APPENDIX W
Preliminary hazards analysis

Evolution MINING

EMM creating opportunities

Preliminary Hazardous Analysis

CGO Continuation Project

Cowal Gold Operations
Document No. RCE-22304_CGO_PHA_Final_3Apr23_Rev(1)
Date 3/04/2023

Preliminary Hazardous Analysis

CGO Continuation Project

Cowal Gold Operations

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Quality Management

Rev	Date	Remarks	Prepared By	Reviewed By
A	30th January 2023	Draft issued for comment	Jason Costa	Renton Parker
0	13th February 2023	Final issued		
1	3rd April 2023	Final revised		

Executive Summary

Background

Evolution Mining (Cowal) Pty Limited (Evolution) is the owner and operator of Cowal Gold Operations (CGO), an existing open pit and underground gold mine approximately 38 kilometres (km) north-east of West Wyalong, in the central west region of New South Wales (NSW).

CGO is located on the traditional lands of the Wiradjuri People and is immediately adjacent to the western foreshore of Lake Cowal, which is an ephemeral waterbody. The existing CGO mine is shown at a regional scale in **Figure 1-1** and **Figure 1-2**.

CGO was first approved in 1999, and open pit mining operations commenced in 2005. Underground mining operations were approved in 2021 and development works to enable underground mining are underway.

This Preliminary Hazard Analysis (PHA) report forms part of the EIS. It documents the assessment methods, results and the initiatives built into the project design to avoid and minimise impact due to chemical hazards, and the additional mitigation and management measures proposed to address residual impacts which cannot be avoided.

Conclusions

A hazard identification table was developed for the Project to identify potential hazards that may be present at the site as a result of operations or storage of materials. Based on the identified hazards, scenarios were postulated that may result in an incident with the potential for offsite impacts. Postulated scenarios were discussed qualitatively and any scenarios that would not impact offsite were eliminated from further assessment. Scenarios not eliminated were then carried forward for consequence analysis. Per the SEARs, the handling and storage of dangerous goods are assessed in this PHA.

The consequence analysis identified that there would be no incidents originating from the site which would result in offsite impacts; hence, the potential for fatality or injury or environmental impacts to occur would be negligible. As the potential for offsite impacts is low to the point of negligibility, it is considered that the acceptable risk criteria published in HIPAP No. 4 (Ref.) would not be exceeded and that the development would be appropriate for the proposed land use.

It is noted that CGO has multiple existing processes and procedures surrounding hazardous chemical handling and related auditing, i.e. environmental and hazard audits. The Hazardous Materials Management Plan and Cyanide Management Plan both thoroughly assess the risks posed by chemicals at the site to an extent that far exceeds the requirements of HIPAP No. 4, and this is due to the many years of experience in handling chemicals at this site.

Additionally, this Project will not result in changes to existing processes and DG handling quantities at the site, and so no change in the risk profile with respect to hazardous chemicals is expected.

Recommendations

Notwithstanding the conclusions following the analysis of the site, the following recommendations have been made:

- Necessary documentation associated with the storage of DGs under the Work Health and Safety Regulation 2011 shall be completed (i.e. risk assessment, register, notification, etc.).

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Abbreviations

Abbreviation	Description
ADG	Australian Dangerous Goods Code
AN	Ammonium Nitrate
ANE	Ammonium Nitrate Emulsion
AS	Australian Standard
CBD	Central Business District
DA	Development Application
DGs	Dangerous Goods
DPE	Department of Planning and Environment
HIPAP	Hazardous Industry Planning Advisory Paper
HSE	Health and Safety Executive
PA	Project Approval
PHA	Preliminary Hazard Analysis
SEPP	State Environmental Planning Policy
SMSS	Storage Mode Sprinkler System

1.0 Introduction

1.1 Background

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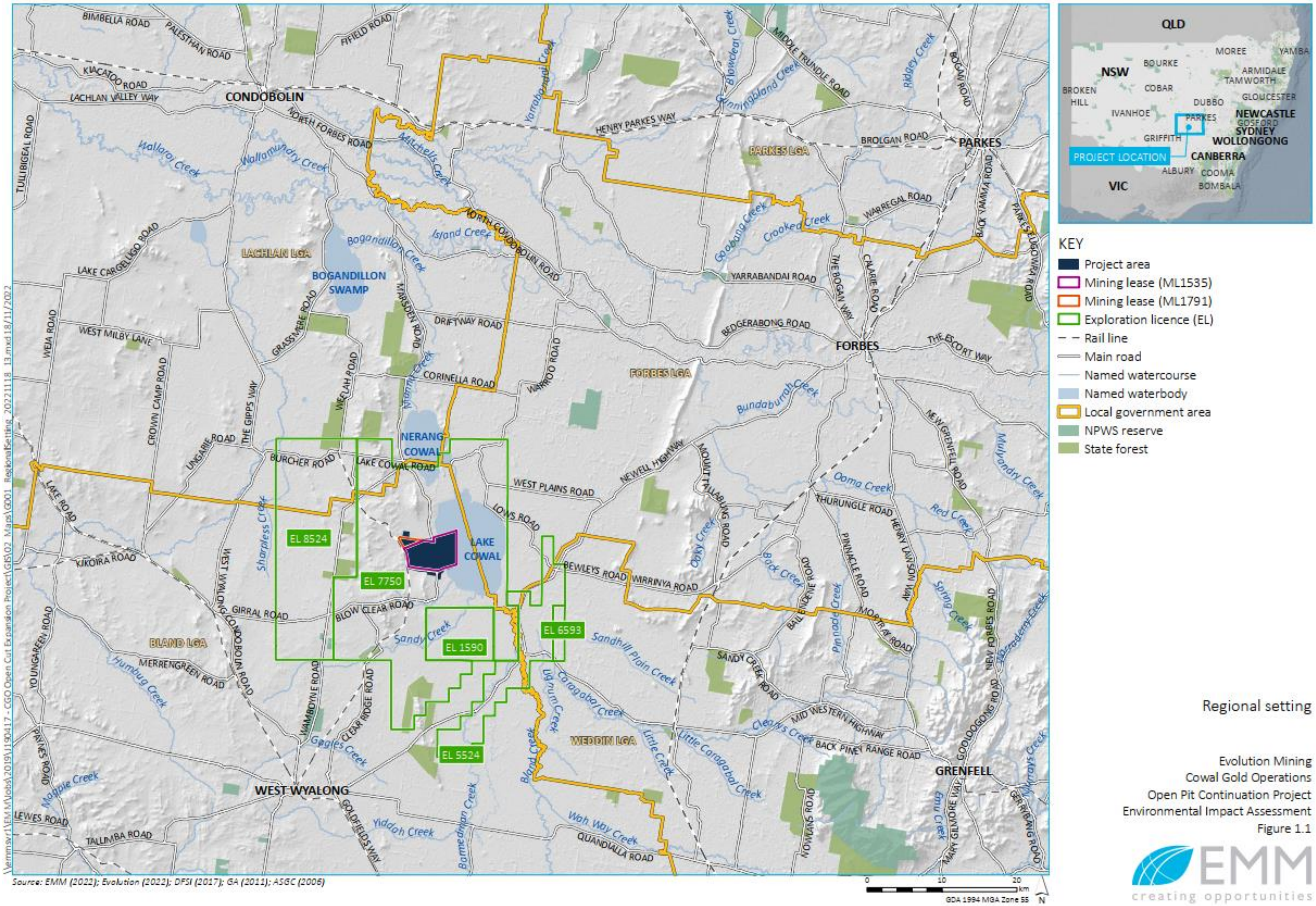

Figure 1-1: Locality Plan

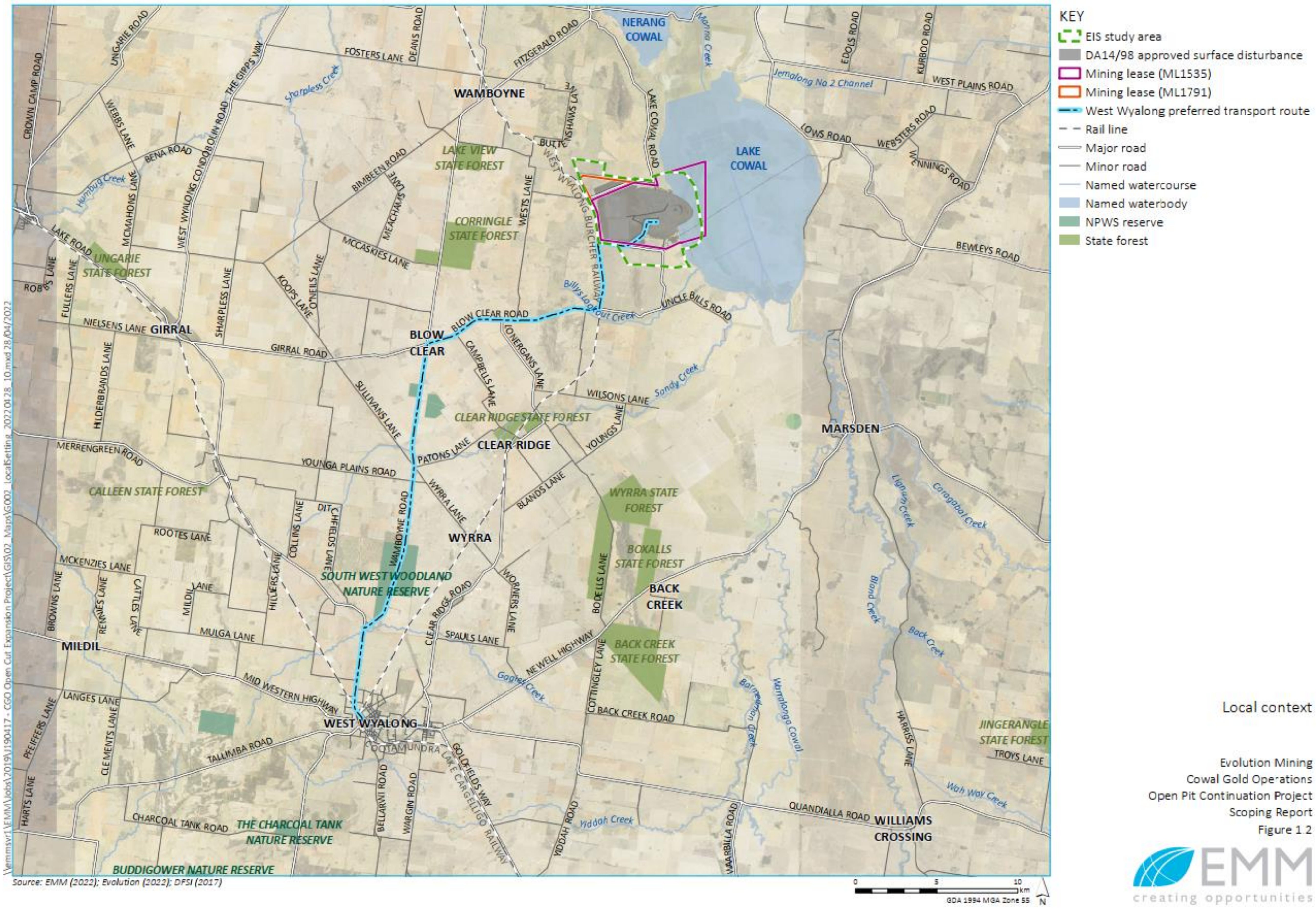

Figure 1-2: Regional Context

1.2 Project overview

Evolution is seeking approval for further open pit mining operations at CGO through the Open Pit Continuation Project (the Project). The Project primarily seeks to continue the open pit operations by approximately 10 years to 2036 and extend the total mine life by approximately two years to 2042.

This will involve further development of the existing E42 Pit and the development of open pit mining in three new and adjacent orebodies, known as the 'E46', 'GR' and 'E41' pits. It is noted that the three new and adjacent ore bodies are within the existing mining lease (ML 1535). No change to the approved ore processing rate of 9.8 Mt per annum is proposed.

Other than the changes to existing approved activities as set out above, all activities that are currently approved under the existing Ministerial development consents are intended to continue. The existing activities approved under the consents are described in Chapter 3 of the EIS.

A detailed description of the Project is contained in Chapter 4 of EIS and a conceptual Project layout is shown in **Figure 1-3**. The project comprises the following key components:

- the continued operation of activities as approved under DA14/98 and SSD 10367;
- development of three new open satellite pits (the 'E46', 'GR' and 'E41' pits) to the north and south of the existing open pit, within the current approved mining lease;
- extending the existing open pit to the east and south via a 'cutback' within the current approved mine lease;
- extending open pit mining operations by approximately 10 years to 2036 and total mine life by approximately 2 years to 2042;
- expansion of the IWL to accommodate life of mine tailings;
- extension of the lake protection bund (LPB) system to provide continued separation and mutual protection between Lake Cowal and the mine;
- backfilling of one of the new open satellite pits (E46) with waste rock and establishment of a new waste rock emplacement on the backfilled pit to minimise the additional area required for waste rock disposal;
- expansion of the footprint of the existing WRE areas to accommodate additional waste rock;
- development of additional topsoil and subsoil stockpiles to accommodate materials from pre-stripping, with materials to be reused during progressive mine rehabilitation;
- upgrades to existing surface water drainage system, to assist with on-site water management and maximise on-site water conservation;
- modification of internal site access and haul roads;
- development of new water storages and relocation of some components of the surface water drainage system;
- modification and relocation of some existing auxiliary mining infrastructure; and
- relevant to this PHA, the existing magazine and AN storage will be relocated in approximately Year 5 of the Project to accommodate the southern WRD expansion and E41 pit development.

The Project will not change existing ore processing rates or methods, tailings disposal methods, main site access, water supply sources, hours of operation, dangerous goods/hazardous chemical storage quantities or management practices. The Project will also retain the existing open pit mining workforce.

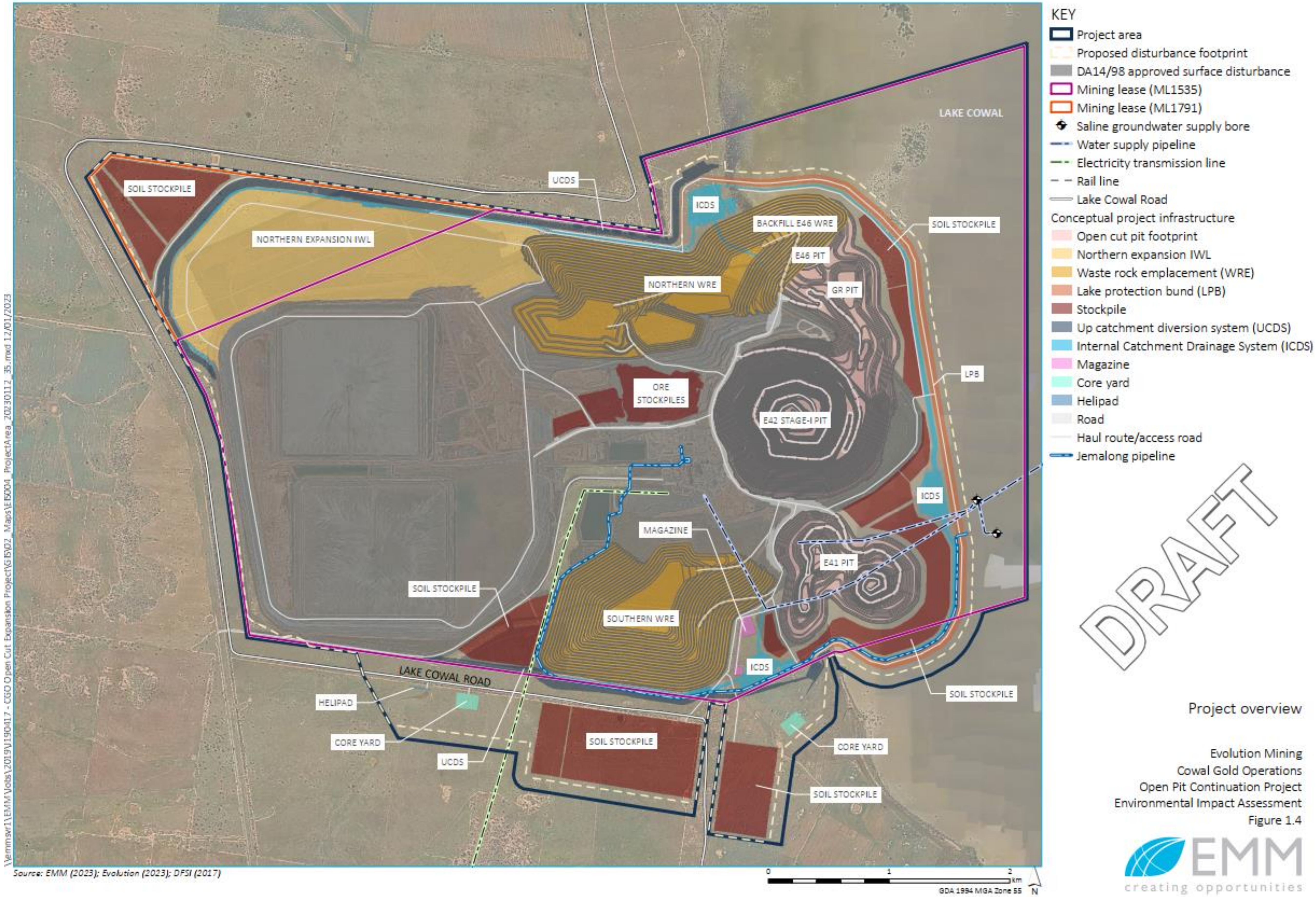

Figure 1-3: Project Elements (Ref. [2])

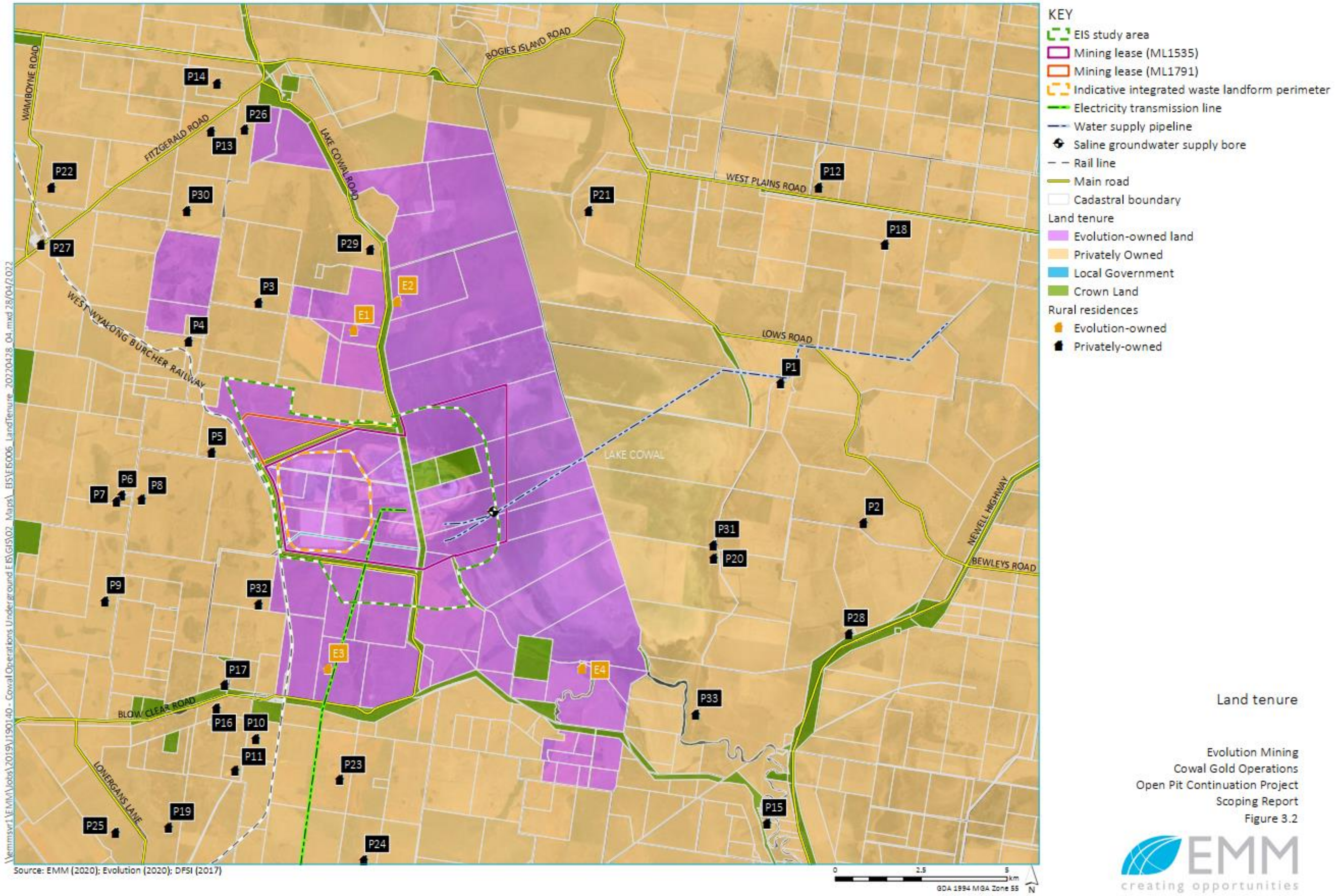

Figure 1-4: Land Tenure (Ref. [2])

1.3 Assessment requirements

This assessment has been prepared in accordance with requirements of the NSW Department of Planning and Environment (DPE). These were set out in the Secretary's Environmental Assessment Requirements (SEARs) for the Project. **Table 1-1** lists individual requirements relevant to this PHA and where they are addressed in this report.

Table 1-1: PHA Related SEARs

Requirement	Section addressed
A detailed description of the management of chemicals, concentrate and waste material and an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks, during storage, handling, transport and use of any dangerous goods.	**Section 4.0** and **Section 5.0**. Bushfire risk is directly addressed in the Bushfire Management Plan.
A Preliminary Hazard Analysis (PHA) prepared in accordance with the Hazardous Industry Planning Advisory Paper No. 6, 'Hazard Analysis' and Multi-Level Risk Assessment (DoP, 2011).	This document.

1.4 Objectives

The objectives of the PHA for the Project include:

- Complete the PHA according to the Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 – Hazard Analysis (Ref. [3]);
- Assess the PHA results using the criteria in HIPAP No. 4 – Risk Criteria for Land Use Planning (Ref. [1]); and
- Demonstrate compliance of the site with the relevant codes, standards and regulations (i.e. NSW Planning and Assessment Regulation 1979, WHS Regulation, 2017 Ref. [4]).

1.5 Scope of Services

EMM Consulting, on behalf of CGO, has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare a PHA for the Project. This document represents the PHA study for CGO Open Pit Continuation Project.

The scope of work is to complete a PHA study for the CGO Open Pit Continuation Project. The scope does not include any other assessments at the site or any other facilities.

2.0 Methodology

2.1 Multi-Level Risk Assessment

The Multi-Level Risk Assessment approach (Ref. [5]) published by the DPE, has been used as the basis for the study to determine the level of risk assessment required. The approach considered the Project in the context of its location, the quantity and type (i.e. hazardous nature) of Dangerous Goods (DGs) stored and used, and the facility's technical and safety management control. The Multi-Level Risk Assessment Guidelines are intended to assist industry, consultants and the consent authorities to carry out and evaluate risk assessments at an appropriate level for the facility being studied.

There are three levels of risk assessment set out in Multi-Level Risk Assessment which may be appropriate for a PHA, as detailed in **Table 2-1**.

Table 2-1: Level of Assessment PHA

Level	Type of Analysis	Appropriate If:
1	Qualitative	No major off-site consequences and societal risk is negligible
2	Partially Quantitative	Off-site consequences but with low frequency of occurrence
3	Quantitative	Where 1 and 2 are exceeded

The Multi-Level Risk Assessment approach is schematically presented in **Figure 2-1**.

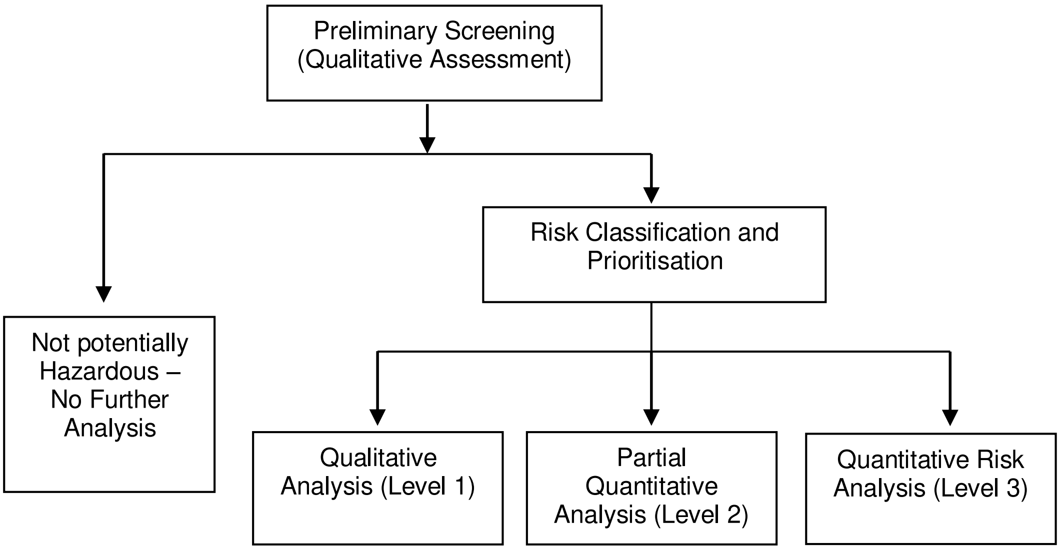

Figure 2-1: The Multi-Level Risk Assessment Approach

Based on the type of DGs to be used and handled at the proposed facility, a **Level 2 Assessment** was selected for the Project. This approach provides a qualitative assessment of those DGs of lesser quantities and hazard, and a quantitative approach for the more hazardous materials to be used on-site. This approach is commensurate with the methodologies recommended in "Applying SEPP 33" and "Multi-Level Risk Assessment" (DPE, 2011).

2.2 Risk Assessment Study Approach

The methodology used for the PHA is as follows:

Hazard Analysis – A detailed hazard identification process was conducted for the site facilities and operations. Where an incident was identified to have a potential off-site impact, it was included in the recorded hazard identification word diagram (**Appendix A**). The hazard identification word diagram lists incident type, causes, consequences and safeguards. This was performed using the word diagram format recommended in HIPAP No. 6 (Ref. [3]).

Each postulated hazardous incident was assessed qualitatively in light of proposed safeguards (technical and management controls). Where a potential offsite impact was identified, the incident was carried into the main report for further analysis. Where the qualitative review in the main report determined that the safeguards were adequate to control the hazard, or that the consequence would obviously have no offsite impact, no further analysis was performed. **Section 3.0** of this report provides details of values used to assist in selecting incidents required to be carried forward for further analysis.

Consequence Analysis – For those incidents qualitatively identified in the hazard analysis to have a potential offsite impact, a detailed consequence analysis was conducted. The analysis modelled the various postulated hazardous incidents and determined impact distances from the incident source. The results were compared to the consequence criteria listed in HIPAP No. 4 (Ref. [1]). The criteria selected for screening incidents is discussed in **Section 3.0**.

Where an incident was identified to result in an offsite impact, it was carried forward for frequency analysis. Where an incident was identified to not have an offsite impact, and a simple solution was evident (i.e. move the proposed equipment further away from the boundary), the solution was recommended, and no further analysis was performed.

Frequency Analysis – In the event a simple solution for managing consequence impacts was not evident, each incident identified to have potential offsite impact was subjected to a frequency analysis. The analysis considered the initiating event and probability of failure of the safeguards (both hardware and software). The results of the frequency analysis were then carried forward to the risk assessment and reduction stage for combination with the consequence analysis results.

Risk Assessment and Reduction – Where incidents were identified to impact offsite and where a consequence and frequency analysis was conducted, the consequence and frequency analysis for each incident were combined to determine the risk and then compared to the risk criteria published in HIPAP No. 4 (Ref. [1]). Where the criteria were exceeded, a review of the major risk contributors was performed, and the risks reassessed incorporating the recommended risk reduction measures. Recommendations were then made regarding risk reduction measures.

Reporting – On completion of the study, a draft report was developed for review and comment. A final report was then developed, incorporating the comments received, for submission to the regulatory authority.

3.0 Quantities of Dangerous Goods Stored and Handled

3.1 Quantity Summary

The classes and quantities stored at the site are summarised in **Table 3-1**. **Figure 3-1** shows the site area and indicates key hazardous material locations.

It is noted that the quantities of materials in **Table 3-1** and locations shown on **Figure 3-1** are dynamic and may change subject to the requirements of relevant AS/Code in place at the time.

Table 3-1: Maximum Classes and Quantities of Dangerous Goods Stored (Ref. [6])

Name	DG Class	Max Quantity (tonnes)	Storage Type
Sodium Cyanide	6.1	90	Fixed roof, atmospheric tank
Ammonium Nitrate	5.1	100	Dedicated storage building
Potassium Amyl Xanthate (PAX) (1)	4.2	40	Fixed roof, atmospheric tank
Diesel	C1	380	Fixed roof, atmospheric tank
Flotation Promoter	8	10	10 x 1 m^3 IBCs in reagent shed
Hydrochloric Acid	8	42	Fixed roof, atmospheric tank
Sulfamic Acid	8	1	20 kg bags in store
Caustic Soda	8	51	Fixed roof, atmospheric tank
Hydrogen Peroxide	5.1	2.3	2 x 1 m^3 IBCs for the Intensive Cyanide Leach Process
		74	Fixed roof, atmospheric tank for Caro's Acid
Sulphuric Acid	8	187	Fixed roof, atmospheric tank
Oils and Greases	C2	64	Dedicated storage tanks
Quicklime	8 (3)	200	Closed silo
Flotation Frother	3	10	10 x 1 m^3 IBCs in reagent shed
AN Emulsion	5.1	100	Storage tanks
Activated Carbon	4.2	10	Air tight bags - 1,000 L
LPG	2.1	27	Bullet
Oxygen	2.2	45	Cryogenic Tank
Sodium Nitrate	5.1	0.5	20 kg bags in plant warehouse

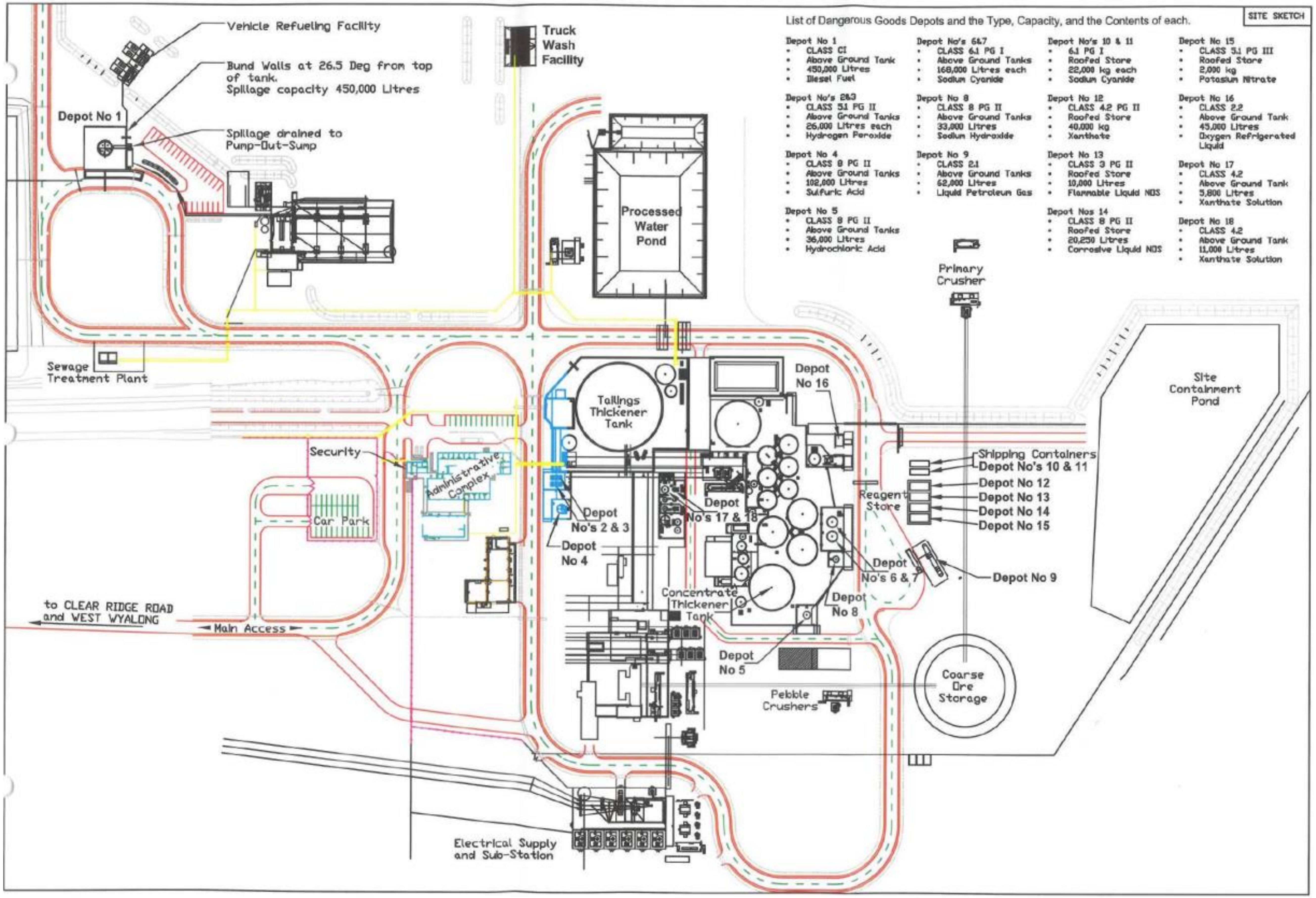

Figure 3-1: Site Area (Ref. [7])

4.0 Hazard Identification

4.1 Introduction

A hazard identification table has been developed and is presented at **Appendix A**. This table has been developed following the recommended approach in Hazardous Industry Planning Advisory Paper No. 6, Hazard Analysis Guidelines (Ref. [3]). The Hazard Identification Table provides a summary of the potential hazards, consequences and safeguards at the site. The table has been used to identify the hazards for further assessment in this section of the study. Each hazard is identified in detail and no hazards have been eliminated from assessment by qualitative risk assessment prior to detailed hazard assessment in this section of the study.

4.2 Properties of Dangerous Goods

Table 4-1 provides a description of the DGs stored and handled at the site, including the Class and the hazardous material properties of the DG Class.

Table 4-1: Properties of the Dangerous Goods and Materials Stored at the Site*

Class	Hazardous Properties
Ammonium Nitrate Solid and Emulsion	Solid AN and ANE are a Class 5.1 oxidising agent and will support combustion of other materials as AN produces oxygen as one of its decomposition products. Toxic gases such as nitrogen dioxide (NO_2) and nitrous oxide (N_2O) are also produced during decomposition of ANE. Solid AN and ANE may explode under certain conditions but does not readily explode. High temperature, confinement and contamination are the primary factors influencing the likelihood and severity of an AN or ANE explosion.
Diesel	Diesel is a combustible liquid which means that it has the potential to produce flammable vapours, which can be ignited. As a combustible liquid, diesel is not a hazardous substance unless stored in association with Class 3 flammable liquids. CGO maintains adequate separation distances in accordance with AS1940 between the CGO Mine bulk combustible liquids storages and flammable liquids storages. The Project will maintain adequate separation distances between bulk combustible liquids storages and flammable liquids storages.
LPG	LPG is stored under pressure in a liquefied state and is composed primarily of propane and butane. At ambient pressure and temperature LPG presents in the gaseous state as a flammable gas. Mixtures of LPG and air within the flammable range (LPG concentrations in air of 2.5% to 9.5%) may be ignited and explode. The resulting explosion is typically a deflagration rather than a detonation associated with high explosives. Jet fires may also result if LPG pipe or vessel fitting leaks are ignited. If the pressurised storage vessel is exposed to excessive heat a boiling liquid expanding vapour explosion (BLEVE) may result.
Flammable Liquids	Class 3 includes flammable liquids which are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc.) which give off a flammable vapour at temperatures of not more than 60°C closed-cup test or not more than 65.6°C open-cup test. Vapours released may mix with air and if ignited, at the right concentration, will burn resulting in pool fires at the liquid surface.

Class	Hazardous Properties
Toxic Substances	Substances liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact. Releases may cause damage to sensitive receptors within the environment.
Corrosive Substances	Class 8 substances (corrosive substances) are substances which, by chemical action, could cause damage when in contact with living tissue (i.e. necrosis), or, in case of leakage, may materially damage, or even destroy, other goods which come into contact with the leaked corrosive material. Releases may cause damage to sensitive receptors within the environment.

* The Australian Code for the Transport of Dangerous Goods by Road and Rail (Ref. [8])

4.3 Hazard Identification

Based on the hazard identification table presented in **Appendix A**, the following hazardous scenarios have been developed:

- AN fire and explosion.
- Diesel tank pool fire.
- AN Decomposition and Toxic Gas Dispersion.
- LPG Release, Ignition and Jet Fire, Flash Fire, Explosion or BLEVE.
- Sodium Cyanide related incident.
- Potentially Contaminated Water from Firefighting Activities.

Each identified scenario is discussed in further detail in the following sections.

4.4 AN Fire and Explosion

The site stores a maximum of 100 tonnes of solid AN in the form of prill, and 100 tonnes of of ANE. If radiant heat from a fire (i.e. bushfire or vehicle fire) were to impinge on the AN bins or ANE tanks, there is the potential that the AN could decompose, ignite and explode. An explosion of this quantity of AN could have major impacts to the plant and personnel in the area.

To prevent any fires from impinging on the storage bins, several hundred metres of clearance to any combustible materials, including grass, trees and other DG stores has been intentionally provided. Hence, in the event of a nearby bushfire, it would be expected that the fire would burn itself out prior to contacting the AN or reaching anywhere nearby. Additionally, the bins are protected by fire extinguishers and hose reels so any fire within the area would be readily extinguished prior to contacting the AN.

The potential for sympathetic detonation of the ANE storage tanks upon detonation of the AN storage bins was considered, and vice versa. However, separation distance has been provided between the nearest AN storage bin and ANE tanks. There is no sufficient evidence within the literature to indicate that sympathetic detonation will occur across such distances and involving non-heated products. Additionally, due to the controls discussed further below, the simultaneous, independent detonation of all of these products is not considered credible.

It is noted that relocation of the AN and ANE processes at the site is the most significant change within the concerned Modification. However, this relocation has not been determined to increase the associated risks, nor introduce additional hazards that have not already been addressed.

Additionally, the risks associated with AN and ANE storage have been thoroughly discussed and assessed in the Hazardous Materials Management Plan (Ref. [9]) developed for the site, as well as the Hazard Audit Report and several HAZOP's. Hence, this scenario has not been carried forward for further analysis.

4.5 Diesel Tank Pool Fire

Diesel is stored in above-ground tanks which are either integrally bunded (i.e. double-skinned) or situated within bunds. These tanks are of various volume throughout the site and the diesel is used to fuel the equipment on site and within blasting recipes. Diesel is not a flammable liquid but a combustible liquid; hence, it is difficult to ignite. However, if it is exposed to an ignition source for a prolonged period of time then it may ignite and will sustain combustion.

The potential for diesel to spill externally to the tanks is extremely low due to several tanks being double walled and other diesel tanks being located within dedicated bunds. The stores are also compliant with the requirements of AS 1940:2017 (Ref. [10]) and AS 1692:2006 (Ref. [11]). The potential for the two walls of a tank to fail simultaneously is low to the point of being negligible as the tanks are protected from physical damage; hence, the potential for a catastrophic release is not considered to be credible. Additionally, the tanks are protected from vehicular impact by bollards.

There is the potential for minor leaks and releases to occur above ground during filling from pipework connections; however, these would be minor (i.e. <100 L) and could easily be cleaned up by the operator using spill kits included on the delivery tankers. As there would always be an operator present when a minor spill occurred, even if the spill did ignite, it would result in a small fire which could be readily combatted by site personnel using first attack firefighting equipment (fire extinguishers and hose reels). Therefore, this incident does not require further analysis as it does not pose a significant risk of propagation or equipment damage.

4.6 AN Decomposition and Toxic Gas Dispersion

In the event AN is impacted by excessive radiant heat, it may begin to decompose resulting in the release of noxious products (i.e. oxides of nitrogen). Noxious products are toxic and thus they may result in downwind impacts. However, this scenario will only occur in the event of a substantial fire as excessive radiant heat exposure would be unlikely to occur under normal operation.

It will be necessary to ensure first responders are not impacted by noxious products that may be produced in the event of an incident. A noxious detection system would likely be unreliable as it would be sized for a decomposition event which may not occur under conditions which may vary substantially from those observed at the site. Therefore, it should be conservatively assumed that toxic gases are present when a fire occurs at the site.

However, the site procedures outline the response to any significant fire scenario of immediate evacuation to an acceptable distance. Based on this response, it is considered that the risks posed by toxic by-products of combustion are sufficiently managed. Hence, this incident has not been carried forward for further assessment.

4.7 LPG Release, Ignition and Jet Fire, Flash Fire, Explosion or BLEVE

LPG is stored in large "bullet" tanks throughout the site. As the site LPG is depleted, it will be refilled by a delivery tanker at the site. During loading of the tank there is the potential for the hose to rupture which may be the result of a puncture of the hosing or deterioration through general wear and tear. It has been assumed the hoses are inspected monthly and pressure tested annually in accordance with the Australian Dangerous Goods Code (ADG, Ref. [12]).

Notwithstanding this, there is the potential for a hose to become damaged between inspection and test periods which may lead to sufficient deterioration resulting in a hose rupture when transferring pressurised LPG. Excess flow and non-return valves will isolate the flow of LPG; however, if these fail in addition to a hose rupture, LPG will be released resulting in an LPG vapour cloud. The operator may be able to respond and isolate the LPG transfer by activating an emergency stop button located on the tanker.

If the operator is incapacitated or unable to stop the transfer, the LPG will continue to flow developing a substantial cloud which may contact an ignition source and ignite which would result in a flash fire or explosion which would burn back to the release point and subsequent jet fire. It is noted the area is unconfined; hence, an explosion is unlikely to occur and would likely result in a flash fire.

The potential for a fatality to occur as a result of a flash fire is not considered credible as the mechanism for a fatality to occur from a flash fire is via combustion of flammable vapours at head height which results in oxygen within the lungs being consumed as the fuel burns. The impacted person will involuntarily inhale, as low oxygen is detected, resulting in inhalation of hot combustion products which burn the sensitive lining of the lungs. As LPG is a dense gas, any release will spread along at ground level and due to the open nature of the site it will not accumulate to a level where a person offsite will be fully engulfed; hence, a fatality is unlikely to occur.

Similarly, an explosion is only likely to occur if the LPG release is confined, which is not the case in this instance.

Similarly, to the scenario described above, a hose may rupture resulting in a jet fire. If this jet fire were aimed at the delivery tanker, the tanker shell would begin to heat, transferring the heat into the LPG within the tank which would begin to vaporise and increase the pressure within the tanker. At the design pressure of the tank, the pressure relief valve will begin to lift to relieve pressure within the tanker.

As the liquid level within the tanker drops, the impact zone of the jet fire may impact the vapour space in the tanker. The vapour will absorb less energy than the liquid which will result in localised heating of the tanker shell at the point of the jet fire impact. This may compromise the structural integrity of the tanker shell which may rupture resulting in a blast overpressure as the vessel fails and formation of an LPG vapour cloud which may also ignite resulting in a vapour cloud explosion known as a Boiling Liquid Expanding Vapour Explosion (BLEVE). A similar scenario may occur within the tank itself.

Despite the risks associated with the storage and potential release of LPG, the incidents described above are not expected to impact over the site boundary due to the size of the site and its purpose. LPG impacts are also not anticipated to result in propagation; hence, this incident has not been carried forward for further analysis.

4.8 Sodium Cyanide Related Incident

Cyanide is received as briquettes in sparging isotainers. The site contains a single cyanide mix tank that can store two isotainers as a 28% solution. The cyanide mix tank is equipped with a pump that can circulate from the mix tank into the isotainer and back to the mix tank. When the briquettes have been completely dissolved, a valve allows the sparging pump to remove solution from the bottom of the isotainer and transfer it to the mix tank. The 28% cyanide solution is then transferred to a cyanide day tank from which it is delivered to the process via a circulating loop.

It is noted that hydrogen cyanide is a product of decomposition from sodium cyanide. Hydrogen cyanide is a flammable gas. However, as the acute toxicity effects of hydrogen cyanide present significant hazards then the likelihood of hydrogen cyanide formation to levels where combustion can occur is low as risk controls/evacuation procedures will have been activated prior to combustion concentrations being reached. This is due to the nature of the process (i.e. the slurry has relatively low sodium cyanide levels) and hydrogen cyanide analysers will be positioned throughout the plant to alert the operators of potential toxic impact (TLV is 5 mg/m^3, i.e. well below the concentrations for flammable concerns).

Incidents relating to sodium cyanide and the potential release of hydrogen cyanide gas have been investigated in the Transport of Hazardous Materials Study previously prepared for this site. Additionally, a dedicated Cyanide Management Plan (Ref. [13]) has been prepared in response to the specific Development Consent Conditions concerning Cyanide management.

Associated risks have been thoroughly discussed and assessed in that document and hence, this scenario has not been carried forward for further analysis.

4.9 Potentially Contaminated Water from Firefighting Activities

It is noted that the preferred strategy for emergency response at the site is evacuation due to the high potential for incident escalation which may result in an explosion and could have far reaching impacts. However, there may be several incidents that could occur on site that won't immediately result in an escalation event (i.e. fuel oil fire, grass land fire) and it may be prudent to combat these incidents to prevent an escalation. Should these incidents occur, it will be necessary to apply water to control and suppress the fires.

During combustion there are a range of combustion products generated with several of these being toxic (i.e. poly aromatic hydrocarbons). As water is applied, it may become contaminated by these products which will be transported by the water flow. Should the water be discharged from the site there is the potential for an environmental incident, in addition to any liquid effluent (i.e. fuel oil) being transported with the water.

The site is located in a 'water management system' which means that no runoff from firefighting activities or other water uses is permitted to leave the site boundaries. However, the storage areas are not located near a site boundary and so water is expected to remain entirely on site.

The volume of firewater which may be potentially contaminated would be assumed to be from fighting a small fire as large events require evacuation. Hydrants connected to the fire mains are available around infrastructure areas. Fire hoses are also supplied by water storage tanks. Notwithstanding, all firewater will remain onsite. Hence, this scenario has not been carried forward for further analysis.

5.0 Consequence Analysis

5.1 Incidents Carried Forward for Consequence Analysis

No incidents were identified to have the potential to propagate an incident or significantly damage equipment at the site beyond those that have been identified, assessed and addressed in **Section 4.0** or supplementary reports.

6.0 Conclusion and Recommendations

6.1 Conclusions

A hazard identification table was developed for the Project to identify potential hazards that may be present at the site as a result of operations or storage of materials. Based on the identified hazards, scenarios were postulated that may result in an incident with the potential for offsite impacts. Postulated scenarios were discussed qualitatively and any scenarios that would not impact offsite were eliminated from further assessment. Scenarios not eliminated were then carried forward for consequence analysis. Per the SEARs, the handling and storage of dangerous goods are assessed in this PHA.

The consequence analysis identified that there would be no incidents originating from the site which would result in offsite impacts; hence, the potential for fatality or injury or environmental impacts to occur would be negligible. As the potential for offsite impacts is low to the point of negligibility, it is considered that the acceptable risk criteria published in HIPAP No. 4 (Ref. [1]) would not be exceeded and that the development would be appropriate for the proposed land use.

It is noted that CGO has multiple existing processes and procedures surrounding hazardous chemical handling and related auditing, i.e. environmental and hazard audits. The Hazardous Materials Management Plan and Cyanide Management Plan both thoroughly assess the risks posed by chemicals at the site to an extent that far exceeds the requirements of HIPAP No. 4, and this is due to the many years of experience in handling chemicals at this site.

Additionally, this Project will not result in changes to existing processes and DG handling quantities at the site, and so no change in the risk profile with respect to hazardous chemicals is expected.

6.2 Recommendations

Notwithstanding the conclusions following the analysis of the site, the following recommendations have been made:

- Necessary documentation associated with the storage of DGs under the Work Health and Safety Regulation 2011 shall be completed (i.e. risk assessment, register, notification, etc.).

7.0 References

[1] Department of Planning, "Hazardous Industry Planning Advisory Paper No. 4 - Risk Criteria for Land Use Safety Planning," Department of Planning, Sydney, 2011.

[2] EMM Pty Ltd, "CGO Open Pit Continuation Project Scoping Report," EMM Pty Ltd, NSW, 2022.

[3] Department of Planning, "Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis," Department of Planning, Sydney, 2011.

[4] SafeWork NSW, "Work Health and Safety Regulation," SafeWork NSW, Lisarow, 2017.

[5] Department of Planning, Multi-Level Risk Assessment, Sydney: Department of Planning, 2011.

[6] Pinnacle Risk Management, "CGO Final Hazard Analysis," Pinnacle Risk Management, NSW, 2006.

[7] Pinnacle Risk Management, "Hazard Audit Report for Evolution Mining Cowal Gold Operations NSW," Pinnacle Risk Management, NSW, 2022.

[8] National Transport Commission (NTC), "Australian Code for the Transport of Dangerous Goods by Road & Rail, 7th Edition," 2011.

[9] Evolution Mining, "CGO Hazardous Materials Management Plan," Evolution Mining, NSW, 2020.

[10] Standards Australia, AS 1940:2017 - Storage and Handling of Flammable and Combustible Liquids, Sydney: Standards Australia, 2017.

[11] Standards Australia, "AS 1692-2006 - Steel tanks for flammable and combustible liquids," Standards Australia, Sydney, 2006.

[12] Road Safety Council, The Australian Code for the Transport of Dangerous Goods by Road and Rail Edition 7.4, Canberra: Road Safety Council, 2016.

[13] Evolution Mining, "CGO Cyanide Management Plan," Evolution Mining, NSW, 2020.

[14] Pinnacle Risk Management, "CGO Fire Safety Study," Pinnacle Risk Management, NSW, 2004.

Appendix A

Hazard Identification Table

A1. Hazard Identification Table

No.	Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
1	Fire in the processing plant area	• Electrical cable/equipment failure • Corrosive reaction, e.g. hydrogen peroxide with combustible materials • Failure of LPG piping systems • Loss of level in the carbon quench tank with subsequent ignition of the activated carbon • Loss of containment of thermal oil for the elution heater or frother (a DG Class 3 material) • Lightning • Hot work permit breach	• Products of combustion • Smoke logging • Propagation to the LPG piping causing further explosion / fire • Failure of polyethylene product piping • Damage to electrical / instrument cables • Contaminated fire water • Loss of production and business interruption • Potential for injury to personnel • Propagation of fire by rubber lining in chutes and piping • Propagation of fire by conveyor belting	• Yard hydrants (as required by AS 2419) • Hose reels (as required by AS 2441) • Portable extinguishers (as required by AS 2444) • Break glass alarms (as required by AS 1670) • Audible and visual alarms (as required by AS 1670) • Automatic and operator-controlled plant shutdowns • Provision of SCBA and protective chemical suits • Trained fire emergency response team and fire tender • All plant and equipment connected to earthing grid • Sprinklers fitted to the elution heater oil reservoirs, mills and crusher lubrication systems (and compressors where applicable) • Containment dams for contaminated fire water • Designated smoking areas & site security

No.	Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
		• Smoking and careless discarding of cigarette butts • Arson		
2	Explosion in the carbon regeneration kiln	• LPG valves leak and an explosive mixture is ignited within the kiln at start-up	• Damage to the kiln and nearby equipment • Potential for injury to personnel • Potential for missiles to be formed	• The burner management system is to comply with the AGA requirements, including the need for a pre-start-up air purge step before ignition
3	Explosion due to hydrogen formed by metal reaction with reagents such hydrochloric or sulphuric acid	• Hydrogen accumulates in tank top and ignites	• Internal explosion within a tank • Tank damage, potential for missiles and injury to personnel	• All atmospheric reagent tanks have high point vents which will allow gases such as hydrogen to disperse
4	Enhanced oxygen combustion of steel / polymers	• Particle impingement • Adiabatic heat of compression • Impurities, e.g. hydrocarbons	• Oxygen fire (rapid combustion of steel / polymer etc) • Potential to injure personnel close to point of ignition	• Oxygen system to be designed to comply with CGA oxygen standards • Piping, valving etc to be installed and kept clean for oxygen service • Oxygen purity specification
5	Clothing saturated with oxygen	• Maintenance work or equipment purging	• Clothing that is saturated with oxygen can readily ignite	• Training and procedures for the safe handling of oxygen. Cotton clothing

No.	Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
6	Explosion in the xanthate mixing or storage tanks	• Carbon disulphide evolved due to mixing with water	• Internal explosion within a tank • Tank damage, potential for missiles and injury to personnel	• Tanks have high point vents which will allow gases such as carbon disulphide to disperse (i.e. not accumulate) • Historically, no incidence of this type recorded. • Tanks installed with hazardous area review to AS 2430
7	Fires at electrical substations and MCCs	• Electrical cable/equipment failure • Radiant heat from adjacent structures • Overheating from ventilation system failure • Lightning • Hot work permit breach • Smoking and careless discarding of cigarette butts • Arson	• Products of combustion • Smoke logging • Contaminated fire water • Corrosion damage to electrical equipment and structure from PVC fires • Loss of production and business interruption • Potential injury to personnel	• As per Item Number 1 plus: • Early warning smoke detection (as required by AS 1670) • Gaseous fire suppression for the SAG and ball mills MCCs, i.e. critical areas (as required by AS 4214) • Cable coating at entry points (up to 3 metres where applicable)
8	Explosions associated with ammonium nitrate (AN) or detonators	• Heating AN whilst confined • Impurities in the AN, e.g. hydrocarbons	• Explosion with potential for injury to personnel and damage to equipment	• Explosives for mining stored and handled as per the requirements of the mining regulations. • The explosives are stored in purpose-built storehouses away from other plant and equipment

No.	Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
		• Stray electrical currents. • Sympathetic detonations • RF interference		
9	Conveyor fires	• Electrical cable/equipment failure • Friction on conveyor belt caused by idler and pulley failures • Belt slippage • Electrical drive and gearbox failures • Brake overheating • Lightning • Hot work permit breach • Smoking and careless discarding of cigarette butts • Arson	• Structural failure of conveyor • Spread of fire to adjacent conveyor systems • Products of combustion • Smoke inside conveyor tunnels • Contaminated fire water • Loss of production and business interruption • Potential for injury to personnel	• As per Item Number 1 plus: • Wet pipe sprinklers (AS 2118 and Factory Mutual Data Sheet 7-11). Sprinkler protection for all elevated and inclined conveyors. Protection of ground conveyors would be by hydrants • Manual belt stop systems

No.	Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
10	Crusher / grinding machinery and compressor fires	• Electrical cable/equipment failure • Hydraulic oil system failures or overheating (e.g. for the lubricators) • Lightning • Hot work permit breach • Smoking and careless discarding of cigarette butts • Arson	• Smoke logging • Radiant heat risk to igniting adjacent plant • Rupture of pressurized oil lines and accumulators causing fire spread • Loss of production and business interruption • Potential for injury to personnel	• As per Item Number 1 plus: • Locate large oil reservoirs in rooms with 2h fire rating • Good housekeeping practices and preventative maintenance procedures
11	LPG bullet fire	• Ignition of leaking gas from a hole in the vessel or piping • Impact from a vehicle • Excavation damaging underground pipe • Lightning • Hot work permit breach	• Potential for a BLEVE (boiling liquid expanding vapour explosion) • Jet fire, flash fire or vapour cloud explosion • Radiant heat risk to adjacent plant • Potential for loss of life • Loss of production and business interruption	• As per Item Number 1 plus: • Continuous welded piping systems (where possible) • Use of underground services drawing when excavating • The LPG bullet is separated from the processing plant

No.	Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
12	Fire / explosion of the main electrical substation transformer	• Electrical cable/ equipment failure/ short circuit • Transformer overheating • Moisture ingress • Lightning • Hot work permit breach	• Explosion • Radiant heat risk to igniting substation • Rupture of transformer body • Contaminated fire water • Loss of all site electrical power resulting in production and business interruption • Potential for injury to personnel	• As per Item Number 1 plus: • In-built fire monitoring equipment • 2hr fire wall between transformer and switch room • Transformer bunding • Routine transformer and oil testing • Backup diesel generator
13	Fire at the diesel storage tank area	• Loss of containment of diesel due to tank overfilling, pump failure, pipe failures, bowser/hose failures • Ignition from a strong source, e.g. lightning	• Pool fire with products of combustion, radiant heat, potential for injury to personnel, damage to nearby equipment and contaminated fire water can occur	• As per Item Number 1 plus: • Tank bunding • Separation from plant areas • Note that combustible liquids have a low probability of ignition
14	Fire in the main electrical cable tunnel	• Electrical cable/equipment failure • Hot work permit breach	• Smoke logging • Toxic / corrosive fire by-products • Radiant heat risk to igniting adjacent plant areas • Loss of production and business interruption	• As per Item Number 1 plus: • Wet pipe sprinklers (AS 2118)

No.	Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
		• Smoking and careless discarding of cigarette butts • Arson	• Potential for injury to personnel	
15	Fire in the electrowinning and gold room	• Electrical cable/equipment failure or furnace / rectifier failure • Hot work permit breach	• Smoke logging • Loss of production and business interruption • Potential for injury to personnel	• As per Item Number 1
16	Cyanide mixing tank fire	• When decommissioning the cyanide mixing tank, the sludge may dry out and ignite due to the presence of carbides	• Internal tank fire	• As per Item Number 1 plus: • Tank cleaning procedures • Cyanide Management Plan (Ref. [13])
17	Bushfires	• Lightning strike • Deliberate act • Smoking and careless discarding of cigarette butts	• Destruction of the bush • Flying embers • Smoke	• As per Item Number 1 plus: • Safe distance between the processing operations and the nearby vegetation
18	Aircraft crash	• Pilot error • Bad weather • Plane fault	• Propagation to equipment damage and fires	• Site is not under a major flight path, hence the likelihood of impact is very low

No.	Area/Operation	Hazard Cause	Hazard Consequence	Safeguards
			• Impact to people, property and the environment (products of combustion)	
19	Earthquakes	• Earthquakes	• Loss of containment leading to a fire if ignited (as above)	• The plant is built AS 1170 to resist the combined effects on internal pressure due to contents, weight of platforms, ladders, live loads, wind loads, earthquake forces and hydrostatic test loads
20	Breach of Security / Sabotage	• Disgruntled employee or intruder	• Possible fire events with consequences as per above	• Security measures include fencing, CCTV, security patrols and operator vigilance • Process computer alarms monitored