GREENHOUSE GAS ASSESSMENT

Constellation Project

PREPARED FOR
AERIS RESOURCES LTD

JANUARY 2025

ENVIRONMENTAL SOLUTIONS

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Glossary and acronyms

CO_2-e	Carbon dioxide equivalence
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
HME	Heavy Mining Equipment
OEM	Original Equipment Manufacturer
NGER	National Greenhouse and Energy Reporting
SEARs	Secretary's Environmental Assessment Requirements

1 Introduction

The Constellation Project (the Project) is located in the 'Bogan Shire' local government area of central-western New South Wales. The Project site is located approximately 20 km north-east of the township of Girilambone and approximately 55 km north-west of Nyngan (Figure 1-1).

The Project is proposed as a satellite site of Tritton Copper Operations (owned and operated by Aeris). Tritton Copper Operations operates as a hub and spoke model with Tritton Copper Mine serving as the hub (where the processing facility is located) and other surrounding deposits supplying ore for processing. The Project is located approximately 45 km north-east of the Tritton processing plant.

The Project proposes mining of copper ore, through the development of an open cut pit and underground mine. Mined ore will be transported via road to the Tritton processing plant for processing, with lower grade oxide ore processed by heap leaching at the Project site. Transport of dewatered tailings material from Tritton Copper Mine (back to the Project site for use in cemented paste fill) will support the underground mining activities. Final rehabilitation of the Project site will occur after mining activities are complete.

The Project proposes to mine an average of 500,000 tonnes of copper ore per annum to replace depleting production from Aeris' existing Tritton Copper Mine and Murrawombie Copper Mine and maintain feed to the Tritton processing plant. Production of ore in any given period would achieve peak volumes of up to 1 million tonnes per annum. Production during operations will vary, as open cut mining is completed, and underground operations ramp up. The anticipated mine life is approximately 16 years, inclusive of the Project construction period, 10 years of mine operation, and rehabilitation/closure period. There is potential for mine life extensions as the deposit is developed down plunge (to depth).

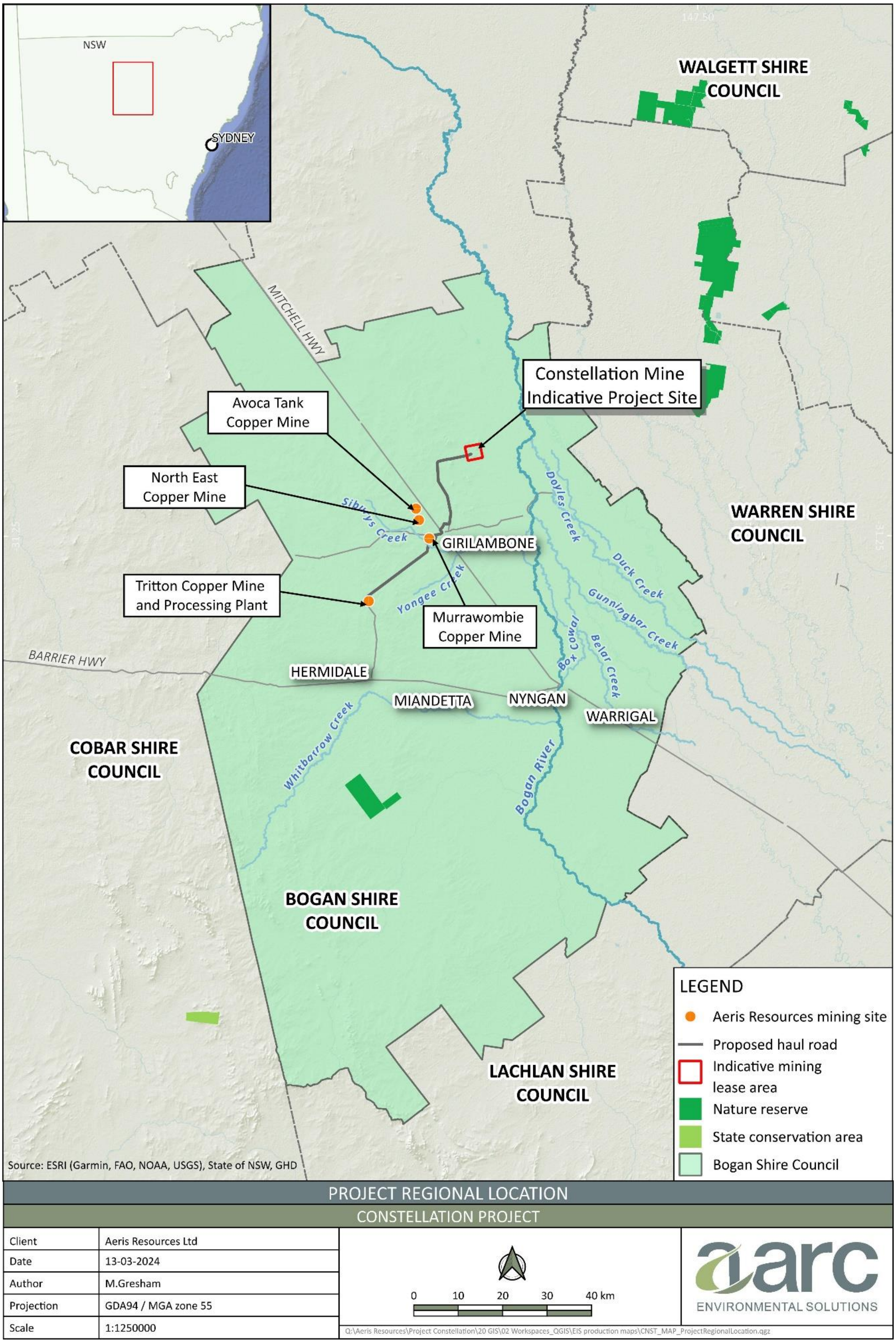

Figure 1-1: Project location

The proposed Project is considered State Significant Development (SSD 41579871) under the NSW *Environmental Planning and Assessment Act 1979* and is subject to the preparation of an Environmental Impact Statement (EIS). As part of the Project EIS, the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project have identified the requirement to undertake a Greenhouse Gas Assessment.

This Greenhouse Gas Assessment has been prepared to satisfy the Project's SEARs. Table 1 specifies the relevant SEARs addressed in this assessment.

Table 1: Relevant SEARs and report reference

SEARs requirement	**Report reference**
General requirements: an assessment of the likely impacts of the development on the environment, focusing on the specific issues identified below, including:	
• a description of the existing environment likely to be affected by the development, using sufficient baseline data;	Section 1
• an assessment of the likely impacts of all stages of the development, including likely interactions between the development and any other existing, approved or proposed developments in the vicinity, including any cumulative impacts, taking into consideration any relevant legislation, environmental planning instruments, guidelines, policies, plans and industry codes of practice;	Section 3
• a description of the measures that would be implemented to avoid, mitigate and/or offset residual impacts of the development, including incident management procedures, and the likely effectiveness of these measures, and an assessment of: o whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented; o the likely effectiveness of these measures, including performance measures where relevant; and o whether contingency plans would be necessary to manage any residual risks; and	Section 4
• a description of the measures that would be implemented to monitor and report on the environmental performance of the development if it is approved;	Section 4
Air Quality – Including:	
• An assessment of the likely greenhouse gas impacts of the development including measures to minimise emissions; and	This Greenhouse Gas Assessment, and Section 6.7 of the EIS
• A description of the measures that would be implemented to monitor and report on air emissions (including fugitive dust and greenhouse gases) of the development;	Section 4 of this Greenhouse Gas Assessment, and Section 6.7 of the EIS

The NSW Environment Protection Agency provided review comments on the first version of this GHG Assessment report through the EIS public . No other agency has provided further recommendations on greenhouse gas information to be considered within the EIS.

AARC Environmental Solutions Pty Ltd has been commissioned by Aeris Resources to undertake a greenhouse gas assessment in relation to the Project. This report addresses greenhouse gas emissions associated with mining activities, and reviews mitigation and offset measures.

1.1 Project overview

The Project will comprise new open cut and underground mining operations. The initial construction activities are proposed to commence in Project year 0 (indicatively 2025) with the open-cut mining expected to start in Project year 1 (indicatively 2026). Underground construction activities are to commence in Project year 1 with underground mining starting in Project year 2.

Supporting infrastructure (Figure 1-2) for the proposed Project will include the development of:

- a road upgrade between the Project site and the Mitchell Highway (to support haulage activity);
- a new T intersection to link the proposed haul road with the eastern side of the Mitchell Hwy (north of Girilambone);
- an upgrade to the intersection of the Mitchell Highway with Railway Road (west of Girilambone);
- a waste rock emplacement at the Project site;
- a run of mine stockpile to support the handling of mined ore;
- a mine laydown area and workshop;
- a heap leach pad and associated processing facility;
- a paste plant, emulsion storage and shotcrete batch plant;
- topsoil stockpiles;
- water management and storage infrastructure, including a bi-directional water pipeline between the Project site and Murrawombie Copper Mine; and
- administrative facilities including offices, amenities, and car park.

An onsite power station, controlled and operated by a third party, will supply electricity to the project. The onsite power station is proposed to consist of diesel generators and a solar farm. The solar farm is proposed to supply 30% of the overall electricity consumption needs.

Once mined, ore will be hauled from the Project's run of mine (ROM) stockpile to Tritton, for processing. Lower grade ore recovery will be processed by heap leaching at the Project site, through a proposed heap leach facility.

Tailings material generated by the processing operations at Tritton will be returned to the Project site, for final treatment (paste plant) to support underground emplacement.

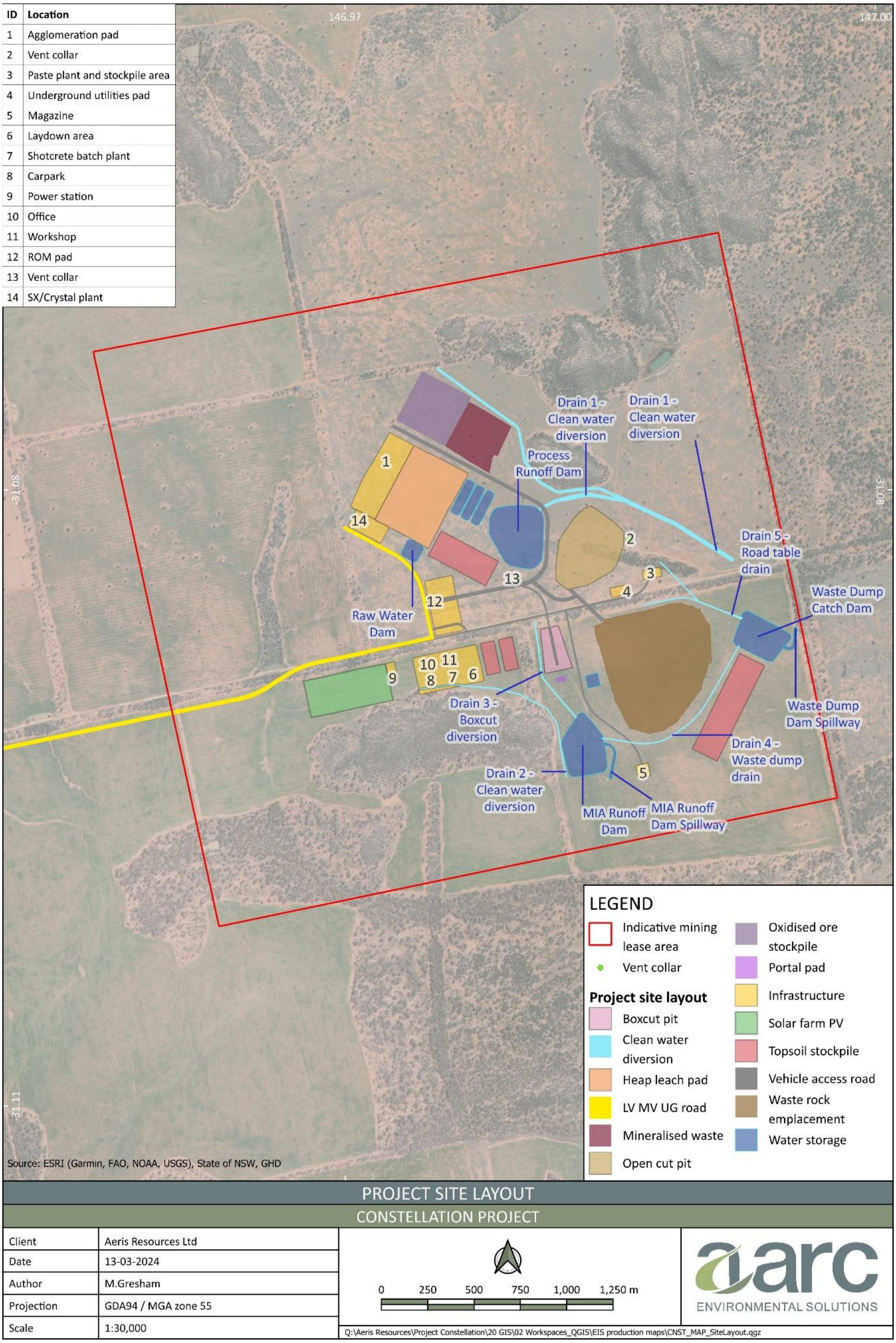

Figure 1-2: Proposed Project layout

2 Legal obligations and criteria

2.1 National Greenhouse and Energy Reporting (NGER)

The national reporting framework for the reporting of greenhouse gas emissions and achievement of Australia's greenhouse gas emissions reduction targets is contained within the *National Greenhouse and Energy Reporting Act 2007* (NGER Act, 12 April 2023). Associated information include:

- National Greenhouse and Energy Regulations 2008 (NGER Regulations, 29 April 2023);
- National Greenhouse and Energy Reporting (Measurement) Determination 2008 (NGER Measurement Determination); and
- Australian National Greenhouse Accounts Factors (DCCEEW 2023).

Greenhouse gas emissions are measured as kilotonnes of carbon dioxide equivalence (CO_2-e). This means that the amount of a greenhouse gas that a business emits is measured as an equivalent amount of carbon dioxide which has a global warming potential of one. The carbon dioxide equivalence for various greenhouse gases is shown in Table 2**.**

Table 2: Carbon dioxide equivalence (global warming potential) of greenhouse gases

Item (NGER Regulation)	Greenhouse gas	Global warming potential
1	Carbon dioxide CO_2	1
2	Methane CH_4	28
3	Nitrous oxide N_2O	265
4	Sulphur hexafluoride SF_6	23,500
5 to 17	Hydrofluorocarbons (HFC's)	116 to 12,400
18 to 24	Perfluorocarbons (PFC's)	6,630 to 11,100

Reference: NGER Regulations 2008 (29 April 2023)

Greenhouse gas emissions are described as Scope 1, 2 or 3, in accordance with DCCEEW (2023) and as described as follows:

- Scope 1 emission of greenhouse gas (as per NGER Regulations), in relation to a facility, means the release of greenhouse gas into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility. Scope 1 emissions are sometimes referred to as direct emissions.
- Scope 2 emission of greenhouse gas (as per NGER Regulations), in relation to a facility, means the release of greenhouse gas into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility. Scope 2 emissions from one facility are part of the scope 1 emissions from another facility. Scope 2 emissions can be referred to as indirect emissions from power generation.
- Scope 3 emission of greenhouse gas are not reported under NGER Regulations. Scope 3 emissions are indirect greenhouse gas emissions other than scope 2 emissions that are generated in the wider economy. They occur as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business (e.g. shipping from port to international customers). Scope 3 emissions can be referred to as indirect emissions from all other (not power generation) sources. Scope 3 emissions can be split into upstream emissions related to purchased or acquired goods or services, and downstream emissions relating to sold product.

When reporting emissions, energy production and energy consumption data, only those activities, fuels and energy commodities for which there are applicable methods under the NGER Regulations are reported.

According to section 13 of the NGER Act, the reporting threshold for greenhouse gas emissions is as follows:

a) *the total amount of greenhouse gases emitted from the operation of facilities under the operational control of entities that are members of the group has a carbon dioxide equivalence of …. (if the year is 2010 or later) 50 kilotonnes or more; or*

b) *the total amount of energy produced from the operation of facilities under the operational control of entities that are members of the group is ….* (if the year is 2010 or later) *200 terajoules or more; or*

c) *the total amount of energy consumed from the operation of facilities under the operational control of entities that are members of the group is ….* (if the year is 2010 or later) *200 terajoules or more; or*

d) *an entity that is a member of the group has operational control of a facility the operation of which during the year causes:*

    i. *emission of greenhouse gases that have a carbon dioxide equivalence of 25 kilotonnes or more; or*

    ii. *production of energy of 100 terajoules or more; or*

    iii. *consumption of energy of 100 terajoules or more.*

2.2 NSW EPA Climate change policy

The NSW Environment Protection Authority (EPA) Climate Change Policy has been developed for addressing climate change and protecting the environment. The EPA is committed to strengthening the regulatory response to climate change to respond to acute and chronic impacts of climate change. The Policy seeks to achieve the EPA's statutory duty to ensure environment protection under the *Protection of the Environment Operations Act 1997* when exercising its environment protection licencing functions. The objectives of the policy are delivered via the Climate Change Action Plan.

2.2.1 NSW EPA Climate Change Action Plan 2023-26

The NSW EPA Climate Change Action Plan describes how the objectives of the EPA Climate Change Policy will be delivered until the policy and plan are reviewed in 2026. The Plan outlines regulatory actions that will be taken relating to climate change and signals stronger regulatory action for the medium and long term, including achieving net zero emissions in NSW by 2050.

The plan outlines staged actions, initially for the gathering of information from environment protection licensees. Subsequent actions under the plan include the setting of emission reduction targets for key industry sectors and requirements for climate change mitigation and adaption plans for licensees.

When emission reduction targets and a requirement for climate change mitigation and adaption plan are implemented by the EPA, the Project will likely be subject to these requirements.

2.2.2 NSW EPA Guide for Large Emitters

The NSW EPA released the draft guideline NSW EPA Guide for Large Emitters in May 2024 for feedback from the public (and is now under review). The guideline was designed to help meet NSW's emission targets and provide transparency and information for the community on greenhouse gas emissions from new projects. The guideline provides a definition for 'large emitters' and specifies that the estimates of emissions must follow National Greenhouse Account factors and NGER methods.

3 Greenhouse gas assessment

Greenhouse gas emissions data was provided by Aeris for quarters from 1st quarter Project year 1 to 2nd quarter Project year 10. The emission sources included in the data are listed in Table 3.

Table 3: Scope 1, 2, and 3 emission sources in supplied data

Scope	Source	Detail
1	Diesel fuel combustion	Fuel used for open cut and underground operations, flotation processing, backhaul of tailings for paste backfill, light vehicles, and transport of ore to Tritton. Calculations based on 2.7 kg CO_2/l.
	Explosives	Ammonium Nitrate/fuel oil used for open cut and underground blasting. Calculations determine ANFO kg based on mining tonnages, and a carbon intensity of 0.20 t CO_2/t of ANFO. ANFO used for open cut is 0.6 kg ANFO per bank cubic meter (bcm). ANFO used for underground stoping is 0.4 kg ANFO per bcm. ANFO used for underground development is 1 kg ANFO per bcm
2	Electricity consumption - Site power as diesel fuel combustion	Power used for open cut and underground operations, flotation processing and heap leach. Data is based on diesel consumption of diesel generators with specifics to be defined by third party provider, and solar power generation. On average 70% of power consumption being from the diesel generator and 30% from solar power. Calculations based on carbon intensity of 726 kg CO_2/MWh power usage for diesel proportion.
3	Trucking concentrate to Tritton processing plant	Fuel used for trucks to transport concentrate (processed from ore from Constellation) from Tritton to rail loading. Calculations based on 36 km return trip, truck capacity of 54 t, and diesel consumption of 0.43 l/km.
	Rail transport to port	Transport of product from the site to the port. Calculations based on 600 km trip, and carbon intensity of 25 g CO_2/net tonne km.
	Sea transport to end user	Transport of product from the port to the end user overseas. Calculations based on 7964 km trip, and carbon intensity of 5 g CO_2/net tonne km.

The emission sources not addressed in the data include:

- Vegetation clearance – The Project will predominantly occupy previously cleared areas. Approximately 97.24 ha of woodland vegetation will be cleared for the Project (Ecoplanning 2024). However, as vegetation clearing is not applicable under the NGER Regulations and cleared vegetation will be offset by new vegetation through progressive rehabilitation, emissions from land clearing are not expected to be significant compared to the annual emissions of the Project.
- Grid electricity consumption – The Project will avoid grid electricity consumption by obtaining power from solar and on-site diesel generation of electricity. The onsite power generation will be operated by a third party and account for Project Scope 2 emissions. Electricity consumed by the Tritton processing plant for ore processing is not included in the Project emissions.
- Production of refined copper from the copper concentrate is expected to be considered as part of Scope 3 emissions of the Tritton processing plant and is not included in Project emissions.
- Scope 3 upstream emissions related to purchased or acquired goods or services are not addressed in Table 3 due to their relatively minor nature. Scope 3 downstream emissions relating to sold product, are addressed in Table 7.

The yearly greenhouse gas emissions based on the divisions noted in Table 3 are shown in Table 4, Table 5, and Table 6. The combined Scope 1, 2 and 3 emissions are summarised in Table 7. The yearly emissions are also shown in Figure 3-1 for Scope 1 emissions, Figure 3-2 for Scope 2 emissions and Figure 3-3 for Scope 3 emissions.

Table 4: Yearly scope 1 emissions

Project year	Mining activities (C = construction, OC = open cut mining, UG = underground mining)	Fuel				Explosives		
		Open cut (l)	Under-ground (l)	Flotation Processing (l)	Total (t CO_2-e)	Open cut (t CO_2-e)	Under-ground (t CO_2-e)	Total (t CO_2-e)
1 (2026)	C, OC, UG	4,119,446	1,036,121	106,559	14,208	514	32	546
2	OC, UG	3,219,767	1,445,263	472,955	13,873	187	65	252
3	UG	0	1,629,729	378,804	5,423	0	78	78
4	UG	0	1,734,698	424,903	5,831	0	70	70
5	UG	0	1,929,367	421,214	6,347	0	57	57
6	UG	0	1,996,364	421,440	6,528	0	53	53
7	UG	0	1,996,364	423,363	6,533	0	49	49
8	UG	0	1,996,364	424,643	6,537	0	46	46
9	UG	0	1,934,539	397,368	6,296	0	39	39
10 (2035)	UG	0	868,353	54,347	2,491	0	5	5
Total					74,066			1,195

Table 5: Yearly scope 2 emissions

Project year	Mining activities (C = construction, OC = open cut mining, UG = underground mining)	Power				
		Open Cut (MWh)	Underground (MWh)	Flotation (MWh)	Heap leach (MWh)	Total (t CO_2-e)
1 (2026)	C, OC, UG	8,586	6,057	3,629	3,901	11,269
2	OC, UG	7,358	15,597	16,107	6,214	23,011
3	UG	2,268	21,465	12,900	3,297	20,295
4	UG	2,268	22,977	14,470	0	20,185
5	UG	2,268	22,685	14,345	0	19,973
6	UG	2,268	22,685	14,352	0	19,977
7	UG	2,268	22,685	14,418	0	20,010
8	UG	2,268	21,713	14,462	0	19,539

9	UG	2,268	19,768	13,533	0	18,078
10 (2035)	UG	1,134	8,139	1,851	0	5,654
Total						177,991

Table 6: Yearly scope 3 emissions

Project year	**Mining activities** (C = construction, OC = open cut mining, UG = underground mining)	**Concentrate (tonnes)**	**Total trucking distance (km)**	**Diesel (l)**	**Scope 3 emissions ($tonnes.CO_2$-e)**			
					Truck	**Rail**	**Sea**	**Total**
1 (2026)	C, OC, UG	15,064	10,043	4,318	12	226	600	837
2	OC, UG	53,864	35,909	15,441	42	808	2,145	2,994
3	UG	43,770	29,180	12,547	34	657	1,743	2,433
4	UG	51,326	34,217	14,714	40	770	2,044	2,853
5	UG	48,023	32,015	13,767	37	720	1,912	2,670
6	UG	46,796	31,198	13,415	36	702	1,863	2,602
7	UG	43,085	28,723	12,351	33	646	1,716	2,395
8	UG	39,181	26,120	11,232	30	588	1,560	2,178
9	UG	35,580	23,720	10,200	28	534	1,417	1,978
10 (2035)	UG	4,335	2,890	1,243	3	65	173	241
Total					295	5,715	15,172	21,182

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Table 7: Summary of yearly scope 1, 2, and 3 greenhouse gas emissions

Project year	**Mining activities** (C = construction, OC = open cut mining, UG = underground mining)	**Scope 1 emissions (tonnes.CO2-e)**			**Scope 2 emissions (tonnes.CO_2-e)**	**Scope 3 emissions (tonnes.CO_2-e)**			
		Fuel	**Explosives**	**Total**		**Truck**	**Rail**	**Sea**	**Total**
1 (2026)	C, OC, UG	14,208	546	14,754	11,269	12	226	600	837
2	OC, UG	13,873	252	14,125	23,011	42	808	2,145	2,994
3	UG	5,423	78	5,501	20,295	34	657	1,743	2,433
4	UG	5,831	70	5,901	20,185	40	770	2,044	2,853
5	UG	6,347	57	6,404	19,973	37	720	1,912	2,670
6	UG	6,528	53	6,581	19,977	36	702	1,863	2,602
7	UG	6,533	49	6,582	20,010	33	646	1,716	2,395
8	UG	6,537	46	6,583	19,539	30	588	1,560	2,178
9	UG	6,296	39	6,335	18,078	28	534	1,417	1,978
10 (2035)	UG	2,491	5	2,496	5,654	3	65	173	241
Total		74,066	1,195	75,261	177,991	295	5,715	15,172	21,182

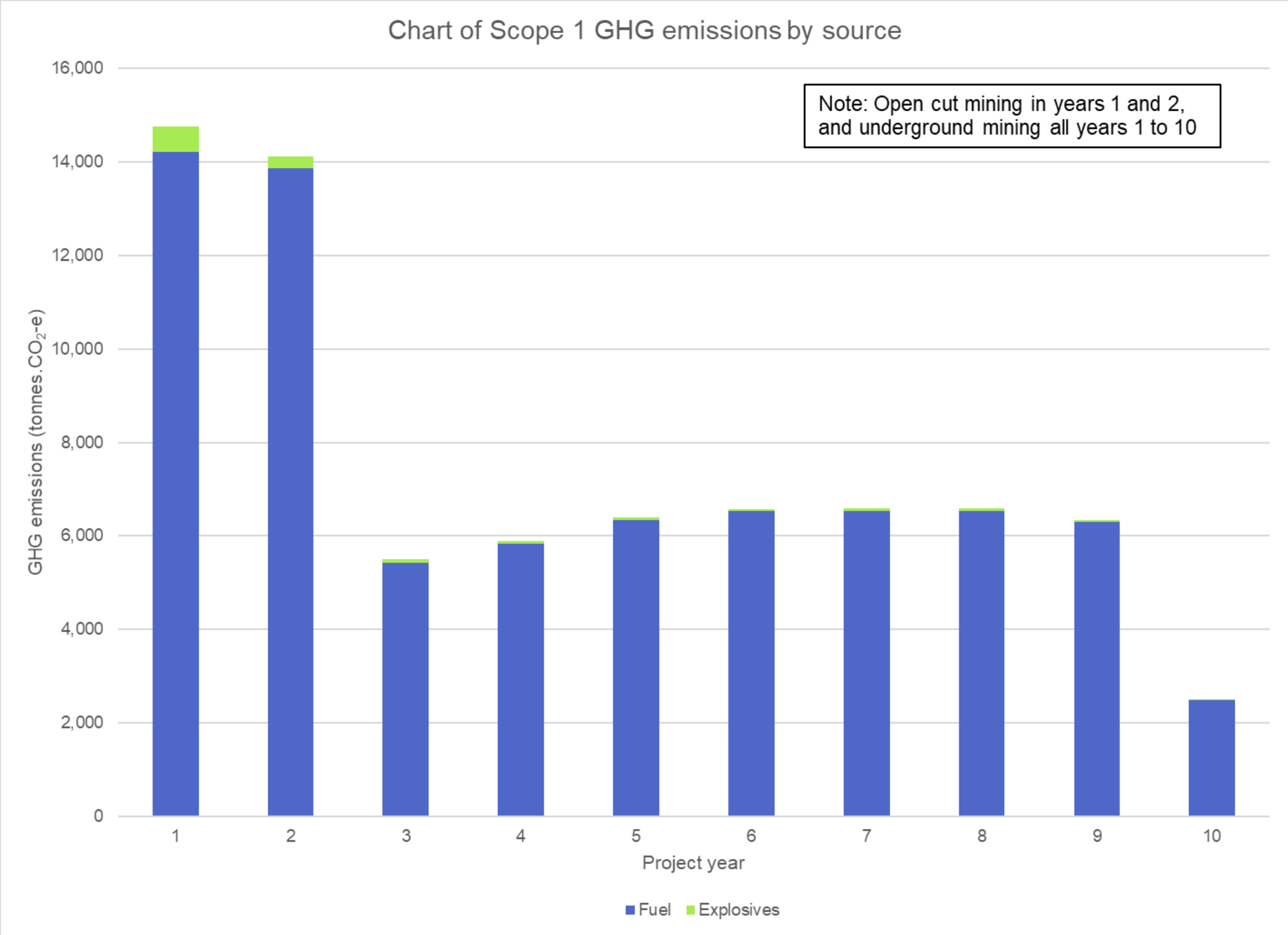

Figure 3-1: Scope 1 GHG emissions by source

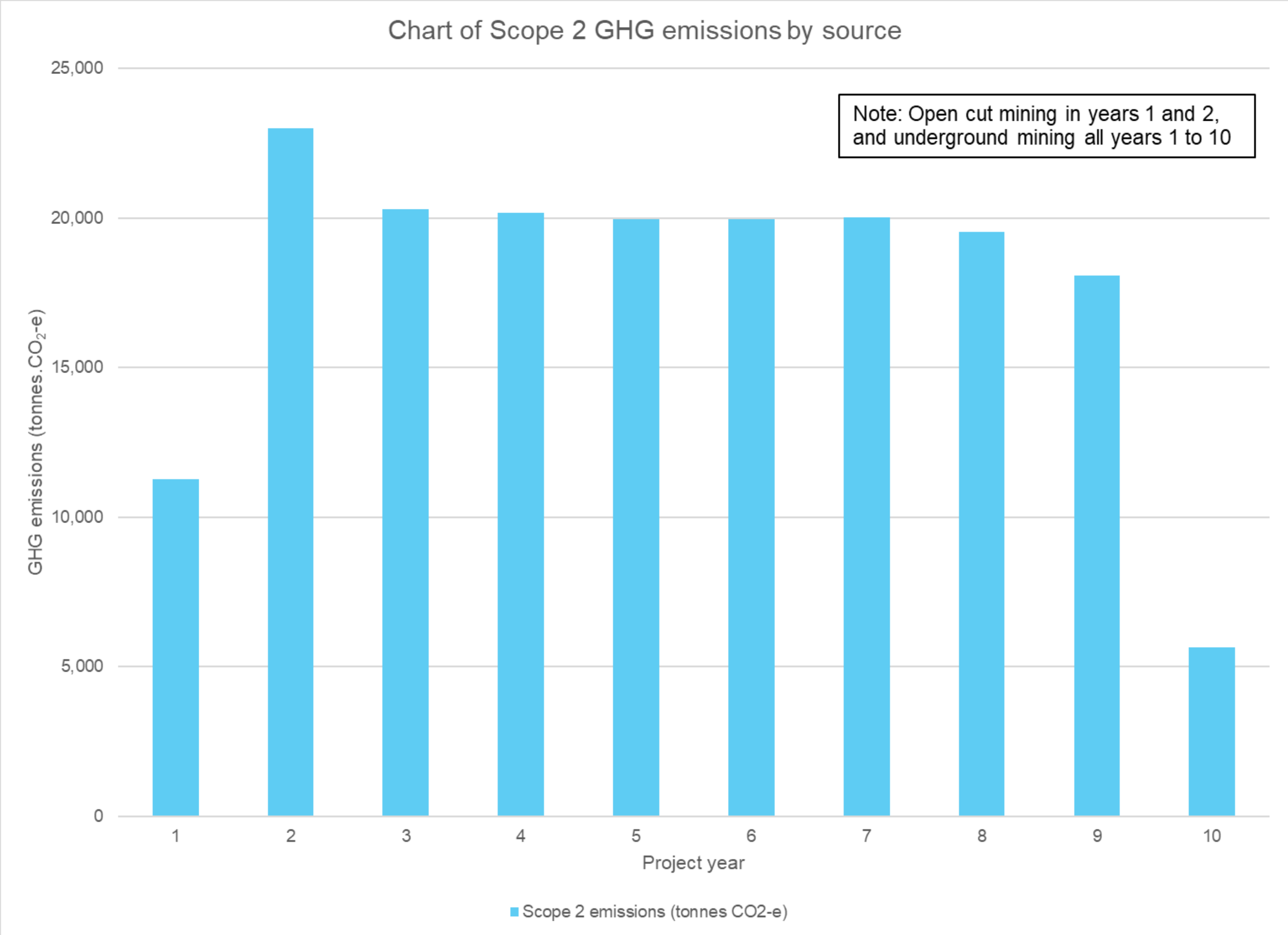

Figure 3-2: Scope 2 GHG emissions

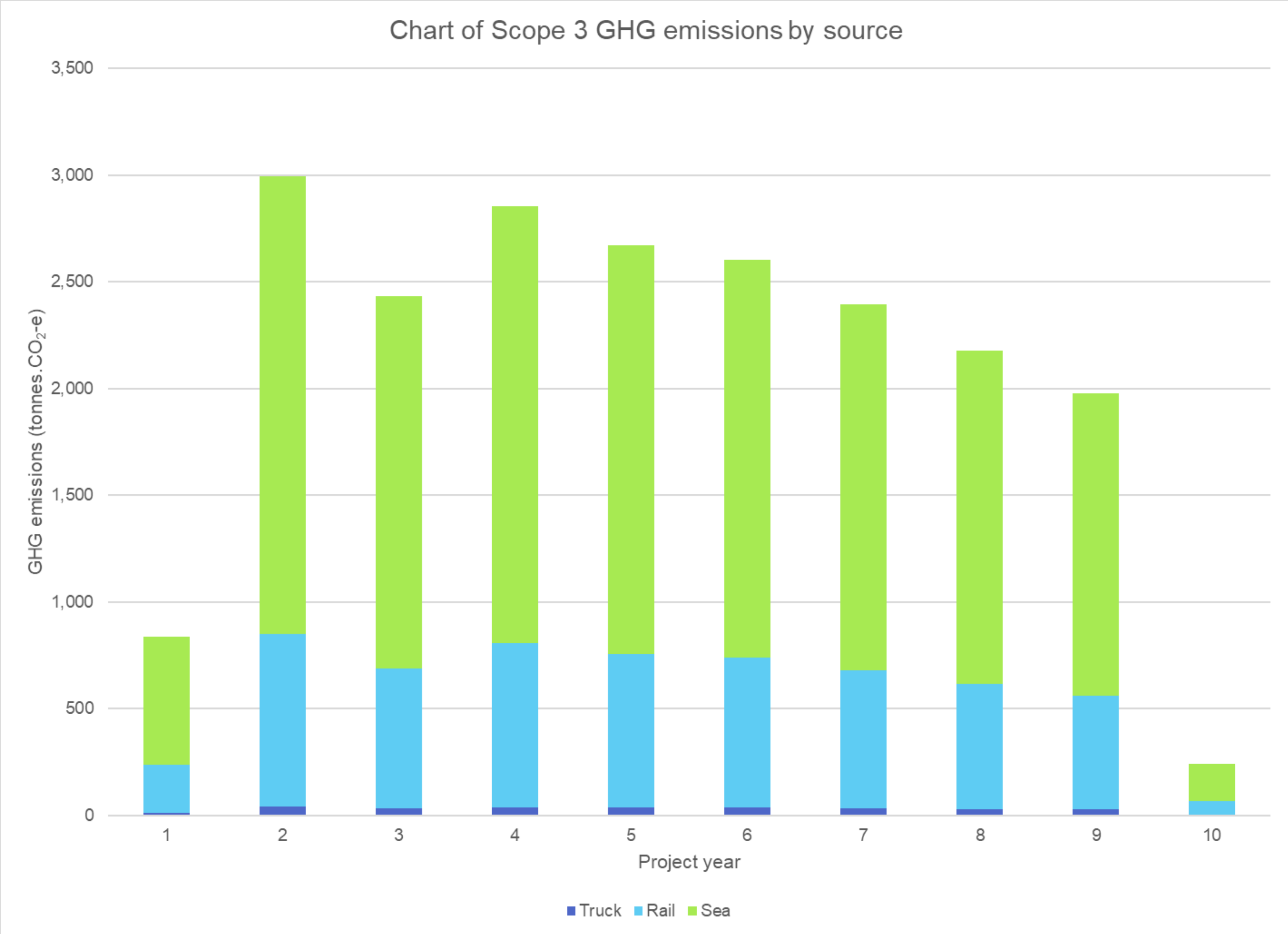

Figure 3-3: Scope 3 GHG emissions by source

Scope 1 and 2 emissions total 37 kilotonnes CO_2-e in the peak year (Project year 2), and total 253 kilotonnes CO_2-e for all years (Table 7).

The Australian total greenhouse gas inventory for 2020 is 498,112 kilotonnes CO_2-e. The peak year (Project year 2) Scope 1 and 2 emissions of the Project are 37 kilotonnes CO_2-e which represents less than 0.01 % of the 2020 Australian total emissions.

The global total greenhouse gas inventory for 2019 is 49.94 gigatonnes CO_2-e. The peak year (Project year 2) Scope 1, 2 and 3 emissions of the Project are 40 kilotonnes CO_2-e which represents less than 0.0001 % of the 2019 global total emissions.

The contributing sources for the peak year (Project year 2) are as follows (in order of emissions):

- Scope 1 emissions:
  - Diesel fuel combustion 13.9 kilotonnes CO_2-e
  - Explosives 0.25 kilotonnes CO_2-e
- Scope 2 emissions
  - Site power as diesel fuel combustion 23.0 kilotonnes CO_2-e
- Scope 3 emissions:
  - Sea transport to end user 2.1 kilotonnes CO_2-e
  - Rail transport to port 0.81 kilotonnes CO_2-e
  - Transport concentrate to Tritton processing plant 0.04 kilotonnes CO_2-e

The principal emissions sources are:

i) site power from the diesel generator; and

ii) diesel fuel usage in the mining fleet.

The Project is predicted to meet the reporting threshold for the NGER scheme. Regardless, the emissions would be reported under Aeris' controlling corporation reporting obligations.

4 Measures to minimise emissions

4.1 Contribution to economy scale emission avoidance

The NSW Net Zero Plan Stage 1: 2020-2030 (DPIE 2020) is the foundation of NSWs action on climate change and it outlines the NSW government's plan for the economy and emission reduction during the decade. The Plan provides the emissions reduction goals which are ultimately to achieve net zero emissions by 2050. There are four priorities under the plan to reach this goal:

1. drive the uptake of emissions reduction technologies that also support economic growth, or reduce cost of living or doing business;
2. empower consumers and businesses to make sustainable choices;
3. invest in the next wave of emissions reduction innovation to ensure economic prosperity from decarbonisation beyond 2030; and
4. ensure the NSW Government leads by example.

Priorities one to three are completely reliant on the availability of low carbon technologies, the economy wide adoption of such technologies and the cost of these technologies decreasing. Key to this is the production of materials which support the electrification of the economy and allows low carbon technologies to outcompete emission intensive alternatives. Copper is an essential metal for low carbon technologies and renewable energy production, with uses in all aspects of electrification of society including manufacture of batteries (including electric vehicle batteries), solar photovoltaic systems, and wind turbines.

The Project proposes to mine an average of 500,000 tonnes of copper ore per annum, as well as other metals important to electrical products. In addition, the Project is essential to allow the continued operation of the Tritton processing facility which will facilitate continued copper and essential minerals production in the region beyond the lifetime of Project. The copper and other minerals produced will be made available to the international economy, where they will play an essential role in the production of low carbon technologies.

In this regard, the Project will provide an essential role in the avoidance of greenhouse gas emissions in NSW and the achievement of the goals of the NSW emissions plan, as well as contribute to global emissions avoidance.

4.2 NSW EPA Greenhouse gas assessment guide for large emitters

A draft Greenhouse gas assessment guide for large emitters has been released for public review. The guide is still under review and consultation, however it provides an emission reduction hierarchy which is a useful approach for considering the proposed Project management of emissions. The hierarchy is as follows:

- Avoid;
- Reduce;
- Substitute; and
- Offset.

The Project design considerations and proposed emission management measures were considered according to the management hierarchy and are described in Section 4.3 and Section 4.4.

4.3 Options assessment

A number of Project design considerations achieve minimisation of greenhouse gas emissions. The rationale of Project design decisions with respect to greenhouse gas emissions are described below.

Power supply infrastructure

Five potential power supply design options were considered for the Project, including:

1) Grid power with backup diesel generator for essential loads;
2) Grid power with solar PV and a backup diesel generator for essential loads;
3) Off-grid solar PV with a diesel generator;
4) Off grid solar PV with battery storage and a diesel generator; and
5) Wind power generation.

Wind power was determined to be not viable due to a combination of low wind speeds, reliability and capital costs. Wind potential was assessed using windPRO modelling software and due to low wind speed and low power demand wind turbines were considered unsuitable for the Project.

Considerations for grid connection included the available capacity of the existing grid, which identified that there was currently insufficient capacity. The Project is located in Essential Energy's network service area where there is an existing 66kV feeder travelling north parallel to the Mitchell Highway, which originates from Nyngan and ends at Bourke. This 66KV line is Tritton's main power source and is at its limit without the additional load of Constellation. Upgrading the existing grid to be able to supply the necessary capacity would have significant capital and time costs associated with it. Solar PV options provided the advantage of long-term economic benefits and disadvantage in terms of large capital investment particularly if battery storage is required for night time supply.

Indicative relative costs of power supply options 1 to 4 were estimated through a Project options study conducted in 2022 and are shown in Table 8. Option 3, consisting of off-grid solar PV (9.1 ha) providing 30% of the site requirements and diesel generator providing the remaining 70% was selected for the Project. This option will be able to effectively satisfy maximum power demand without a large excess generation, which would be wasted without battery storage capacity or grid connection. The chosen option represents:

- a low total capital cost option (approximately 71% of option 1);
- a high annual cost for the life of mine (approximately 212% of the cost of option 1);
- a high net cost (approximately 168% of option 1); and
- a substantial capital outlay for the solar component upfront (approximately $2 million) which the alternative options do not incur as an initial cost.

Option 4, which would have provided the greatest greenhouse gas emission minimisation is considered prohibitively expensive, largely due to the capital cost of the battery component.

Therefore, the chosen option can be considered to achieve the positive outcome of reduced greenhouse gas emissions through substitution power sources with solar power generation at the outlay of the initial capital expense for the solar plant, while retaining the required reliability of on-site diesel power generation. The solar PV setup is expected to generate approximately 11,290 MWh per year. Given diesel generated power will emit approximately 726 kg CO_2 per MWh (refer Table 3), the solar generation is considered to represent avoidance of approximately 8 kilotonnes CO2-e per year.

The proposed power supply system is presented as controlled and operated by a third party. During feasibility and prior to construction Aeris will go to market to seek the best available power solution for the off-grid solar PV and diesel generator with potential battery storage for changeover function. In the event that third party controlled systems are not competitive, Aeris may seek to control and operate the system.

Table 8: Power supply options relative costs summary

Option	Capital costs as % of option 1*	Annual costs as % of option 1*	Net costs^ as % of option 1*
Option 1 – grid power with diesel generator backup	100%		
Option 2 – hybrid grid and solar PV with diesel generator backup	155%	68%	94%
Option 3 (Selected option) – solar PV and diesel generator	71%	212%	168%
Option 4 – solar PV and battery storage with diesel generator backup	638%	16%	206%

*Excluding additional capital costs to upgrade the grid.

^ Net costs account for predicted changes in annual costs over infrastructure life.

4.4 Project design emission avoidance and reduction

Maintenance of existing infrastructure

On-site processing options were considered during Project design. The life of mine, status of Tritton processing plant and transport requirements were considerations for potential options.

Continued use of the existing processing infrastructure at Tritton, rather than constructing facilities at the Constellation site represents a considerable avoidance of emissions. New processing facilities at Constellation would have resulted in emissions from the additional project footprint size, associated fuel use for construction and emissions associated with the construction materials. These emissions are avoided by the adoption of the proposed design, and potential future emissions are avoided by maintaining the Tritton processing facility for the processing of ore from other future Projects in the region.

Water management

The Project is proposed to be a nil water release system with water managed and treated for reuse. A bi-directional pipeline to the Aeris Murrawombie project site is proposed to provide or receive Project water for when on-site management is unable to achieve requirements. Maximising water reuse will minimise requirements for pumping to and from Murrawombie and minimise the pumping to extract water from rivers under licencing arrangements. Pumping to and from Murrawombie or rivers would generate greenhouse gas emissions and the proposed management system strategy will therefore reduce potential emissions.

Tailings reuse

Tailings material will be reused as paste backfill for underground stopes. Alternative backfill paste options would require obtaining materials quarried from alternative sources with consequential greenhouse gas emissions. The proposed approach therefore represents a sustainable substitution of materials and avoidance of greenhouse gasses associated with alternative sources of materials.

Haul truck dual use

Project ore will be transported to the Tritton processing facility by road and the tailings material generated will be transported back to the Project for reuse by the same vehicles. The dual use of these vehicles in both directions of travel represents an efficient reuse of transport resources and will avoid greenhouse gas emissions by minimising the fuel for necessary transport of materials.

Site transport

During Project operation, staff access to site will predominantly be via 12-seater shuttle bus with approximately 65% of staff movements in this transport form. This arrangement will reduce the potential greenhouse gas emissions compared to staff transport by light vehicles.

Site layout design

The Project layout has been designed to reduce the disturbance footprint, which concurrently achieves minimised greenhouse gas emissions. The Project footprint is considered to be the smallest possible while still providing all necessary features, and therefore minimises potential greenhouse gas emissions resulting from vegetation clearing.

The Project layout has also been designed to prioritise efficiency in haulage of material around the site, between the open cut, waste rock emplacement, heap leach, and underground mine. Relevant design features include minimisation of haul distances, road slope limits. The proposed approach will reduce fuel consumption for haulage and consequently reduce greenhouse gas emissions.

Haulage and access route design

Multiple options for the access and haulage route were considered, the requirements of landholders, the Bogan Shire Council and the transport authority were incorporated in the decision making process. The route adopted aims to minimise travel distances by using the existing road network as much as possible (including the use of existing local and state roads), and only developing new roads where required. These design decisions reduce potential greenhouse gas emissions by reducing the Project footprint and associated vegetation clearing, and also minimising fuel use for transport by adopting the shortest feasible haulage route.

The initial haul road design was for a width of up to 50 m for the portions of the new road sections. Consideration of the consequences of clearing vegetation for this road width led to a reduction in this width to 18 m. The decision to use the narrower road design achieves an approximately 28 ha reduction in clearing of mature eucalypt woodland. A conservative estimation of carbon stock for this vegetation is equivalent to 70 tonnes of carbon dioxide per hectare (Peeters and Butler 2014), and the redesign of the haul road is therefore conservatively considered to represent the avoidance of emission of at least 1,960 tonnes of carbon dioxide.

4.5 Potential avoidance measures

The following list includes potential measures for reducing greenhouse gas emissions from operations at the site. These measures are not required under the NSW Climate Change Plan, under which no mitigation, monitoring and reporting requirements apply. It is anticipated that future Climate Change Plans may require emission mitigation with monitoring requirements. Therefore, at this stage, the proposed measures represent voluntary options to be considered in the interest of avoiding, reducing and substituting greenhouse gas emissions.

Equipment and Energy Efficiency

(1) Include energy efficiency as a criterion when selecting diesel and electric powered motors and other equipment for purchase, for example variable speed drive pumps. This approach has the potential for substantial reductions in electricity demand. Energy demand for assets is quantified by the supplier/manufacturer and intended to be compared within the procurement and decision-making framework. It is intended that this process will be applied in the procurement of all new assets from Year 1 of the Project.

(2) Include energy efficiency as a criterion when selecting mining tools and Heavy Mining Equipment (HME). Fuel and energy demand by application are quantified by the Original Equipment Manufacturer (OEM) and

intended to be compared within the procurement and decision-making framework. It is intended that this process will be applied in the procurement of all new assets from Year 1 of the Project.

(3) Review potential for alternate mining tools and HME, and their application in the mining process, including the potential for multi-functional mining tools presenting opportunity in reduced fuel consumption for day-to-day operations. The review of available technology practically meeting the operational needs of the mine is an ongoing process implemented from Year 1 of the Project. Any implemented change will be managed utilising the mine's management of change process(es), which provides for the quantification and assessment of change and post implementation review.

(4) The installation of energy efficient lighting and controls, where practical has the potential for reductions in electricity demand in fixed infrastructure, and reduced diesel usage in mobile in-pit lighting. Lighting demand and control efficiencies are quantifiable utilising OEM information and are proposed for consideration from Year 1 of the Project.

Mine Planning

(5) Mine design is proposed to consider optimised haul routing and minimisation of material re-handle, minimising equipment utilisation, fuel demand and consumption by design. Optimised mine designs and plans are proposed to be implemented from Year 1 of the Project utilising a 'life of mine' approach for total best overall outcomes. Alternate plans and iterations are quantifiable utilising 'rise and run' modelling methodologies, rimpull, fuel data etc.

(6) Minimising vegetation clearing has the potential for reductions in emissions due to decay of vegetation. Clearing and pre-stripping is proposed to be planned and executed in stages sufficient only to support the mining process – minimising the cleared vegetation footprint of the mine at all times. Where practical, it is proposed that the reuse of cleared vegetation be considered and utilised in the form of timber product or mulch (for rehabilitation). Use of timber for creation of products has potential to reduce emissions due to decay of vegetation. Minimising the footprint of cleared vegetation and the potential re-use of materials is to be considered from Year 1 of the Project and is an ongoing process.

(7) Progressive Rehabilitation is proposed which will involve the rehabilitation of land as soon as practical. The subsequent growth of vegetation would provide an offset sink for CO_2 and ensure a minimised cleared vegetation footprint at all times.

Mine Operations

(8) The potential use of fuel products that promote and deliver efficiency in consumption (i.e. premium fuels, additives etc) is to be reviewed and considered for use in the mining and associated processes. Fuel products and additives have been proven to improve fuel efficiency and consumption and are quantifiable. The review of available products and additives that suit the operating equipment of the mine and provide practical outcomes is an ongoing process and will be considered from Year 1 of the Project.

(9) All operational HME is proposed to be maintained to design criteria and efficiency through effective maintenance strategies and practices. This approach ensures fuel demand/consumption is optimised and assets are reliable and consistently working within their design envelope (minimising fuel utilisation). These practices are ongoing over the life of the Project, beginning from Year 1. HME performance is quantifiable via key metrics such as 'fuel burn', 'availability', 'reliability', 'Mean Time Between Failure' etc.

(10) It is proposed that electrical equipment shall be maintained to acceptable standards to retain energy efficiency. This approach has potential to ensure that electricity demand is optimised and consumption 'creep' is avoided. This approach is ongoing over the life of the Project, beginning from Year 1, and is quantifiable via testing and adjusting procedures for respective equipment.

(11) Consistent review of blasting practices and technology is proposed ensuring that designs are optimised in order to ensure that blasting energies are best utilised in material movement where practical (e.g. directional/cast blasting techniques). Such practices reduce HME utilisation and associated fuel/energy

consumption. Reduced fuel consumption can be quantified utilising material volumes as a point of reference. This approach is ongoing over the life of the Project, beginning from Year 1.

(12) It is proposed that the capture, storage and re-use of rain and pit water for use in mining operations (e.g. road watering, compaction etc) presents the opportunity to minimise the requirements for importing water and associated pumping. Reduced pumping demand has the potential to reduce electrical and/or diesel usage for pumping requirements. This is an ongoing process and proposed for consideration from Year 1 of the Project.

(13) The recycling of water utilised in the processing operations is proposed to reduce off site pumping requirements. Reduced pumping demand has the potential to reduce electrical and/or diesel usage for pumping requirements. This is an ongoing process and proposed for consideration from Year 1 of the Project.

(14) Effective stock holding, management and logistic processes (focusing on 'critical insurance' stock, freight consolidation and minimising ad-hoc freight transport) has the potential to minimise associated fuel for freight/transport. As far as practical, it is proposed that construction materials and ongoing consumables be procured from local suppliers to reduce fuel consumption. This is an ongoing process and proposed from Year 1 of the Project.

(15) Where suitable, it is proposed that local personnel be engaged to operate the mine. This approach presents opportunity to reduce transport emissions and provide reductions in transport fuel consumption. This is an ongoing process and proposed from Year 1 of the Project.

New Technology

(16) It is proposed that current and future technologies be continually reviewed for opportunity in efficiencies and greenhouse gas contributing reductions in HME and ancillary equipment design and technology. The development and introduction of hybrid technologies, capture and use of regenerative energies, alternative fuel/energy sources (high density compressed natural gas, hydrogen etc.) and battery/electrification technologies presents significant opportunity in diesel and energy consumption and associated greenhouse gas emissions. This is an ongoing process in conjunction with the development of new technologies and proposed from Year 1 of the Project.

(17) Where possible and practical, solar energy is proposed to be considered to replace small diesel plants (e.g. lighting plant) or extend battery life (e.g. remote monitoring and control stations). This is an ongoing process and proposed from Year 1 of the Project. Offset energy is quantifiable against modelled energy demand from traditional energy supplies (i.e. imported electricity and/or diesel).

5 Conclusions and recommendations

A greenhouse gas assessment has been conducted for the proposed Constellation mine. The key points of the assessment are as follows:

- Scope 1, 2 and 3 greenhouse gas emissions have been presented for the Project on an annual basis.
- The intent of the NSW EPA Climate change policy and action plan is recognised through the proposal to include a solar farm to provide part of the power generation requirements for the site. The solar farm is to provide approximately 30% of the power generation requirements, with the remaining 70% of power generation from diesel generators.
- A number of measures for reducing greenhouse gas emissions are proposed to be included in the Project as outlined in Section 4.4. Other potential measures are included in Section 4.5.
- The peak year (Project year 2) Scope 1 and 2 emissions of this Project are estimated to be 37 kilotonnes CO_2-e which represents less than 0.01 % of the 2020 Australian total emissions.
- The peak year (Project year 2) Scope 1, 2 and 3 emissions of this Project are estimated to be 40 kilotonnes CO_2-e which represents less than 0.0001 % of the 2019 global total emissions.

6 References

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