuits	Operation
	Infrastructure replacement	As equipment reaches end of life, likely to occur from 2046 - 2048.	Infrastructure for the AKP has a limited operational life span. Albemarle expects that by year 2046 several key pieces of infrastructure will have reached the end of their safe/usable life and require replacing, this equipment includes: • Calcination Kiln • Acid Roast Kiln • Boilers • SSA dryer The infrastructure will be replaced with the best available technology at the time of replacement and is expected to occur over a three to four year period. This may include the use of hydrogen burning technology or electrical heating. Infrastructure replacement will result in a GHG emission reduction of 70,000 t CO_{2-} e/ annum for a LHM production rate of 100,000 t / annum.	Operation

Management Objective	Management Action	Timing for Implementation	Description	Project Phase
	Location	Implemented during the Proposal design phase.	The Proposal is located within the KSIA which has been designated for the development of industrial infrastructure. The extent of native vegetation clearing for the development of the Proposal is minimal. Albemarle has provided an offset strategy as required under MS 1085 to offset the significant residual impacts of the AKP, this includes the clearing of native vegetation that is considered Carnaby's Black-Cockatoo foraging and roosting habitat. The Power Station will be located within an area of land that was cleared for the development of the AKP, therefore no further clearing is required.	Construction
Offset GHG emissions	Integration of Renewables (Power Station)	Considered for implementation over the life or the Proposal. Progressive supplementation of power supply with solar power is likely to occur from 2030 onwards. As new technologies become viable, they will be considered for implementation.	Over time, renewable energy technologies such as solar power, wind power, hydrogen and bulk energy storage, are predicted to supplement and eventually replace the natural gas power generation units at the Power Station. This approach will provide ongoing opportunities for reductions in Total GHG emissions for the life of the Proposal.	Operation
	Tangible Offsets	Considered as a last resort to meet GHG Emissions Limits listed in Table 10.	In the event that Albemarle is not able to meet their GHG Emission Limits (Section 5.2), Albemarle will offset the remaining GHG emissions with tangible offsets. Potential tangible offset options include but are not limited to investing in carbon offset projects and purchasing and surrendering carbon offset credits that meet the Australian Government's Climate Active Carbon Neutral Standard's offsets integrity principles.	Operation

5.2 MANAGEMENT TARGETS AND MONITORING

Measurable management targets adopted in this GHGMP are based on the GHG emission limits (Emission Limits) that have been set in MS 1085. Emission Limits will enable Albemarle to measure the performance of the AKP against the overarching environmental outcome and management objectives. Monitoring will be implemented to provide sufficient information to determine when Albemarle is on track to achieving these Emission Limits. The Emission Limits for this GHG MP are detailed in Table 10. Consistent with condition 9-3 of MS1085, Albemarle will calculate the Emission Limit for the period between the Commencement of Operations and the end of the relevant time period detailed in Table 10 using the following calculation:

$$\text{Emission Limit} = \frac{A}{B} * C$$

Where:

A is the relevant Emission Limit for the period as specified in Table 10

B is the time (in days) in the relevant period

C is the days remaining between the Commencement Date and the end of the relevant period

Table 10: GHG Emission Limits

Time Period	Emission Limit
Power Station GHG Emissions	
1 January 2021 - 31 December 2024	GHG emissions of no more than 956,000 t CO2-e
1 January 2025 - 31 December 2029	GHG emissions of no more than 1,195,000 t CO2-e
1 January 2030 - 31 December 2034	GHG emissions of no more than 1,186,000 t CO2-e
1 January 2035 - 31 December 2039	GHG emissions of no more than 1,110,000 t CO2-e
1 January 2040 - 31 December 2044	GHG emissions of no more than 960,000 t CO2-e
1 January 2045 - 31 December 2049	GHG emissions of no more than 700,000 t CO2-e
From 1 January 2050 onwards	Net zero GHG emissions (including tangible offsets as required)
AKP GHG Emissions	
1 January 2021 - 31 December 2024	GHG emissions of no more than 1,240,000 t CO2-e
1 January 2025 - 31 December 2029	GHG emissions of no more than 1,550,000 t CO2-e
1 January 2030 - 31 December 2034	GHG emissions of no more than 1,000,000 t CO2-e
1 January 2035 - 31 December 2039	GHG emissions of no more than 1,000,000 t CO2-e
1 January 2040 - 31 December 2044	GHG emissions of no more than 1,000,000 t CO2-e
1 January 2045 - 31 December 2049	GHG emissions of no more than 740,000 t CO2-e
From 1 January 2050 onwards	Net zero GHG emissions (including tangible offsets as required)

5.2.1 PROJECTED EMISSION REDUCTIONS

The design of the AKP allows for a staged approach in the construction and operation of the LHM production trains. Emissions from the consumption of electricity are largely dependent on the number of active trains and the production rate of the AKP. In order to demonstrate Albemarle's intended emissions reductions for the Proposal, it is best to consider the AKP and Power Options separately. Albemarle's intended emissions reductions for the Power Options and the AKP are discussed in the following sections.

AKP Emissions (excluding power supply)

Due to uncertainties in the timing of the commissioning of each LHM train it is appropriate to compare the GHG emissions output of the AKP at the maximum production rate of 100,000 t LHM / annum. This approach enables Albemarle to demonstrate their contribution to the GHG emissions reduction aspirations for the 'worst case' GHG emissions scenario (Figure 3).

The GHG emissions of the Jiangxi plant operation is only shown from 2021 to 2030 as it represents the AKP Baseline GHG emissions from which Albemarle will target a 26% reduction. In 2030, the Emission Limit changes from a 26% reduction from the AKP Baseline to zero emission by 2050.

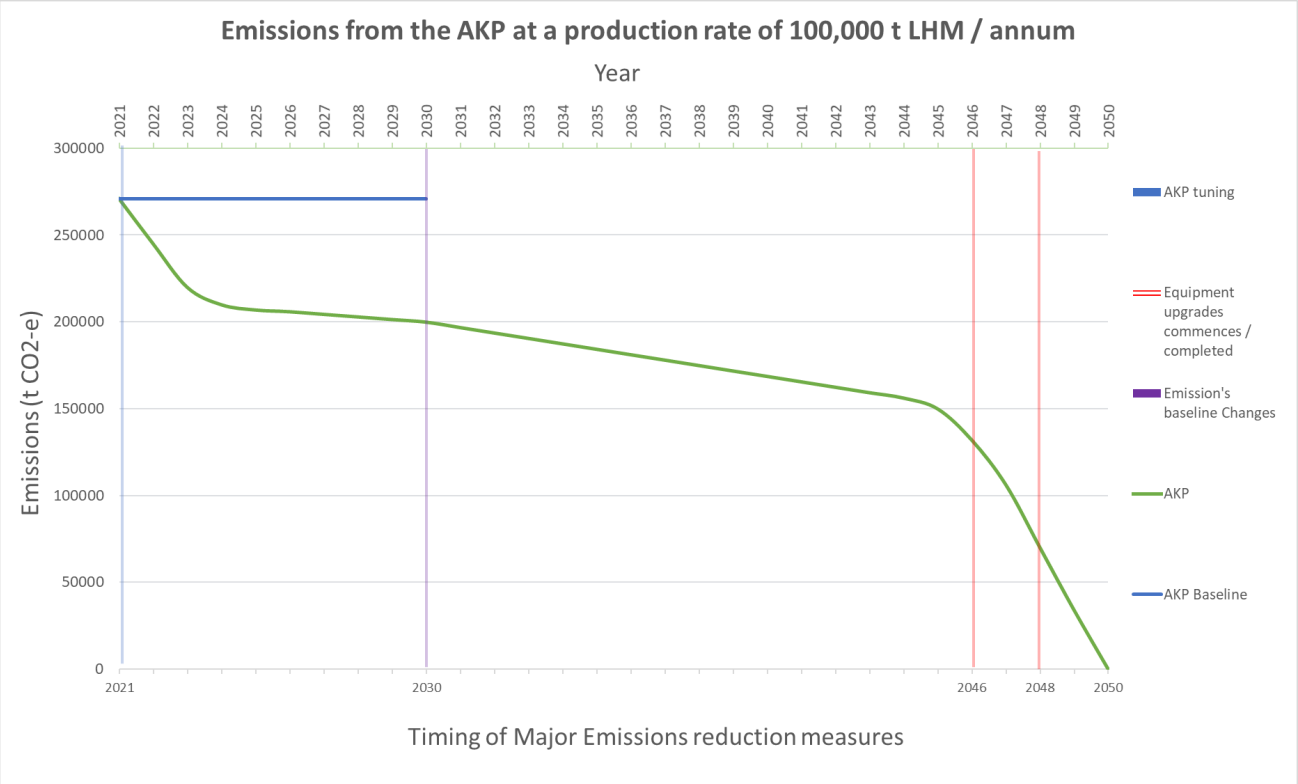

Figure 3: Emissions intensity over time for the AKP (excluding power supply)

AKP optimisation

Albemarle's AKP expands on knowledge gained from the operation of their existing LHM plants in China which has resulted in an increase in efficiency into the design and operation of the AKP. In the first years of operation Albemarle will commence fine tuning and optimising the operation of the AKP, this is expected to result in an initial reduction in GHG emissions (Blue line, Figure 3). Albemarle will continue to optimise the efficiency of the AKP over the life of the Proposal by drawing on past performance data and knowledge of typical ore characteristics. As a result, the predicted GHG emissions of the AKP is expected to reach 200,000 t CO2-e / annum for a LHM production rate of 100,000 t / annum by 2030. This equates to a reduction of 71,000 t CO2-e / annum (26.2 %) in GHG emission for a LHM production rate of 100,000 t / annum.

AKP Infrastructure

Infrastructure for the AKP has a limited operational life span. Albemarle expects that by 2046 several key pieces of infrastructure will have reached the end of their safe/usable life and require replacing, this equipment includes:

- Calcination Kiln;
- Acid Roast Kiln;
- Boilers; and
- SSA dryer.

The infrastructure will be replaced with the best available technology at the time of replacement and is expected to occur over a three to four year period (Red lines; Figure 3). This may include the use of hydrogen burning technology or electrical heating. This change will result in a significant reduction in GHG emissions intensity, to 70,000 t CO2-e / annum for a LHM production rate of 100,000 t / annum. This GHG emissions reduction event is illustrated by the red lines in Figure 3.

Power Options

SWIS

The way power is delivered to main electricity grid consumers in WA (particularly via the SWIS) is set to change to help the state meet its GHG emissions targets. The WA energy policy includes the Energy Transformation Strategy (ETS) and Whole of System Plan (WOSP) which ensures the delivery of secure, reliable and sustainable and affordable electricity to consumers (Government of WA, 2020).

Traditionally, electricity has been delivered to consumers in a linear supply chain of generation, transmission and distribution. The ETS sets out to redevelop the electricity supply chain to integrate large and small-scale renewables (before and after the meter), battery storage and micro-grids. The ETS sets out to include Distributed Energy Resources (DER; smaller–scale devices that can either use, generate, or store electricity and form a part of the local distribution system) to mitigate SWIS network instability and capacity bottlenecks. As a result of these changes, Albemarle expects to see an ongoing decrease in the GHG emission intensity of power supplied into the SWIS. Indicative GHG emissions reduction for the SWIS is shown in Figure 4.

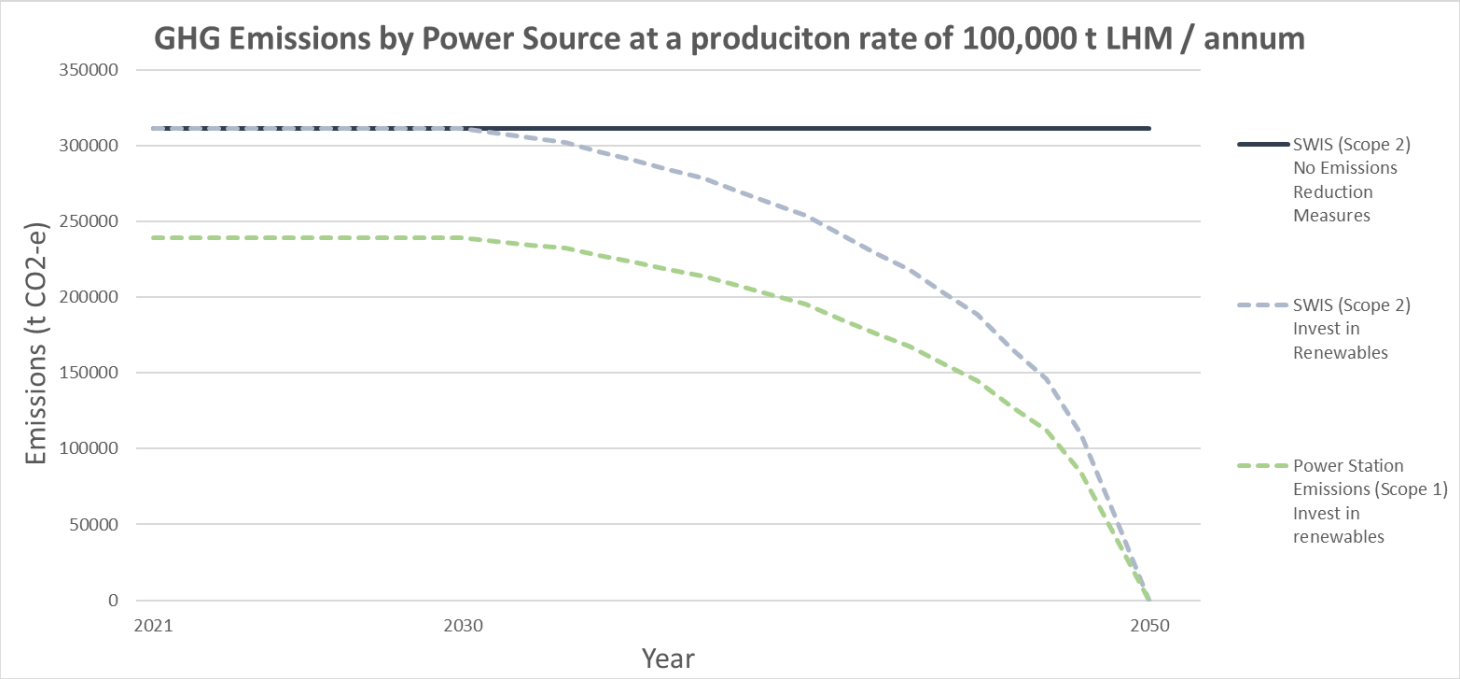

Figure 4: GHG emissions (Scope 1 & 2) based on power sourced from the SWIS or Power Station

AKP Power Station

Figure 4 shows that the AKP Power Station represents a GHG reduction measure when compared to SWIS. Over time, the AKP Power Station is likely to be further supplemented (commencing approximately by 2030) and eventually replaced by renewable energy technologies such as solar power, wind power, hydrogen and bulk energy storage. The GHG Emission Limit for the AKP Power Station are detailed in Table 10.

It is anticipated that the incorporation of renewable energy technology will enable Albemarle to meet the Emission Limits listed in Table 10. If it is not possible to meet these Emission Limits (i.e. if renewable energy technology is not suitable for the substitution of power from the Power Station) Albemarle commits to offsetting their residual GHG emissions with tangible offsets (Table 9).

Indicative GHG emissions reductions for the Power Station are shown in Figure 4.

Indicative Cumulative GHG Emissions

Albemarle has calculated the cumulative GHG emissions of both the AKP + SWIS option and the AKP + Power Station option to illustrate the total indicative GHG emissions from the Proposal for a production rate of 100,000 t LHM / annum. The calculated cumulative GHG emissions are based on the projected GHG emissions for the AKP (Figure 3), the SWIS option and the Power Station option (Figure 4). Indicative GHG emissions are displayed in Figure 5 below. The indicative cumulative GHG emissions for both the AKP + SWIS option and the AKP + Power Station option (Figure 5) illustrates Albemarle's projected 'worst case' emissions for each option; the projected 'worst case' GHG emissions fall within the Emission Limits detailed in Table 10 (note that the Emission Limits in Table 10 exclude emissions from the SWIS as they represent Scope 2 emissions). From the commencement of operations, the Proposal is predicted to source power from the SWIS (AKP + SWIS option; orange line), switching to the Power Station option (AKP + Power Station option; green line) at a later date based on market conditions.

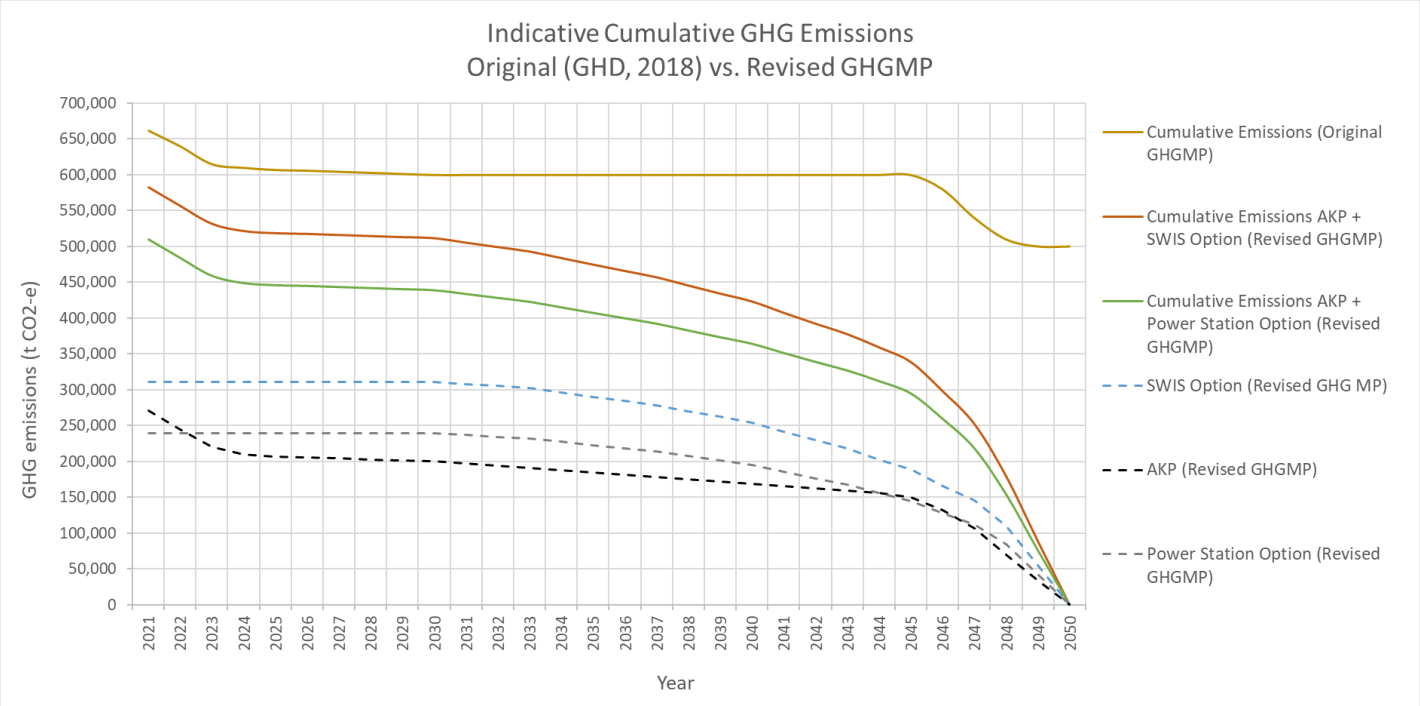

Figure 5: Indicative cumulative GHG emissions of the Proposal

To demonstrate the overall improvement in GHG emissions management presented in this version of the GHGMP, calculated cumulative emissions from the original GHGMP (GHD,2018) have been included in Figure 5 for comparison. The calculated cumulative emissions from the original GHGMP include similar reduction measures proposed from 2021 to 2030 (plant optimisation) and from 2046 to 2048 (infrastructure replacement with BAT). The original calculated cumulative emissions do not include the emissions reduction strategies employed from 2030 to 2046 and from 2048 onwards (generally, supplementation of the power supply with renewables and offsetting with tangible offsets) as they were not part of the scope of the original GHGMP.

As demonstrated, Albemarle will reduce the cumulative GHG emissions of the AKP from the original GHGMP estimate of 661,000 t CO_2-e / annum at a production rate of 100,000 t LHM / annum to 511,000 t CO_2-e / annum (AKP + SWIS option) or 439,000 t CO_2-e / annum by 2030, a total reduction of 22.7% or 33.6% respectively.

Indicative cumulative GHG emissions of both scenarios reduce from 2021 to 2030, however only the cumulative emissions from the revised GHGMP will continue to reduce from 2030 to 2046 where an overall reduction of 360,000 - 400,000 t CO_2-e / annum is expected. Both scenarios will continue to see a reduction in annual GHG emissions from 2046 to 2048 as old equipment is replace with new equipment. The cumulative emissions from the revised GHGMP will continue to fall to zero by 2050.

The total GHG emissions from 2021 to 2050 presented in the original GHGMP is 18 Mt CO_2-e. This revised GHGMP presents a total of 12.7 Mt CO_2-e for the AKP + SWIS option, approximately 29% less than predicted in the original GHGMP, or 11 Mt CO_2-e, approximately 39% less than predicted in the original GHGMP.

5.3 Monitoring Program

GHG emissions and the production and consumption of energy arising from the operation of the AKP will be estimated as per the NGER requirements. In addition to the measurement and collection of NGER data, the record keeping requirements of the NGER Scheme are required to be adhered to.

The following data would require annual monitoring, in order to estimate GHG emissions and energy consumption:

- Natural gas use;
- Diesel consumption in equipment;
- Diesel consumption in any Albemarle transport fleet;
- Limestone (or any other carbonate) use;
- Grid electricity use; and
- Minor fuels such as oils and greases, LPG and acetylene, if above reporting thresholds.

5.4 Reporting

5.4.1 National Greenhouse and Energy Reporting

Under the NGER scheme, corporations that exceed the corporate and facility thresholds for emissions, energy production or energy consumption need to report annually to the Clean Energy

Regulator (CER). The current (2018) reporting thresholds for facilities and corporate groups are outlined in Table 11.

Table 11: Current facility and corporate group reporting thresholds

Threshold type	Facility threshold	Corporate group threshold
Scope 1 and Scope 2 emissions	>25 kt CO2-e	>50 kt CO2-e
Production of energy	>100 TJ	>200 TJ
Consumption of energy	>100 TJ	>200 TJ

Scope 1 emissions associated with the operation of the facility will be above the threshold for facility and corporate level reporting of 25,000 t CO_2-e and 50,000 t CO_2-e respectively under the NGER Act 2007. The AKP will also be above the facility and corporate reporting threshold for energy consumption.

Albemarle is required to register as a controlling corporation under the NGER Scheme and report annually. Reporting will be required for a capacity of 20,000 tpa LHM product onwards. Scope 1 emissions for construction do not exceed the NGERS reporting threshold.

5.4.2 SAFEGUARD MECHANISM

Scope 1 covered emissions arising from the operation of the AKP are estimated to be above the Emissions Reduction Fund Safeguard Mechanism benchmark threshold of 100,000 t CO_2-e. Albemarle is required to apply for a baseline to be set by the CER prior to its Scope 1 emissions exceeding the threshold – this is expected to be before the first two trains are operational. The safeguard mechanism requires facilities whose net emissions exceed the safeguard threshold to keep emissions at or below the baseline set for that facility.

5.4.3 CONDITIONAL REPORTING

Annual Report

Consistent with Condition 9-8 of MS 1085, Albemarle will submit an annual report to the CEO of DWER each year by 31 March (commencing on the first 31 March after the commencement of operations). The annual report will be comprised of the following information from the previous calendar year:

- The quantity of GHG emissions from the Proposal and the LHM produced; and
- The emissions intensity of the Proposal.

Consolidated Report

Consistent with Condition 9-9 of MS 1085, Albemarle will prepare and submit a consolidated report to the CEO of DWER on 31 March 2030 (or as otherwise agreed by the CEO) and every fifth year thereafter. The consolidated report will be comprised of:

- For each of the previous five calendar years:
  - The quantity of GHG emissions from the Proposal and the LHM produced; and
  - The emissions intensity of the Proposal.
- For the period in Table 10 that ended on 30 June of the year before the Consolidated Report is due:
  - The quantity of GHG emission from the Proposal

    - The quantity of emissions from the power source, from the AKP and the total
    - Details of the retirement or cancellation of any authorised offsets used to calculate the emission detailed above; and
    - Any measures that have been implemented to avoid or reduce GHG emissions.
- A audit and peer review report of the consolidated report carried out by an independent person with suitable technical experience as defined in the conditions.

Summary Report

Consistent with condition 9-10(2) of MS 1085, Albemarle will provide a summary report to accompany the Consolidated Report detailed above. The Summary Report will be for the period in Table 10 that ended on 30 June of the year before the Consolidated Report is due and will include:

- A graphical comparison of the power source and AKP GHG emissions and the relevant GHG Emission Limits detailed in Table 10;
- The Proposal Emission Intensity compared to comparable facilities;
- A summary of the measures undertaken by Albemarle to avoid or reduce the GHG emission from the Proposal; and
- A summary stating whether the Emission Limits in Table 10 have been met or whether future Emission Limits are likely to be met and if they have not been met, justification that this is the case.

5.4.4 PUBLIC REPORTING

Consistent with Condition 9-11 of Statement 1085, Albemarle will make the following information publicly available:

- The latest confirmed GHGMP;
- The summary of the latest confirmed GHGMP;
- All reports detailed in Section 5.4.3.

Each time the GHGMP is revised and submitted to DWER for approval (Section 6), Albemarle will prepare and submit a separate summary of the GHGMP consistent with Condition 9-6 of MS 1085 to the CEO for public disclosure. The summary will outline key information from the GHGMP (and reports to that time), in an accessible form which can be easily reviewed by third parties for transparency.

6 ADAPTIVE MANAGEMENT AND REVIEW

This GHGMP has been developed to avoid and minimise the GHG emissions of the Proposal. Albemarle aims to achieve this by implementing the mitigation and management measures outlined in this GHGMP. The success of the GHGMP will be measured against the condition requirements, EPA objectives for GHG emissions and Albemarle's GHG emission aspirations.

Albemarle has designed this GHGMP to incorporate an adaptive management and review strategy. This strategy includes ongoing evaluation of monitoring data to determine if the environmental objectives are being met. In the event that the GHGMP is failing to achieve the objectives defined in Section 5, Albemarle will initiate a review of the GHGMP. If the GHGMP is revised as a result of this review a copy of the GHGMP and a summary of the GHGMP (detailed in Section 5.4.3) will be submitted to DWER for approval.

In order to facilitate an adaptive management approach and comply with Condition 9-5 (3) of MS 1085 Albemarle will revise and submit the GHGMP to DWER for approval every 5 years. Each revision will draw on information learned in the preceding years and will typically include a review of following:

- Assumption and uncertainties;
- The performance of the GHGMP;
- Re-evaluation of the risk assessment;
- A refined understanding of the ecological regime; and
- External changes during the life of the Proposal.

In addition to the above, Albemarle will consider committing to the following conditions in the next 5 year revision of the GHGMP (2026):

- Outlining other relevant potential GHG emission abatement measures that were considred but not proposed to be implemented;
- Provide a rationale as to why the abovementioned abatement measures were not implemented; and
- Provide a breif discussion on the feasibnility and avalibility of offsets.

In the event that this GHGMP is altered for any other reason (other than administrative edits), the revised plan will be submitted to DWER for approval.

7 STAKEHOLDER CONSULTATION

Changes made in this revision of the GHGMP include the addition of a second power source option (the Power Station), revisions to the predicted GHG emissions of the Proposal and administrative updates to ensure the GHGMP aligns with the EPA's guidance (EPA, 2020b).

Furthermore, representatives from Albemarle and Preston Consulting have met and liaised with EPA Services from the Department of Water and Environmental Regulation to:

- Discuss and apply for approval under Part IV of the EP Act to construct the Power Station;
- Discuss the changes to GHG emissions and air quality as a result of this change;
- Seek advice on the approach taken in this GHGMP;
- Determine the preferred process for the submission of the S45c application; and
- Ensure this document meets the relevant conditions of MS 1085.

8 REFERENCES

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9 GLOSSARY

Term	Meaning
AKP	Albemarle Kemerton Plant
Albemarle	Albemarle Lithium Pty Ltd
BAT	Best Available Techniques
CEO	Chief Executive Officer
CER	Clean Energy Regulator
CO_2-e	Carbon Dioxide Equivalent
DAWE	Department of Agriculture, Water and the Environment
DER	Distributed Energy Resources
DotEE	Department of the Environment and Energy
EF	Emissions Factor
Emission Limits	Emission limit set by the EPA for the AKP
EMS	Environmental Management System
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
ETS	Energy Transformation Strategy
GHG	Greenhouse Gas
GHG Factor Guideline	The EPA's Key Environmental Factor Guideline - GHG Emissions
GHG MP	Greenhouse Gas Management Plan
GWP	Global Warming Potential
ISO	International Organisation for Standardisation
km	Kilometres
KSIA	Kemerton Strategic Industrial Area
LED	Light Emitting Diode
LHM	Lithium Hydroxide Monohydrate
LPG	Liquified Petroleum Gas
MS	Ministerial Statement
MS 1085	Ministerial Statement 1085
MW	Mega Watt
NGER	National Greenhouse and Energy Reporting Determination 2008
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
Power Station	Albemarle Kemerton Plant Power Station
S45c	Section 45c
SWIS	South West Interconnected System
TAGG	Transport Authorities Greenhouse Group
TEC	Threatened Ecological Communities
Technical Guidelines	National Greenhouse and Energy Reporting Scheme Measurement – Technical Guidelines
WA	Western Australia