Part 4
Hazard Analysis of Dangerous Goods

State Significant Development No. 5765

Prepared by:

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Hazard Analysis of Dangerous Goods

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COMMONLY USED ACRONYMS

ADGC	Australian Dangerous Goods Code
AEP	Annual Exceedance Probability
AN	Ammonium Nitrate
ANE	Ammonium Nitrate Emulsion
ANFO	Ammonium Nitrate Fuel Oil
DG	Dangerous Goods
DoP	(NSW) Department of Planning
DPE	(NSW) Department of Planning and Environment
EIS	Environmental Impact Statement
EPL	Environment Protection Licence
GHS	Globally Harmonised System
HIPAP	Hazardous Industry Planning and Advisory Paper
LGA	Local Government Area
MIBC	Methyl Isobutyl Carbinol
NaCN	Sodium Cyanide
NEQ	Net Explosive Quantity
NOx	Nitrogen oxides
NSW	New South Wales
PG	Packing Group
PHA	Preliminary Hazard Analysis
ROM	Run-of-mine
RWC	R.W. Corkery & Co Pty Ltd
SDS	Safety Data Sheet
SEARs	Secretary’s Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
TNT	Trinitrotoluene
TSF	Tailings Storage Facility
WAD	Weak acid dissociable (cyanide)
WHS	Work Health and Safety
WRE	Waste Rock Replacement

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EXECUTIVE SUMMARY

Bowdens Silver Pty Limited (Bowdens Silver) intends to submit an Environmental Impact Statement (EIS) to obtain development consent to develop and operate an open cut silver mine within an area named the “Mine Site” in this report, 2km to 3km northeast of Lue, NSW. The EIS is being prepared for Bowdens Silver by R.W. Corkery & Co. Pty Limited (RWC).

Sherpa Consulting Pty Ltd (Sherpa) was engaged by RWC to undertake a hazard analysis covering the proposed use of Dangerous Goods (DG) for the Project and prepare a report for inclusion in the EIS.

The analysis covers three activities which are reported in this combined report as follows:

- State Environmental Planning Policy 33 – Hazardous and Offensive Development (SEPP 33) Screening Study
- Preliminary Hazard Analysis (PHA)
- Hazardous Material Transport Route Evaluation Study

SEPP 33 Screening:

A SEPP 33 screening was carried out using *Hazardous & Offensive Development Application Guidelines – Applying SEPP 33 (Ref* [1]*).*

This screening determined that sodium cyanide and Class 5.1 Ammonium Nitrate (AN) based blasting agents proposed to be used and potentially stored on the Mine Site exceeded the SEPP 33 screening thresholds and a Preliminary Hazard Analysis (PHA) was therefore required to be included in the EIS. No other DGs were identified as requiring assessment in the PHA.

The SEPP 33 screening process also identified that a hazardous materials transport route evaluation study was required only for trucks carrying sodium cyanide. All other transport movements of DGs are well below SEPP 33 transport screening thresholds.

Preliminary Hazard Analysis (PHA):

A PHA has been prepared in accordance with *Hazardous Industry Planning Advisory Paper No. 6 Hazard Analysis* (Ref [2]) and *Multi-Level Risk Assessment* (Ref [3]). The analysis included the following steps:

- Identification of hazards and description of potential incident scenarios.
- Analysis of the consequences of these incidents on the biophysical environment and people off site.
- Comparison of risk levels with relevant risk criteria as detailed in *Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning (Ref* [4]*)*.

Due to the limited quantities of DGs and large separation distances to the Mine Site boundary from their points of storage/use, a qualitative analysis has been selected for this study, supplemented by quantitative consequence modelling for blasting agents only. This approach is known as a Level 2 risk assessment.

Hazardous Materials Transport Route Evaluation:

A route evaluation for sodium cyanide transport has been prepared in accordance with *Hazardous Industry Planning Advisory Paper No. 11 Route Selection;* (Ref [5])

Findings:

Sodium cyanide solution would be stored in a dedicated area in the processing plant with containment, bunding and large separation distances (>300m) to the Mine Site boundary. Solid cyanide would be delivered to site in a purpose-built sparge isotainer and a solution made up via a closed and automated dissolution process, minimising exposure risk to cyanide. Very few materials are proposed for use that are incompatible with cyanide. Therefore, a potential spill of sodium cyanide in the processing plant is very unlikely to have any significant effects that could extend off site.

Blasting agents (AN based) would be brought on site as required on each blast day, mixed on site, and transferred to pre-drilled holes. The explosives would be used with large separation distances to the Mine Site boundary complying with AS 2187.1 *Explosives – Storage, transport and use – Storage*. Consequence modelling has confirmed these controls are adequate. Overnight storage on site could occur on rare emergency situations. In this case, the explosive supplier would adopt their standard safety procedures.

Qualitative analysis of the risk of potential off-site safety effects to surrounding land uses or environmental effects to surrounding ecosystems from hazardous materials indicates that all qualitative environmental and land use safety risk criteria identified in *Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning* are met by the Project, and accordingly the risk has been assessed as being very low.

The transport route of sodium cyanide from Mudgee to the Mine Site was assessed as a low risk to the biophysical and human environment as:

- cyanide would be transported in solid (rather than liquid) form in purpose-built iso sparge isotainers and the cyanide solution made up on site.
- road quality is suitable for heavy vehicles and no specific risk factors leading to higher than average accident rates were identified;
- transport would occur using DG licensed vehicles and DG licensed drivers in accordance with the Australian Dangerous Goods Code (ADGC); and
- cyanide manufacturers in Australia (e.g. Orica) are signatories to the *International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide* and their cyanide transporters are certified as compliant with the Cyanide Code's Principles and Transport Practices.

Recommendations

The hazard analysis has been based on the proposed Mine Site layout. It is therefore recommended that:

- the proposed storage and use locations of sodium cyanide and blasting agents (AN based) are reviewed upon finalisation of the design to ensure that the >300m separation distances to the Mine Site boundary and to incompatible materials are maintained.
- bunding and containment structures for sodium cyanide meet the requirements of the relevant Australian Standard, AS NZS 4452 *The storage and handling of toxic substances.*

No specific recommendations are made as a result of the route evaluation of sodium cyanide transport against Hazardous Industry Planning and Advisory Paper (HIPAP) 11 factors.

1. INTRODUCTION

1.1 BACKGROUND

Bowdens Silver Pty Limited (Bowdens Silver), a Company owned by Silver Mines Limited, intends to submit an Environmental Impact Statement (EIS) to obtain development consent under the *Environmental Planning and Assessment Act 1979* (EP&A Act) to develop and operate an open cut silver mine within an area named as the "Mine Site" in this report) 2km to 3km northeast of Lue, NSW (named the "Project" in this report).

The Mine Site is located approximately 26km east of Mudgee within the Mid-Western Regional Local Government Area (LGA). The Project involves a conventional open cut mine including a waste rock emplacement (WRE), tailings storage facility (TSF), ore stockpiles, processing plant, and other ancillary infrastructure including the relocated Maloneys Road.

R.W. Corkery & Co. Pty Limited (RWC) has been commissioned by Bowdens Silver to prepare the EIS and has assembled a team of specialist consultants to assist in the assessment of various environmental issues associated with the Project.

1.2 STUDY REQUIREMENT

The Secretary's Environmental Assessment Requirements (SEARs) for the Project and requirements nominated by other government agencies relating to hazards are listed in **Table 1** together with the relevant section of this document where each requirement is addressed.

Table 1
Coverage of SEARs and Other Government Agency Requirements

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Relevant Requirement(s)		**Coverage in Report**
Secretary's Environmental Assessment Requirements		
The EIS must address the following specific issues: • **Hazards** - including an assessment of the likely risks to public safety, paying particular attention to the handling and use of any dangerous goods, having regard to the EPA's requirements.		This report
Relevant Requirements Nominated by Other Government Agencies		
Environment Protection Authority 14/05/19	The EIS should include details of chemicals, including fuel, used on the site and proposed methods for their transportation, storage, use and emergency management.	Sections 2, 3 and 4
	Provide details of the types and quantity of any chemical substances, including but not necessarily limited to, hydrocarbons (oils and fuels), hazardous or dangerous materials (e.g. explosives etc.) to be used or stored onsite.	Sections 2.4 and 2.5

Table 1 (Cont'd)
Coverage of SEARs and Other Government Agency Requirements

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Relevant Requirement(s)		**Coverage in Report**
Relevant Requirements Nominated by Other Government Agencies (Cont'd)		
Environment Protection Authority 14/05/19 (Cont'd)	Provide details of procedures for the assessment, handling, storage, transport and disposal of all chemical substances, hazardous or dangerous materials used, stored, processed or disposed of at the site, in addition to the requirements for liquid and non-liquid wastes.	Summarised in Table 6 for hazardous material storage. Wastes refer to EIS Section 2.14
	Outline pollution control measures relating to storage of wastes, materials, possibility of accidental spills (e.g. Preparation of contingency plans), appropriate disposal methods and management of contaminated stormwater.	Summarised in Table 6 for hazardous material storage. Stormwater refer to EIS Section 4.7
Mid-Western Regional Council 14/02/13	Assess the potential impact and any required mitigation procedures for the transportation of hazardous materials along the proposed haulage routes.	Section 4

Sherpa Consulting Pty Ltd (Sherpa) was engaged by RWC on behalf of Bowdens Silver to undertake the hazard analysis component of this requirement covering the proposed use of Dangerous Goods (DG) for the Project. The analysis covers three stages which are reported in a combined report as follows:

- SEPP 33 Screening Study (Section 2 of this report)
- Preliminary Hazard Analysis (Section 3 of this report)
- Hazardous Material Transport Route Evaluation Study (Section 4 of this report)

1.3 SCOPE

The hazard assessment report addresses potential off-site acute impacts associated with the proposed storage and use of DG only.

1.4 DESCRIPTION OF THE PROJECT

1.4.1 Mine Site Location and Surrounding Land Uses

The Mine Site is located approximately 2km to 3km northeast of Lue (**Figure 1**). Land uses surrounding the Mine Site include:

- rural residential; and
- agriculture.

'Sensitive land uses' in the context of the PHA as per HIPAP 6 include people who may be exposed to safety impacts of abnormal or emergency events and may be difficult to manage in this type of event, e.g. people in schools, hospitals and aged care facilities.

There are no identified sensitive land uses in the vicinity of the Mine Site. The nearest sensitive land uses are in Lue at least 2km away from the closest activity within the Mine Site.

The nearest "suburban" residential use is located in Lue, i.e. approximately 2km from the closest activity within the Mine Site and 3km from the processing plant area as shown in **Figure 2**. There is scattered rural residential housing around the Mine Site as shown in **Figure 1,** with the nearest privately-owned residences >1km from processing or blasting areas.

1.4.2 Mine Site Layout

The seven principal components within the Mine Site are:

i) a main open cut pit and two satellite open cut pits, collectively covering approximately 52ha;

ii) a processing plant and related infrastructure covering approximately 22ha;

iii) a waste rock emplacement (WRE) covering approximately 77ha;

iv) a low grade ore stockpile covering approximately 14ha (9ha above WRE)[1];

v) an oxide ore stockpile covering approximately 8ha;

vi) a tailings storage facility (TSF) covering approximately 117ha; and

vii) the southern barrier to provide visual and acoustic protection to properties south of the Mine Site covering approximately 32ha.

The processing area incorporates the processing plant and the DG storage and handling area, i.e. the reagents storage area. The indicative layout for the processing area is presented in **Figure 3**. The processing area is located more than 300m from the nearest Mine Site boundary.

1.4.3 Extraction and Processing Overview

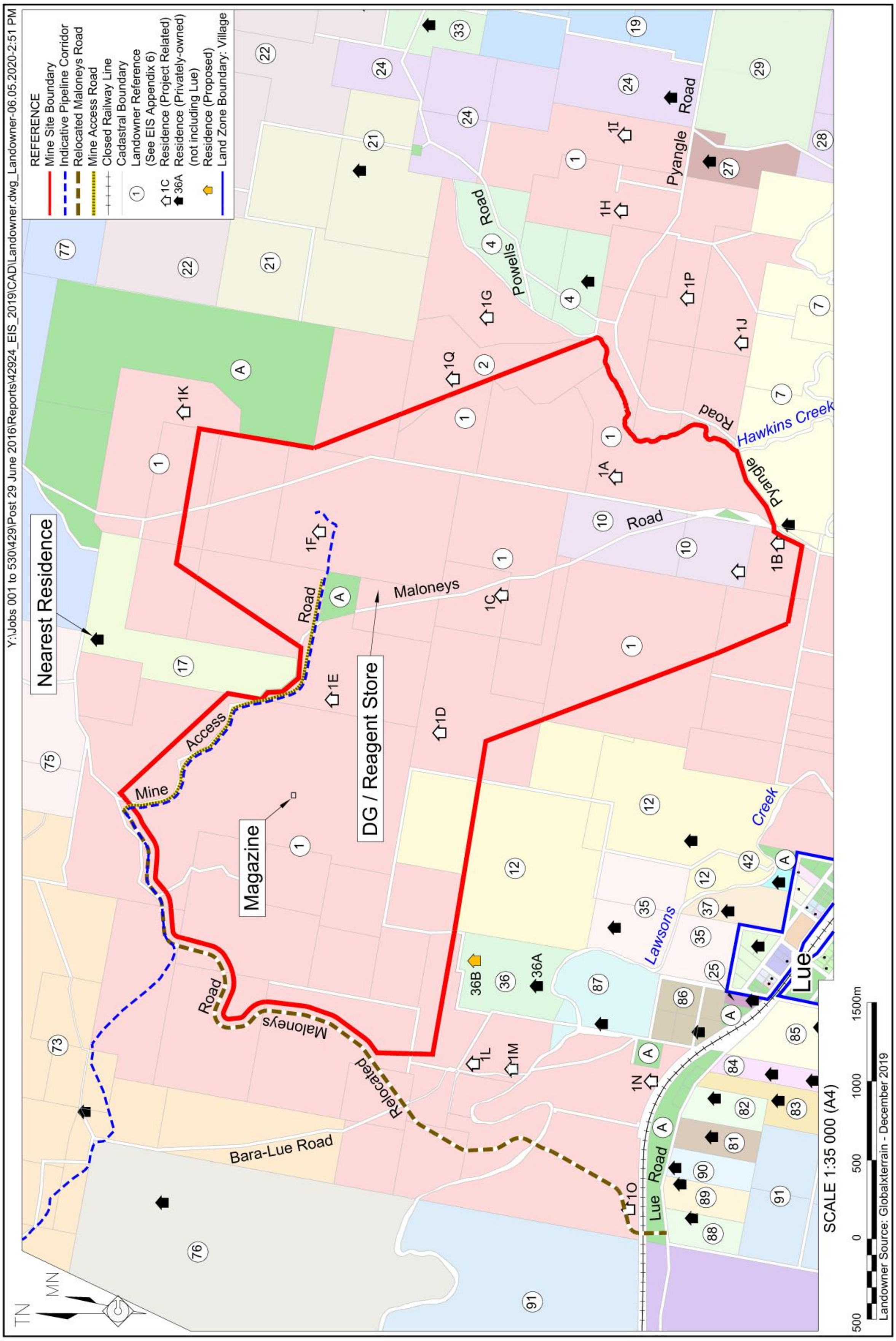
Ore would be extracted from the open cut pits and processed to produce two mineral concentrates:

- a silver/lead concentrate; and
- a zinc concentrate (with a small content of silver).

Drill and blast methods would be used to fragment material that cannot be excavated using a bulldozer or excavator alone. The blasting operation would use a blasting agent.

[1] The low grade ore stockpile would be constructed adjacent to but largely upon the northern sections of the WRE.

Figure 1 Rural Residential Housing Around the Mine Site



Note: Approximate locations of storages only

Figure 2 Mine Site Layout

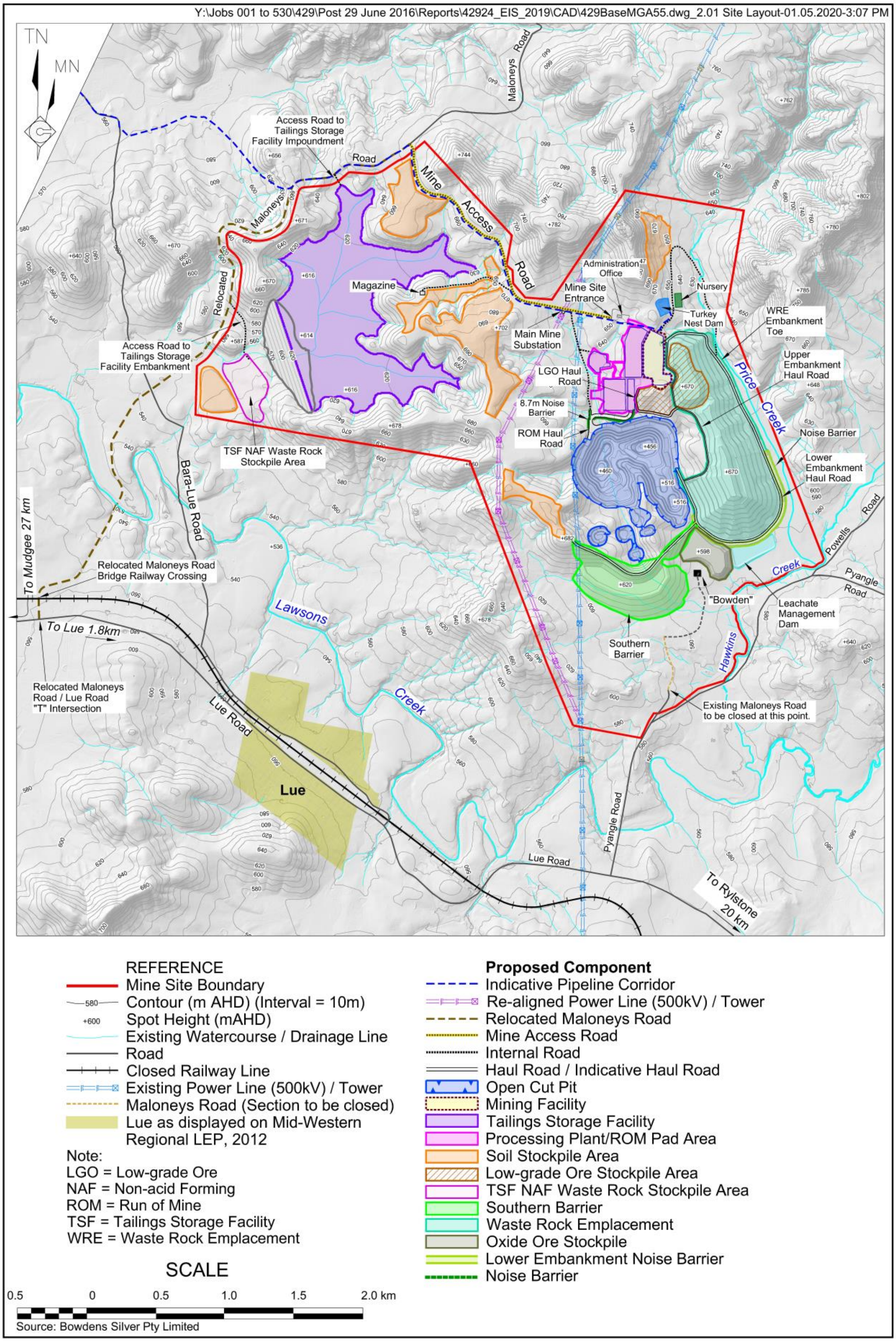
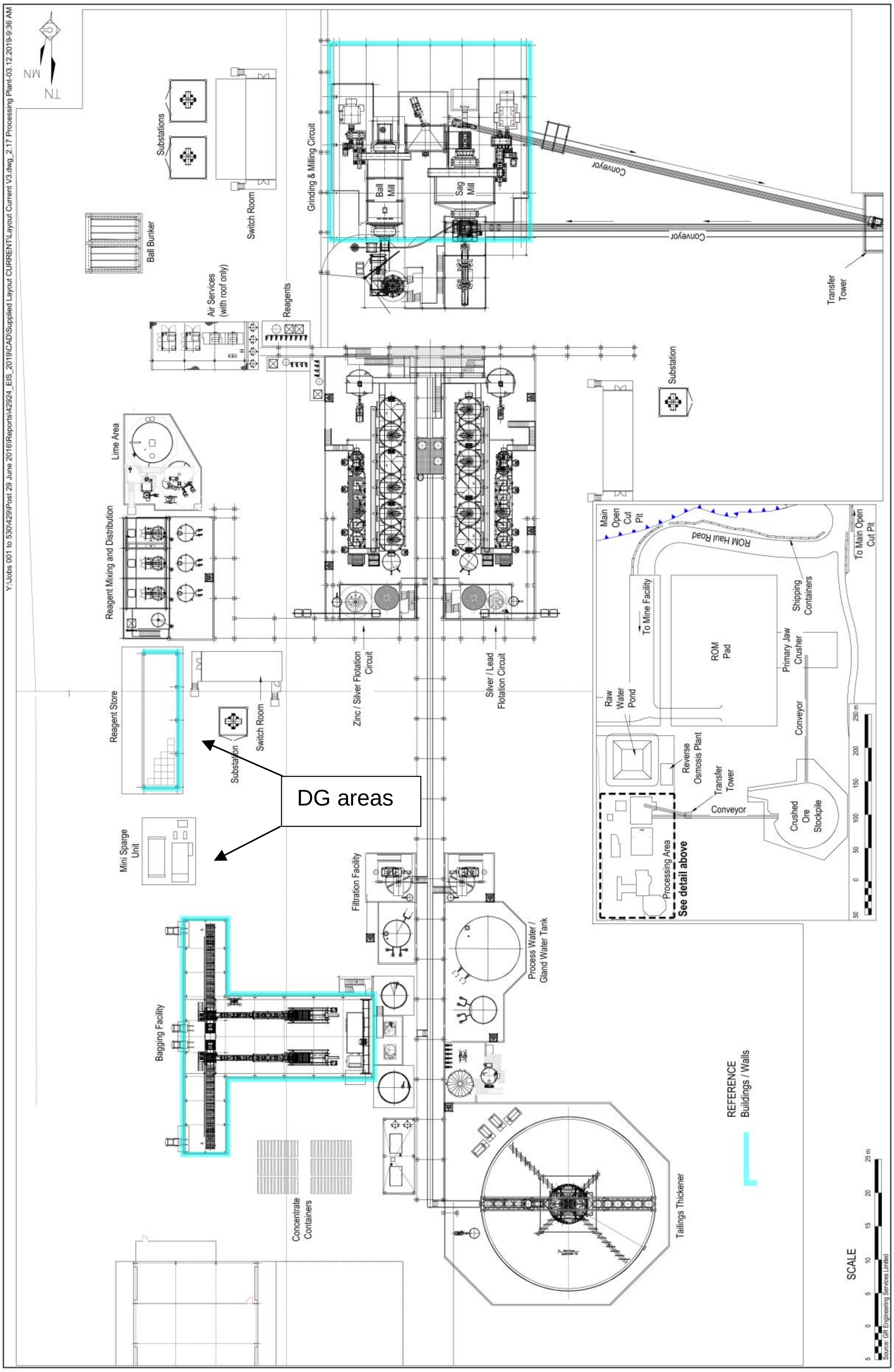


Figure 3 Processing Area



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Recovery of the metal concentrate from the Run-Of-Mine (ROM) ore material involves the following process operations.

- **ROM Stockpiling, Crushing and Grinding –** The mined ore would be loaded from the ROM pad into the primary crusher to reduce the size of the material to smaller than 23mm in diameter. The product would then be conveyed to a grinding circuit to further reduce the size of the ore to less than 106 microns. A solution of zinc sulphate, caustic soda and sodium cyanide would be added to the milled ore in the conditioning tank to reduce the potential for sphalerite ((Zn, Fe) S) and pyrite (FeS_2) minerals to float in the lead flotation circuit.
- **Flotation Circuits (Silver/Lead and Zinc)** – The ore would be passed through two flotation circuits (silver/lead and zinc) which involves the rougher concentrate going through to a regrind to liberate the minerals. The reground slurry would go through a two stage cleaning process to upgrade to the concentration to a saleable grade. Flotation reagents would be added to assist the flotation process of the concentrate. After the zinc circuit, the tailings would be pumped to the tailings thickener to recover process water for recirculation.
- **Concentrate handling** – Both the silver/lead and zinc concentrates would be thickened separately and pumped to storage tanks. This would then be filtered to produce a filter cake suitable for loading into bulk containers or bagging and loading into shipping containers, ready for dispatch off site.
- **Tailings Management –** The remaining slurry exiting the flotation circuit process would be pumped to the TSF. Water would be recovered from the TSF via the decant pond and returned to the process water tank via the water return pipeline for recycling and reuse in the process circuit.

Sodium Cyanide

The Project would utilise approximately 190t of sodium cyanide each year principally as a sphalerite and pyrite depressant in the lead flotation circuit. This is a relatively small amount of sodium cyanide and represents approximately 0.1% of the total sodium cyanide manufactured in Australia each year.

Sodium cyanide is a common commodity chemical used for a range of industrial and processing purposes worldwide. In Australia, sodium cyanide is principally used by the gold mining industry. Gold mining operations typically utilise large quantities of sodium cyanide as it is generally the principal medium used to extract the gold from the ore. For example, the McPhillamys Gold Project, a proposed gold mine located in the Blayney – Kings Plain district of Central West New South Wales, proposes to use approximately 5 700t of sodium cyanide per year or approximately 3.3% of the total sodium cyanide manufactured in Australia each year (EMM Consulting, 2019 Ref [7]).

Australia is a major manufacturer and exporter of sodium cyanide with two manufacturing facilities located in Western Australia and Queensland. These plants have a combined production capacity of approximately 173 000t per year. It is estimated that approximately 40% to 60% of sodium cyanide manufactured in Australia is exported, with similar quantities used by Australian industries (NICNAS, 2010 Ref [6]). There are also several companies that import sodium cyanide for use in Australia.

1.4.4 Security

To ensure that access to the Mine Site is restricted to authorised personnel only, the following security measures would be implemented to ensure that members of the public do not access the Mine Site at any time.

- Security fence around the perimeter of the key operational areas within the Mine Site, with the exception of areas where rugged topography naturally restricts access.
- A security gate installed in the vicinity of the mine entrance. This would be the only vehicular access point to the operational sections of the Mine Site. Visitor or non-authorised vehicles would be required to report to the gate house before being permitted to enter the operational sections of the Mine Site.
- Security/warning signs would be positioned at strategic locations around or within the Mine Site indicating the presence of earthmoving and mining equipment, deep excavations and steep slopes. The signs would be positioned as appropriate to the location of the mining activities at any given time.
- Signs identifying blasting procedures and times would also be installed at the entrance to the mine access road and within Lue.

1.5 LOCATION

DGs, with the exception of blasting agents, would be handled within the processing plant area.

Figure 2 displays the Mine Site layout, including the overall Mine Site boundary, location of processing area and location of the magazine. **Figure 3** presents a more detailed layout of the processing area identifying the location of the DG storage area (the Reagent Store).

1.6 METHODOLOGY

The hazard assessment has been prepared based on the guidance provided by then NSW Department of Planning and Environment (DPE), which replaced the NSW Department of Planning (DoP). The key DPE guidance documents related to hazard assessment of DGs in relation to land use safety planning are:

- *Hazardous & Offensive Development Application Guidelines – Applying SEPP 33 (Ref* [1]*)*
- *Hazardous Industry Planning and Advisory Paper No 6 Hazard Analysis (HIPAP 6) (Ref* [2]*)*
- *Hazardous Industry Planning and Advisory Paper No 4 Risk Criteria for Land Use Safety Planning (HIPAP 4) (Ref* [4]*)*
- *Multi-Level Risk Assessment (Ref* [3]*)*
- *Hazardous Industry Planning Advisory Paper No. 11 – Route Selection (HIPAP 11) (Ref* [5]*)*

1.7 LIMITATIONS AND EXCLUSIONS

The study does not cover:

- hazards unrelated to the use of DG including:
  - subsidence risks;
  - bushfire risks; and
  - pollution control measures (i.e. management of routine air emissions).
- blasting operations;
- vehicle movements within the Mine Site; and
- on-site or employee risk.

The focus is on the acute effects of potential accident scenarios or abnormal events on people or the environment beyond the Mine Site. The study does not cover impacts from long-term or continuous emissions associated with routine operations, or work health and safety (WHS) issues that may arise from routine operations. These issues are addressed in other assessment undertaken for the EIS (e.g. Air Quality Assessment, Ramboll, 2020, Ref [8]; Human Health Risk Assessment, EnRisks 2020, Ref [9]) or would be managed using other mechanisms applicable at the operational stage, such as WHS policies and an Environment Protection Licence (EPL).

2. SEPP 33 REVIEW

2.1 SEPP 33 APPLICABILITY

As the first part of the hazards assessment, a review of the proposed development has been undertaken against the State Environmental Planning Policy 33 – Hazardous and Offensive Development (SEPP 33) to determine whether the Project would be 'potentially hazardous industry' or 'potentially offensive industry'.

SEPP 33 links the permissibility of an industrial development to its off-site safety and environmental risks. Developments that involve storage, handling, or processing materials which, in the absence of locational, technical or operational controls, may create an off-site risk or offence to people, property or the environment are defined by SEPP 33 as 'potentially hazardous industry' or 'potentially offensive industry'.

Development proposals that are classified as 'potentially hazardous' industry must undergo a Preliminary Hazard Assessment (PHA) to determine the risk to people, property and the environment. If the residual risk exceeds the acceptability criteria, the development is 'hazardous industry' and may not be permissible within NSW.

Developments that have the potential to emit contaminants to the environment and which require an Environment Protection Licence (EPL) are referred to as 'potentially offensive'.

2.2 SCOPE AND OBJECTIVES

The objectives of the SEPP 33 screening are to determine whether the Project is:

- 'potentially hazardous', hence establish whether a PHA is required and document the basis for the decision; and/or
- 'potentially offensive' and document the basis for the decision.

2.3 METHOD

The DPE guideline *Hazardous & Offensive Development Application Guidelines – Applying SEPP 33* (Ref [1]), known as the *'Applying SEPP 33 guideline'* was used to establish whether the Project is 'potentially hazardous' or 'potentially offensive', hence whether further analysis is required.

2.4 POTENTIALLY HAZARDOUS DEVELOPMENT

SEPP 33 defines potentially hazardous industry as:

> *'Potentially hazardous industry' means a development for the purposes of an industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:*
>
> *(a) to human health, life or property; or*
>
> *(b) to the biophysical environment; and*
>
> *includes a hazardous industry and a hazardous storage establishment.*

To determine whether a proposed development is 'potentially hazardous', the risk screening process in the *Applying SEPP 33 guideline* considers the type and quantity of hazardous materials to be stored on site and the distance of the storage area to the nearest site boundary, in addition to the expected number of transport movements.

The *Applying SEPP 33* screening method is based on the Australian Dangerous Goods Code (ADGC) Edition 7 (National Transport Commission, 2009, Ref [10]) and refers to hazardous materials by their Dangerous Goods (DG) classification. In this report, for consistency with the *Applying SEPP 33 guideline,* materials have been referred to by their DG classification, not their classification under the Globally Harmonized System (GHS), which is used in most recent ADGC Edition 7.6 (National Transport Commission, 2018, Ref [11]).

2.4.1 Dangerous Goods (Excluding Blasting Agents)

A list of the expected types and quantities of materials to be stored or handled at the Mine Site, together with the relevant SEPP 33 screening threshold, is presented in **Table 2.** All chemicals (with the exception of materials used for blasting) would be stored or used in the processing plant area which would include a reagent store and a cyanide mini sparge facility. This area is located more than 300m from the nearest Mine Site boundary as per **Figure 2**.

Table 2 presents a comparison of the proposed storage quantities of DG against SEPP 33 screening thresholds.

The SEPP 33 threshold is exceeded for the proposed sodium cyanide storage, Class 6.1 Packing Group (PG) I, i.e. the total proposed sodium cyanide inventory exceeds the SEPP 33 threshold for Class 6.1 PG I which is 0.5 tonnes.

2.4.2 Blasting Agents

Ammonium nitrate-based blasting agents would be used. It is anticipated that these would be Ammonium Nitrate Emulsions (ANE), which are Class 5.1 DGs. However, Ammonium Nitrate Fuel Oil (ANFO) (Class 1.1) may also be used.

Blasting agents would be brought to the Mine Site as required from either a regional depot or from a local depot located on Ulan Road immediately south of Moolarben Mine, in quantities of 5 to 16 tonnes per day. The location of use would change depending on blasting activities, i.e. within the main open cut pit or the satellite open cut pits. Overnight storage on site could occur on rare emergency situations. In this case, the supplier would adopt their standard safety procedures.

The total proposed blasting agent inventory would be up to 16 tonnes.

- This exceeds the threshold for Class 5.1 Packing Group II which is 5 tonnes.
- For a quantity of up to 16 tonnes of a Class 1.1 material, the SEPP 33 screening distance to all land uses is approximately 370m. The magazine would be located in accordance with AS 2187.1 *Explosives – Storage, transport and use – Storage* and is more than 400m from the Mine Site boundary as shown in **Figure 2**.

Table 2
Dangerous Goods Storage Screening Summary

Material	Reagent Form	Storage Arrangements[1]	DG Class	Total Quantity Stored (tonnes)	SEPP 33 Threshold (DoP, 2011, Ref [1])	SEPP 33 Determination	Inclusion in PHA?
Detonators and boosters	-	Magazine	1.4	5,000 det units	No threshold for Class 1.4 identified based on SEPP 33 – excluded from screening.	Screening not required Class 1.4 -1.6 explosives defined as having no significant hazard in storage, as any effects are largely contained within the packages.	No
Methyl Isobutyl Carbinol (MIBC)	Liquid	1,000L IBC	3 PG III	20	Based on **Figure 9** the screening distance is approximately 8m from sensitive land uses (including residential) and 6m from all other land uses (e.g. commercial or industrial).	The separation distance between the proposed DG store to the Mine Site boundary is far greater than 8m.	No
Blasting agent, typically: - Ammonium Nitrate Emulsion (ANE) - Ammonium Nitrate Fuel Oil (ANFO)	Liquid Solid	-	5.1 PG II 1.1D	- 16 (maximum total mass of all blasting agents)	Class 5.1: **Table 3**, screening threshold is 5 tonnes. Class 1.1: **Figure 5**, approximately 370m to all land uses for 16 tonnes	The primary explosives would be stored off site and transported to the Mine Site as needed in quantities of up to 16 tonnes per day. Location of use would be within the main open cut pit and satellite open cut pits. An explosive magazine storage is proposed to be on site in the event detonators or primers need to be stored overnight.	Yes

Table 2 (Cont'd)
Dangerous Goods Storage Screening Summary

Material	Reagent Form	Storage Arrangements[1]	DG Class	Total Quantity Stored (tonnes)	SEPP 33 Threshold (DoP, 2011, Ref [1])	SEPP 33 Determination	Inclusion in PHA?
Sodium Cyanide – Solid	Solid Briquettes	Up to 20t sparge isotainer	6.1 PG I	Up to 20	Based on **Table 3**, the screening threshold is 0.5t.	Solid cyanide would be stored on site within the sparge isotainer. Upon arrival, the sparge isotainer would be connected to the on-site tank, which would be pre-filled with water. The Isosparge contents would then be dissolved in batches by water circulated between the dissolving tank and the Sparge isotainer. The solution would then be transferred to the solution tank.	Yes
Sodium Cyanide – Solution up to 30%	Aqueous solution	on-site dissolving tank	6.1 PG 1	Up to 20 (as solution in a storage tank)	Based on **Table 3**, the screening threshold is 0.5t.	Threshold exceeded	Yes
Zinc Collector A3477	Liquid	1000L IBC	8 PG II	4	Based on **Table 3**, the screening threshold is 25t.	Total Class 8 PG II storage does not exceed the SEPP 33 threshold.	No
Caustic soda	Solid	25 kg bags	8 PG I	1			

Table 2 (Cont'd)
Dangerous Goods Storage Screening Summary

Material	Reagent Form	Storage Arrangements[1]	DG Class	Total Quantity Stored (tonnes)	SEPP 33 Threshold (DoP, 2011, Ref [1])	SEPP 33 Determination	Inclusion in PHA?
Zinc Sulphate ($ZnSO_4.7H_2O$)	Granular	1,000kg bulka bags	9 PG III	50	No threshold identified based on SEPP 33 – excluded from screening. Class 9 PG III is not classified as potentially hazardous material under SEPP 33. Note: Diesel would be stored in dedicated fuel tanks, away from other Class 3 flammable liquids.	As per **Figure 4** Class 9 PG III materials are not potentially hazardous.	No
Copper Sulphate ($CuSO_4.5H_2O$)	Blue crystals	1,000kg bulka bags	9 PG III	40			
Diesel	Liquid	2 x 110,000L tanks	9 PG III	220m^3			
Flocculant (Magnafloc M10 or equivalent)	Powder	800kg bulka bags	Non-DG	12	Classified as non-dangerous goods. No significant hazards with the potential to cause off-site effects identified in safety datasheet review. Excluded from SEPP 33 screening.	As per Figure 4 (DoP, 2011), non-dangerous good materials are not potentially hazardous.	No
Hydrated Lime	Fine powder	60,000kg silo	Non-DG	60			
Lead Collector 3418A	Liquid	1,000L IBC	Non-DG	4			
Notes: Information provided by Bowdens Silver.							

2.4.3 Other Hazards

Additional hazards to be considered under the *Applying SEPP 33 guidelines* (that are not explicitly covered by the DG quantity screening levels) include:

- reactions/incompatibilities between materials;
- dust explosion hazards (applicable to combustible dusts only); and
- hazardous processing conditions (e.g. high temperatures and pressures).

A review of the material characteristics in the process design criteria (Bowdens Silver, 2019 Ref [12]) as well as Safety Data Sheets (SDS), for the materials to be handled at the Mine Site that are not specifically included in the DG screening thresholds, was undertaken.

- None of the ROM ores, metal concentrate products or solid wastes are a source of combustible dust.
- No chemical processing incompatibilities or reaction hazards with the potential to cause significant off-site impacts were identified.

There is potential for toxic exposure to heavy metals such as lead in metal concentrates and wastes (i.e. waste rock and tailings). Metal ores, metal concentrates and waste materials would be handled in solid form and may generate dust containing metals (silver, zinc, lead, as well as trace elements such as arsenic) in various concentrations. It is noted that the metal concentrates would contain a few % moisture and the tailings would occur as a slurry. Hence, neither would be sources of dust.

However, dusts containing heavy metals do not typically cause acute health effects resulting in immediate injury. Dusts containing heavy metals may cause chronic health effects due to repeated exposures over time. The potential exposures to dusts containing metals are assessed in the Air Quality Assessment (Ramboll, 2020, Ref [8]) and Human Health Risk Assessment (EnRisks, 2020, Ref [9]) undertaken for the Project.

2.4.4 PHA Requirement

Based on the Class 5.1 screening threshold and the proposed quantities of sodium cyanide to be used in processing operations, the Project is classified as 'potentially hazardous' and a Preliminary Hazard Analysis (PHA) is required.

The PHA is provided in Section 3 of this report.

2.5 HAZARDOUS MATERIAL TRANSPORT

A list of the expected types and quantities of hazardous materials transport movements to and from the Mine Site together with the relevant SEPP 33 screening thresholds is presented in **Table 3.**

A route evaluation study is required only for trucks carrying sodium cyanide. All other transport movements of DGs are well below SEPP 33 screening thresholds.

This hazardous materials transport route evaluation is presented in Section 4 of this report.

2.6 POTENTIALLY OFFENSIVE DEVELOPMENT

SEPP 33 defines potentially offensive industry as follows:

> *'Potentially offensive industry' means a development for the purposes of an industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would emit a polluting discharge (including, for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land, and includes an offensive industry and an offensive storage establishment.*

In the absence of controls, the Project has the potential to cause pollutants such as dusts and contaminated waters to be discharged to the surrounding environment. Therefore, the Project is considered 'potentially offensive industry' and would require an Environment Protection Licence (EPL).

2.7 CONCLUSION

The SEPP 33 screening risk assessment demonstrates that the quantities of sodium cyanide and blasting agents proposed to be stored and handled at the Mine Site are above the screening thresholds nominated in SEPP 33. The quantities of all other DGs held on site would be well below threshold quantities, and no other hazards associated with materials to be handled (e.g. reactivity, dust explosion hazard) with a potentially significant off-site effect were identified.

Consequently, the Project is classified as 'potentially hazardous' and a PHA covering sodium cyanide and blasting agents is required to be included in the EIS.

A hazardous materials transport route evaluation study is also required due to the movement of trucks carrying sodium cyanide. All other DG vehicle movements, including AN-based blasting agents, are below annual and peak vehicle movement screening thresholds.

Table 3
Hazardous Material Transport Screening Summary

Trip Type (Receipt of Goods by Truck)	Indicative Number of Vehicle Loads		Average Annual Delivery (tonne)	DG Class	Comments	SEPP 33 Threshold Vehicle Movements (Table 2)		Threshold Quantity Note 1 per Load (tonne)		Threshold Exceeded?
	Annually	Peak Weekly				Annually	Peak Weekly	Bulk	Package	
Methyl Isobutyl Carbinol (MIBC)	22	1	222	Class 3 PG III	MIBC would be delivered to site in packaged form. Between 11 to 24 IBCs per delivery (808kg per IBC).	>1000	>60	10	no limit	No
Blasting agent (e.g. Ammonium Nitrate Emulsion (ANE) or Ammonium Nitrate Fuel Oil (ANFO))	242	5	1,210 – 3,862	Class 5.1 PG II Note 3	Delivery would vary from 5 to 16 tonnes requiring either one mobile manufacturing unit or one unit with a trailer.	>500	>30	2	5	No
Sodium Cyanide (Solid)	9 - 10	1	190 - 200	Class 6.1 PG I	Sodium cyanide would be delivered to site in purpose-built sparge isotainers. 1 isotainer per delivery up to 20 tonnes per load.	All	All	1	3	Yes
Zinc Collector A3477	11	1	22	Class 8 PG II	A3477 would be delivered to site in packages. Between 2 to 4 packages per delivery.	>500	>30	2	5	No

Table 3 (Cont'd)
Hazardous Material Transport Screening Summary

Trip Type (Receipt of Goods by Truck)	Indicative Number of Vehicle Loads		Average Annual Delivery (tonne)	DG Class	Comments	SEPP 33 Threshold Vehicle Movements (Table 2)		Threshold Quantity Note 1 per Load (tonne)		Threshold Exceeded?
	Annually	Peak Weekly				Annually	Peak Weekly	Bulk	Package	
Caustic soda	2	1	2.5	Class 8 PG II	Delivery approximately three times per year					
Zinc Sulphate ($ZnSO_4.7H_2O$)	24	1	610	Class 9 PG III	Zinc sulphate would be delivered to site in bulka bags. Between 12 to 30 packages per delivery.					
Copper Sulphate ($CuSO_4.5H_2O$)	23	1	450	Class 9 PG III	Copper sulphate would be delivered to site in bulka bags or drums. Between 12 to 30 packages per delivery.	>1000	>60	no limit	(not defined in SEPP 33 guideline)	No
Diesel	163 - 295	3 - 6	6.7ML – 12.1ML Note 2	Class 9 PG III	Diesel would be delivered to site by tanker. Average 3 to 6 deliveries per week.					

Notes:

1 If total vehicle load quantities are below this level, the potential risk is unlikely to be significant. i.e. route evaluation is not required if load quantity is below this level.

2 Maximum annual diesel usage (12.1ML) during site establishment and construction stage only. Average usage for remaining years would be 6.7ML per year.

3. For class 1.1 transport the SEPP 33 requirement is to consult with DPE (not specifically to do a transport study). 'ANFO' is not actually transported in the form of Class 1.1. A Mobile Manufacturing Unit (MMU) transports the raw materials (typically AN or an ANE which are Class 5.1, and diesel in separate tanks) and then mixes the materials on site with other agents to make the explosive in situ.

3. PRELIMINARY HAZARD ANALYSIS

3.1 STUDY OVERVIEW

The PHA has been developed in accordance with NSW DPE guidelines as listed in Section 1.6 of this report. The principal steps in the PHA are:

- identification of hazards and description of potential incident scenarios.
- qualitative analysis of the consequences of these incidents on people and the biophysical environment; and
- comparison of risk levels with risk criteria as detailed in *HIPAP No. 4 Risk Criteria for Land Use Safety Planning* (HIPAP 4) (Ref [4]).

As suggested in the *Multi-Level Risk Assessment* (Ref [3]) guidelines, depending on the potential severity and complexity of the hazards, the consequence and risk analysis can be carried out either qualitatively or quantitatively, or using a combination of techniques.

In accordance with the SEPP 33 screening, there would be limited quantities of DG and large separation distances to the Mine Site boundary, so a qualitative analysis has been selected for this study, supplemented by quantitative consequence modelling for blasting agents. This approach is known as a Level 2 risk assessment.

3.1.1 Risk Criteria

Risk criteria for qualitative analysis are given in HIPAP 4 as follows:

a. *All 'avoidable' risks should be avoided. This necessitates the investigation of alternative locations and alternative technologies, wherever applicable, to ensure that risks are not introduced in an area where feasible alternatives are possible and justified.*

b. *The risk from a major hazard should be reduced wherever practicable, irrespective of the numerical value of the cumulative risk level from the whole installation. In all cases, if the consequences (effects) of an identified hazardous incident are significant to people and the environment, then all feasible measures (including alternative locations) should be adopted so that the likelihood of such an incident occurring is made very low. This necessitates the identification of all contributors to the resultant risk and the consequences of each potentially hazardous incident. The assessment process should address the adequacy and relevancy of safeguards (both technical and locational) as they relate to each risk contributor.*

c. *The consequences (effects) of the more likely hazardous events (i.e. those of high probability of occurrence) should, wherever possible, be contained within the boundaries of the installation.*

d. *Where there is an existing high risk from a hazardous installation, additional hazardous developments should not be allowed if they add significantly to that existing risk.*

Quantitative fatality and injury risk criteria are also given in HIPAP 4. As per Section 3.2 the hazard identification indicates very limited effects. Accordingly, risk quantification and comparison with quantitative risk criteria was not undertaken.

3.1.2 Scope and Objective

The scope of the PHA study includes the following:

- DG storage and handling associated with the proposed mine operations within the boundary of the Mine Site.
- Consideration of external factors to determine if they have any material effect on the risk associated with DG storage and handling.

The objective of the study is to undertake a PHA of the Project in accordance with NSW DPE guidelines, *Hazardous Industry Planning Advisory Paper No. 6 Hazard Analysis* (HIPAP 6) (Ref [2]). The overall objective of the PHA is to determine whether the off-site risks associated with the Project are acceptable according to the NSW DPE land use safety planning risk criteria.

3.2 HAZARD IDENTIFICATION

3.2.1 Dangerous Goods

The hazardous materials proposed to be used at the Mine Site were reviewed in the SEPP 33 screening study. The SEPP 33 screening study indicated that solid sodium cyanide and blasting agent (AN based) exceeded the thresholds for consideration in the PHA.

The hazards associated with sodium cyanide (taken from the SDS) and AN-based blasting agents are summarised in **Table 4.**

The remaining hazardous materials (e.g. corrosives and combustibles), were not considered in the PHA as the SEPP 33 screening identified that the quantities were below the thresholds likely to present an off-site impact

Sodium Cyanide

Sodium cyanide is a white solid with a faint ‘bitter almond’ odour. As a solid under normal ambient and storage and handling conditions, it is stable. Short term exposure to sodium cyanide is considered to be highly toxic to humans.

Sodium cyanide is brought onsite as a solid and mixed with water to create sodium cyanide solution (approximately 30%). Sodium cyanide solution is corrosive when in contact with metals and skin and toxic when ingested or inhaled. Sodium cyanide decomposes when heated to produce toxic hydrogen cyanide and ammonia gases.

Sodium cyanide is also toxic to aquatic life, birds, plants and animals. It is water soluble and spillage can potentially contaminate wetlands, rivers and groundwater. There would be a significant environmental hazard if cyanide in any form spills into waterways. Cyanide, however, oxidises and breaks down by a variety of mechanisms and is not persistent in the environment (NICNAS, 2010 Ref [6]).

Blasting Agents (AN based)

ANFO is an explosive material which can be ignited by shock, friction, fire and other sources. ANE is an oxidising agent that sustains combustion even in the absence of an external source of oxygen.

The main hazard associated with these materials is excessive heating which can cause accelerating decomposition to the point where explosion or detonation can occur.

Table 4
Hazardous Materials

Material	State	DG Class	Hazard Statement (from SDS)	Hazard Type (for PHA)
Sodium cyanide	Solid (delivered) stored as a solid and solution	6.1 PG I	H290 May be corrosive to metals. H300+H310+H330 Fatal if swallowed, in contact with skin or if inhaled. H315 Causes skin irritation. H318 Causes serious eye damage. H372 Causes damage to organs through prolonged or repeated exposure. H410 Very toxic to aquatic life with long lasting effects. Contact with acids liberates very toxic gas. Reacts with water liberating toxic hydrogen cyanide (HCN) gas. There would be a significant environmental hazard if cyanide spilled into waterways. Sodium cyanide decomposes when heated to produce toxic hydrogen cyanide and ammonia gases.	Toxic
Blasting agent (ANE)	Liquid	5.1 PG II	H205 - May mass explode in fire. H319 - Causes serious eye irritation. H351 - Suspected of causing cancer. An explosion or detonation could occur, if the decomposition gases are sufficiently confined. The presence of contaminants (e.g. acids, alkalis) or energetic sensitising materials increases decomposition/detonation. Toxic Nitrogen Oxide (Nox) gases are formed during decomposition.	Explosion
Blasting agent (ANFO)	Solid	1.1D	H201 Explosive; mass explosion hazard. H319 Causes serious eye irritation. H351 Suspected of causing cancer. Explosive material. A major fire may involve a risk of explosion. An adjacent detonation may also involve the risk of explosion. Heating can cause expansion or decomposition of the material, which can lead to the containers exploding	Explosion

3.2.2 External Events

The potential for external events to affect the DG storage and handling activities at the Mine Site was considered as part of the hazard identification process. **Table 5** summarises the external events considered.

No external events were identified as a significant or unmanaged potential concern with respect to DG storage and handling activities.

Table 5
External Events

External Event	Comments
External flooding	Likelihood of flooding low and not considered significant.
Earthquakes	According to GeoScience Australia (Geoscience Australia, 2019, Ref [13]), this area is classified as a moderate earthquake hazard. Equipment and the structures in the facility are designed accordingly. The TSF embankment has been designed to the following Annual Exceedance Probability (AEP) criteria. • Operating Basis Earthquake: 0.001% AEP (1 000 year ARI); and • Maximum Design Earthquake: 0.0001% AEP (10 000 year ARI).
Land slip/subsidence	Mine Site subsidence issues are covered as part of Project design and geological risk assessment. Not a significant factor in DG handling and use.
Cyclones	Not a cyclone area. Facility structures assumed to be designed in accordance with relevant wind/loading codes.
Tsunami/storm surge tides	Located inland. Not a potential hazard for the Project.
Lightning	Systems would comply with relevant Australian Standards (*AS/NZS 1768:2007 Lightning Protection*) to manage the risks associated with lightning.
Plane crash	Mudgee airport is located 25km northwest of the Mine Site. There are no air strips located in the area surrounding the Mine Site. Therefore, likelihood of a plane crash would be low and not considered significant.
Vehicle crash	Assumed that Mine Site speed limits and plant protection for structures are installed to prevent vehicle impact on critical equipment.
Sabotage/vandalism	The Mine Site would be fenced and would be manned and operational 24 hours a day with restricted access. Security plan for Mine Site as per regulatory requirements for AN-based blasting agents.
Utilities failure	Assumed that power failure would result in 'fail safe' condition and plant operations are not possible in the event of loss of power.
Bushfire	Credible risk due to surrounding environment. A cleared buffer zone would be in place separating the processing area and blasting agent magazine from any vegetation. A site Bushfire Protection Plan would be developed in accordance with the relevant Planning for Bush Fire Protection guidelines issued by the Rural Fire Service NSW.

3.2.3 Potential Hazardous Incidents

Potential hazardous incident scenarios were identified based on a review of the Mine Site layout, the SEPP 33 screening and experience with hazard identification work undertaken previously by the author of this report, for similar operations.

Table 7 summarises:

- the potential hazardous incident scenarios;
- potential causes;
- control measures and safety guards; and
- potential for off-site safety or environmental effects.

Sodium Cyanide

Sodium cyanide briquettes would be delivered to the Mine Site by truck in purpose-built sparge isotainers. Upon arrival, the isotainer would be unloaded and stored in a dedicated, bunded area within the processing area (see **Figure 3**). The isotainer would then be connected to the on-site sparging tank which would pump water through the sparge isotainer to dissolve the solid sodium cyanide briquettes. The cyanide solution (approximately 30%) would then be pumped from the sparging tank to the conditioning tank prior to the flotation circuit to enhance metal separation from other substances.

The concentration of cyanide in the slurry at the point of addition in the processing plant would be approximately 66 milligrams per litre (mg/L) or parts per million (ppm). In addition, caustic soda would also be added to increase the pH of the solution to prevent the formation of hydrogen cyanide gas. The proposed concentration of cyanide compares with typical concentrations in gold processing plant slurries of 400 to 500 ppm, so between 13% and 17% of the concentrations used to extract gold). Sodium cyanide concentrations in the discharge water from the processing plant, i.e. tailings discharge would average approximately 2.5 ppm (Free), 6.5 ppm (Weak Acid Dissociable, WAD) and 6.7 ppm (Total) cyanide. It is noted that at concentrations of <10mg WAD CN/L (i.e. <10 ppm WAD) no acute mortalities and minimal sublethal effects are experienced by wildlife (NICNAS, 2010 Ref [6]).

The environmental fate of sodium cyanide is complex and depends upon a range of factors including concentration, pH, temperature and exposure to sunlight (NICNAS, 2010 Ref [6]). However, free cyanide is a highly reactive substance and readily degrades and transforms via a number of processes (NICNAS, 2010 Ref [6]). It is anticipated that sodium cyanide in the tailings discharge would rapidly decompose due to photolysis (the decomposition of cyanide due to exposure to ultraviolet radiation) and volatilisation as hydrogen cyanide (HCN) at extremely low concentrations. It is noted that the already low cyanide concentrations within the tailings discharge at the point of entry to the TSF would rapidly decrease still further due to these processes. It is anticipated that the WAD cyanide concentration in the decant water would reduce to less than 1mg/L by the time it is pumped back to the processing plant.

Blasting Agent (AN based)

The explosive, primers and detonators would be transported to the Mine Site as required by either one manufacturing unit or one unit with a trailer. The products would be mixed on site and loaded into the pre-drilled holes before initiation.

Should any blasting agent material need to remain on site overnight this would be stored accordance with the blasting contractor's standard safety procedures.

3.3 CONSEQUENCE ANALYSIS

3.3.1 Scenarios Modelled

To confirm the extent of impact, an explosion of a single inventory (16 tonnes) of either ANE or ANFO was modelled. This is a worst-case scenario as per scenarios 7 and 8 in hazard identification **Table 7.**

Blasting agent explosion efficiency were assumed based on industry standards (compared to trinitrotoluene (TNT) efficiency of 1) to estimate the Net Explosive Quantity (NEQ) for modelling overpressures resulting from a blast wave associated with an explosion. The Kingery-Bulmash TNT correlation was used to estimate distances to the overpressures defined in **Table 6.**

3.3.2 Overpressure

As required by HIPAP 4 for assessing explosion events, different impacts (i.e. injury or probabilities of fatality) are equated to overpressure levels as summarised in **Table 6.**

These criteria are based on the impacts due to overpressure given in HIPAP 4. The probability of fatality is higher for a person inside a building because of the potential structural failure of the building and hence, impact on the person.

The specific magazine location would be in accordance with the relevant Australian Standard, AS2187 *Explosives – Storage, transport and use – Storage.*

Table 6
HIPAP 4 Overpressure Levels

Overpressure (kPa)	HIPAP 4 description
7	Damage to internal partitions and joinery but can be repaired. Probability of injury is 10%. No fatality.
14	Houses uninhabitable and badly cracked.
21	Reinforced structures distort. Storage tanks fail. 20% chance of fatality for a person in a building.
35	House uninhabitable. Wagons and plant items overturned. Threshold of eardrum damage. 50% chance of fatality for a person in buildings and 15% chance of fatality for a person in open.
70	Threshold of lung damage. 100% chance of fatality for a person in a building or in the open. Complete demolition of houses.
Note:	Overpressure is the pressure caused by a shock wave (generated by an explosion) over and above normal atmospheric pressure. As required by HIPAP 4 this is the measure used to assess the effects of abnormal / accidental larger scale explosions. Effects from planned and relatively frequent blasting operations involving small quantities of blasting agents are assessed using noise and vibration impacts.

Table 7
Potential Hazardous Incident Scenarios

ID	Risk Event	Main Material	Causes	Controls and Safeguards	Qualitative Consequence	Potentially Significant[2] Off-site Consequence?	
						Environmental	Safety
1	Loss of Containment (LOC) of Sodium Cyanide (NaCN) into dry area - small spill	Solid sodium cyanide	Isotainer pierced and breached	• Isotainers designed and tested in accordance American Society of Mechanical Engineers (ASME) and International Cyanide Management Institute (ICMI) guidelines and the requirements of the *International Cyanide Management Code*. • Bunding constructed to AS NZS 4452:1997 *The storage and handling of toxic substances* (impermeable material). • Routine inspections. • Operator trained in emergency response and/or HAZMAT. • Hazardous Materials Management Plan. • Emergency Response Plan. • Solid is high pH (by manufacturer), low evolution of hydrogen cyanide at high pH even if combined with water	• Spillage of NaCN onto dry tarmac – very small quantities of Hydrogen Cyanide produced due to reaction of moisture in the air - quickly diluted to safe concentrations in air. • NOTE: Site boundary > 300m away, no adjoining occupied land uses. Off-site exposure extremely unlikely.	No	No
2	LOC of sodium cyanide solution	Sodium cyanide aqueous solution (30%)	Tank failure / pipe failure	• Bunding constructed to AS NZS 4452:1997 *The storage and handling of toxic substances* (impermeable material). • Routine inspections. • Operator trained in emergency response and/or HAZMAT. • Hazardous Materials Management Plan. • Emergency Response Plan. • Solution is high pH (by manufacturer), low evolution of hydrogen cyanide at high pH	• Spill contained in bund, no offsite consequence	No	No

[2] 'Significant' means serious injury or fatality off site, or an environmental incident threatening the long term viability of an aspect of the natural environment as per HIPAP 4 risk criteria.

Table 7 (Cont'd)
Potential Hazardous Incident Scenarios

ID	Risk Event	Main Material	Causes	Controls and Safeguards	Qualitative Consequence	Potentially Significant[3] Off-site Consequence?	
						Environmental	**Safety**
3	Mixing of a spill of cyanide solution from the sparging tank with incompatible materials	Sodium cyanide aqueous solution (30%)	Leak from tank / piping / dissolving equipment Mixing with acid due to storage of incompatible materials	• Bunding constructed to AS NZS 4452:1997 *The storage and handling of toxic substances* (impermeable material). • No acid is stored – no acid leaching in process. • Mini sparge unit is a closed system which mitigates the risk of a leak during the dissolution process.	• Not credible – no acidic materials stored or used in process	N/A	N/A
4	Fire impinging on stored sodium cyanide	Solid / aqueous sodium cyanide	Bushfire Combustible / flammable storages	• Buffer zones around processing area. • Small quantity of flammables - separation distances comply to AS1940 and AS4452.	• Possible toxic decomposition products, would be thermally buoyant, very limited effect at ground level	No	No
5	Spill of process solution containing cyanide	Aqueous solution containing dilute cyanide, typically < 66ppm (total cyanide)	Loss of containment from processing equipment	• Dilute cyanide concentration. • Bunding and containment around processing area.	• Spill onto ground, contamination of soil or water if runoff occurs. Effects likely to be very localised due to dilute cyanide concentration	N/A	No
6	Spill of TSF solution containing cyanide	Aqueous solution containing very dilute cyanide, typically < 7ppm (total cyanide)	Loss of containment from TSF e.g. leaching through liner or overflow/ high level in TSF	• Very dilute cyanide concentration. • TSF.	• Contamination of soil or water if runoff occurs. Effects likely to be very localised due to dilute cyanide concentration	N/A	No

[3] 'Significant' means serious injury or fatality off site, or an environmental incident threatening the long term viability of an aspect of the natural environment as per HIPAP 4 risk criteria.

Table 7 (Cont'd)

Potential Hazardous Incident Scenarios

ID	Risk Event	Main Material	Causes	Controls and Safeguards	Qualitative Consequence	Potentially Significant[4] Off-site Consequence?	
						Environmental	**Safety**
7	Contamination causes decomposition in blasting agent (AN based) inventory	AN based blasting agent	Contaminated material delivered to site	• Product specification and quality assurance. • Visual detection of venting – note that contamination could only occur at the loading location and venting would be occurring and detected en-route to the Mine site. • Emergency response.	• With warning event (i.e. visual detection). • Toxic fume emission and eventual explosion	No	No Refer to Section 3.3
8	External fire causes decomposition in blasting agent (AN based) inventory.	AN based blasting agent	- Electrical fire - Vehicle fire - Security breach - Bushfire	• Minimal fuel/combustible material in the area. • Separation distance from neighbouring land uses. • Cleared area / no vegetation around site – RFS buffer zone. • Vehicle fire extinguishers. • Visual detection of fire. • Emergency response and evacuation procedures.	• With warning event (i.e. visual detection). • Toxic fume emission and eventual explosion	No	No Refer to Section 3.3
9	Loss of containment of blasting agent (AN based)	AN based blasting agent	Impact to container containing AN based blasting agent by truck or forklift	• Packaged in accordance with ADG code. – thick walled pressure rated container, protected by frame, no protruding valves, special lifting connection, drop tested. • ANE blasting agents are very viscous – do not spread, ANFO is solid.	• No significant consequence	N/A	N/A

[4] 'Significant' means serious injury or fatality off site, or an environmental incident threatening the long term viability of an aspect of the natural environment as per HIPAP 4 risk criteria.

3.3.3 Results

The consequence results for the modelled scenario at the maximum quantity of 16 tonnes are shown in **Table 8.**

Table 8
Consequence Results

Overpressure (kPa)	Distance to overpressure (m) ANE TNT Equivalence 0.68	Distance to overpressure (m) ANFO TNT Equivalence 0.8	Comments
7	398	420	Does not extend to the nearest privately-owned residences
14	232	245	Within Mine Site boundary
21	174	184	Within Mine Site boundary
35	126	133	Within Mine Site boundary
70	85	90	Within Mine Site boundary

3.4 RISK ASSESSMENT

3.4.1 Safety Risk to Off-site Land Uses

No hazardous incidents have been identified with potentially significant off-site safety impacts on surrounding land uses. Therefore, the Project is consistent with the HIPAP 4 qualitative risk criteria as summarised in **Table 9**.

Table 9
Comparison against HIPAP4 Qualitative Risk Criteria

Page 1 of 2

Criteria	Comments	Complies?
(a) All ‘avoidable’ risks should be avoided. This necessitates the investigation of alternative locations and alternative technologies, wherever applicable, to ensure that risks are not introduced in an area where feasible alternatives are possible and justified.	Storage and use of DG minimised by choice of process. Acid leaching process is not adopted – mostly physical processing not chemical intensive processing. Low hazard DG with the exception of sodium cyanide. Sodium cyanide use is minimised and storage and handling well-separated from the Mine Site boundary. Dissolution of sodium cyanide would occur within a controlled, closed mini sparge system. Cyanide added as solution to conditioning tank resulting in very dilute concentration in process. Blasting agents brought to site and used on ‘just in time; basis	Yes

Table 9 (Cont'd)
Comparison against HIPAP4 Qualitative Risk Criteria

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Criteria	Comments	Complies?
(b) The risk from a major hazard should be reduced wherever practicable, irrespective of the numerical value of the cumulative risk level from the whole installation. In all cases, if the consequences (effects) of an identified hazardous incident are significant to people and the environment, then all feasible measures (including alternative locations) should be adopted so that the likelihood of such an incident occurring is made very low. This necessitates the identification of all contributors to the resultant risk and the consequences of each potentially hazardous incident. The assessment process should address the adequacy and relevancy of safeguards (both technical and locational) as they relate to each risk contributor.	No identified events involving DG with significant safety or environment effects beyond the Mine Site boundary. DG storage and use would be compliant with relevant Australian Standards. Large separation distances to Mine Site boundary. Sodium cyanide handled in controlled, closed mini sparge system minimising the potential of a spill. Magazine complying with AS2187.1 for occasional storage of blasting agents. As per Clause 3.2.1 *'separation distances specified in this Standard are based on international testing and experience, and when used as guidelines for Class 1 explosives should provide an acceptable level of risk'.*	Yes
(c) The consequences (effects) of the more likely hazardous events (i.e. those of high probability of occurrence) should, wherever possible, be contained within the boundaries of the installation.	No identified events involving DG with significant safety or environment effects beyond the Mine Site boundary.	Yes
(d) Where there is an existing high risk from a hazardous installation, additional hazardous developments should not be allowed if they add significantly to that existing risk.	Not applicable – no existing hazardous developments in the area.	Yes

3.4.2 Risk to Biophysical Environment

The principal concern relating to environmental risk from accident events typically relates to effects on whole systems or populations. HIPAP 4 provides the following qualitative guidance for assessment of environmental risk due to accident events.

- *Industrial developments should not be sited in proximity to sensitive natural environmental areas where the effects (consequences) of the more likely accidental emission may threaten the long-term viability of the ecosystem or any species within it.*
- *Industrial developments should not be sited in proximity to sensitive natural environmental areas where the likelihood (probability) of impacts that may threaten the long-term viability of the ecosystem or any species within it is not substantially lower than the background level of threat to the ecosystem.*

The chemical stored on site with the most serious potentially hazardous environmental impact is cyanide. If sodium cyanide is released and comes in contact with water, it is very toxic and has an acute impact on aquatic life.

Sodium cyanide would be stored and used for processing as part of the Project. Full containment would be provided around any cyanide equipment.

All sodium cyanide would be stored within contained/bunded areas. Spill kits would be provided to enable recovery of small quantities of spilled materials.

The processing plant is also fully contained. The likelihood of any spill reaching the environment would be very low due to the on-site containment and sealed surfaces.

Cyanide would be used in dilute concentrations only (typically 66 ppm) during processing.

No scenarios have been identified which would result in long term harm to the ecosystem and the Project is consistent with the HIPAP 4 biophysical risk criteria.

3.5 CONCLUSIONS

The SEPP 33 screening determined that solid sodium cyanide and blasting agents (AN based) have the potential for significant off-site impacts.

Sodium cyanide would be stored in a dedicated area within the processing plant (mini sparge unit adjacent to the reagent store) with bunding and large separation distances (>300m) to the Mine Site boundary. Very few materials would be used that are incompatible with cyanide. It is therefore very unlikely that a spill of sodium cyanide would have any effects that could extend off site.

Blasting agents (AN based) would be brought on site as required on the day of each blast, mixed and transferred to pre-drilled holes and would be located with large separation distances complying with AS 2187.1 to the Mine Site boundary, with consequence modelling confirming these are adequate. They would only be stored overnight on site only in rare emergency situations.

Qualitative analysis of the risk of potential off-site safety effects to surrounding land uses or environmental effects to surrounding ecosystems indicate the risk is very low and all HIPAP 4 qualitative risk criteria are met by the Project.

3.6 PHA RECOMMENDATIONS

The PHA is based on an indicative Mine Site layout. It is therefore recommended that:

- the proposed storage and use locations of sodium cyanide and blasting agent (AN based) are reviewed upon finalisation of the design to ensure that separation distances to the Mine Site boundary and incompatible materials are maintained; and
- bunding and containment structures for sodium cyanide meet the requirements of the relevant Australian Standard, AS NZS 4452 *The storage and handling of toxic substances.*

4. HAZARDOUS MATERIAL TRANSPORT ROUTE EVALUATION STUDY

4.1 REQUIREMENT FOR STUDY

The quantities of hazardous materials transported for the Project are given in **Table 3**. According to the *Applying SEPP 33* guidelines, any movement of sodium cyanide exceeds the threshold must be considered in a route evaluation study. No other materials exceeding the screening SEPP 33 thresholds.

The relevant DPE guidance for undertaking a route evaluation study is *Hazardous Industry Planning Advisory Paper No. 11 – Route Selection (HIPAP 11) (Ref* [5]*).*

4.2 METHODOLOGY

HIPAP 11 is a guideline specific to NSW and covers road transport only (i.e. no other modes such as rail). HIPAP 11 is typically used to assess two or more options for road transport routes according to a hierarchy of factors.

The majority of sodium cyanide used in mining applications in Australia is manufactured in Australia and transported by road to end markets. There are very limited options for routes suitable for heavy vehicles between the only cyanide manufacturing site in Eastern Australia (in Queensland) and the Mine Site. The Newell Highway route is already used for heavy vehicles and hazardous material transport between Queensland and New South Wales (NSW), so it is not possible to compare cyanide delivery route options for the overall route.

Therefore, the scope of this review is limited to assessment of the sodium cyanide road transport route within NSW only, with a focus on the part of the proposed transport route where the vehicle would not be travelling on major roads with existing heavy vehicles and Dangerous Goods traffic.

4.2.1 Scope and Objectives

The assessment included:

1. Identification of the route for sodium cyanide transportation;
2. Identification of potentially sensitive areas in the event of an incident;
3. Summarising the potential incident scenarios in the form of a hazard identification word diagram; and
4. For the portion of the road transport route located between the main highway and the Mine Site, a qualitative review of the route evaluation factors identified in HIPAP 11 to identify any risk factors that would preclude use of the proposed route or require additional risk reduction measures to be put in place.

4.2.2 Limitations

The HIPAP 11 guidelines have been developed to help in land use safety planning. They are not intended to be used as a basis for preventing vehicles carrying hazardous materials from travelling on roads classified under the Roads Act. Similarly, they should not be used as an argument for upgrading any roads classified under the Roads Act. (These matters fall within the jurisdiction of the relevant NSW Government agencies).

4.3 TRANSPORT ACTIVITY

4.3.1 Transport Route

For this Project, sodium cyanide would most likely be delivered by road from the Orica cyanide manufacturing facility in Yarwun, Queensland. The route to the Mine Site is shown in **Figure 4**. In NSW, the route runs from the Queensland border south along the Newell Highway, onto the Castlereagh Highway east to Mudgee and then onto Lue Road to the Mine Site. Entry to the Mine Site is from Lue Road onto the relocated Maloneys Road as shown in **Figure 5**.

It is noted that the relocated Maloneys Road would be completed as part of the construction of the Mine Site and chemical delivery would only occur prior to the commissioning of the processing plant, i.e. there would be no chemical delivery until after the relocated Maloneys Road is constructed.

Other possible transport routes include the following:

- Delivery of chemicals by road or rail to Dubbo (from either Yarwun or Sydney) to a storage depot. Note that this option is not specific to the Project and may not be available depending on Project timing. Then road delivery from Dubbo to the Mine Site.
- Delivery from Port Botany or an intermodal DG warehouse in Sydney (unlikely as there is little imported cyanide), then road delivery to the Mine Site.

Road characteristics and sensitive receptors in the vicinity are summarised in **Table 10.** The suitability of roads for total heavy vehicle movements associated with the Project (of which DG transport is a small proportion only) is covered in the Traffic component of the EIS.

The overall route from Mudgee (Market St) to the Mine Site (entrance via relocated Maloneys Road) is approximately 32km shown in **Figure 5**.

Table 10
Road Characteristics

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Road*	Description	Covered in HIPAP 11 assessment?	Potentially sensitive receptors
Newell Highway	Highway, existing heavy commercial transport including DGs.	No	-
Castlereagh Highway (TR55) to Mudgee	Highway. Carries extensive traffic including heavy commercial transport and a high volume of tourist traffic year-round.	No	-
Market Street, Duoro Street and Short Street (within Mudgee)	Urban road, wide verges with angle parking on both sides provide separation to buildings.	Yes	Residential and commercial populations adjacent to roads. Several roundabouts One right turn.

Table 10 (Cont'd)
Road Characteristics

Page 2 of 2

Road*	Description	Covered in HIPAP 11 assessment?	Potentially sensitive receptors
Ulan Road (MR214)	Used extensively by freight and passenger vehicles that service the Ulan Mines and logistic systems based on Newcastle. This includes Hazardous Materials and flammable fuels.	Yes	Minimal populations. Bridge over Cudgegong River.
Lue Road	Rural single lane road (no dividers).	Yes	Minimal populations – scattered rural housing along road (Route does not go as far as Lue). Crosses Lawson Creek and runs close to it in some areas. One intersection.
Relocated Maloneys Road	New road built for Mine Site access.	Yes	Minimal populations. Crosses Lawson Creek.
* See **Figure 4**			

4.3.2 Transport Containers

Solid sodium cyanide would be transported in purpose-built sparge isotainers to lower the risk during transport to the Mine Site. These isotainers have been designed in accordance with the requirements of the *International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide*.

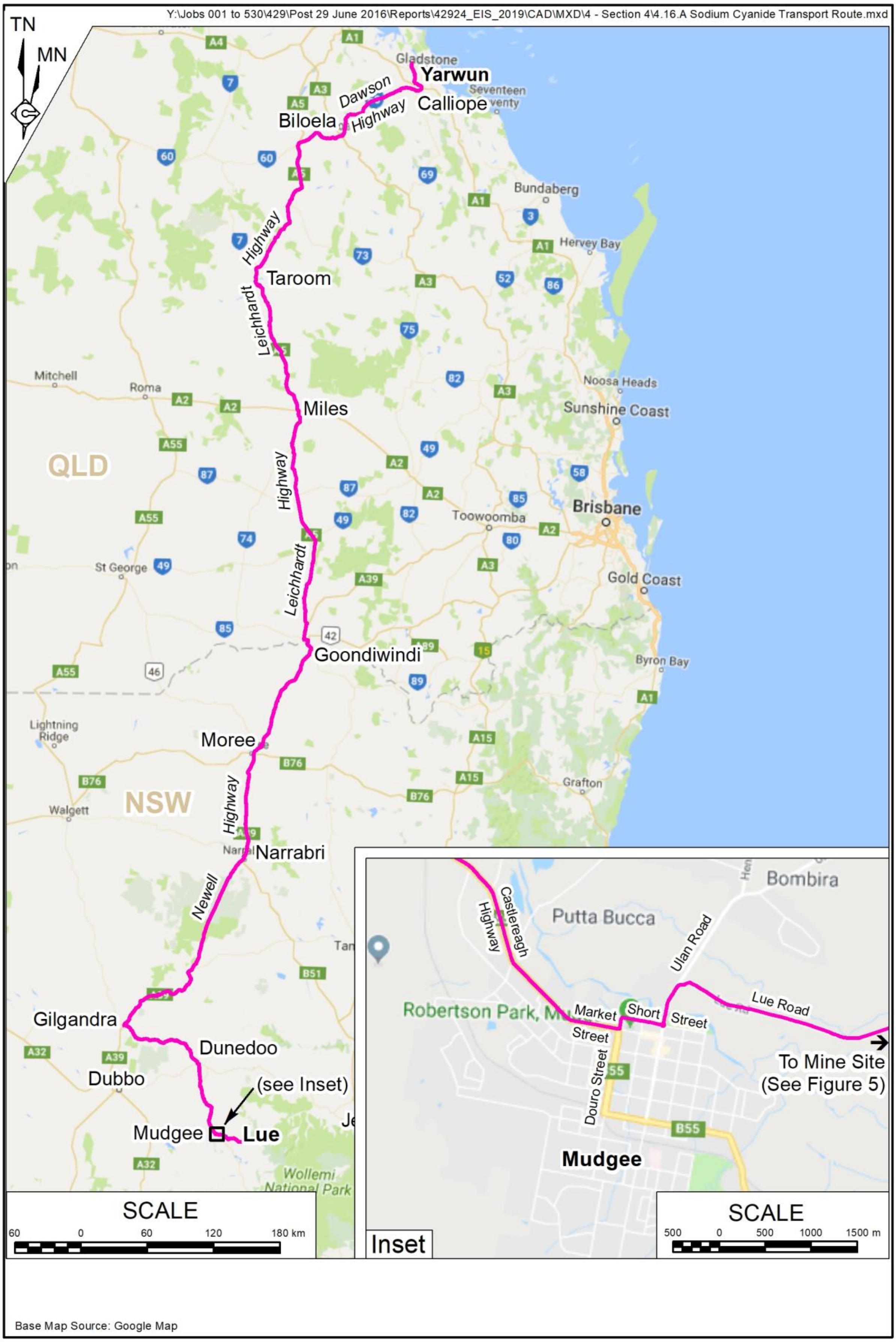
4.3.3 Selection of Transporter

The voluntary industry code of practice *International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide* in the production of gold and for manufacturers is aimed at minimising risks during handling of the cyanide.

Bowdens Silver is not currently signatory to the Code. The Project would not have direct control over the delivery of hazardous materials to the Mine Site as it would be undertaken by a supply contractor.

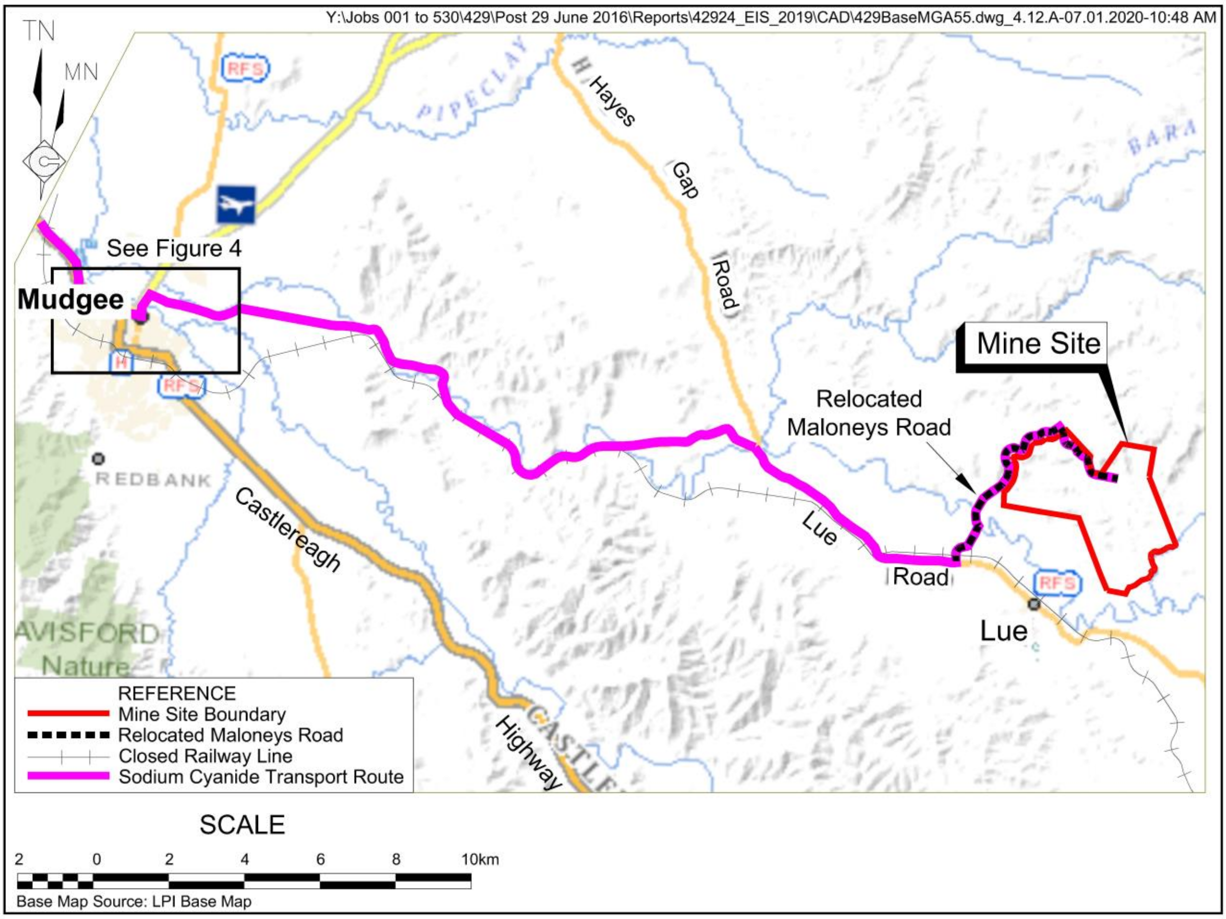
However, Bowdens Silver would select cyanide supply contractors that are approved carriers of dangerous goods and have suitable safety management systems to ensure the safe transport of hazardous materials.

Figure 4 Sodium Cyanide Transport Route from Orica Yarwun



sherpa consulting

Figure 5 Sodium Cyanide Transport into the Mine Site



Orica, the intended supplier of cyanide is a signatory to the Cyanide Code and its cyanide transporters are certified as compliant with the Cyanide Code's Principles and Transport Practices.

4.3.4 Australian Dangerous Goods Code (ADGC) Requirements

As part of the licensing requirements for transport of cyanide in the proposed quantities under the ADGC, the following conditions must be met:

- Driver must be DG licensed
- Vehicle must be DG licensed
- The transporter must prepare a detailed route specific transport risk assessment for the entire route.

4.3.5 Emergency Plans

Under the ADGC, an emergency plan is required for DG transport. All drivers undergo emergency response training for incidents such as vehicle accidents or vehicle fires. The training includes:

- Mitigation measures in the event of a vehicle fire, such as battery isolation and extinguishing of fire.

- Measures to ensure the safety of the public, including, in the event of a large fire or leak, the implementation of an exclusion zone around the vehicle.
- Activation of the Orica Emergency Response Systems including emergency services in the area and specialist personnel on hand to assist in the management of the incident. The general public are also able to activate the Emergency Response System, with the contact details for the co-ordinating group detailed on the vehicle Dangerous Goods placarding.
- Each vehicle carries an Orica's Emergency Response Guide Sodium Cyanide which summarises the risks identified in the route assessment and the appropriate response requirements in likely scenarios.

4.4 HAZARDOUS INCIDENTS

The event of most concern during transport of sodium cyanide is if a loss containment from the isotainers were to occur where the solid briquettes mix with water to form aqueous sodium cyanide. Potential causes of such incidents would be:

- Impact or loss of load events such as a vehicle accident.

Incidents are summarised, together with causes, consequences and safeguards in the hazard identification word diagram in **Table 11.**

Table 11
Transport Incidents

Transport Activity	Initiating Events	Hazard Type	Consequences	Prevention/Protection Measures
Road transport of sodium cyanide sparge isotainers	• Impact leading to loss of containment. • Loss of control of vehicle and impact on roadside obstacle. • Collision with another vehicle.	Corrosive and toxic (in aqueous form). OHS issues to clean-up personnel / responders.	Pollution of waterways (environmental impact). Evolution of irritant forms (human impact).	Communications capability between driver and base at all times (mobile and satellite phone where applicable). Driver experience. Good road conditions and well signed roads. Delivery of cyanide during daylight hours only. Vehicular maintenance regimes. Solid product requires dissolution for major environmental affect. Clean-up kits and PPE available Availability of emergency services in Dubbo. All fire stations have personnel with basic HAZMAT training (e.g. Mudgee fire station) GPS tracking of Isosparges

A spill of solid sodium cyanide has very localised toxicity effects with the main risk to first responders. Solid cyanide is lower risk than cyanide solution. The purpose-built isotainers have been designed to reduce the risk of loss of containment events.

4.5 HIPAP 11 ROUTE FACTORS

As described in HIPAP 11, factors to be considered when selecting routes may be grouped into the following interrelated categories:

- Mandatory factors, including statutory requirements and legal and physical constraints.
- Subjective factors that reflect community priorities and values which may not be easily quantified. Such factors include sensitive populations, special land uses and emergency response capability.
- Road and traffic factors including the identification of the most suitable routes.
- Environmental and land use risk, including the identification of hazards and determining the risk qualitatively. These are location dependent.
- Operational factors including economics and operator's requirements.

These issues are summarised in **Table 12** for the sodium cyanide road transport from Mudgee to the Mine Site.

Table 12
HIPAP 11 Considerations for Sodium Cyanide Transport

Page 1 of 3

Factors	Considerations	Mudgee to Mine Site
Mandatory	Physical considerations	The roads are considered to be structurally adequate for heavy vehicle transport as per the Traffic Assessment for the Project (TTPP 2020, Ref [14]). There are no other suitable heavy vehicle routes.
	Legislation, codes and standards	Transport of Dangerous Goods such as sodium cyanide is regulated under the ADG7 (Australian Dangerous Goods Code, version 7.6) managed by Worksafe NSW. Transport methods comply with the ADGC (Ref [11]). A route risk assessment would be prepared in accordance with AS 31000 *Risk Management and the ADGC* once the transporter has been appointed. Drivers are Dangerous Goods licensed. Vehicles are Dangerous Goods licensed.
Subjective	Sensitive land uses (people)	A spill of solid sodium cyanide has very localised toxicity effects with the main risk to first responders. (Solid cyanide is lower risk than cyanide solution). The route attempts to avoid populated areas, congested crossings, tunnels, narrow streets, alleys, or sites where there is, or may be, a concentration of people. Lue is avoided and the route passes through a small section of Mudgee only.
	Sensitive ecosystems and natural landscapes	Sensitive ecosystems include: Creek crossings as identified in **Table 10**.

Table 12 (Cont'd)
HIPAP 11 Considerations for Sodium Cyanide Transport

Page 2 of 3

Factors	**Considerations**	**Mudgee to Mine Site**
Subjective (Cont'd)	Emergency and evacuation planning and infrastructure	Emergency planning and infrastructure available include: • Communications capability between driver and base at all times (mobile and satellite phone wherever applicable). • Emergency services in area have response capability with specialist advice provided by cyanide supplier and specialist personnel provided as appropriate to incident. • Each vehicle carries an Emergency Response Guide for Sodium Cyanide which summarises the risks identified in the route assessment. • Local emergency response e.g. fire brigade Mudgee and Dubbo.
Road and traffic	Road structure	Mainly two-lane sealed road with sound verges. Majority of instances with waterways is protected with concrete bridges, guardrails and signage. Roads are of good quality.
	Volume & composition	Moderate traffic conditions.
	Travel time	Approximately 50 mins.
	Level of service	Approved heavy vehicles route.
	Traffic signals	Route is mainly controlled by road and traffic signs. Some roundabouts, no lights No accident blackspots or high risk intersections identified
	Alternative routes	No alternative routes possible.
Environmental and land use risk	Adjacent land use	As above.
	Population levels	Limited contact with residential and business areas. Does not pass through high density residential areas, schools, hospitals. Lue is avoided and the route passes through a small low density section of Mudgee only
	Sensitivity of ecosystems	As above.
	Accident and incident rates potential	As above for road quality.
	Drainage system	Road has sound verges.
	Emergency access	Good access to emergency services along this route.
	Driver training	All drivers who carry Dangerous Goods are required to be licensed by state regulatory agencies. In NSW, the EPA is the responsible agency. To obtain a licence, drivers must complete an accredited training course, complete a medical and meet the driving history requirements.
	Vehicle safety design and maintenance	DG vehicles have regular maintenance regimes.

Table 12 (Cont'd)
HIPAP 11 Considerations for Sodium Cyanide Transport

Page 3 of 3

Factors	Considerations	Mudgee to Mine Site
Environmental and land use risk (Cont'd)	Hazards	As per HAZID word diagram.
	Risk level	Judged to be low given the high integrity of the isotainers, low traffic volumes and reasonable road quality.
Operational	Distance	Approximately 30km.
	Travel time	Approximately 50 mins.
	Operating costs	Not assessed.

4.6 CONCLUSION

The transport route of sodium cyanide to the Mine Site is assessed as a low risk activity to the biophysical and human environment as:

- Cyanide is transported in solid (rather than liquid) form in purpose-built sparge isotainers.
- Road quality is suitable for heavy vehicles and no specific risk factors leading to higher than average accident rates were identified.
- Transport would occur using DG licensed vehicle and DG licensed drivers in accordance with the ADGC; and
- Cyanide manufacturers in Australia (e.g. Orica) are signatories to the *International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide* and their cyanide transporters are certified as compliant with the Cyanide Code's Principles and Transport Practices.

No specific recommendations are made as a result of the route valuation against HIPAP 11 factors.

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