BOWDENS SILVER

ENVIRONMENTAL IMPACT STATEMENT

State Significant Development No. 5765

May 2020

Prepared by: **R.W. CORKERY & CO. PTY. LIMITED**

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Bowdens Silver Project

Environmental Impact Statement

State Significant Development No. 5765

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May 2020

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Authors' Certification

for the submission of an Environmental Impact Statement prepared in accordance with the *Environmental Planning and Assessment Act 1979*.

a)	**EIS prepared by:**	R.W. Corkery & Co. Pty Limited
	address:	Level 1, 12 Dangar Road BROOKLYN NSW 2083
b)	**Development application by:**	
	applicant name:	Bowdens Silver Pty Limited
	applicant address:	Level 11, 52 Phillip Street SYDNEY NSW 2000
c)	**Application Number:**	SSD No. 5765
d)	**Address/land details:** Properties to be developed/Land Description:	See Table A1.1 in Appendix 1 of this Environmental Impact Statement for Schedule of Properties
e)	**Project Outline:**	The Project is comprised of three main components. • A Mine Site that includes the lands and infrastructure required for open cut mining and processing of ore, and the production of silver/lead and zinc concentrates including associated management of water resources, waste rock and tailings materials. • The relocated Maloneys Road (a public road) which would provide access to the Mine Site from Lue Road west of Lue and including a new railway bridge overpass and a new road crossing of Lawsons Creek. • The water supply pipeline corridor extending approximately 58.5km from the Mine Site to the Ulan and Moolarben Coal Mines to supply the Project with make-up water required for processing and dust suppression. It is proposed that a total of approximately 29.9 million tonnes of ore would be extracted from the deposit and processed on site to produce approximately 310 000t of mineral concentrates. The maximum rate of extraction and processing would be 2 million tonnes per annum over a mine life of 16.5 years. Rehabilitation would occur progressively, and an additional seven years would be required for final rehabilitation of the Project, resulting in a Project life of 23 years.
f)	**Assessment of Environmental Impact:**	The assessment of environmental impacts of this Project includes the matters referred to in the Secretary's Environmental Assessment Requirements provided to the Applicant on 21 June 2019 under Schedule 2, Part 2 of the *Environmental Planning and Assessment Regulation 2000*.

g) Declaration: The following principal authors declare that they have overseen the preparation of the contents of this assessment and to the best of their knowledge:

i) this EIS has been prepared in accordance with the requirements of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000;*

ii) the document contains all available information that is relevant to the environmental assessment of the proposed development; and

iii) that the information contained in the document is neither false nor misleading.

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Graeme Campbell & Associates Pty Ltd

Part 4: Hazards Analysis of Dangerous Goods
Sherpa Consulting Pty Ltd

Volume 2:

Part 5: Groundwater Impact Assessment
Jacobs Group (Australia) Pty Limited

Part 6: Surface Water Assessment
WRM Water and Environment Pty Ltd

Volume 3:

Part 7: Human Health Risk Assessment
Environment Risk Sciences Pty Ltd

Part 8a: Visibility Assessment
Richard Lamb & Associates

Part 8b: Lighting and Sky Glow Assessment
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Part 9a: Biodiversity Assessment Report
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Part 17: Social Impact Assessment
Umwelt (Australia) Pty Ltd

BOWDENS SILVER PROJECT
SUMMARY OF KEY FACTS AND STATISTICS

Applicant	• Bowdens Silver Pty Ltd ("Bowdens Silver")
Location	• The Mine Site is located approximately 26km east of Mudgee and approximately 2km to 3km northeast of Lue.
Indicative Key Mine Site Component Areas	• Total area of disturbance within Mine Site = 422ha (Excludes water supply pipeline corridor, 132kV transmission line corridor and relocated Maloneys Road) • Area of open cut pits = 52ha (main open cut pit = 48ha) • Processing plant, mining facility and related infrastructure area = 22ha • Waste rock emplacement (WRE) area = 77ha • Low grade ore stockpile area = 14ha (9ha overlapping WRE) • Oxide ore stockpile area = 8ha • Tailings storage facility (TSF) area = 117ha • Southern barrier area = 32ha • Remaining disturbance areas = approximately 107ha (Including soil and NAF waste rock stockpiles, roads, water management structures, etc.)
Water Supply Pipeline	• A water supply pipeline would be constructed between the proposed Mine Site and the Ulan and Moolarben Coal Mines, approximately 40km to the north-northwest. • The pipeline would be located in a corridor approximately 58.5km in length up to 10m wide with a wider area required for the proposed intermediate pumping station. • The pipeline would commence at an elevation of approximately 420m AHD near Ulan and increase in elevation to approximately 640m AHD within the Mine Site.
Ore Types and Quantities	• Primary and low grade sulphide ore – approximately 29.9 million tonnes. • Oxide ore – approximately 1.8 million tonnes (to be stored separately on site).
Maximum Annual Ore Extraction	• Approximately 2.07 million tonnes.
Annual Water Usage and Sources	• Average Annual Water Usage for the Project is 1 857ML for processing and dust suppression. • This includes water from the following sources. – Capture of water in storage dams such as from rainfall and runoff as well as TSF return water - 806ML/year in an average year. – Groundwater inflows of 637ML/year in an average year. – Externally sourced via the water supply pipeline 331ML in an average year. – Moisture in the ore materials - 83ML/year in an average year.
Waste Rock Types and Quantities	• Total potentially acid forming (PAF) waste rock – approximately 26.6 Mt (57%). • Total non-acid forming (NAF) waste rock – approximately 19.8 Mt (43%).
Stripping Ratio	• The stripping ratio of waste rock and oxide ore to primary and low grade ore would be approximately 1.6:1.

Ore Processing	• Primary crushing (jaw crusher); milling (semi-autogenous grinding (SAG) mill and ball mill); sequential flotation (producing silver/lead concentrate and zinc concentrate); tailings production and thickening (56% solids). • Maximum annual throughput of approximately 2 million tonnes.
Tailings Storage Facility	• Tailings storage facility capacity approximately 30 million tonnes. • Constructed in three stages: Stage 1 – Years 0 to 3 (6 million tonnes); Stage 2 – Years 4 to 8 (16 million tonnes cumulative); and Stage 3 – Years 9 to 16 (30 million tonnes cumulative).
Metal Production	• Produced as mineral concentrates i.e. silver/lead concentrate and zinc concentrate. • Annual mineral concentrate production of between 20 000 tonnes and 30 000 tonnes. • Expected total production of 66.3 million ounces of silver, 130 000 tonnes of zinc and 95 000 tonnes of lead.
Mine Site Access	• During months 0 to 6 of the site establishment and construction stage Pyangle Road and existing Maloneys Road will be used. • Relocated Maloneys Road (comprising a new intersection with Lue Road 1.8km west of Lue, a new crossing across Lawsons Creek and 5.2km of new public road) beyond Month 7 of the site establishment and construction stage. • Mine access road (former northern section of Maloneys Road closed from Month 7) – approximately 2.2km in length from the relocated Maloneys Road to the proposed Mine Site entrance.
Employment	• Site establishment and construction stage – up to 320 personnel (includes 74 head office personnel - management, procurement, engineering, drafting, administration etc). On-site full-time equivalent – 131 (over 18 months). • Operations – approximately 190 to 228 personnel (includes 20 exploration personnel).

Hours of Operation (Operations)

Activity	Days	Hours
Clearing / topsoil and subsoil removal	Monday to Saturday[1]	7:00am to 6:00pm[2]
Blasting	Monday – Saturday[1]	10:00am to 4:00pm
Mining	7 days	7:00am to 6:00pm 7:00am to 10:00pm[3] 24 hrs[3]
NAF waste rock transfer to the TSF embankment	Monday – Saturday[1]	7:00am – 6:00pm
Processing	7 days	24hrs
Concentrate Despatch	Monday to Saturday[1]	7:00am to 6:00pm[4]
Maintenance	7 days	24hrs
Rehabilitation	Monday to Saturday[1]	7:00am to 6:00pm[2]

Notes: 1 Public Holidays excluded.
2 Daylight hours only.
3 Subject to demonstrating noise limits can be satisfied during the evening and night-time periods.
4 Excluding 7:30am to 8:30am and 3:30pm to 4:30pm (School bus period) – when heavy vehicles (other than buses) must not travel on Lue Road.

Key Distances

Mine Component	Distance to Lue (Northern Extent)	Distance to Lue Public School
Closest Activity (southern barrier)	1.9km	2.3km
Main Open Cut Pit	2.1km	2.6km
Primary Crusher	2.9km	3.4km
Semi Autogenous Grinding Mill	3.3km	3.8km
Tailings Storage Facility (TSF)	1.9km	2.8km
Note: Intervening topography provides a considerable visual and noise barrier between the Mine Site components and Lue.		

Project Life

- Approximately 23 years comprising the site establishment and construction stage, mining and processing operations (to the end of concentrate production) and includes an approximately 7 year period for final rehabilitation and maintenance*.
- * Progressive rehabilitation would occur from the commencement of site establishment and construction.

Mine Life

- Approximately 16.5 years comprising the site establishment and construction stage (approximately 18 months), mining (approximately 15.5 years commencing after the first 6 months) and processing (approximately 15 years to the end of concentrate production).

Capital Investment Value

- $246.55 million

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Executive Summary

INTRODUCTION

Bowdens Silver Pty Limited (Bowdens Silver) proposes to develop and operate an open cut silver mine approximately 26km east of Mudgee within the Mid-Western Regional Local Government Area of New South Wales (see **Figure ES-1**). The Mine Site would be located approximately 2km to 3km northeast of Lue on Bowdens Silver-owned land, land under option to purchase, or land the subject of agreements with Bowdens Silver.

The proposed mine and its associated infrastructure (the "Project") would comprise the following three principal component areas displayed on **Figure ES-1** and which are collectively referred to as the "Application Area".

1. The "Mine Site" that includes the lands and infrastructure required for open cut mining and processing of ore, and the production of silver/lead and zinc concentrates including associated management of water resources, waste rock and tailings materials.
2. The "relocated Maloneys Road" (a public road) which would provide access to the Mine Site from Lue Road west of Lue and would comprise a relocated section of Maloneys Road, a new railway bridge overpass and a new road crossing of Lawsons Creek.
3. A "water supply pipeline corridor" extending approximately 58.5km from the Mine Site to the Ulan and Moolarben Coal Mines to supply the Project with make-up water required for processing and dust suppression.

It is proposed that a total of approximately 29.9 million tonnes of ore would be extracted from the deposit and processed on site to produce approximately 310 000t of mineral concentrates throughout the mine life. The principal products to be produced from the Bowdens Silver Mine would include a silver/lead concentrate and a zinc concentrate (with a small content of silver).

These products have a wide range of applications across a number of industries. For example, silver is widely used in the production of photovoltaic cells (for solar panels), telecommunication applications, consumer electronics, electric vehicles, robotics, industrial automation, aerospace and medical products (**Plates ES-1** to **ES-4**).

This EIS has incorporated assessment of the proposed relocation of 500KV powerlines that currently traverse the proposed Mine Site. In addition, external electrical power supply for the Project will be required but is not assessed as part of this application. These component of the development would be the subject of separate Part 5 applications under the *Environmental Planning and Assessment Act 1979* ("EP&A Act") prepared in conjunction with the relevant energy provider.

THE APPLICANT

The Applicant, Bowdens Silver Pty Limited, is a 100% owned subsidiary of Silver Mines Limited, a publicly-listed company trading on the Australian Securities Exchange. Bowdens Silver holds 100% of Exploration Licence EL5920 which contains the Bowdens silver deposit.

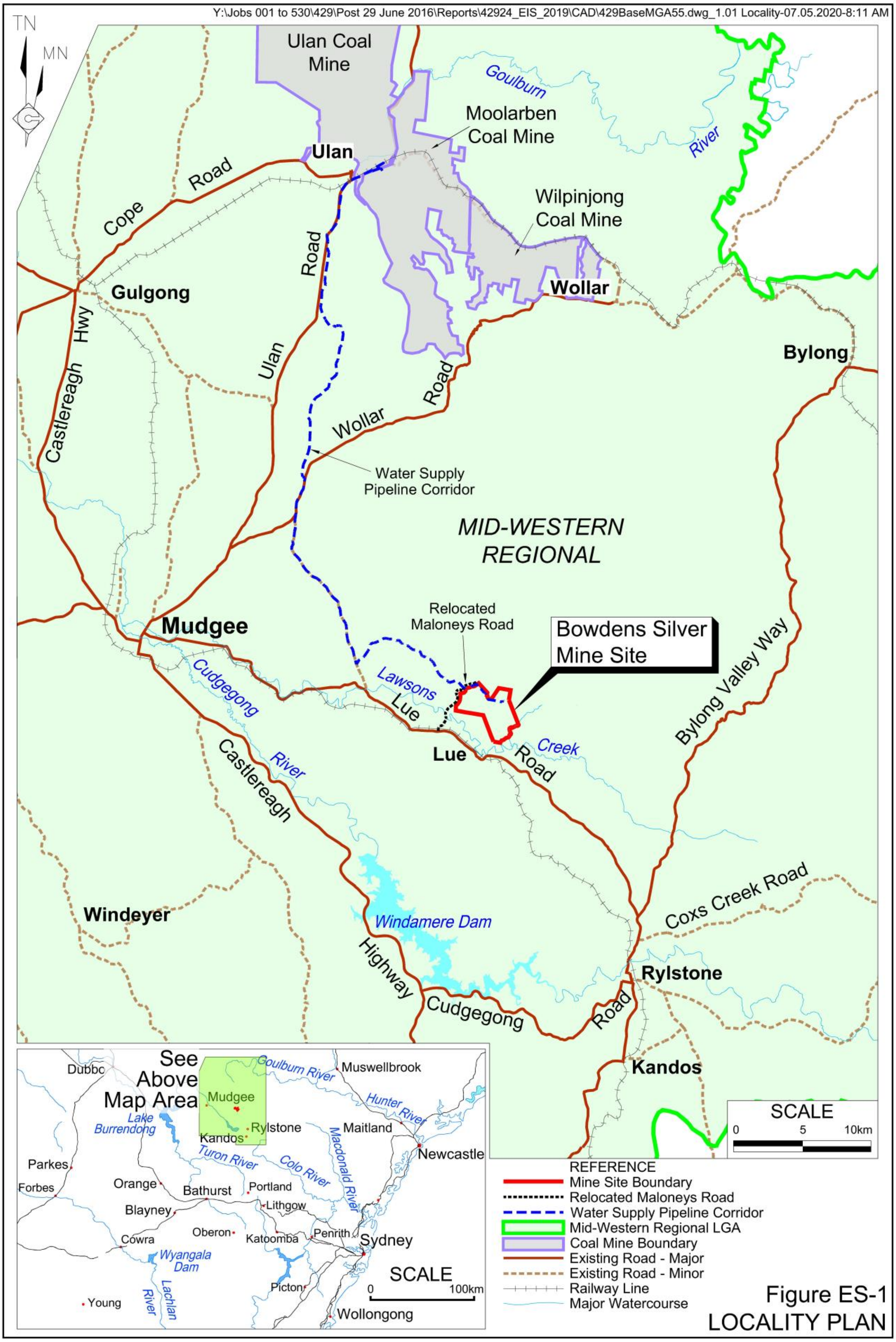


Figure ES-1
LOCALITY PLAN

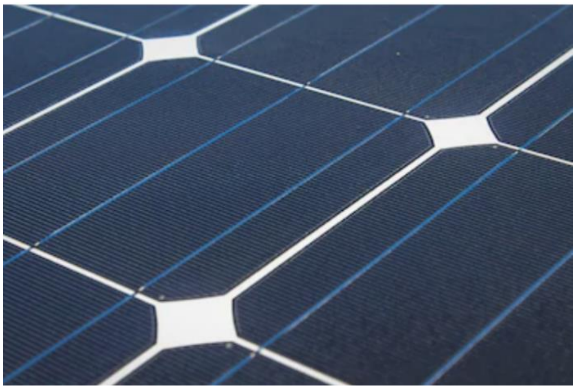


Plate ES-1 Photovoltaic Cells

Plate ES-2 Telecommunication Applications

Plate ES-3 Water Filters

Plate ES-4 Brazing Alloys and Solders

Bowdens Silver is controlled by a Board of Directors and management team with a comprehensive range of skills and experience in exploration, mine development, finance and administration.

PROJECT OBJECTIVES

The objectives of Bowdens Silver in developing and operating the Project are to:

- maximise the recovery of the silver, zinc and lead minerals from the defined ore reserves within the proposed open cut pits;
- undertake all activities in an environmentally and socially responsible manner to demonstrate compliance with relevant criteria and satisfy reasonable community expectations;
- ensure the health of its workforce and the surrounding community is not adversely affected;
- preserve the existing character of Lue;
- maintain a positive relationship with the surrounding agricultural industry and maximise productivity on land retained for agricultural production;
- provide a stimulus for the Mudgee, Rylstone, Kandos and district economies; and

- achieve the above objectives in a cost-effective manner to ensure the Bowdens Silver Project is economically viable.

LEGISLATION, PLANNING AND APPROVALS

Legislative Context

A range of Commonwealth and State legislation apply to the Project. Relevant legislation was reviewed to identify the suite of environmental aspects that need to be addressed in the Environmental Impact Statement. The key Commonwealth legislation relevant to the Project are as follows.

- *Native Title Act 1993*
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *National Greenhouse and Energy Reporting Act 2007*

The Project was referred to the Commonwealth Department of Energy and the Environment (DoEE) on 20 December 2018 (now the Department of Agriculture, Water and the Environment). On 5 April 2019 advice was received from the then DoEE that the Project was determined to be a controlled action under the EPBC Act due to the potential for impacts to listed threatened species and communities protected under Section 18 and Section 18A of the EPBC Act. The action is to be assessed under the bilateral agreement with the NSW Government.

The key NSW legislation relating to the approvals, leases and licences required for the Project are as follows.

- *Environmental Planning and Assessment Act 1979*
- *Mining Act 1992*
- *Protection of the Environment Operations Act 1997*
- *Water Management Act 2000*
- *Roads Act 1993*
- *Explosives Act 2003*

State and Local Planning Context

The *Environmental Planning and Assessment Act 1979* (EP&A Act) provides the framework for the assessment and determination of development applications in NSW and is administered by the Department of Planning, Industry and Environment.

Development consent is required under the EP&A Act for the purposes of mining in NSW. The Project has been submitted for approval under Part 4, Division 4.7 of the EP&A Act as a State Significant Development as the capital investment value for the Project would exceed the $30 million threshold for State Significant Development. This is because of the effect of Clause 8 and Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011*.

The Project has been designed with recognition of a number of relevant State planning instruments and regional strategic documents as well as the requirements of the *Mid-Western Regional Local Environmental Plan (LEP) 2012*.

The Mid-Western Regional LEP identifies that the Mine Site and relocated Maloneys Road are wholly located within land zoned RU1 – Primary Production with, open cut mining permissible with consent within this zone. The water supply pipeline corridor traverses land zoned RU1 – Primary Production and RU5 – Large Lot Residential. Water supply systems are permissible with consent on land zoned RU1 – Primary Production, however, they are prohibited on land zoned R5 – Large Lot Residential. In accordance with Section 4.38(3) of the EP&A Act, development consent may still be granted by the Minister for the development of the water supply pipeline on land zoned

R5 – Large Lot Residential as only part of the development is prohibited by the Mid-Western Regional LEP.

It is considered that the Project would be consistent with the Mid-Western Regional LEP and would not compromise the achievement of the relevant objectives of the plan.

Approvals Required

In addition to development consent, Bowdens Silver anticipates that the following key environmental and planning approvals, licences and leases would be required.

- An approval from the Commonwealth Minister for the Environment and Energy under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* as the Project has been determined to be a controlled action.
- An Environment Protection Licence under the *Protection of the Environment Operations Act 1997*.
- A Mining Lease(s) under the *Mining Act 1992*.
- Water Access Licences under the relevant water sharing plans under the Water Management Act 2000.
- Permits under the *Roads Act 1993* to undertake the proposed relocation of Maloneys Road, intersection works and the installation of the water supply pipeline beneath public roads.
- Appropriate approvals and licences from SafeWork NSW for the on-site storage (detonators, boosters/primers only) and use of explosives and notification of dangerous goods stored and used on site.

Other Agreements

The Project would require the following agreements in order to proceed as proposed. While not formal approvals, these agreements would be subject to terms as agreed between the relevant parties.

- Commercial agreements would be required with the relevant parties for the supply of make-up water from the Ulan Coal Mine and Moolarben Coal Mine.
- Agreements with the owners of residences that are predicted to experience noise levels generated by the Project at levels that exceed the assessment criteria in accordance with the NSW Government’s Voluntary Land Acquisition and Mitigation Policy (VLAMP).
- Although not a requirement, Bowdens Silver has volunteered to provide a further six landowners with mitigation (under agreement) where noise levels are predicted to only negligibly exceed the assessment criteria.
- The current Biodiversity Offset Strategy is for Biodiversity Stewardship Agreements to be sought over land within the Mine Site and other properties to establish areas for in-perpetuity biodiversity conservation in order that the residual biodiversity impacts of the Project are offset.
- Bowdens Silver has negotiated a range of agreements with landowners that would result in purchase or lease of properties should approval for the Project be granted. The details of these agreements are confidential, however, where appropriate, the property over which there is such an agreement is included in the EIS and relevant technical assessments as Project-related.

PROJECT BACKGROUND

The original exploration licences covering the “Bowdens” property and a number of surrounding properties were granted in 1989 and 1990 to CRA Exploration Pty Limited. In July 1989, follow-up exploration of an anomalous stream sediment sample and mineralised float, led to the discovery of outcropping sulphide-bearing rocks which assayed 860 parts per million silver, 1.0% zinc and 0.5% lead. Exploration drilling within the exploration licence has since been undertaken by a number of companies with the principal objective of delineating a mineral resource and ore reserve for the deposit.

In March 2016, Silver Mines Limited announced it had entered into a Sale and Purchase agreement with Kingsgate Consolidated Limited (Kingsgate) whereby it would acquire 85% of the Bowdens Silver Project. The purchase of the Bowdens Silver Project by Silver Mines Limited was completed on 29 June 2016. The acquisition of the remaining 15% of the Project was announced on 29 December 2016.

An Ore Reserve Statement, compliant with the JORC[1] Code, was completed for the Bowdens silver deposit in May 2018 based upon data from approximately 83 500m of drilling in 653 drill holes. The recoverable primary and low grade ore within the proposed open cut pits is estimated to be approximately 29.9 million tonnes at an average grade of 69g/t silver, 0.44% zinc and 0.32% lead. This corresponds to total in situ quantities of approximately 66.3 million ounces of silver, 130 000t of zinc and 95 000t of lead.

[1] 2012 Joint Ore Reserves Committee, i.e. the “Australian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves”.

NSW MINES NEAR POPULATION CENTRES

In recent years, mining has contributed significantly to the growth of some towns and cities in central western NSW such as Orange, Parkes and Mudgee and, in some cases, mining has co-existed on the edges of population centres such as Blayney, Peak Hill and Tomingley. It is noted that each of these latter population centres were/are closer to the mining operations than is proposed for the Bowdens Silver Project in respect to Lue.

Bowdens Silver acknowledges the concerns expressed by some community members in Lue regarding the proximity of Lue to the proposed Mine Site for the Project, particularly given many of the residents have not previously lived near a mine. Whilst it is acknowledged that some environmental issues arose during the operation of the Peak Hill and Tomingley mines, particularly during the site establishment and construction stage, the greater distance between Lue and the operational areas within the Mine Site, together with the early implementation of mitigation measures and specific procedures introduced for the Peak Hill and Tomingley Mines, would assist to substantially minimise and potentially avoid the environmental issues for the Bowdens Silver Project.

It is noted that no part of the Mine Site, the Tailings Storage Facility (TSF), the processing facilities or other related infrastructure will be visible from Lue.

It is further noted that, whilst the Project would result in a significant overall net benefit to the local, national and global economies, it would have a significantly smaller footprint than some other operations within the region (e.g. Ulan Coal Mine, Moolarben Coal Mine, Wilpinjong Coal Mine, Cadia Valley Operations). As such, the Project would be in a unique position to be able to provide maximum social and economic benefits to the community whilst its scale would limit potential impacts.

PROJECT DESCRIPTION

Overview

Figure ES-2 displays the indicative Mine Site layout which includes the following principal components.

- a main open cut pit and two satellite open cut pits, collectively covering approximately 52ha;
- a processing plant and related infrastructure covering approximately 22ha;
- a waste rock emplacement covering approximately 77ha;
- a low grade ore stockpile covering approximately 14ha, including 9ha that would be located on the waste rock emplacement);
- an oxide ore stockpile covering approximately 8ha;
- a tailings storage facility covering approximately 117ha; and
- the southern barrier to provide visual and acoustic protection to properties south of the Mine Site covering approximately 32ha.

The above components would be supported by a range of on-site and off-site infrastructure. The on-site infrastructure would comprise haul roads, water management structures, power/water reticulation, workshops, stores, compounds and offices/amenities. The off-site infrastructure would comprise a relocated section of Maloneys Road (including a new railway bridge crossing and new crossing of Lawsons Creek), a 132kV power transmission line and a water supply pipeline for the delivery of water from the Ulan Coal Mine and/or Moolarben Coal Mine to the Mine Site. It is noted that the 132kV power transmission line required for the mine power supply would be the subject of a separate Part 5 application submitted under the EP&A Act.

No smelting activities will be undertaken at the Project.

Site Establishment and Construction Stage

Mine Site

Bowdens Silver would undertake key site establishment and construction activities within the Mine Site during an approximate 18 month period following receipt of development consent and all other necessary approvals, licences and leases. These activities would include the following

- Preparatory activities for the establishment of infrastructure and Mine Site components. This includes all vegetation clearing and preliminary environmental controls.
- Pre-strip of the main open cut pit to remove waste rock material above the identified ore materials and to prepare the area for mining.
- Civil works to allow for the construction of the pads for the processing plant, mining facility, run-of-mine pad, crushed ore stockpile, raw water pond and the 1ML capacity dewatering pond.
- Construction of the various plant items or infrastructure and commissioning of the processing plant.
- Construction of the initial embankment of the tailings storage facility (Stage 1).

Off-site Road Network

The off-site road network would be constructed during the initial 6 months of the site establishment and construction stage. The key activities that would be undertaken during this period would include the following.

- Construction of the relocated Maloneys Road.
- Construction of the relocated Maloneys Road/Lue Road Intersection.

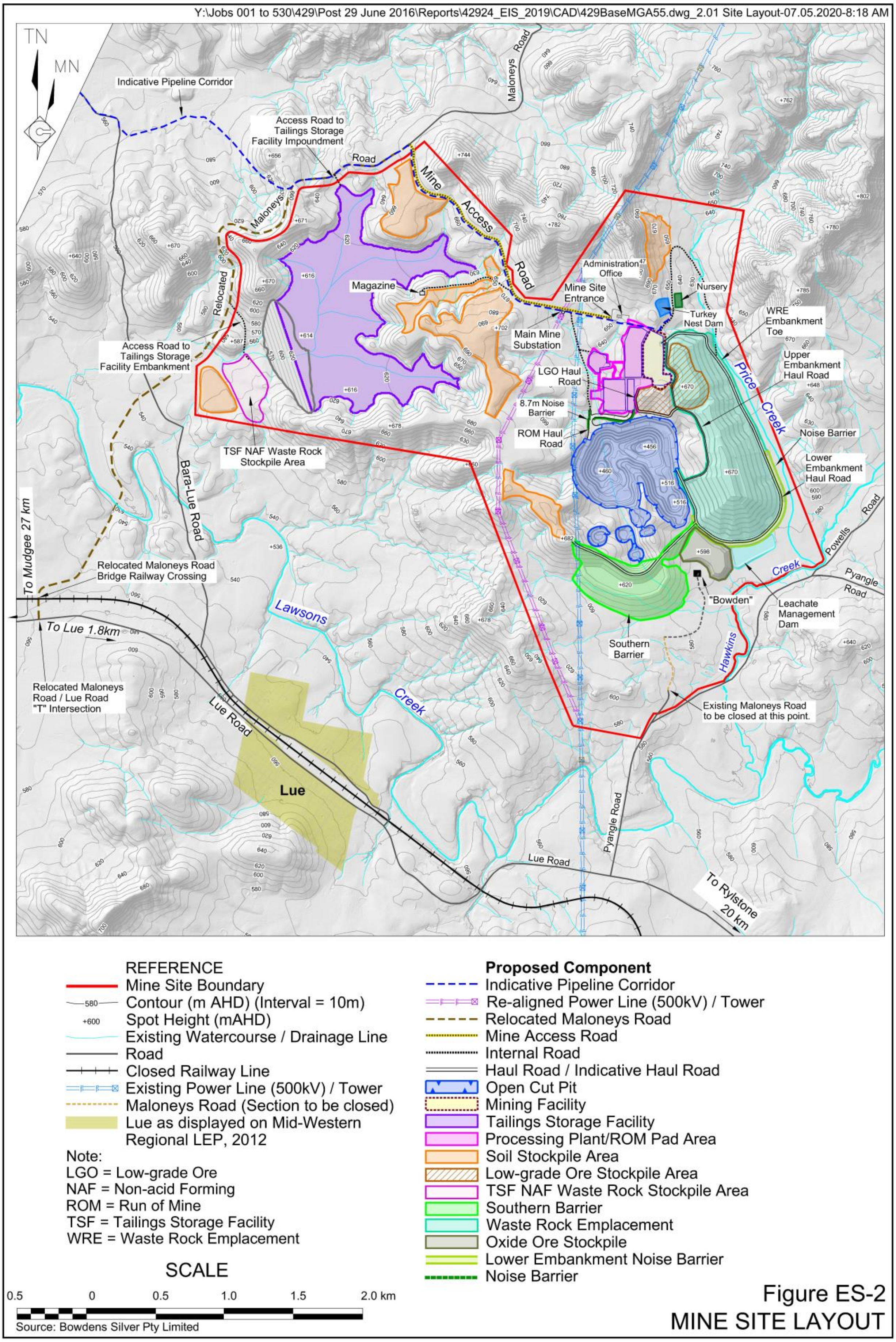


Figure ES-2
MINE SITE LAYOUT

- Construction of the new crossing across Lawsons Creek.
- Construction of the relocated Maloneys Road Rail Bridge.

Water Supply Pipeline Corridor

The construction of the water supply pipeline would occur over a 10 month period (i.e. from Month 7 to Month 16 of the site establishment and construction stage).

Mining Operations

Following removal of vegetation and soil materials, mining would commence with the removal of any friable weathered materials. These materials would be directly extracted using an excavator or ripped and pushed up using a bulldozer and loaded into haul trucks using an excavator or front-end loader. Extracted material would be loaded into haul trucks for transportation to the waste rock emplacement, low grade ore stockpile or other locations where waste rock is being used for construction of infrastructure.

Following removal of the friable weathered materials, the bulk of the ore and waste rock would require blasting. Following completion of each blast, boundaries between ore and each type of waste rock would, if required, be identified and marked out. Fragmented material would then be loaded into haul trucks using an excavator. Ore would be transported to the run-of-mine pad and stockpiled prior to being processed.

Waste Rock Management

Material containing insufficient quantities of silver, zinc and/or lead to justify processing would be identified as part of infill drilling. Potentially-acid forming waste rock would be directed to the waste rock emplacement for placement and encapsulation. All non-acid forming waste rock would be used for on-site construction activities such as the staged development of the tailings storage facility embankment, backfilling of satellite pits east and west, placed in the southern barrier for subsequent retrieval and for rehabilitation activities.

Low Grade and Oxide Ore Stockpiling

Low grade ore and oxide ore generated by the mining operations throughout the mine life would be stockpiled. Processing of these materials would be dependent upon either the economic conditions (low grade ore) or treatment (processing) requirements (oxide ore). In the event they are not processed, quantities of the low grade ore and oxide ore may remain in part, or in full at the end of the Project life.

Processing Operations

Bowdens Silver proposes to process all ore extracted from the open cut pits using an on-site processing plant to produce a silver/lead concentrate and a zinc concentrate (with a small content of silver). Bowdens Silver would produce approximately 310 000t of mineral concentrates throughout the mine life, approximately 60% of which would be zinc concentrate and approximately 40% silver/lead concentrate. The bulk of the silver recovered would be within the silver/lead concentrate. Annual production of mineral concentrates would vary from approximately 20 000t to 30 000t, with the quantity and proportion varying annually and reflecting the proportion of the recovered minerals in the ore extracted.

The processing plant has been designed to process approximately 2 million tonnes per annum of run-of-mine ore to produce silver/lead and zinc concentrates using sequential flotation. The processing plant would include the following principal components.

- A single stage primary jaw crusher.
- A crushed ore stockpile and reclaim.

- A semi-autogenous grinding mill, ball mill and pebble crusher.
- Reagent mixing and distribution including sodium cyanide and other reagents.
- A silver/lead flotation circuit comprising roughers, rougher concentrate re-grind and cleaners.
- Silver/lead concentrate thickening and filtration.
- A zinc flotation circuit comprising roughers, rougher concentrate re-grind and cleaners.
- Zinc concentrate thickening and filtration.
- Concentrate bagging/containerisation facilities and storage.
- Tailings thickening and pumping.

Tailings from the flotation circuits would be pumped to the tailings thickener where flocculant would be added to assist fine particle settling. The thickened tailings underflow (approximately 56% solids by weight) would be pumped to the tailings storage facility for storage and further water (decant) recovery. Recovered water from the tailings storage facility would be collected at a floating pontoon and pumped to the process plant water tank for re-use in the processing plant.

Transportation and Traffic

Access to the Mine Site is currently provided via Lue Road, Pyangle Road and Maloneys Road. Lue Road is the main road between Mudgee and Rylstone whilst Pyangle Road and Maloneys Road are local roads.

Access to the Mine Site during the early stages of the site establishment and construction stage (until approximately the end of Month 6) would be provided by the existing road network, i.e. principally using Pyangle Road (from Lue Road) and Maloneys Road. Access to the Mine Site during the latter stages of the site establishment and construction stage (from about Month 7) and the entire operational stage would be via Lue Road, relocated Maloneys Road and the mine access road.

Whilst it would be necessary for some heavy vehicles accessing the Mine Site during the initial 6 months of the site establishment and construction stage to transit through Lue, it is envisaged that by establishing access to the Mine Site from Lue Road to the west of Lue early in the development of the Project, very few heavy vehicles delivering components and consumables would pass through Lue in order to gain access to the Mine Site.

Operational traffic movements would principally be generated by mine and exploration personnel attending or departing the Mine Site for work. In order to limit traffic generation at key shift changeover, Bowdens Silver proposes to offer bus transportation to employees, in addition to adopting staggered shifts times across the administration, mining, processing and maintenance functions.

Based on the annual production of between 20 000t and 30 000t of mineral concentrates, average daily product despatches would be approximately one to three truckloads generating two to six heavy vehicle movements Monday to Saturday, public holidays excluded. B-double trucks would be used to transport the concentrate containers in order to maximise the load carried and minimise the number of truck movements. Additional truck movements would be generated by the delivery of equipment and consumables necessary for the operation of the Project.

Water Supply and Licensing

Once operations commence, water would be required principally for the processing of ore with lesser quantities required for dust suppression on the crushing and screening equipment and haul roads throughout the Mine Site. Average water use would require up to approximately 5.0ML of water per day when it peaks in Year 8 of operations.

Water sources for the Project would include the following sources listed preferentially in order and type of use.

1. Surface water collected by the leachate management dam for recycling and reuse in processing operations.
2. Groundwater and surface water accumulating within the open cut pit for recycling and reuse in processing operations.
3. TSF return decant water for recycling and reuse in processing operations.
4. Surface water collected within the sediment dams (but unsuitable for release) or authorised under harvestable rights entitlements for use in dust suppression activities.
5. External supply of excess water from the Ulan Coal Mine and/or Moolarben Coal Mine via a dedicated water supply pipeline.

In order to ensure sufficient water is available on a continuous basis for processing and dust suppression, Bowdens Silver proposes to construct a buried pipeline from the Ulan Coal Mine and the Moolarben Coal Mine to the Mine Site that could convey up to 5.5ML of water per day, thereby removing any uncertainties related to the availability of other water sources on site. Surplus water from the Ulan Coal Mine and/or Moolarben Coal Mine would be pumped to the Mine Site via the proposed water supply pipeline in accordance with commercial agreements between the parties. All water sourced via the water supply pipeline would be pumped to a turkeys nest dam with any excess diverted to the TSF.

Water sourced via the water supply pipeline would preferentially be treated near the initial section of the pipeline and be subject to commercial arrangements. This would permit better quality water to be pumped within the pipeline and to be received at the Mine Site.

Given the number of options available within and externally for the supply of water to the Mine Site, Bowdens Silver is confident that suitable contingencies are in place should the recently experienced drought conditions continue.

The predicted maximum annual water access licence requirement from the respective water sources during mining would be as follows.

- *NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* - Sydney Basin Murray Darling Basin Groundwater Source – 194ML.
- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011* Lachlan Fold Belt Murray Darling Basin Groundwater Source - (Other) Management Zone – 907ML.
- *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Source 2012* – Lawsons Creek Water Source – 136ML.

These requirements include groundwater inflows to the open cut pit, surface water captured due to the construction of the TSF and the predicted baseflow reduction to Lawsons Creek and Hawkins Creek.

Bowdens Silver has secured sufficient allocation to account for peak groundwater inflows during mining and would secure the necessary surface water licence allocation prior to determination of the application.

Project Life and Operational Hours

The Project would require a site establishment and construction period of approximately 18 months during which the processing plant and all related infrastructure and the initial embankment of the tailings storage facility would be constructed. Once operational, Bowdens Silver anticipates the mine would produce concentrates for approximately 15 years. In total, it is proposed the mine life would be approximately 16.5 years, i.e. from the commencement of the site establishment and construction stage to the completion of concentrate production. It is envisaged rehabilitation activities would be completed over a period of approximately 7 years, i.e. from Year 16 to Year 23. **Figure ES-3** displays the duration of each of the main components throughout the mine life and Project life.

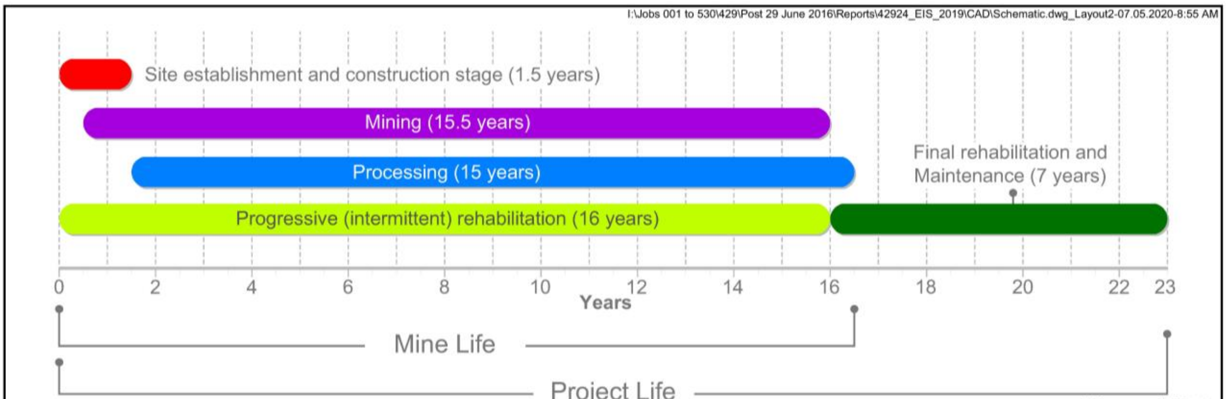


Figure ES-3
MINE LIFE AND PROJECT LIFE

Table ES-1 presents the proposed operating hours during the site establishment and construction stage.

Table ES-2 presents the proposed operating hours throughout the remainder of the Project life.

Table ES-1
Site Establishment and Construction Stage Operating Hours

Activity	Days	Hours
Site Earthworks and Infrastructure (and within main open cut pit)	Monday – Friday	7:00am – 10:00pm[1]
	Saturday	7:00am – 6:00pm
Processing Plant	Monday – Friday	7:00am – 10:00pm[2]
	Saturday	7:00am – 6:00pm
Tailings Storage Facility	Monday – Friday	7:00am – 6:00pm[3]
	Saturday	7:00am – 6:00pm[3]
Off-site Road Construction	Monday – Friday	7:00am – 6:00pm[3]
	Saturday	8:00am – 1:00pm
Water Pipeline and Transmission Line Installation	Monday – Friday	7:00am – 8:00pm[3]
	Saturday	8:00am – 6:00pm[3]

1. Subject to demonstrating noise limits can be satisfied during this period
2. Only low-noise/inaudible activities would be undertaken beyond 6:00pm during the latter stages of construction and commissioning
3. Daylight hours only

Table ES-2
Operational Stage Operating Hours

Activity	Days	Hours
Clearing / topsoil and subsoil removal	Monday – Saturday[1]	7:00am – 6:00pm[2]
Blasting	Monday – Saturday[1]	10:00am – 4:00pm
Mining	7 days	7:00am – 6:00pm[3]
Non-acid forming waste rock transfer to the tailings storage facility embankment	Monday – Saturday[1]	7:00am – 6:00pm
Processing	7 days	24hrs
Concentrate Despatch	Monday – Saturday[1]	7:00am – 6:00pm[4]
Maintenance	7 days	24hrs
Rehabilitation	Monday – Saturday[1]	7:00am – 6:00pm[2]

1. Public Holidays excluded.
2. Daylight hours only.
3. Operations outside these times dependent upon demonstrating noise limits can be satisfied
4. Excluding 7:30am to 8:30am and 3:30pm to 4:30pm (School bus period).

Rehabilitation and Final Landform

Rehabilitation of all areas disturbed by mining-related activities would be an integral part of the Project. Emphasis would be placed upon progressively creating final landforms, wherever practicable, and re-establishing soil profiles and vegetation essential to achieving the preferred final land use(s) during and following the cessation of operations. The nature of the Project dictates, however, that the disturbed areas associated with the main open cut pit, processing area and tailings storage facility would remain active throughout the mine life and, as a consequence, the opportunity to undertake progressive rehabilitation of these components would be minimal. **Figure ES-4** displays the final landform across the Mine Site at the end of the Project life.

CONSULTATION

Consultation has been undertaken to inform the community and government agencies about the Project and to gain an understanding of the issues that need to be considered by Bowdens Silver and addressed in the Environmental Impact Statement.

Initial community consultation for the Project was undertaken by Kingsgate prior to the 2012 exploratory drilling programs. Since acquiring the Project in 2016, Bowdens Silver has undertaken extensive community consultation throughout the design stages of the Project and during the environmental and social assessments for the *Environmental Impact Statement*. Consultation has been undertaken using a range of forums and formats including, but not limited to, a program of individual landowner consultation, distribution of newsletters / Project information sheets, the establishment of a website, a series of Community Information Days and a Community Consultative Committee (CCC).

As part of the wider Social Impact Assessment undertaken by Umwelt (Australia) Pty Limited to inform the Project design, a program of research and engagement was also undertaken.

ENVIRONMENTAL FEATURES SAFEGUARDS AND IMPACTS

The components and features of the existing environment within and in the vicinity of the Mine Site have been studied in detail and used to inform the design of the Project to avoid or minimise potential impacts. The Mine Site is situated on the outer western flanks of the Great Dividing Range which is dominated by elevated rocky ridges separated by either broad and flat or partially confined alluvial valley settings.

The Mine Site is located within a rural area principally used for cattle and sheep grazing. A total of 28 privately-owned rural residences are located within 3km of the edge of the closest open cut pit with four of these residences located within 2km. All residences within Lue lie between approximately 2km and 3km southwest of the closest open cut pit. **Figure ES-5** displays the surrounding land ownership and residence locations used to inform the design of the Project and the assessment of potential environmental impacts.

The following provides a brief overview of the main components of the existing environment, the proposed safeguards to be implemented to minimise adverse effects and the assessed level of impact(s) arising from the Project.

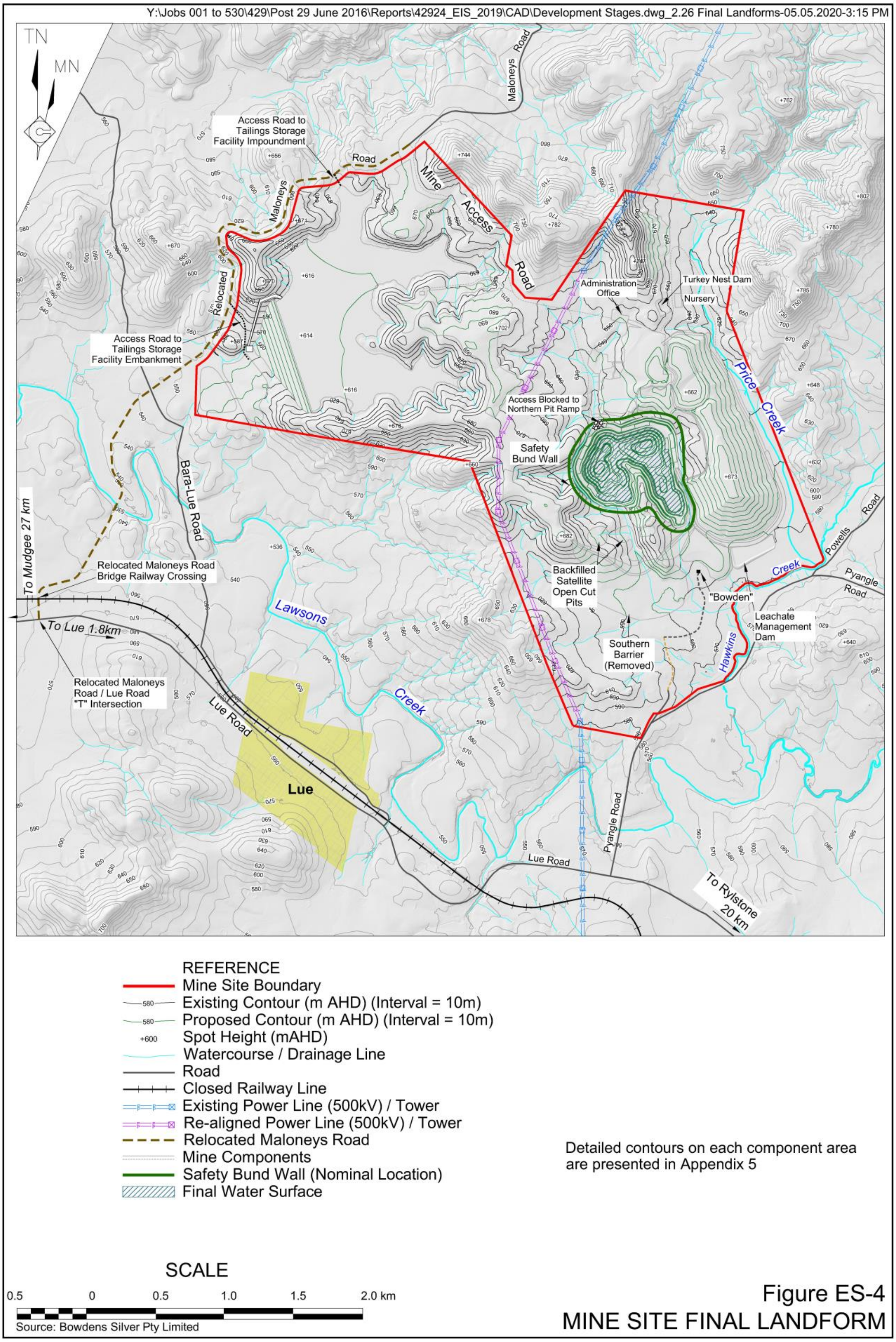


Figure ES-4
MINE SITE FINAL LANDFORM

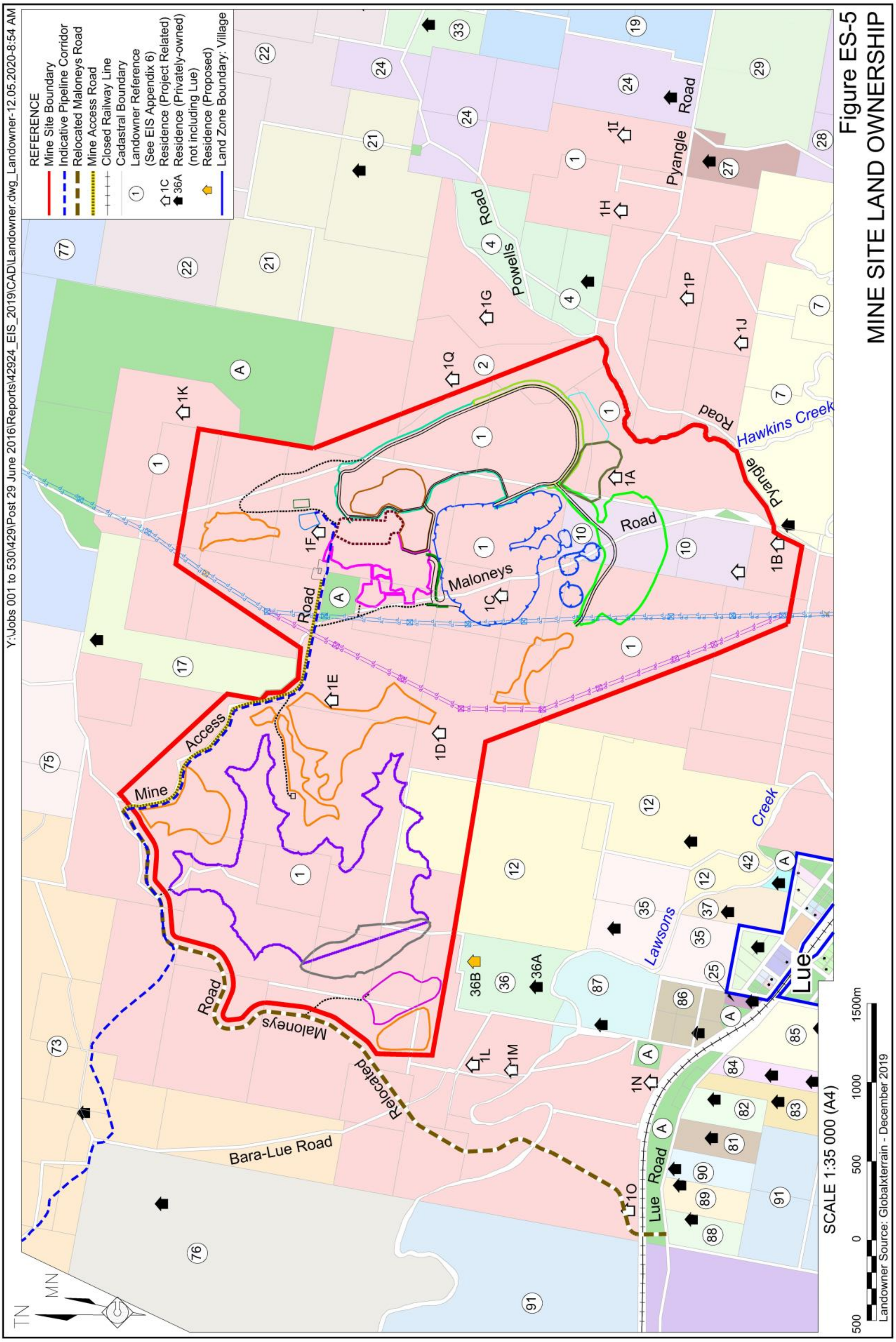


Figure ES-5
MINE SITE LAND OWNERSHIP

Noise

During mining and processing operations, the day-time and evening / night-time Project Noise Trigger Levels would be satisfied at all residences and receivers in the vicinity of the Mine Site with the exception of eleven of the closest privately-owned residences. These outcomes would be managed in accordance with the NSW Government's Voluntary Land Acquisition and Mitigation Policy (VLAMP) with ongoing management designed to minimise the risk of impact.

Background noise measurements around the Mine Site and within Lue have established that the existing day-time noise levels are low and typically in the range 25dB(A) to 30dB(A). Background noise levels of an evening and night are also low and typically around 25dB(A) or less. A suite of meteorological data has also been assembled to assist in predicting noise levels attributable to the Project.

The day-time Construction Noise Management Level for the first 6 months of the site establishment and construction stage would be $L_{Aeq15min}$ 45dB(A). From Month 7 onwards and throughout the entire Project operation, the day-time Project Noise Trigger Level would be 40dB(A) whereas for evening and night-time operations, the Project Noise Trigger Level would be 35dB(A).

Management of noise impacts throughout the operation of the Project would involve the following.

- The use of noise-attenuated mobile equipment.
- Restrictions on the number and location of mobile equipment items used.
- Restricted operations of an evening and night-time.
- The use of interim or long-term noise barriers.
- Full or partial enclosure of noisy fixed plant.
- Use of predictive meteorological forecasting.
- A regime of real-time noise monitoring.
- Regular liaison with surrounding landowners to inform and/or discuss any noise-related issues.
- Adaptive site management.

During the site establishment and construction stage, the Construction Noise Management Level would be satisfied at all privately-owned residences and receivers except for the following.

1. Road construction activities during the construction of the new Lue Road / relocated Maloneys Road intersection – throughout a period of approximately 1 to 2 months: at five residences.
2. Water supply pipeline installation, principally when the trench for the pipeline is being excavated – throughout a period of 1 to 2 days: at seven residences (sequentially).

During mining and processing operations, the day-time and evening / night-time Project Noise Trigger Levels would be satisfied at all residences and receivers in the vicinity of the Mine Site with the exception of eleven of the closest privately-owned residences. **Table ES-3** presents a summary of the operational noise assessment outcomes in accordance with EPA *Noise Policy for Industry* (2017) and the VLAMP. **Figures ES-6**, **ES-7** and **ES-8** present the outcomes of the operational noise impact assessment during the daytime, evening and night periods, respectively. It is noted that these outcomes include Project-related residences.

Table ES-3
Noise Impact Assessment Outcomes (under the Voluntary Land Acquisition and Mitigation Policy)

Predicted noise exceedances	Predicted impact	No. of residences	Bowdens Silver's approach
No exceedance	Acceptable (but not inaudible at all times)	112	No mitigation actions required at the residences
1-2dB(A)	Negligible	6	No mitigation actions required, however, Bowdens would commission a builder and acoustic technician to visit properties to assess measures to improve properties
3-5dB(A)	Marginal	4	Mitigation to the dwelling may include air conditioning, double window glazing, other façade and roof upgrades etc.
>5dB(A)	Moderate (day/evening) Significant (Night)	1	Flexibility in mine operation, in noise enhancing weather conditions. Offer acquisition or enter into an agreement with compensation.

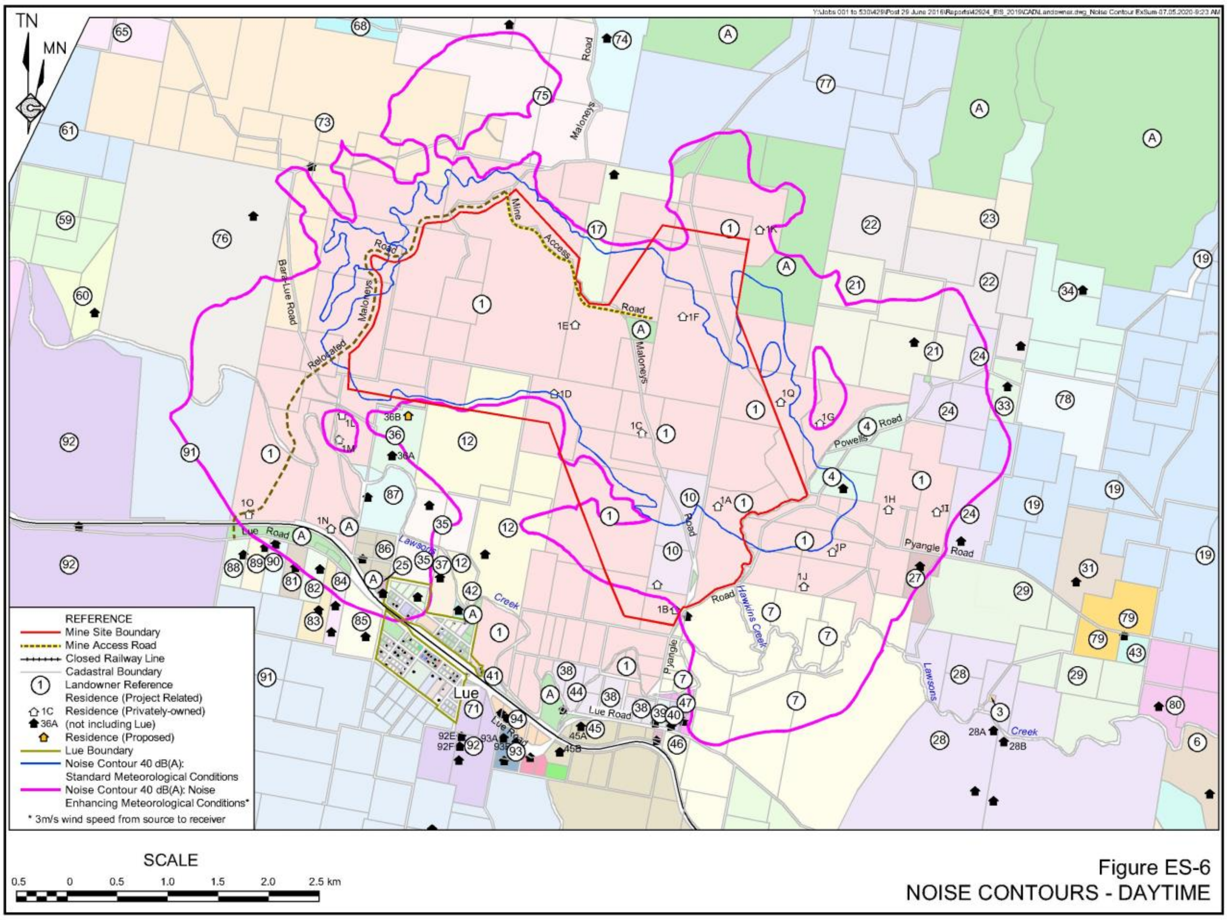


Figure ES-6
NOISE CONTOURS - DAYTIME

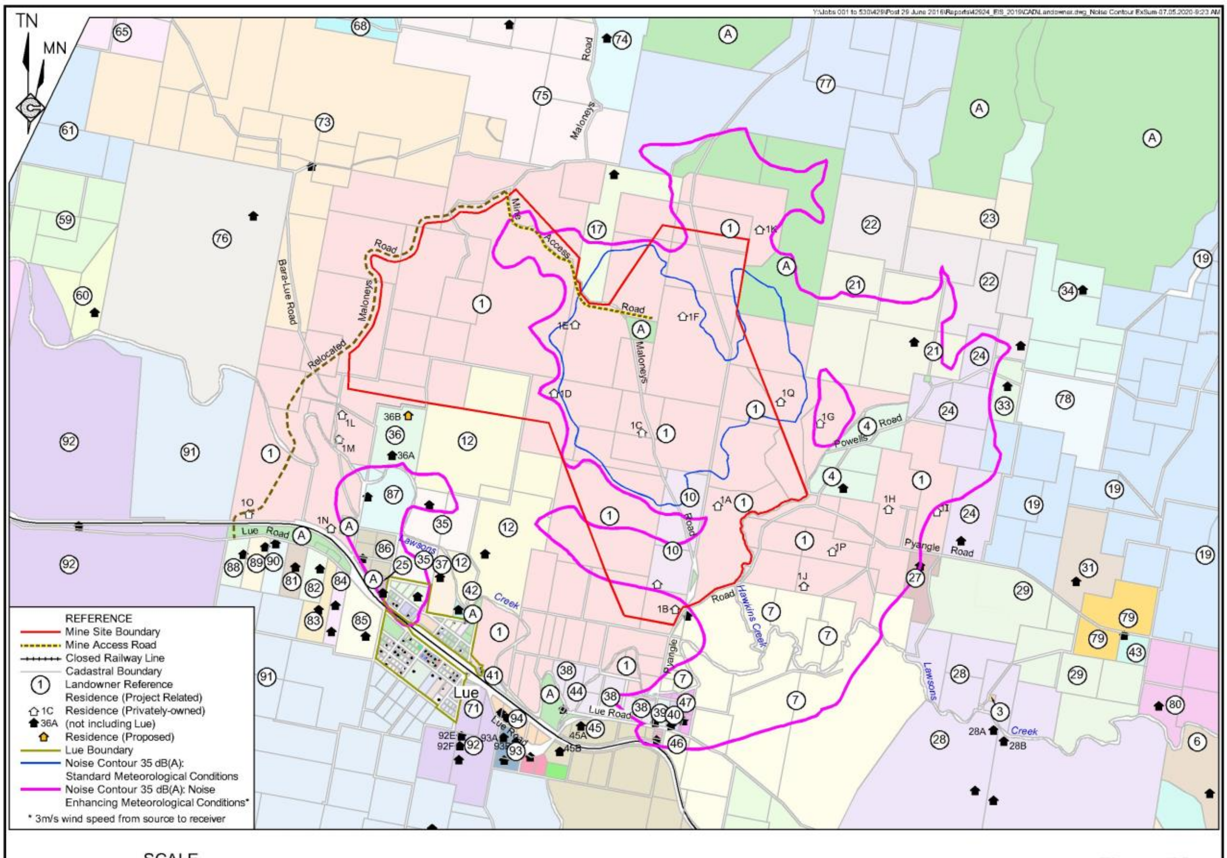


Figure ES-7
NOISE CONTOURS - EVENING

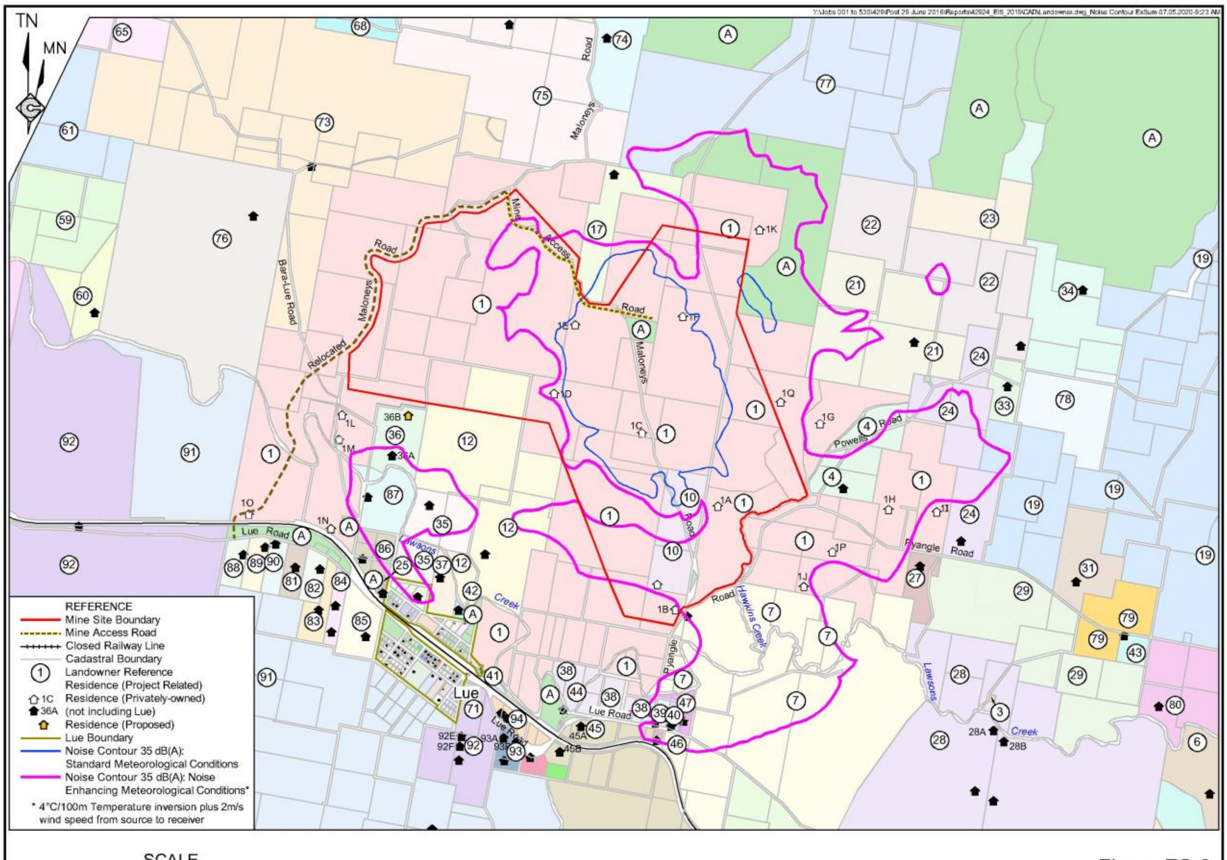


Figure ES-8
NOISE CONTOURS - NIGHT TIME

Bowdens Silver proposes to enter into agreements with the owners of the four residences where exceedances of 3dB(A) to 5dB(A) are predicted, to mitigate predicted noise levels at the properties through architectural improvements determined during an inspection of the residence by an acoustic specialist and experienced builder. Bowdens Silver has also offered the remaining six landowners the opportunity to enter into an agreement to install relevant mitigation measures as agreed by the landowner despite any requirement to do so under the VLAMP.

It is acknowledged that whilst the Project Noise Trigger Levels would be satisfied at all other residences around the Mine Site and within Lue, the existing low background noise levels would result in noise generated within the Mine Site being periodically audible external to residences located up to approximately 3km from the Mine Site. This would include the bulk of Lue and a number of the surrounding rural lifestyle blocks. Mine noise levels may also be discernible external to residences at distances greater than approximately 3km from the Mine Site subject to the prevailing background noise level, the extent of the intervening topography and disposition of the receiver (i.e. a resident going about their daily activities or standing silent listening for distant mine noise).

Predicted road traffic noise levels at two residences 10m and 15m away from Lue Road would be above the relevant vibration criteria during the first 6 months of the site establishment and construction stage. During the remainder of the site establishment and construction stage and throughout the operational stage of the Project, predicted traffic noise levels would be compliant at all privately-owned residences. There would be a minor impact from the increases in traffic travelling past Lue Public School, however, the impact is assessed as minor, particularly given the existing level of traffic passing the school generates noise levels over the nominated noise criterion for a school.

Bowdens Silver is committed to operating the Project in accordance with Noise Management Plans (i.e. one for the site establishment and construction stage and one for all mining and processing operations) with at least two real-time noise monitors to assist in maximising the opportunities to pre-emptively adjust operations to comply with the Construction Noise Management Levels and Project Noise Trigger Levels.

Blasting and Vibration

In order to ensure the impacts from blasting associated with the Project are minimised, each blast would be designed to ensure compliance with the relevant blasting criteria. Based upon the assessment of indicative blast designs and maximum instantaneous charges for the blasts in both ore and waste rock, the blasting and vibration assessment has predicted there would only be minor exceedances of the relevant amenity blast criteria at three residences, two of which would be the subject of a Voluntary Land Acquisition and Mitigation Policy agreement.

All residents within 2km of the open cut pits would be informed of the proposed blasting schedules, noting that most of the blasts in the first six years of operation would not be located at the closest point of the open cut pits to privately-owned residences.

Prior to the commencement of blasting, Bowdens Silver would commission structural surveys of residences within a 2km radius of the open cut pit limits, subject to access being provided by the landowner/occupier.

All blasts would be monitored to enable continuous refinement of blasting practices and the development and updating of site laws based on blast monitoring results.

Blasting personnel would iteratively design all blasts based upon the refined site blast laws that would be developed over time through monitoring and feedback of outcomes from blasting within the open cut pits to avoid any exceedances at all privately-owned residences.

Monitoring of the impacts associated with blasting and vibration would be undertaken in accordance with a Blast Management Plan.

Air Quality

The air quality modelling predicts that there would be no exceedance of annual average TSP, PM_{10} and $PM_{2.5}$, maximum 24-hour average PM_{10} and $PM_{2.5}$, or dust deposition criteria at any privately-owned residences or receivers, either from the Project alone or cumulatively.

Furthermore, no exceedances of the impact assessment criteria are predicted at any Project-related or private residences for metal dust concentrations, respirable crystalline silica or hydrogen cyanide.

The qualitative assessment for the water supply pipeline concludes that, given the limited footprint of disturbance and fact that construction activities would only be occurring at any one location for a limited period of time, with the implementation of the proposed management measures, the potential for dust impacts from the water supply pipeline are very low.

An extensive air quality monitoring network was established for the Project in order to characterise the existing ambient air quality environment. Using collected data, the baseline air quality presented in **Table ES-4** has been established and used for assessment purposes.

A suite of meteorological data has also been assembled to assist in modelling dust emissions attributable to the Project.

Table ES-4
Adopted Background for Cumulative Assessment

Pollutant	Averaging period	Adopted background value
PM_{10}	24-hour average[1]	Daily varying with a maximum of 43.7µg/m³
	Annual average	13.6µg/m³
$PM_{2.5}$	24-hour average	Daily varying with a maximum of 15.4µg/m³
	Annual average	3.9µg/m³
TSP	Annual average	30.7µg/m³
Dust deposition	Annual average	1g/m²/month

1. Calculated based on the highest measured concentration across each site for each day, except for the two days that the BAM1 measurement was already at or above the impact assessment criterion due to regional dust storms.

Source: Ramboll (2020) – Table 5.3

Potential air quality impacts resulting from construction and operational activities at the Mine Site have been quantitatively assessed using a Level 2 assessment in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA, 2016). A qualitative assessment was also undertaken for emissions associated with the water supply pipeline.

Management measures which have been applied in the modelling (as applicable) include the following.

- Application of a site-wide vehicle speed limit and confinement of vehicle travel to designated routes to reduce wheel-generated dust.
- Haul roads would be actively maintained and watered to reduce wheel-generated dust.
- Progressive rehabilitation (both temporary and long-term) of disturbed areas.
- Minimisation of travel speed and the distance travelled by bulldozers and coordination of activities to reduce push and haul distances and double handling.

- Minimising drop heights when loading ore, waste rock, and soil.
- Enclosure of the run-of-mine feed hopper on three sides and water application during crushing.
- Use of water sprays and/or dust aprons/collectors for drill rigs.

In addition to these management measures, a proactive air quality management system would be adopted using a combination of the following.

- Meteorological forecasts – to predict when the risk of dust emissions may be high (due to adverse weather) in specific directions around the Mine Site and allow procedures and preparatory measures to be implemented.
- Visual monitoring – to provide an effective mechanism for proactive control of dust at source. For example, using the NSW EPA Dust Assessment Handbook, visual triggers for unacceptable dust at source (e.g. wheel-generated dust above tray height) are established to determine the need for action and response.
- Real-time meteorological and air quality monitoring – to provide alerts for appropriate personnel when short-term dust levels increase, to allow management of the location and intensity of activities or increased controls.

These management measures and the proactive air quality management system would be outlined within an Air Quality Management Plan prepared for the Project.

Greenhouse Gas

The predicted annual average Scope 1 Greenhouse Gas emissions generated by the Project would represent approximately 0.02% of total Greenhouse Gas emissions for NSW and 0.004% of total Greenhouse Gas emissions for Australia. Given Australia's contribution to global greenhouse gas emissions is approximately 1.3%, the contribution of the Project to global emissions is approximately 0.000052%.

Based upon conservative assumptions, the total estimated Greenhouse Gas emissions for the Project over the life of the mine are as follows.

- Scope 1: 444 442t CO_2-e (~31% total)
- Scope 2: 812 319t CO_2-e (~57% total)
- Scope 3: 166 055 CO_2-e (~12% total)

  Total: 1 422 816 CO_2-e

The Greenhouse Gas emission estimates are conservative as they do not account for the offset of emissions through the increase in vegetative biomass that would be achieved within the biodiversity offset areas to be established for the Project or the return of vegetative biomass through progressive rehabilitation. Therefore, the inclusion of Greenhouse Gas emissions from vegetation clearing without inclusion of the subsequent emission offsets provides a highly conservative estimate of the Scope 1 emissions.

Furthermore, in relation to Scope 3 emissions, allowance has not been provided for the use of silver in the production of 'green' power generation, such as the production of photovoltaic (solar) cells and other electrical applications. Based on world silver supply/demand data, approximately 7% to 8% of total silver demand is for use in photovoltaic production and 21% to 23% for other electrical fabrication purposes.

In comparison to other metal ore mining projects, the Project's Scope 1 emissions are less than half of the average. They are also significantly lower than emissions from coal mining operations and would produce a product that is an important component of 'green' power generation in the form of photovoltaic cells and which can be recycled for ongoing use and benefit.

Groundwater

Based on the outcomes of the groundwater modelling and assessment, it is considered that potential impacts to the groundwater setting are well understood and would be acceptably managed through the implementation of the Water Management Plan that includes a program for ongoing groundwater monitoring and management.

A Groundwater Assessment has been prepared by Jacobs (2020) to assess the possible risks to groundwater resources associated with the Project including impacts to water supply bores, streamflow and natural ecosystems that are dependent on groundwater. The assessment has been informed by local groundwater investigations that have been completed since 1998 and a groundwater monitoring program that commenced in 2012. The previous investigations and ongoing monitoring were used to develop an understanding of the groundwater setting, including geological and hydrogeological factors, groundwater levels and groundwater quality. A numerical groundwater model was developed that simulates the regional groundwater system and known influences on the existing hydraulic behaviour of the system.

The numerical groundwater model was subjected to a peer review by Dr Noel Merrick of SLR Consulting Pty Ltd that considered the approach and assumptions used in developing modelling scenarios, steady-state and transient calibration methods and outcomes and the sensitivity analysis of key inputs to the modelling.

The principal changes to the groundwater setting would be caused by groundwater inflows to the open cut pit as it is developed and subsequent drawdown to the regional water table and minor reduction to baseflow contributions to Hawkins Creek and Lawsons Creek.

Based on modelling predictions, the key residual impacts to the groundwater system as a result of the Project include the following.

- During the mine life, groundwater inflow rates are predicted at an average of 2.4ML/day, with a peak of 3.5ML/day and peak annual inflow of 1 066ML/year predicted in Year 4 of mining.
- Post-mining, the extent of drawdown would expand to an approximate maximum extent over 16 years, with further minor variations expected for 50 years. Post-mining inflows would progressively decrease over time as an equilibrium is reached in the open cut pit lake. Inflows of 133ML/year would be expected 200 years after mining has ceased due principally to evaporation from the surface of the open cut pit lake. The extent of drawdown 50 years post-mining is presented in **Figure ES-9**.
- In the final landform, the main open cut pit lake would act as a groundwater sink that would draw groundwater to the lake (as a result of evaporative pressure). As a result, salinisation of the water would intensify over time, however, would remain within the lake. Surface water would be diverted away from the open cut pit lake in the final landform with a final water level approximately 20m to 26m below any potential point of discharge.
- A potential decrease in water level of greater than 2m at two registered groundwater bores may occur. However, closer examination of these locations indicates that this level of impact is unlikely.

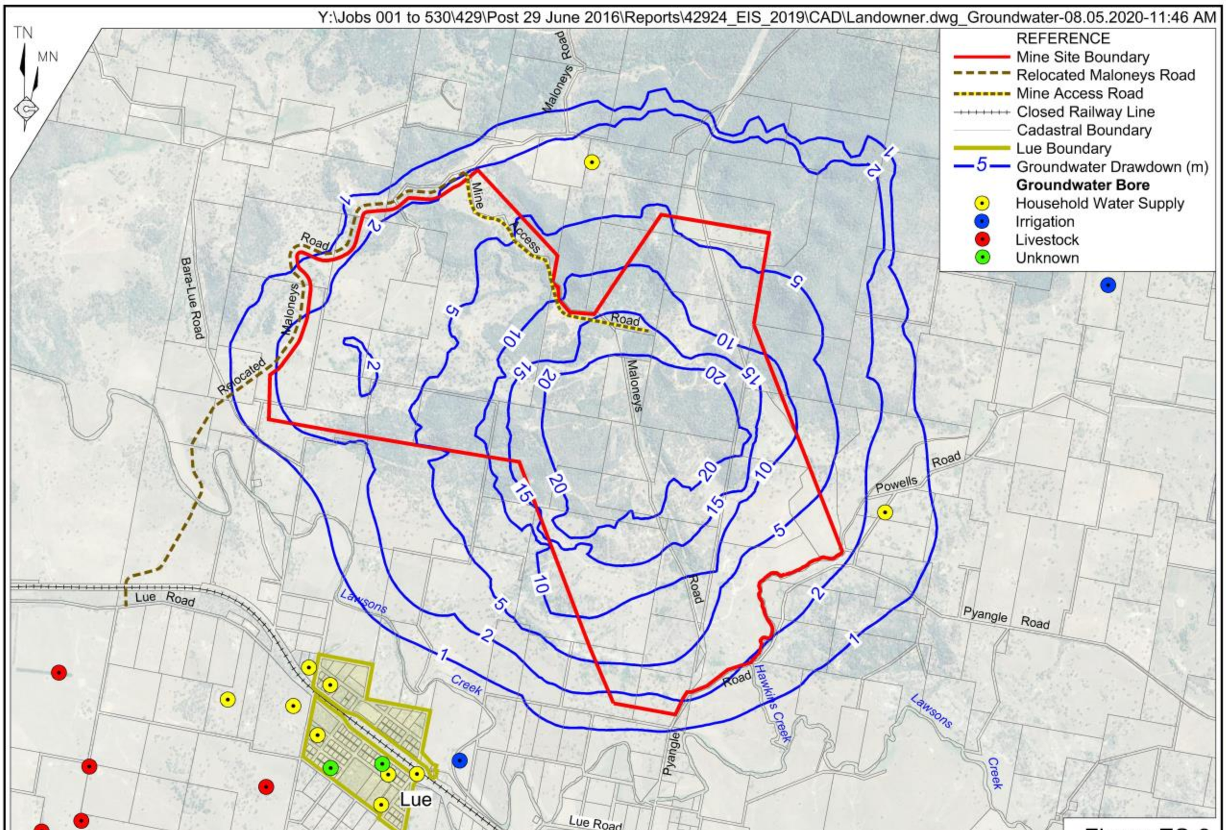


Figure ES-9
PREDICTED DRAWDOWN AT 50 YEARS POST MINING

- There would not be any impacts to high priority Groundwater Dependent Ecosystems. The terrestrial vegetation present in the vicinity of the predicted extent of drawdown is not likely to be obligate phreatophytes (i.e. groundwater dependent), and where it does draw on groundwater it is most likely rainfall infiltration that has seeped into the capillary zone, has reached the soil-rock interface, or is stored in perched aquifers. It is considered unlikely that terrestrial vegetation would be impacted by predicted drawdown within the regional groundwater table.
- Baseflow reductions at Hawkins Creek and Lawsons Creek would occur along relatively short sections of these creeks and would be most noticeable to water users in periods of drought when it would be experienced as a reduction in water levels in remnant pools.
- Potential changes to groundwater quality would be carefully monitored and managed throughout mining operations and in the final landform, including in the vicinity of the tailings storage facility, however, it is predicted that there would be no water quality impacts beyond 40m from the Mine Site boundary.

Water take through groundwater inflows and subsequent dewatering and reduced baseflow contribution to Hawkins and Lawsons Creeks would be accounted for in water licensing for the Project, including post-mining inflows to the main open cut pit lake.

Monitoring of groundwater levels and quality in the network of on-site monitoring bores and selected off-site private bores would provide valuable data to assess actual changes to the groundwater setting and enable comparison against groundwater model predictions.

Potential impacts to groundwater availability at two registered bores would be subject to compensatory measures, should they be required. Remaining risks and potential impacts would be managed through implementation of a Water Management Plan for the Project.

Surface Water

The potential impacts relating to surface water including erosion and sediment control, water availability and water quality, and flooding have been addressed through the design of the Project. The assessment concludes that with water diversion around the Mine Site, effects to downstream flows in both Hawkins and Lawson Creeks are predicted to be minimal. The potential for impacts for surface water quality would be managed over the life of the Project and monitored in accordance with an approved Water Management Plan.

The Mine Site is located within the Lawsons Creek catchment in the eastern headwaters of the Macquarie River Basin. Runoff from the eastern section of the Mine Site flows towards Hawkins Creek, a tributary of Lawsons Creek. Runoff from the western section of the Mine Site flows within Walkers Creek, also a tributary of Lawsons Creek. The eastern section of the Mine Site is traversed by two named watercourses, Price Creek and Blackmans Gully, and an un-named watercourse. **Figure ES-10** presents the catchment boundaries within the Mine Site.

Runoff in Hawkins and Lawsons Creeks catchments is largely influenced by the retention of runoff in farm dams and effectively displays intermittent / ephemeral flow characteristics. Calculated flows in Lawsons Creek are currently greater than 1ML/day for approximately 75% of the time. Average annual flows in Hawkins and Lawsons Creek (downstream from Hawkins Creek are respectively 712ML/year and 7 212ML/year.

Up to 1 014ML of water is extracted from Lawsons Creek by 27 landowners holding water access licences and works approvals downstream from Hawkins Creek principally for irrigation with limited stock watering. No extraction permits are approved on Hawkins Creek.

Sediment dams proposed for the Project are also presented in **Figure ES-10**. A detailed site water balance incorporating water from each of these sources established that the Project's water requirements would be met and that contaminated water captured in the containment zone could be contained on site without discharge or significant interruption to operations through the mine life.

The Project has been designed to maximise the quantity of water that can practically be diverted around disturbance areas within the Mine Site and to provide for as much sediment-laden water to be released off site (after settlement or treatment to satisfy water quality requirements) to maximise downstream environmental flow. Only water contaminated with dissolved metals through contact with the mineralised ore and processing chemicals would be retained and recycled on site, thereby not affecting the downstream water quality. Bowdens Silver's proposal to import surplus (treated) mine water as make-up water for processing and dust suppression would negate the need to seek water currently within the Cudgegong River Valley destined for agricultural or municipal uses.

The Project is predicted to reduce downstream flows in both Hawkins and Lawsons Creeks through the interception and retention of runoff within the Mine Site and a reduction in base flow in both creeks.

During Operation:

- the flow in Hawkins Creek for a distance of 3.5km from its confluence with Lawsons Creek would decrease by 4.4%;

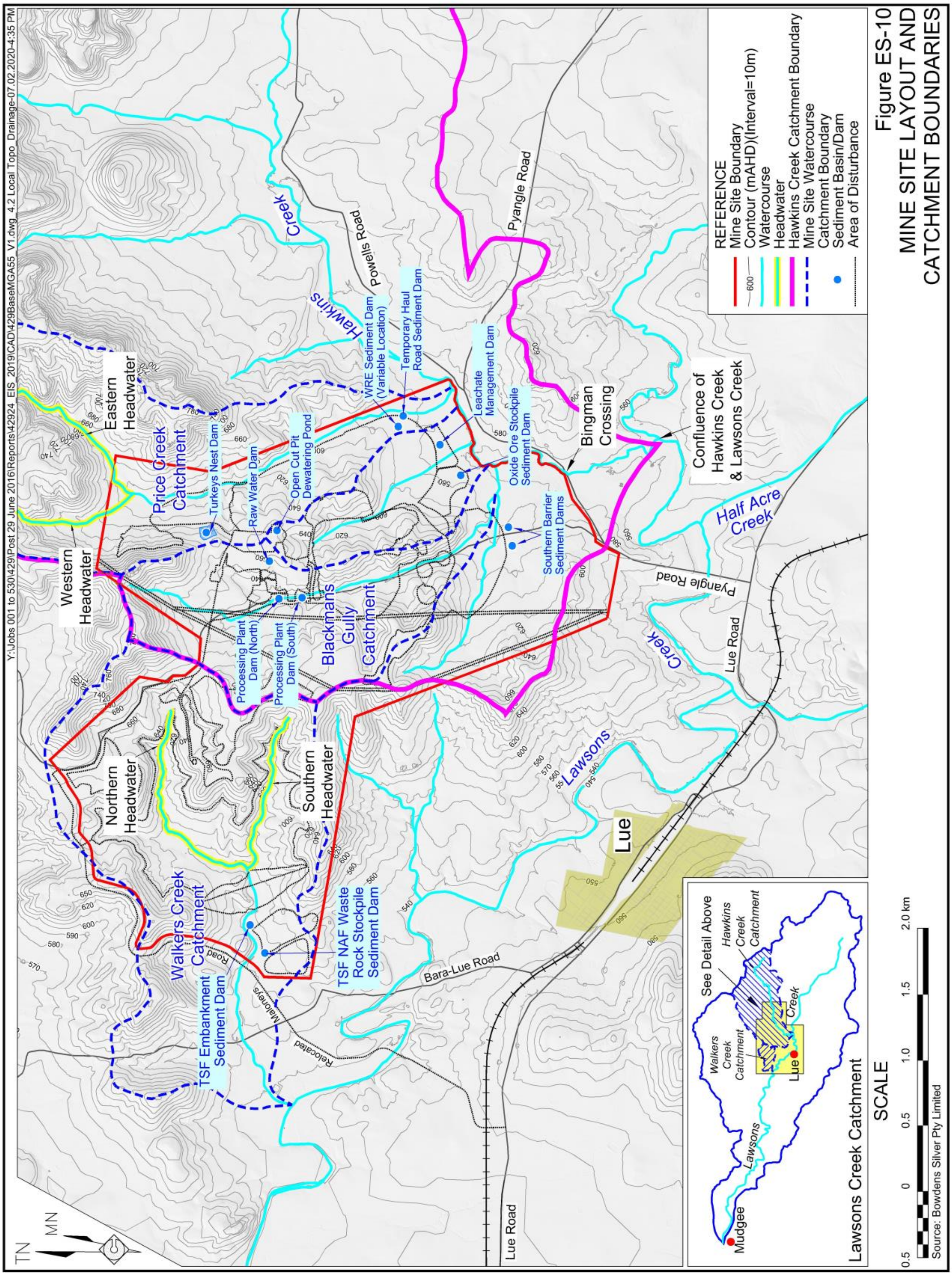


Figure ES-10
MINE SITE LAYOUT AND CATCHMENT BOUNDARIES

- the flow in Lawsons Creek between the confluence of Hawkins and Walkers Creeks would decrease by 1.2%; and
- the flow in Lawsons Creek downstream from its confluence with Walkers Creek would decrease by 2.2%.

Post-Mine Closure:

- the flow in Hawkins Creek for a distance of 3.5km from its confluence with Lawsons Creek would decrease by 1.4%.
- the flow in Lawsons Creek between the confluence of Hawkins and Walkers Creeks would decrease by 0.4%; and
- the flow in Lawsons Creek downstream from its confluence with Walkers Creek would decrease by 0.4%.

The reduction in flow in Lawsons Creek would cause the flows greater than 1ML/day to occur on two fewer days per year.

Overall, the reductions in flow and changes in availability of water to downstream users would be negligible. Bowdens Silver would acquire the necessary Water Access Licences from the Lawsons Creek Water Source prior to the commencement of the Project.

Throughout the mine life, runoff from approximately 5.5km^2 would be retained on site. However, following rehabilitation, only the final void covering approximately 0.5km^2 would retain water on site and rehabilitation of the remaining Project components would be completed in a manner that would allow runoff from those areas to both Hawkins and Lawsons Creeks.

A detailed flood study has established that the more significant flood level impacts would be confined to within the Mine Site and land owned by Bowdens Silver. Any expected increases in flood velocities in Hawkins and Lawsons Creeks would be negligible and would not adversely impact off-site property or infrastructure.

The flood study also established that the proposed Lawson Creek crossing on the relocated Maloneys Road would be included in a 10% (1 in 10 year) Annual Exceedance Probability flood event, thereby closing the road for up to 6 hours.

The potential for the Project to impact upon downstream water quality would exist through three sources.

1. Runoff containing sediment derived from exposed areas.
2. Runoff from exposed NAF waste rock, potentially affecting the chemical composition of downstream water.
3. Release of contaminated water from the containment zone potentially affecting the chemical composition of downstream water with respect to pH levels and soluble metals.

While it is the preference of Bowden Silver to release water accumulating within the sediment dams to contribute to maintaining downstream flows, this would be subject to confirmation of suitable water quality. Each of the above risks to downstream water quality has been incorporated into the proposed water management for the Mine Site.

Based on the proposed open cut pit design, the final void within the main open cut pit would be up to 141m deep, with a floor level of 456m AHD and an overflow level of approximately 597m AHD. The theoretical total potential storage volume to this elevation is approximately 22GL. The assessment undertaken by WRM (2020) has concluded that the final void would not overflow to the surface and remain a groundwater sink post-mining.

Health Risks

The human health risk assessment has considered human health risks associated with local changes to air quality, noise, surface water and groundwater. No physical health risk issues of concern have been identified that would be associated with the Project.

The assessment of risks to human health was undertaken using the methodology and framework outlined by enHealth (2012) with the following tasks undertaken.

1. Data review, evaluation and issue identification.
2. Toxicity/hazard assessment.
3. Exposure assessment.
4. Risk characterisation.

In assessing human health risk, assessment was made of potential impacts arising from air quality, surface water, groundwater and noise. Consideration has also been given to mental health and opportunities for health improvement.

Air Quality Health Risk

The assessment of air quality focused on dust emissions from the Project, being a key concern to some members of the Lue and district community. The presence of lead and other metals in these dust emissions was also evaluated in detail. The assessment addressed multiple exposure pathways including: the inhalation of dust; the deposition of dust onto roofs and the washing of these dusts into rainwater tanks where water may be used for drinking/household use; the deposition of dust to soil and other surfaces where people may come into direct contact; and/or the accumulation of these metals into home-grown produce that may be consumed.

The assessment concluded that impacts derived from the Project make a negligible contribution to overall exposures to particulates and the assessed metals with no health risks of concern during any stage of the Project operation. These conclusions apply to all members of the community, adults and children as well as sensitive individuals.

The assessment of potential exposure to silica and hydrogen cyanide also concluded that there were no health risk issues.

Water Quality Health Risk

Consideration was given to potential water quality impacts arising from Project-related activities, including leaching of metals from waste rock and seepages from the tailings dam.

Based on the assessments undertaken, the potential for adverse health impacts within the off-site community due to Project-related surface water and groundwater impacts were considered to be negligible.

Noise and Vibration

Assessment was made of predicted noise levels during site establishment and construction activities, on-site operational activities, road noise, and blasting.

Based upon the predicted levels and duration, there are no health impacts of concern in relation to noise from the Project. It is noted that, given the existing comparatively quiet noise environment of the area, it is likely that, at times, noise from the Project would be audible and distinguishable above background noise levels. While these noises may be distinguishable, they would remain too low to impact upon community health.

Mental Health

In addition to physical health, mental health matters, principally stress and anxiety, have been raised by the community as a concern.

Should the Project be approved, members of the community concerned about negative impacts may continue to experience stress and anxiety. It is likely that a lack of information and uncertainty about the extent of impacts that are actually occurring would be a significant contributor as was raised as a factor during the community engagement program. Therefore, a range of management measures, including a ‘Good Neighbour’ Program and Social Impact Management Plan, have been proposed to keep the community informed about the activities and results of monitoring. As the Project progresses, and with demonstrated compliance with relevant air and water quality criteria, the level of stress and anxiety regarding these matters would be expected to reduce. Residual mental health effects would be further mitigated through proposed support for health services as part of Bowden Silver’s Community Investment Program.

For other members of the community, the approval of the Project would result in positive mental health effects. As part of the community survey, unemployment was a significant perceived challenge facing the community, particularly given the loss of several local businesses in the local government area (e.g. the cement / lime works and the recent Bylong Coal Project refusal by the Independent Planning Commission). With the proposed range of measures to maximise the local benefit of employment and use of local businesses, the potential positive mental health benefits of the Project would be maximised.

Visibility

Day-time Impacts

The development of the Project would result in changes in the visual landscape in the vicinity of the Mine Site. However, the limited visibility of the mining activities within the Mine Site and the range of visual controls would achieve an acceptable level of impact. Importantly, no components of the Mine Site would be visible from Lue. Beyond the end of the Project life, the visual impacts of the Project would progressively diminish as the areas of revegetation established progressively over the Project life matures and revegetation of the final landform progresses.

Consideration of visual impacts has been an important factor in the design of the Project principally given the bulk of the rock to be mined is light cream to buff in colour.

The visual catchment for the key Project components is limited to:

- six residences between 0.7km and 4.6km from the nearest Project component;
- sections of Lue Road, approximately 2km south of the nearest Project component;
- a 1.5km section of local roads, Pyangle Road and Powells Road, where the waste rock emplacement and southern barrier would be 0.4km to 0.6km from these roads; and
- scattered rural land throughout the Lue area.

No mine components would be visible from Lue given the substantial ridges present between Lue and the Mine Site. Most of the views towards the Mine Site are dominated by the elevated background topography of a dissected sandstone plateau with gently sloping partly cleared or grassed rural areas in the foreground. The general setting of the Project varies in scenic quality from moderate to moderate/high with the Mine Site itself of moderate quality. There are extensive areas of similar landscape and land uses in the vicinity.

The key visual controls include:

- the design of the non-geometric waste rock emplacement to resemble a ridge similar in orientation and elevation to other nearby ridges;

- prioritising the construction of the southern barrier to shield views of mining activities from the south;
- progressively revegetating the outer slopes of the southern barrier, oxide ore stockpile and completed sections of the waste rock emplacement;
- enhancing the existing tree screens adjacent to Pyangle and Powells Roads;
- establishing vegetation on the upper benches of the main open cut; and
- all buildings/structures would be completed in dark green/grey colours.

The key visual impacts of the Project throughout the Project life are as follows.

- A high level of impact would be experienced by motorists travelling along Pyangle and Powells Road, albeit over a distance of only 1.5km.
- An overall medium level of impact would be experienced by occupants of residences typically greater than approximately 1.5km from the component areas within the Mine Site, i.e. principally to the south of the Mine Site near the intersection of Lue and Pyangle Road.
- A low level of impact would be experienced by motorists travelling along Lue Road and occupants of at least six residences from the re-alignment of the 500kV power transmission line.
- No visual impacts of the Project activities within the Mine Site would be experiences by residents of Lue or road users.

After Dusk Impacts

The potential for lighting impacts on the local environment has been assessed to be minimal. In addition, the impacts of sky glow on the local environment were assessed to be insignificant under both clear sky and cloudy conditions.

It was identified that the use of lighting within the Mine Site could potentially impact upon the local environment after dusk. These impacts could occur due to direct impacts (i.e. where light is directed towards a viewer), indirect impacts (i.e. where the source of light is not directed at the viewer but the spread of light is observable) and sky glow (i.e. where light is reflected in the atmosphere). Sky glow, in particular, was determined to be an important factor in the design of the Project as the Mine Site is located approximately 168km from the Siding Spring Observatory which falls within the Dark Sky Region stipulated in the Dark Sky Planning Guideline.

In order to mitigate the lighting impacts on the local environment and at the Siding Spring Observatory, a range of measures would be adopted to manage lighting within the Mine Site. Given the implementation of these measures, it was determined that the Project would comply with the limits for dark rural environments as stipulated in AS/NZS 4282:2019 *Control of the Obtrusive Effects of Outdoor Lighting*.

A number of calculations were also undertaken to determine the total lumens, total upward lumens and the illuminance of sky particles at varying levels above the Mine Site to determine potential impacts at Siding Spring Observatory. These calculations were provided to the Siding Spring Observatory who calculated that the night sky brightness above the observatory as a result of the Project would be negligible.

Terrestrial Ecology

Comprehensive field surveys have concluded that the Project as proposed would result in the removal of approximately 381.7ha of native vegetation of variable condition. This vegetation has the potential to be habitat for *a range of native fauna including threatened species. However, the Project is not expected to result in significant impacts upon migratory or threatened species. Biodiversity impacts that cannot be avoided would be offset in accordance with the NSW Biodiversity Offsetting Scheme, with 795ha within and surrounding the Mine Site currently intended to be conserved in perpetuity. Additional 'off-site' biodiversity offset areas would also be established.*

The terrestrial biodiversity values of the Study Area have been comprehensively surveyed between November 2011 and April 2019. Field surveys have identified a total of 11 vegetation communities within the Study Area (**Figure ES-11**). Of these, three meet the definition of a threatened ecological community, namely Box-Gum Woodland, as listed by the NSW *Biodiversity Conservation Act 2016* (BC Act) and, under specific identification criteria, as a critically endangered ecological community under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The field surveys also identified a total of 370 flora species, of which 267 are native flora species and 103 are exotic flora, and a total of 168 fauna species including:

- 123 species of bird;
- 21 species of mammal;
- 18 species of reptile; and
- six species of frog.

Of the individual flora and fauna species, a total of 14 fauna and two flora species are listed under the BC Act and/or EBPC Act and two migratory species were also recorded. Additionally, several previously recorded threatened species are located close to the proposed Mine Site, relocated Maloneys Road, and water supply pipeline corridor.

Two of these recorded threatened species, the Ausfeld's Wattle (*Acacia ausfeldii*) and Koala (*Phascolarctos cinereus*), classify as species credit species and have been recorded within the disturbance footprint. Two other species credit species, Squirrel Glider (*Petaurus norfolcensis*) and Regent Honeyeater (*Anthochaera phrygia*), whilst not recorded, are predicted to occur within the disturbance footprint.

Throughout the design process Bowdens Silver has attempted to avoid impacts upon biodiversity values to the greatest extent possible. This process involved the preparation of a 'traffic light' model to visualise areas of high, medium and low biodiversity value. The model was first developed in 2017 and, as a result, a range of alterations were made to both the Mine Site layout and positioning of the water pipeline corridor to reduce the area of disturbance within the areas of high and medium biodiversity value.

The final Project design would result in the removal of approximately 381.7ha of native vegetation of variable condition (**Figure ES-11**). This includes approximately 182.3ha of BC Act listed Box-Gum Woodland, of which approximately 147.8ha also meets the classification under the EPBC Act. Notably, of the 182.3ha of Box-Gum Woodland, approximately 88.2ha (48%) comprises derived grassland only, having had the trees and shrubs cleared by past agricultural activities.

In assessing the potential for significant impacts, EnviroKey (2020) concludes that, excluding the Regent Honeyeater, the Project would not result in significant impacts upon migratory or threatened species. In assessing the potential for impacts upon the Regent Honeyeater, EnviroKey (2020) considered the Project would:

- not lead to a long-term decline in the size of a population of the species;

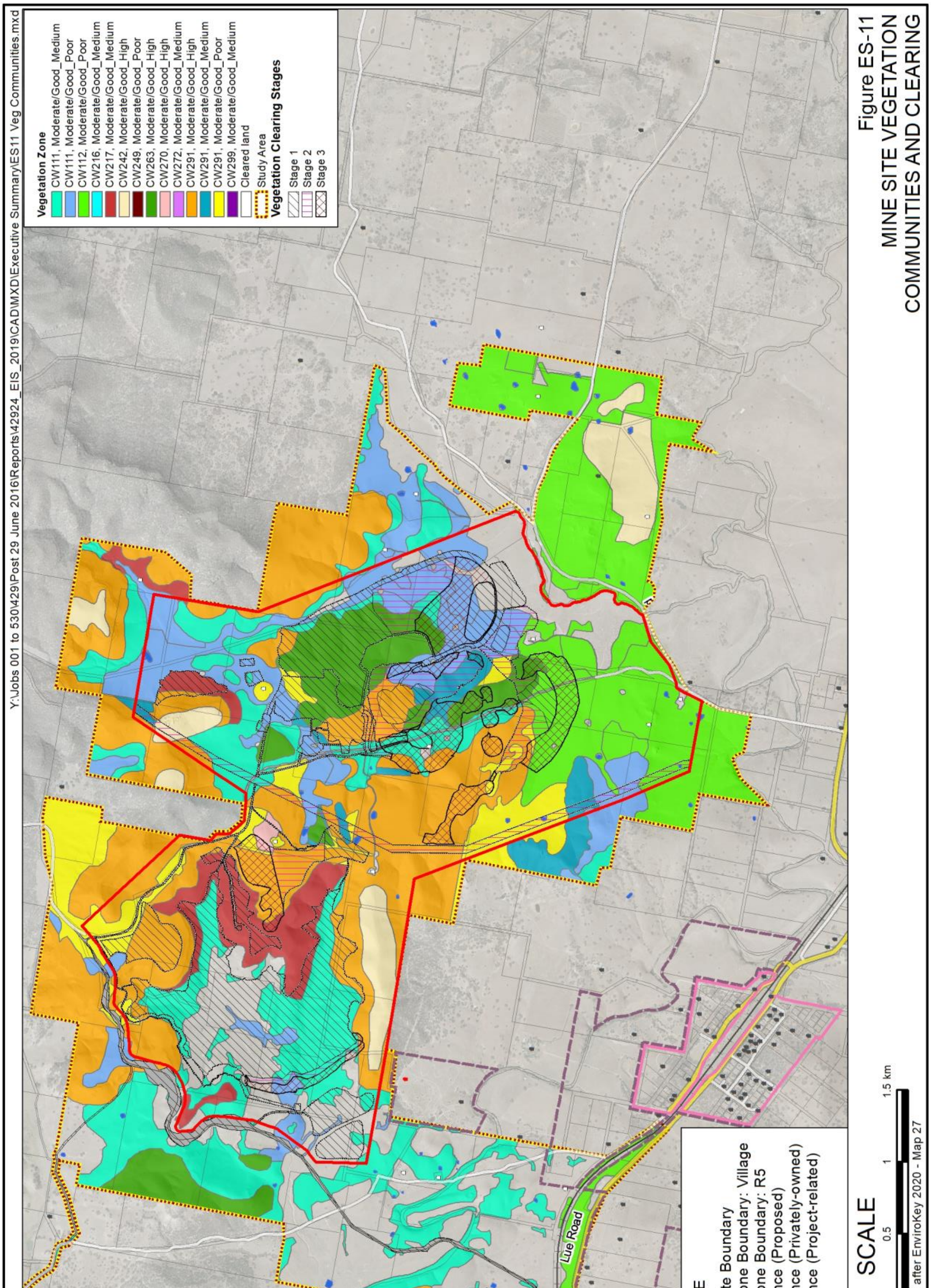


Figure ES-11
MINE SITE VEGETATION COMMUNITIES AND CLEARING

- not reduce the area of occupancy to the detriment of the species; and
- be unlikely to result in the introduction of species or diseases that are potentially harmful to the Regent Honeyeater.

For Box-Gum Woodland, a range of mitigation measures have been proposed, including establishment of a biodiversity offset providing in perpetuity security for areas of Box-Gum Woodland and Regent Honeyeater foraging and breeding habitat that may have otherwise been subject to intense agricultural activity over time. A draft biodiversity offset strategy has been prepared which includes 795ha within and surrounding the Mine Site and would satisfy approximately 43% of the total offset requirement. The remaining requirements will be met through additional properties within the surrounding bioregion. Currently seven landholders with potentially suitable vegetation communities have expressed interest in creation of biodiversity offset sites on their properties.

Notably, the impact assessment has conservatively been undertaken without formally considering that approximately 344ha of the Mine Site would be revegetated to native woodland and grasslands using species consistent with the existing vegetation communities. In the long-term, these rehabilitation areas would further reduce impacts to biodiversity.

Aquatic Ecology

The Project would not cause any direct impacts to Hawkins and Lawsons Creeks, however several ephemeral watercourses with limited aquatic habitat located within the footprint of the Mine Site would be displaced and realigned.

An aquatic ecology assessment was undertaken for the Project with a total of five field surveys conducted between December 2011 and December 2018. These surveys focussed principally on Hawkins and Lawsons Creeks which border the Mine Site and provide the principal surface aquatic habitat within the Study Area. Several of the ephemeral watercourses, springs and groundwater bores within the Mine Site were also inspected and assessed for aquatic ecology.

Hawkins and Lawsons Creeks were found to comprise degraded aquatic habitat with reduced bank stability and associated erosion and sediment input. Surveys identified a total of four native fish species and three introduced fish species, none of which are listed as threatened. Stygofauna sampling undertaken within and surrounding the Mine Site also indicated that stygofauna assemblages, namely fauna associated with groundwater aquifers, comprise relatively common and widespread taxa.

Existing ephemeral drainage lines within the Mine Site have been assessed as having limited aquatic habitat, and their loss and/or disturbance is expected to result in very minor to negligible associated impacts to aquatic ecology.

The interception of surface flow on site and groundwater drawdown as a result of the excavation of the open cut pit would result in a minor (a few percent) reduction in surface flow in Hawkins and Lawsons Creeks. Cardno (2020) has assessed that the likely impacts to aquatic habitat would be minor. The potential loss of stygofauna and their habitat due to direct displacement or groundwater drawdown has also been assessed to represent minor potential impacts to these fauna

The greatest potential impact to aquatic ecology is associated with accidental release of poor-quality water. This risk would be effectively managed given the design of the Project and ongoing management and monitoring aimed at preventing the release of such water to watercourses.

The water supply pipeline would be constructed using underboring techniques below perennial watercourses and other watercourses where significant water flows are present at the time of construction. Whilst trenching would be used to cross watercourses without significant flows of water, the pipeline would be buried and the watercourse profile would remain unchanged. In the event temporary watercourse diversions or coffer dams are required to manage minor flows, NSW DPI (Fisheries) would be consulted on appropriate methodology. As such, impacts to fish passage and aquatic habitat within the water supply pipeline corridor are expected to be no more than minor and temporary.

Traffic and Transportation

With the proposed relocation of Maloneys Road to avoid the need for much of the Project-related traffic to travel through Lue and the implementation of the proposed mitigation and management measures, the traffic travelling to and from the Mine Site would be accommodated on the surrounding road network with virtually no adverse impacts to road users, the condition of the road network and the amenity of the residents of Lue.

Assessment of the potential traffic-related impacts of the Project has considered the proposed transportation routes, anticipated traffic volumes and traffic types. The assessment was undertaken by The Transport Planning Partnership (TTPP, 2020) and considered traffic-related impacts associated with:

- the initial 6-month construction period during which the relocated Maloneys Road would be constructed;
- the peak of the site establishment and construction stage (13 months into this stage); and
- the operational period for the Project.

The existing road network has been reviewed with the assessment informed by traffic counts at eleven locations, analysis of traffic composition and intersection turning movement analysis. TTPP (2020) also completed a road safety audit, historic crash analysis and considered local public transport and pedestrian use of the road network.

The Project has the potential to impact the local and regional road network through the generation of additional light and heavy vehicle traffic that would be travelling to and from the Mine Site during the site establishment and construction stage and the operational stage. The additional Project-related traffic could impact road capacity, efficiency, travel times for existing road users and the amenity of residents of Lue.

Potential traffic-related impacts would be avoided or mitigated through improvements to the road network including the relocation of Maloneys Road and intersection treatments to suit traffic requirements. Additional management measures to avoid or mitigate the impacts of the increased traffic in the locality would include the following.

- Preparation and implementation of a comprehensive Traffic Management Plan.
- Structuring the operations of the Project such that the operational shift commencement and finish times would be spread at different times throughout the day, evening and night.
- Careful management of oversize and overmass vehicles movements with all relevant permits and licences obtained and suitable escorts provided.
- Provision of the bus service in order to reduce the number of personnel travelling to and from the Mine Site in light vehicles.

- Provision of sufficient car parking within the Mine Site to accommodate personnel requirements.
- Protocols for the transportation of dangerous goods in accordance with the relevant codes and legislation.

Bowdens Silver has proposed to relocate Maloneys Road and avoid the need for much of the Project-related traffic to travel through Lue. Improvements to the local road network would benefit all road users and any negative impacts would be most likely experienced as a change to the capacity and efficiency of the local road network.

An analysis of existing and future traffic volumes has indicated that Project-related traffic during the site establishment and construction stage is expected to contribute approximately 10% of the daily traffic on Lue Road within Lue and 15% of daily traffic on Lue Road towards Mudgee. During operations traffic travelling through Lue decreases with daily traffic expected to contribute 7% of the total traffic on Lue Road within Lue and 10% of daily traffic on Lue Road towards Mudgee. Although during the morning and afternoon peak hours the Project would contribute 22% and 19% of all traffic, respectively.

Project-related traffic would contribute approximately 22% of the daily traffic on Pyangle Road and approximately 1% of the daily traffic on Ulan Road and Castlereagh Highway.

The predicted hourly traffic at intersections used by Project-related traffic would remain well below the thresholds at which intersection capacity may be impacted and therefore are predicted to continue to operate with acceptable delays.

Soils and Land and Soil Capability

There is no Biophysical Strategic Agricultural Land located within the Mine Site. The proposed use of appropriate soil stripping, handling and stockpiling procedures would maximise the value of soils as a resource for rehabilitation purposes and minimise losses through erosion. There is no indication that soil conditions would constrain rehabilitation success.

Seven Soil Landscape Units have been identified within the Mine Site based upon geology, position in the landscape and slope.

Most of the Mine Site is hilly and comprises ‘sedimentary’ and ‘acid (felsic) volcanic’ parent materials with poor conditions for plant growth. The minor areas in which Ordovician shale parent material is present are less acidic, however, soils within these areas are generally shallow. Sodicity was not identified as a widespread problem within Mine Site Soil Landscape Units except for some of the alluvial soils located near watercourses. Soils generally displayed low soil organic carbon concentrations and very low electrolyte concentrations which could potentially make untreated soil prone to water erosion losses.

The Land and Soil Capability class for Mine Site Soil Landscape Units was determined in accordance with the *Land and Soil Capability Assessment Scheme – Second Approximation.* Land and Soil Capability classes within the Mine Site ranged between 3 and 6 with approximately 86% of disturbance within the Mine Site located within areas with a class of 6 (i.e. low capability land with very high limitations for high-impact land uses). With the exception of the final void area, the soils in the rootzones of the modified landscapes would retain or improve their qualities required for the long-term rehabilitation of the Mine Site.

No Biophysical Strategic Agricultural Land is located within the Mine Site. A Site Verification Certificate, confirming the absence of Biophysical Strategic Agricultural Land within the Mine Site, was issued by the then DPE on 8 November 2017.

The water supply pipeline corridor would traverse a total of ten Soil Landscape Units. Potential constraints for these Soil Landscape Units include soil acidity, sodicity and inadequate nutrient levels to encourage plant growth. These limitations would be managed through a range of soil stripping, handling and stockpiling procedures. It is noted that disturbance of land during the construction of the pipeline would be short term with all topsoils and most subsoils replaced within several months following the completion of the pipeline. Excess subsoils would be transported to the Mine Site for use in rehabilitation or stockpiling.

The water supply pipeline corridor traverses Soil Landscape Units with Land and Soil Capability Class of between 3 and 8 (i.e. land with moderate to very severe limitations). The majority (approximately 34km) of the pipeline would be constructed within land with Land and Soil Capability Class of 4 (i.e. moderate capability land) with land uses typically restricted to cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry and nature conservation. All land disturbed within the water supply pipeline corridor would be returned to the respective or better Land and Soil Capability Class following the completion of rehabilitation.

Aboriginal Cultural Heritage

The Project would require the salvage of items of Aboriginal cultural heritage significance from 25 identified sites within the Mine Site with 31 sites identified that would be protected over the Mine Life from inadvertent harm. All sites have been identified by the registered Aboriginal parties to be of high cultural significance. The majority of sites are considered by Landskape (2020) to be of low scientific, educational and aesthetic significance.

The Aboriginal and Historical Cultural Heritage Assessment undertaken by Landskape (2020) was informed by regional and Project-specific research undertaken between 1980 and 1998 as well as a search of the Aboriginal Heritage Information Management System database to consider existing records of sites with Aboriginal cultural heritage value. This information and written ethno-historical records were used to compile a predictive model to aid prediction of the types of sites and their likely locations to inform with archaeological field surveys. The archaeological field surveys within the Mine Site were undertaken between 2011 and 2017 and within the proposed water supply pipeline corridor and the proposed relocated Maloneys Road in April 2019.

Registered Aboriginal parties were invited to participate in the archaeological field surveys, to review the survey methodology prior to survey and later to review a draft of the Aboriginal and Historical Cultural Heritage Assessment in accordance with the Aboriginal Cultural Heritage Community Consultation Requirements for Proponents (DECCW, 2010). A meeting with registered Aboriginal parties was held to discuss the residual impacts of the Project and proposed management of identified sites during the Project life.

The salvage of 25 sites within the Mine Site would be required with one site (the rock shelter identified as site BL44) requiring test excavation. These artefacts would be properly curated and stored in an on-site “Keeping Place”. The artefacts would be replaced within rehabilitated areas in consultation with representatives of the local Aboriginal community and BCD.

A further 31 identified sites within the Mine Site, whilst not directly impacted, would require protection from inadvertent disturbance via the installation of protective barriers. All six identified sites within the water supply pipeline corridor have been avoided by minor adjustments to the corridor. The two sites previously identified in the vicinity of the Ulan Coal Mine would not be directly impacted. No sites were identified within the proposed relocated Maloneys Road.

All sites have been identified by the registered Aboriginal parties to be of high cultural significance. The majority of sites are considered by Landskape (2020) to be of low scientific, educational and aesthetic significance, excepting:

- Lue 8, BL40, BL41, BL43, BL45 and BL53 that are of low to moderate scientific significance.
- BL44 (the rock shelter site) that is of moderate scientific, education and aesthetic significance.

It is acknowledged that approximately 20% of the water supply pipeline corridor and proposed relocated Maloneys Road were not surveyed for the Aboriginal and Historical Cultural Heritage Assessment due to access constraints at the time of the surveys. These areas would be surveyed prior to any ground disturbance in these locations. Landskape (2020) consider that the likelihood of finding additional sites in the remaining 20% of the corridor would be consistent with the areas surveyed. It is also likely that any identified sites may be avoided through minor adjustments to the alignment of the relevant areas as was the case with the six sites identified within the water supply pipeline corridor.

Aboriginal heritage management would be documented in a Heritage Management Plan incorporating the process for salvage, recording and storage of sites and protocols for management of unexpected finds of items of potential Aboriginal heritage significance.

Historic Heritage

Three sites of potential historical heritage significance have been identified within the Mine Site. Each of the sites have been assessed to be of low significance except for the potential for identified hut ruins to be of moderate local significance for its research potential. All sites would be removed with salvage of the items identified within the hut ruins.

The Aboriginal and Historical Cultural Heritage Assessment undertaken by Landskape (2020) identified the following sites of potential historical heritage significance.

- Hut ruins including three sandstone blocks, fragments of cast iron stove, sheet iron, broken glass bottles, broken ceramic vessels.
- Two shallow pits.

There were no sites of potential historic heritage significance identified within the proposed water supply pipeline corridor and the relocated Maloneys Road.

Landskape (2020) assessed the historic heritage significance of the identified sites in accordance with the NSW Heritage Branch's assessment criteria detailed in Assessing Significance for Historical Archaeological Sites and 'Relics' (NSW Heritage Branch, 2009). It was concluded that the sites were of low significance on all criteria except for the potential for the hut ruins to be of moderate local significance for its research potential. None of the sites would meet the thresholds for consideration of State heritage significance.

All sites would be removed with salvage of the items identified within the hut ruins. All items would be archived for future access.

As noted for the assessment of Aboriginal cultural heritage, approximately 20% of the water supply pipeline corridor and proposed relocated Maloneys Road were not surveyed for the Aboriginal and Historical Cultural Heritage Assessment due to access constraints at the time of the surveys. These areas would be surveyed prior to any ground disturbance in these locations, however it is considered unlikely that items of historic heritage significance are present in these locations.

Historic heritage management would be documented in a Heritage Management Plan incorporating protocols for management of unexpected finds of items of potential historic heritage significance.

Public Safety Hazards

Bush Fire

A bush fire assessment was undertaken by RWC to inform the management of bush fire risk within the Mine Site. It was assessed that it is likely that the Project would be able to provide suitable Asset Protection Zones around key Mine Site components and comply with all requirements stipulated in RFS (2006) and RFS (2010).

Dangerous Goods

Sherpa Consulting Pty Ltd (Sherpa) was engaged by Bowdens Silver to undertake a hazard analysis covering the proposed use of dangerous goods for the Project.

A screening of dangerous goods to be used by the Project was undertaken against *State Environment Planning Policy 33 – Hazardous and Offensive Development* which identified that that the proposed storage and use of sodium cyanide, cyanide solution and the proposed use of Class 5.1 ammonium nitrate-based blasting agents required assessment in a Preliminary Hazard Analysis.

The Preliminary Hazard Analysis found that, with the implementation of standard controls and safeguards, the use and storage of sodium cyanide, cyanide solution and Class 5.1 ammonium nitrate-based blasting agents would result in very low off-site environmental and safety risks. All qualitative environmental risk criteria identified in *Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning* would be met by the Project.

A Hazardous Material Transport Route Evaluation Study was also undertaken for sodium cyanide due to the risks associated with a loss containment during transport. The transport route for sodium cyanide was assessed to be a low risk to the biophysical and human environment with the implementation of standard controls and safeguards.

Agricultural Impacts

The Project would have a negligible to minor impact upon the agricultural resources and enterprises through the Region. The continued operation of the Bowdens Farm, and the proposed progressive rehabilitation schedule, would ensure that the Project would only have minor impacts on agricultural lands.

Agricultural activities within the Mid-Western Region Local Government Area are dominated by the grazing of cattle and sheep although the Region also has a long history of grape production and a growing olive production industry.

Grazing is the predominant agricultural activity within the area immediately surrounding the Mine Site although one vineyard and two olive growers are located within a radius of approximately 7.5km from the Mine Site.

The majority of land within the Mine Site is currently used for the grazing of livestock on approximately 910ha of land. This grazing land comprises approximately 427ha of heavily vegetated and/or steeply sloping land with low agricultural capability (principally Land and Soil Capability Class 6) and use and approximately 483ha of modified pasture with a low to moderate agricultural capability (Land and Soil Capability Classes 3 to 6). Approximately 12ha within the Mine Site is used for cropping. **Figure ES-12** presents the existing land uses within and immediately surrounding the Mine Site.

The Project would remove a maximum of approximately 1 498ha of land currently used for agriculture (principally low value grazing) out of production throughout the Project life due to land use changes. This land would comprise approximately 901ha of land within the Mine Site, 20ha of land within the footprint of the relocated Maloneys Road and a further 577ha in the area immediately surrounding the Mine Site which would be set aside as part of the Project's biodiversity offset area. Beyond the end of the Project life, it is anticipated that approximately 1 170ha of land within the Bowdens Farm would be either retained or returned to agricultural production. The total amount of land that would be permanently removed from agricultural production after rehabilitation would be approximately 865ha, or 0.17% of the total land used for agriculture within the Region. **Figure ES-13** presents the indicative land uses post Project life.

The land traversed by the water supply pipeline corridor is predominantly used for grazing with approximately 48km of the corridor beyond the Mine Site used for this purpose. Approximately 3.5km of the water supply pipeline corridor is used for cropping with these areas likely to be used for a combination of forage crops and pasture improvement.

Approximately 54.7ha of land would be temporarily and sequentially disturbed during the construction of the water supply pipeline. All land disturbed during the construction of the water supply pipeline beyond the Mine Site, excluding the dedicated pumping stations, would be returned to its previous land use within a few months of the completion of the pipeline. No agricultural land beyond the Mine Site would be permanently removed from production.

It has been assessed that the Project would have a negligible to minor impact upon the agricultural resources and enterprises through the Region. Whilst the Project would marginally reduce the availability of agricultural land throughout the Project life, the continued operation of the Bowdens Farm and the proposed progressive rehabilitation schedule, would ensure that the Project would only have minor impacts on agricultural lands. Furthermore, the commitment from Bowdens Silver to provide a range of part-time jobs throughout the Project life would provide an opportunity to acquire off-farm income to local farmers which in turn would benefit a number of agricultural enterprises within the region.

Economic Benefits and Impacts

The Cost Benefit Analysis and Local Effects Analysis demonstrate that there would be substantial economic and employment benefits resulting from the Project.

The economic assessment for the Project has been undertaken in accordance with relevant guidelines and feedback from an independent peer review. The economic assessment has analysed the Project using both Cost Benefit Analysis and Local Effects Analysis methodologies.

The results of the Cost Benefit Analysis conclude that the Project is estimated to deliver the net economic benefits presented in **Table ES-5** (i.e. following the inclusion of environmental, social and cultural costs).

Table ES-5
Net Economic Benefits

Scale	Base Benefit	Base plus Employment Benefits
Globally	$78M	$181M
National	$89M	$192M
NSW	$44M	$146M

The Local Effects Analysis and supplementary Local Effects Analysis has also considered the impacts at a local scale. In terms of employment, during operation the Project would provide between 73 and 129 net direct Full-time Equivalent jobs and, with flow-on effects, between a further 74 and 131 net indirect Full-time Equivalent jobs.

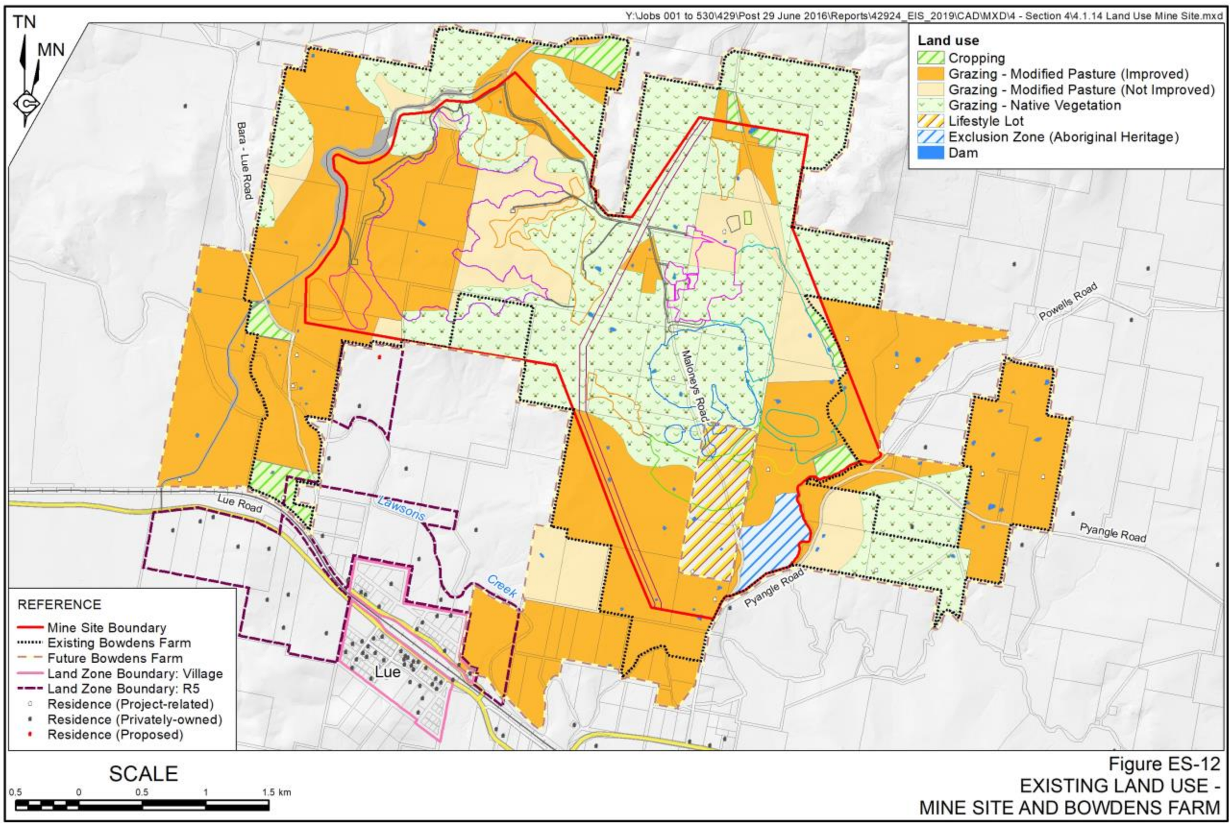


Figure ES-12
EXISTING LAND USE -
MINE SITE AND BOWDENS FARM

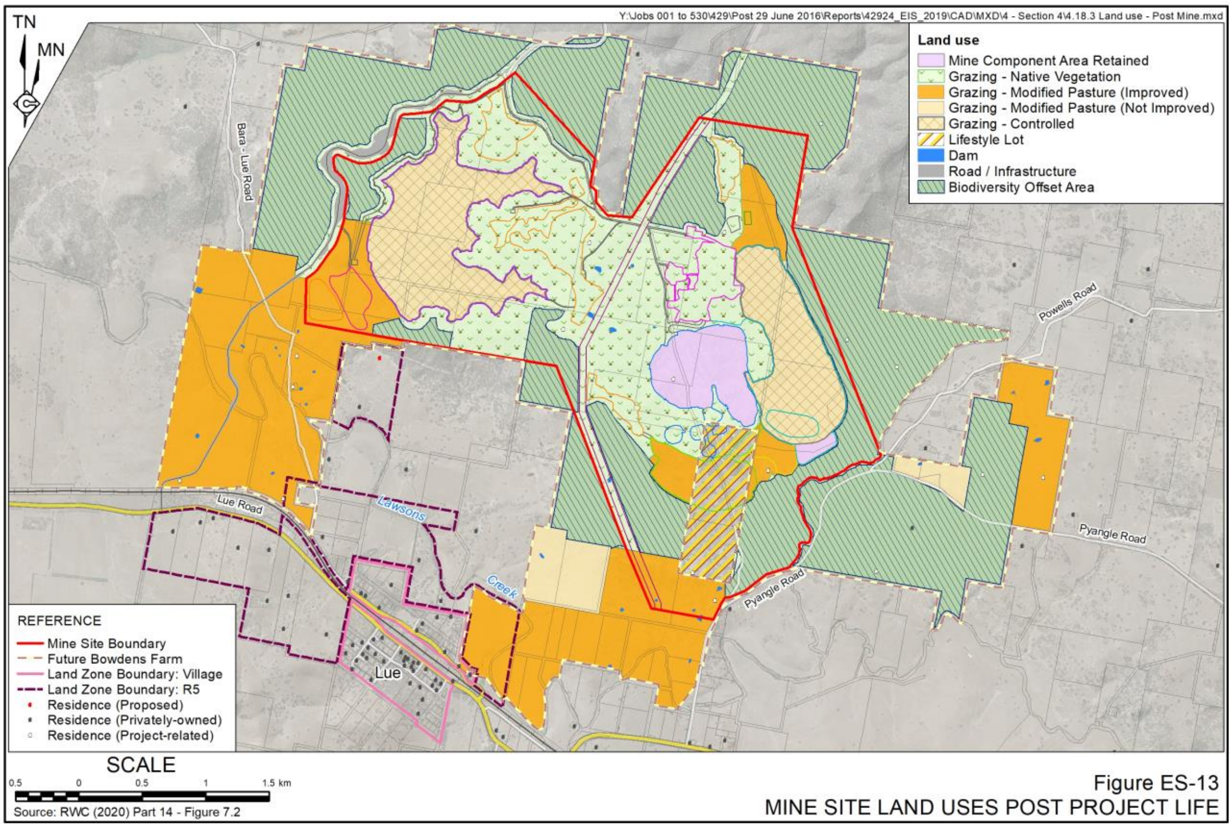


Figure ES-13
MINE SITE LAND USES POST PROJECT LIFE

Employment effects would be even greater when allowance is made for people who migrate into the region. The Full-time Equivalent jobs should not be confused for the proposed employment of up to 320 personnel during construction and site establishment and between 190 and 228 personnel during operations.

In relation to negative effects, the economic assessment concluded the following.

- There would be very small and inconsequential impacts upon agricultural economic activity.
- Impacts on wages would not likely be significant. Where upward pressure on local area wages does occur, it would attract skilled labour to the local area leading to downward pressure on wages.
- Based on 15% of the operational workforce migrating to the area, in comparison to the existing population and number of unoccupied dwellings located in the Mid-Western Local Government Area, the potential impact on housing and rental prices would likely be positive but negligible.
- Some impact to property values would be expected where a property is likely to be impacted by noise, air, visual, etc. Where these impacts are contained / mitigated, no impact to property value would be expected to occur.

In order to mitigate potential negative economic impacts and to maximise positive economic and employment benefits, a range of measures would be implemented, including:

- giving preference to hire of local employees;
- provide ongoing training and certification opportunities for local community members to ensure they have the necessary skills to work in mining;
- inform local businesses of the goods and services required for the Project and encourage them to meet the requirements of the Project for supply contracts;
- implementation of a Planning Agreement with Mid-Western Regional Council to provide monetary contributions to or the physical provision of public amenity and public services, transport or other infrastructure; and
- development of a Community Investment Program to expand upon current community support and sponsorships.

Social Impact

A comprehensive program of community engagement and research has identified the anticipated and likely social risks of the Project. A range of feedback has been received indicating both support for and objection to the Project. Overall, the local communities strongly support the Project primarily due to its economic benefits including local job creation. Consideration of community concerns and feedback on potential support programs has resulted in a range of social enhancement strategies being collated for further consideration and funding under measures that would be implemented by Bowdens Silver. With the implementation of these measures, the social benefit of the Project would be maximised and negative social impacts would be minimised.

While a number of social and environmental issues have been raised by some local landholders in proximity to the Mine Site, particularly the impact of the Project on social amenity and sense of place and community in Lue; the broader LGA community has appeared more accepting of the Project due to the predicted positive economic benefits.

It is acknowledged the outcomes of the Project would be experienced differently in the community, with ongoing meaningful engagement throughout the Project life proposed to ensure that mitigation programs are refined over time and the benefits of the Project are distributed as equitably as possible.

A detailed social impact assessment has been completed for the Project together with extensive consultation and engagement with key stakeholders within both the Lue district and wider Mid-Western Regional LGA. A range of perceived social issues and impacts have been identified and have been considered in the design process for the Project. Careful consideration has also been given to the remaining matters that would need to be managed throughout both the construction and operational stages of the Project.

It is noted that the level of concern relating to the Project varies across stakeholder groups and geographic location **Figure ES-14** presents an overview of the level of support for both mining generally and for the Project in the local and regional community as identified in a random community survey undertaken by Jetty Research from 19 to 28 August 2019 across the Mid-Western Regional LGA.

A summary of the issues and frequency that they were raised in all engagement activities for the social impact assessment is presented in **Figure ES-15**. Key negative social impacts identified include impacts relating from property acquisitions, impacts on social amenity (as a result of noise, visual and traffic impacts); changes to sense of community, community cohesion and culture; and conflict as a result of competing land uses. In addition to these impacts, stakeholders have raised concerns relating to impacts upon health and wellbeing; Aboriginal cultural heritage; population change as a result of construction and operational workforce influx and subsequent impacts to community services.

Key positive impacts identified include potential economic benefits to the region through employment, procurement and business opportunities – providing a much needed social and economic stimulus. It is notable that the economic outcomes of the Project were the most frequently raised issue In addition, regional community members also suggested that the increase in population as a result of workforce influx associated with the Project, may have a positive impact on the LGA in relation to service provision.

It is acknowledged that, whilst mining projects can result in significant positive economic and social benefits, the negative impacts experienced need to be equally considered. Therefore, in order to minimise the potential negative social impacts relating to the Project and enhance the positive benefits, the following key mitigation and enhancement strategies are proposed.

- Development of a dedicated Community Investment Program that focuses on enhancement initiatives for Lue and other key communities in the LGA.
- Development of a Local employment and procurement strategy to maximise the economic benefits of the Project within in the Mid-Western Regional LGA and involves:
  - giving preference to hire of local employees; and
  - informing local businesses of the goods and services required for the Project and encouraging them to meet the requirements of the Project for supply contracts.
- Development of a Good Neighbour Program and employment of a dedicated Community Liaison Officer to maintain and further develop Company-community relationships and manage monitoring and management commitments.

Figure ES-14 Level of Support by Locality

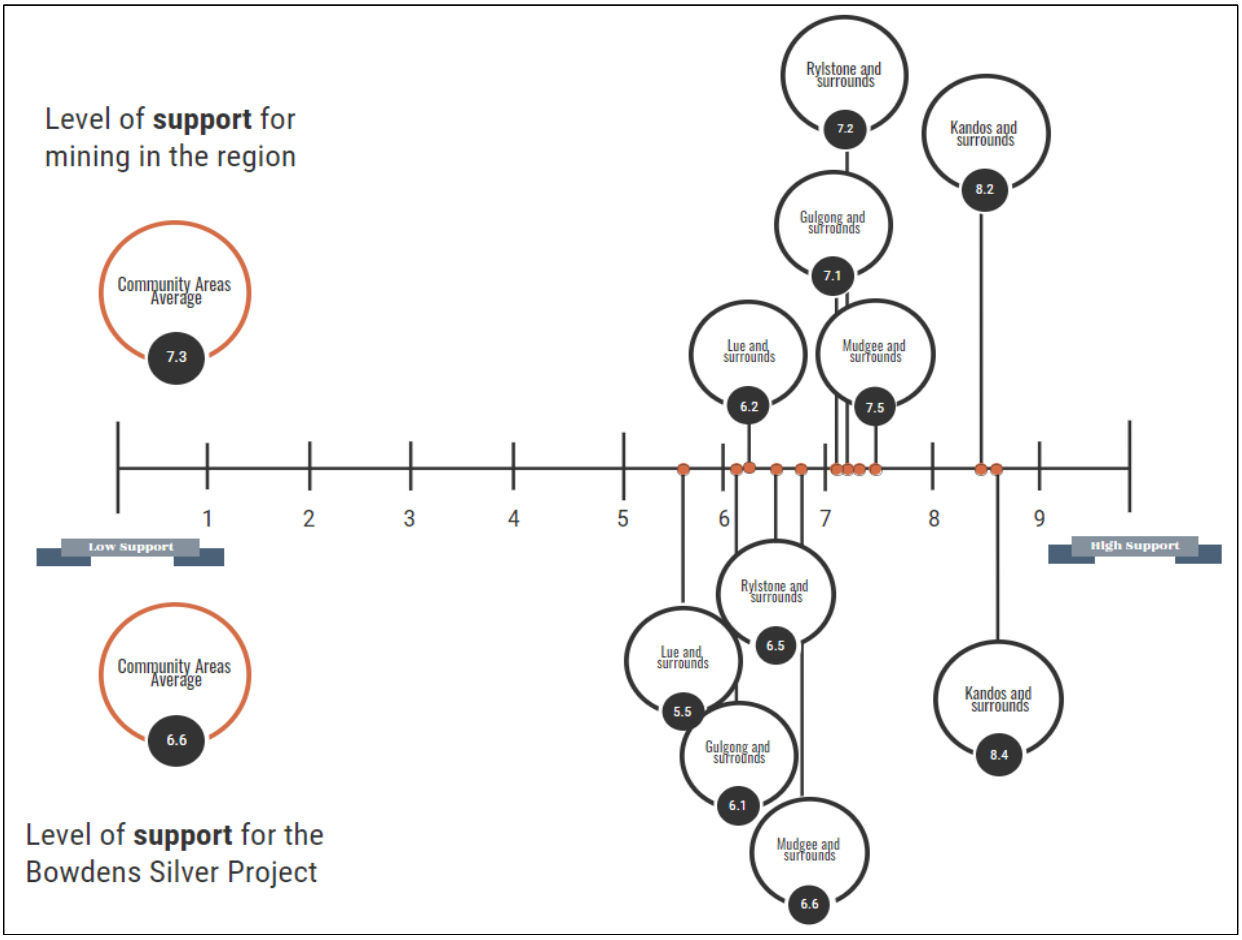
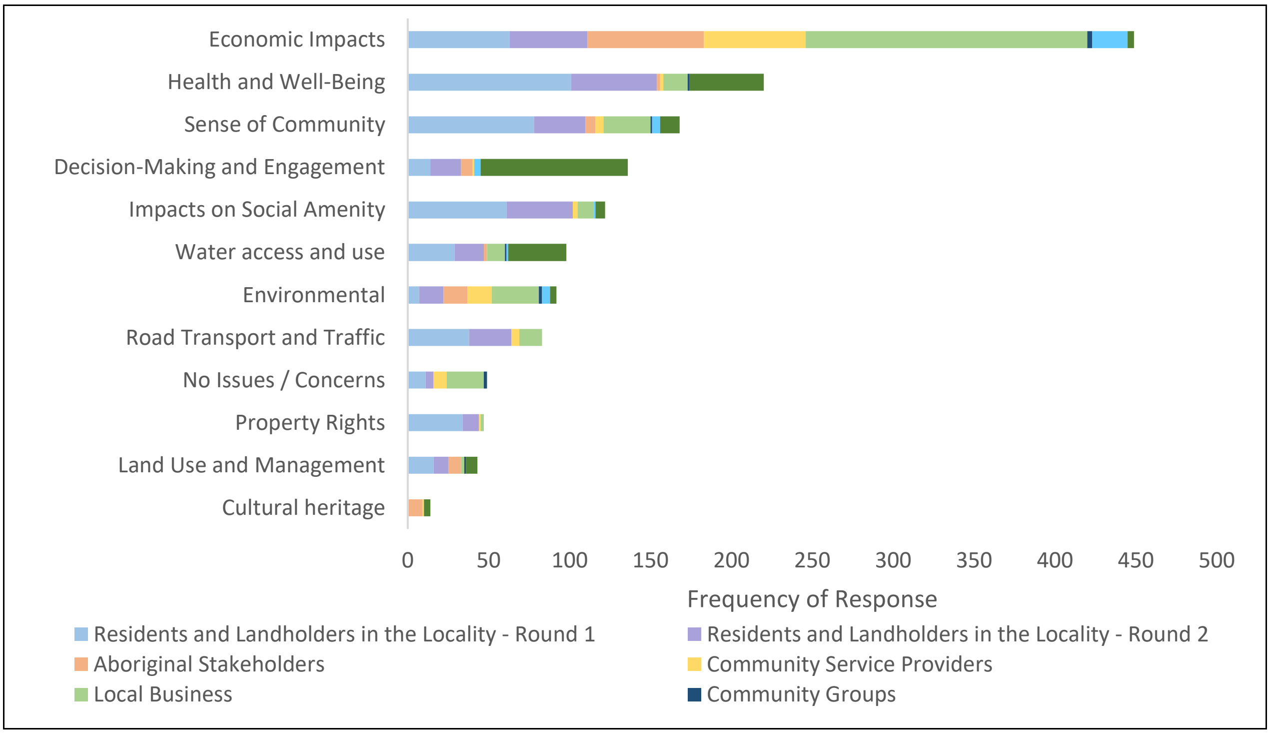


Figure ES-15 Frequency of Themes Raised – All Engagement



Source: Umwelt

- Development of a Good Neighbour Program and employment of a dedicated Community Liaison Officer to maintain and further develop Company-community relationships and manage monitoring and management commitments.
- Implementation of a Planning Agreement with the Mid-Western Regional Council to contribute to the provision of public amenity and public services, transport and/or other infrastructure requirements.
- Development of a Social Impact Management Plan that provides for monitoring and evaluation of social and community aspects of the Project and the application of adaptive management to minimise potential impacts and maximise benefits.
- Prepare an appropriate complaint receipt / response and incident notification / reporting processes to respond to community concerns and complaints.
- Regular public reporting of relevant statistics, monitoring results and engagement outcomes in order to keep the community informed, maintain transparency, and to remain accountable.

With the implementation of these measures, the social benefit of the Project would be maximised and negative social impacts would be minimised.

The benefits and costs from projects are not always evenly distributed across individuals and stakeholder groups. Therefore, the proposed mitigation and enhancement strategies have particularly focused upon residents surrounding the Mine Site and within Lue. In particular, the focus of the Community Investment Program would be to develop projects and programs that are consistent with the local community needs, values and aspirations.

Notwithstanding these measures, it is acknowledged that some residents may, for example, experience a loss associated with their sense of place or expectations of the future. However, others, both locally and within the broader LGA, may benefit from improved opportunities available through the proposed community investment and distribution of benefits.

Bowdens Silver would continue meaningful engagement throughout the Project life and monitor the social outcomes from the Project and the implementation of the various strategies. This would provide for adaptive management and refinement of enhancement strategies to ensure that benefits are distributed as equitably as possible and negative impacts minimised to the extent feasible. In addition to information that would be provided through the Good Neighbour Program, the outcomes of the engagement and monitoring would be reported annually through publicly available reporting in order to keep the community informed, maintain transparency, and to remain accountable to the community.

ENVIRONMENTAL MANAGEMENT AND ONGOING CONSULTATION

Environmental Management

Environmental management of the Project would be undertaken as an integral component of the overall management of the approved activities. All personnel would be inducted and trained in environmental management, consistent with their role and responsibilities. Bowdens Silver would employ a suitably experienced and qualified person whose principal function would be to coordinate the on-site environmental requirements, including compliance with commitments and procedures. The environmental manager would be assisted by a range of professionally trained and qualified environmental scientists and technicians. The environmental manager would report directly to the senior management position on the Mine Site and would pro-actively promote the consideration of environmental issues in all tasks undertaken on site.

Bowdens Silver intends to prepare all relevant environmental management documentation required by the NSW Government following the granting of development consent and a mining lease. This documentation would include a range of management and monitoring plans, a Rehabilitation Management Plan and ongoing annual documentation. Bowdens Silver would also maintain a register to comprehensively record all enquiries, complaints, the results of any investigations and responses.

Community Consultation

Bowdens Silver is committed to implementing a "Good Neighbour Program" to maintain and further develop Company-community relationships through regular and effective engagement and communication throughout the site establishment and construction stage and the operation of the Project. Components of the program would involve the following.

- Regular provision of environmental monitoring results via the Company website.
- Provision of site visits to view construction activities and operations.
- Continued operation of the CCC and publishing of meeting minutes on the Company website.
- Use of local community noticeboards.
- Regular information provision and community engagement including Open Days, newsletters, etc.

Bowdens Silver would continue to employ a dedicated Community Liaison Officer to manage the ongoing consultation, consistent with the "Good Neighbour Program" and a Social Impact Management Plan. The Company would operate with an 'open door' policy to enable Lue and district residents to discuss any components of the Project.

PROJECT EVALUATION AND JUSTIFICATION

The evaluation of the Project was undertaken in light of:

- Bowdens Silver's approach to project design and consideration of alternatives, including engagement with the community on the alternatives considered;
- the commitments made by Bowdens Silver that relate to reducing the potential impacts of the Project, ongoing management in an environmentally and socially responsible manner and final rehabilitation of the Mine Site;
- design and planning of the Project in accordance with the principles of ecologically sustainable development;
- consistency with State, regional and local planning matters and the objects of the EP&A Act, the principal legislation guiding development in NSW; and
- the achievement of the objectives of the Project.

The design, scale and location of the Project has also been justified in terms of the outcomes of biophysical, social and economic assessment and consideration of the predicted residual impacts.

The Project has been subject to detailed review, refinement and assessment during design and planning, and the preparation of this EIS. It is concluded that the Project as proposed, would enable Bowdens Silver to maximise the efficient mining for silver, zinc and lead while mitigating the identified potential environmental and social impacts and maximising economic and social benefits. Importantly, it has been recognised that some people in the community may experience impacts or that the opportunities of the Project may not be evenly distributed. Therefore, substantial social and economic mitigation measures have been proposed to ensure that benefits are distributed locally and negative impacts minimised to the extent feasible. These measures include initiatives to develop projects and programs that are consistent with the local community needs, values and aspirations. Bowdens Silver recognises the importance of establishing a relationship of mutual trust with the community that would be achieved through accountability and transparency. This would be achieved through meaningful engagement throughout the Project life, such as through the Good Neighbour Program, and monitoring of the environmental and social outcomes with results made available to the public.

CONSEQUENCES OF NOT PROCEEDING WITH THE PROJECT

The consequences of not proceeding with the Project relate principally to the lost opportunity to mine the silver, zinc and lead resources identified within the Mine Site. Bowdens Silver is confident that it has presented a Project that not only seeks the efficient development of the Mine but has taken into consideration the likely experience of the mining activities for the local community and the predicted short, medium and long term environmental outcomes. It is concluded that the Project, as presented, provides an acceptable balance of environmental and social outcomes in achieving the economic benefits of the Mine.

The demand for silver, zinc and lead correlates directly with need. The Economic Impact Assessment for the Project has identified that the Project would provide benefits to NSW of between \$44M and \$146M. The concept of the 'mining town' is something that may create apprehension for some people (that is, a town that exists to support mining) and it is acknowledged that, where mining occurs in a community, the benefits are greatest where there is a diverse mix of economic opportunities to complement the mining benefits. In these situations, mining provides additional opportunities as it is often connected to other industries (manufacturing, retail and service-based industry) and often provides the training and education that is eventually of benefit to other aspects of the community. These opportunities would be lost if the Project were not to proceed.

Should the Project not proceed, not only would the anticipated broader economic benefits associated with local employment and procurement of services and consumables not be achieved, but local enhancement projects and other community benefits would be foregone.

Should the Project not proceed it is also likely that future exploration by Bowdens Silver and others in the region would be reduced and subsequently the attractiveness of mineral development in the region. As a result, there would be lost opportunity to diversify the Mid-Western Regional LGA's mining industry from principally coal mining.

It is commonly understood that employment opportunities within the Mid-Western Regional LGA are a source of concern for Council and some members of the community. This is closely associated with concerns regarding the viability of some of the smaller towns and villages in the region. Concerns have been exacerbated by the closure of the Kandos Cement Works and the recent refusal of the Bylong Coal Project. It is noted that the level of support received to date for the Project was captured in consultation prior to the refusal of the Bylong Coal Project. Therefore, as the opportunities from the Bylong Coal Project are not likely to eventuate, the perceived importance of the employment and economic opportunities provided by the Bowdens Silver Project have likely increased.

It is anticipated that the Project would improve outcomes for local people seeking employment in the mining industry. The community anticipation of this benefit has been reflected in the preliminary job information requests received to date by Bowdens Silver and the outcomes of engagement for the Social Impact Assessment, for which the most frequent topic raised was the economic outcomes of the Project.

It is also accepted that should the Project not proceed, a range of residual environmental and social impacts would be avoided.

PUBLIC INTEREST

In accordance with Section 4.15(1e) of the EP&A Act, evaluation of a development application by a consent authority must consider the public interest. Based on the assessments undertaken for the Project, it is considered that the EIS has been thorough in its consideration of matters relating to the public interest.

Consultation and engagement throughout the development of the EIS has identified a range of supportive feedback as well as opposition to the Project. As a result, Bowdens Silver has proposed a range of measures to mitigate social impacts and enhance opportunities. Programs such as the Community Investment Program would provide mechanisms for the local and regional distribution of the economic benefits of the Project to the surrounding and local communities. Furthermore, the Project would be developed in accordance with the principles of ecologically sustainable development and the relevant planning considerations at both State and local government levels that need to be satisfied for the Project. The outcomes of environmental, economic and social assessments for the Project have confirmed that the Project would operate in accordance with the legislation, policies and guidelines developed to ensure responsible environmental practices for development. It is therefore concluded that should it be approved the Project would operate in accordance with the public interest.

It is acknowledged that there is opposition to the Project in the community and the Project would change the local setting and for some people the amenity they receive from the locality. However, the EIS has demonstrated that these changes would be managed acceptably. In addition, the outcomes in terms of employment generation, income for businesses supplying the Project including contracts for its construction as well as social benefits experienced through the programs funded by Bowdens Silver would represent significant public benefits.

It is therefore concluded that, on balance, the Project is in the public interest.

CONCLUSION

This EIS has described the identified mineral resources in detail and explained the procedures necessary to develop the Mine Site in a suitable manner. Each component of the assessment has been accompanied by a description of the environmental management commitments that have been proposed in order that:

- predicted residual environmental impacts remain acceptable;
- ongoing management, monitoring and reporting ensures that compliance is maintained;

- there are measures in place to ensure the community is aware of how environmental risks are being managed; and
- in the case of social commitments, benefits are distributed as equitably as possible.

The assessment of impacts for the Project has determined that noise would be a residual Project-related impact. Bowdens Silver would implement all reasonable and feasible noise mitigation measures and is in negotiation with those residents that would be unacceptably impacted under the VLAMP. Remaining residents would experience mine-related noise for the first time, particularly under noise enhancing conditions, however, those noise levels are predicted to be less than the relevant criteria. All other environmental aspects have been mitigated to the maximum extent practicable and Bowdens Silver contends that these would not result in unacceptable or unreasonable impacts.

Planning and design of the Project has been an iterative process that has involved refinements in response to the outcomes of assessment and the feedback from community engagement. Bowdens Silver considers that the scale of the Project would be sufficient to provide a boost to the local economy but not cause substantial adverse environmental or social impacts. The Project, as presented, provides an acceptable balance of environmental and social outcomes in achieving the economic benefits of the Mine.

Bowdens Silver recognises the importance of establishing a relationship of mutual trust with the community that would be achieved through accountability and transparency. This would be achieved through meaningful engagement throughout the Project life and monitoring of the environmental and social outcomes, with results made available to the public. In addition, the legacy of the Project has been considered with regards to the rehabilitation and final land use options and mechanisms to preserve the existing character of Lue while providing sufficient economic stimulus to support existing businesses and a reasonable level of growth.

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Section 1

Introduction

PREAMBLE

This section introduces the Bowdens Silver Project to develop and operate an open cut silver mine and associated infrastructure ("the Project") located approximately 2km to 3km northeast of Lue and 26km east of Mudgee within the Mid-Western Regional Local Government Area. This section provides:

- *an outline of the scope and format of the document;*
- *an introduction to the Applicant, Bowdens Silver Pty Limited and the Application Area for the Project;*
- *Project terminology;*
- *relevant background about the Project and preparation of the EIS;*
- *an overview of the properties, uses, sources and prices of silver, zinc and lead;*
- *a brief overview of mines in NSW in close proximity to population centres;*
- *a summary of the approvals process; and*

the personnel involved in the design of the Project, document preparation and specialist consultant investigations.

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1.1 SCOPE

Bowdens Silver Pty Limited ("Bowdens Silver" or "the Applicant") proposes to develop and operate an open cut silver mine approximately 26km east of Mudgee within the Mid-Western Regional Local Government Area (LGA) of New South Wales (see **Figure 1.1**). The proposed mine and its associated infrastructure (the "Project") would be located approximately 2km to 3km northeast of Lue on Bowdens Silver-owned land, land under option to purchase or land the subject of lease agreements with Bowdens Silver. The Project is comprised of three main components (also presented on **Figure 1.1**).

- The "Mine Site" that includes the lands and infrastructure required for open cut mining and processing of ore, and the production of silver/lead and zinc concentrates including associated management of water resources, waste rock and tailings materials.
- The "relocated Maloneys Road" (a public road) which would provide access to the Mine Site from Lue Road west of Lue and would comprise a relocated section of Maloneys Road, a new railway bridge overpass and a new road crossing of Lawsons Creek.
- A "water supply pipeline corridor" extending approximately 58.5km from the Mine Site to the Ulan and Moolarben Coal Mines to supply the Project with make-up water required for processing and dust suppression.

External electrical power supply for the Project will be required but is not assessed as part of this application. That component of development would be the subject of a separate Part 5 application under the *Environmental Planning and Assessment Act 1979* ("EP&A Act") prepared in conjunction with the relevant energy provider.

The Project was referred to the Commonwealth Department of Energy and the Environment (DoEE) (now the Department of Agriculture, Water and the Environment) on 20 December 2018. On 5 April 2019 advice was received from the then DoEE that the Project was determined to be a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) due to the potential for impacts to listed threatened species and communities protected under Section 18 and Section 18A of the EPBC Act. The action is to be assessed under the bilateral agreement with the NSW Government. The Project is a "State Significant Development" pursuant to the *State Environmental Planning Policy (State and Regional Development) 2011* by virtue of the Project having a capital investment value greater than $30 million. The Project Development Application (DA) will therefore require assessment under Division 4.7 of Part 4 of the EP&A Act. The consent authority for the Project will be the Minister for Planning or the Independent Planning Commission.

The Application Area is located wholly within the Mid-Western Regional LGA for which the *Mid-Western Regional Local Environmental Plan 2012* (Mid-Western LEP) is relevant. Under Mid-Western LEP, the Mine Site is designated as occurring within Zone RU1 – Primary Production, with open cut mining being permissible with consent within this zone. The relocated Maloneys Road is situated within Zone RU1 – Primary Production with the water supply pipeline occurring within Zone RU1 – Primary Production and Zone R5 – Large Lot Residential. **Appendix 1** lists all land titles within the Application Area. The objectives of the Mid-Western Regional LEP are discussed further within Section 3.2.3.6, particularly with respect to the manner in which the Project satisfies the objectives of the various zones.

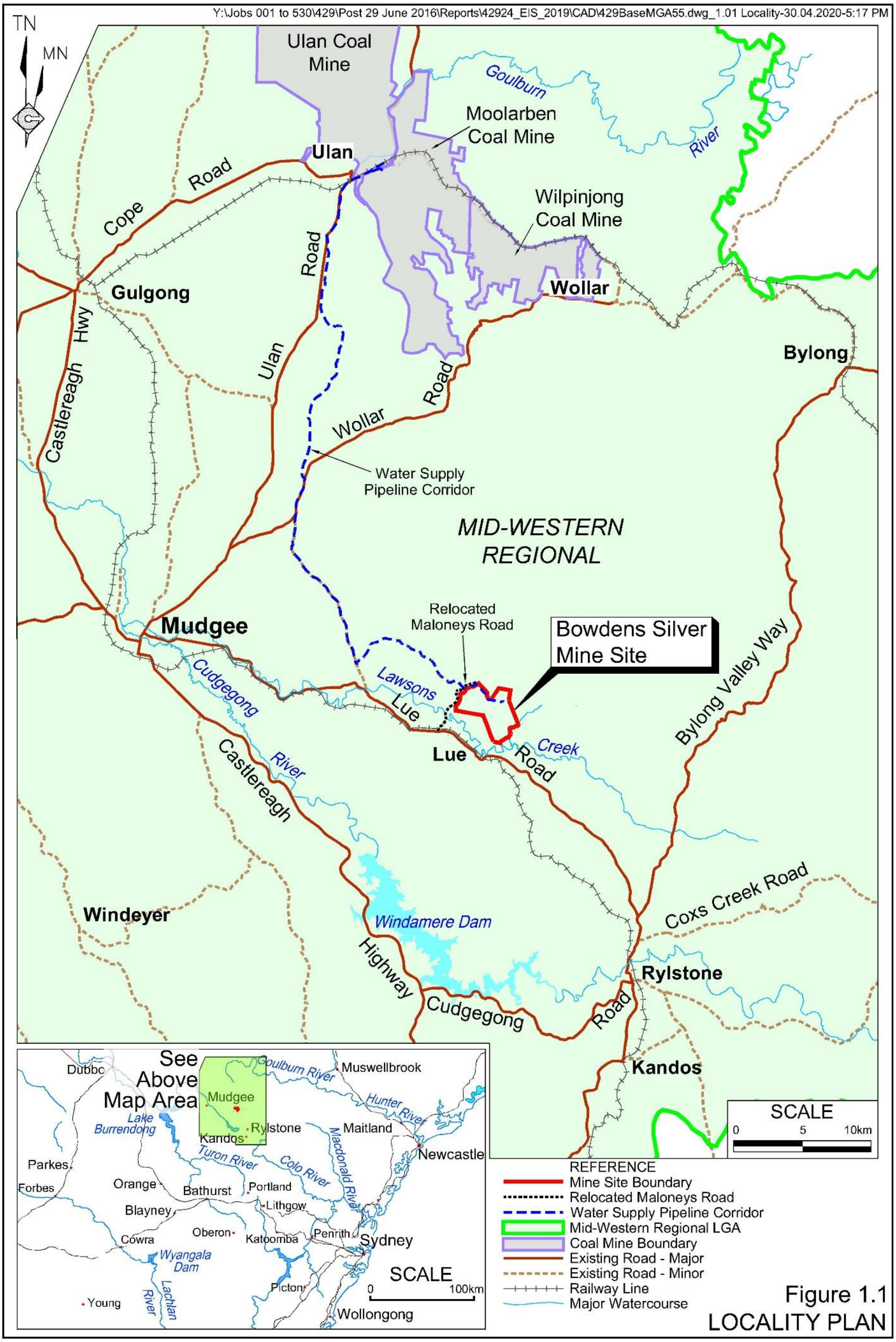

Figure 1.1
LOCALITY PLAN

The information presented in this Environmental Impact Statement (EIS) covers all aspects of the planning, site establishment and construction, mining and processing operations, waste management, rehabilitation, environmental management and monitoring of the Project to a level of detail consistent with industry standards, the scale of the proposed operations and the potential for environmental impacts. These aspects are presented in a manner that addresses the specific requirements of the Secretary of the then Department of Planning and Environment (DPE), the matters identified for consideration in correspondence submitted to DPE by other State and local government agencies and other matters identified during the community consultation process.

A copy of the Secretary's Environmental Assessment Requirements (SEARs) and the requirements of the then Commonwealth Department of Environment and Energy (now the Commonwealth Department of Agriculture, Water and the Environment (DoAWE)) under the EPBC Act are provided in **Appendix 2.** A table recording where each of the requirements nominated in the SEARs and their supporting documentation and relevant matters raised by other government agencies and the community are addressed in this document is presented in **Appendix 3**.

The issues addressed throughout this EIS and their relevant importance to the assessment of the Project have been identified through consultation with government agencies, the local communities, surrounding landowners, a risk assessment and a diversity of specialist consultants assessments.

1.2 THE APPROVALS PROCESS

Table 1.1 presents the component stages of the overall approvals process for a "*State Significant Development"* concluding with the determination of a development application by the Minister for Planning or his/her delegate.

Table 1.1
Approvals Process for the Bowdens Silver Project and Status

Page 1 of 2

Stage	Activity	Status
1.	Bowdens Silver commenced consultation with the local and wider community in the third quarter of 2016. An application for SEARs was prepared and submitted to the then DPE in November 2016 accompanied by a Preliminary Environmental Assessment for the Project.	Completed
2.	DPE received the written requirements from the government agencies consulted and issued the SEARs for the Project on 23 December 2016. The SEARs were updated on 15 August 2017 requiring Bowdens Silver to establish and operate a CCC for the Project.	Completed
3.	A CCC was formally established under the EP&A Act and first met on 5 September 2017 by DPE (see Section 3.2.2.1 for further detail re. community consultation). Community consultation has been an ongoing process throughout the preparation of the EIS.	Ongoing
4.	Amended SEARs were sought in April 2019 to address the addition of the water supply pipeline from the Ulan mining area to the Mine Site and the decision from the then DoEE to determine the Project to be a controlled action under the Environment Protection and Biodiversity Conservation Act ("EPBC Act").	Completed
5.	The EIS was provided to DPIE in January 2020 for a high level review (prior to it being placed on public exhibition).	Completed
6.	DPIE places all documents on public exhibition and notifies adjoining landowners and other stakeholders about the Project and the exhibition period.	*

Table 1.1 (Cont'd)
Approvals Process for the Bowdens Silver Project and Status

Page 2 of 2

Stage	Activity	Status
7.	Review of the EIS by the community and government agencies during the exhibition period.	*
8.	DPIE requests Bowdens Silver to prepare a response/clarification of issues raised in the submissions from government agencies and the community.	*
9.	The Applicant provides a Submissions Report responding to the issues raised in community and government agency submissions.	-
10.	DPIE prepares its assessment report based on all documentation submitted by Bowdens Silver, government agencies and the community. If the Planning Minister is the consent authority, the Project would be determined at this stage. If the Independent Planning Commission (IPC) is the consent authority, the assessment report would present a recommendation and the determination would be referred to the IPC.	*
11.	The Applicant prepares a response to the DPIE assessment report for consideration by the IPC, if the IPC is the consent authority.	*
12.	Determination of the application by the IPC, i.e. either approval (with conditions) or refusal.	*
* Timing beyond the control of Applicant		

In the event development consent is granted, the Applicant would apply for the various licences and approvals nominated in Section 2.1.3. In most cases, the grant of development consent is a pre-requisite for the other approvals and licences required to operate the Project.

1.3 THE APPLICANT AND THE APPLICATION AREA

1.3.1 The Applicant

The Applicant, Bowdens Silver Pty Limited, is a 100% owned subsidiary of Silver Mines Limited ("Silver Mines"), a publicly-listed company trading on the Australian Securities Exchange ("ASX"). Bowdens Silver is committed to the development and operation of the Bowdens Silver Project. The Feasibility Study for the Project was completed in mid-2018 determining a production profile of approximately 53 million ounces of silver over a 16.5 year mine life. Production of approximately 116 000 tonnes of zinc and approximately 83 000 tonnes of lead is also planned.

Bowdens Silver holds 100% of Exploration Licence 5920 (EL5920) which contains the Bowdens silver deposit. Bowdens Silver also holds nine exploration licences in a contiguous area which covers from near Kandos and extending to the north of Gulgong focussing on the eastern margin of the Lachlan Fold Belt (see **Figure 1.2**). In addition, Bowdens Silver holds an 80% interest and manages a Joint Venture over Exploration Licence EL7391 (5km west of Lue) with Thomson Resources Limited. Bowdens Silver is committed to undertaking the nominated exploration within the exploration licences and would relinquish the parts of the licences no longer required in accordance with the provisions of the Mining Act 1992.

The following projects, all of which are located within New South Wales, are controlled by Silver Mines.

- Barabolar Project (copper/gold) – 15km north-northwest of Bowdens
- Webbs Project (silver/polymetallic) – 45km north of Glen Innes

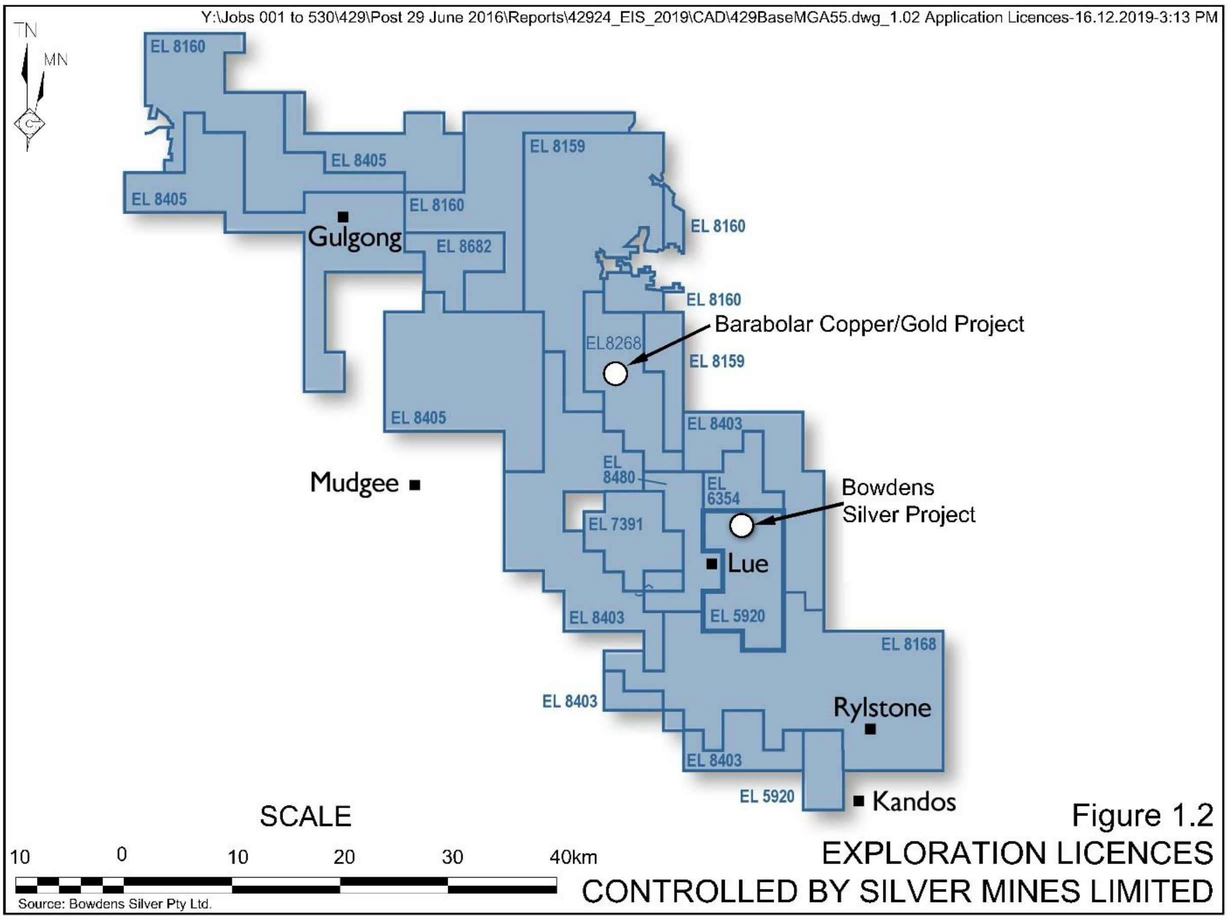

Figure 1.2
EXPLORATION LICENCES
CONTROLLED BY SILVER MINES LIMITED

- Conrad Project (silver/polymetallic) – 25km south of Inverell
- Tuena Project (gold/silver) – 70km south of Bathurst.

Bowdens Silver is controlled by a Board of Directors and management team with a comprehensive range of skills and experience in exploration, mine development, finance and administration. Further information in relation to the Applicant is available at www.silvermines.com.au and www.bowdenssilver.com.au.

Bowdens Silver is committed to operate the Project is a manner that achieves the objectives set out in Section 2.1.1 and in a manner that is transparent, particularly in its communication with the Lue and district residents.

1.3.2 The Application Area

The Application Area for the Project comprises three areas, namely:

- the Mine Site[1] (covering an area of approximately 1000ha) incorporating the open cut pits, processing plant, tailings storage facility, waste rock emplacement and a range of infrastructure including roads, offices, amenities and a range of services;

[1] The southern boundary of the Mine Site is set back 20m from the hydro line depicting Hawkins Creek as presented on the Water Management (General) Legislation 2018.

- a relocated section of Maloneys Road (covering an area of approximately 19ha and including a new railway bridge crossing and new crossing of Lawsons Creek); and
- a water supply pipeline corridor (covering a length of approximately 58.5km and a width of up to 10m) for the supply of make-up water for processing activities sourced from the Ulan Coal Mine and/or Moolarben Coal Mine.

Figure 1.3 shows the locations of the Application Area and its three component areas.

The land titles within the Application Area are displayed in **Appendix 1**, namely on **Figures A1.1**, **A1.2** and **A1.3** and listed in **Table A1.1**.

1.4 PROJECT TERMINOLOGY

The following terminology is referred to regularly throughout this document. A glossary of all other mining and environment-related terminology referred to throughout this document is presented in Section 8.

- The Project – The Bowdens Silver Project.
- Application Area – The Application Area comprises the Mine Site and corridors for the relocated Maloneys Road and the water supply pipeline.
- Mine Site – The Mine Site encompasses all land within which the mining, processing and management of waste rock and tailings would occur (approximately 1 000ha).
- Relocated Maloneys Road – A 5.2km section of road from Lue Road to the retained section of Maloneys Road approximately 2.5km northeast of the main open cut pit.
- Water Supply Pipeline – a 58.5km pipeline that would supply water to the Mine Site from the Ulan Coal Mine and/or Moolarben Coal Mine.
- Mine life – Approximately 16.5 years comprising the site establishment and construction stage (approximately 18 months - including 12 months of mining pre-strip) and mining / processing for approximately 15 years (to the end of concentrate production).
- Project life – Approximately 23 years comprising the site establishment and construction stage, mining and processing operations (to the end of concentrate production) and includes the period for final rehabilitation.

1.5 BACKGROUND TO THE PROJECT

1.5.1 Introduction

The following subsections provide background information regarding exploration that led to the discovery and acquisition of the Bowdens Silver mineralisation zone, details of the various exploration activities and detailed information on the calculated mineral resources and ore reserves. A brief overview is provided on the environmental investigations undertaken, the consideration of alternatives in the Project design and the preparation of the Project Feasibility Study and EIS.

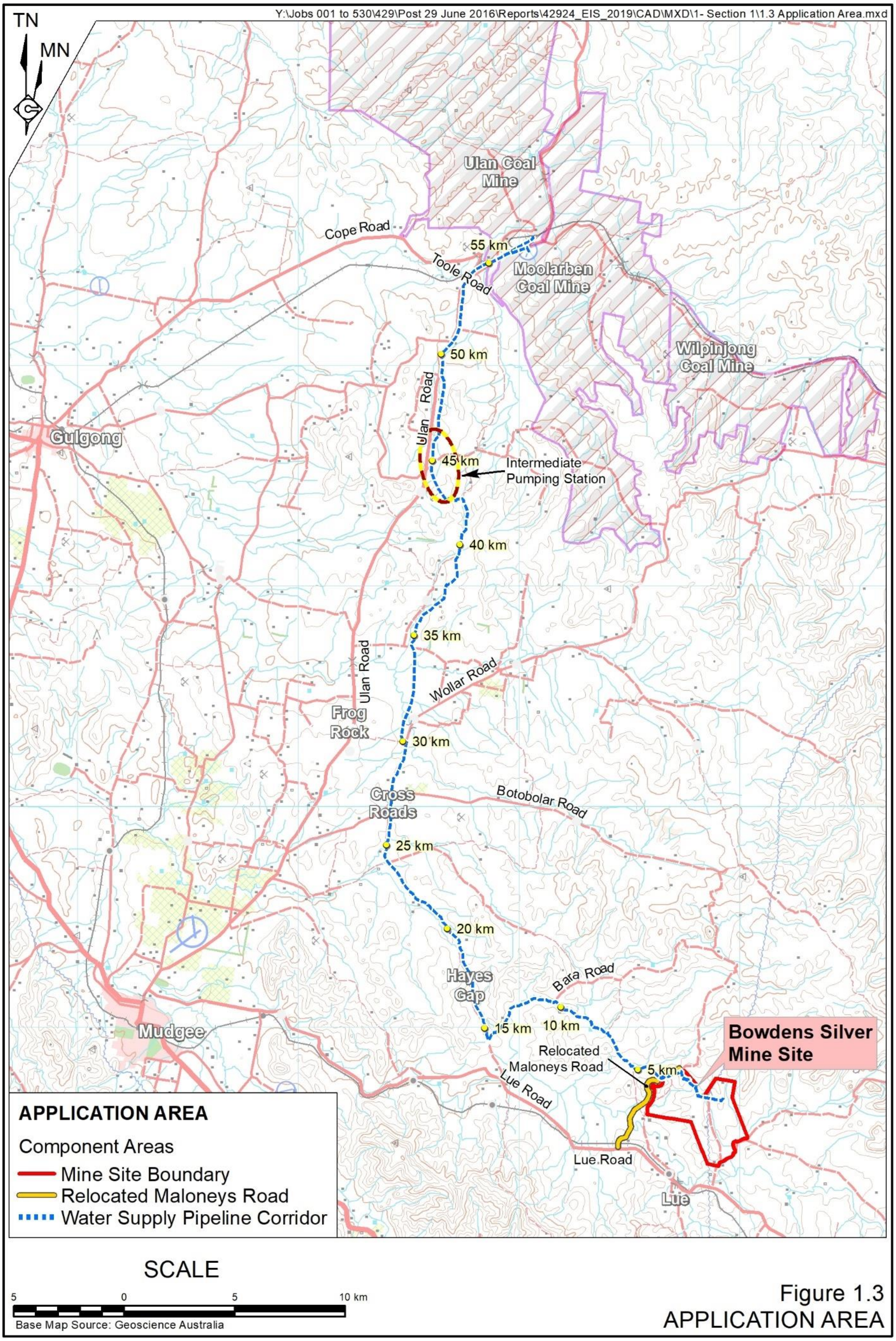

Figure 1.3
APPLICATION AREA

1.5.2 Previous Exploration Activities

The original exploration licences covering the "Bowden" property and a number of surrounding properties were granted in 1989 and 1990 to CRA Exploration Pty Limited (CRAE). In July 1989, follow-up exploration of an anomalous stream sediment sample and mineralised float, led to the discovery of outcropping sulphide-bearing rocks which assayed 860ppm silver, 1.0% zinc and 0.5% lead. Between 1989 and 1992, CRAE carried out exploration activities which resulted in the discovery of the Bowdens Gift Zone of outcropping mineralisation approximately 500m east of the discovery outcrops.

In 1994, CRAE sold the project to GSM Exploration Pty Limited (GSME), a subsidiary of Golden Shamrock Mines Limited. The original prospect was re-named Main Zone South, and the mineralisation extending north-northwest was named Main Zone North. The Bundarra North and South Zones were later discovered 400m west of the Main Zone. GSME undertook a scoping study for a near-surface resource of 18.8 million tonnes of resource at 99g/t silver including metallurgical testing and preliminary environmental studies.

In 1997, Golden Shamrock Mines Limited merged with Ashanti Goldfields Limited, and GSME was acquired by Silver Standard Resources Inc. GSME was renamed Silver Standard Australia Pty Limited ("Silver Standard"). Silver Standard continued exploration activities, with a feasibility study commenced in mid-1998. However, work on the feasibility study was suspended in favour of additional drilling to expand and delineate the mineral resources and ore reserves.

The drilling and feasibility work by Silver Standard led to the definition of a Canadian NI 43-101 compliant resource in 2004, completion of a scoping study and detailed metallurgical work. The project was then put on care and maintenance in 2006 while Silver Standard advanced other projects.

In October 2011, Kingsgate Consolidated Limited ("Kingsgate") completed the purchase of the Bowdens Silver Project from Silver Standard and created Kingsgate Bowdens Pty Limited. Kingsgate used the existing drilling database to complete a Joint Ore Reserves Committee (JORC) Code-compliant resource estimate in late 2011 and again later in November 2012 at the conclusion of the 2012 exploration drilling program. Kingsgate also commenced a Feasibility Study and EIS that were halted in early 2015.

1.5.3 Project Purchase

In March 2016, Silver Mines announced it had entered into a Sale and Purchase agreement with Kingsgate whereby it would acquire 85% of the Bowdens Silver Project. The purchase of the Bowdens Silver Project by Silver Mines Limited was completed on 29 June 2016. The acquisition of the remaining 15% of the Project was announced on 29 December 2016.

1.5.4 Bowdens Silver Exploration Activities

Bowdens Silver continued exploration activities throughout the 2017 and 2018 financial years within the "Bowden" property focussing upon:

- increasing silver resources within and surrounding the previously identified resource area;

- converting identified silver resources to higher levels of confidence as part of a Project Feasibility Study;
- further drilling of exploration targets where silver mineralisation had been identified but not yet fully evaluated; and
- testing exploration targets proximate to the current resource associated with surface geochemical and geophysical anomalies.

The drilling program was successful in achieving these objectives and clarified the most appropriate and economic depth of the Project's proposed open cut mining operation. It was noted that further mineralisation was identified below the proposed base of the main open cut pit, although insufficient metal grades were present in the holes drilled to warrant a deeper open cut pit. An ore reserve statement is provided in Section 2.2.3 based upon the defined ore and mineralisation. **Figure 1.4** presents the locations of exploration drill holes undertaken by Bowdens Silver together with those undertaken by Kingsgate, Silver Standard and other previous explorers.

1.5.5 Environmental Investigations and Documentation

A range of environmental investigations were commenced alongside exploration activities as early as 1996. These investigations have been used to support and qualify the investigations undertaken for this EIS. It is considered that the local setting of the Project is well understood and consideration of environmental risks have been comprehensive. Silver Standard initiated a range of baseline environmental studies in June 1996. These included background deposited dust levels, surface water quality and groundwater quality in June 1996. The collection of weather data commenced in November 2003. Data collection was suspended in February 2010, although some datasets for the weather data were incomplete.

Silver Standard also commissioned Aboriginal heritage surveys in 1996 and 1998 and a flora survey in 2003.

In early 2012, Kingsgate re-established a number of the previous baseline environmental studies and data collection and expanded the investigations to include the following.

- Surface water quality.
- Stream gauging in Hawkins Creek.
- Groundwater quality, depths and hydraulic parameters.
- On-site meteorological monitoring (from May 2012) and commencement of meteorological monitoring in Lue in March 2013.
- Flora and fauna studies.
- Stygofauna sampling in groundwater bores.
- Aboriginal heritage and historical surveys.
- Soils surveys.

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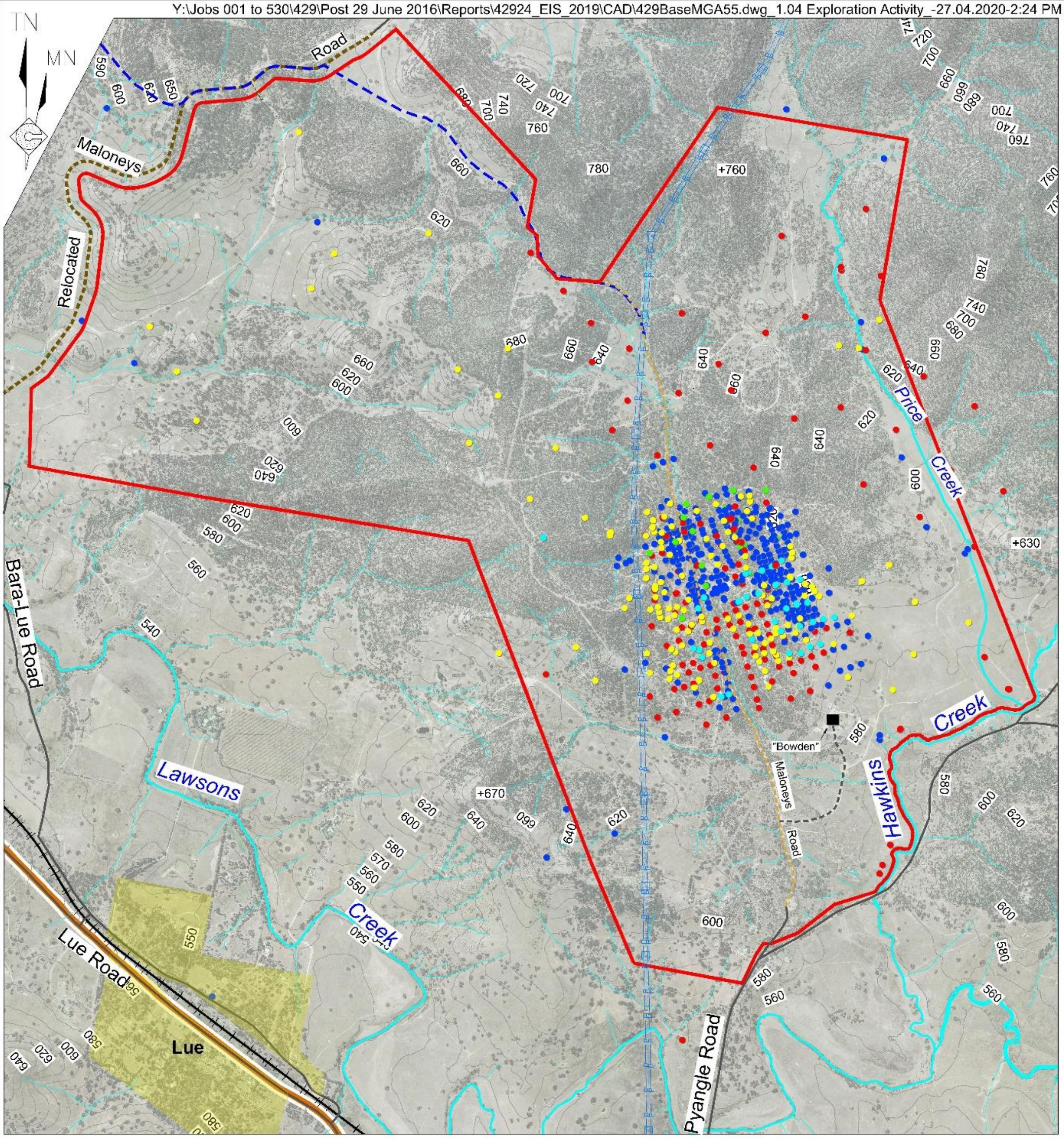

REFERENCE

- Mine Site Boundary
- Relocated Maloneys Road
- Water Supply Pipeline Corridor
- Road
- Closed Railway Line
- Closed Maloneys Road (to be retained)
- Existing Power Line (500kV) / Tower
- 500 Contour (mAHD)(Interval=10m)
- +595 Spot Height (mAHD)
- Watercourse / Drainage Line
- Lue as displayed on Mid-Western Regional LEP, 2012

Drilling by Company

- Bowdens Silver
- CRA Exploration
- GSME
- Kingsgate
- Silver Standard

SCALE

500 0 500 1000 1500 m

Source: Bowdens Silver Pty Limited

Figure 1.4
EXPLORATION ACTIVITIES WITHIN THE MINE SITE

- Background noise surveys.
- Waste rock and tailings characterisation.
- Water and sediment quality surveys in local drinking water tanks.
- Lead surveys in the Lue area, particularly at Lue Public School.
- A seed collection program from the native trees and shrubs within the likely Mine Site area.

Kingsgate commenced a design for a project to extract and process the ore defined at that time at a rate of 4 million tonnes of ore per year. In December 2012, Kingsgate prepared a Preliminary Environmental Assessment and sought Director-General's Requirements from the former Department of Planning and Environment (DPE) for preparation of an EIS for the Project. A range of additional environmental studies were commenced together with a community consultation program. The duration of the project design extended beyond that originally planned and further requirements were sought from the DPE in December 2014. By May 2015, the bulk of the environmental studies and monitoring were placed on hold until Silver Mines Limited purchased the Project in 2016.

1.5.6 Project Feasibility Study

A detailed Feasibility Study for the Project was compiled by GR Engineering Services Limited and completed in mid-2018, in conjunction with a range of specialist mine development consultants, to confirm the viability of the Project. The Feasibility Study demonstrated that the Project would be able to produce concentrates containing an average of 3.4 million ounces of silver per annum, together with approximately 6 900 tonnes per annum of zinc and 5 100 tonnes per annum of lead. It was established that average production during the first three years of operation would be approximately 5.4 million ounces of silver per annum, 6 000 tonnes per annum of zinc and 5 200 tonnes per annum of lead due to the higher silver grades during the early stages of mining.

Initial capital costs for the Project were estimated at $246 million which includes the development of the mine, processing plant, TSF and power supply with a further $54 million of sustaining capital required over the mine life. The operating costs estimated in the Feasibility Study indicate that the Project would have a Life of Mine (LOM) C1 Cost of A$15.47/oz (US$11.60/oz) and an All in Sustaining Cost of A$17.25/oz (US$12.94/oz). Financial modelling undertaken for the Project indicates a total operating margin of A$558.7 million, with project payback approximately 4.8 years after the commencement of production.

It is noted that whilst the Feasibility Study for the Project focussed on its viability, further design work was required to assemble sufficient information for use in the assessment of a range of environmental impacts of the Project (see Section 1.5.8).

As discussed in Section 1.3.1, Bowdens Silver continued its exploration activity across the various exploration licences covering 2,007 km^2 along approximately 80km of highly mineralised Permian Rylstone Volcanics overlying Ordovician and Silurian Formations. **Figure 1.2** displays the locations of the exploration licences currently controlled by Silver Mines Limited.

Geological and structural mapping in conjunction with a regional soil geochemical program and geophysical exploration works has highlighted a corridor with surface geochemistry anomalies in gold, copper, silver, molybdenum, zinc and lead. The exploration in this corridor has led to the discovery and initial definition of the Barabolar Project located approximately 15km north-northwest of the Bowdens Silver Mine Site (see **Figure 1.2**).

1.5.7 Project Design Alternatives

During the design of the Project, Bowdens Silver examined a range of alternatives for a number of the components before deciding upon the location, scale and/or form of the proposed components of the Project as presented within the EIS. This subsection outlines the feasible alternatives considered for these components and the reasons for not proceeding with the various alternative(s) and proceeding with the preferred alternative for each component.

For a number of components, consideration of alternatives was not undertaken. Rather, Bowdens Silver firstly assembled all relevant information that would influence the design of the component in order to achieve a design which avoided or minimised environmental impacts. For components such as the WRE design, no alternatives were considered as they were simply designed to achieve the least or no environmental impacts.

Table 1.2 reviews the key feasible alternatives considered and provides the basis for the selected alternative that forms part of the overall Project. **Figure 1.5** displays the locations of the key alternatives considered.

It is noted that whilst a range of alternatives are currently being considered to supply electrical power to the Mine Site, these alternatives would be addressed in a separate document seeking approval for the preferred transmission line route.

1.5.8 Environmental Impact Statement Preparation

Bowdens Silver commissioned the preparation of an EIS to document its plans to develop the Project in the manner outlined in the Feasibility Study. A Preliminary Environmental Assessment (PEA) was submitted to the DPE in November 2016 accompanying a request for SEARs for the Project. The SEARs were issued in December 2016 and subsequently amended by the DPE in August 2017 with the request for Bowdens Silver to establish and operate a Community Consultative Committee (CCC) for the Project in accordance with the *Community Consultative Committee Guidelines: State Significant Projects* dated November 2016.

Throughout 2017 and 2018, a range of supporting environmental and project design studies continued which resulted in a range of adjustments to the Project design. Wherever feasible alternatives were identified for Project components or activities, these alternatives were investigated in order to identify the most appropriate components for the Project, as outlined in Section 1.5.7.

The most significant design change was the introduction of a water supply pipeline to provide make-up water for processing and dust suppression.

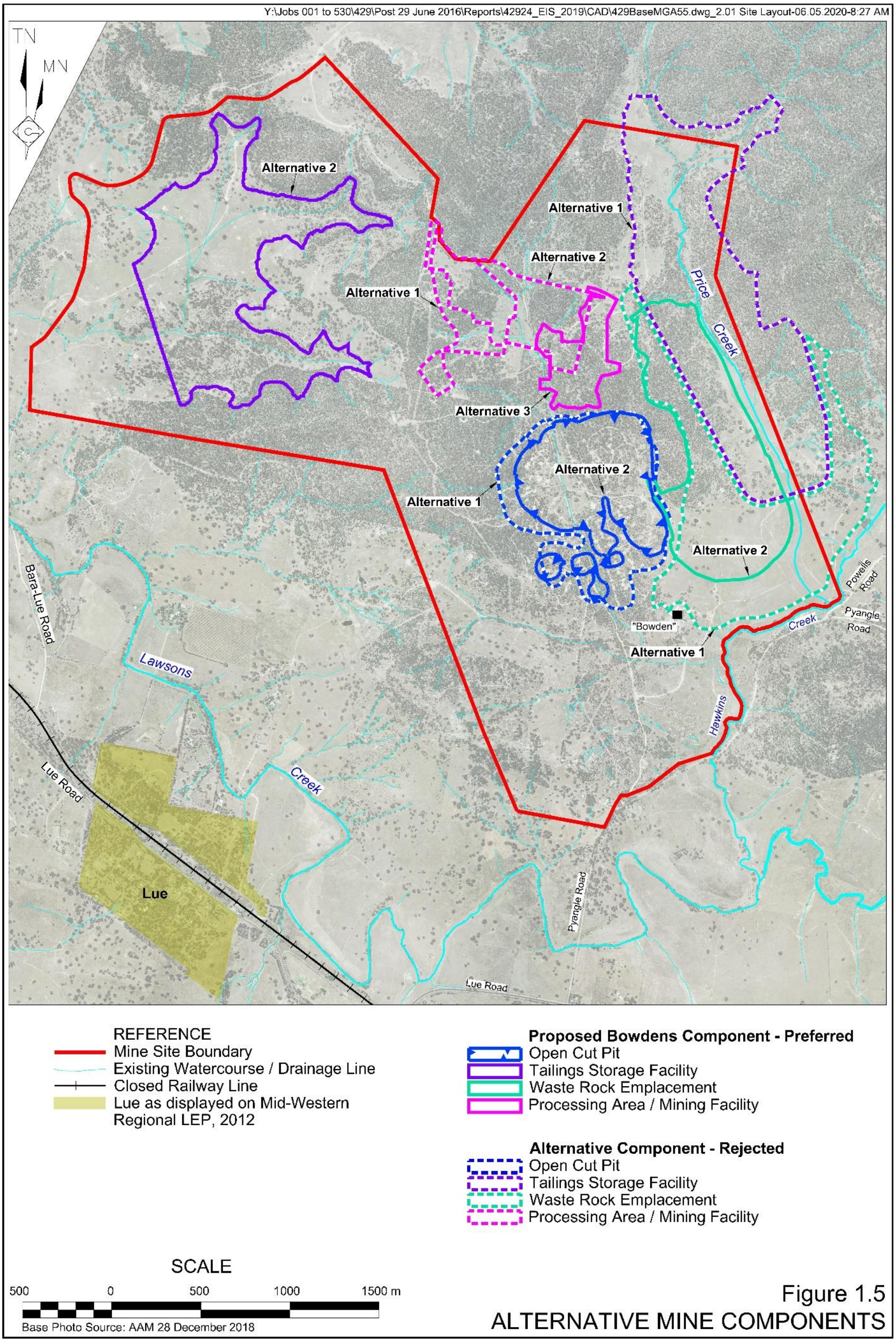

Figure 1.5
ALTERNATIVE MINE COMPONENTS

Table 1.2
Key Project Design Alternatives Considered

Page 1 of 4

Alternatives Considered	**Reason for Rejection / Preference**
Water Sources	
Alternative 1: Use of water from a single source There are a variety of sources of water that have been identified through investigations undertaken to date. These include the following. **Groundwater -** The use of groundwater is considered feasible based on the investigations to date and given Bowdens Silver has already obtained significant entitlements for the recovery of groundwater from the regional groundwater table under the relevant water sharing plans. **Surface Water (On Site) -** Bowdens Silver proposes to capture an average of 123ML of surface water annually within the Mine Site that will require licencing. Enlarged water management structures may be developed to expand water capture on-site under licence. **Surface Water (Off Site) -** Bowdens Silver has examined the use of water pumped from either the Lawsons Creek catchment or Cudgegong River Catchment (and Windamere Dam). Pumping water from the Lawsons Creek catchment has been rejected due to the insufficient regular flow present in Lawsons Creek. In the case of water sourced from Windamere Dam, water would be released from the dam and Bowdens Silver would need to pump it from the Cudgegong River near Mudgee to the Mine Site. **Surplus Water from Nearby Mining Operations –** Excess water from other mining operations may be used to supply water for the Project. The Ulan Coal Mine and the Moolarben Coal Mine have identified that excess water from their operations may be pumped to the Mine Site via a dedicated pipeline. Excess water at these mines is currently treated and discharged in accordance with development consent for the mines. Rather than discharging this water to the environment it may be re-used for the Project. The Project requirements would represent a small proportion of the projected surplus water that would be pumped from underground mine workings at Ulan Coal Mine or Moolarben Coal Mine over the life of those operations.	**Rejected** a sole water source for the Project Although sourcing water from a single source would be economically and technically beneficial, each of the identified water supply options has constraints that limit the feasibility of relying on a single source of water. • The recovery of groundwater would be limited by the nature of the fractured rock aquifers from which it would be sourced and unpredictable nature of water supply from fracture flows. • The quantity of surface water that can be recovered from within the Mine Site would be limited by the provisions of the Water Sharing Plan (WSP) for the Macquarie-Bogan Unregulated and Alluvial Water Sources: Lawsons Creek Water Source 2012. The total number of unit entitlements within the WSP are limited to 1 496 units. It is highly unlikely that Bowdens Silver could acquire sufficient unit entitlements from the market to allow the Company to harvest the required quantity of water on site. Furthermore, Bowdens Silver is committed to maximising the diversion of clean water around disturbed areas and limiting its collection of surface water from within the Mine Site to minimise the number of unit entitlements that need to be acquired from other licence holders. • Bowdens Silver would prefer not to source water from Windamere Dam as its priority uses are for Mudgee's town water supply, irrigation and stock water, none of which Bowdens Silver would wish to affect. • While water may be sourced from the Ulan Coal Mine and/or Moolarben Coal Mine, recent prolonged drought has challenged the reliability of these mines as a sole source of water for the Project.
Alternative 2: Variety of Sources Relied Upon Planning for the Project has identified that water captured in water storage structures within the Mine Site, decant water in the TSF and groundwater inflows to the open cut pit could be managed through preferential use in processing activities. Additional water requirements may be made up from a variety of sources such as on-site water capture and external supply of surplus water. Water for the preliminary activities required for site establishment and construction may be sourced from groundwater bores located within the Mine Site.	**Preferred** The ability to access water from a variety of sources reduces reliance on a single source and provides Bowdens Silver with the flexibility to plan for varied operating conditions (including drought). As a result, Bowdens Silver has elected not to source any surface water for the Project from off-site sources such as Lawsons Creek and Windamere Dam, but would rely on on-site sources and external make-up supply.

Table 1.2 (Cont’d)
Key Project Design Alternatives Considered

Page 2 of 4

<table>
<tr><th>Alternatives Considered</th><th>Reason for Rejection / Preference</th></tr>
<tr><td colspan="2">Underground - v - Open Cut Mining Operation</td></tr>
<tr><td>Alternative 1: Underground Mining Operation
The extraction of the defined ore by underground methods.</td><td>Rejected as a proportion of the defined ore reserves are present at the surface of the proposed main open cut pit. Hence, it would not be practical to recover the resources other than open cut methods.</td></tr>
<tr><td>Alternative 2: Open Cut Mining Operation
The extraction of the defined ore by open cut methods to the base of defined ore (approximately 180m below the land surface and approximately 140m below the final rim of the main open cut pit.</td><td>Preferred as the ratio of the quantity of waste rock to be removed (46.4 million tonnes) against the quantity of ore to be removed (29.9 million tonnes), i.e. 1.6:1 is assessed as financially feasible.</td></tr>
<tr><td colspan="2">Area of Open Cut Pit and Recovered Ore</td></tr>
<tr><td>Alternative 1: Enlarged Open Cut Pit (73ha)
This alternative (originally proposed by Kingsgate) would involve a single open cut pit covering approximately 73ha to recover approximately 45.5 million tonnes of ore at a cut-off grade lower than the grade proposed by Bowdens Silver.</td><td>Rejected as the recovery of the higher quantity of ore at a lower grade would not be economic.</td></tr>
<tr><td>Alternative 2: Reduced Open Cut Pits (52ha)
Bowdens Silver proposes a main open cut pit and two small satellite pits to recover 29.9 million tonnes of ore at a cut-off grade of 30 grams of silver per tonne of ore. The proposed open cut pit lies within the footprint of the enlarged open cut pit.</td><td>Preferred as the recovery of the defined 29.9 million tonnes of ore is considered economic based upon the average life of mine projected commodity prices of:
<table>
<tr><th></th><th>US$</th><th>A$</th></tr>
<tr><td>Silver/ounce</td><td>20.91</td><td>27.88</td></tr>
<tr><td>Zinc/tonne</td><td>2,756</td><td>3,675</td></tr>
<tr><td>Lead/tonne</td><td>2,205</td><td>2,940</td></tr>
<tr><td colspan="3">A$/$US Exchange rate of 0.75</td></tr>
</table></td></tr>
<tr><td colspan="2">Annual Processing Rate and Annual Water Requirement</td></tr>
<tr><td>Alternative 1: 4Mtpa Processing Rate
This alternative (originally proposed by Kingsgate) involved an annual processing rate of approximately 4 million tonnes of ore per year which would require approximately 3.5 gigalitres of water annually.</td><td>Rejected as the proposed annual production rate through the processing plant could not be achieved as the quantity of earthmoving equipment required to extract the required 4 million tonnes of ore could not satisfy the nominated noise limits.</td></tr>
<tr><td>Alternative 2: 2Mtpa Processing Rate
Bowdens Silver proposes to process approximately 2 million tonnes of ore per year which would require approximately 2.1 gigalitres of water annually.</td><td>Preferred as the proposed annual production rate through the processing plant could be achieved with the proposed quantity of earthmoving equipment that would satisfy the nominated noise limits.</td></tr>
</table>

Table 1.2 (Cont'd)
Key Project Design Alternatives Considered

Alternatives Considered	Reason for Rejection / Preference
Road Access to the Mine Site	
Alternative 1: Lue Rd / Pyangle Rd / Maloneys Rd The existing access to the Mine Site involves all traffic from Mudgee travelling through Lue to Pyangle Road and then travelling northwards via Maloneys Road. Smaller quantities of vehicles would travel to the Mine Site from the east, i.e. from Rylstone and Kandos.	**Rejected** as this route would result in the bulk of the heavy vehicles delivering mine components and consumables to the Mine Site and transporting the mineral concentrate from the Mine Site travelling through Lue. This alternative is rejected given Bowdens Silver's objective to preserve Lue's existing character.
Alternative 2: Lue Rd / Relocated Maloneys Rd A new 5.2km public road would be constructed from a point on Lue Road approximately 1.8km west of Lue. The new road would join the retained section of Maloneys Road north of its intersection with the mine access road.	**Preferred** as the construction of a new road during the first six months of the site establishment and construction stage would result in all operations traffic originating from or travelling through Mudgee to avoid travelling through Lue.
Wallerawang-Gwabegar Railway Crossing	
Alternative 1: New Level Crossing A new level crossing would be constructed along the alignment of the relocated Maloneys Road which in turn would require the existing level crossing at the end of Cox Street to be closed.	**Rejected** as the level crossing option is not favoured given the results of consultation with Lue residents who use the existing level crossing when travelling to Mudgee.
Alternative 2: New Rail Overbridge A new rail overbridge would be constructed along the alignment of the relocated Maloneys Road. This overbridge would be designed to meet all requirements of the rail infrastructure should the railway line re-open in the future.	**Preferred** as the rail overbridge is preferred given it would enable the nearby level crossing near Cox Street to remain open for use by Lue Residents.
Processing Plant / Mining Facility Location	
Alternative 1: This alternative (originally proposed by Kingsgate) would be located on the elevated area west of Maloneys Road.	**Rejected** as the location would straddle the proposed re-aligned power transmission line and its elevated location could contribute to excessive noise. The location is closer to Lue.
Alternative 2: This alternative (proposed by Bowdens Silver) located further north with a number of components at lower elevations (more noise protection).	**Rejected** as the location would also straddle the re-aligned power transmission line and substantially cover Lot 7007 DP 1029353, a Crown Land lot which is the subject of a native title claim.
Alternative 3: This alternative (proposed by Bowdens Silver) located in an area with the jaw crusher positioned at the lowest possible elevation with an opportunity to cut and fill the site to lower the elevation of the land to be used.	**Preferred** because the mining facility would be approximately 0.7km further away from Lue and the plant and facility could be located away from Lot 7007 DP 1029353.

Table 1.2 (Cont'd)
Key Project Design Alternatives Considered

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Alternatives Considered	Reason for Rejection / Preference
TSF Location	
Alternative 1: Within Price Creek Valley This alternative (originally proposed by Kingsgate) would involve the construction of an embankment across Price Creek and the diversion of upslope runoff around the facility. The TSF embankment would be effectively buttressed by the waste rock emplacement	**Rejected** principally because of the fact that Price Creek would be fully blocked (with a catchment larger than Alternative 2) and that it would be necessary to pump the tailings to the TSF.
Alternative 2: Within Walkers Creek Valley This option would involve the construction of an embankment across the ephemeral watercourses in the upper Walkers Creek catchment. The embankment would be constructed with waste rock extracted from the open cut pit.	**Preferred** principally because the facility would be in a valley with a smaller catchment and the tailings could be gravity fed to the facility.
Processing Plant Reagents	
Alternative 1: The bulk of the chemicals used are standard n the recovery of metals from multi-element ore bodies. The suppression of zinc in the silver/lead flotation circuit can be undertaken using sodium sulphite Na_2SO_3	**Rejected** as the use of sodium sulphite (other alternate chemicals) have been trialled with ore samples and have returned considerably lower recoveries of silver.
Alternative 2: The suppression of zinc in the silver/lead flotation circuit is proposed using sodium cyanide (NaCN).	**Preferred** as the use of sodium cyanide (at low concentration) has been demonstrated through test work to be a far superior zinc suppressant than any other chemical.
Waste Rock Emplacement (WRE)	
Alternative 1: Within Price Creek Valley This option (originally proposed by Kingsgate) would involve the placement of the waste rock in the southern end of the Price Creek valley within 40m of Hawkins Creek.	**Rejected** because of its close proximity to Hawkins Creek, including on the Hawkins Creek floodplain with insufficient area to appropriately manage leachate generated by the WRE.
Alternative2: On the Western Side of Price Creek Valley This alternative would involve the construction of the WRE on the western side of the Price Creek valley lapping onto the central ridge line to the east of the main open cut pit.	**Preferred** as the full quality of PAF waste rock can be positioned outside the flood extent of Hawkins Creek and be constructed in a manner that is generally consistent with the existing nearby north-south ridges.
Soil Stockpiles	
Alternative 1: Subsoil stockpiles constructed to 3m in height and topsoil stockpiles constructed to 2m in height.	**Rejected** as the area of remnant vegetation to be cleared for the stockpiles would be approximately 91ha.
Alternative 2: Subsoil stockpiles constructed to 5m in height with a 1m topsoil cover and topsoil stockpiles constructed to 2m in height.	**Preferred** as the area of remnant vegetation to be removed for stockpiles would be approximately 62ha, i.e. 29ha less than Alternative 1.

Bowdens Silver sought an amendment to the SEARs in April 2019 to accommodate the proposed water supply pipeline and to reflect a decision by the then DoEE to determine the Project to be a controlled action under the EPBC Act. The amended SEARs were received in June 2019.

The preparation of the EIS continued throughout 2018, 2019 and 2020 to the point where the Project design and its associated mitigation measures were recognised as being appropriate to finalise the EIS and lodge the document with the Department of Planning, Industry and Environment (DPIE).

1.6 SILVER, ZINC AND LEAD

1.6.1 Introduction

This subsection describes the properties and uses of silver, zinc and lead, and their current sources both in Australia and internationally together with a summary of the pricing of each metal. Further details of the properties, uses and pricing of silver, zinc and lead are provided in **Appendix 4**.

1.6.2 Silver

Silver is one of the most commonly recognised metals due to its long association with wealth, fine jewellery and its place in the history of exploration and mining.

Demand for silver is currently benefiting from new applications in photovoltaic cells (for solar panels), electronics, electric vehicles, robotics, industrial automation, aerospace, pharmaceuticals, and biosciences.

As an element, silver is the best electrical and thermal conductor among metals, and superior reflector of visible light.

Silver is used as a store of wealth, traded as a commodity and used in industrial processes, consumer electronics, medical products and increasingly in renewable power production (**Plates 1.1** to **1.4**). Broadly, the physical demand for silver can be broken down into four segments, namely: industrial fabrication (60%), jewellery (20%), coins and bars (15%) and silverware (5%). These proportions have been relatively stable since about 2008.

Recent estimates from The Silver Institute as of 2019, Mexico, Peru, and China represented the three largest global silver producers responsible for 23%, 16%, and 13% of all silver produced respectively. In 2019, Australia was the world's fourth largest producer of silver, with 43 million ounces (Moz), well off the 2013 high of 59Moz due to lower by-product values at major base metal mines.

Physical silver demand is approximately 1000Moz per year and has varied within a narrow band since 2010. In 2019, physical demand for silver declined -3% year on year with industrial fabrication and jewellery reducing by -7% each offset by net physical investment increasing by +16%.

During the past decade (January 2000 through December 2019), silver prices have ranged between approximately US$13.80 per ounce to approximately US$48.60 per ounce with an average of approximately US$21.20 per ounce.

1.6.3 Zinc

Zinc is the fourth most widely used metal in the world, principally for a wide range of industrial and medical uses. Its primary use is in the process of galvanising that involves adding a zinc/iron alloy layer on steel to protect it from corrosion (up to 170 years). The global cost of corrosion to steel is estimated to be in excess of US$2.0 trillion annually. The value and use of zinc is assured as this process significantly increases the service life of steel, reduces costs and protects valuable steel resources.

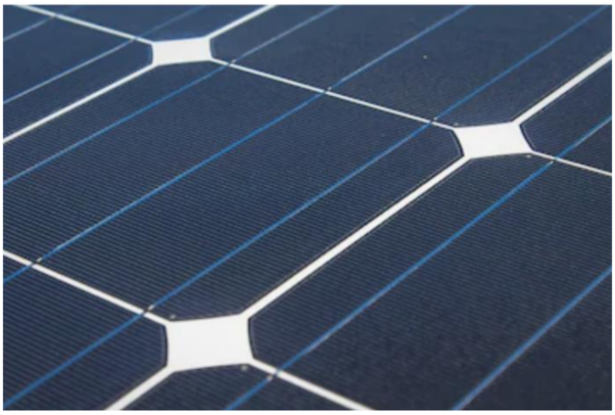
Plate 1.1 Photovoltaic Cells


Plate 1.2 Telecommunication Applications


Plate 1.3 Water Filters


Plate 1.4 Brazing Alloys and Solders

Other primary zinc uses are:

- Brass – when zinc (30%) is combined with copper (70%) it forms a particularly rust-resistant alloy called brass. Brass is used extensively in the manufacture of sailing boat hulls and other marine hardware, musical instruments and for various scientific applications.
- Diecast Objects – the low melting point of zinc allows it to be mixed with aluminium to form a strong alloy which can be diecast to make a range of items. Common examples of diecast objects include carburettors, staples and zippers.
- Batteries – are produced using a variety of chemistries including: zinc-bromine, zinc-air, zinc-carbon and zinc-nickel. Due to zinc's abundance, it is an attractive research area for battery cell technology.
- Zinc Oxide - zinc oxide has a range of applications and is used in the production of rubber, skin products (e.g. zinc cream), paints, floor coverings, plastics and ceramic glazes.

In 2018, primary production of zinc on a global basis totalled 13 million tonnes, with some 30% of zinc originated globally from recycled or secondary zinc. This proportion or recycling has been increasing on a yearly basis. As zinc's primary use is in galvanising steel, consumption is strongly correlated to steel use.

In 2018, the key global zinc producers were China (33%), Peru (12%), Australia (7%) and India (6%).

The price of zinc in December 2019 was approximately US$2,300 per tonne.

1.6.4 Lead

Lead is a very corrosion-resistant, dense, ductile, and malleable blue-grey metal that has been in use for at least 6 400 years. Although historically it has been widely used due to its softness and ease of working, as the negative impacts on health have been recognised, the suitable uses have narrowed over time. Today its main use is in batteries.

Lead-acid batteries make up 82% of total lead use. Other significant uses are in ammunition 3%, oxides in glass and ceramics 5%, the remaining 13% are used in solders, bearing metals, brass and bronze billets, covering for cable, caulking lead, and extruded products.

The uses for these products range widely from in health services where lead is used as a radiation shield around X-ray and radiotherapy equipment and nuclear equipment. The high density and softness of lead makes it an extremely effective insulator of noise and vibration. Lead is often laid in thin sheets between building materials to provide very effective sound insulation. Lead's innate property of being stable in corrosive environments means it is still widely used to line containers and pipes for storing and carrying corrosive chemicals.

In 2018, the key global lead primary producers were China (47%), Australia (10%), Peru (7%) and USA (6%).

The price of lead in December 2019 was approximately US$1,920 per tonne.

1.7 MINES IN CENTRAL NSW

1.7.1 Introduction

It is recognised that many population centres in rural NSW were established as pastoral centres on the larger rivers, railway service centres (such as Lue) and around mines. Towns such as Broken Hill and Cobar are centres that have continued their close association with mining. In recent years, mining has contributed significantly to the growth of some towns and cities in central western NSW such as Orange, Parkes and Mudgee and, in some cases, mining has co-existed on the edges of a number of population centres such as Blayney, Peak Hill and Tomingley. Each of these latter population centres were/are closer to the mining operations than is proposed for the Bowdens Silver Project. **Figure 1.6** displays the locations of a number of mines in the NSW Central West.

This section provides a brief overview of the Cadia Valley Operation and the three operations in the Ulan coalfield principally to assist readers to appreciate the scale of the Bowdens Silver Project in comparison to these other well-known mines. A brief profile is also provided of the mining operations near Peak Hill and Tomingley. Bowdens Silver acknowledges the concerns expressed by some community members in Lue regarding the proximity of Lue to the proposed Mine Site for the Project, particularly given many of the residents have not previously lived near a mine. Whilst it is recognised some environmental issues arose during the operation of the Peak Hill and Tomingley mines, particularly during the site establishment and construction stage, it is recognised that the greater distance between Lue and the operational areas within the Mine Site, together with the early implementation of mitigation measures and specific procedures introduced for the Peak Hill and Tomingley Mines, would assist to substantially minimise and potentially avoid the environmental issues for the Bowdens Silver Project.

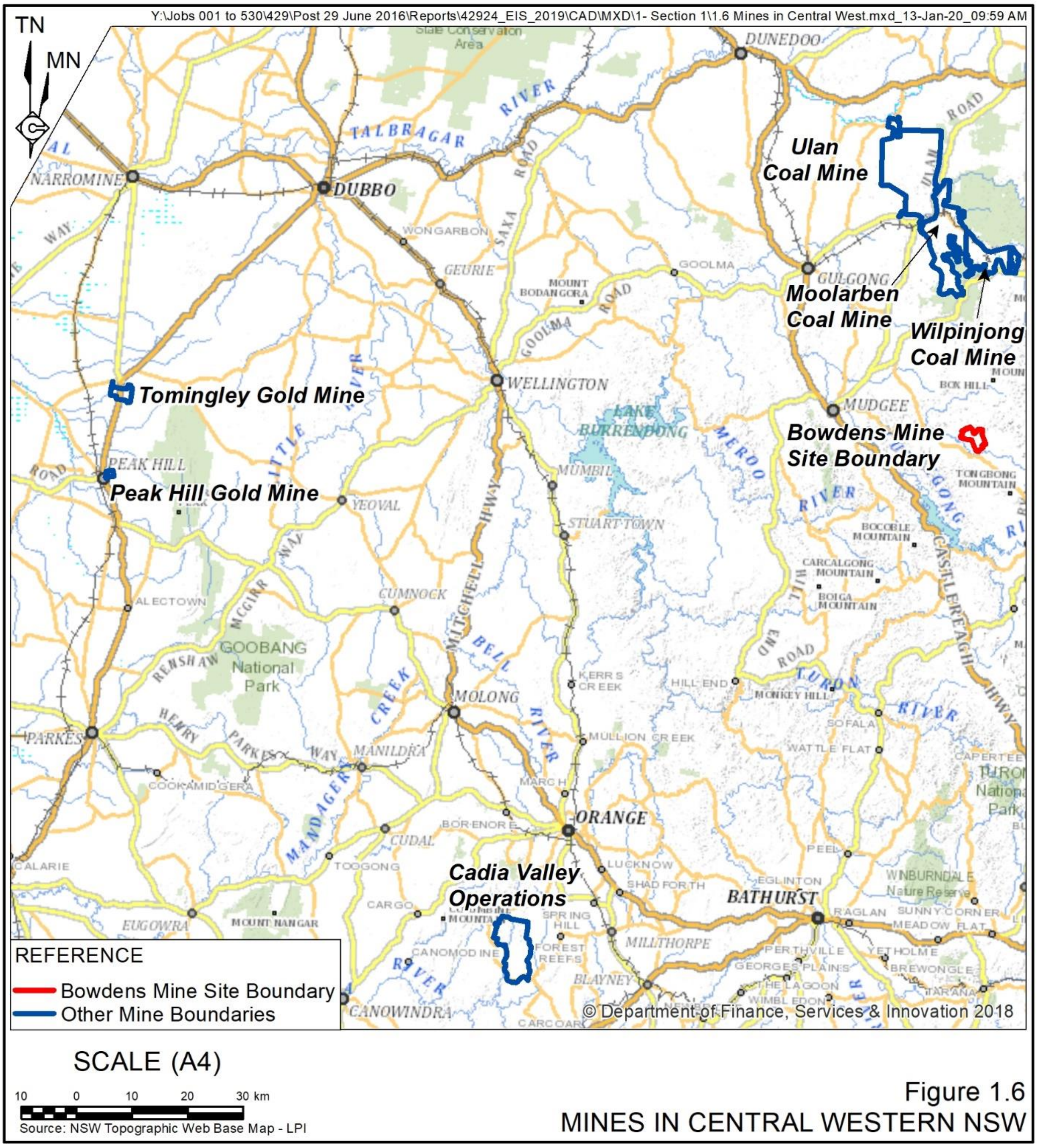

Figure 1.6
MINES IN CENTRAL WESTERN NSW

1.7.2 Cadia Valley Operations

Cadia Valley Operations (CVO) comprises a series of large underground and open cut gold-copper mines located approximately 20km south of Orange. Orange is a major regional centre which offers extensive cultural, retail, industrial and government services and a population of approximately 38 000 people (ABS, 2016). The mine which is owned and operated by Cadia Holdings Pty Ltd (a wholly-owned subsidiary of Newcrest Mining Limited) began operations at Cadia Hill in 1998. CVO has developed a number of resources within the mine site including Cadia Hill, Ridgeway and Ridgeway Deeps.

Plate 1.5 An oblique aerial view to the south across Cadia Valley Operations

CVO initially extracted ore and waste rock from open cut pits, the largest of which has a surface disturbance of approximately 150ha and is approximately 500m deep. **Plate 1.5** displays an oblique aerial view across the Cadia Valley Operations The mine is currently extracting ore from Cadia East underground mine with a maximum production rate of 32Mtpa. Ore is processed on site to produce a concentrate which is pumped approximately 30km through a pipeline to the Blayney Dewatering Facility for dewatering and subsequent loading onto trains for transport to Port Kembla. The amount ore processed at CVO each year is typically between 20Mtpa and 30Mtpa. In the 2017-2018 period approximately 21Mt of ore was processed with approximately 600 000Koz of gold and 62 000t of copper recovered. Mining at Cadia East currently has approval until 30 June 2031 and is expected to provide on average approximately 900 direct jobs annually. The current area of disturbance at the combined activities within the Mine Site is estimated to be approximately 2700ha. Mining and processing operations occur 24 hours per day, 7 days per week.

CVO has implemented extensive mitigation strategies including dust suppression, progressive rehabilitation, amenity bunding and lighting management.

Over the life of the mine, CVO has been committed to maintaining strong community partnerships providing roughly $2.9 million dollars in donations in the 2019 financial year alone. Beneficiaries include the Clontarf Foundation, Western NSW Local Health District, Orange Local Aboriginal Land Council's Designing Futures program and the Cadia District Enhancement Project.

1.7.3 Ulan Coal Mine

Ulan Coal Mine is located approximately 1.5km north of Ulan, approximately 45km north-northeast of Mudgee, and is jointly owned by Glencore Coal Assets Australia Pty Ltd and Mitsubishi Development. Coal mining first commenced near Ulan in the 1920s with intermittent operations until the 1980s when a substantial expansion was undertaken with open cut and underground mining of the Ulan No.3 mine continuing until 2008 when the resource was exhausted. The mine is currently approved to extract up to 20 million tonnes of coal per year until August 2033. The mine currently employs approximately 930 people and operates both underground and open cut mines with a total disturbance area (open cut and subsidence) of approximately 7 820ha. **Plate 1.6** displays an oblique aerial photograph across the Ulan Coal Mine.

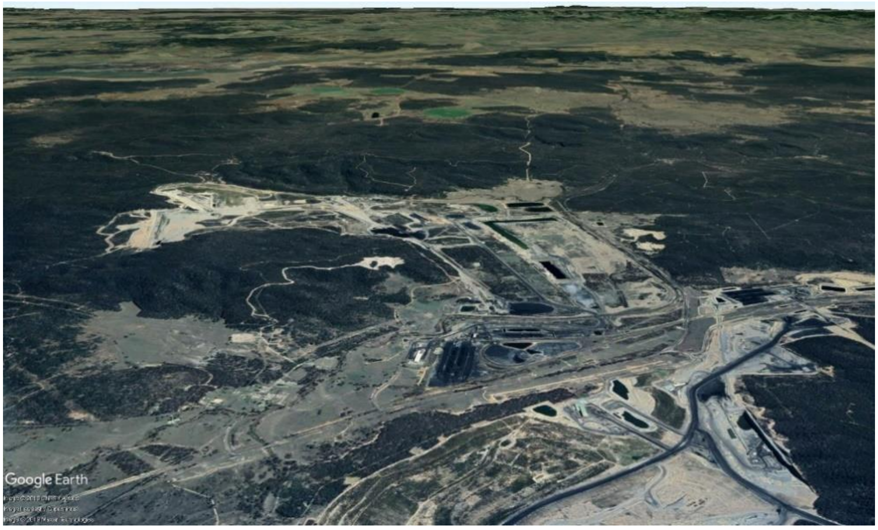

Plate 1.6 An oblique aerial view to the north across Ulan Coal Mine

Mining and processing occur 24 hours a day 7 days a week with blasting approved to occur between 9:00am and 5:00pm Monday to Saturday.

1.7.4 Moolarben Coal Mine

The Moolarben Coal Complex is located east of Ulan, approximately 40km north of Mudgee and lies between the Wilpinjong Mine and Ulan Coal Mine. The mine is operated by Moolarben Coal Operations Pty Ltd (MCO), a wholly owned subsidiary of Yancoal Australia Limited, on behalf of the Moolarben Joint Venture. Approval for mining was granted in September 2007 and allows for the extraction of 16 million tonnes of coal per year from the open cut mining operations and 8 million tonnes of coal per year from the underground mining operations until 31 December 2038. MCO comprises four open cut mines, three approved underground mines and associated infrastructure with a total disturbance area of approximately 2272ha. **Plate 1.7** displays an oblique aerial photograph across the Moolarben Coal Mine. MCO currently employs over 700 people as direct employees or contractors.

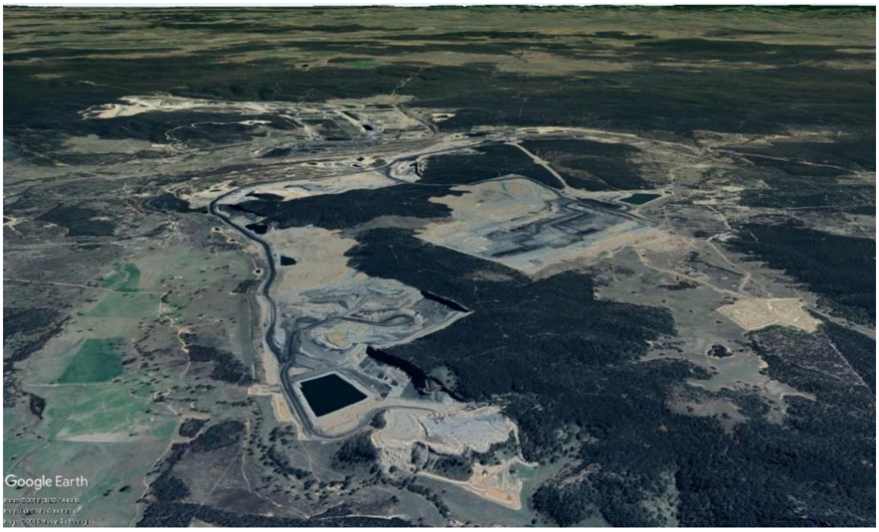

Plate 1.7 An oblique aerial view to the north across Moolarben Coal Mine

Mining and processing occur 24 hours a day 7 days a week with construction generally occurring between 7:00am and 6:00pm Monday to Sunday. Blasting is approved between 9:00am and 5:00pm Monday to Saturday.

1.7.5 Wilpinjong Coal Mine

Wilpinjong Mine is located approximately 48km northeast of Mudgee and is owned and operated by Wilpinjong Coal Pty Ltd, a wholly owned subsidiary of Peabody Energy Incorporated. Approval for mining was granted in February 2006 and the site currently comprises eight open cut pits and associated infrastructure with a total disturbance area of approximately 2 790ha. **Plate 1.8** displays an oblique aerial photograph across Wilpinjong Coal Mine. Wilpinjong Mine has approval to extract 16 million tonnes of coal per year of coal until 2033 and is expected to employ a peak operational workforce of approximately 650 people.

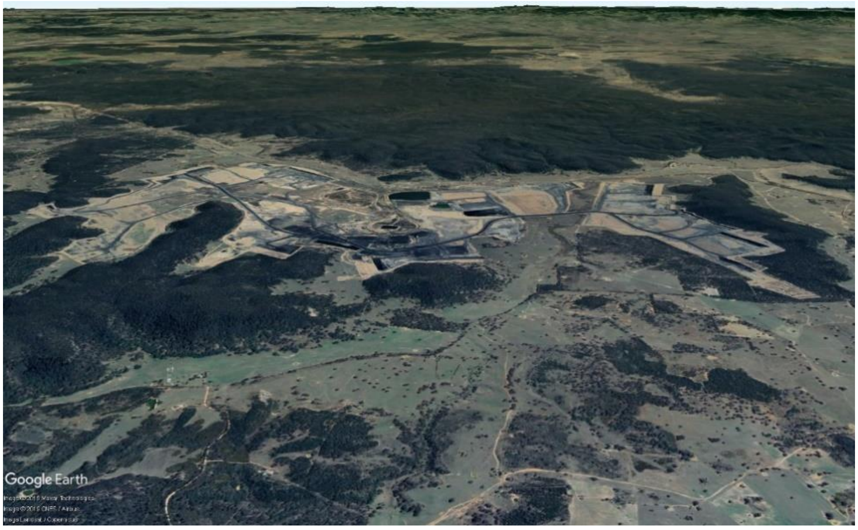

Plate 1.8 An oblique aerial view to the north across Wilpinjong Coal Mine

Open cut mining and coal processing are permitted to occur 24 hours a day 7 days a week with blasting frequency limited to two blasts per day for no more than five blasts per week (averaged over a calendar year) between 9:00am and 5:00pm Monday to Saturday.

1.7.6 Peak Hill Gold Mine

The Peak Hill Gold Mine is located immediately east of the town of Peak Hill, 75km southwest of Dubbo. The open cut gold mine operated between 1996 and 2005. **Plates 1.9** and **1.10** display oblique aerial photographs of the mine and its proximity to Peak Hill. Drill and blast methods were employed to extract ore at a maximum rate of 420 000tpa from several open cut pits up to 100m deep, with mining operations occurring between 7:00am and 6:00pm and ore crushing occurring between 7:00am and 10:00pm, Monday to Saturday for 48 weeks per year. Blasting impacts at the closest residences to the Peak Hill Gold Mine, located on Euchie Street in Peak Hill (a distance of approximately 0.25km) were minimised through careful design of each blast and weighing explosives loaded into each hole. The Peak Hill Gold Mine was able to comply throughout the project life with the 5mm/sec ground vibration and 115dBL airblast overpressure limits imposed by the EPA. Near surface blasting was delayed if the wind was in an unfavourable direction.

Gold ore was processed using the heap leach method which involved the processing and stacking of crushed ore to form a heap followed by the application of a cyanide solution to dissolve gold and form a gold-bearing solution which was directed to a collection pond. Heap leaching and gold processing operations occurred 24 hours per day, 365 days per year. The processing plant was located approximately 1.4km northeast of Peak Hill.

Plate 1.9 An oblique aerial view of the northeast across the eastern side of Peak Hill towards the open cut pits of the former Peak Hill Gold Mine

Rehabilitation of the Peak Hill Gold Mine site has largely been completed, with the final landform consisting of retained open cut voids as well as vegetated heap leach and waste rock emplacement hills which each cover an area of approximately 18ha and are 20m above the natural surface respectively. The perimeter of the retained open cut voids has been securely fenced and a walking trail and viewing platform established, permitting ongoing use of the site as a tourist attraction. Alkane Resources Ltd, the operators of the Peak Hill Gold Mine, continue to use the mine site and associated facilities as a base for mineral exploration on the central west of NSW, with these activities representing a source of ongoing economic activity at Peak Hill and in the broader region.

A total of 127 complaints were received by Alkane between January 1996 and February 2002. Blast vibration was the cause of the majority of complaints particularly in the early months of the operation as near surface blasting encountered many old working which made controlling airblast overpressure problematic. Approximately 70% of the complaints were received from one individual Peak Hill resident who was not a near neighbour. Only a small number of noise complaints were received possibly due to the comparatively high levels of traffic noise from the Newell Highway which bisects the town. Dust from the mining operation caused occasional nuisances but it was largely mitigated with a water cart or relocating mobile equipment to other parts of the mine during windy periods.

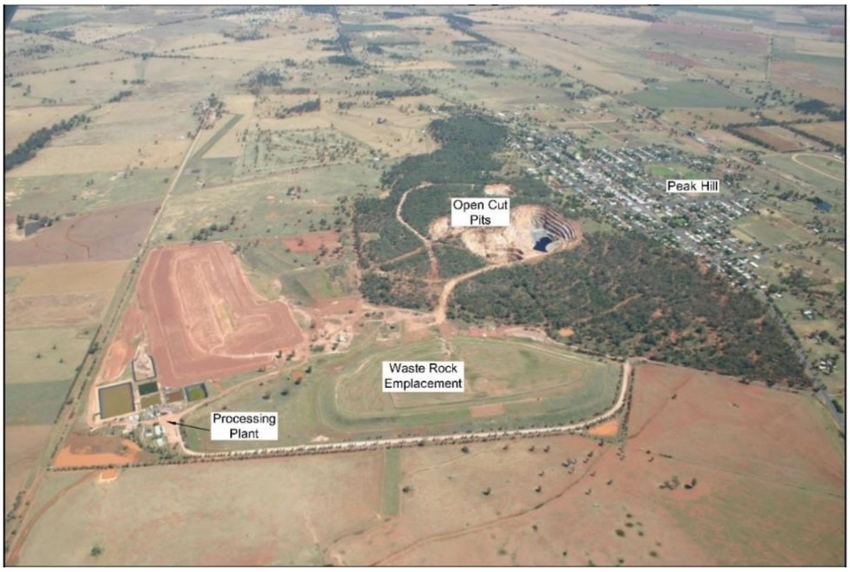

Plate 1.10 An oblique aerial view to the southwest across the Peak Hill Gold Mine towards Peak Hill

1.7.7 Tomingley Gold Mine

The Tomingley Gold Mine is located less than 250m south of Tomingley, a town with a population of approximately 230 people[2]. The mine, which is owned and operated by Alkane Resources Limited, commenced mining operations in November 2013 and was officially opened in March 2014 following the commissioning of the on-site processing plant located approximately 1.3km from the edge of Tomingley. Mining operations at the site comprised four open cut pits, with maximum depths of between 100m and 180m below the natural surface with ore and waste rock extracted using either drill and blast methods or through ripping and pushing using bulldozers. In 2019, mining commenced underground from the base of one of the completed open cut pits to a maximum development depth of 360m below the natural surface using drill and blast methods. Up to 1.4Mt of ore has been mined and processed at the mine each year, with waste rock from mining operations directed to three waste rock emplacements which each covering an area of between 13ha and 66ha and maximum approved heights of between 30m and 40m. Tailings generated through the processing of gold ore is pumped to an above ground tailings storage facility covering approximately 42ha. Construction, mining and processing operations occur 24 hours per day, 7 days per week and blasting operations occur between 9:00am and 5:00pm, Monday to Saturday. **Plates 1.11** and **1.12** show the proximity of the Tomingley Gold Mine to Tomingley.

Plate 1.12 An oblique aerial view to the north across an open cut pit and waste rock emplacement at the Tomingley Gold Mine – pre revegetation

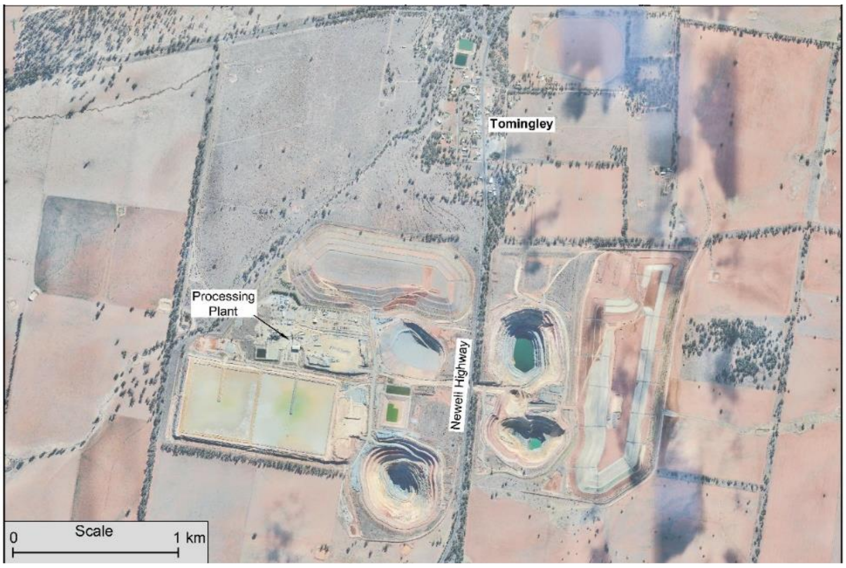

Plate 1.11 Aerial photography of Tomingley and Tomingley Gold Mine

[2] Population within the Tomingley State suburb

During the construction and initial mining operations at the Tomingley Gold Mine in 2013, the operator received a number of complaints concerning noise and dust emissions from Tomingley residents principally relating to dust with some relating to noise. In response to noise complaints, Alkane implemented a range of mitigation strategies including the construction of an enhanced noise bund, use of a weather forecast system to identify potentially noise enhancing conditions, alterations to site equipment to reduce noise and the treatment of residences in the vicinity of the mine with noise attenuation features (e.g. noise attenuating glass). In response to complaints regarding dust as well as measured exceedances of nominated air quality criteria, Alkane developed and implemented a site specific dust control protocol, introduced the use of chemical dust suppressants for use in water carts during summer periods and installed a real time alert system to inform dynamic dust management actions. As a consequence of the adopted mitigation methods, no noise-related complaints and just one dust-related compliant were received at the mine site in 2018.

The Tomingley Gold Mine has been progressively rehabilitated over the life of operations at the site, with significant rehabilitation activities including the partial backfilling of one of the open cut pits and the shaping and revegetation of two waste rock emplacements. Over the life of the mine to date, Alkane has committed to significant contributions to the local community including $360 000 for road maintenance, improvements to the Tomingley water supply and $430 000 to the Tomingley Gold Project – Community Fund. The Fund supports projects aimed at encouraging long term economic growth locally, education and training, community connectivity and community infrastructure.

1.8 ENVIRONMENTAL MANAGEMENT AND DOCUMENTATION

1.8.1 Environmental Management

Environmental management of the Project would be undertaken as an integral component of the overall management of the approved activities. All personnel would be inducted and trained in environmental management, consistent with their role and responsibilities. Environmental management is an important component of operational health and safety, compliance requirements and in satisfying community expectations. Bowdens Silver would employ a suitably experienced and qualified person whose principal function would be to coordinate the on-site environmental requirements, including compliance with commitments and procedures. The environmental manager would be assisted by a range of professionally trained and qualified environmental scientists and technicians. The environmental manager would report directly to the senior management position on the Mine Site and would pro-actively promote the consideration of environmental issues in all tasks undertaken on site.

The workforce, including Bowdens Silver’s staff and the staff of all contractors, would be required to undertake induction (and re-induction) training courses and specific environmental training to ensure all operational condition requirements and commitments are satisfied throughout the Project life.

1.8.2 Environmental Documentation

Bowdens Silver intends to prepare all relevant environmental management documentation required by the NSW Government following the granting of development consent and a mining lease. An overview of the range of environmental documentation that would be prepared is as follows, noting that requirements may change between the time when the Project development application is determined and when the Project commences.

Management and Monitoring Plans

When development consent is granted for the Project, Bowdens Silver would prepare a range of management and monitoring plans including the following.

- Environmental Management Strategy.
- Construction and Operational Noise Management Plan.
- Blast Management Plan.
- Air Quality Management Plan.
- Greenhouse Gas Management Plan.
- Site Water Management Plan incorporating Surface Water and Groundwater Monitoring Plans.
- Visual Impacts Management Plan.
- Biodiversity Management Plan.
- Transport Management Plan.
- Heritage Management Plan.
- Social Impact Management Plan.
- Waste Management Plan.
- TSF Management Plan including a Seepage Management Plan
- Conceptual Mine Site closure plan / final Void Management Plan.
- Cyanide Management Plan.
- Rehabilitation Management Plan.

Each of the above management plans would be reviewed either annually or biennially throughout the Project life and updated, where appropriate, to reflect any outcomes arising from operational modifications, the results of monitoring and/or external audits.

Rehabilitation Management Plan

The Rehabilitation Management Plan (RMP), which would be prepared in accordance with the Guidelines published by the Resources Regulator, would provide a mechanism for Bowdens Silver to present a greater level of detail regarding the range of operations necessary for compliance with the conditions imposed upon the mine under the terms of its mining lease, particularly with respect to rehabilitation of the areas disturbed by the Project. It is acknowledged that if development consent is granted for the Project, the consent would include conditions relating to rehabilitation of the site.

The RMP would be prepared prior to the commencement of the site establishment and construction stage and would be updated whenever required, but at intervals not greater than every 7 years. The RMP would also form the basis for estimating the security deposit imposed through the mining lease.

Annual Documentation

An Annual Review would be prepared in satisfaction of the development consent and mining lease conditions. The document would be designed to consolidate the Government reporting requirements relating to environmental management, monitoring and rehabilitation of the disturbed areas within the Application Area.

Each Annual Review would be prepared to:

- record the activities undertaken on site during the previous 12 month period and review the effectiveness of the adopted environmental controls;
- outline the planned activities during the following 12 month period and any additional environmental controls;
- present a summary and an evaluation of the Applicant's environmental management activities over the previous 12 month period, including the results of environmental monitoring; and
- provide any other information nominated in the development consent and mining lease.

The Applicant would also submit Annual Returns to the Environment Protection Authority (EPA) in accordance with the requirements of its environment protection licence.

Enquiries and Complaint Management and Monitoring Reporting

The Applicant would implement a documented system to comprehensively record all enquiries and complaints and the resultant investigations, if needed, responses and communications with the enquirer(s) or complainant(s). The Applicant would respond to all enquiries and complaints in a timely manner.

The Applicant would place all validated monitoring data on its website generally on a monthly basis together with any relevant comments relating to the monitoring data. The website would incorporate a provision for on-line input/response by members of the community. Monitoring results would also be discussed at each CCC meeting.

1.8.3 Ongoing Community Consultation

Bowdens Silver is committed to an open and transparent consultation program throughout the site establishment and construction stage and the operation of the Project. Components of the program would involve:

- circulation of regular newsletters;
- annual open days;
- a community notice board (outside the Lue Public School);

- maintaining a community information system on the Project website; and
- regular / periodic meetings with adjoining landowners.

Bowdens Silver will continue to employ a dedicated Community Liaison Officer to manage the ongoing consultation, consistent with the Social Impact Management Plan. The Project would operate with an 'open door' policy to enable Lue and district residents to discuss any components of the Project.

1.9 FORMAT OF THE ENVIRONMENTAL IMPACT STATEMENT

The EIS has been compiled in eight sections and a set of supporting appendices with its format as follows.

Section 1: introduces the Project, the Applicant, the Application Area and provides background information about the Project and the EIS preparation. The section also explains the key terminology used throughout this document and provides an overview of the approvals process. The uses and current sources of silver, zinc and lead are outlined. Bowdens Silver's approach to the environmental management and the documentation for the Project is reviewed. The section concludes with information on the management of investigations for the EIS.

Section 2: describes the Applicant's objectives and components of the Project. A description is provided of the activities to be undertaken throughout the proposed site establishment and construction stage, open cut mining, ore processing, tailings and waste rock management, transport and rehabilitation activities. This section also describes the proposed relocated Maloneys Road and water supply pipeline.

Section 3: provides a description of the process used to identify and prioritise the key issues for assessment within this EIS with reference to the SEARs for the Project, the range of matters raised by other government agencies, stakeholder consultation throughout the Project planning stages, and a review of the relevant legislation, planning issues, policies and guidelines. The approach to the environmental risk analysis undertaken for the Project is introduced with respect to the specific environmental risk(s) for each of the environmental issues relevant to the Project.

Section 4: describes the environmental setting within and surrounding the Mine Site. Emphasis is placed on providing information about the environmental features that would contribute to, or influence, the assessment of a wide range of other environmental parameters. Information is provided on the topography, geology, meteorology, land ownership and land uses within and surrounding the Mine Site. This section also describes the specific environmental features of the Mine Site, relocated Maloneys Road and the water supply pipeline corridor and their surrounds that would or may be affected by the Project. Information on the existing environmental setting, the proposed design and operational safeguards and mitigation measures and residual impacts the Project may have following the implementation of these measures is presented for all relevant issues together with the proposed monitoring to demonstrate compliance with all operating limits or assessment criteria.

Section 5: provides a record of the full range of environmental management and monitoring measures that would be adopted when developing and operating the Project. The measures are designed to effectively manage, mitigate, guide and monitor the operation of the Project throughout its entire operational life.

Section 6: provides a conclusion to the document which justifies the Project in terms of biophysical, economic and social considerations and identifies the consequences of not proceeding with the Project.

Section 7: lists the various source documents referred to for information and data used during the preparation of the EIS.

Section 8: presents a glossary of acronyms, symbols and units, and technical terms, used throughout the EIS.

Appendices: present the following additional information.

1. Land Titles for the Application Area.
2. The SEARs and requirements issued by the then DoEE.
3. A summary of the coverage of the SEARs and matters identified for consideration in the correspondence submitted to DPE by other State government agencies, Mid-Western Regional Council, and the community and where each matter is addressed in this document and/or the supporting Specialist Consultant Studies Compendium.
4. An overview of the properties, land uses, sources and prices of silver, zinc and lead.
5. Documentation Supporting the Project Description.
6. A list of all properties and their landowners referred to in this document and distances between the various residences or receptors and the closest area of disturbance and various Project components.
7. An assessment of Environmental Risk in accordance with the Australian Standards.
8. Project Capital Investment Value.
9. Electricity Supply Options

The EIS is supported by a six volume, *Specialist Consultant Studies Compendium*, which incorporates:

- 18 separate reports prepared by specialist environmental consultancies who have been engaged by R.W. Corkery & Co. Pty Limited on behalf of Bowdens Silver to assess specific aspects of the Project; and
- three project design reports prepared by specialist mining consultants engaged by Bowdens Silver to assist in the design of the waste rock emplacement and other structures, the tailings storage facility and the capping and cover of the waste rock emplacement and tailings storage facility. These reports are included in Parts 16A, 16B and 16C of the Specialist Consultant Studies Compendium (Volume 5)

The contents of these reports are summarised in the appropriate section(s) of the EIS.

1.10 MANAGEMENT OF INVESTIGATIONS

This document has been prepared by a team within R.W. Corkery & Co. Pty Limited ("RWC") managed by Mr Rob Corkery, M.Appl.Sc., B.Sc (Hons) and Mr Nick Warren, B.Sc.,M.Bus. M.Env.Sc, Principal Environmental Consultant, with the assistance of Mr Scott Hollamby, BEnvSc(Hons), Senior Environmental Consultant; Mr Paul Ryall, BSc (Hydrology) (to August 2019); Mr Caiden O'Connor, BSc (Geology), Environmental Consultant; and Ms Fabliha Pritha, (BEng (EnvEng) (Hons), Graduate Environmental Consultant.

Details of the Project have been provided by the following Bowdens Silver personnel: Managing Director, Mr Anthony McClure; Project Manager, Mr Neville Bergin; Public and Government Liaison and Compliance Officer, Ms Jane Munro (to December 2019); Community Liaison Officer, Mr Blake Hjorth; Geological Data Scientist, Mr David Biggs, Environmental Officer Mr Tom Purcell, with assistance from other Bowdens Silver team members.

The following consultancies and key personnel provided input to the design and engineering studies for the Project.

- Open cut pit design and mine scheduling – AMC Consultants Pty Ltd – Mr Adrian Jones.
- Processing plant design and operations – GR Engineering Services Limited – Mr Tony Mathwin.
- Tailing Storage Facility Design – ATC Williams Pty Ltd – Ms Heather Wardlaw.
- Waste rock emplacement design / TSF and WRE capping and cover design – Advisian – Mr Fabio Canzian da Silva.

A range of environmental investigations have been undertaken by specialist consultants, initially to identify the environmental constraints to be taken into account by Bowdens Silver during the design of the Project and subsequently, to assess the impacts of the Project and make recommendations for appropriate design and operational safeguards or mitigation measures to be incorporated within the Project Design. The fields of study, lead specialist consultant(s) and consultancies managed directly by RWC, together with the respective part of the *Specialist Consultants Studies Compendium* (SCSC) where each area of assessment is documented, are as follows.

Part 1: **Noise and Vibration Assessment**
Mr Glenn Thomas – BSc (Geophysics and Atmospheric Science) and
Mr Martin Davenport - M.Des.Sc(Acoustics)
SLR Consulting Australia Pty Ltd

Part 2: **Air Quality Assessment**
Mr Ronan Kellaghan – MEnvMan, HDip (Comp.Sc.), BSc(Hons)
Ramboll Australia Pty Ltd

Part 3: **Materials Characterisation Assessment**
Dr Graeme Campbell – PhD (Chem), BSci.(Agric.) (Hons), Dip.Ed.
Graeme Campbell & Associates Pty Ltd

Part 4: **Hazards Analysis of Dangerous Goods**
Ms Jenny Polich – M(EnvEng),BEng(ChemEng)(Hons)
Sherpa Consulting Pty Ltd

Part 5:	**Groundwater Impact Assessment** Mr Greg Sheppard – MSc(Eng. Geology), BSc(Geology) *Jacobs Pty Ltd*
Part 6:	**Surface Water Assessment** Mr Michael Batchelor – BE (Hons) *WRM Water and Environment Pty Ltd*
Part 7:	**Human Health Assessment** Dr Jackie Wright –, PhD (Public Health, Health and Environment), BE(Hons) *Environment Risk Sciences Pty Ltd (EnRisks)*
Part 8a:	**Visibility Assessment** Dr Richard Lamb –PhD, BSc(Hons) *Richard Lamb & Associates Consulting*
Part 8b:	**Lighting and Night Glow Assessment** Mr Peter McLean – MBdgSc, BE (Electrical Engineering) *Lighting Art & Science Pty Limited*
Part 9a:	**Terrestrial Ecology Assessment** Mr Steve Sass – BAppSc (EnvSc) (Hons) *EnviroKey Pty Ltd*
Part 9b:	**Biodiversity Offset Strategy** Mr Simon Tweed – BEnvSc (Hons) *Niche Environment and Heritage Pty Ltd*
Part 10:	**Aquatic Ecology Assessment** Mr Dan Pygas – BSc (Hons 1) *Cardno (NSW/ACT) Pty Ltd*
Part 11:	**Traffic and Transportation Assessment** Mr Ken Hollyoak – BSc (Hons) (Civil Engineering), MSc (Dist), (Transport Planning) and Ms Penny Dalton – BE (Civil)(Hons) *The Transport Planning Partnership Pty Ltd*
Part 12:	**Soils and Land Capability Assessment** Dr David McKenzie – PhD (Soil Physics), MSc (Agriculture), BNatRes (Hons) *Soil Management Design Pty Ltd*
Part 13:	**Aboriginal and Historic Heritage Assessment** Dr Matt Cupper – PhD (Archaeology/Geology), BA (Archaeology/Classical History), BSc (Hons) (Botany) *Landskape Natural and Cultural Heritage Management*
Part 14:	**Agricultural Impact Statement** Mr Caiden O'Connor – BSc (Geology) and Mr Robert Corkery - MApplSc, BApplSc.(Hons) *R.W. Corkery & Co. Pty Limited*
Part 15:	**Economic Assessment** Dr Robert Gillespie – PhD (Economics), MEc, MPlan, BSc, BEc *Gillespie Economics*

Part 16A: **Preliminary Designs of Mine Components**
Tailings Storage Facility Preliminary Design
ATC Williams Pty Ltd

Part 16B: **Preliminary Design of PAF Waste Rock Emplacement, Oxide Ore Stockpile and the Southern Barrier**
Advisian (Worley Parsons Group)

Part 16C: **TSF and WRE Closure Cover Design**
Advisian (Worley Parsons Group)

Part 17: **Social Impact Assessment**
Dr Sheridan Coakes – PhD (Psych), BAppSc (Psych) (Hons 1) and
Dr Sarah Bell – PhD(Human Geog), BDevStudies(Urban & Reg. Dev.)
Umwelt (Australia) Pty Ltd

The Applicant also commissioned the following specialist consultants, consultancies and individuals to undertake peer reviews of the nominated assessments.

Part 1: **Noise and Vibration Assessment**
Mr Najah Ishac – MEngSc, BEng(Mech)
EMM Consulting Pty Limited

Part 2: **Air Quality Assessment**
Ms Jane Barnett – BTech (AtmosphericSc) (Hons)
Environmental Resource Management Australia Pty Ltd (ERM)

Part 5: **Groundwater Impact Assessment**
Dr Noel Merrick – PhD, MSc, BSc.
HydroSimulations

Part 6: **Surface Water Assessment**
Mr Tony Marszalek – MEngSc, BE (Civil)
Hydro Engineering & Consulting Pty Ltd

Parts 7: **Human Health Risk Assessment**
Mr Brian Priestly – PhD
Priestly Toxicology Consulting

Part 15: **Economic Assessment**
Mr Drew Collins – BEcon (Agricultural), GradCertMgt
BDA Group Pty Ltd

Section 2

Description of the Project

PREAMBLE

This section describes Bowdens Silver's plans for the proposed site establishment / construction, operation and rehabilitation of the Bowdens Silver Project ("the Project"). Bowdens Silver's objectives for the Project and a brief scenario of the operation as well as a description of the geological setting and the resource to be mined. The proposed site establishment and construction activities, mining operations and processing activities are outlined together with the management of the waste rock and tailings generated. This section also describes the proposed hours of operation, infrastructure and services, site security, waste management, transportation of mineral concentrates and rehabilitation activities. Emphasis is placed in this section upon describing the proposed components of the Project.

The proposed relocation of Maloneys Road and the construction and operation of the proposed water supply pipeline is also described in this section.

The Project is described in sufficient detail to provide the reader with an overall understanding of the nature and extent of activities proposed and to enable an assessment of the potential impacts on the surrounding environment. A range of information outlining how each of the Project components would be undertaken is provided in ***Appendix 5*** *entitled "Documentation Supporting the Project Description".*

Details of the safeguards and mitigation measures that Bowdens Silver would implement to protect and manage noise, air quality, visibility, surface water, groundwater, Aboriginal heritage, flora, fauna, soils and other components of the local environment are detailed in Section 4 of this document.

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2.1 INTRODUCTION

2.1.1 Objectives

The principal objectives of the Bowdens Silver Project are to:

i) maximise the recovery of the silver, zinc and lead minerals from the defined ore reserves within the proposed open cut pits;

ii) undertake all activities in an environmentally and socially responsible manner to demonstrate compliance with relevant criteria and satisfy reasonable community expectations;

iii) ensure the health of its workforce and the surrounding community is not adversely affected;

iv) preserve the existing character of Lue;

v) maintain a positive relationship with the surrounding agricultural industry and maximise productivity on land retained for agricultural production;

vi) provide a stimulus for the Mudgee, Rylstone, Kandos and district economies; and

vii) achieve the above objectives in a cost-effective manner to ensure the Bowdens Silver Project is economically viable.

2.1.2 Overview of the Project

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 above components would be supported by a range of on-site and off-site infrastructure. The on-site infrastructure comprises haul roads, water management structures, power/water reticulation, workshops, stores, compounds and offices/amenities. The off-site infrastructure comprises a relocated section of Maloneys Road (including a new railway bridge crossing and new crossing of Lawsons Creek), a 132kV power transmission line and a water supply pipeline for the delivery of water to the Mine Site. **Figure 2.1** displays the indicative locations of the principal mine components.

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

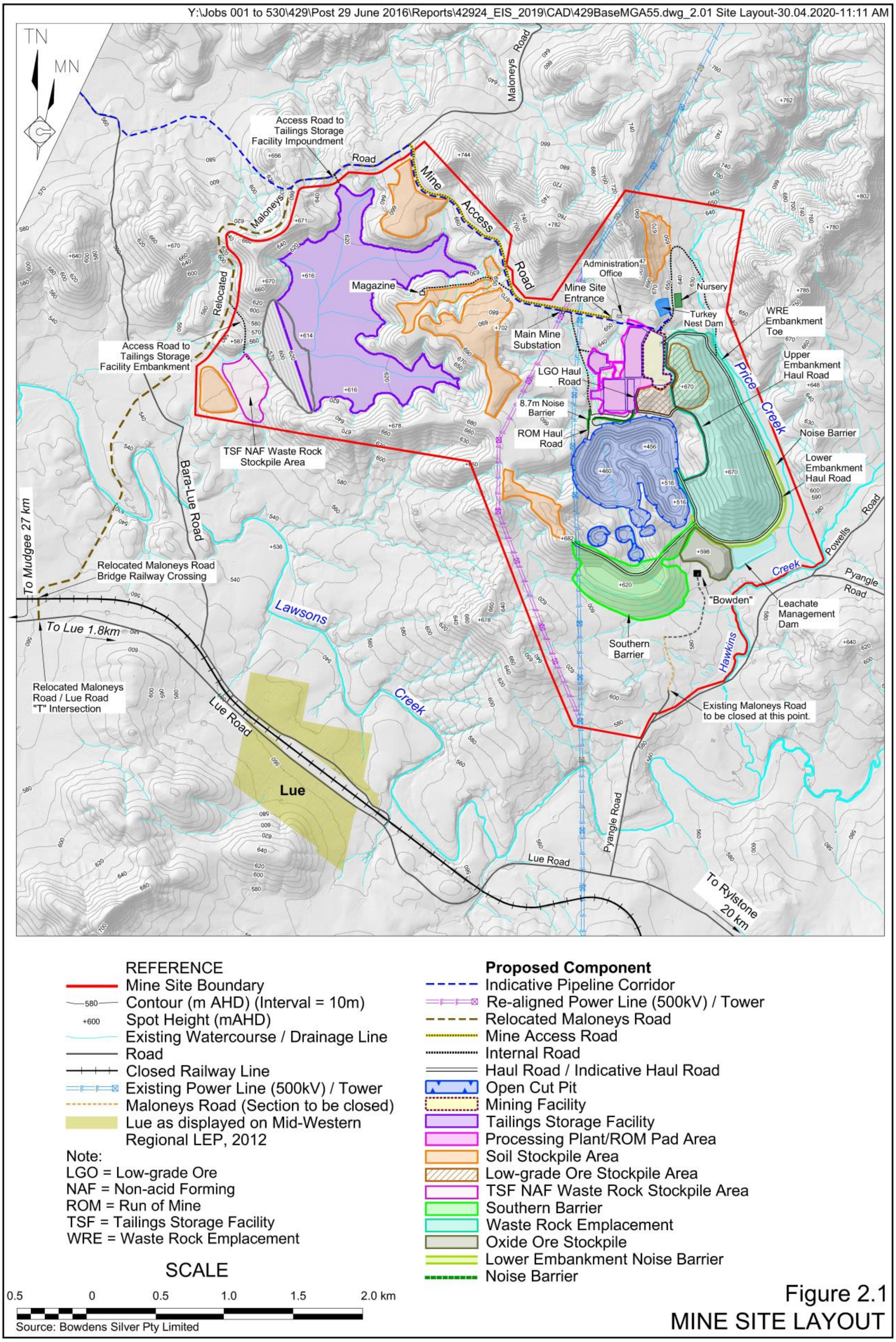


Figure 2.1
MINE SITE LAYOUT

The Project would incorporate conventional open cut pits (one main and two smaller, satellite pits), from which overburden/waste rock is removed from above and around the silver-zinc-lead ore and either used for on-site construction activities or placed in the out-of-pit WRE or the southern barrier. The mined ore would be transported by haul trucks to the on-site processing plant where it would be crushed, milled and processed to liberate the silver, zinc and lead minerals. These minerals would be collected by conventional froth flotation to produce two concentrates that would be dewatered and transported off site by truck. The residual materials from processing (tailings) would be pumped in the form of a slurry to a TSF located to the west of the main open cut pit.

The Project would require a site establishment and construction period of approximately 18 months during which the processing plant and all related infrastructure and the initial embankment of the TSF would be constructed. Once operational, Bowdens Silver anticipates the mine would produce concentrates for approximately 15 years. In total, it is proposed the mine life would be approximately 16.5 years, i.e. from the commencement of the site establishment and construction stage to the completion of concentrate production. It is envisaged rehabilitation activities would be completed over a period of approximately 7 years, i.e. from Year 16 to Year 23. **Figure 2.2** displays the duration of each of the main components throughout the mine life and Project life.

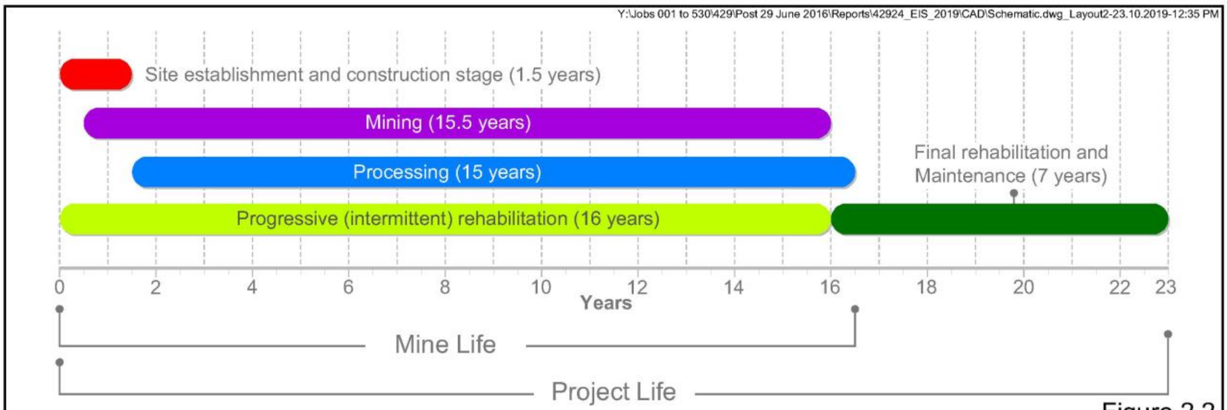


Figure 2.2
MINE LIFE AND PROJECT LIFE

2.1.3 Approvals Required

Based upon the design of the Project and understanding of relevant environmental issues, the Bowdens Silver Project would require the following approvals to proceed.

1. Development Consent issued under the *Environmental Planning and Assessment Act 1979* (EP&A Act) as the Project, being for the purposes of mining-related works with a capital investment value of greater than $30 million, is classified as a State Significant Development under the *State Environmental Planning Policy (State and Regional Development) 2011*, for which approval is required from the Minister for Planning or his/her delegate.
2. An approval from the Commonwealth Minister for the Environment and Energy under the *Environment Protection and Biodiversity Conservation Act 1999 Cth* (EPBC Act) as the Project has been determined to be a controlled action under the EPBC Act.

3. A Mining Lease issued under the *Mining Act 1992* for the area nominally referred to as the Mine Site[2]. The issuing authority would be the Minister responsible for the administration of the *Mining Act 1992* or his/her delegate.
4. An Environment Protection Licence issued under the *Protection of the Environment Operations Act 1997.* The issuing authority would be the Environment Protection Authority (EPA).
5. Several Water Access Licences to cover the amounts of groundwater and surface water intercepted during mining operations, above that which is permitted under the maximum harvestable rights provisions of the *Water Management Act 2000*. The issuing authority would be the DPIE Water operating under the *Water Management Act 2000* and in accordance with:
   i. the *Water Sharing Plan for the Unregulated and Alluvial Water Sources 2012, Lawsons Creek Water Source;*
   ii. the *Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2011, Lachlan Fold Belt Groundwater Source; and*
   iii. the *Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources 2011, Sydney Basin Groundwater Source.*
6. One or more permit(s) issued under the *Roads Act 1993* by Mid-Western Regional Council to:
   i. undertake intersection works on Lue Road;
   ii. construct a new section of the road referred to as relocated Maloneys Road; and
   iii. install the water supply pipeline beneath public roads and administered by Council.[3]
7. Appropriate approvals and licences from SafeWork NSW for the on-site storage (detonators, boosters/primers only) and use of explosives and notification of dangerous goods stored and used on site.
8. All necessary approvals from Mid-Western Regional Council for construction, erection and/or placement of buildings, structures and appropriate sewage treatment systems for the Project.
9. All necessary approvals from the managing agent of the Country Regional Network (on behalf of Transport for NSW), with regard to the railway bridge for the relocated Maloneys Road.
10. One or more licences or leases required to occupy Crown Land for the relocated road and water supply pipeline.

[2] The exact area of the mining lease is yet to be finalised – it may or may not exactly coincide with the Mine Site as displayed on **Figure 2.1**.
[3] The Roads and Maritime Services would be a concurrence authority for those activities for classified public roads, e.g. Ulan Road.

The alignment of the water supply pipeline corridor, as displayed on **Figure 1.3**, has been discussed during consultation with 17 of the 19 landowners[4] along the corridor. It is acknowledged that access to all areas that are intended to be used for the water supply pipeline has not be possible to date. Finalising the necessary agreements and alignment of the pipeline would occur before receipt of development consent. However, the assessments undertaken to date indicate that the proposed alignment is acceptable. In the event a minor adjustment to the alignment of the corridor is required at the request of a landowner or for an engineering design reason following the receipt of development consent, Bowdens Silver would identify this requirement with the relevant authorities and undertake the necessary assessments to accompany an application to modify the alignment for the new corridor section. To date it is expected that this would not be required.

This EIS incorporates assessment of the proposed realignment of the of approximately 3.5km of the 500kV power transmission line that traverses the western side of the proposed main open cut pit. Bowdens Silver would seek to finalise approval in accordance with Part 5 of the EP&A Act from TransGrid for the re-alignment. This agreement would be finalised prior to commencing operations within the Mine Site.

An approval to construct the required 132kV power transmission line to the Mine Site would be sought separately in accordance with Part 5 of the EP&A Act. Power supply requirements for the Project are discussed in more detail in Section 2.11.3. It should be noted that assessment of the power supply infrastructure and associated works is not included here but would be addressed in a future application to the relevant energy provider.

2.1.4 Other Agreements

The Project would require a number of other agreements in order to proceed as proposed. While not formal approvals, these agreements would be subject to terms as agreed between the relevant parties.

Planning for the supply of make-up water for the Project has identified the option to source water from the Ulan Coal Mine and/or Moolarben Coal Mine via a dedicated water supply pipeline. A summary of the current status of the agreements with the relevant mines is as follows.

- Bowdens has been discussing the prospect of a water sharing arrangement with Ulan Coal Mine. Whilst no agreement has been reached, Ulan Coal Mine has expressed a willingness to continue those discussions. Bowdens and Ulan intend to do further work on the respective water requirements of both parties, and to continue to explore whether such an agreement is feasible. However, Bowdens Silver acknowledges that the ability to transfer water from Ulan Coal Mine is dependent on reaching agreement with Ulan Coal Mines Limited on the operational and commercial terms that would apply to any such arrangement, and the entry into a formal water sharing agreement.

[4] The remaining two landowners have not been able to be contacted to date.

- Moolarben Coal Operations Pty Ltd has confirmed that should the Moolarben Coal Mine have available water in excess of its own requirements, including (but not limited to) other water sharing commitments, it would be willing to provide that water to the Project. Any such excess water supply would be subject to a commercial agreement between the relevant parties. Moolarben Coal Operations Pty Ltd has also advised it does not object to the pipeline traversing land it controls.

Assessment for various stages of the development has identified that, despite the adoption of a comprehensive suite of feasible and reasonable mitigation measures, noise levels generated by the Project may be experienced at some residences at levels that exceed the assessment criteria. Agreements with the owners of residences that would experience marginal/moderate exceedances would be required in accordance with the NSW Government's Voluntary Land Acquisition and Mitigation Policy (VLAMP). A total of eight properties require consideration and agreement in accordance with the VLAMP. Bowdens Silver has also volunteered to provide a further six landowners with mitigation (under agreement) where noise levels are predicted to only negligibly exceed the assessment criteria. The mitigation offered to landowners under agreement is discussed in more detail in Section 4.2.2.6.

The current Biodiversity Offset Strategy is for Biodiversity Stewardship Agreements to be sought over land within the Mine Site and other properties to establish areas for in-perpetuity biodiversity conservation in order that the residual biodiversity impacts of the Project are offset. The biodiversity offset strategy is discussed in more detail in Section 2.17.

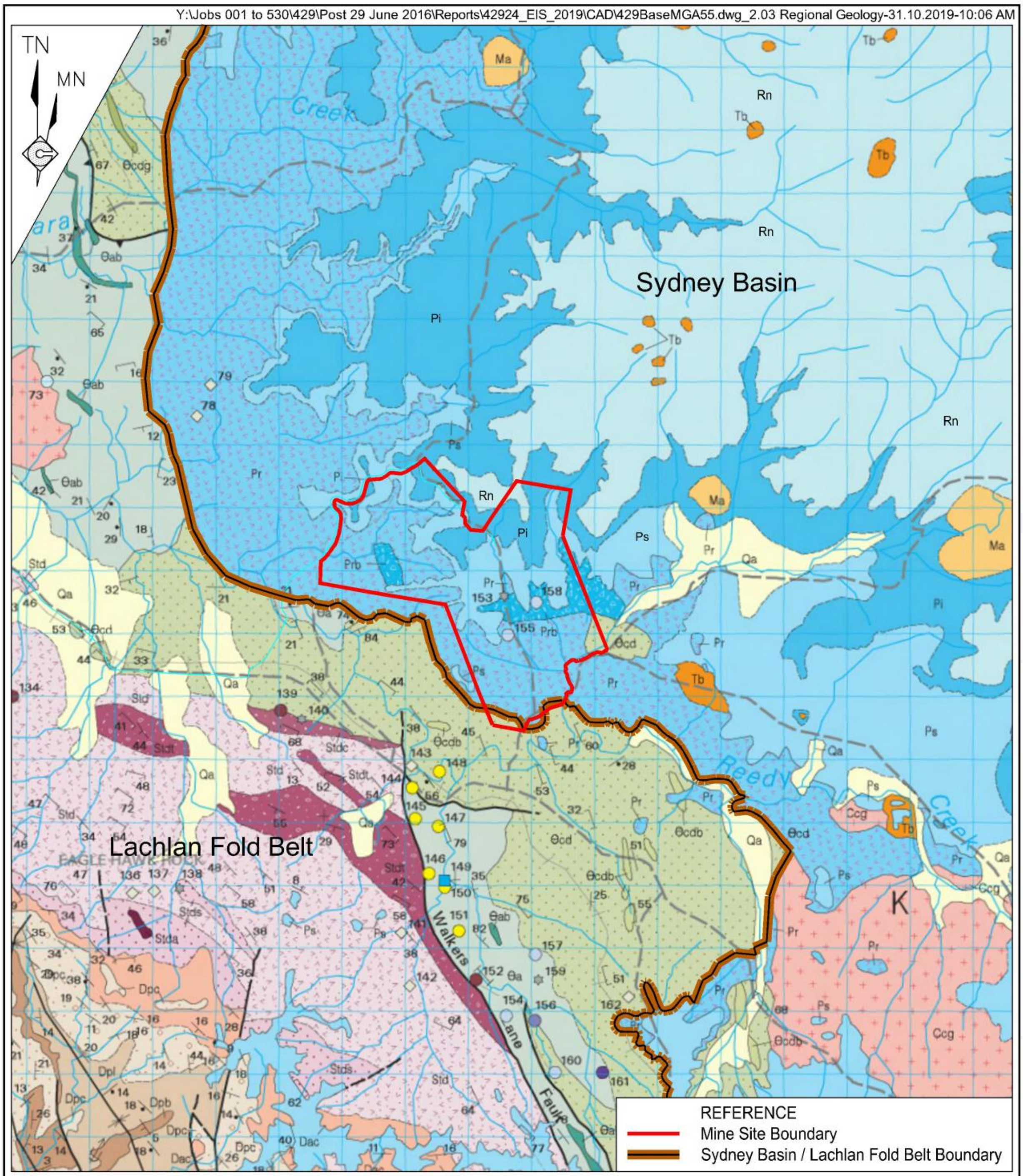
It is noted that Bowdens Silver has negotiated a range of agreements with landowners that would result in purchase or lease of properties should approval for the Project be granted. The details of these agreements are confidential, however where appropriate, any property over which there is such an agreement is included in the EIS and relevant technical assessments as Project-related.

2.2 GEOLOGICAL SETTING AND RESOURCES

2.2.1 Regional Geology

The Mine Site is situated near the northeastern margin of the Lachlan Fold Belt, one of the main components of the Tasman Fold Belt System, and the western edge of the Sydney Basin. **Figure 2.3** presents an extract of the geological map of the Mudgee to Rylstone district displaying the locations of the geological units of the Lachlan Fold Belt and the Sydney Basin together with more recent igneous rocks and Quaternary alluvium.[5]

5 It is noted that Bowdens Silver proposes to establish an explosives magazine on site for emergency use only, i.e. in the event any explosives, primers or detonators need to be stored overnight.



Geological Reference - Lue Area

CAINOZOIC UNITS	Qa	Quaternary Alluvium	MOUNT KNOWLES GROUP	Dpb	Bumberra Formation
	Tb	Tertiary Basalt		Dpc	Buckaroo Conglomerate
MESOZOIC IGNEOUS ROCKS	Ma	Mesozoic Igneous Rocks		Dpl	Lawsons Creek Shale
SYDNEY BASIN	Rn	Narrabeen Group	TANNABUTTA GROUP	Std	Dungeree Volcanics
	Pi	Illawarra Coal Measures		Stdc	Dungeree Volcanics (polymictic conglomerate)
	Pr	Rylstone Volcanics			
	Pr(b)	Rylstone Volcanics (volcanic breccia & conglomerate)		Stdt	Dungeree Volcanics (volcanic conglomerate)
KANDOS GROUP	Ps	Shoalhaven Group	CABONNE GROUP	Øcd	Coomber Formation (mafic volcanic sandstone)
	Ccg	Pyangle Pass Granite			
				Øcdg	Coomber Formation

SCALE

1 0 1 2 3 4 5 km

Source: Mudgee 1:100 000 Geological Map (2000)

Figure 2.3
REGIONAL GEOLOGICAL SETTING

2.2.2 Mine Site Geology

The Bowdens silver deposit is a carbonate-silver-base metal associated low-sulphidation epithermal deposit. The deposit is hosted principally within siliceous volcanic rocks of the early Permian Rylstone Volcanics (approximately 290 million years old) that unconformably overlie a sequence of Ordovician aged metasediments (approximately 460 million years old). The Rylstone Volcanics which range in thickness from 10m to >200m comprise mainly rhyolitic ignimbrites, tuffs and volcanic breccias and are partially overlain by the Snapper Point Formation of the Shoalhaven Group sediments of the Sydney Basin. **Figure 2.4** displays the surface geology within and adjacent to the Mine Site. **Plate 2.1** displays the colour and appearance of the various rock types defined within and immediately surrounding the Mine Site.

The bulk of the mineralisation within the proposed open cut pits occurs as a thick zone extending from surface, and near surface, to vertical depths of at least 180m. Drilling undertaken to date has identified mineralisation to depths of approximately 330m below the natural ground surface, i.e. below the proposed depth of the main open cut pit.

A proportion of the rocks within the proposed open cut pits display mineral alteration with an assemblage of clays (illite-smectite), sericite, silica, adularia and carbonate. **Plate 2.1** highlights that the bulk of the rock types to be extracted from the open cut pits are a light cream to light brown in colour, a factor that would potentially contribute to increased visibility of the extraction operations and the placement of the waste rock within the embankment of the TSF, WRE and the southern barrier.

The siliceous volcanic rocks comprising the ore and waste rock contain varying proportions of free silica. Laboratory testing of representative samples of each of the ore and waste rock established that the free silica concentration in the ore and waste rock is typically 47% and 64% respectively.

2.2.3 Ore Reserves

An Ore Reserve Statement, which complies with the JORC [6] standard, was completed for the Bowdens silver deposit in May 2018 by AMC Consultants Pty Ltd (see **Table 2.1**). The silver, zinc and lead grades are expressed in either grams per tonne (g/t) or percentage (%) in accordance with the conventions set out in the JORC standard.

Table 2.1
Ore Reserve Statement – 18 May 2018

Reserve Category	Tonnes (Mt)	Reserve Grades			Contained Metal		
		Ag (g/t)	Zn (%)	Pb (%)	Ag (Moz)	Zn (kt)	Pb (kt)
Proved	28.6	69.75	0.44	0.32	64.05	125.11	91.43
Probable	1.3	53.15	0.43	0.29	2.27	5.74	3.91
Total	**29.9**	**69.01**	**0.44**	**0.32**	**66.32**	**130.84**	**95.33**
Mt = million tonnes	g/t = grams per tonne			Moz = million ounces		kt = thousands of tonnes	
Source: AMC Consultants Pty Ltd							

[6] 2012 Joint Ore Reserves Committee, i.e. the "Australian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves".

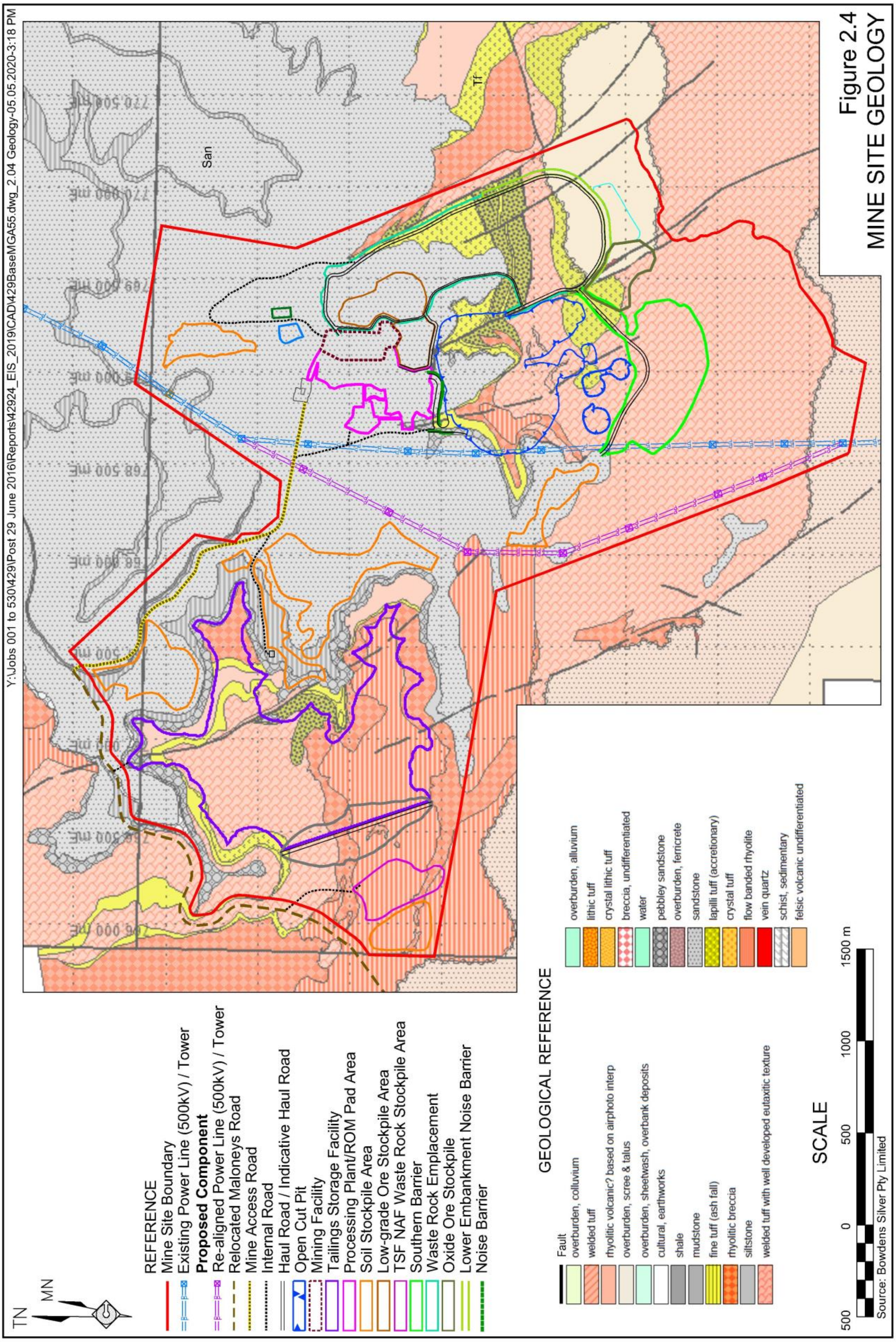


Figure 2.4
MINE SITE GEOLOGY
Y:\Jobs 001 to 530\429\Post 29 June 2016\Reports\42924_EIS_2019\CAD\429BaseMGA55.dwg_2.04 Geology-05.05.2020-3:18 PM
San
Tf
TN
MN
REFERENCE
Mine Site Boundary
Existing Power Line (500kV) / Tower
Proposed Component
Re-aligned Power Line (500kV) / Tower
Relocated Maloneys Road
Mine Access Road
Internal Road
Haul Road / Indicative Haul Road
Open Cut Pit
Mining Facility
Tailings Storage Facility
Processing Plant/ROM Pad Area
Soil Stockpile Area
Low-grade Ore Stockpile Area
TSF NAF Waste Rock Stockpile Area
Southern Barrier
Waste Rock Emplacement
Oxide Ore Stockpile
Lower Embankment Noise Barrier
Noise Barrier
GEOLOGICAL REFERENCE
Fault
overburden, colluvium
welded tuff
rhyolitic volcanic? based on airphoto interp
overburden, scree & talus
overburden, sheetwash, overbank deposits
cultural, earthworks
shale
mudstone
fine tuff (ash fall)
rhyolitic breccia
siltstone
welded tuff with well developed eutaxitic texture
overburden, alluvium
lithic tuff
crystal lithic tuff
breccia, undifferentiated
water
pebbley sandstone
overburden, ferricrete
sandstone
lapilli tuff (accretionary)
crystal tuff
flow banded rhyolite
vein quartz
schist, sedimentary
felsic volcanic undifferentiated
SCALE
500
0
500
1000
1500 m
Source: Bowdens Silver Pty Limited

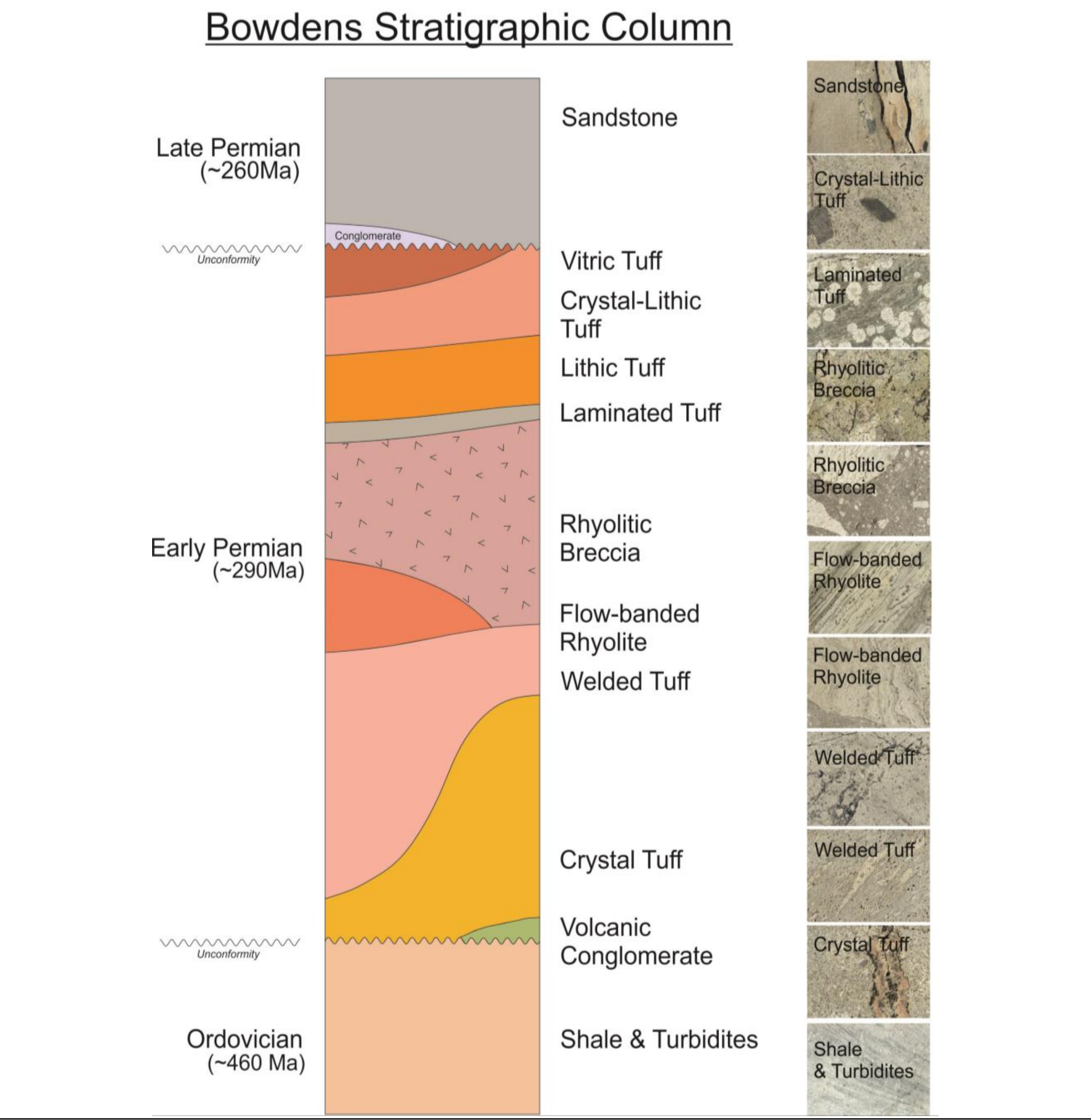


Plate 2.1 Bowdens Stratigraphic Column and Representative Rock Types

The Ore Reserve Statement presented in **Table 2.1** is based on data from approximately 83 500m of drilling in 653 drill holes that comprise reverse circulation holes (80%) and diamond drill holes (20%). This information has been sourced from recent drilling by Bowdens Silver and previous drilling undertaken by Kingsgate Consolidated Limited, Silver Standard Australia Pty Limited, GSM Exploration Pty Limited and CRA Exploration Pty Limited. The ore reserves listed in **Table 2.1** have been calculated following the design of the open cut pits in which the recovery of silver, zinc and lead minerals has been optimised, i.e. with respect to the quantity of recoverable ore and its ratio to the quantity of overburden extracted to recover the defined ore.

For the purposes of the EIS, Bowdens Silver has defined three types of recoverable ore.

i) Primary Ore: Unweathered silver, zinc and lead sulphide minerals within the host rock with a silver grade exceeding a nominated cut-off grade of 30g/t.

ii) Low Grade Ore: Unweathered silver, zinc and lead sulphide minerals within the host rock with a silver grade marginally below the nominated cut-off grade of 30g/t.

iii) Oxide Ore: Weathered silver, zinc and lead minerals within the host rock with a silver grade exceeding a nominated cut-off grade[7].

Bowdens Silver proposes to extract and process all primary ore and extract and stockpile all low grade ore. The low grade ore would be processed subject to prevailing silver prices and potentially blended with the primary ore. The oxide ore would not be able to be processed within the processing plant on site however, it would be separately stockpiled adjacent to the southwestern side of the WRE for processing should this become feasible in the future, either on or off site.

Based upon the studies to optimise the recovery of the defined ore from the open cut pits and ultimate design of the open cut pits, the recoverable primary and low grade ore within the proposed open cut pits is estimated to be approximately 29.9 million tonnes at an average grade of 69g/t silver, 0.44% zinc and 0.32% lead. This corresponds to total in situ quantities of approximately 66.3 million ounces of silver, 130 000 tonnes of zinc and 95 000 tonnes of lead.

The recoverable primary and low grade ore would be mined in conjunction with approximately 1.8 million tonnes of oxide ore and 46.3 million tonnes of waste rock. The stripping ratio of waste rock to ore would be approximately 1.6:1.

2.2.4 Further Resource, Grade Control and Infill Drilling Operations

Bowdens Silver intends to undertake further exploration beyond the current projected base of the main open cut pit and the western boundary of the main open cut pit to establish whether any ore is recoverable either by open cut or underground mining method, from those areas.

Grade control and infill drilling operations would be routinely undertaken in conjunction with the blast hole drilling program to identify and delineate ore and waste rock mining blocks. All grade control samples would be analysed within an on-site laboratory, whilst infill samples would be analysed to establish total carbonate concentration and thus sub-classify the waste rock to be mined.

2.3 SITE ESTABLISHMENT AND CONSTRUCTION ACTIVITIES

2.3.1 Introduction

The site establishment and construction activities for all key components within the Mine Site would be sequenced to achieve the commencement of concentrate production approximately 18 months after the commencement of the site establishment and construction stage. The

[7] It is not proposed to process the oxide ore recovered from the open cut pit – see further discussion in Section 2.6.2.

locations of the key activities to be undertaken during the site establishment and construction stage are presented in **Figure 2.5** and listed in **Table 2.2**, displaying an indicative construction schedule. For the purposes of the assessment of impacts during the site establishment and construction stage, distinction is made between the period from Months 1 to 6 and from Months 7 to 18. **Figure 2.5** distinguishes between those activities that are planned during the first 6 months, the period from Month 7 to Month 18 or throughout the entire 18 month site establishment and construction stage.

During the initial 6 months, construction activities would be confined to off-site road construction, land clearing, vegetation clearing, soil stripping and some initial earthworks within the Mine Site.

During the 12 month period between Months 7 and 18, the bulk of the on-site activities would be undertaken (including the commencement of the mining pre-strip) involving considerably more earthmoving equipment and a greater area of disturbance.

A brief description of general preparatory activities and the proposed hours of operation during this period is provided in the following subsections. A description of the site establishment and construction components of the key infrastructure within the Mine Site is included in the description of that infrastructure in later subsections. Details of the number and type of equipment to be used during this stage is presented in Section A5.2 (**Appendix 5**).

2.3.2 Preparatory Activities

The boundaries of all areas to be disturbed during the site establishment and construction stage would be surveyed and marked out prior to the commencement of disturbance in the respective operational areas. Key boundaries and locations would be marked with painted posts and recorded on relevant site construction plans and documents (e.g. Rehabilitation Management Plan and/or Environmental Management Strategy or Sub-plans).

Where necessary, the existing fencing within the operational areas would also be removed, with suitable materials salvaged for use elsewhere within Bowdens Silver's landholdings or recycled. The existing 11kV power transmission lines (and poles) within the Mine Site would be removed by or on behalf of the distribution network service provider. Residences and related farm buildings within the proposed disturbed areas within the Mine Site would either be relocated for use as offices or demolished, with the useful building materials recycled.

A program of initial earthworks would be undertaken firstly to establish the surface water management system (erosion and sediment control) and secondly, to develop the required operational areas. No substantial earthworks would commence in each operational area until sign-off confirming that all required erosion and sediment controls are in place.

Vegetation clearing would be undertaken initially by one or more firewood and mulching contractors who would remove the vegetation only in areas for approved mine components. During all vegetation clearing, any available seed would be collected and timber either mulched or set aside for fencing, habitat relocation/reconstruction or off-site beneficial uses such as saw logs, firewood or fencing.

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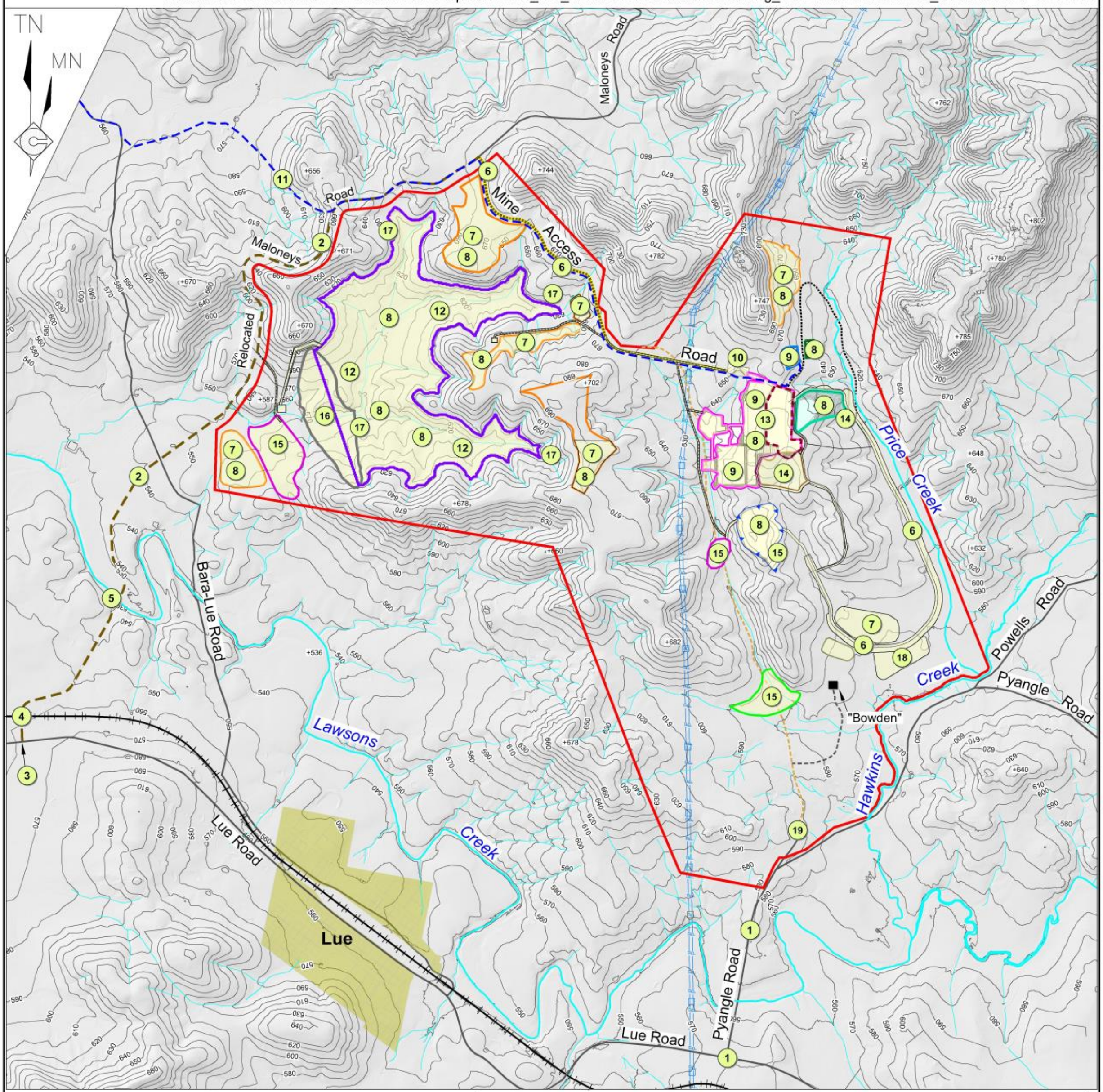

REFERENCE
- Mine Site Boundary
- Road
- Closed Railway Line
- Existing Power Line (500kV) / Tower

Proposed Component
- Indicative Pipeline Corridor
- Relocated Maloneys Road
- Mine Access Road
- Internal Road
- Haul Road
- Open Cut Pit
- Tailings Storage Facility Boundary
- Waste Rock Emplacement Boundary
- Processing Plant/ROM Pad Area
- Mining Facility
- Soil Stockpile Boundary
- NAF Waste Rock Stockpile
- Southern Barrier
- Low-grade Ore Stockpile Boundary
- Disturbance During Site Establishment and Construction Stage

	Construction Activities
1	Upgrade Pyangle Road (to the Mine Site)
2	Construct Relocated Maloneys Road
3	Construct Relocated Maloneys Road/Lue Road Intersection
4	Construct Relocated Maloneys Road Bridge Railway Crossing
5	Construction of Lawsons Creek Crossing
6	Construct Internal Access Roads & Install Services
7	Establish Soil Stockpile Areas
8	Vegetation Clearing & Soil Stripping
9	Excavation / Earthworks for Processing Plant Site
10	Install Administration Offices and Amenities
11	Construct Water Supply Pipeline
12	Preparation of TSF Impoundment Area
13	Processing Plant, Mining Facility Construction and Assembly
14	Establish Stage 1 Low Grade Ore Stockpile & Initial Cell of Waste Rock Emplacement
15	Initial Development of Main Open Cut Pit, Ore & Waste Rock Extraction and Stockpiling / Placement
16	Construct Initial TSF Embankment
17	Construct Decant Pond Area & Tailings Pipeline
18	Construct Leachate Management Dam
19	Close Maloneys Road Following Opening of Relocated Maloneys Road

SCALE
0.5 0 0.5 1.0 1.5 2.0 km

Base Map Source: Bowdens Silver Pty Limited

Figure 2.5
SITE ESTABLISHMENT AND CONSTRUCTION ACTIVITIES

Table 2.2
Indicative Site Establishment and Construction Schedule

Construction Activity	Month																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Approvals, Engineering and Procurement																		
Secondary approvals	■	■	■															
Engineering/detailed design	■	■	■	■	■	■	■	■	■									
Procurement	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Off-site Road Network																		
Survey and mark out key boundaries			■															
Install erosion and sediment controls, vegetation clearing and soil stripping			■	■	■													
Construct relocated Maloneys Road			■	■	■	■												
Construct relocated Maloneys Road/Lue Road Intersection			■															
Construct new crossing across Lawsons Creek				■	■													
Construct relocated Maloneys Road Rail Bridge				■	■													
Site Earthworks and Infrastructure																		
Survey and mark out key boundaries				■														
Install erosion and sediment controls				■	■													
Vegetation clearing, soil stripping and stockpiling				■	■													
Construct internal roads, culverts, drains and underground services				■	■	■												
Establish low grade ore stockpile area 1 and WRE Cells 1 and 2					■	■												
Construct/install administration offices/amenities, etc.													■	■	■	■		
Processing Plant and Mining Facility																		
Earthworks/footings						■	■	■	■	■	■	■	■					
Plant construction/assembly/installation								■	■	■	■	■	■	■	■	■	■	
Piping/Electricals									■	■	■	■	■	■	■	■	■	■
Instrumentation												■	■	■	■	■	■	■
Commissioning															■	■	■	■
Open Cut Pit Development																		
Vegetation clearing					■													
Soil Stripping						■												
Ore and waste rock extraction							■	■	■	■	■	■	■	■	■	■	■	■
Tailings Storage Facility and Pipeline																		
Vegetation clearing, soil stripping and ripping						■	■	■	■									
Construct interception dams						■	■	■	■									
Tailings impoundment area preparation							■	■	■	■	■	■	■					
Delivery of NAF Waste Rock and Crushing							■	■	■	■	■	■	■	■	■	■	■	
Construct Initial Embankment											■	■	■	■	■	■	■	
Lining of decant area																	■	
Install decant return and monitoring infrastructure																	■	
Install Tailings and Decant Pipelines																	■	■
Water Pipeline and Power Transmission Lines																		
Construct Water Pump Stations (2)																	■	
Install Water Pipeline							■	■	■	■	■	■	■	■	■	■		
Construct 132kV Power Transmission Line						■	■	■	■	■	■	■	■	■				

Source: Bowdens Silver Pty Limited

Topsoil and subsoil removed during the site establishment and construction stage would either be re-used as part of the initial stabilisation / rehabilitation activities or stockpiled in nominated soil stockpile locations (see Section 2.16.4 and Section 4.13 with additional information presented in Section A5.3.2.2). The soil stockpile areas displayed on **Figure 2.5** would not be fully cleared during the site establishment and construction stage. Some stockpile areas or parts thereof would be cleared progressively prior to topsoil and subsoil removal throughout the early years of operation.

A construction office comprising transportable buildings would be established in the vicinity of the proposed administration offices and all necessary communications and other services installed. The construction contractor would also install temporary workshop and materials management facilities and construct internal roads required for site establishment and construction activities generally within the areas or alignments of the long term mine components.

2.3.3 Site Establishment and Construction Hours

Table 2.3 lists the proposed hours of operation during the site establishment and construction stage. No activities would be undertaken on Sundays.

Table 2.3
Site Establishment and Construction Hours

Construction Activity	Monday to Friday	Saturday
Site Earthworks and Infrastructure (and within main open cut pit)	7:00am – 10:00pm[1]	7:00am – 6:00pm
Processing Plant	7:00am – 10:00pm[2]	7:00am – 6:00pm
Tailings Storage Facility	7:00am – 6:00pm[3]	7:00am – 6:00pm[3]
Off-site Road Construction	7:00am – 6:00pm[3]	8:00am – 1:00pm
Water Pipeline and Transmission Line Installation	7:00am – 8:00pm[3]	8:00am – 6:00pm[3]

1. Subject to demonstrating noise limits can be satisfied during this period
2. Only low-noise/inaudible activities would be undertaken beyond 6:00pm during the latter stages of construction and commissioning
3. Daylight hours only

2.4 MINING OPERATIONS

2.4.1 Introduction

Mining operations would effectively commence in Month 7 of the site establishment and construction stage with the main open cut pit pre-strip. Mining would be undertaken using conventional open cut drill and blast, load and haul mining methods. This would involve the sequential removal/storage or mulching of vegetation, the stockpiling of topsoil and subsoil (where recoverable), the removal/placement or stockpiling of waste rock and the recovery of ore.

This subsection presents information relating to the mining operations from the site establishment construction stage to the end of mining including the design of the open cut pits, mining methods and mine sequencing. **Appendix 5** (Section A5.3) includes details of the proposed vegetation clearing, soil stripping and annual production rates together with indicative mobile equipment list.

2.4.2 Open Cut Pit Design and Mining Sequence

The design of the main open cut pit and the two satellite pits has been undertaken through a series of pit optimisation realisations carried out by AMC Consultants Pty Ltd (AMC) using Whittle Four-X pit optimisation software. **Figure 2.6** presents the conceptual final layout and cross-sections of the main open cut pit and the two satellite pits highlighting the relative depths of extraction at various years throughout the mine life. The rim of the main open cut pit varies from 597m AHD within the current alignment of Blackmans Gully to 652m AHD on its northeastern edge. The deepest section of the main open cut pit of 456m AHD, approximately 180m below natural ground level, would be reached in about Year 9 of the Project. The open cut pits have been designed using the following parameters.

- Operational bench height: 5m
- Maximum terminal bench height = 25m
- Maximum face angle: 65º
- Berm width: 9m
- Nominal ramp width: between 15m and 25m
- Ramp gradient: 1 in 10 (10%)

Development of the main open cut pit would commence in about Month 7 of the site establishment and construction stage with vegetation clearing, followed by the stripping and stockpiling of topsoil and subsoil. This stage is referred to as the open cut pit pre-strip. Emphasis would be placed in this stage upon the recovery of sufficient non-acid forming (NAF) waste rock for the construction of the initial TSF embankment and the accumulation of sufficient ore on the ROM pad to enable the processing plant to be commissioned. Any low grade ore recovered during this stage would be transported by haul truck to the first stage of the low grade ore stockpile area east of the ROM pad. During the main open cut pit pre-strip, all potentially-acid forming (PAF) waste rock would be recovered and transported by haul truck and placed in Cell 1 of the WRE, i.e. to the east of the mining facility (see **Figure 2.1**). All oxide ore extracted during the development of the open cut pits would be transported to the oxide ore stockpile area southwest of the WRE (see **Figure 2.1**).

Figure 2.7 displays the indicative mining sequence from the end of the site establishment and construction stage to Year 15. Mining activities would be concentrated in the eastern side of the main open cut pit until about Year 8 after which mining activities would extend to the western limit of the main open cut pit. Beyond Year 10, extraction would be confined to the main open cut pit increasing in depth as displayed in the cross-sections in **Figure 2.6**.

Dual lane (25m wide) and single lane (15m wide) ramps would provide for operations with roadside drainage and safety bunds. Horizontal switchbacks would also provide flat turning surfaces to reduce wear and tear to the haul trucks. All ramps would be positioned to achieve the shortest possible distance from the limits of the open cut pits to the ROM pad, low grade ore stockpile, oxide ore stockpile and the WRE. Two entry/exit ramps would be included in the design of the main open cut pit, namely one to the north (mainly for transportation of ore or waste rock of an evening and ore during the night-time) and one to the east (mainly for waste rock and oxide ore for waste rock during the day). The northern exit ramp from the main open cut pit would not be developed until about Year 3 of operations. Access and egress from the two satellite pits would occur via a single ramp for each pit.

These design features would be reviewed and optimised following further geotechnical investigations to establish open cut pit wall stability and extraction requirements.

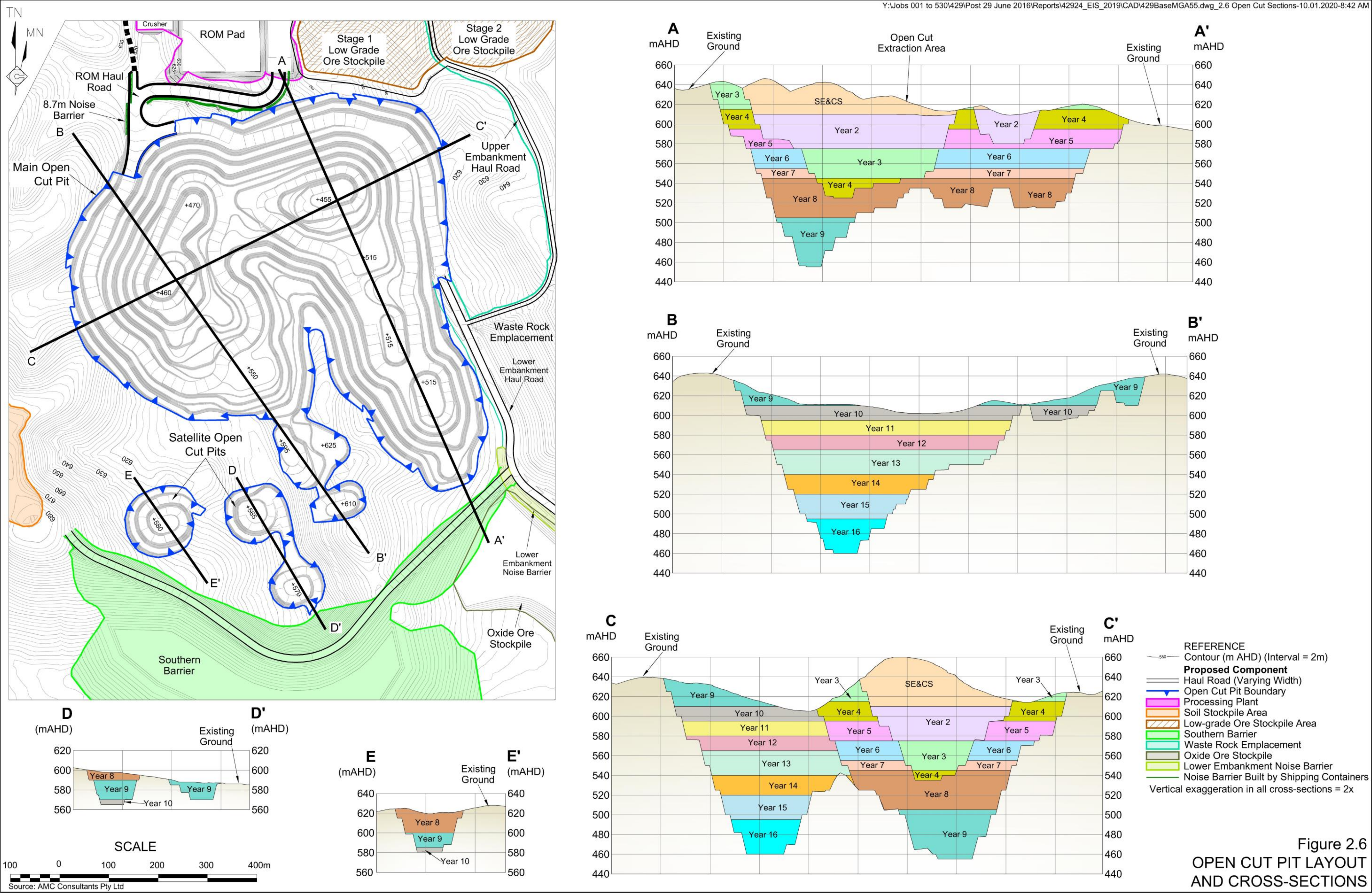

Figure 2.6
OPEN CUT PIT LAYOUT AND CROSS-SECTIONS

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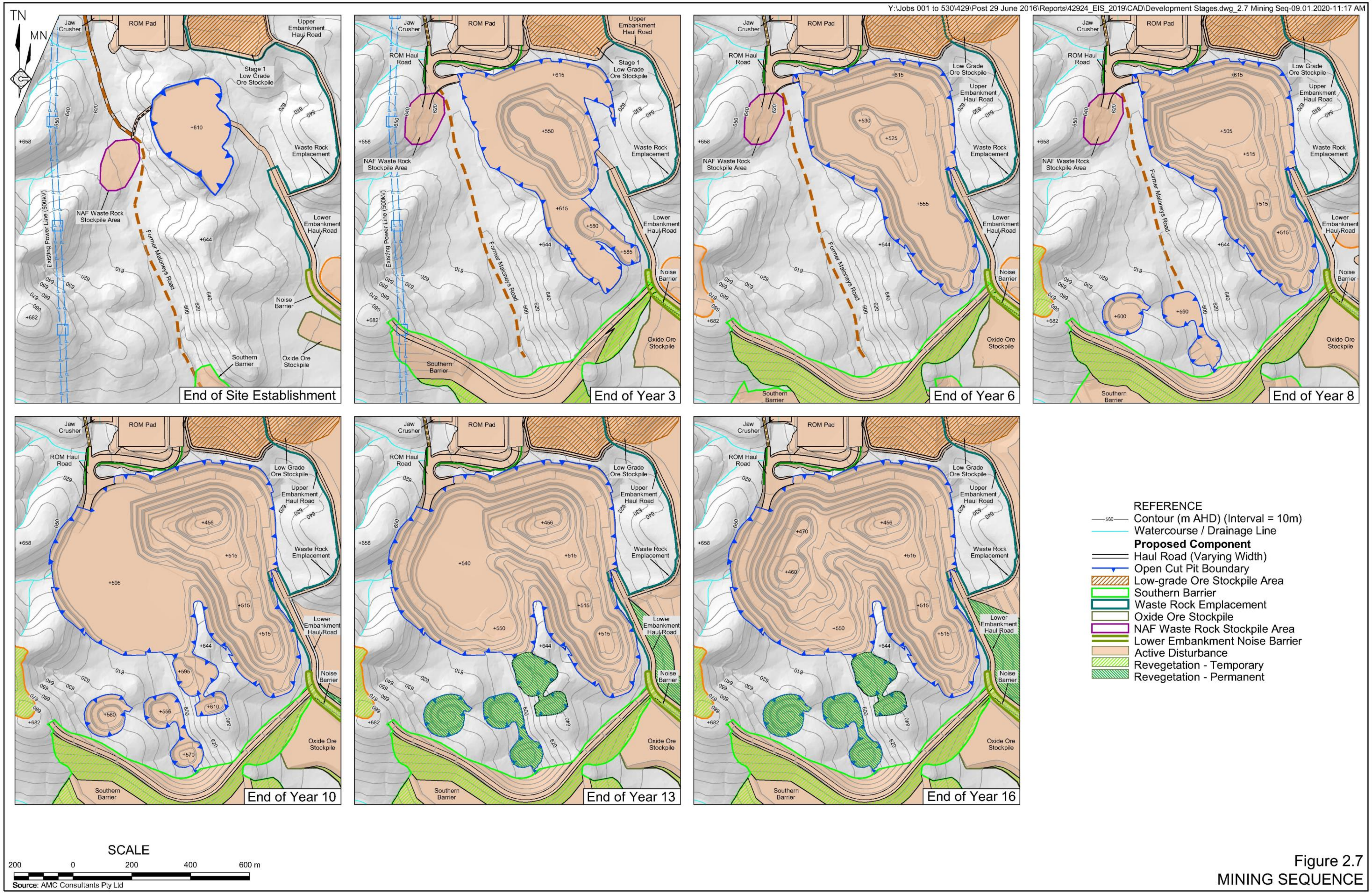

Figure 2.7
MINING SEQUENCE

2.4.3 Mining Operations

2.4.3.1 Extraction of Friable Material

Following removal of vegetation and soil materials as described in **Appendix 5** (Section A5.3.2.2), mining would commence with the removal of any friable weathered materials. Where present, these materials would be directly extracted using an excavator or ripped and pushed up using a bulldozer and loaded into haul trucks using an excavator or front-end loader. Extracted material would be loaded into haul trucks for transportation to the WRE, low grade ore stockpile or other locations where waste rock is being used for construction of infrastructure (e.g. TSF embankment). Exploration to date indicates friable weathered material occurs from the base of the subsoil to depths of between approximately 20m and 30m.

2.4.3.2 Drill and Blast

The bulk of the ore and waste rock would require blasting following removal of the friable weathered materials, principally to achieve the required level of fragmentation to enable the ore to be processed. Drilling would be undertaken typically 2 to 3 days in advance of each blast to allow the drill cuttings to be analysed for metal grades and to sub-classify any waste rock present into the respective category (see Section 2.5.2) so as to inform the planning undertaken following the routine infill drilling (see Section 2.2.4). Each blast would yield an average of 25 000t of fragmented rock with maximum yields up to approximately 60 000t. Drilling and blasting would be a regular activity within the open cut pits with blasts generally initiated 3 to 5 days per week from Monday to Saturday[8].

The emphasis in blasting would be upon fragmentation of the rock in situ rather than heaving it away from a defined face. This approach would ensure the reliability of metal grades identified during the drilling of the blast holes to assist to identify whether the fragmented rock is ore, low grade ore, oxide ore, NAF waste rock or PAF waste rock.

Blast hole drilling would be undertaken by up to two production drills. Drill and blast production would be carried out on a bench with a height of approximately 5m (5.5m with sub-drill). The burden and spacing for each blast would be adjusted to reflect the rock type to be blasted and any inherent features present. An indicative pattern of drill holes in the waste rock would be 4.6m x 4.9m with a blasthole diameter of 152mm and 0.48kg of explosives per bank cubic metre. An indicative pattern of drill holes in the ore would typically be 3.3m x 3.6m with a hole diameter of 127mm and 0.65kg of explosives per bank cubic metre. The drill pattern used would depend upon the type of explosive used and reflect observations about the extent of fragmentation achieved. Drill patterns would be regularly reviewed to ensure fragmentation is being optimised. The explosives, together with the primers and detonators used for each blast would be transported by the blasting contractor to the Mine Site on the day of each blast. The quantity of explosives transported to the Mine Site on the day of each blast would vary from approximately 5 tonnes to 16 tonnes thereby requiring either one mobile manufacturing unit (up to 9t of explosives) or one unit with a trailer (up to a total of 18t of explosives). It is noted that Bowdens Silver proposes to establish a transportable explosives magazine on site for emergency use only, i.e. in the event any explosives, primers or detonators need to be stored overnight.

[8] The frequency of blasting would largely depend upon the quantity of rock to be fragmented during each blast, i.e. if all blasts fragmented 25 000t per blast, there would be approximately 240 blasts per year, whereas if all blasts fragmented 60 000t per blast, there would be approximately 100 blasts per year.

The typical maximum instantaneous charge (MIC) for a blast would be in the order of 216kg in waste rock and 117kg in ore, although the MIC would be varied in line with on-site experience and Bowdens Silver's commitment to satisfy all blast limits at all privately-owned residences without VLAMP agreements (see Section 4.3.4.1) throughout the mine life. While production blasting would take place in 5m benches, a flitch height of 2.5m would be used in excavating and loading ore and waste rock.

Pre-split blasting would be adopted to achieve the required stability of the final or terminal open cut pit walls, particularly in the fresh rock zones.

Bulk ammonium nitrate emulsion or ammonium nitrate/fuel oil (ANFO) would be used in production blasting. The selection of the type of explosive used would reflect a range of parameters including the presence or absence of water within each bench to be blasted. All drill and blast operations would be supervised by a suitably qualified and experienced blasting engineer or shot-firer.

Bowdens Silver would establish a protocol to inform interested surrounding landowners and residents about the timetable for blasts. Whenever possible, blasts would be initiated generally at a similar time of day. Further information on the management of blasts and the proposed design and operational safeguards is provided in Section 4.3.

2.4.3.3 Load and Haul

Following completion of each blast, boundaries between ore and each type of waste rock would, if required, be identified and marked out on the fragmented materials using paint, tape or similar materials. Fragmented material would then be loaded into haul trucks using a hydraulic excavator and transported to the ROM pad, WRE, the southern barrier or any infrastructure component being constructed using NAF waste rock.

At the commencement of mine production, one excavator, used in backhoe configuration, would be matched with a fleet of three off-road 90t capacity haul trucks. The trucking requirements would increase over time as the open cut pits deepen and haul distances increase. The initial strategy for the placement of waste rock would involve its placement in such a manner that the placed material provides a noise barrier for subsequent deliveries of waste rock to the WRE or the southern barrier. It is anticipated an additional 90t capacity haul truck would be required at around Year 3 of the mine's operation.

2.5 WASTE ROCK MANAGEMENT

2.5.1 Introduction

During mining operations, material containing insufficient quantities of silver, zinc and/or lead to justify processing would be identified as part of infill drilling and potentially during the analysis of blast hole cuttings. The waste rock emplacement (WRE) would be the sole repository for all PAF waste rock extracted from the open cut pits which would be transported via the internal haul road network to the WRE for placement and encapsulation. All NAF waste rock would be transported via the internal road network (and a 1.4km section of the relocated

Maloneys Road) to its point of use for on-site construction activities such as the staged development of the TSF embankment, backfilling of satellite pits east and west, placement in the southern barrier for subsequent retrieval and for rehabilitation activities.

This subsection describes the characteristics of the waste rock that would be generated throughout the mine life, its management and uses including the design and development sequence of the WRE and the use of waste rock in the development of the southern barrier. The use of waste rock for the construction of the TSF embankment is discussed in Section 2.8. Section A5.4 (in **Appendix 5**) further provides information regarding the waste rock characterisation, quantities and the design/construction of the WRE.

2.5.2 Waste Rock Characterisation and Quantities

Static and kinetic testing of a representative set of waste rock samples by Graeme Campbell and Associates (GCA) has enabled the waste rock within the proposed open cut pits to be classified according to the total sulphur content within either the weathered or primary (unweathered or fresh) zones.

- Weathered Zone
  - WZ1: Total Sulphur content < 0.3% (NAF)
  - WZ2: Total Sulphur content ≥ 0.3% (PAF)
- Primary (Unweathered or fresh) Zone
  - PZ1: Total Sulphur content < 0.1% (NAF)
  - PZ2: Total Sulphur content 0.1% to < 0.3% (NAF)
  - PZ3: Total Sulphur content ≥ 0.3% (PAF)

The detailed results of the testing and the implications upon the management of the different types of waste rock are presented in GCA (2020).

The two waste rock types classified as PAF (WZ2 and PZ3) would account for approximately 26.6 million tonnes (or 57% of the total volume of waste rock to be generated throughout the mine life). The quantity of each PAF waste rock classification and their approximate percentage of the total volume of PAF waste rock is as follows.

- WZ2 4.1 million tonnes (9%)
- PZ3 22.5 million tonnes (91%)

The three waste rock types classified as NAF (WZ1, PZ1 and PZ2) would account for approximately 19.8 million tonnes (or 43% of the total volume of waste rock to be generated throughout the mine life). The quantity of each NAF waste rock sub-classification and its approximate percentage of the total volume of NAF waste rock is as follows.

- WZ1 10 million tonnes (50%)
- PZ1 3.5 million tonnes (18%)
- PZ2 6.3 million tonnes (32%)

A breakdown of the annual volumes of waste rock produced is presented in **Appendix 5**.

2.5.3 Waste Rock Storage and Encapsulation

Bowdens Silver proposes to utilise and/or store the 19.8 million tonnes of NAF waste rock recovered during the mining operations as a construction material within the following.

- WRE: (progressive construction of the lower and upper embankments, haul road, flood protection bund, noise barrier and cover and capping to produce the final landform at the end of the Project life)
  - 0.6 million tonnes for WRE construction.
  - 2.5 million tonnes for WRE cover and capping.
- TSF: (staged construction and retained landform at the end of the Project life)
  - Up to 7.3 million tonnes for construction (Stage 1 = 2.0Mt; Stage 2 = 2.2Mt; Stage 3 = 3.1Mt).
  - 5.7 million tonnes for TSF capping.
- Southern Barrier: stockpile landform removed at the end of the Project life
  - Initial Barrier (approximately 4.9 million tonnes): comprising the initial Stage 1 development of the southern barrier, constructed by end of Year 6 and retained until the end of the mine life when the materials would be progressively removed and utilised for rehabilitation across the Mine Site.
  - Extended southern barrier (maximum of approximately 3.9 million tonnes): progressively developed in stages over the mine life and utilised for the stockpiling of construction material for the staged development of the TSF embankment raises or the closure and capping of the WRE and TSF. The southern face of this temporary landform would be retained over the mine life.
- Satellite pits east and west and the southern sections of the main open cut pit: backfilling upon completion
  - Up to 1.9 million tonnes.

The WRE would be designed and constructed to encapsulate the 26.6 million tonnes of PAF waste rock that would be generated throughout the mine life.

Table A5.9 within **Appendix 5** provides an annual summary of NAF waste rock storage and utilisation. It is anticipated that the Southern Barrier would progressively be removed as the stored material is used for rehabilitation activities with an estimated surplus of 1.8 Mt of NAF waste rock available for additional rehabilitation works.

2.5.4 Waste Rock Emplacement

2.5.4.1 Design

The proposed layout of the WRE is presented in **Figure 2.8** and has been designed to provide for the long term storage and encapsulation of compacted PAF waste rock in a constructed landform that would be developed via a sequence of seven cells. The WRE would effectively form an integrated landform between the ridge immediately east of the main open cut pit and Price Creek. The indicative design criteria for the WRE are as follows.

- Area – 77ha
- Maximum elevation – 670m AHD
- Height of each lift – 10m
- Width of construction berms – 4m
- Slope of final external faces – 1:3 (V:H)

The WRE would also include the following design elements that have been included for the purpose of waste rock management and access and environmental management.

- Internal drainage system and leachate management dam.
- A 1.5mm low permeability HDPE liner.
- Upper, lower and intercell embankments.
- WRE lower embankment haul road.
- A flood protection bund.
- A noise barrier.

Further details of the design elements of the WRE and its construction are presented in **Appendix 5** (Section A5.4.4).

2.5.4.2 Development

The construction of the WRE would commence in the north with vegetation clearing, topsoil and subsoil removal and storage and the excavation of the required area for waste rock placement in WRE Cell 1 and WRE Cell 2. Following vegetation clearing and soil removal, construction of the WRE design components would commence with the construction of the lower embankment and haul road (including flood bund and noise barrier) along the entire downstream perimeter of the WRE. As well the construction of the upper embankment and two intercell embankments (Cell 1 and Cell 2) that would provide the anchor points for the 1.5mm HDPE liner would be installed to underlie the emplaced PAF waste rock and intercept seepage. Excavated material from within the footprint of the WRE, as well as NAF waste rock from the open cut pits, would be utilised for the construction of the WRE embankments.

The leachate management dam, adjacent to a southern section of the lower embankment, would be constructed as part of the site establishment and construction activities and would involve the excavation of the dam area, construction of the dam embankment using the excavated material, and installation of a 1.5mm thick HDPE liner. Once constructed, the dam would be connected to the leachate sump within the active WRE cell via HDPE pipe.

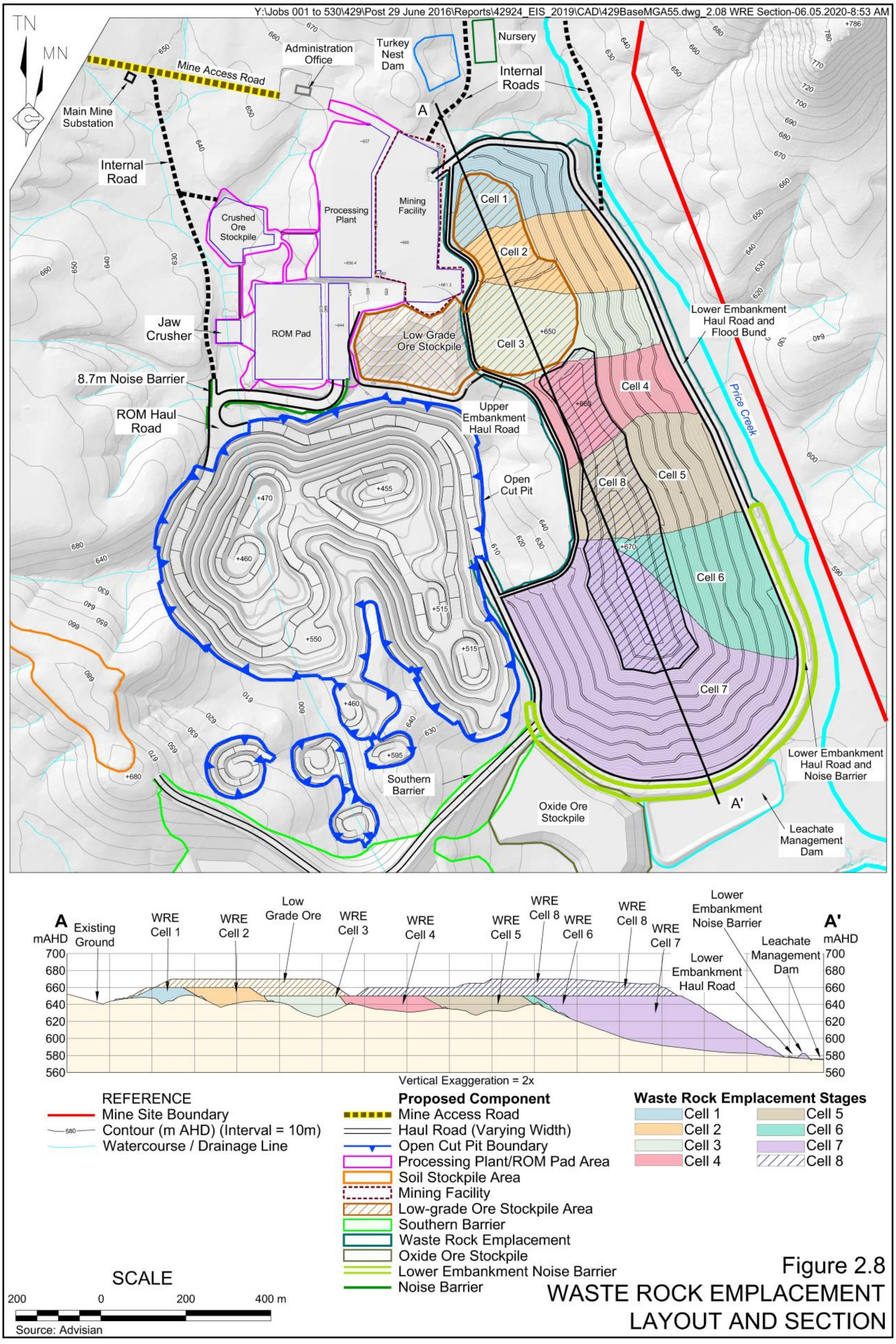

Figure 2.8
WASTE ROCK EMPLACEMENT LAYOUT AND SECTION

Once the construction of WRE Cell 1 and Cell 2 and the leachate management dam has been completed, it would be feasible to begin placing the PAF waste rock within Cell 1.

During mining operations, each of the WRE cells would be developed in sequential lifts (approximately 10m high). Typically, this would occur from the lower embankment of the respective cell, up and west towards the main open cut pit. This would enable the construction of a series of noise bunds, typically 5m higher than the lift level, that would be constructed along the outer perimeter of the respective lift and relied upon during the progressive development of the WRE. The PAF waste rock would then be placed in the respective cell in horizontal layers of approximately 2m depth, spread and compacted using a bulldozer to achieve a density of approximately $2t/m^3$ so as to achieve a stable, level and compacted surface. PAF waste rock would be transported from the open cut pits using haul trucks which would transport the material to the respective cell and lift via the lower embankment haul road. As the incremental 10m lifts increase the height of the cell being developed, some of the PAF waste rock may be transported from the open cut pits via the haul road on the upper embankment.

2.5.4.3 Development Sequence

Figure 2.9 displays the sequential development of the WRE from north to south. The indicative operational years for each of the cells are as follows.

- Cell 1: site establishment and construction stage – Year 1
- Cell 2: Year 1
- Cell 3: Year 1 – Year 2
- Cell 4: Year 2 – Year 3
- Cell 5: Year 3 – Year 4
- Cell 6: Year 4 – Year 5
- Cell 7: Year 6 – Year 15

Following the completion of each lift, the PAF waste rock would be capped and covered with compacted, clayey material that would be obtained either during the development of the WRE cells or from the stockpiled subsoil material that would be stripped from the disturbed areas of the Mine Site during the site establishment and construction stage.

2.5.5 Southern Barrier

The southern barrier would be the repository for all excess NAF waste rock not required for the on-site construction activities. The southern barrier would be developed across Blackmans Gully, directly south of the open cut pits for the purpose of stockpiling NAF waste rock that would subsequently be utilised for closure and rehabilitation activities. In addition to being proximal to the open cut pits, thus resulting in shorter haul distances for waste rock, the principal selection criterion for the location of the southern barrier was to provide for a noise and visual barrier that would shield the open cut pits, ROM pad, processing plant and associated mining infrastructure from points to the south of the Mine Site.

The southern barrier would comprise an initial barrier which would incorporate a 15m wide haul road with a 5m high noise barrier along the crest and an extended barrier (see **Figure 2.10**). Apart from the NAF waste rock that would be required to construct components such as the WRE embankments, lower embankment haul road and bunds as well as the TSF embankment, the southern barrier would be the principal destination for all NAF waste rock generated during mining operations.

Figure 2.10 presents the overall footprint of the southern barrier, including cross-sections through the initial barrier and the extended barrier. The indicative elements of the southern barrier are as follows.

- Area – 32ha
- Key elevations
  - Initial barrier (including access road acoustic barrier), Blackmans Gully - 640mAHD
  - Extended barrier, maximum elevation – 625mAHD
- Height of each lift – 10m
- Slope of final faces
  - Initial barrier - 1:3 (V:H)
  - Extended barrier - 1:4 (V:H)
- Maximum volume of stockpiled NAF waste rock – 8.8 million tonnes (Year 12)

Section A5.4.5 (**Appendix 5**) provides information on the staged construction of the southern barrier.

2.6 LOW GRADE AND OXIDE ORE STOCKPILES

Low grade ore and oxide ore generated by the mining operations would be stockpiled throughout the mine life. Processing of these materials would be dependent upon either the economic conditions (low grade ore) or treatment (processing) requirements (oxide ore). In the event they are not processed, quantities of the low grade ore and oxide ore may remain in part, or in full at the end of the Project life.

2.6.1 Low Grade Ore

2.6.1.1 Introduction

Geological investigations established that, of the 29.9 million tonnes of recoverable ore, approximately 6.1 million tonnes contains silver equivalent grades that are less than but approaching 30g/t and which are considered uneconomic at current or projected silver prices and therefore considered as low grade ore. Bowdens Silver proposes to make provision to stockpile up to 2.7 million tonnes of low grade ore adjacent to and above the three northern cells of the WRE to allow for the selective processing of this material should either economic conditions support its processing or to manage process grade control. Given the capacity of the processing plant would be approximately 2 million tonnes per year and the quantity of primary ore extracted in a number of years would not approach 2 million tonnes, it is likely that a considerable proportion of the low grade ore would be processed during most years of operation.

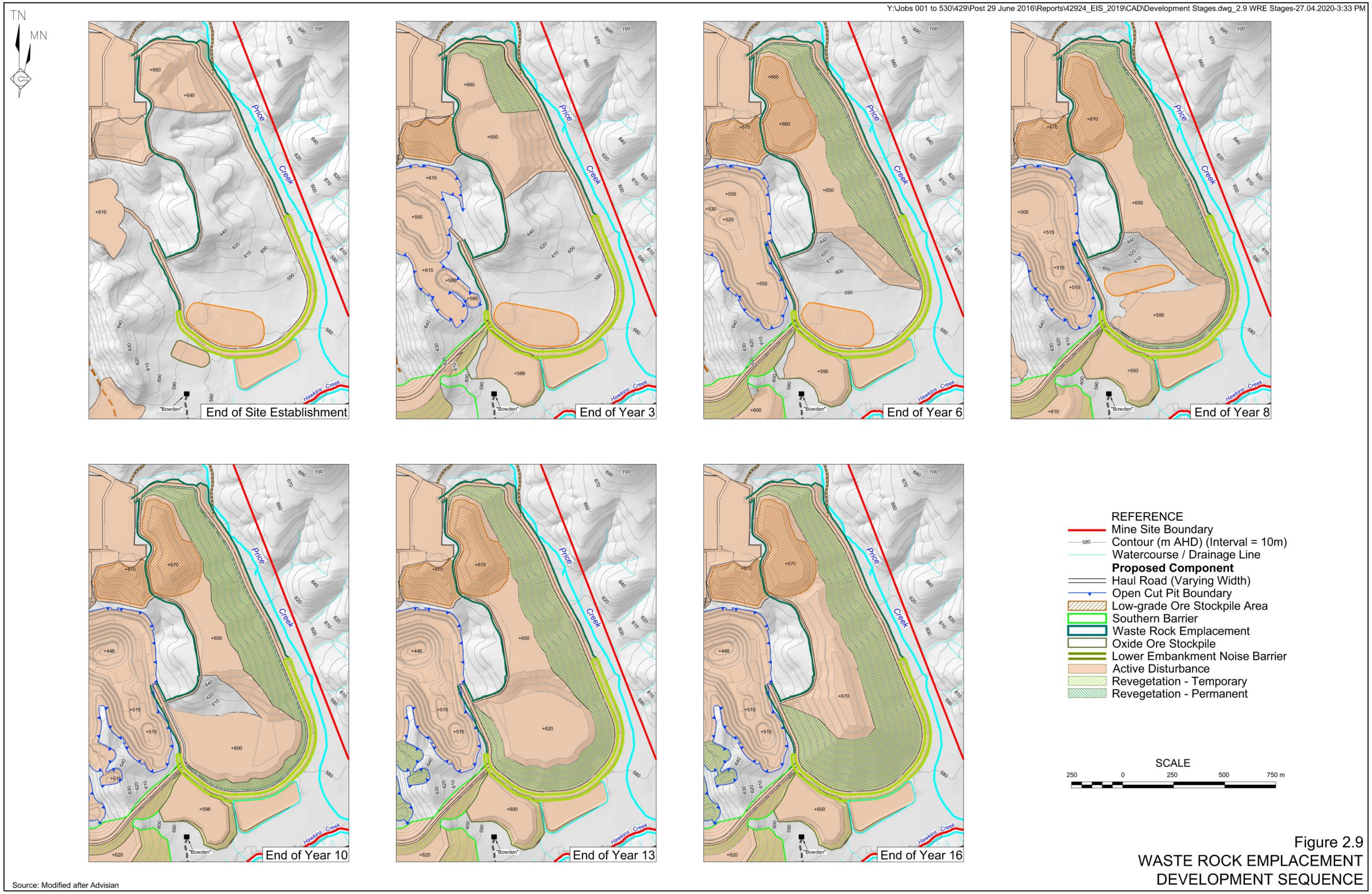

Figure 2.9
WASTE ROCK EMPLACEMENT DEVELOPMENT SEQUENCE

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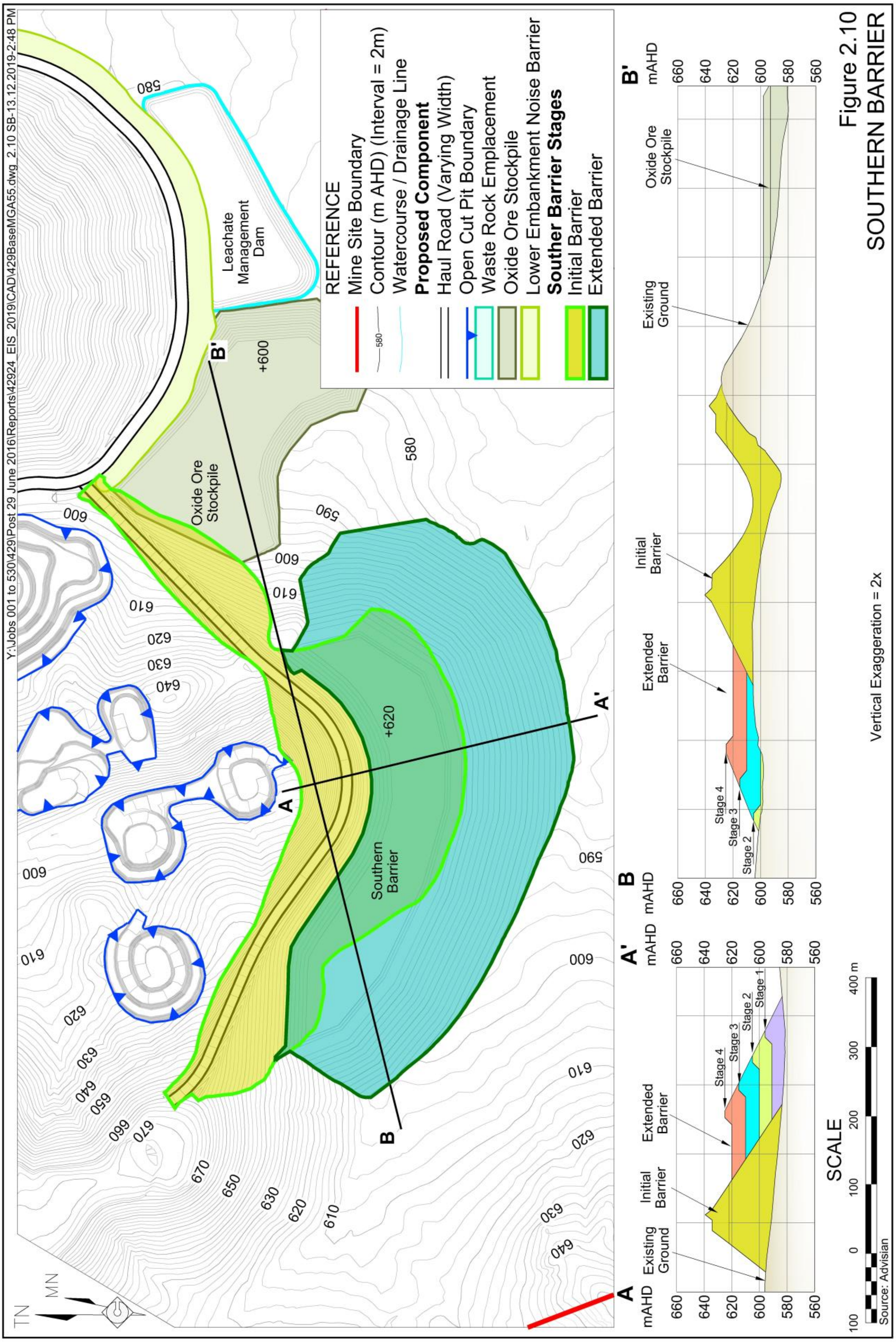

Figure 2.10
SOUTHERN BARRIER

2.6.1.2 Characterisation

Static and kinetic testing of a representative set of waste rock samples by Graeme Campbell and Associates (GCA, 2020) has enabled the low grade ore to be classified according to the total sulphur content within either the weathered or primary (unweathered) zones of the Bowdens silver deposit. As a consequence of the testing, the low grade ore is anticipated to exhibit similar variation in geochemical behaviour to that of the waste rock sub-classifications described in Section 2.5.2. However, given there would be no segregation of the low grade ore based upon its acid-forming potential, all low grade ore would be treated as PAF.

2.6.1.3 Low Grade Ore Stockpile Design

Figure 2.11 displays the layout of the low grade ore stockpile and the sections through the eastern and western sections of the stockpile. The low grade ore stockpile would be developed in two distinct sections with the western section (5ha) located east of the ROM pad, whilst the eastern section (9ha) would be placed on the initial three completed cells of the WRE from 650mAHD. The key design features of the low grade ore stockpile are as follows.

- Total design capacity: 1.3Mm^3 (2.6 million tonnes).
  - Western section – 0.4Mm^3 (0.8 million tonnes)
  - Eastern section – 0.9Mm^3 (1.9 million tonnes)
- Maximum elevation: 670m AHD (western section)
- Width of construction berms – 4m
- Slope of final faces – 1:3 (V:H)

Details of the development of the low grade ore stockpile are presented in **Appendix 5** (Section A5.5).

2.6.2 Oxide Ore

Geological investigations have established that approximately 1.8 million tonnes of oxidised rock mined would have sufficient silver, zinc and lead grades to warrant processing. However, processing of this ore would not be possible in the on-site processing plant as the plant is designed to solely process sulphide ores. Rather than mixing the oxide ore with the benign waste rock within the WRE, Bowdens Silver proposes to establish a dedicated stockpile area adjacent to the southwestern corner of the WRE for oxide ore. Its separate storage would provide the opportunity at some future date for the ore to be processed on site or at another location in conjunction with other similar ore.

Figure 2.11 displays the location of the oxide ore stockpile, covering an area of 8ha with a maximum elevation of approximately 600m AHD. Further details of the construction of the oxide ore stockpile is presented in **Appendix 5** (Section A5.5.2). This location would enable the ultimate integration of the oxide ore stockpile into the final WRE landform should the processing of this material prove uneconomic.

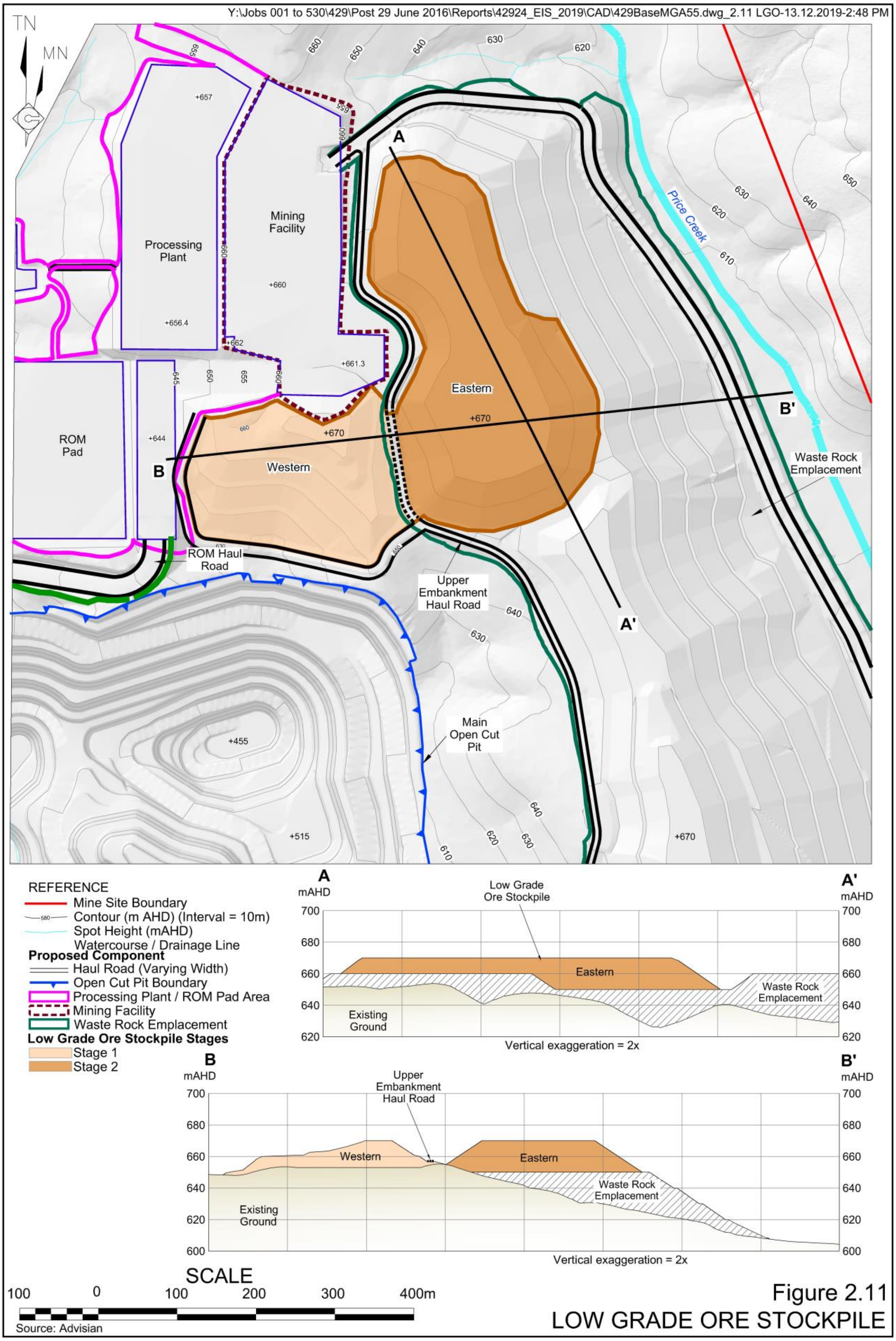

Figure 2.11
LOW GRADE ORE STOCKPILE

The key design features of the oxide ore stockpile are as follows.

- Design capacity: $0.9Mm^3$ (1.8 million tonnes).
- Maximum elevation: 600m AHD.
- Width of construction berms – 4m.
- Slope of final faces – 1:3 (V:H).

2.7 PROCESSING OPERATIONS

2.7.1 Introduction

Bowdens Silver proposes to process all ore extracted from the open cut pits within an on-site processing plant to produce two mineral concentrates, namely:

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

Based upon the processing of the defined 29.9 million tonnes of ore, Bowdens Silver would produce approximately 310 000t of mineral concentrates throughout the mine life, approximately 60% of which would be zinc concentrate and approximately 40% silver/lead concentrate. The bulk of the silver recovered would be within the silver/lead concentrate. Annual production of mineral concentrates would vary from approximately 20 000t to 30 000t with the quantity and proportion varying annually and reflecting the proportion of the recovered minerals in the ore extracted.

2.7.2 Processing Plant Design and Process Flowchart

The processing plant has been designed to process approximately 2 million tonnes per annum of ROM ore to produce silver/lead and zinc concentrates using sequential flotation. The processing plant includes the following principal components.

- A single stage primary jaw crusher.
- A crushed ore stockpile and reclaim.
- A semi-autogenous grinding (SAG) mill, ball mill and pebble crusher.
- Reagent mixing and distribution.
- A silver/lead flotation circuit comprising roughers, rougher concentrate re-grind and cleaners.
- Silver/lead concentrate thickening and filtration.
- A zinc flotation circuit comprising roughers, rougher concentrate re-grind and cleaners.
- Zinc concentrate thickening and filtration.
- Concentrate bagging/containerisation facilities and storage.
- Tailings thickening and pumping.

Figure 2.12 displays the conceptual layout of the processing plant whilst a simplified overall process flowsheet for the plant is shown in **Figure 2.13**. The components of the processing plant that would be enclosed are highlighted on **Figure 2.12**. The design maximises the use of gravity flow although some pumping would be required. **Figure 2.14** displays a perspective sketch of the main components of the processing plant.

2.7.3 Reagent Management

Table 2.4 lists the reagents that would be used within the processing plant in order of expected annual consumption together with their function, chemistry, storage, quantities, the maximum quantity held on site at any time, annual usage and fate of each reagent. Section 4.16.1.3 discusses the on-site management and use of sodium cyanide in the context of the potential hazard created by this chemical.

Table 2.4
Processing Plant Reagents

Reagent	Chemistry	Function	Form / Container	Annual Usage (tpa)	Maximum Quantity on Site	Fate of Reagents
Hydrated lime/ soda ash	$CaOH/Na_2CO_3$	pH Adjustment	Powder / 60t silo	1 236	60t	Tailings
Zinc sulphate	$ZnSO_4.7H_2O$	Zinc Depressant	Powder / 1t bulk bag	610	50t	Tailings
Copper sulphate	$CuSO_4.5H_2O$	Activator	Powder / 1t bulk bag	450	40t	Tailings
MIBC	Methyl Isobutyl Carbinol	Frother	Liquid / 800kg IBC	222	20t	Tailings / Decomposed
Sodium cyanide#	NaCN	Zinc Depressant	Pellets / Isotainer	190	20t	Tailings / Decomposed
Flocculant	Anionic polyacrylamide	Flocculation	Powder / 0.8t bulk bag	139	12t	Tailings
Lead collector	Na - diisobutyl dithiophosphinate	Lead Collector	Liquid / 1000L IBC	24	4t	Most to Concentrate / Balance to Tailings
Zinc collector	Na isobutyl dithophosphate	Zinc Collector	Liquid / 1000L IBC	22	4t	Most to Concentrate / Balance to Tailings
Caustic Soda	NaOH	pH Adjustment	Flake / 25kg bag	2.5	1t	Tailings
Antiscalant	Polycarboxylic acid or similar	Antiscalant	1000L IBC	20	4t	Tailings
* IBC = Intermediate Bulk Container				# NaCN would be added with a concentration of 66mg/L		

Details of the initial development of the processing plant and mining facility as well as individual processing components and the management of the mineral concentrates, process water and reagents is presented in **Appendix 5** (Section A5.6).

2.8 TAILINGS MANAGEMENT

2.8.1 Introduction

As part of the processing operation, a thickened tailings slurry (from which the majority of the silver, zinc and lead minerals would be removed) would be pumped to the tailings storage facility (TSF) situated in the western section of the Mine Site in the valley of Walkers Creek (see **Figure 2.15**). The preliminary design of the TSF has been undertaken by ATC Williams Pty Ltd, engineers specialising tailings management. The report describing the preliminary design of the TSF is reproduced as Part 16A of the Specialist Consultant Studies Compendium

The TSF would comprise an embankment which would be constructed in three stages and an area behind the embankment referred to as the impoundment area in which to store the tailings and water released from the tailings. The TSF embankment would be constructed with its raises progressing downstream, as opposed to the upstream tailings dam raise method that has been associated with recent overseas tailings dam failures. Since the tailings decant water would sit against the TSF embankment, the embankment has been designed as a conventional water retaining embankment with a bituminous liner.

A NAF waste rock stockpile area covering approximately 10ha would be established immediately downstream from the TSF embankment for the storage of NAF waste rock transported from the main open cut pit until it is used in the construction of each raise for the TSF embankment. A mobile crushing and screening plant would be positioned within the TSF NAF waste rock stockpile area to produce the required crushed products for the construction of the TSF embankment. During the early stage of each crushing campaign, a barrier built from shipping containers would be positioned to mitigate noise generated by the plant in the event insufficient waste rock is available for use as an acoustic barrier.

Appendix 5 (Section A5.7) provides an overview of the characteristics of the tailings, details of the TSF components and the construction and operation of the TSF.

2.8.2 Tailings Storage Facility Design

2.8.2.1 Design Objectives

The tailings impoundment area would be contained by an embankment across the upper section of the valley of Walkers Creek. A plan showing the TSF layout is shown in **Figure 2.15**. The key design objectives of the TSF are as follows.

- To minimise water losses through seepage through the embankment and floor of the impoundment.
- To provide tailings, decant and rainfall storage capacity with sufficient freeboard to prevent overtopping of the TSF embankment.
- To provide a robust and serviceable structure, in particular the embankment, under operational and earthquake loadings.

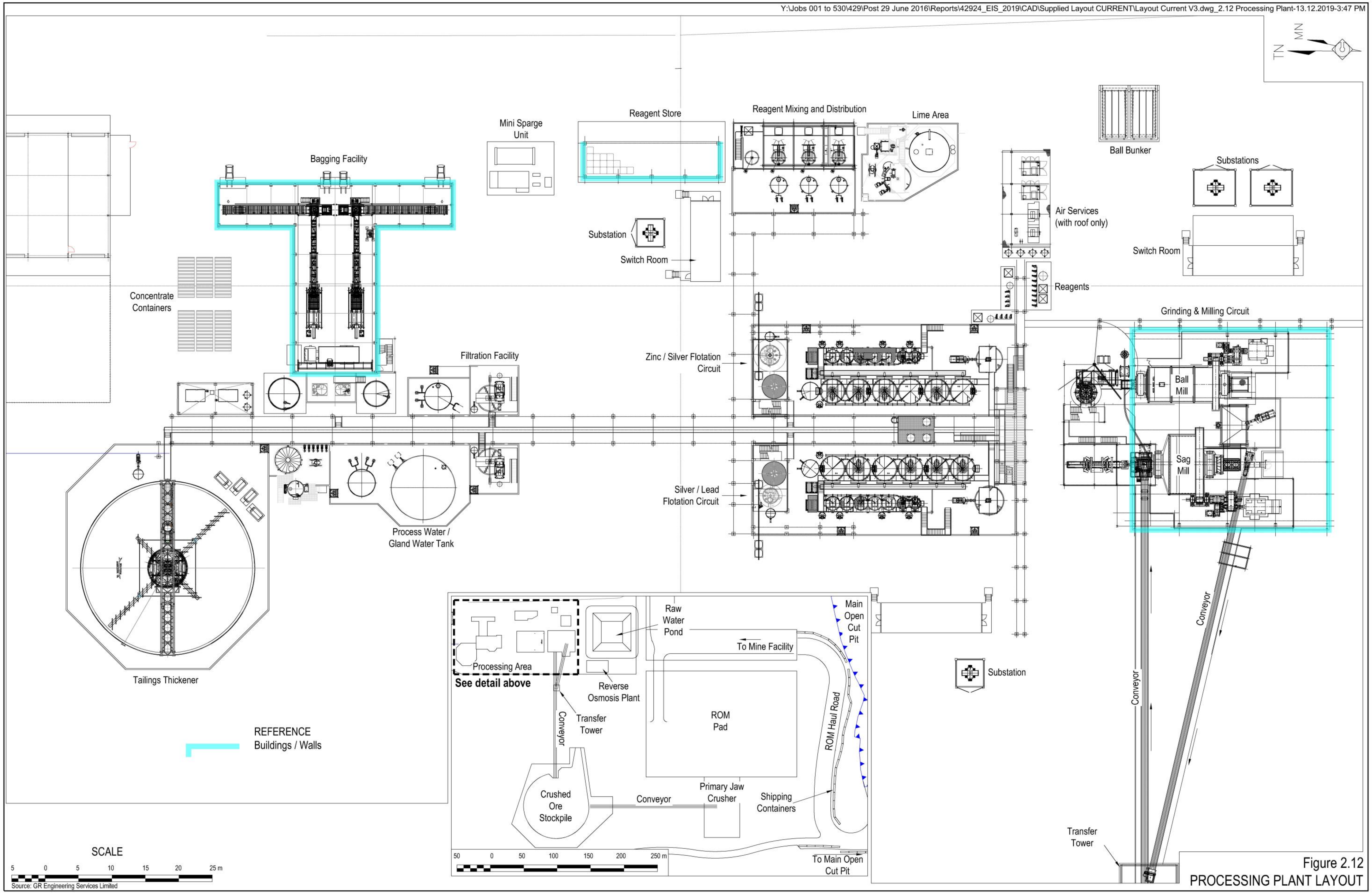

Figure 2.12
PROCESSING PLANT LAYOUT

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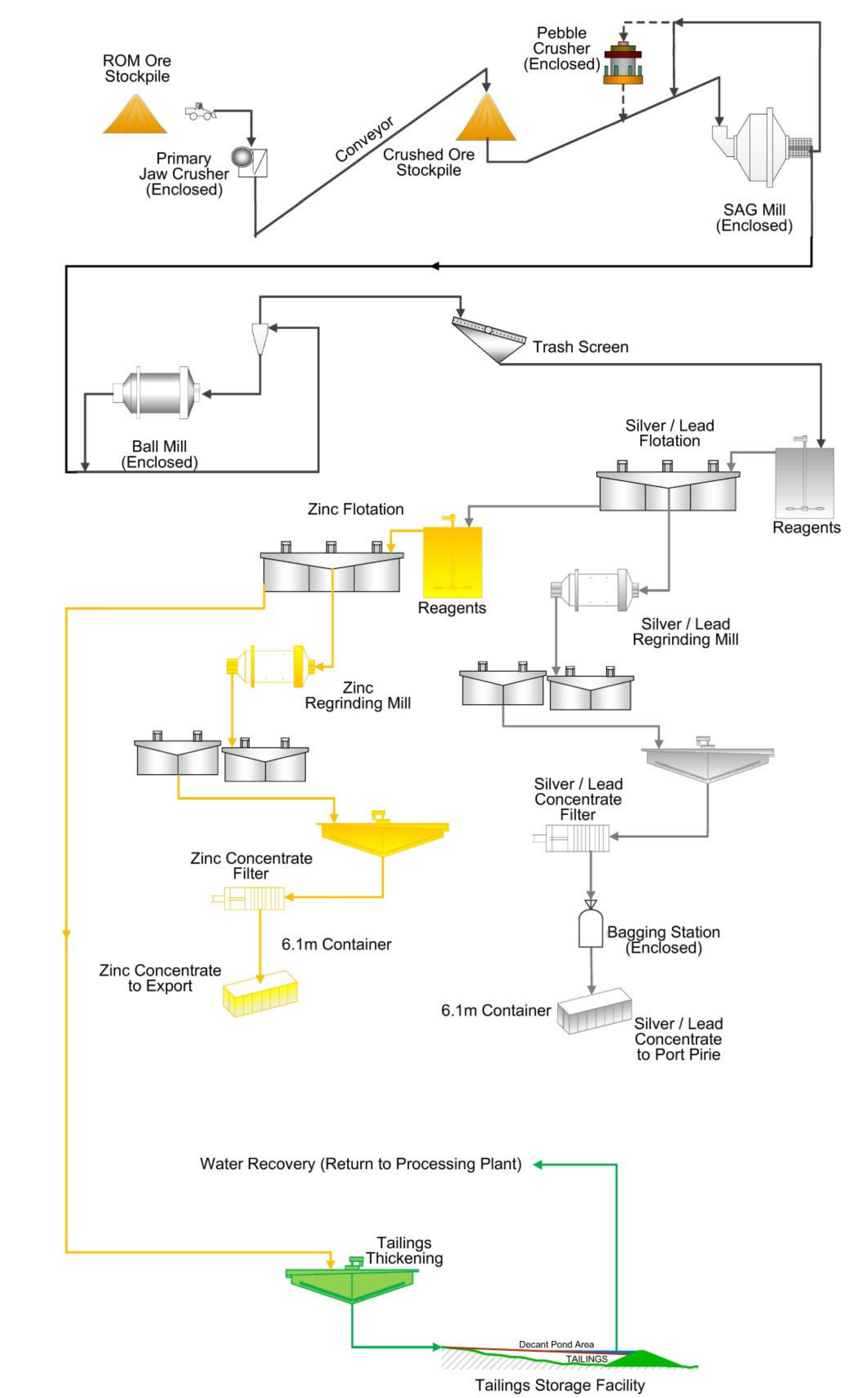

Source: GR Engineering Services Limited

Figure 2.13
PROCESSING PLANT FLOWSHEET

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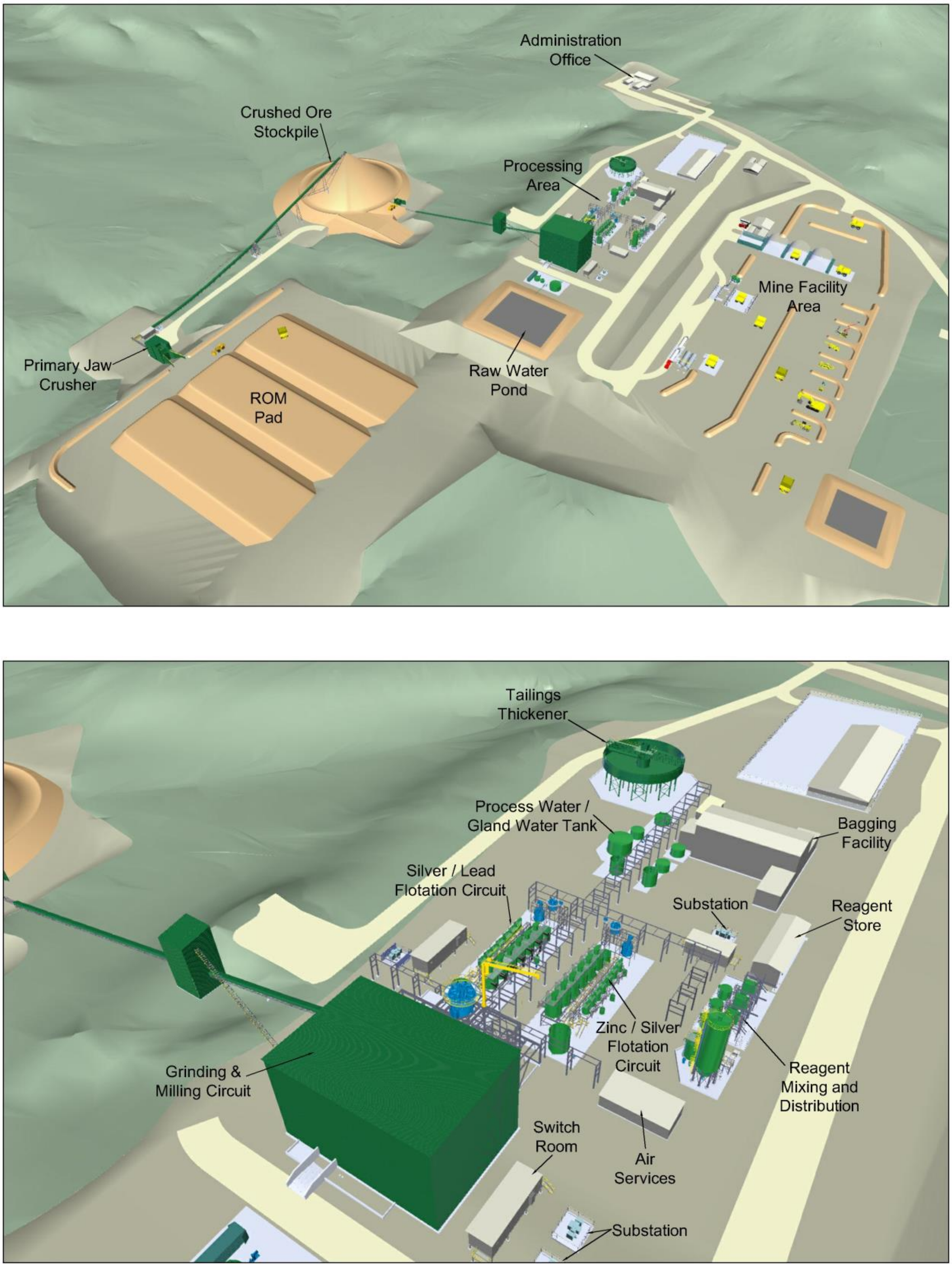

Source: GR Engineering Services Ltd

Figure 2.14
PROCESSING PLANT
PERSPECTIVE SKETCH

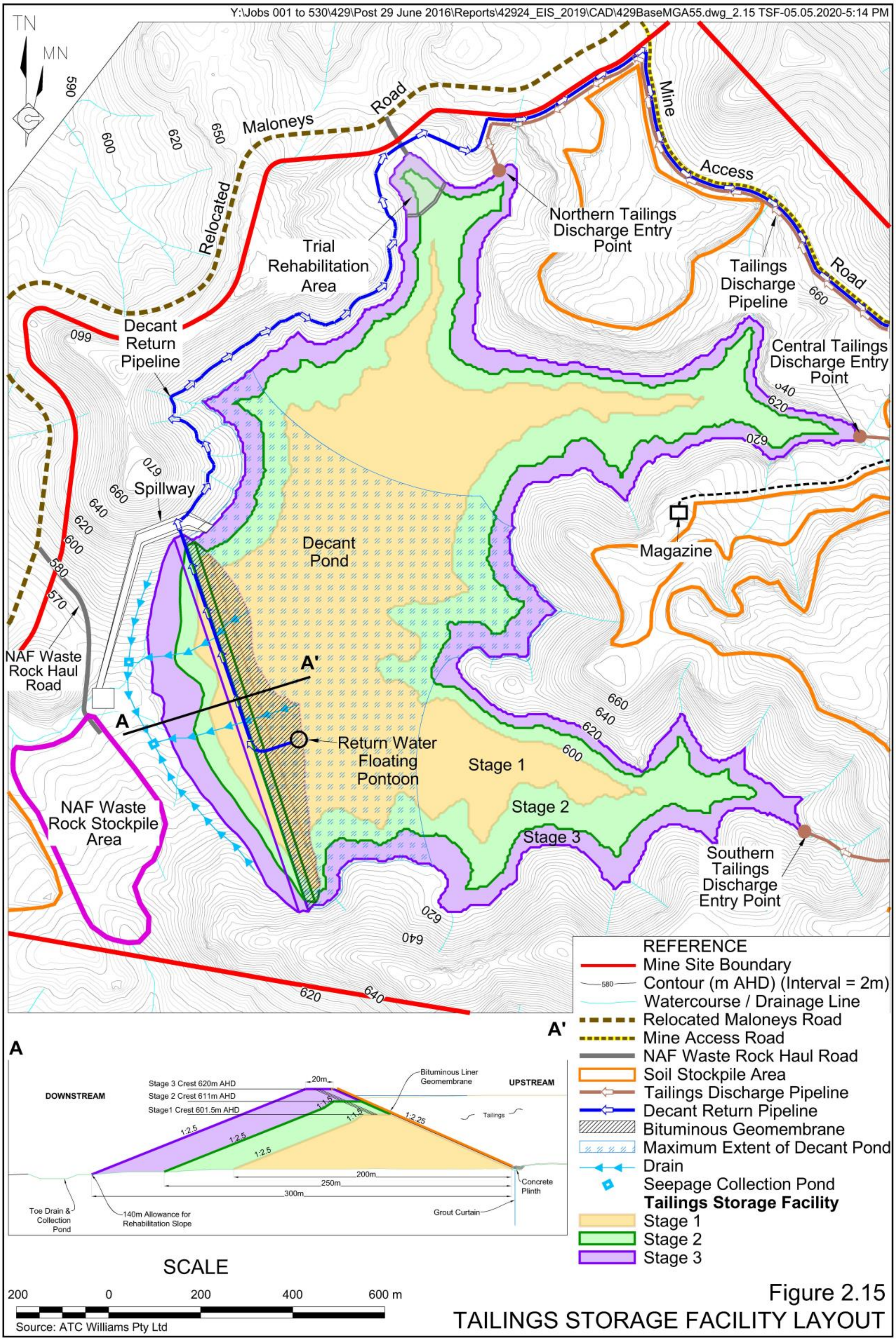

Figure 2.15
TAILINGS STORAGE FACILITY LAYOUT

- To provide capacity for the controlled discharge via an emergency spillway in rare and extreme rainfall events whilst maintaining the structural integrity of the TSF embankment[9].
- To manage the available storage volume effectively to maximise the return of decant water to the processing plant for recycling and reuse.
- To maximise the utilisation of construction materials drawn from the main open cut pit.

2.8.2.2 Design Criteria

The TSF would be designed, constructed and operated in accordance with the Australia National Council on Large Dams (ANCOLD) 2012 Guidelines on Tailings Dams under the supervision of Dams Safety NSW (DS NSW) for the provision of secure and safe tailings storage and to meet the design objectives outlined above. The overarching intent of these guidelines is for the TSF to have minimal impact on the existing surrounding environment.

The design criteria for a given dam are based on the "Consequence Category" for the structure that is determined through the evaluation of the potential consequences should water and tailings be released from the TSF as a result of dam failure.

The design criteria for the TSF are based on a High C Consequence Category that is required by the DS NSW for a TSF which impounds PAF waste rock in a rural environment. The key elements of the design criteria adopted from the ANCOLD guidance are as follows.

- Design Storage Allowance: 72-hour 1% AEP[10] (100 year) rainfall event, i.e. 100 year ARI[11].
- Contingency Freeboard (to dam embankment crest): 0.5m.
- Wave Run-up (to spillway invert): 0.5m.
- Emergency Spillway Capacity: 0.00001% AEP (100 000 year) rainfall event, i.e. 100 000 year ARI.
- Seismic Event (embankment stability):
  - Operating Basis Earthquake: 0.001% AEP (1 000 year ARI); and
  - Maximum Design Earthquake: 0.0001% AEP (10 000 year ARI).

---

[9] All tailings storage facilities must be designed and operated at all times with a minimum freeboard (capacity) to retain design floods without the need to discharge. Subsequently, whilst no operational discharge from the TSF is proposed, ANCOLD and NSW DSC require the TSF design considers safe discharge during a rainfall event which exceeds the TSF design flood so as to maintain the structural integrity of the TSF. This is achieved via an emergency spillway that can pass higher floods in a controlled fashion and safely direct flows away from the embankment.
[10] AEP = Annual Exceedance Probability
[11] ARI = Average Recurrence Interval

Key design features of the TSF are as follows.

- Embankment footprint area = 16ha
- Impoundment surface area = 103ha
- Total area of disturbance – approximately 117ha.
- Development stages (embankment raises) – three.
- Method of embankment raise – downstream type.
- Maximum crest of embankment:
  - Stage 1 – 601.5m AHD (38m above the lowest natural ground level).
  - Stage 2 – 611m AHD (47m above the lowest natural ground level).
  - Stage 3 – 620m AHD (56m above the lowest natural ground level).
- Maximum capacity:
  - Stage 1 – 6 million tonnes
  - Stage 2 – 10 million tonnes (cumulative, 16 million tonnes).
  - Stage 3 – 14 million tonnes (cumulative, 30 million tonnes).
- Embankment crest widths – 12m to 20m and embankment base widths – 200m (Stage 1), 250m (Stage 2), 300m (Stage 3).
- Method of tailings deposition – down valley discharge from three locations (northern, central and southern tailings discharge points) connected to tailings pipeline.
- Method of water and decant management – collected and pumped from a floating pontoon on the decant pond for return via a water return pipeline for reuse in the process circuit.
- Embankment construction – zoned rockfill with low permeability geomembrane / clay zone on the upstream face, a bituminous geomembrane (BGM) liner, curtain grouting along upstream toe, with connection of the BGM and grout curtain via a concrete plinth along the upstream toe.
- Embankment construction material – benign, NAF waste rock from the open cut pits as well as material stripped from within the TSF footprint.
- The perimeter of the impoundment area would be marked by a track retained for access, when required.

2.8.2.3 Geotechnical Considerations

A program of field investigation was conducted by ATC Williams Pty Ltd in May and June 2017 involving borehole drilling, test pit excavation and in-situ permeability tests to establish the condition and type of foundation materials, estimate the permeability of the foundation material and to identify any high permeability zones in the foundation material.

Foundation material samples were also collected during the investigation to identify the properties of the foundation materials and the potential for construction materials within the TSF footprint.

The investigation identified the following.

- Foundation material:
  - Depth to rock: 0.55m to 6.8m
  - Rock strength:
    - Valley west – moderate to very high
    - Valley east – weak to moderate
- Foundation permeability: 6.9 x 10^{-6}m/s to 1.6 x 10^{-10}m/s
- Site construction materials:
  - High plasticity clay
  - Medium to low plasticity clay
  - Sandy clay
  - Gravelly clay
  - Clayey sand
  - Clayey gravel

2.9 ROAD TRAFFIC AND TRANSPORTATION

2.9.1 Access to the Mine Site

Access to the Mine Site is currently provided via Lue Road, Pyangle Road and Maloneys Road (**Figure 2.16**). Lue Road is the main road between Mudgee and Rylstone whilst Pyangle Road and Maloneys Road are local roads.

Access to the Mine Site during the early stages of the site establishment and construction stage (until approximately the end of Month 6) would be provided by the existing road network, i.e. principally using Pyangle Road (from Lue Road) and Maloneys Road. Although warranted under existing traffic conditions, Bowdens Silver would widen the road shoulder on the southern side of Lue Road at the intersection of Lue Road and Pyangle Road to safely accept traffic generated for the Project.

Access to the Mine Site during the latter stages of the site establishment and construction stage (from about Month 7) and the entire operational stage would be via Lue Road, relocated Maloneys Road and the mine access road.

Whilst it would be necessary for some heavy vehicles accessing the Mine Site during the initial 6 months of the site establishment and construction stage to transit through Lue, it is envisaged that by establishing access to the Mine Site from Lue Road to the west of Lue early in the development of the Project, very few heavy vehicles delivering components and consumables would pass through Lue in order to gain access to the Mine Site.

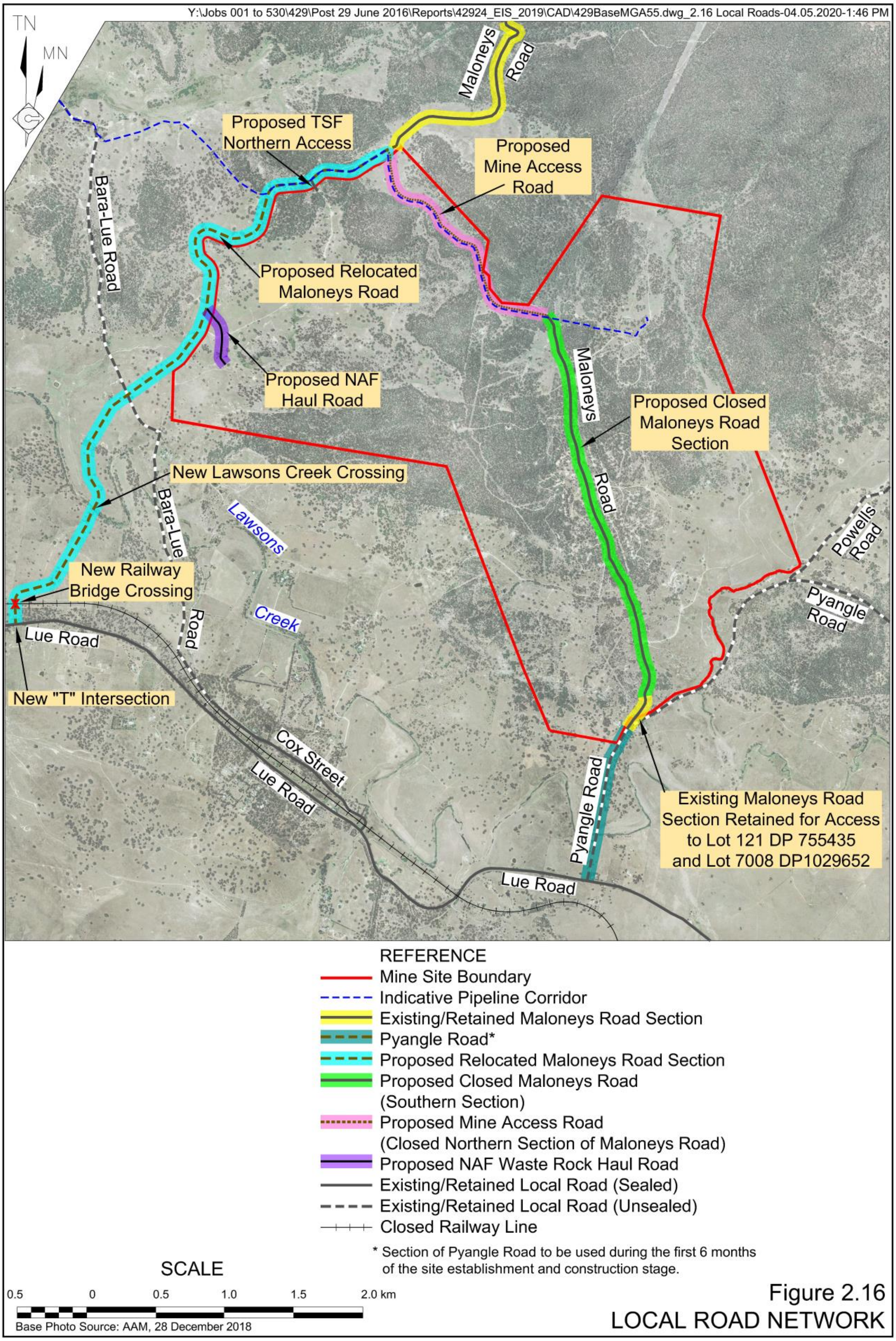

Figure 2.16
LOCAL ROAD NETWORK

2.9.2 Relocated Maloneys Road

A 4.5km section of the existing Maloneys Road traverses the Mine Site. Consequently, Bowdens Silver proposes to permanently close that section of road and relocate it to a new location west of its current alignment (see **Figure 2.17**), forming a new section of public road. The relocated section of Maloneys Road would link the retained northern section of Maloneys Road with Lue Road and include a newly constructed "T-intersection" 1.8km west of Lue (see Section 2.9.2.1), a new railway bridge crossing (see Section 2.9.2.2) and a new crossing of Lawsons Creek (see Section 2.9.2.3). The section of road which is to be closed and relocated would require closure pursuant to the relevant provisions of the *Roads Act 1993*.

Once the relocated Maloneys Road is opened to traffic and the section of road through the Mine Site is formally closed by Mid-Western Regional Council, Bowdens Silver would place a gate at the southern end of the section of the former Maloneys Road that is closed and removed from public use. A 350m section of the former Maloneys Road would be maintained to provide access to Lot 121 DP 755435 and Lot 7008 DP 1029652. Bowdens Silver would continue to use the southern section of the former Maloneys Road (principally with light vehicles) to access the existing Bowdens exploration office and core library facilities. **Figure 2.17** displays the indicative alignment of the relocated Maloneys Road and the extent of cut and fill. The road would be constructed beyond the western boundary of the Mine Site to minimise the visibility of the activities within the Mine Site to motorists travelling along the road.

The full 5.2km length of the relocated Maloneys Road, from Lue Road to its connection with the retained Maloneys Road north of the Mine Site would be progressively sealed to achieve a Type 4 class road suitable for B-double vehicles. The section of Maloneys Road from the north beyond the intersection with the mine access road would be retained in its current form. Following the receipt of development consent, details of the road alignment and associated infrastructure would be prepared in consultation with Council, DPI-Water and Transport for NSW's managing agent for the Country Regional Network (rail).

Details regarding the construction of the relocated Maloneys Road are presented in Section A5.8 (**Appendix 5**). All sections of road and associated infrastructure would be constructed during Months 3 to 6 of the Site Establishment and Construction Schedule (see **Table 2.2**) and would be completed in its final form prior to closure to the public of the section of Maloneys Road within the Mine Site.

The key design parameters of the relocated road are as follows.

- Total width – up to 11m, comprising.
  - 2 x lane widths of 3.5m;
  - 2 x shoulder widths of 1.0m; and
  - V drains up to 2.0m wide.
- Proposed maximum speed – 100km/hr (Note: This is the same speed limit posted on the existing Maloneys Road).

Further details regarding the additional infrastructure proposed for the relocated Maloneys Road are presented in the following subsections.

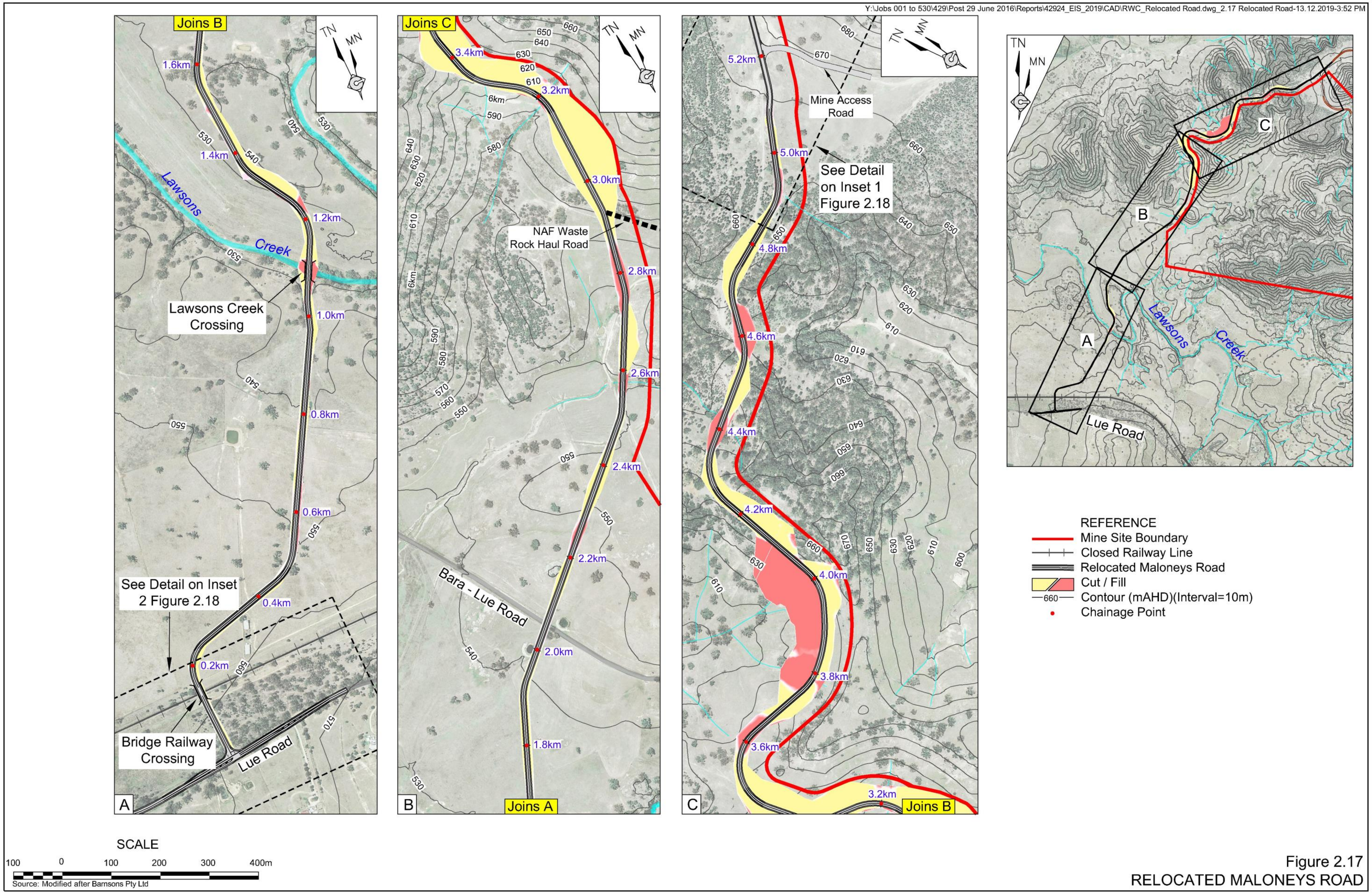

Figure 2.17
RELOCATED MALONEYS ROAD

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2.9.2.1 Relocated Maloneys Road/Lue Road T-Intersection

The relocated Maloneys Road/Lue Road T-intersection (see **Figure 2.17**) would be designed in accordance with Austroads design guidance and would comprise the following elements.

- An at-grade, 95m long single deceleration lane, left turn in for eastbound vehicles entering the relocated Maloneys Road from Lue Road.
- An at-grade, left turn out and 108m long single acceleration lane with merge for vehicles exiting the relocated Maloneys Road, entering Lue Road and travelling east towards Lue.
- A 108m long centre deceleration lane on Lue Road for westbound vehicles undertaking a right turn into the relocated Maloneys Road.

These lanes would be created by local widening, sealing and line marking of Lue Road.

The construction of the intersection would be undertaken in Months 3 and 4 to enable vehicular access to the proposed new railway bridge crossing.

2.9.2.2 Relocated Maloneys Road Railway Crossing

A new railway crossing would be constructed across the closed Wallerawang-Gwabegar Railway Line (see **Figure 2.18**). The crossing would involve the design and construction of a bridge in accordance with the Australian Standard, AS 5100:2017 (Bridge Design) and Country Rail Network construction standards. The bridge would be a dual lane concrete structure constructed with pre-cast concrete piles, headstocks, deck planks and retaining walls together with appropriate approach earthworks. The bridge would be completed with steel guardrails.

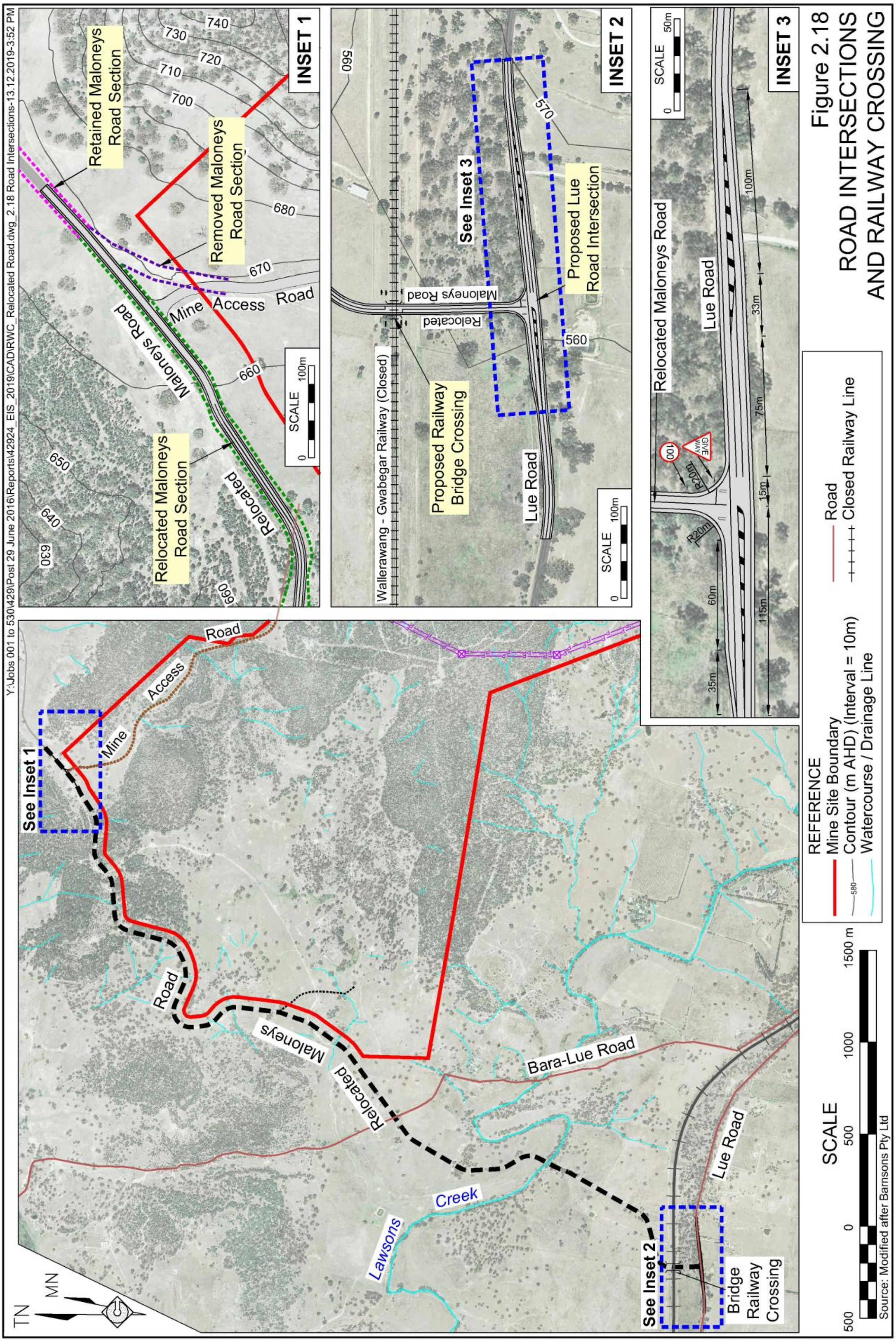
2.9.2.3 Lawsons Creek Crossing

The relocated Maloneys Road would cross Lawsons Creek via a new crossing that would be constructed approximately 1.2km downstream of the current Bara-Lue Road crossing of Lawsons Creek.

The proposed floodway crossing would be designed to be overtopped by flows within Lawsons Creek during the modelled 10% Annual Exceedance Probability, or 10-year average recurrence interval rainfall event (WRM, 2020), and constructed to resist the damaging effects of any overtopping.

In order to maintain habitat connectivity for aquatic fauna, the floodway would be constructed with a series of reinforced concrete box culverts, whereby the culverts would be designed to pass a lesser flood and sustain flows whilst the floodway would provide access during flood events up to a 10% (1 in 10) AEP flood event.

The road would be closed to light vehicle access once the depth of flow over the floodway reaches 200mm although heavy vehicle access would be maintained until a flow depth of 500mm is exceeded.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INSET 1
Retained Maloneys Road Section
Removed Maloneys Road Section
Relocated Maloneys Road Section
Mine Access Road
Maloneys Road
Relocated
740
730
720
710
700
680
670
660
650
640
630
660
SCALE
0
100m
INSET 2
560
Wallerawang - Gwabegar Railway (Closed)
Proposed Railway Bridge Crossing
See Inset 3
Proposed Lue Road Intersection
Maloneys Road
Relocated
570
560
Lue Road
SCALE
0
100m
INSET 3
SCALE
0
50m
Relocated Maloneys Road
Lue Road
100
GIVE WAY
R20m
R20m
100m
33m
75m
15m
115m
60m
35m
Figure 2.18
ROAD INTERSECTIONS AND RAILWAY CROSSING
See Inset 1
Mine
Access
Road
Road
Maloneys
Relocated
Bara-Lue Road
Lue Road
Lawsons
Creek
See Inset 2
Bridge
Railway
Crossing
TN
MN
SCALE
500
0
500
1000
1500 m
Source: Modified after Barnsons Pty Ltd
REFERENCE
Mine Site Boundary
Contour (m AHD) (Interval = 10m)
Watercourse / Drainage Line
Road
Closed Railway Line

Figure 2.19 presents the indicative design elements of the floodway crossing and the location of the proposed Lawsons Creek crossing. The design parameters would generally follow the guidance presented in the document *"Floodway Design Guide"* (MRWA, 2006).

2.9.3 Site Establishment and Construction Traffic

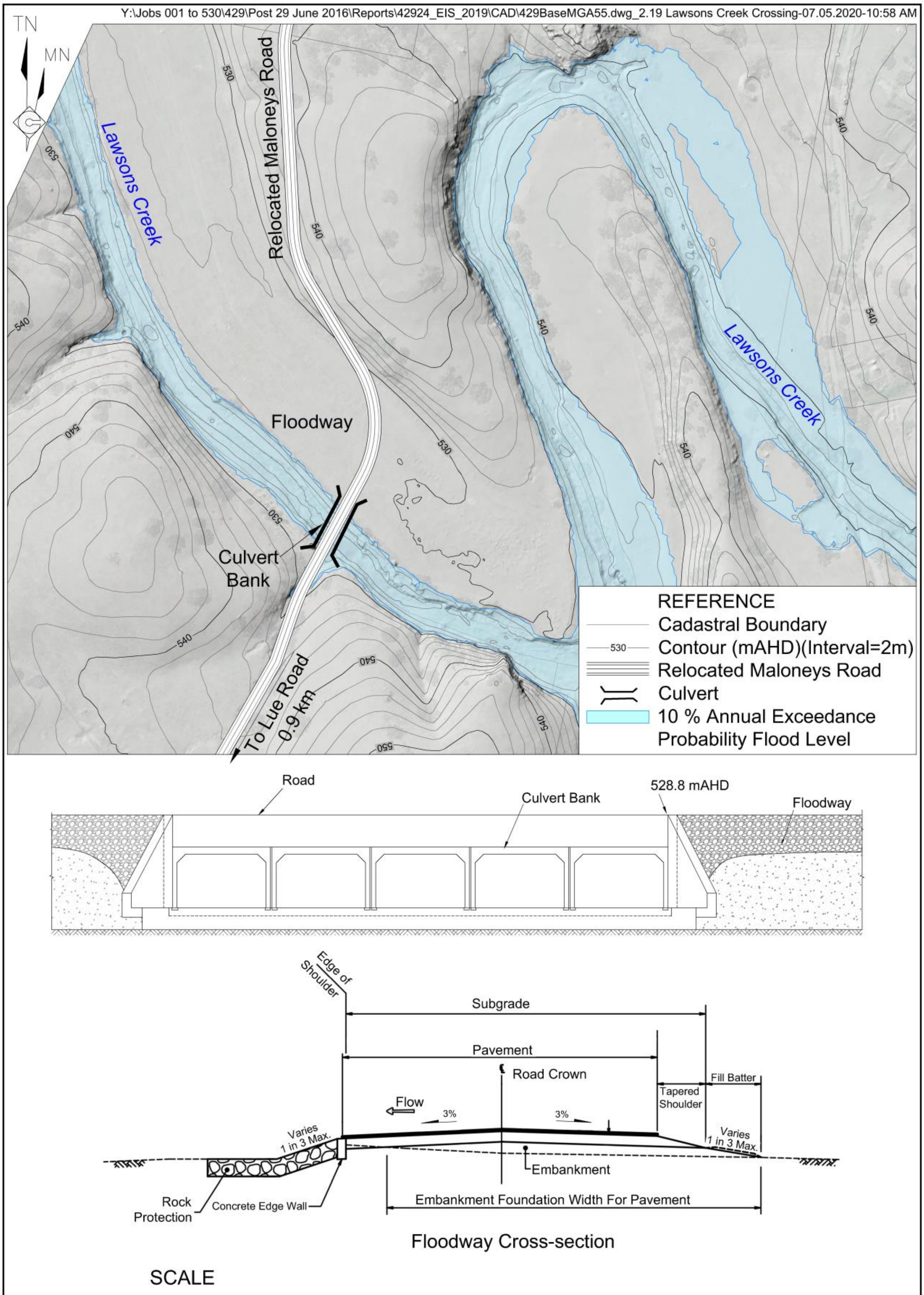
2.9.3.1 Mine Site and Relocated Maloneys Road

Table 2.5 lists the range of light vehicles, buses and heavy vehicles that Bowdens Silver anticipates would travel to and from the Mine Site on a daily basis throughout the site establishment and construction stage. Distinction is made between the traffic movements prior to and after the construction of the relocated Maloneys Road, i.e. the long-term access to the Mine Site.

Table 2.5
Daily Traffic Movements During Site Establishment and Construction Stage

	Light Vehicles	Buses	Heavy Vehicles	Oversize Vehicles	TSF Haulage	Total
Month 6 with Existing Road Network						
Lue Road east of Pyangle Road	42	4	10	4	0	**60**
Lue Road through Lue	78	4	32	4	0	**118**
Pyangle Road Lue Road to Maloneys Road	120	8	42	8	0	**178**
Maloneys Road Pyangle Road to Secondary mine access road	120	8	42	8	0	**178**
Month 13 With Relocated Maloneys Road						
Lue Road east of Pyangle Road	70	4	10	4	0	**88**
Pyangle Road Lue Road to Maloneys Road	40*	0	0	0	0	**40**
Maloneys Road Pyangle Road to Secondary mine access road	40*	0	0	0	0	**40**
Secondary mine access road	40*	0	0	0	0	**40**
Lue Road through Lue	82	4	10	4	0	**100**
Lue Road west of Relocated Maloneys Road	130	4	32	4	0	**118**
Relocated Maloneys Road Lue Road to TSF Embankment	160	8	42	8	0	**218**
Relocated Maloneys Road Mine Access Road to TSF Embankment	160	8	42	8	266	**484**
New mine access road	160	8	42	8	266	**484**

* Comprises light vehicle trips for exploration personnel travelling to and from the Bowdens office and core library



Flood Level Source: WRM Water and Environment
Culvert Concept Source: Transport and Main Roads, QLD (2018)
Floodway Cross-section Source: Main Roads, WA (2006)

Figure 2.19
INDICATIVE LAWSONS CREEK CROSSING

It is anticipated that the level of heavy vehicle traffic would be limited during the initial 4 to 6 months period. The bulk of the heavy vehicle traffic would be related to the transportation of heavy machinery to the Mine Site for initial construction activities including the construction of the relocated Maloneys Road.

Bowdens Silver has programmed the delivery of the bulk of the mobile equipment to be used in the open cut pit development and the delivery of processing plant components until after the relocated Maloneys Road and mine access road are constructed.

From about Month 7 until the end of the site establishment and construction stage, approximately 2.04 million tonnes of NAF waste rock would be transported from the main open cut pit to the footprint of the TSF starter embankment (or TSF Stage 1). A fleet of B-double trucks capable of transferring approximately 50t of NAF waste rock per load would be used during this 12 month period. Approximately 41 000 truck loads would be transported from the NAF waste rock stockpile adjacent to the main open cut pit (see **Figure 2.1**) via:

- an upgraded section of the former Maloneys Road within the Mine Site;
- the mine access road; and
- a 1.4km section of the relocated Maloneys Road, i.e. from the intersection of the mine access road and relocated Maloneys Road and the entrance to the TSF embankment site.

The 41 000 truck loads would require six B-doubles each undertaking approximately 20 loads per day between 7:00am and 6:00pm or an average of 11 return trips per hour, Monday to Sunday, public holidays excluded, thereby generating an average of 22 movements per hour.

Additional periods of heavy vehicle traffic would be experienced during the construction / installation of the processing plant (Months 8 to 14) and during the construction/installation of the water pipeline (commencing approximately Month 8) when excess material from the trenching of the pipeline is transported to the Mine Site for placement/use.

Light vehicle traffic would largely comprise passenger vehicles with a small proportion of light trucks. It is envisaged that some personnel accommodated within Mudgee would travel daily to the Mine Site by bus at the start and finish of each day. In the event that a substantial number of personnel are domiciled in Rylstone and/or Kandos, an additional bus service would also be provided. Whilst the majority of light vehicle traffic would utilise the relocated Maloneys Road and mine access road, a small number of light vehicles, used by exploration personnel would continue to use Pyangle Road and the existing Maloneys Road to access the Bowdens exploration office and core library throughout the Project life.

Heavy vehicles would include rigid trucks, semi-trailers, tankers and B-doubles delivering equipment and plant items, consumables, processing reagents and other supplies.

A total of approximately 95 oversized loads, principally low loaders, would be required to deliver processing plant components and mobile equipment. In addition, approximately 45 oversized loads (>2.5m wide but <3.4m wide) would be delivered to the Mine Site, predominantly for site transportable buildings. These loads would be delivered principally from Month 13 of the site establishment and construction stage (see **Table 2.2**).

Bowdens Silver would ensure that all oversize and overweight vehicles have the appropriate permits and approvals and would be appropriately escorted, when required. It is noted that the required permits and approvals would be obtained by the road transportation contractors.

2.9.3.2 Water Supply Pipeline

The contractor constructing the water supply pipeline would utilise a range of vehicles throughout the construction period namely, low loaders (for delivery of earthmoving equipment), trucks for the delivery of the pipe and sand and the transfer of excess spoil back to the Mine Site, and a range of light vehicles. The overall number of heavy vehicles on any one day would typically be less than 12 and light vehicles less than 20 with these vehicles spread across a number of sites.

2.9.4 Operational Traffic

Table 2.6 lists the range of light vehicles, buses and heavy vehicles Bowdens Silver anticipates would travel to and from the Mine Site throughout the operational Project life. Each vehicle travelling to the Mine Site would generate two vehicle movements (vehicle in/vehicle out).

Table 2.6
Daily Traffic Movements Throughout the Life of the Operations

	Light Vehicles	Buses	Heavy Vehicles	TSF Haulage[A]	Mineral Concentrate	Total
Lue Road east of Pyangle Road	58	12	2	0	0	**72**
Pyangle Road Lue Road to Maloneys Road	40	0	0	0	0	**40**
Maloneys Road Pyangle Road to Secondary mine access	40	0	0	0	0	**40**
Secondary mine access road	40	0	0	0	0	**40**
Lue Road Pyangle Road to Relocated Maloneys Road	70	12	2	0	0	**84**
Lue Road west of Relocated Maloneys Road	98	16	8	0	6	**128**
Relocated Maloneys Road Lue Road to TSF Embankment	116	28	10	0	6	**160**
Relocated Maloneys Road TSF Embankment to mine access road	116	28	10	102[B]	6	**262**
Mine access road	116	28	10	102[B]	6	**262**

[A] Occurs during Years 1 to 8 of operations only
[B] Years 1 to 3 (Stage 2) reducing to 86 trips per day in Years 4 to 8 (Stage 3)

Operational traffic movements would principally be generated by mine and exploration personnel attending or departing the Mine Site for work. In order to limit traffic generation at key shift changeover, Bowdens Silver proposes to offer bus transportation to employees, in addition to adopting staggered shifts times across the administration, mining, processing and maintenance functions.

Due to the staggering of shifts and the use of a bus service to transport personnel during the peak shift changeover periods, the anticipated peak light vehicle and bus movements would occur as follows.

- Morning peak (between 5:30am and 8:00am Monday to Friday) - approximately 95 light vehicle movements (i.e. 80 inbound and 15 outbound) and 4 bus movements (i.e. 2 inbound and 2 outbound).
- Afternoon shift change (between 1:30pm and 3:00pm) - approximately 8 light vehicle movements (i.e. 4 inbound and 4 outbound).
- Day shift end (between 4:00pm and 4:30pm Monday to Friday only) - approximately 40 light vehicle movements (outbound only) and 2 bus movements (i.e. 1 inbound and 1 outbound).
- Evening peak (between 5:30pm and 7:30pm) - approximately 50 light vehicle movements (i.e. 15 inbound and 35 outbound) and 2 bus movements (i.e. 1 inbound and 1 outbound).
- Evening shift end (between 10:00pm and 10:30pm) – approximately 4 light vehicle movements (outbound only).

Details of light and heavy vehicles movements during each hour are presented in the Traffic and Transport Assessment (SCSC Part 11) (TTPP, 2020).

Additional light vehicle movements would also occur throughout the day as a result of visits by equipment/supply representatives, consultants and government agency representatives. It is expected that, on average, this would result in a further five light vehicle trips (10 movements) per day.

In addition to trucks transporting concentrates, it is anticipated that, on average, one to two heavy loads vehicle trips (two to four movements) would occur daily for delivery of fuel, explosives and other consumables.

Between Years 2 and 8 of the mine life, for the construction of the second and third raises of the TSF, Bowdens Silver would continue to utilise the fleet of three B-double trucks capable of transporting approximately 50t of NAF waste rock per load from the main open cut pit or satellite pits to the TSF embankment via a 1.4km section of the relocated Maloneys Road to the TSF embankment site. Approximately 2.3 million tonnes and 3.2 million tonnes of waste rock would be transported respectively for the second and third raises of the TSF embankment requiring approximately 46 000 truck loads over a period of approximately 36 months to complete the Stage 2 TSF embankment raise and approximately 64 000 truck loads over a period of approximately 60 months to complete the Stage 3 TSF embankment raise. During Years 1, 2 and 3, this would result in approximately 51 loads (102 truck movements per day) (7:00am to 6:00pm) or approximately five loads per hour (10 movements). During Years 4 to 8, approximately 43 loads would be transported daily to the TSF embankment area and generating approximately 86 truck movements or approximately four loads per hour. Between Years 1 and 8 of the mine life, it is anticipated that the transportation of NAF waste rock would be confined to Monday to Saturday, i.e. six days per week, public holidays excluded.

2.9.5 Concentrate Despatch

Based on the annual production of between 20 000t and 30 000t of mineral concentrates, average daily product despatches would be approximately one to three truckloads generating two to six heavy vehicle movements Monday to Saturday, public holidays excluded. B-double trucks would be used to transport the concentrate containers in order to maximise the load carried and minimise the number of truck movements.

The silver/lead concentrate would be transported in 2t capacity sealed bulk bags that would be loaded by forklift into 6.1m shipping containers for despatch to the lead smelter in Port Pirie in South Australia, approximately 1 350 km from the Mine Site. Each shipping container destined for Port Pirie would be loaded with approximately 22t of concentrate and each truck carrying silver/lead concentrate would carry two shipping containers, i.e. approximately 44t of concentrate per load. Shipping containers bound for Port Pirie would be transported by road from the Mine Site to either Parkes or Kelso (near Bathurst) and from either Parkes or Kelso by rail to Port Pirie. In total, between approximately 200 and 290 loads of silver/lead concentrate would be despatched annually or one to two loads per day.

The zinc concentrate would be transported by road in sealed containers to either the Port of Newcastle or Port Botany for shipment to an overseas zinc refinery. The number of loads of zinc concentrate despatched would be between approximately 280 and 410 per year or one to two loads per day.

Figure 2.20 displays the proposed transport routes to Port Pirie, Port of Newcastle and Port Botany. All routes involve a common route from the Mine Site to Mudgee via Lue Road beyond which trucks travelling to Port Pirie travel westward. Those trucks destined for the Port Newcastle travel northward then eastward whilst those destined for Port Botany would travel southward and then eastward.

Figure 2.21 displays the transport routes to be used by trucks travelling through Mudgee.

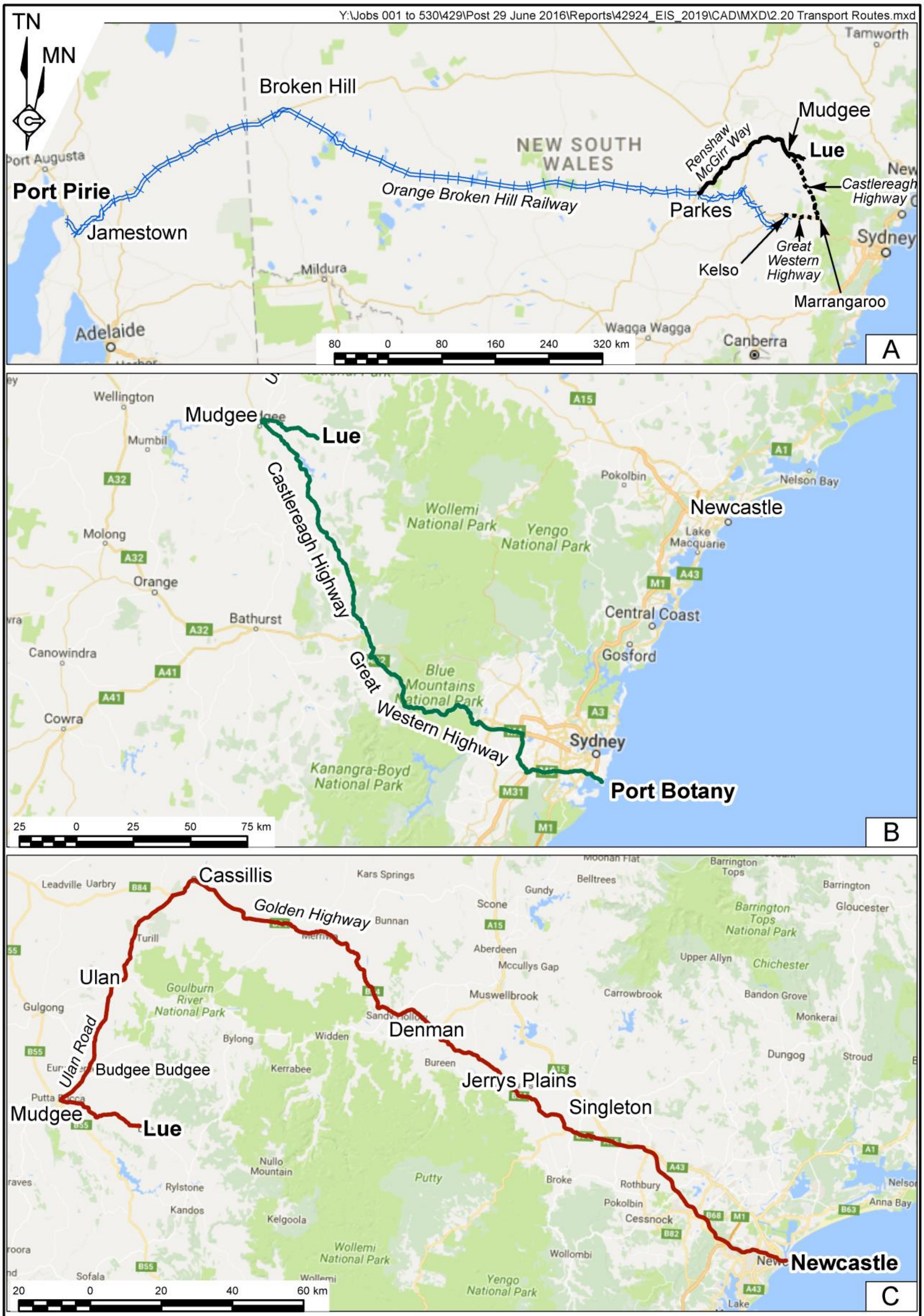
The routes used by trucks transporting the concentrate to Parkes or Kelso, from where they would be transferred to rail and transported to Port Pirie, are as follows.

Silver/Lead Concentrate to Parkes

Silver/lead concentrate would be transported to Parkes by road, a distance of 242km through Wellington and Parkes on B-double trucks along the following route (as displayed on **Figure 2.20A**).

- Relocated Maloneys Road, Lue Road, Ulan Road, Short Street to Douro Street (Castlereagh Highway (B55)) and Goolma Road to Wellington (130km); and
- Renshaw McGirr Way to Parkes (112km).

It is anticipated that one return trip (two movements) involving loading the containers, transportation to Parkes, unloading the containers and the return trip to the Mine Site would take approximately 8 hours.



Base Map Source: Google Map

Figure 2.20
CONCENTRATE TRANSPORT ROUTES

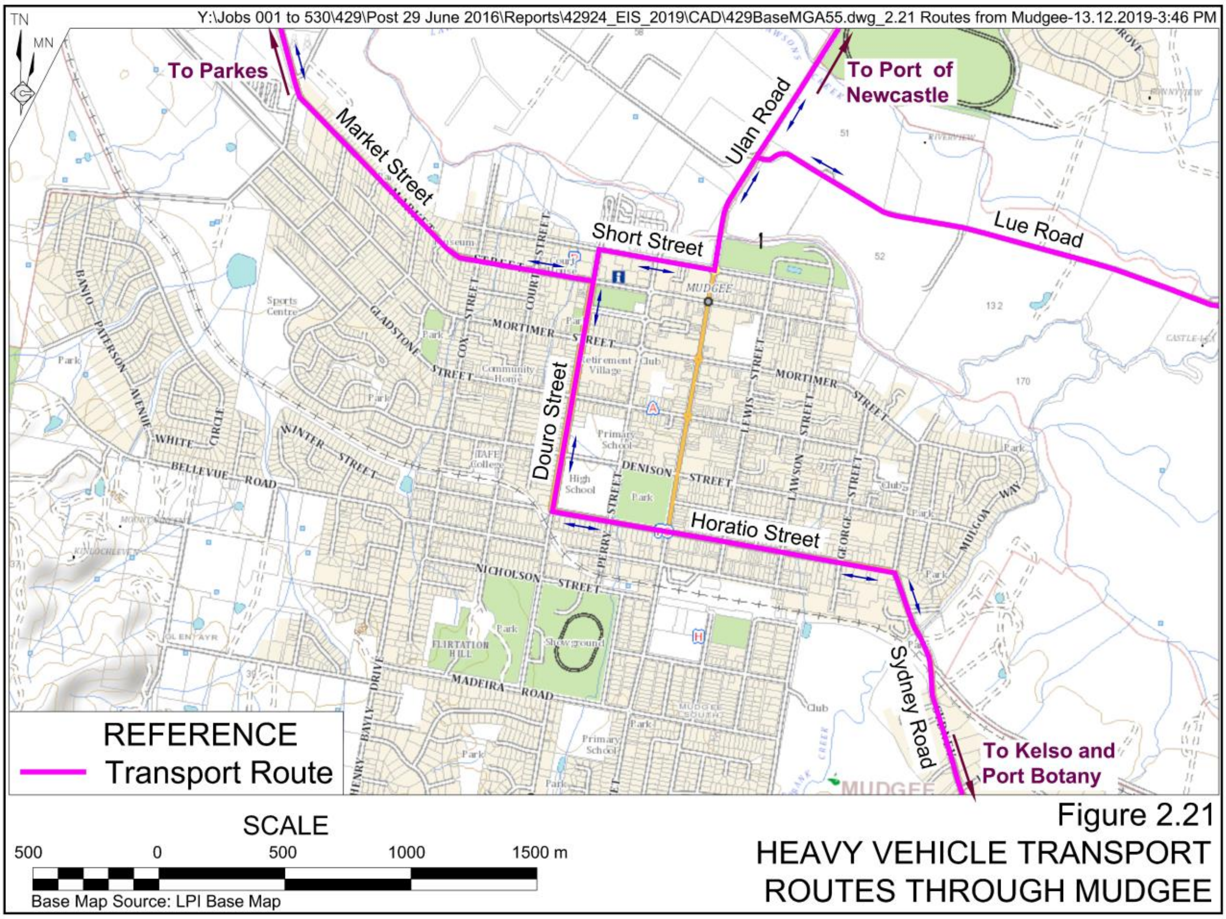


Figure 2.21
HEAVY VEHICLE TRANSPORT ROUTES THROUGH MUDGEE

Silver/Lead Concentrate to Kelso

Silver/lead concentrate would be transported to Kelso, a distance of 205km, along the following route (as displayed on **Figure 2.20A**).

- Relocated Maloneys Road, Lue Road, Ulan Road, Short Street to Douro Street (Castlereagh Highway (B55)) (33km);
- Castlereagh Highway (B55) to Great Western Highway (118km); and
- Great Western Highway to Kelso (54km).

It is anticipated that one return trip (two movements) involving loading the containers, transportation to Mudgee, unloading the containers and the return trip to the Mine Site would take approximately 6 hours.

Zinc Concentrate to Port Botany

In the event zinc concentrate is transported to Port Botany, a distance of 327km, it would be transported via Mudgee on B-double trucks along the following route (as displayed on **Figure 2.20B**).

- Relocated Maloneys Road, Lue Road, Ulan Road, Short Street to Douro Street (Castlereagh Highway (B55)) (33km);
- Castlereagh Highway (B55) to Great Western Highway (A32) (118km); and
- Great Western Highway (A32), M4, M7 and M5 to Port Botany (176 km).

It is anticipated that one return trip (two movements) involving loading the containers, transportation to Port Botany, unloading the containers and the return trip to the Mine Site would take approximately 10 hours.

Zinc Concentrate to Port of Newcastle

In the event the zinc concentrate is transported to the Port of Newcastle, a distance of 334km, it would be transported on B-double trucks via Mudgee and Ulan along the following route (as displayed on **Figure 2.20C**).

- Relocated Maloneys Road and Lue Road to Ulan Road (31 km);
- Ulan Road to Golden Highway (71 km); and
- Golden Highway, New England Highway, M15, John Renshaw Drive (B68), Maitland Road, Industrial Drive (232 km).

It is anticipated that one return trip (two movements) involving loading concentrate, transportation to the Port of Newcastle, unloading and the return trip to the Mine Site would take approximately 9 hours.

2.10 WATER SUPPLY

2.10.1 Water Sources and Projected Usage

During the site establishment and construction stage, approximately 0.5 to 1.0ML/day of water would be required principally for dust suppression and achieving the optimum moisture content in those components or areas where compaction is required. Water during this period would be drawn from on-site groundwater bores and water storages.

Once operations commence, water would be required principally for the processing of ore extracted from the open cut pits with lesser quantities required for dust suppression on the crushing and screening equipment and haul roads throughout the Mine Site. Average daily water use would require up to approximately 5.0ML of water for both processing and dust suppression (Year 8).

Water sources for the Project would include the following sources listed preferentially in order and type of use.

1. Surface water collected by the leachate management dam for recycling and reuse in processing operations.
2. Groundwater and surface water accumulating within the open cut pit for recycling and reuse in processing operations.
3. TSF return decant water for recycling and reuse in processing operations.
4. Surface water collected within the sediment dams (but unsuitable for release) or authorised under harvestable rights entitlements for use in dust suppression activities.
5. External supply of excess water from the Ulan Coal Mine and/or Moolarben Coal Mine.

Considerable reliance would be placed upon water pumped from external supply during the first 2 years of operations as:

- regular volumes of return water from the TSF would not occur at the long term rate until approximately 6 months after processing commences; and
- groundwater recovered from the base of the open cut pit would not achieve the projected sustained inflows until about the end of the second year of operations.

Once reliable quantities of TSF return water and groundwater are achieved, on average approximately 2.8ML would be recovered daily from the thickeners and TSF. Other sources of make-up water for processing and dust suppression would include surface water (2.1ML/day on average) and groundwater (1.75ML/day)[12] drawn from the main open cut pit. It is noted that each of these daily estimates represent average values and would fluctuate on a daily basis. The leachate originating from the WRE and captured in the leachate management dam would also be used in processing (without treatment), however, no specific reliance would be placed on this water until later in the mine life.

Average annual predictions of water use for dust suppression throughout the Mine Site indicate that between 0.42ML and 0.87ML of water would be required daily. The principal sources of water suitable for use in dust suppression would be on-site groundwater bores, surface water and groundwater recovered from the open cut pits and potentially on-site sediment dams, in the event the quality of the water is not suitable for release.

The predicted maximum annual water access licence requirement from the respective water sources during mining would be as follows.

- *NSW Murray Darling Basin Porous Rock Groundwater Sources, 2011* - Sydney Basin Murray Darling Basin Groundwater Source – 194ML.
- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011* - Lachlan Fold Belt Murray Darling Basin Groundwater Source - (Other) Management Zone – 907ML.
- *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Source 2012* – Lawsons Creek Water Source – 136ML.

These requirements include groundwater inflows to the open cut pit, surface water captured due to the construction of the TSF on a third order stream and the predicted baseflow reduction to Lawsons Creek and Hawkins Creek. Bowdens Silver has secured sufficient allocation to account for peak groundwater inflows during mining and would secure the necessary surface water licence allocation prior determination of the application.

In order to ensure sufficient water is always available on a continuous basis for processing and dust suppression, Bowdens Silver proposes to construct a buried pipeline from the Ulan Coal Mine and the Moolarben Coal Mine to the Mine Site that could convey up to 5.5ML of water per day, thereby removing any uncertainties related to the availability of other water sources on site. Surplus water from the Ulan Coal Mine and/or Moolarben Coal Mine would be pumped to the Mine Site via the proposed water supply pipeline. All water sourced via the water supply pipeline

[12] This quantity assumes approximately 30% of inflows evaporate on the open cut pit faces.

would be pumped to a turkeys nest dam with any excess diverted to the TSF. An outline of the proposed water supply pipeline is presented in the remainder of this subsection with the indicative alignment of the corridor displayed on **Figure 2.22**.

Water sourced via the water supply pipeline would preferentially be treated near the initial section of the pipeline. This would permit better quality water to be pumped within the pipeline and to be received at the Mine Site. Water treatment would involve a reverse osmosis plant with the following options considered.

- Water treatment using existing approved facilities at one or both of the mines

  This option would result in minimal additional management requirements as water treatment would be consistent with that currently approved. The management of process inputs, power supply and waste products (principally brine) have been assessed and approved. This option would be subject to a commercial agreement on water treatment.

- Water treatment at an intermediate location along the water supply pipeline on privately-owned land under a lease agreement

  This option would require a dedicated reverse osmosis plant to be commissioned and operated by Bowdens Silver. An area of up to approximately $250m^2$ for the treatment facility and additional area for an evaporation dam may be required. Water treatment infrastructure that achieves 75% to 94% recovery of water has been investigated by Bowdens Silver as well as the use of evaporation ponds or a Brine Crystalliser Plant. It is projected that, based on treatment of 5.5ML/day (the maximum pipeline capacity), in the order of 350kL of brine would be produced at 94% recovery efficiency.

  Under this option, environmental considerations such as lining of evaporation ponds, transport and disposal of waste materials and vegetation clearing for development of the infrastructure would need to be reviewed in detail. While this option is not preferred, it is feasible for the Project. Assuming the successful management of water within lined evaporation ponds, minor additional traffic levels associated with transport of waste materials to the Mine Site, and the disposal and encapsulation of waste materials in the TSF, this option would be expected to result in only a minor contribution to the cumulative environmental outcomes of the Project.

- Water treatment at the Mine Site, should it still be required

  Once water has been transported to the Mine Site, it may require a low level of treatment to ensure it is suitable for use in processing operations. Dedicated brine management facilities or evaporation ponds would not be required as brine would be pumped directly to the TSF. No additional land would need to be disturbed for this option as the treatment plant would be located adjacent to existing proposed facilities.

It is acknowledged that the use of water treatment facilities installed and managed by others would be subject to commercial arrangements being reached between the relevant parties. Bowdens Silver would resolve the location and management of water treatment for the water supply pipeline coincident with finalisation of commercial arrangements for water supply.

Treated water would have an electrical conductivity in the order of 800µS/cm. **Table 2.7** lists the anticipated water quality after treatment.

Table 2.7
Indicative Treated Water Quality from Ulan Coal Mine

Analyte#	**Concentration**	**Analyte#**	**Concentration**
pH	7.5	Mercury	0
EC	790	Nickel	0.02
Aluminium	0.004	Nitrate (as N)	0.09
Arsenic	0.00003	Potassium	10
Cadmium	0.0001	Selenium	0
Calcium	38	Silver	0.00008
Chloride	38	Sodium	64
Copper	0.0003	Sulphate	260
Fluoride	0.2	Total Alkalinity (as $CaCO_3$)	30
Iron	0.025	Total Nitrogen	0.08
Lead	0.00003	Total Phosphorus	0.004
Magnesium	27	Zinc	0.028
Manganese	0.3		
# All analytes expressed in mg/L except pH (pH units) and EC (µS/cm)			

Once processing operations are underway, Bowdens Silver intends to maximise the use of groundwater collected in the open cut pits and maximise the recovery and re-use of water in the processing operations. Water sourced via the water supply pipeline would essentially be make-up water supplying shortfall after water from all on-site sources is used. WRM calculate that the quantity of make-up water used for processing from the water supply pipeline would range from 0ML/day to 4.1ML/day.

Potable water requirements during construction would be delivered to the Mine Site by water tanker until such time as a reverse osmosis (RO) plant is installed on site. The RO plant would be used during operations to treat a combination of groundwater, surface water and mine water to produce up to 37 500 litres of potable water daily or approximately 14ML/year.

The recent prolonged drought being experienced across NSW has prompted Bowdens Silver to consider contingency strategies available to permit ongoing operations during drought conditions. Discussions with the owners of the Ulan Coal Mine and the Moolarben Coal Mine regarding make-up supply has also included the need for operational contingencies should make-up water not be available from either operation. Bowdens Silver has investigated the reliable supply of groundwater from production bores within the Mine Site or on surrounding properties owned by Bowdens Silver. It is noted that Bowdens Silver has access to approximately 1 066ML of groundwater entitlements to provide for peak groundwater inflow. Therefore, these entitlements could also be called upon outside of peak groundwater inflow periods.

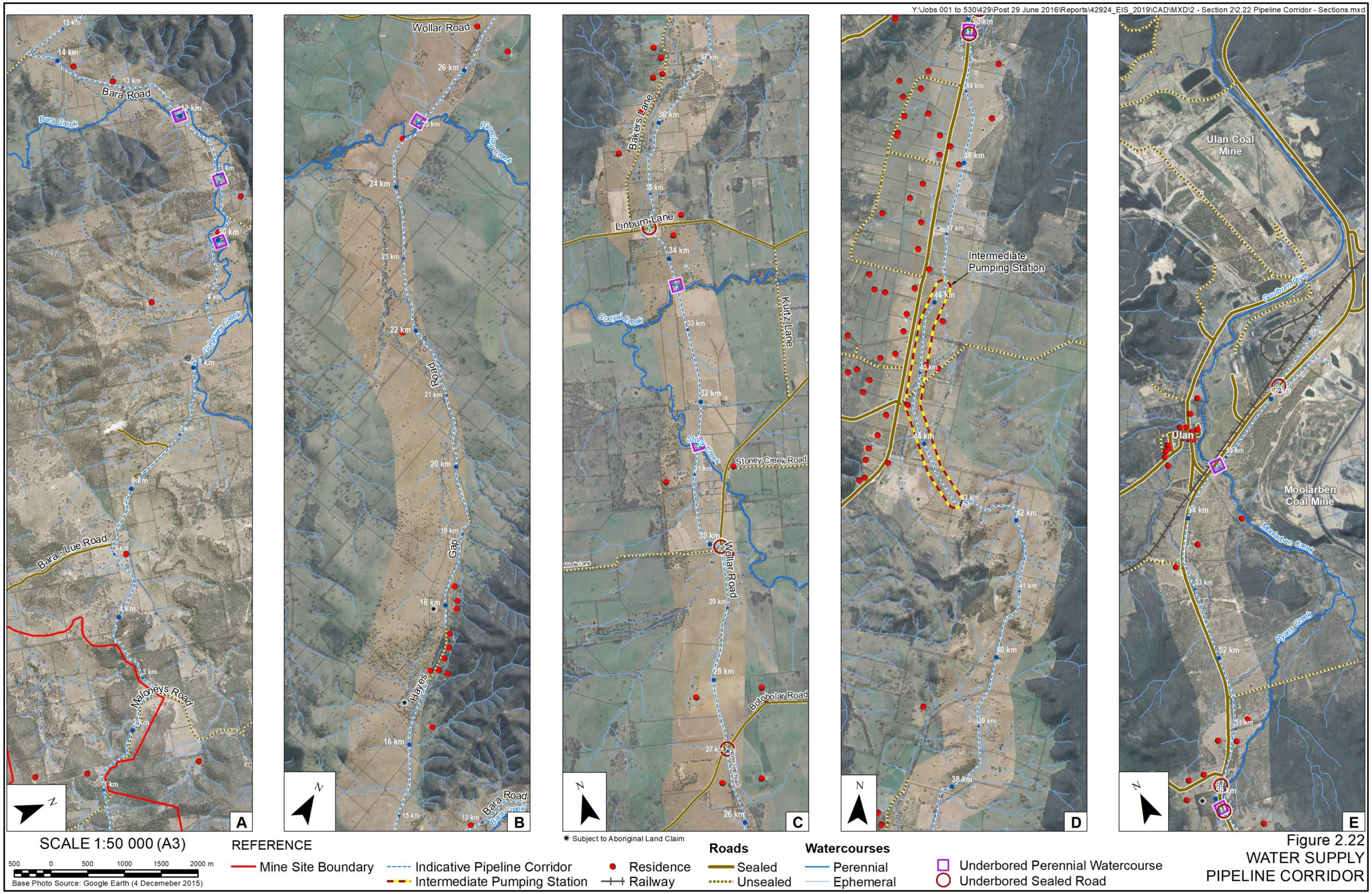


Figure 2.22
WATER SUPPLY PIPELINE CORRIDOR

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Jacobs (2020) has identified that supplementary groundwater supply is possible via the installation of additional groundwater bores within the Mine Site and surrounds. Previous investigations have identified that enhanced permeability and useful yields are possible from fractured rock aquifers in the vicinity of the major geological structures. In addition, deeper exploration drilling at the Mine Site and beyond 600m in depth has confirmed large regional structures with significant porosity that have the potential to accommodate productive aquifers. Ongoing supplementary water supplies may also be sourced from similar hydrogeological environments within land surrounding the Mine Site. While using this source of water as a sole source of water for the Project would be constrained by the potential for unpredictable permeability and yield, with the necessary investigations and bore installation, groundwater would provide an alternative water supply option, if required.

It is acknowledged that, should water sources that rely on rainfall (within the Mine Site or elsewhere) be constrained, Bowdens Silver would need to adjust the rate of production in accordance with the water available. This may lead to an eventual short-term shut down of the operation. However, this constraint is the same experienced across all metalliferous mines throughout NSW and Australia in these conditions and demonstrates the Project's reliance on the supply of water. Bowdens Silver is confident that such constraints would be managed appropriately to maintain the long-term viability of the operation.

2.10.2 Pipeline Corridor

Figure 2.22 displays the indicative water supply pipeline corridor with chainages commencing at 0km at the Mine Site. With the exception of the two pumping stations, the easement created for the water supply pipeline would be approximately 10m wide. The pumping stations would require an area of approximately 20m x 20m.

The corridor traverses a distance of approximately 58.5km. The corridor length and exact location from the off-take point to the water source within the Ulan Coal Mine and Moolarben Coal Mine is yet to be determined.

Approximately 33.8km (or 60%) of the pipeline to the off-take point would be constructed on privately-owned, freehold land with the remaining 22.6km (or 40%) constructed within public formed or unformed road reserves or Crown land.

The freehold land section of the water supply pipeline corridor would principally traverse land used for agricultural purposes including grazing and cropping. It is noted that whilst sections of remnant vegetation would also be intersected by the pipeline, this land is also generally used for grazing.

The contractor responsible for the construction of the pipeline would liaise with landowners within and adjacent to the water supply pipeline corridor to ensure that access during the construction period is maintained with minimal impact. Bowdens Silver would maintain contact with the landowners within the corridor throughout the Project life to ensure that any concerns regarding the operation and maintenance of the pipeline are addressed as quickly as possible.

The pipeline would intersect a number of constructed infrastructure and natural watercourses, as follows.

1. Beneath six sections of sealed roads.
2. Adjacent to or within approximately 18.5km of unsealed rural roads.

3. Eight perennial watercourse crossings.
4. Across numerous ephemeral watercourses or depressions.

Figure 2.22 displays the indicative locations of each of these constructed infrastructure and natural watercourses along the water supply pipeline corridor.

2.10.3 Pipeline Design

The pipeline would be designed to carry flows of up to 64L/sec or 5.5ML/day. The maximum pressures expected to be experienced along the pipeline would be 20 bar reflecting the approximately 220m elevation difference between Ulan (420m AHD) and the proposed processing plant (640m AHD).

The pipeline would be a combination of 375mm internal diameter ductile iron cement lined (DICL) and high density polyethylene (HDPE) pipe that would incorporate the following range of equipment and components.

- Up to four pumping stations would be used, one located at the Ulan Coal Mine and one at the Moolarben Coal Mine at the start of the pipeline, a third station located at the reverse osmosis plant (if required) and a fourth at an intermediate location as a booster to pump the water the remaining distance to the Mine Site. Should water treatment occur at either the Ulan or Moolarben coal mines, the third pumping station would not be required. The intermediate location of the booster pump would be in the vicinity of chainages 42km to 46km in the Cooks Gap area in an area where electrical power is close nearby. Both pumping stations would include two pumps which would be operated in a duty / standby arrangement. These would be rotated on a regular basis to achieve equal rates of wear and thus delay the need for maintenance and bearing replacement.
- Each pumping station would be located within a security-fenced compound (approximately 400m^2 in area) that would include a covered steel water storage tank and enclosed structure (container or shed) which would house the duty and standby pumps – see **Plate 2.2**.
- Isolation valves would be installed along the pipeline to enable access to any particular section for maintenance / repair works. These valves would be located inside concrete pits at regular intervals of approximately 2km to 4km. An off-take fire hydrant would be installed at a number of the isolation valves along the pipeline near existing roads to enable water to be recovered for firefighting purposes, if required. **Plate 2.3** displays a typical valve pit.
- Air release valves would be located in concrete pits at the highest points along the pipeline route to prevent the accumulation of air in those reaches.
- Scour valves would be located in concrete pits at the lowest points along the pipeline route to allow collection of water, if necessary from particular reaches of the pipeline.

Plate 2.2 Typical Pumping Station Facilities

Plate 2.3 Typical Valve Pit

A fibre optic communications cable would be laid in the same trench as the pipeline to provide efficient communications from the instrumentation located at each of the valves and pre-determined locations, particularly with respect to leak detection procedures to be incorporated along the pipeline.

It is proposed that the pipeline would be laid in a trench approximately 0.65m wide and between 1.2m and 1.4m deep for the bulk of its length. The exact depth of the trench would be determined by the contractor during its excavation. **Figure 2.23** displays a typical section through a trench with the pipe positioned on a bedding material

(typically sand or screened subsoil/excavated material) and covered by approximately 0.775m of backfilled material, including approximately 0.15m of topsoil.

Crossing of perennial watercourses would involve either the use of existing structures such as bridges[13] or culverts or directional underboring methods. The smaller ephemeral watercourses / depressions would be traversed by a trench in which case an appropriate concrete/rip rap rock cover would be placed above the completed section(s) to prevent any future erosion.

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[13] Attaching the pipeline to the bridge crossing the Goulburn River at Chainage 53.8km is understood to be feasible. Further investigations would be undertaken following the receipt of development consent to confirm this with a Section 138 permit application lodged with the RMS.

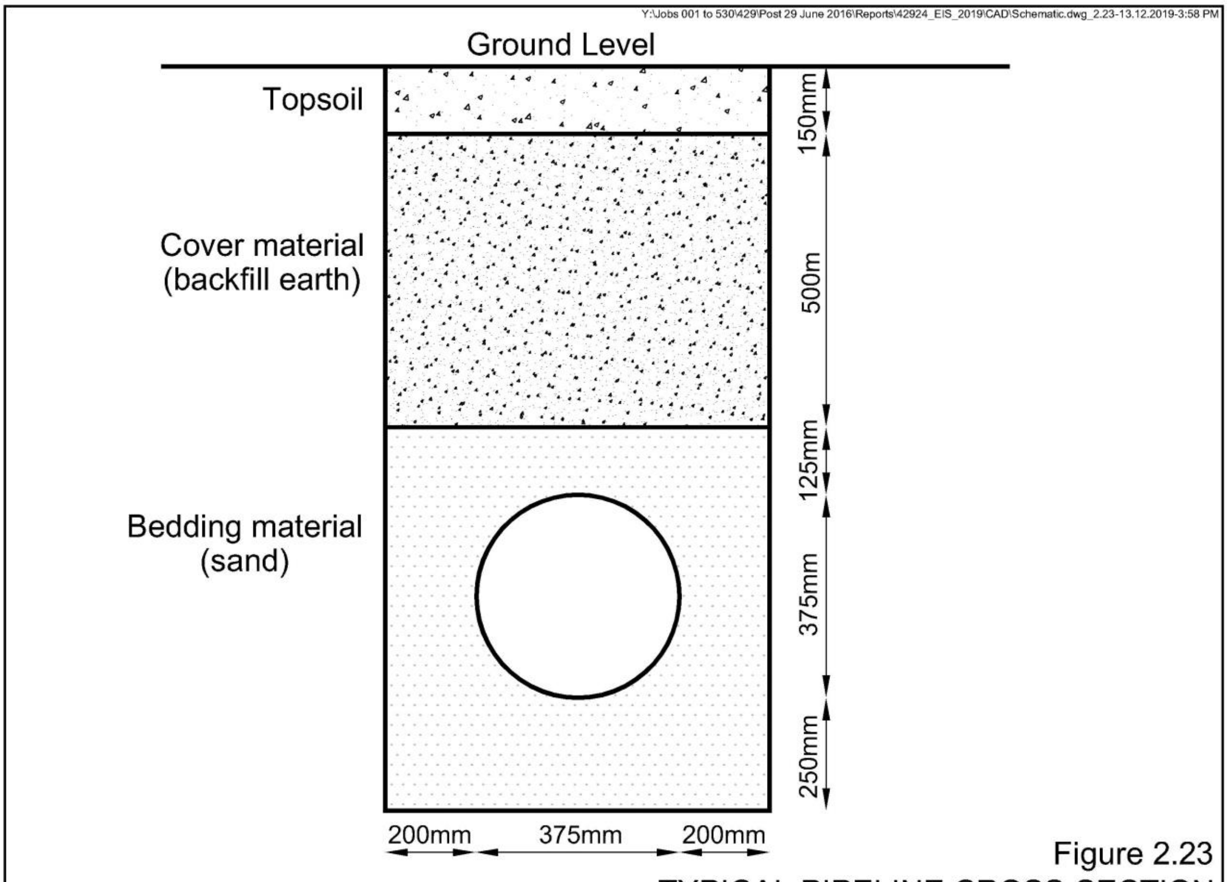

Figure 2.23
TYPICAL PIPELINE CROSS-SECTION

All sealed roads traversed by the pipeline would similarly involve underboring beneath whereas the pipeline would be placed in a trench excavated across or along any unsealed roads. The approach to crossing beneath or through roads would be determined in consultation with the Mid-Western Regional Council (MWRC). The contractor responsible for the pipeline installation would provide Council with all relevant details regarding the location, depth, clearances and traffic control for each crossing. In the event of the pipeline crossing beneath sealed roads, DICL pipes would be required. All construction work within any road reserves would be undertaken in accordance with the conditions imposed by MWRC on the Section 138 Consent for the works. The concurrence of the RMS would be sought for any pipeline-related construction activities across any classified road or road reserve.

It is proposed that the pipeline construction would involve the disturbance width of up to approximately 10m of land within the corridor although the width of disturbance could be as low as 6m. **Figure 2.24** displays a typical section across the pipeline corridor and the range of components.

It is noted that some localised conditions may require this typical section to be modified, i.e. in conjunction with the landowner or MWRC.

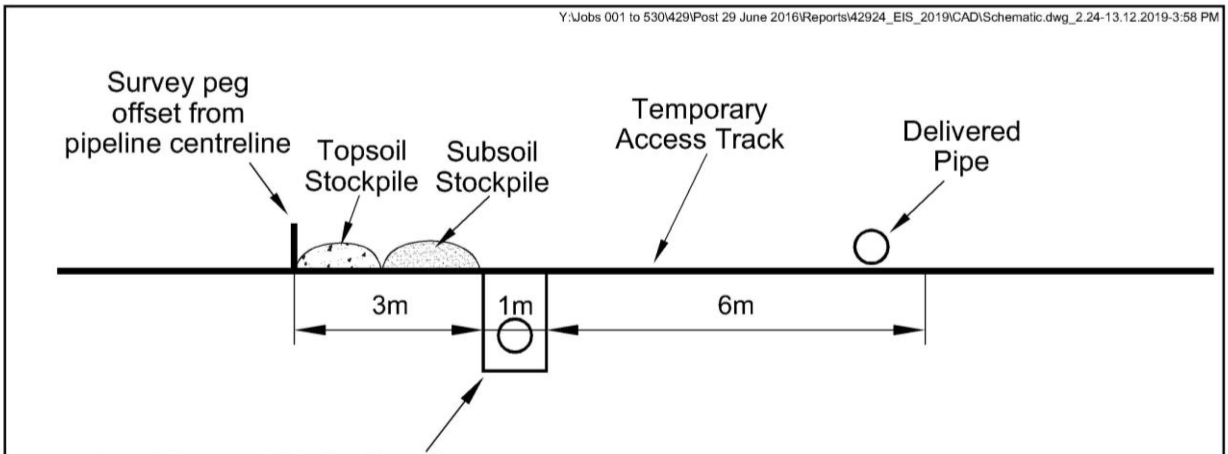

Figure 2.24
TYPICAL SECTION ACROSS PIPELINE CORRIDOR

2.10.4 Pipeline Construction

It is proposed that the pipeline contractor would deploy a number of crews to undertake the nominated tasks. The individual crews would undertake the following.

1. Vegetation clearing, fence removal (and replacement) and grading the construction corridor.
2. Unloading and stringing the pipe.
3. Joining sections of ductile iron cement lined (DICL) pipe or welding HDPE pipes and fitting if using HDPE.
4. Trench excavation and pipeline installation of pipe with valve fitting and backfilling of trench.
5. Underboring sealed roads and watercourses.

Details of the activities involved in the construction of the water supply pipeline are presented in **Appendix 5** (Section A5.9).

It is proposed that these crews would operate independently in a sequential manner to achieve the required efficiencies and minimal periods of disturbance. In total, it is anticipated the pipeline contractor would employ approximately 35 persons on a full-time equivalent basis throughout the construction program, of which approximately 10 persons are anticipated to be employed by local subcontractors.

All crews would be required to undertake their tasks in a manner consistent with the development consent for the Project and the contractor's quality, health, safety and environmental policies.

It is envisaged that approximately six compounds each of approximately 0.2ha, would be established along the length of the pipeline for the storage of pipe, joints, backfilling sand etc. The contactor would select these sites near the water supply pipeline corridor on cleared privately-owned land in much the same manner as the MWRC or RMS would during road upgrading campaigns. Each selected compound site would be the subject of an agreement with the landowner. Each compound would be verified to have no ecological or Aboriginal heritage constraints prior to its establishment and use.

The construction of the intermediate pumping station (see **Figure 2.22**) would be undertaken concurrently with the construction of the pipeline so that it is completed in time for the commissioning of the pipeline. The intermediate station would be located in the Cooks Gap area between Chainages 42km and 46km. Connection of power to the pumping stations would be sought from Essential Energy's three phase powerlines that run parallel along these chainages.

It is estimated that the water supply pipeline would be constructed in a period of approximately 10 months subject to the duration of inclement weather conditions. Towards the end of the pipeline construction, commissioning would commence through a combination of tests using air and/or water. Water for the testing would be delivered in water tankers to the relevant valve pits. All water used in the commissioning process would ultimately end up at the Mine Site.

It is planned that the contractor's crew installing the pipeline would achieve the excavation, placement and backfilling of approximately 400m of the pipeline each operational day, however, this may vary depending on local environmental and inclement weather conditions.

The construction program would be undertaken over a period of up to 10 months between 7:00am and 6:00pm, Monday to Friday, and 8:00am and 1:00pm, Saturday, public holidays excluded.

2.10.5 Pipeline Operations

Once the pipeline has been fully tested, pumping of water would commence at the required rate. Bowdens Silver proposes to operate the pipeline at a relatively constant flow rate 24 hours per day, 7 days per week with all water pumped to the 8ML raw water dam within the processing area. Any excess water to that required for processing or dust suppression would be pumped to a turkeys nest storage dam located immediately west of the on-site nursery.

Regular maintenance would be undertaken along the full length of the pipeline to ensure it is operating fully in accordance with the required specifications.

2.10.6 Pipeline Decommissioning

In the event that a third party does not require the pipeline and associated infrastructure upon cessation of mining operations, the pipeline and the pumping stations and valves would be decommissioned. The decommissioning would involve:

- the removal of all equipment at the pumping stations and re-establishment of the former landform and vegetation;
- the removal of all valves and instrumentation and backfilling of all pits; and
- removal of the pipeline, backfilling and rehabilitation of the trench – in the event this is a requirement of the landowner.

A rehabilitation program similar to that undertaken during the construction stage would be undertaken following the backfilling of the trench.

2.11 SITE INFRASTRUCTURE AND SERVICES

2.11.1 On-site Road Network

Bowdens Silver would maintain a network of internal light vehicle and off-road haul roads to provide access between the main open cut pit, processing plant and other operational areas throughout the Mine Site.

A series of haul roads would be constructed to enable haul trucks to transport waste rock from the open cut pits to the WRE and ROM ore to the ROM pad (see **Figure 2.8**). It is anticipated that the WRE upper and lower embankment haul roads from the eastern side of the main open cut pit, would be in use for the life of the mine whereas the northern ROM haul road would be in use from about Year 3 of operations.

It is proposed to upgrade a section of the existing Maloneys Road between the main open cut pit and the mine access road to provide access for the B-double trucks transporting NAF waste rock to the TSF embankment from the site establishment and construction stage until about Year 8.

Other internal haul roads may be semi-permanent and relocated as required to maintain minimum haul distances and optimum grades, whilst minimising potential noise impacts. Roads located in the open cut pits would be designed and constructed to a maximum gradient of 10%, with all two-way traffic roads designated for use by mining equipment formed to a minimum width of three times the maximum width of the largest vehicle, plus berms and drainage features. All haul roads would be all-weather roads.

The light vehicle road network would comprise all remaining roads within the Mine Site that would not accommodate off-road vehicles and include access roads to the mining facility, TSF, magazine, primary jaw crusher, processing plant and other minor roads. The main internal road from the main security gate to the processing plant and mining facility would be approximately 9m wide. This road would be the principal route within the Mine Site for the delivery of processing consumables and fuel. All other internal roads on the Mine Site would typically be 4m to 5m wide.

2.11.2 Buildings

Bowdens Silver would establish the administration buildings, site offices and amenities block close to the entrance gate north of the proposed processing plant (see **Figure 2.1**). A car park would also be constructed adjacent to the administration buildings to provide parking for the mine workforce and visitors. The site buildings and their indicative dimensions would include the following.

- Gatehouse (3.3 m x 12 m);
- Safety and ERT complex (10m x 14m);
- Main administration building (14m x 20m);
- Training facility (6m x 12m);
- Processing plant office (12m x 14m);
- Change rooms (16m x 12m);

- Processing plant control room within processing plant (3m x 12m);Milling control room (3m x 6m);
- Mining office (15m x 14.4m);
- Analytical laboratory (33m x 14m);
- Mining warehouse and light vehicle workshop facility (18m x 36m);
- Mining heavy vehicle and light vehicle workshop facility (65m x 18m);
- Product packaging shed (6m x 35m);
- Reagents storage shed (30m x 6m); and
- Processing plant workshop/warehouse facility (4m x 18m).

2.11.3 Power

2.11.3.1 Mine Site Power Supply

Bowdens Silver estimates that the annual power consumption would be approximately 84 000 MW hours, with the total power consumption through the mine life in the order of 1 510GW hours.

As noted in Section 2.1.3, approval for the construction and use of the necessary power supply infrastructure to supply the Project is not being sought at this time. A separate application in accordance with Part 5 of the EP&A Act would be sought from the relevant energy provider.

A range of options for reliable supply of electricity have been identified, each with its own requirements for augmentation or upgrade of facilities in order for reliable supply to be possible. However, preliminary technical enquiries have been sent to both TransGrid and Endeavour Energy have identified the viability of reliable supply. A summary of the seven options considered and the feedback from the relevant energy provider to date is provided in **Appendix 9**.

Electricity would be supplied via a 132kV transmission line that would terminate at the Mine Site's Main Mine Substation (see **Figure 2.1**) that includes a 132kV/11kV transformer in which the voltage would be reduced to 11kV before being distributed throughout the Mine Site from the main 11kV switchboard. It is expected that within the Mine Site electricity would be distributed via underground cables. All site components, including all crushing, grinding, flotation activities as well as power for the administration areas would operate from mains power. The only main component that would not be powered from mains power is the TSF decant pump which would be powered by an independent diesel generator.

In the event of a power outage or failure, Bowdens Silver would utilise an 800kW emergency diesel generator connected to the power system to allow plant lighting to function normally and selected machinery within the processing plant to operate. It is envisaged that no more than 0.5 MW would be required for emergency power. Emergency generators would also be retained on site for the key pumps used to transfer water to the raw water dam.

2.11.3.2 Re-alignment of 500kV Power Transmission Line

The Mine Site is traversed by the existing No. 5A3 Bayswater to Mt Piper and 5A5 Wollar – Mt Piper 500kV power transmission line. The quad bundle conductor double circuit 500kV power transmission line would be re-aligned to allow the open cut mining operation to proceed towards the western boundary of the main open cut pit. **Figure 2.1** displays an indicative alignment of the existing 500kV power transmission line and the proposed re-aligned section of the line.

The exact location of the re-aligned section of the line would be determined by TransGrid following the completion of three stages of investigation.

Stage 1: A desktop investigation incorporating a review of the available environmental information (principally from the EIS and supporting assessments), a review of the indicative route and development of a concept design route and transmission line profiles (to ensure sufficient ground clearance exists) and the development of a construction program, including the ability to minimise power outages when the new line is commissioned.

Stage 2: A scoping study including on-site investigations such as geotechnical studies.

Stage 3: A detailed design stage for all of the work involved in the construction, connection of the new transmission line and dismantling of the existing transmission line.

Whilst detailed staged investigations would not commence until the commencement of the Project, TransGrid has advised Bowdens Silver that "*there is no engineering reason for the line realignment to be unfeasible and that network outages, constructability and design can all be managed*". A Modification Processes Agreement would be entered into with TransGrid to facilitate Stage 1 to 3 and a Relocation Agreement would be required for the procurement and construction activities. It is estimated that the re-aligned line would be constructed during Year 3 of operations.

The proposed re-aligned power transmission line would be approximately 3km in length comprising 10 to 14 new steel towers, each approximately 45m to 60m high, i.e. comparable to the existing towers. The re-aligned section of line would be located wholly within the Mine Site on land owned by Bowdens Silver.

Overall, it is estimated the construction and dismantling of the line would take approximately 6 to 10 months. All works would be undertaking during the site establishment and construction stage within the proposed hours of operation listed in **Table 2.3**, i.e. consistent with construction activities for infrastructure projects. Between 20 to 30 persons would be employed by a contractor to construct and dismantle the power transmission line.

2.11.4 Fuel

The mining equipment fleet would be diesel-fuelled with bulk diesel stored adjacent to the workshop in self-bunded above-ground tanks with a total capacity of approximately 220 000L. The more mobile equipment such as the haul trucks would be refuelled adjacent to the on-site tanks within a bunded refuelling pad while the less mobile equipment such as the bulldozers, excavators and drills would be refuelled in pit using a mobile service truck.

Annual average diesel fuel usage for the mobile equipment operating within the Mine Site is estimated to be approximately 7.8ML/year. The trucks transporting the NAF waste rock during the construction of the initial TSF embankment would use approximately 1.2ML, whilst the transport of NAF waste rock to the TSF in the subsequent years would use between approximately 0.5ML and 0.8ML annually. In total, the annual average diesel fuel usage would be approximately 8.0ML until about Year 9 after which it would revert to 6.2ML/year. The fuel consumption would vary across the life of the mine in accordance with the destinations for the waste rock around the Mine Site.

Fuel would be delivered in B-double tankers at a rate of approximately two loads per week.

2.11.5 Consumables Storage and Maintenance

The workshop and warehouse facilities would incorporate storage areas for all mine consumables and would have properly designed and constructed drainage systems incorporating adequate hydrocarbon management and storage facilities designed in accordance with relevant Australian Standards (AS 1940:2017 – the Storage and Handling of Flammable and Combustible Liquids), including an oily water separation facility and waste oil storage areas.

Appropriate spill response measures and equipment would be maintained for hydrocarbons and any chemical storage.

2.11.6 Explosives

As discussed in Section 2.4.3.2, ANFO-based bulk explosives or customised emulsions would be used within the open cut pits to fracture the overburden and ore with NONEL or electronic detonators and boosters used for blast initiation. The ammonium nitrate prill, emulsion, diesel and other blasting products would be transported to the Mine Site as required by a licensed contractor on the day of each blast where the blasting products would be mixed as required, loaded into the pre-drilled holes and initiated.

A transportable magazine would be placed within a fenced compound in a location approved by the Resources Regulator. An indicative location for the transportable magazine is displayed on **Figure 2.1**.

2.11.7 Other Chemicals/Hazardous Materials

Table 2.4 lists the suite of chemicals and reagents to be used within the Mine Site.

2.11.8 Communications

Telephone, internet and data transfer requirements would be provided to the offices and amenities area, workshops and processing plant through a microwave radio network linking the Mine Site to the existing mobile telephone network as the Mine Site does not currently have access to fibre optic cables. Should fibre optic technology become available during the mine life, this would be investigated and potentially installed. Alternatively, a sole purpose wireless relay station could be set up to link into the national broadband network in Mudgee. Mobile phones and 2-way radio would also be used.

2.12 EMPLOYMENT

2.12.1 Site Establishment and Construction Stage

It is estimated that a workforce of up to 320 personnel would be required throughout the 18 month site establishment and construction stage. It is noted that the total number of personnel includes 74 persons from head offices involved with management, procurement, engineering, drafting, administration etc. The number of personnel on site would vary throughout this stage with the average full-time equivalent employment of 131 persons during the 18 month period.

Bowdens Silver anticipates the site establishment and construction workforce would comprise persons engaged under the following employment arrangements.

- Employed by the contractor appointed to construct the processing plant (likely to be based either in Sydney, Newcastle, Wollongong or interstate).
- Employed by local contractors or service providers either employed directly or sub-contracted to undertake specific tasks, e.g. site earthworks, crushing and screening construction materials, cleaning and rubbish removal.
- Employed directly by Bowdens Silver and drawn from local towns, villages and surrounds.

During the 6 to 8 month period when the 500kV power transmission line would be re-aligned (prior to Year 4), approximately 30 personnel would be employed by the contractor undertaking this activity.

Bowdens Silver proposes that all construction personnel engaged from outside the surrounding communities would rely upon temporary accommodation in the Mudgee / Rylstone / Kandos area.

2.12.2 Operations

The operations workforce is expected to vary between approximately 190 and 228 personnel. **Table 2.8** presents the summary of daily and total employment level throughout the mine life with a distinction made between the periods when mining is undertaken during the day only, of a day-time and evening and 24 hours per day. The variation is attributed to the variation in the number of mining shifts per day. When mining is undertaken during the day only, a total of 46 persons would be employed, i.e. on the basis of 7 days on and 7 days off whereas when mining is undertaken during the day and evening or 24 hours per day, a further 24 persons would be employed.

Whilst the bulk of the jobs associated with the Project would be full-time, Bowdens Silver would be supportive, where practical, to offer a range of part-time jobs that would be suited to a number of workers, e.g. off surrounding properties to earn an off-farm income.

Table 2.8
Summary of Daily and Weekly Employment

Personnel	Weekday	Weekend	Total Weekly
Mining - Day Only			
Administration, Technical and Professional	42	nil	42
Mining (7 days on / 7 days off) (1 x 12hr shift)	23	23	46
Processing Plant, Maintenance and Technical (4 days on / 4 days off)	42	42	84
Exploration	20	nil	20
Total	**127**	**65**	**192**
Mining – Day / Evening			
Administration, Technical and Professional	42	nil	42
Mining (7 days on / 7 days off) (2 x 8hr shift)	35	35	70
Processing Plant, Maintenance and Technical (4 days on / 4 days off)	48	48	96
Exploration	20	nil	20
Total	**145**	**83**	**228**
Mining – Day / Evening / Night			
Administration, Technical and Professional	42	nil	42
Mining (7 days on / 7 days off) (2 x 12hr shift)	35	35	70
Processing Plant, Maintenance and Technical (4 days on / 4 days off)	48	48	96
Exploration	20	nil	20
Total	**145**	**83**	**228**

The personnel listed in **Table 2.8** would be employed directly by Bowdens Silver or through the mining contractor or other contractors employed on site. The bulk of the operations workforce would be sourced from either Mudgee or Rylstone, Kandos and Lue and nearby smaller towns and villages. Bowdens Silver has estimated that at least 40% of the on-site workforce would be drawn from the Rylstone/Kandos area. Many of the workforce from the former Kandos Cement Works have expressed their interest in working at the Mine Site, rather than travel considerable distances to the various coal mines north of Mudgee at which they have worked since the Kandos Cement Works ceased operations.

Bowdens Silver does not plan to build any housing in Mudgee, Rylstone, Kandos or Lue.

2.13 HOURS OF OPERATION, SHIFTS AND PROJECT LIFE

2.13.1 Hours of Operation

Table 2.9 displays the proposed hours of operation for the key operational activities within the Mine Site. Site establishment and construction hours have previously been outlined in **Table 2.3**.

Table 2.9
Hours of Operation

Activity	Days	Hours
Clearing / topsoil and subsoil removal	Monday to Saturday[1]	7:00am to 6:00pm[2]
Blasting	Monday – Saturday[1]	10:00am to 4:00pm
Mining	7 days	7:00am to 6:00pm 7:00am to 10:00pm[3] 24hrs[3]
NAF waste rock transfer to the TSF embankment	Monday – Saturday[1]	7:00am – 6:00pm
Processing	7 days	24hrs
Concentrate Despatch	Monday to Saturday[1]	7:00am to 6:00pm[4]
Maintenance	7 days	24hrs
Rehabilitation	Monday to Saturday[1]	7:00am to 6:00pm[2]

Notes: 1 Public Holidays excluded.
2 Daylight hours only.
3 Subject to demonstrating noise limits can be satisfied during the evening and night-time periods.
4 Excluding 7:30am to 8:30am and 3:30pm to 4:30pm (School bus period) – when heavy vehicles (other than buses) must not travel on Lue Road.

During the early stages of mining, after the site establishment and construction stage, operational hours would continue to be confined to day-time only. Bowdens Silver proposes to progressively extend mining operations into the evening and ultimately 24 hours per day subject to demonstrating the relevant noise limits set for the mine can be complied with during those periods. Based upon the outcomes from the noise assessment it is anticipated that evening and night-time mining operations would commence in Year 2 and Year 3 respectively.

Section 4.2.2.5 includes discussions on how Bowdens Silver intends to modify its evening and night-time mining operations in order to satisfy the relevant noise limits. It is noted that there would be some occasions throughout the mine life when it would be necessary to revert to day/evening or only day mining operations in order to satisfy the noise criteria nominated in the environment protection licence for the Project.

2.13.2 Workforce Shifts

Operations would be undertaken in staggered shifts across the administration, mining, processing, maintenance and exploration functions.

- Administration, Technical, Professional and Exploration Personnel – 8 hour shift, five days (Monday to Friday) with two days off (Saturday and Sunday).
- Mining Personnel – the number of shifts per day would vary throughout the mine life depending upon the restrictions relating to noise compliance. Mining personnel would work 7 days on / 7 days off. Typical shift arrangements would be as follows.
  - Day only: one x 11 hour shift from 7:00am to 6:00pm
  - Day / Evening: two x 8 hour shifts from 6:30am to 2:30pm and 2:00pm to 10:00pm
  - Day / Evening / Night: two x 12 hour shifts from 7:00am to 7:00pm and 7:00pm to 7:00am.

- Processing Plant & Maintenance Personnel – varied shifts per day working 4 days on / 4 days off rotation, with typical shift arrangements as follows.
  - Day only: one x 12 hour shift from 6:00am to 6:00pm
  - Day / Evening: two x 8 hour shifts from 6:00am to 2:00pm and 2:00pm to 10:00pm
  - Day / Evening / Night: two x 12 hour shifts from 6:00am to 6:00pm and 6:00pm to 6:00am.

Table 2.10 lists the planned number of personnel per shift for the administration, technical and professional roles; mining; and processing plant, maintenance and technical roles and the respective shift times.

Table 2.10
Workforce Shift Arrangements and Total Employment

<table>
<tr><th rowspan="2">Personnel</th><th rowspan="2">Days</th><th rowspan="2" colspan="2">Shift Arrangements</th><th colspan="2">Workforce</th></tr>
<tr><th>per Shift</th><th>Total</th></tr>
<tr><td>Administration, Technical and Professional</td><td rowspan="2">Monday to Friday</td><td rowspan="2" colspan="2">8:00 am to 4:00 pm
5 days on/2 days off</td><td>42</td><td>42</td></tr>
<tr><td>Exploration</td><td>20</td><td>20</td></tr>
<tr><td rowspan="8">Mining</td><td rowspan="8">7 days</td><td colspan="2">7 days on/7 days off</td><td></td><td></td></tr>
<tr><td>Day only</td><td>6:30am to 6:30pm</td><td>23</td><td>46</td></tr>
<tr><td rowspan="2">Day / evening</td><td>6:30am to 2:30pm</td><td>23</td><td rowspan="2">70</td></tr>
<tr><td>2:00pm to 10:00pm</td><td>12</td></tr>
<tr><td rowspan="3">Day / evening / night</td><td>7:00am to 7:00pm</td><td>23</td><td rowspan="3">70</td></tr>
<tr><td>2:00pm to 10:00pm</td><td>3</td></tr>
<tr><td>7:00pm to 7:00am</td><td>9</td></tr>
<tr style="display:none"></tr>
<tr><td rowspan="9">Processing Plant, Maintenance and Technical</td><td rowspan="9">7 days</td><td colspan="2">4 days on/4 days off
4 nights on/4 nights off</td><td></td><td></td></tr>
<tr><td rowspan="2">Day only*</td><td>6:00am to 6:00pm</td><td>37</td><td rowspan="2">84</td></tr>
<tr><td>6:00pm to 6:00am</td><td>5</td></tr>
<tr><td rowspan="3">Day / evening*</td><td>6:00am to 6:00pm</td><td>37</td><td rowspan="3">96</td></tr>
<tr><td>2:00pm to 10:00pm</td><td>1</td></tr>
<tr><td>6:00pm to 6:00am</td><td>10</td></tr>
<tr><td rowspan="3">Day / evening / night*</td><td>6:00am to 6:00pm</td><td>37</td><td rowspan="3">96</td></tr>
<tr><td>2:00pm to 10:00pm</td><td>1</td></tr>
<tr><td>6:00pm to 6:00am</td><td>10</td></tr>
<tr><td colspan="6">* Shift configurations dependent upon mining shift arrangements</td></tr>
</table>

2.13.3 Mine Life and Project Life

For the purposes of this document, the mine life refers to the period of the 18 month site establishment and construction stage and the 15 year period of processing and concentrate manufacture, i.e. the mine life would be 16.5 years.

The Project life refers to the mine life and the estimated 7 year final rehabilitation and maintenance period (commencing 0.5 years before the end of processing), i.e. a total of 23 years. **Figure 2.2** displays schematically the duration of each of the key components of the Project.

It is anticipated that the completion of the rehabilitation of the surface of the TSF would take the longest period of time, i.e. in the order of 4 years. A 3-year period of maintenance is proposed, although greater clarity on the duration of the maintenance period would be determined during the post operational period. Bowdens Silver is committed to maintaining the revegetation and water management processes, particularly with respect to the leachate reporting to the leachate management dam. Over time the quantity of leachate would reduce until leachate generation ceases. Relinquishment of the mining lease over the entire Mine Site would only occur once all revegetation satisfies the requirements of the Resources Regulator and leachate generation from the WRE ceases. It may be feasible to progressively relinquish the section of the mining lease where all rehabilitation constructions have been satisfied.

The Project life may be extended depending on the results of future exploration and drilling activities, particularly at depth beneath the main open cut pit. That said, the Feasibility Study for the Project indicates that the previously defined mineral resources beneath the main open cut pit do not contain sufficient mineral grades to warrant their extraction.

2.14 GENERAL WASTE MANAGEMENT

2.14.1 Introduction

The principal non-production wastes that would be generated during the proposed site establishment and construction stage and subsequent operations would include the following.

- Residual materials remaining after the demolition of the four residences, farm buildings and fencing within the active area of the Mine Site.
- General domestic type wastes from the on-site offices, shower blocks, workshop and processing facilities and routine maintenance consumables.
- Scrap steel, hydrocarbons including waste oil and other wastes remaining from equipment maintenance.
- Sewage.
- Reverse osmosis brine generated on-site from treatment for potable water.

2.14.2 Demolition Materials

All efforts would be taken to re-use any suitable building materials recovered during the demolition of the four residences. All unusable materials would be disposed of at either the Mudgee Waste Depot or Kandos Waste Transfer Station. Any asbestos waste would be fully wrapped to meet Council’s requirements for acceptance at Council’s waste facilities or another suitably licensed facility.

Suitable fencing materials recovered would be re-used on Bowdens Silver's properties retained for ongoing agricultural uses and any unusable fencing wire and metal posts would be set aside for metal recycling.

2.14.3 Domestic Type Waste

Domestic type wastes would be treated as general waste. Two collection streams would be provided with recyclables separated and placed in bins or collection skips fitted with lids or covers. The principal recyclables collected would be steel, aluminium, glass, paper and cardboard. Bins and/or collection skips would be located in areas or adjacent to buildings in which the wastes are generated and collected on an as needs basis by Council or licensed waste contractors. The maximum quantity of wastes stored would not exceed the maximum quantity nominated by the EPA and the contents disposed of at either the Mudgee Waste Depot or Kandos Waste Transfer Station.

Bowdens Silver estimates approximately $450m^3$ of domestic mixed solid waste and $280m^3$ of recyclables would be produced annually. Mid-Western Regional Council has advised Bowdens Silver that Council would be prepared to accept this quantity of wastes.

2.14.4 Maintenance Waste

Routine maintenance of mobile mining and earthmoving equipment would be undertaken within the on-site workshop or, in the case of any major refurbishment activities which cannot be undertaken on site, at equipment maintenance facilities away from the Site.

Waste oil would be stored in a 5 000L self-bunded waste oil tank within the mining facility from where it would be collected and removed from site for disposal/reuse by an appropriately licensed waste recycler. All other waste hydrocarbons associated with equipment maintenance would be stored in a concrete bunded area, designed in accordance with relevant Australian Standards (AS 1940:2017 – the Storage and Handling of Flammable and Combustible Liquids), to await collection. An oily water separation facility would be installed, with the separated hydrocarbons sent to the recycling tank and the treated water reporting to the process water tank.

All routine maintenance consumables and non-hazardous solid wastes would be treated as general mixed solid waste. Separate bins or collection skips would be maintained at the workshops for cardboard and metals.

2.14.5 Sewage

All sewage generated during site establishment and construction would be managed through temporary systems. These systems would likely be pump-out systems and would be maintained by a licensed contractor.

For the operational period, it is proposed to construct and operate an appropriately sized sewage management system within the footprint of the processing plant, capable of managing sewage from up to 150 persons per day. All water treated through the system would either be irrigated or used as process water (treated waste water discharged to TSF for recycle to the process plant.). Any waste water used for irrigation from the systems would be undertaken in compliance with the EPA's guidelines "*The Use of Effluent by Irrigation*" with the remaining water treated in compliance with Australian Standard AS/NZS 1547:2012 "*On-site Domestic Wastewater Management*".

2.14.6 Reverse Osmosis Brine

All saline brine generated by the on-site potable water reverse osmosis plant would be pumped to the process water tank for entry into the process water circuit.

2.15 SAFETY/SECURITY MANAGEMENT

2.15.1 Public and Employee Safety

It is Bowdens Silver's policy that each person working on or visiting the Mine Site would be provided with a safe and healthy environment and that facilities and equipment would be kept secure from unauthorised access. In order to achieve this, Bowdens Silver would implement recruitment, induction and training programs to achieve the following objectives.

- Comply with statutory regulations and maintain constant awareness of new and changing regulations;
- Eliminate or control safety and health hazards in the working environment in order to achieve the highest possible standards for occupational safety in the mining industry;
- Ensure the suitability of prospective employees through a structured recruitment procedure;
- Provide relevant occupational health and safety information and training to all personnel;
- Develop and constantly review safe working practices and job training;
- Conduct regular safety meetings and provide an open forum for input from all employees;
- Provide effective emergency arrangements for all employees, visitors and general public protection;
- Maintain good morale and safety awareness through regular employee assessment and counselling;
- Collaborate with local emergency services in training and security initiatives;
- Ensure all contractors adopt and maintain Bowden Silver's policy objectives and safety standards at all times; and
- Undertake regular drug and alcohol testing in accordance with Bowdens Silver's Fitness for Work Policy.

Further to the above, the following operational safety controls would be installed within the Mine Site.

- A safety bund wall approximately 2m high would be constructed around the perimeter of the main open cut pit. This bund would be constructed at the time when mining operations are being undertaken close to the boundary of the main open cut pit.
- Signs identifying blasting times would be installed adjacent to the entrance of the Mine Site from the relocated Maloneys Road and in Lue. The issue of blast notification would be the subject of ongoing discussions with the community.
- Where internal roads are adjacent to steep slopes, windrows along the down-slope margins of those haul roads would be constructed to a minimum of half the wheel height of the largest item of mobile equipment on site.
- The blasting engineer or shotfirer would use appropriate blasting procedures to contain all fly rock within the design blast envelope and minimise the generation of excessive ground and air vibrations.
- All earthmoving equipment would be fitted with appropriate safety equipment in accordance with the Guideline for Mobile and Transportable Equipment for Use in Mines (MDG 15) published by the NSW Resources Regulator (January 2018).

Central to all aspects of public and employee safety would be the adoption of a pro-active approach to workplace safety, the preparation of a Work Health and Safety Policy to cover all activities at the Mine Site and strict compliance at all times with the requirements of the relevant regulations, Acts and Australian Standards (including AS 1470-1986 Health and Safety at Work – Principles and Practices).

Bowdens Silver is committed to ensuring the safety of all visitors and the general public and would adopt a set of procedures when member of the general public visit the Mine Site. A number of the security measures outlined in 2.14.2 would assist in achieving the safety of the general public at all times, including the period following the cessation of mining and processing, when final rehabilitation is underway.

2.15.2 Mine Site Security

Bowdens Silver recognises that the proximity of the Mine Site to Lue and the relocated Maloneys Road would necessitate the implementation of procedures and controls to protect the safety of the public. In order to ensure that access to the Mine Site is restricted to authorised personnel only, the following items would be implemented to ensure that members of the public do not access the Mine Site at any time, unless authorised.

- Installation of a 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. The security fence would consist of a combination of a cyclone fence and a five strand barbed wire rural fence.

- A security gate would be 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 and 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 mine entrance.

2.16 REHABILITATION, MINE CLOSURE AND FINAL LAND USES

2.16.1 Introduction

Rehabilitation of all areas disturbed by mining-related activities would be an integral part of the Project to be undertaken by and paid for by Bowdens Silver. Emphasis would be placed upon progressively creating final landforms, wherever practicable, and re-establishing soil profiles and vegetation essential to achieving the preferred final land use(s) during and following the cessation of operations. The nature of the Project dictates, however, that the disturbed areas associated with the main open cut pit, processing area and TSF would remain active throughout the mine life and as a consequence, the opportunity to undertake progressive rehabilitation of these components would be minimal.

Rehabilitation activities within the Mine Site would be planned and undertaken in accordance with a Rehabilitation Management Plan to be submitted to the Resources Regulator and approved following the issue of development consent and grant of the mining lease for the Project, and prior to the commencement of any mining-related activities within the Mine Site. The Plan would also address all rehabilitation-related requirements nominated in the development consent for the Project.

The proposed rehabilitation strategy for the Project has been designed with reference to the following documentation.

- Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth Government, 2016).
- Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth Government, 2016).
- Towards Closure – Mine Rehabilitation in the Australian Minerals Industry (MCA, 2015).
- Strategic Framework for Mine Closure (ANZMEC, 2000).
- Safety Bund Walls around Abandoned Open Pit Mines (WA Department of Industry and Resources, 1997).

This subsection focusses upon outlining rehabilitation activities planned within the Mine Site and during the construction of the relocated Maloneys Road between the Mine Site and Lue Road. The rehabilitation activities are addressed for the site establishment and construction stage and for each of the key domains within the Mine Site. For each domain within the Mine Site, the specific rehabilitation objectives are defined together with relevant design information, rehabilitation procedures and specific success criteria. Details of how each rehabilitation component would be undertaken is presented in **Appendix 5**.

This subsection concludes with an overview of the sequence of rehabilitation activities across the entire Mine Site throughout the Project life and Bowdens Silver's plan for rehabilitation monitoring and maintenance and ultimately mine closure together with discussions regarding interim and final land uses.

2.16.2 Rehabilitation Objectives

Bowdens Silver recognises that the rehabilitation of the areas disturbed throughout the mine life is an integral component of the Company's development strategy. Bowdens Silver is committed to the integration of sustainable development principles in all components of the Project, particularly for rehabilitation and mine closure, as the ongoing productivity of much of the Mine Site is important for future generations. In this regard, Bowdens Silver recognises that, given the nature of some of the Project components, there would be a need for some different land uses within parts of the Mine Site and variations to species composition from those within the existing ecosystems in other parts of the Mine Site.

In the short term, Bowdens Silver's objectives would be to commence rehabilitation as soon as practical in areas no longer required for mining in order to improve long-term outcomes and to temporarily rehabilitate areas not required in the short term (but that may be disturbed later) in order to stabilise disturbance and, by doing so, minimise visual impacts, dust generation and erosional sedimentation until further mining-related disturbance is required.

Bowdens Silver's longer term rehabilitation objectives are that:

- the rehabilitated landform is safe, stable and sustainable particularly with regards to soils and hydrology;
- components of the final landform, including diversion channels, are re-instated or stabilised with native vegetation to specifically provide fauna habitat and corridors;
- the surrounding environment is not polluted by any mine-related activity during the mine life or following mine closure;
- the contaminated areas remaining on site, namely the WRE and TSF are appropriately covered and vegetated to ensure the materials in both component areas does not contribute to any off-site pollution.
- the rehabilitated final landform requires low levels of maintenance;
- the approach to rehabilitation is continually reviewed based on site specific knowledge, research and monitoring; and

- the mining lease over the rehabilitated landforms can be progressively relinquished and the security returned progressively within a reasonable timeframe after the successful completion of rehabilitation activities.

2.16.3 Planning

Successful rehabilitation of mining-related disturbance can only be achieved with diligent and structured planning, a practice implemented for the Bowdens Silver Project. The elements of the rehabilitation for the Project relied upon in planning involved the following.

1. Baseline Data Collection

The key data collected has included the following.

- Climate Data
  - long term daily average rainfall, rainfall intensity, temperature and evaporation - this data is summarised in Section 4.1.2.
- Soils Data from Soil Management Designs
  - this data is summarised in Section 4.13 and focusses upon the chemical and physical properties of the soils within the Mine Site that influence erosion potential and their value as a growth medium.
- Vegetation and Ecosystems Data
  - vegetation communities, threatened species, canopy cover and rooting depths- this data is summarised in Section 4.10.
- Fauna presence and populations
  - known fauna habitat, existing fauna corridors, threatened species.
- Topography and Drainage Data
  - detailed contours (from LIDAR mapping), defined major and minor watercourses.

2. Waste Rock Characterisation

Considerable emphasis has been placed upon the characterisation of the waste rock to be extracted from the open cut pits. Details of the characterisation studies are provided in the Materials Characterisation Assessment (Part 3 of the SCSC) with a summary included in EIS Sections 2.5.2 and Section A5.4.2 (**Appendix 5**). This information has assisted to identify what quantities and types of NAF waste rock would be produced and during which stages of the mining operation. Importantly, this information is required principally for the covers to be constructed on the final landform surfaces of the WRE and TSF.

3. Landform Design

All of the key components of the Mine Site have been designed initially as functional operational components with emphasis placed, wherever possible, upon minimising the disturbance footprint yet achieving a stable and safe structure that reflects best practice for each component. Upon completion of the preliminary design of each component, the approach to the final landform design commenced, (such as the WRE and TSF), where emphasis was placed on the design of a long-term cover. For the processing area and mining facility, emphasis was placed upon re-profiling the area to blend the final landform into the surrounding natural topography.

4. Surface Water Management

Each of the final landforms for each domain would provide for the long-term management of surface water with consideration of diversion, collection and discharge, if appropriate.

5. Seed and Fertiliser Selection

The stabilisation of disturbed areas around the Mine Site and long term growth of vegetation for habitat development would be achieved through the growth of a range of trees, shrubs and ground covers. In order to temporarily stabilise disturbed areas, particularly slopes, emphasis would be placed upon the use of exotic grasses suited to the planting season. Details of the seed and fertiliser selection are provided in **Appendix 5** (Section A5.10.2.2).

6. Defining Success Criteria

Bowdens Silver has defined the success criteria for each component of the Mine Site to be rehabilitated focussing on key long term objectives outlined in Section 2.16.2. Individual performance and completion criteria would be established for each component and presented in the Rehabilitation Management Plan for the Project following the receipt of development consent and prior to the initial disturbance for the Project.

7. Stakeholder Consultation

During the community consultation program undertaken by Bowdens Silver, a number of aspects relating to the rehabilitation and final use of the Mine Site were raised, particularly with respect to stability of the final slopes, water quality runoff and weed management.

The community open day held on 15 June 2019 provided an opportunity for interested persons to provide comments on the final landform, planned revegetation strategies and long term land uses. Feedback received on the open day related to the following.

- *The water quality within the final lake.*
- *The extent of native vegetation on the final landform.*
- *Will Bowdens Silver continue to own the land on which the main open cut pit, TSF and WRE are located?*
- *When will Bowdens Silver sell the areas of land currently owned after the completion of the Project?*
- *The proportion of revegetated areas within the Mine Site returned to grazing.*

The 3D interactive model presented to the community at the open day on 15 June 2019 provided interested persons with the opportunity to comment on the final landform and extent of progressive revegetation.

Once sufficient detail was available on each Project component and the possible approach to their rehabilitation established, discussions were sought with two local Landcare Groups, namely Bingman Landcare (based in Lue) and Watershed Landcare (based in Mudgee), and the Aboriginal stakeholders involved in the cultural heritage assessment for the Project.

Both Landcare groups chose not to provide input to the rehabilitation design component of the Project as they claimed they had no knowledge of the overall project and the type of disturbance requiring rehabilitation. Bingman Landcare, a group that formed the Lue Action Group, has formally recorded that the group opposes the Project as the environmental impacts, that they assume would occur as a result of the Project, are "directly at odds" with their key values and primary focus to look after their local environment. Watershed Landcare, a group which is related to the Bingman Landcare with a number of common members, expressed similar sentiments to those of Bingman Landcare that their "input was only being sought on a very narrow subject" given their group had a range of core interests such as water quality, soil health, biodiversity, impacts on agriculture and other socio-economic issues.

Discussions held with the Aboriginal stakeholders regarding the final landform established that, whilst they did not endorse the configuration of the final landforms, there was support for the replacement of the artefacts salvaged during the mine life on those parts of the final landform that would be stable long term, preferably near where they were originally located.

2.16.4 Rehabilitation Domains

Rehabilitation domains refer to areas of related disturbance based on similar activities and/or use prior to rehabilitation and for which rehabilitation and decommissioning activities would be similar. **Figure 2.25** displays the boundaries of eight domains within the Mine Site and a description of each domain is as follows.

Domain 1 – Open Cut Pits

This domain would include the main open cut pit and the two satellite pits together with a setback of approximately 50m from the boundary of the main open cut pit to provide for safety bunding required during the mine life and beyond. The two long term accesses to the main open cut pit would also be included in this domain.

Domain 2 – Southern Barrier

This domain includes the entire footprint of the southern barrier and a 25m setback from its boundary to accommodate activities on the edge of the domain.

Domain 6 – Stockpile Areas

This domain includes all soil stockpile areas outside the key component areas within the Mine Site that would be used to stockpile topsoil and subsoil recovered during the mine life and used for long term rehabilitation of the Mine Site. A total of six soil stockpile areas would be created within the Mine Site, referenced as Domain 6 on **Figure A5.3**. The NAF waste rock stockpile area located adjacent to the TSF embankment is also included in this domain.

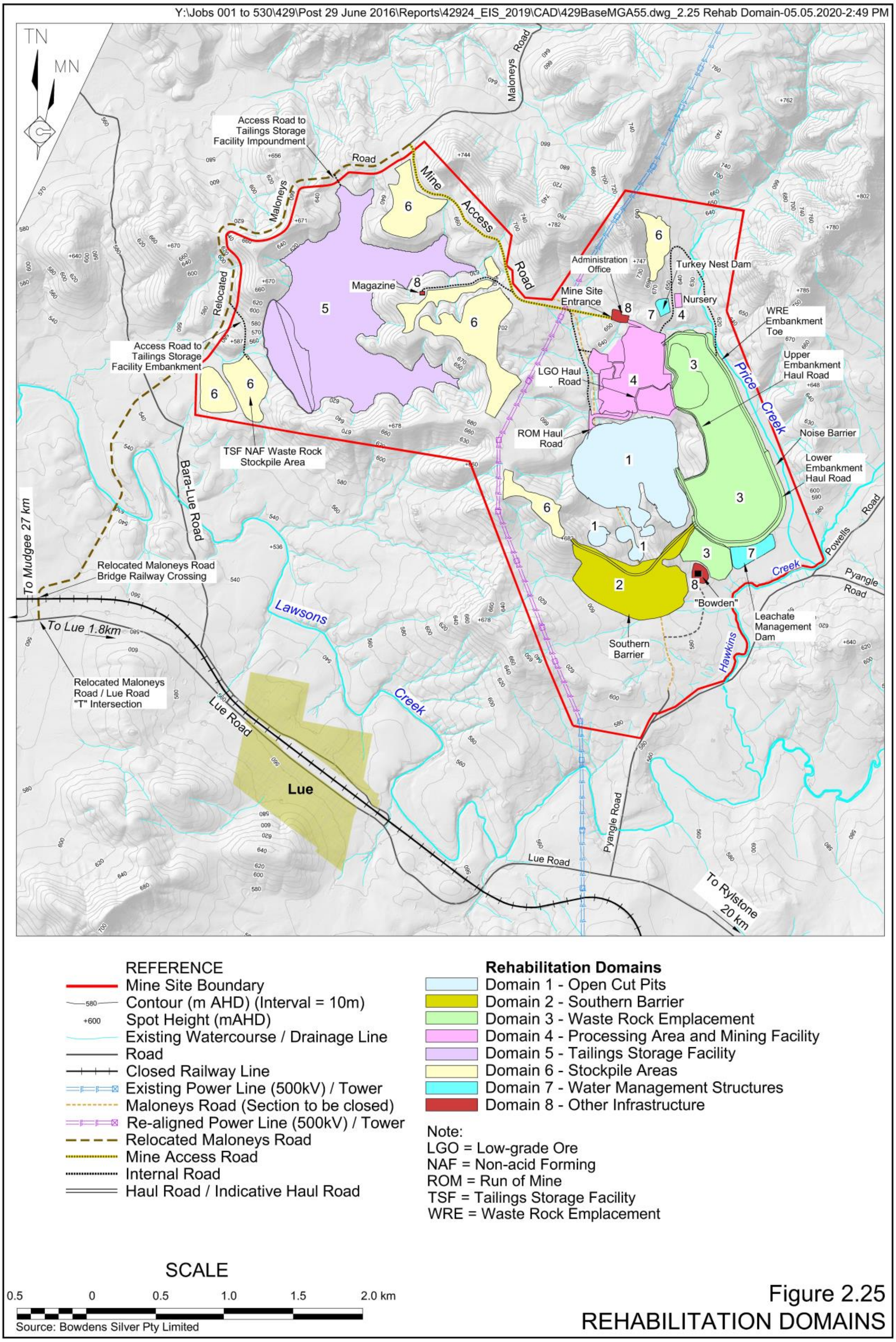

Figure 2.25
REHABILITATION DOMAINS

Domain 7 – Water Management Structures

This domain includes all dams outside the key component areas used to manage sediment-laden water across the Mine Site together with the leachate management dam.

Domain 8 – Other Infrastructure

The domain includes the remaining buildings on the Mine Site including the administration building and amenities, the Bowdens exploration office and core library, the explosives magazine and the remaining tracks and roads across the Mine Site.

2.16.5 Final Landform

Figure 2.26 displays the final landform across the Mine Site at the end of the Project life. The key features of the final landform would be as follows.

1. The main open cut pit would be left as a void covering approximately 53ha and allowed to progressively fill largely with groundwater as most surface water would be diverted around the void.
2. The two small satellite open cut pits would be fully backfilled and their surfaces returned to pre-mining levels.
3. The WRE would remain as a north-south oriented ridge similar in elevation to surrounding ridges. The leachate management dam would be retained until leachate is no longer being generated. The dam would be removed and the former landform established in this area.
4. The TSF would remain as a self-draining landform with the upper surface shaped to direct all runoff to the closure spillway on the northwestern side of the former embankment.
5. The oxide ore stockpile would remain integrated with the southwestern side of the WRE.
6. The area formerly occupied by the processing plant and mining facility would be recontoured to create an undulating landform.
7. The area formerly occupied by the southern barrier would be recontoured to a landform similar in form to the pre-Project landform.
8. All soil stockpile areas would be re-established to their pre-Project landform.

Further information on the landforms for the above component areas of the Mine Site are provided in **Appendix 5**. Rehabilitation Procedures

Appendix 5 presents details of the rehabilitation procedures and relevant success criterion to be adopted throughout the site establishment and construction stage and for all key components within the Mine Site.

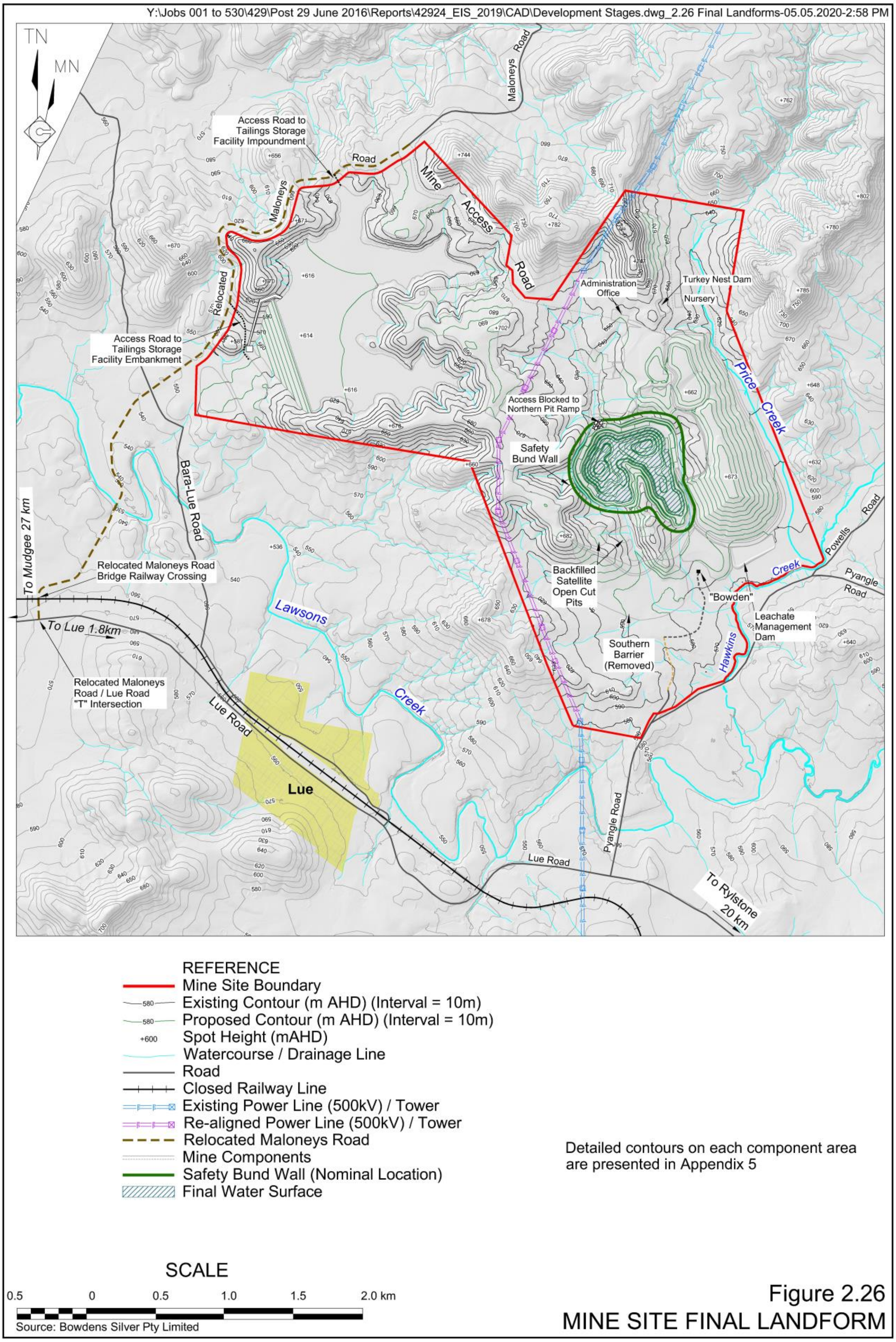

Figure 2.26
MINE SITE FINAL LANDFORM

2.16.6 Revegetation Planning and Progressive Revegetation Sequence

As discussed in Section 2.16.1, a number of Project components would remain active throughout the mine life without the opportunity to progressively rehabilitate the areas of disturbance. However, wherever possible for other Project components, progressive rehabilitation would be implemented.

Figure 2.27 displays the areas within the Mine Site that would be the subject of either temporary or permanent revegetation for a number of representative years throughout the mine life. The temporary revegetation would occur on:

- all soil stockpiles; and
- the southern faces of the southern barrier and WRE.

Permanent revegetation would commence on the WRE in Year 2, the TSF embankment and TSF NAF stockpile area in about Year 9, the satellite open cut pits in about Year 12, and two areas of the TSF impoundment during Year 16.

Following the completion of the final landform, all disturbed areas, with the exception of the open cut pit, would be revegetated in the manner described in the previous subsections.

Overall, it is anticipated the full range of rehabilitation activities would be completed within approximately 7 years of the completion of mining.

2.16.7 Rehabilitation Monitoring and Maintenance

Bowdens Silver's commitment to effective rehabilitation would involve an ongoing monitoring and maintenance program following both the progressive and end-of-Project operations. Monitoring throughout the Project life would involve the following.

- Evidence of any erosion or sedimentation from areas with establishing vegetation cover.
- Success of initial cover crop or grass cover establishment.
- Success of tree and shrub plantings.
- Natural regeneration of native species.
- Adequacy of drainage controls.
- General stability of the rehabilitated areas.
- Evidence of any acidic runoff.

Should any of the above identify a sub-optimal performance, remediation and enhancement activities would include but not be limited to the following.

- Where rehabilitation success appears limited, maintenance activities would be initiated. These may include re-seeding and where necessary, re-topsoiling and/or the application of specialised treatments.

- If drainage controls are found to be inadequate for their intended purpose, or compromised by wildlife or vegetation, these would be replaced.
- Temporary fences would be installed to exclude native fauna, if grazing appears to be excessive.
- In the event areas of excessive erosion and sedimentation are identified, remedial works such as importation of additional rocky fill, subsoil or topsoil, or re-designing of water management structures would be undertaken.
- Appropriate noxious weed control or eradication methods and programs would be undertaken in consultation with the Department of Primary Industries – NSW Agriculture (DPI-Ag) and/or the local Noxious Weeds Inspector.

No time limit would be placed on post-mining rehabilitation monitoring and maintenance. Rather, maintenance would continue until such time as the objectives outlined in Section 2.16.2 are achieved to the satisfaction of the relevant government agencies.

2.16.8 Interim and Final Land Uses

A range of regional and local strategic documents were reviewed during the design process to identify suitable post-rehabilitation land uses. The key documents which were considered include the following.

- *Central West and Orana Regional Plan 2036*
- *Mid-Western Regional Local Environmental Plan 2012*
- *Mid-Western Region Towards 2030 Community Plan*
- *The Mid-Western Regional Comprehensive Land Use Strategy 2010*

Sections 3.2.3.5 and 3.2.3.6 present a detailed discussion of how the Project has been designed to meet the objectives of these documents. Broadly, however, these documents emphasise the importance of balancing land uses within the region to minimise potential land use conflicts. The importance of agriculture, the natural environment and industry (including mining) are recognised in each of these documents. These objectives are reflected in the rehabilitation objectives of the Project and the proposed final land uses within the Mine Site which principally comprise land for grazing and nature conservation.

Interim Land Uses

Undisturbed land within the Mine Site would principally be used for nature conservation throughout the mine life and would comprise approximately 356ha of land used for passive nature conservation and 199ha which would form part of the Project’s biodiversity offset area. Grazing would not be undertaken within the biodiversity offset area, however, controlled grazing would be undertaken periodically on land used for passive nature conservation to reduce bush fire fuel loads to acceptable levels. A total of 35ha of land within and 547ha immediately surrounding the Mine would be retained for agricultural purposes throughout the mine life on land owned by Bowdens Silver. The majority of this land would comprise modified pasture suitable for improvement and/or cropping thus ensuring stocking rates are maintained or improved, wherever possible. A single lifestyle lot (18ha) would be maintained within the southeastern quadrant of the Mine Site throughout the mine life.

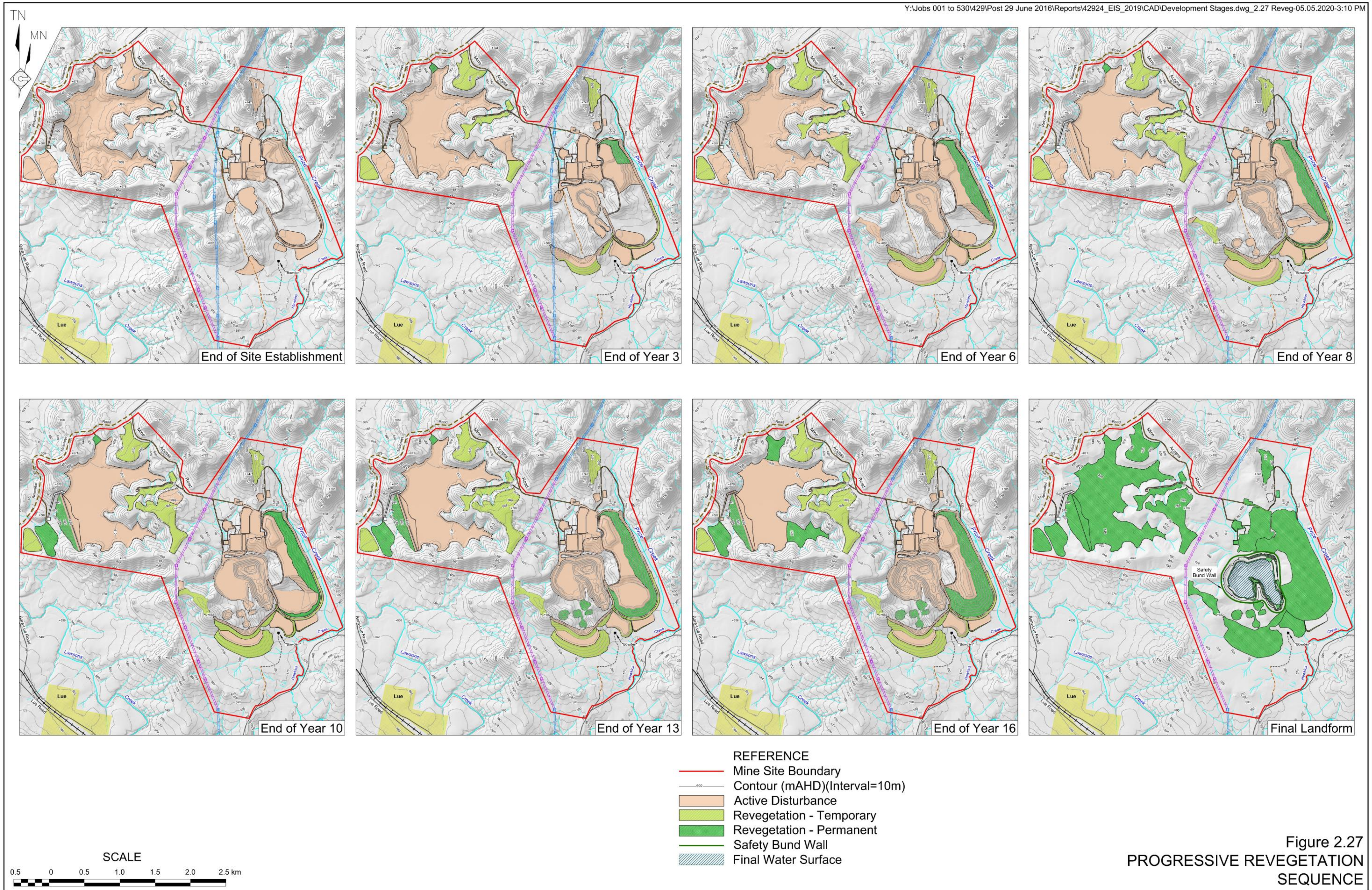

Figure 2.27
PROGRESSIVE REVEGETATION SEQUENCE

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A more detailed analysis of the changes in pre-Project and interim land uses is provided in Section 4.18.6.

Final Land Uses

Beyond the end of the Project life, it is anticipated that approximately 699ha of land within the Mine Site would be returned to agricultural production with approximately 252ha permanently removed from production. The land within the Mine Site to be permanently removed from production would include the void left by the main open cut pit (53ha) and the on-site biodiversity offset area (199ha). A single lifestyle lot (49ha) would be located in the southeastern quadrant of the Mine Site.

A more detailed analysis of the changes in pre- and post-Project land uses is provided in Section 4.18.6.

2.16.9 Mine Closure

2.16.9.1 Introduction

This subsection provides an overview of Bowdens Silver's approach towards mine closure, however, preparation for mine closure is a substantial commitment and would be reviewed and upgraded progressively throughout the life of the mine.

2.16.9.2 Mine Closure Completion Criteria

The individual rehabilitated areas would be monitored against the following broad completion criteria throughout the Project life, i.e. both during and following the period of mining operations, with the performance against each considered by the Resource Regulator when assessing any subsequent application for the relinquishment of the mining lease (or parts thereof) covering the Mine Site.

- The rehabilitated landform is clean and tidy, and free of rubbish, metal and derelict equipment/structures.
- Areas of the rehabilitated landform nominated for agricultural production are progressively returned for that use as soon as practicable. All sediment dams would be retained as farm dams within the future Bowdens farm.
- The rehabilitated landform is suitable for the proposed subsequent agricultural land use(s) and is compatible (as far as possible) with the surrounding land fabric and land use requirements.
- The uses of the rehabilitated landform are consistent with the capability of that landform.
- The rehabilitated landform is sustainable in terms of the intended land use(s), i.e. is stable and the maintenance needs are no greater than those of similar surrounding lands unaffected by mining activities.

- The rehabilitated landform integrates areas of re-established native vegetation and undisturbed native vegetation specifically to maintain or improve wildlife corridors.
- The rehabilitated landform provides for fauna habitat in nominated areas.
- The rehabilitated landform does not cause unacceptable air or water pollution, or other adverse environmental effects.

Success criteria for each of these broad completion criteria would be detailed within the MOP for the Project.

Site specific criteria for each of the rehabilitation domains would be detailed in a Mine Closure Plan prepared at least 5 years prior to the cessation of approved activities.

2.16.9.3 Timetable

As discussed in Section 2.13.3, Bowdens Silver proposes that the final rehabilitation activities would be undertaken over a period of approximately 7 years. Beyond that time it is envisaged some minor maintenance may be required. The completion of the mine closure program would occur when there is no further seepage from both the TSF and WRE and the respective collection dams can be removed.

2.16.9.4 Rehabilitation Security

The Division of Mining, Exploration and Geoscience (MEG) will require Bowdens Silver to lodge a bank guarantee to cover the cost of rehabilitation of the activities/land disturbance undertaken throughout the mine life in the event the Company defaults on its rehabilitation responsibilities. The quantum of the rehabilitation security would be calculated through the use of the MEG's Rehabilitation Calculation Tool and revised either annually or biennially to ensure the security is appropriate for the extent of rehabilitation required. The progressive rehabilitation undertaken would be taken into account when rehabilitation security is calculated.

2.17 BIODIVERSITY OFFSET STRATEGY

2.17.1 Introduction

For State significant development in NSW, residual impacts to biodiversity values must be offset in accordance with the relevant policies, guidelines and legislation. Niche (2020) were commissioned to review the outcomes of the assessments undertaken by EnviroKey (2020) and prepare a Biodiversity Offset Strategy for the Project.

In accordance with the SEARs provided by DPIE (**Appendix 2**), the Project is a "pending or interim planning application" under the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* and the environmental assessment may be undertaken under former legislation including the *Threatened Species Conservation Act 1995* and former Section 5A of the EP&A Act. The transitional arrangements are designed to permit applications that were formally in progress at the time of legislation changes to be completed under that legislation. This approach does not provide any advantage in approach other than the benefit of saving time and cost in repeating assessment work that was already underway. Accordingly, Niche (2020) addressed the requirements of the *Framework for Biodiversity Assessment* (FBA) (OEH, 2014a) in accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014b).

2.17.2 Biodiversity Offset Requirements of the Project

Using the OEH Biobanking Calculator (version 4.0), EnviroKey (2020) has determined the biodiversity offset requirements for the Project as outlined in **Tables 2.11** (ecosystem credits) and **Table 2.12** (species credits).

Table 2.11
Ecosystem Credits Required for Biodiversity Offset

Plant Community	Area Disturbed (ha)	Credits Required
CW217 White Box shrubby open forest on fine grained sediments on steep slopes in the Mudgee region of the central western slopes of NSW	21.68	1 340
CW 112* Blakely's Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	21.80	1 168
CW 111* Rough-barked Apple – Red Gum – Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	159.23	9 989
CW 216* White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	1.24	38
CW 291 Red Stringybark – Inland Scribbly Gum open forest on steep hills in the Mudgee – northern section of the NSW South Western Slopes Bioregion	112.71	6 115
CW 263 Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes	56.65	4 010
CW 242 Blue-leaved Stringybark open forest of the Mudgee region NSW central western slopes	1.04	40
CW 270 Mugga Ironbark – Red Box – White Box – Black Cypress Pine tall woodland on rises and hills in the northern NSW South Western Slopes Bioregion	0.77	46
CW 249 Derived grassland of the NSW South Western Slopes	5.18	202
CW 299 Rough-barked Apple – Blakely's Red Gum – Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	0.76	33
CW 272 Narrow-leaved Ironbark – Black Cypress Pine +/- Blakely's Red Gum shrubby open forest on sandstone low hills	0.65	38
Total	**381.71**	**23 019**

* Community meets the definition of Box Gum Woodland.

Source: EnviroKey (2020) – Modified after Table 31

Table 2.12
Species Credits Required for Biodiversity Offset

Species	Extent of Impact (ha)	Species Credits Required
Squirrel Glider	183.73	4 042
Regent Honeyeater	377.08	29 035
Koala	139.59	3 629
Ausfeld's Wattle	120.0	9 240
Source: EnviroKey (2020) – Modified after Table 32		

2.17.3 Biodiversity Offset Strategy

It is proposed that the required offsets would be met in a staged manner as outlined in **Table 2.13**. A staged approach to offsetting has been implemented for several State significant developments and requires that the biodiversity offset requirements for each stage be satisfied prior to vegetation clearing for that stage, or where a Biodiversity Stewardship Agreement is proposed (as would be the most likely outcomes for the Project), within 12 months of commencement of clearing. It is noted that the Biodiversity Offset Strategy must be approved by DPIE prior to vegetation clearing commencing.

Table 2.13
Staged offset requirement

Offset Stage	Year from commencement	Clearing area (native vegetation only)	Proportion of overall clearing/ offset requirement (approx.)
Stage 1*	0-1	222.77ha	58.36%
Stage 2	3-4	82.36ha	21.58%
Stage 3	6-12	76.61ha	20.07%
* Includes clearing associated with the relocated Maloneys Road and water supply pipeline.			

A detailed summary of the biodiversity credits required for each offset stage is presented in **Table 2.14** and the stages presented graphically in **Figure 2.28**.

To satisfy the Project's offset requirements Bowdens Silver propose to establish or facilitate the establishment of Biodiversity Offset Sites using Biodiversity Stewardship Agreements. It is noted that this is the preferred/optimum option for offsetting by DPIE. The Biodiversity Offset Sites would be established either on land within or adjacent to the Mine Site (on-site offsets) or on other freehold land within the region where offsets can be sourced under the FBA rules (off-site offsets).

The proposed on-site offsets (see **Figure 2.28**) would be established on land owned by Bowdens Silver and cover a combined area of 795ha. The on-site offsets would generate approximately 9 939 credits, meeting 43% of the Project's overall ecosystem credit offset requirement and 71% of the Stage 1 requirements.

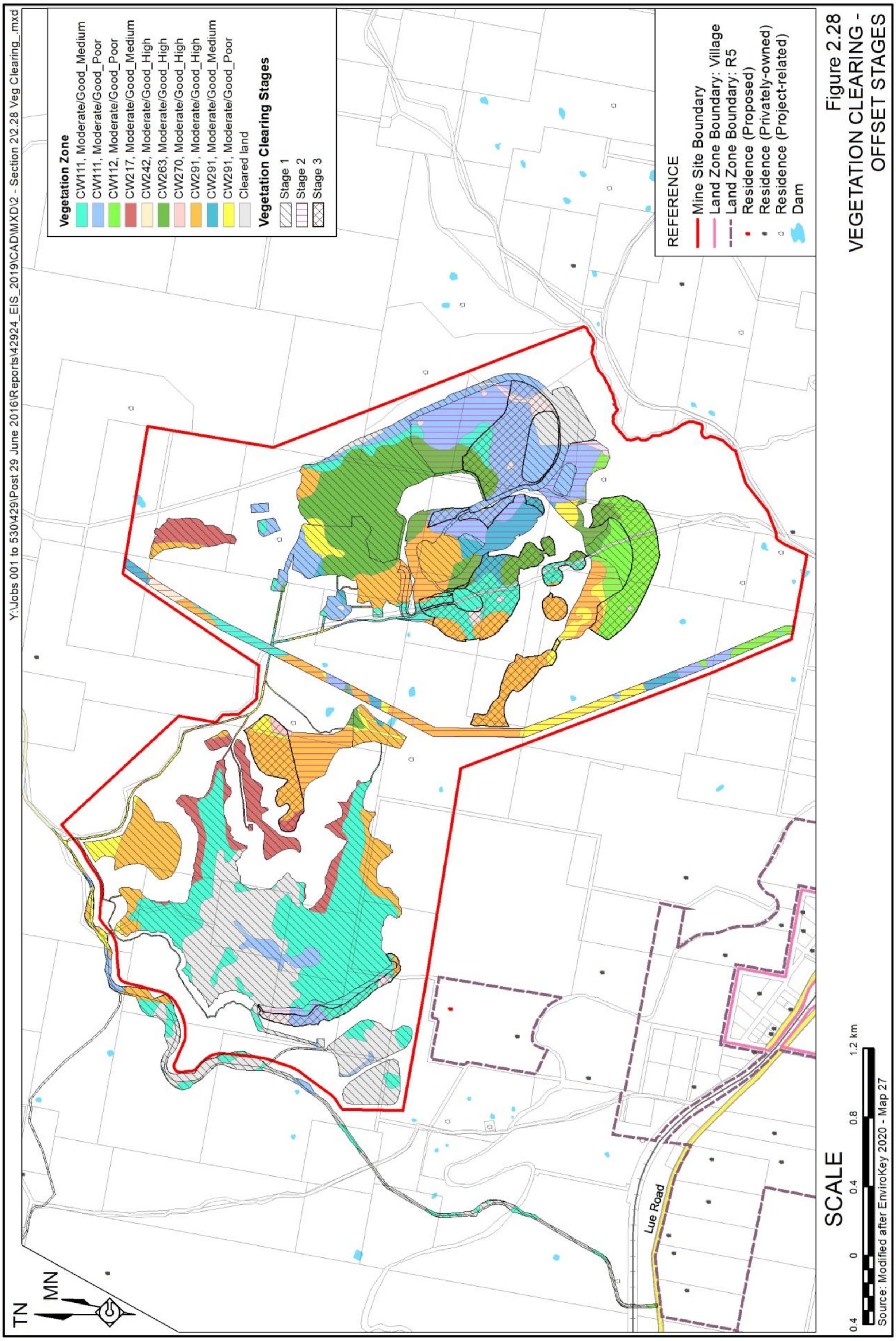

Figure 2.28
VEGETATION CLEARING - OFFSET STAGES

Table 2.14
Staged Credit Requirements for Biodiversity Offsetting

Ecosystem Credits	Credits Required			
	Stage 1	**Stage 2**	**Stage 3**	**Total**
CW217 White Box shrubby open forest on fine grained sediments on steep slopes in the Mudgee region of the central western slopes of NSW	1 288	0	52	1 340
CW 112* Blakely's Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	228	229	711	1 168
CW 111* Rough-barked Apple – Red Gum – Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	6 730	1 559	1 700	9 989
CW 216* White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	38	0	0	38
CW 291 Red Stringybark – Inland Scribbly Gum open forest on steep hills in the Mudgee – northern section of the NSW South Western Slopes Bioregion	2 659	2 007	1 449	6 115
CW 263 Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes	2 770	614	626	4 010
CW 242 Blue-leaved Stringybark open forest of the Mudgee region NSW central western slopes	0	40	0	40
CW 270 Mugga Ironbark – Red Box – White Box – Black Cypress Pine tall woodland on rises and hills in the northern NSW South Western Slopes Bioregion	4	5	37	46
CW 249 Derived grassland of the NSW South Western Slopes	202	0	0	202
CW 299 Rough-barked Apple – Blakely's Red Gum – Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	33	0	0	33
CW 272 Narrow-leaved Ironbark – Black Cypress Pine +/- Blakely's Red Gum shrubby open forest on sandstone low hills	38	0	0	38
Total*	**13 990**	**4 454**	**4 575**	**23 019**
Squirrel Glider	2 384	747	911	4 042
Regent Honeyeater	16 778	6 350	5 907	29 035
Koala	1 992	867	770	3 629
Ausfeld's Wattle	9 240	0	0	9 240
Source: Niche (2020) – Modified after Annexure 1				

The locations for prospective off-site offset sites have been determined following a desktop assessment that included analysis of existing vegetation mapping and species records with particular emphasis on areas mapped as BGW and proximity to previous Regent Honeyeater, Koala and Squirrel Glider records. A short-list of ten properties were identified with each landholder subsequently contacted with an expression of interest. To date no off-site offset sites have been finalised, however of the ten properties identified, seven landholders have so far expressed interest in the creation of a stewardship site (which would be facilitated by the Applicant).

Given the extent of native vegetation within the identified properties it is likely that the residual offset obligation would be met through establishment of one or two of the ten candidate properties. Bowdens Silver is therefore confident that the offsetting obligations for the Project would be satisfied by this approach. Upon confirmation of the available off-site offset areas, further fieldwork would be undertaken to determine the ecosystem and species credits that would be generated at these sites and confirm that the generated biodiversity credits would satisfy the offsetting requirements of the Project.

If necessary, any residual offset requirements would be satisfied by purchasing available credits from the market, through payment into the NSW Biodiversity Conservation Trust Fund, or other supplementary measures, subject to agreement. Niche (2020) placed the credits required for the Project onto the Biobanking credit register with several parties expressing interest in selling ecosystem and species credits. This indicates that suitable credits area available on the market. This option would be investigated further should the proposed strategy not be achievable. However, as noted above, this is considered unlikely.

The Biodiversity Offset Strategy would be approved by DPIE prior to commencement of any vegetation clearing.

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Section 3

Consultation, Issue Identification and Prioritisation

PREAMBLE

This section describes how the environmental issues assessed in the Environmental Impact Statement were identified and prioritised.

Throughout the preparation of the EIS, a comprehensive list of all relevant environmental issues has been assembled through consultation with the Lue and district community, government agencies and other stakeholders, a review of environmental monitoring and preliminary environmental assessments and a review of relevant legislation, planning documents and environmental guidelines.

Following identification of these environmental issues, a review of the preliminary Project design and the local existing environment was undertaken to:

- *firstly identify risk sources and potential environmental impacts for each environmental issue; and*
- *review a range of options to improve the environmental outcomes for some of the Project components.*

An analysis of the risk posed by each potential impact for the Project was then completed assuming the adoption of standard control or mitigation measures with a risk rating assigned based on likelihood and consequence of occurrence.

By considering the frequency with which each environmental issue was raised or identified, the associated environmental impacts and the allocated risk ratings, the relative priority of each issue was determined. This order of priority was then used to provide the general order of assessment and depth of coverage within Section 4.

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3.1 INTRODUCTION

In order to undertake a comprehensive assessment of the Project, appropriate emphasis needs to be placed on those issues likely to be of greatest significance to the environment, surrounding landowners, the local community and the wider community. In order to ensure this has occurred, a program of community and government consultation and a review of preliminary environmental studies, planning and other environmental documentation was undertaken to identify relevant environmental issues and potential impacts. This was followed by an analysis of the risk posed by each potential impact in order to prioritise the assessment of the identified environmental issues within this EIS.

3.2 ISSUE IDENTIFICATION

3.2.1 Introduction

Identification of environmental issues relevant to the Project involved a combination of consultation and background investigations and research. This included:

- consultation with surrounding landowners, the local community and other surrounding stakeholders (Section 3.2.2.1 and Section 3.2.2.2);
- consultation with Federal, State and local government agencies (Section 3.2.2.3); and
- reference to relevant NSW legislation, planning issues, policies and guidelines (Section 3.2.3).

The following subsections summarise the methods used by Bowdens Silver throughout the planning for the Project to inform interested stakeholders about the Project and its status and to identify issues for coverage in the EIS and supporting technical and related studies. Each of the groups, organisations or individuals consulted were nominated in the SEARs for the Project or identified during the consultation process. Consultation was undertaken by one or a combination of Bowdens Silver, RWC and/or relevant specialist consultancies. The engagement and research undertaken by Umwelt (Australia) Pty Ltd as part of the Social Impact Assessment for the Project has also identified a range of issues that have also been addressed throughout the preparation of the EIS and supporting *Specialist Consultant Studies Compendium*.

3.2.2 Consultation

3.2.2.1 Community Consultation

Since acquiring the Project in 2016, Bowdens Silver has undertaken extensive community consultation throughout the design stages of the Project and during the environmental and social assessments for the EIS with Lue and district residents and landowners along the WSP corridor. Consultation has been undertaken using a range of forums and formats including the following.

- A program of individual landowner consultation was undertaken by Bowdens Silver to ensure surrounding residents and landowners were kept appraised of proposed activities and environmental investigations. Documentation maintained by Bowdens Silver records that the Company’s personnel contacted over 103 households / landowners and held more than 83 meetings.

- The following community information sessions were held.
  - 18 June 2016 at Mudgee Stables Complex and 19 June 2016 at Rylstone Showground to introduce community members to the new owners of the Project, discuss initial plans for the progression of the development and discuss employment opportunities.
  - 20 November 2016 at the Bowdens Farm to update residents and interested parties on the progress of the Project following its acquisition by Bowdens Silver in June 2016.
  - 7 May 2017 at Lue Community Hall to discuss the plans for the Project's design and a range of environmental matters. Individual scientific experts for a number of the environmental studies were also in attendance to answer questions. This session was attended by in excess of 60 persons. **Plates 3.1** and **3.2** record some of the Lue and district community present during the 7 May 2017 session. Emphasis was placed upon presenting the baseline environmental data that had been collected or was being obtained and outlining the proposed approach to the assessment of impacts and mitigation measures for many of the Project's components.

Plate 3.1 Community Session 7 May 2017

Plate 3.2 Community Session 7 May 2017

  - 12 June 2019 at Kandos and 13 June 2019 at Mudgee to provide an introduction to the overall Project, its key components and the range of environmental studies underway to assist in the design of the Project and to minimise environmental impacts.
  - 15 June 2019 at the Bowdens Farm. This session was attended by almost 100 persons who were provided with a presentation and update about the Project and were able to review over 40 information boards displaying details about the key environmental issues and the preliminary results of the various studies. **Plates 3.3** and **3.4** record some of the Lue and district community present during the 15 June 2019 session.

Plate 3.3 Community Session 15 June 2019

Plate 3.4 Community Session 15 June 2019

Those present were able to discuss the assessments with a number of the scientific experts undertaking a number of the environmental studies. Those present were able to observe the first digital version of the three-dimensional model of the Project and to gain an appreciation of the manner in which the design of the Project had evolved.

- Bowdens Silver has maintained contact with the Principal and staff of Lue Public School since mid 2016 so that information could be shared with the wider school community. Interaction with the school has involved the following.
  - Several face to face meetings to discuss the overall project, potential educational opportunities and also potential sponsorship ideas.
  - Face to face meeting to discuss modelled noise, air quality, blasting and water drawdown scenarios. This meeting provided an opportunity to share information and answer questions.
  - Multiple email and phone communications to discuss Bowdens Silver involvement in school community events and sponsorship. Bowdens Silver attended some school events where Bowdens Silver staff discussed the Project with staff/parents/attendees.
  - Email and phone communication to discuss water testing results. (Mainly via Enviro team).
  - An excursion for all school children to the Bowden property.
  - Phone calls and emails to discuss potential rental accommodation options and endeavours to find tenants that can send their children to Lue Public School.
- A stall was operated at the Rylstone Kandos Show on 25 February 2017, 24 February 2018 and 23 February 2019 with a number of visual aids (posters and geological core samples, etc.) available for viewing. Bowdens Silver representatives were available to provide further information and answer any questions from interested community members.
- A total of eight newsletters / Project information sheets have been circulated to inform the local and broader community about Bowdens Silver's activities and other relevant information.

- A website, www.bowdenssilver.com.au has been established. The website has provided a mechanism for members of the community to pose questions and raise any issues/concerns, as well as a means to present summaries of monitoring locations, copies of the newsletters and Project information sheets, news and press releases, information about sponsorship and opportunities and the minutes of CCC meetings. Bowdens Silver also posted a number of the questions and answers posed during the community consultation program. The website has also been utilised by different community members and stakeholders to contact Bowdens Silver on a range of topics that have included Project-related questions, employment and supplier opportunities as well as seek sponsorship for a range of community events or organisations.

Water Supply Pipeline Corridor

The consultation undertaken by Bowdens Silver with the stakeholders for the proposed water supply pipeline involved discussions with individual landowners, interested Aboriginal parties and State and local government agencies.

Once an initial proposed corridor for the pipeline was identified, letters were sent to landowners via registered post to introduce the Bowdens Silver Project, the proposed water supply pipeline and to seek permission for specialist consultants commissioned by Bowdens Silver to conduct initial ecology and heritage surveys within the proposed corridor for the pipeline.

Multiple phone calls and emails were exchanged with landowners in response to the initial letters providing information about the proposed Project and pipeline as well as providing individual maps showing locations of the proposed route on each property. Discussions also focussed on the approach to establish future compensation that would be determined with each landowner via an independent valuer, easement creation, potential access, rehabilitation and importantly, landholder considerations in relation to the optimal route. Over time, the route has been optimised and face-to-face interaction and meetings have occurred with 17 of the 19 landowners during public information sessions and one-on-one meetings with Bowdens Silver staff and a specialist consultant that has been engaged to facilitate the preparation of documentation relating to compensation, access and rehabilitation agreements and ultimately easement creation. Landowner concerns raised during this phase of consultation centred around compensation and how it would be determined, the process of easement creation and the impact this may have on future land use and value, the construction process, individual access requirements and also rehabilitation methods and requirements. With guidance from the specialist consultant, landholders have been informed of their rights during the consultation and negotiation process, relevant experiences and outcomes from similar projects and opportunities to ask and seek more information. Importantly, landholder considerations have been taken into account and based on their feedback, the pipeline route has been altered in some areas to suit individual needs or preferences.

An advertisement was placed seeking registration of any interested Aboriginal parties, i.e. over and above those who had previously registered their interest in the Bowdens Silver Project. An additional three parties registered their interest in addition to the original six groups for the Bowdens Silver Project. Meetings were held with the groups in consultation with specialist archaeologist, Dr Matt Cupper regarding appropriate survey methodology. No concerns were raised by the registered Aboriginal groups or the participating landholders during either the ecological or heritage surveying.

Bowdens Silver has also consulted with representatives of MWRC and DPIE regarding a broad range of topics but has been primarily focussed on providing an overview of the project and rationale for a pipeline, advice and updates on surveying approach and requirements, input into the use of road reserves where required. MWRC was provided a preliminary overview of the proposed water supply pipeline corridor, however it was determined that formal feedback would be withheld until the public exhibition period for the application was finished. A request was provided to the Department of Planning, Industry and Environment - Crown Lands to determine the ownership status of some sections of Crown land along the water supply pipeline corridor where existing publicly available records could not conclusively determine if the land was Crown land or owned by MWRC.

Community Consultative Committee

In addition to the above, Bowdens Silver voluntarily established the Bowdens Silver Exploration Community Consultative Committee (CCC) in 2016 to provide a forum for open discussion between Bowdens Silver and stakeholder representatives from within the Bowdens Silver Exploration Licences' catchment and local and State Government. A total of four meetings of the Bowdens Exploration CCC were held between 14 November 2016 and 5 September 2017.

Bowdens Silver subsequently established the Bowdens Silver Project CCC following a request from the former DPE on 15 August 2017 when the SEARs for the Project were amended. The new committee was established in accordance with the new CCC guidelines introduced by DPE in 2016. The Project CCC is chaired by Mr Darryl Watkins with members comprising representatives from Mid-Western Regional Council (one representative), the Lue Action Group (four representatives), the Wellington Valley Wiradjuri Aboriginal Corporation (one representative), the Rylstone Kandos Chamber of Commerce (one representative), one non-aligned community representative, and Bowdens Silver (three representatives).

The Bowdens Silver Project CCC has met on eight occasions since 12 December 2017 at the Mid-Western Regional Council offices and on site. An inspection of the Mine Site was undertaken on 14 February 2018 when committee members were able to inspect the location of the proposed open cut pits and other key Project component areas. Following the inspection of the Mine Site, committee members identified a number of environmental issues that were likely to be of interest to community members. These environmental issues related primarily to hydrology, lead and human health and the EIS preparation process. In response to the raising of these issues, Bowdens Silver arranged for scientific experts in each of these fields to attend the following meeting held on 10 April 2018. Mr Rob Corkery, a principal author of the EIS, was also present at the CCC meeting held on 10 April 2018 to address a range of other environmental issues relating to the Project. In addition, Mr Nicholas Warren attended the CCC meeting held on 27 February 2020 and presented a summary of the environmental assessment outcomes to date and answered questions from CCC members.

Umwelt (2020) has documented that a total of 13 issues have been raised and documented in the CCC Meeting minutes with the five most frequently raised issues relating to health and wellbeing, water access and use, community engagement, the approvals process and regulations and information transparency.

Bowdens Silver has continued to respond to a range of questions posed by CCC members with copies of responses placed on the Bowdens Silver website.

Table A3.5 provides a compilation of issues raised throughout the comprehensive community consultation programs undertaken for the Bowdens Silver Project since 2016. The section(s) of this document and/or specialist consultant studies in which each issue is addressed are also identified in **Table A3.5**.

3.2.2.2 Other Resource Companies and Infrastructure Owners

Other Resource Companies

Bowdens Silver has held discussions with Ulan Coal Mines Limited (UCML) and Moolarben Coal Operations (MCO), regarding the provision of surplus water for use as make-up water for the Project. As a result of those discussions, Bowdens Silver is proposing to enter into separate commercial agreements with each Company for the supply of excess water from those mines. Whilst it is recognised that the current development consent for the Ulan Coal Mine expires in 2033, the opportunity will remain for Bowdens Silver to continue to pump from the underground mining operations to obtain the required water supply from that Site, i.e. in the event that the mining operations do not extend beyond 2033. MCO has also been supportive of Bowdens Silver aligning sections of the water supply pipeline on the Company's land, subject to avoiding a designated biodiversity offset and mine operation areas.

General discussions have also been held with Mudgee Dolomite & Lime Pty Limited (MDL), the operator of the Bara Quarry, 2.4km to the northwest of the Mine Site. This dialogue has provided two-way information on current and proposed future operations for both businesses with an emphasis on the proposed relocated Maloneys Road and potential construction timing. MDL has shown interest in this part of the Bowdens Silver Project as the relocated Maloneys Road would be utilised by their trucks to gain access to and from their nearby rhyolite quarry.

Electricity Providers

Realignment of the 500kV Transmission Line

TransGrid is the operator and manager of the main high voltage electricity transmission network in NSW. TransGrid is operated by NSW Electricity Networks under a 99 year lease agreement with the NSW State Government.

As the operator and manager of the 500kV power transmission line that traverses the Mine Site, TransGrid was consulted with respect to the progressive development of the open cut and proposed future re-alignment of the 500kV power transmission line to the west of the open cut in about Year 3 of the Project. Correspondence supplied by TransGrid on 23 August 2017 stated that TransGrid had identified *"no engineering reason for the line relocation to be unfeasible"* and that *"outages, constructability and design can all be managed"*.

Following the receipt of development consent for the Project, Bowdens Silver would enter into a Modification Processes Agreement with TransGrid to facilitate the investigations required for the re-alignment of the 500kV power transmission line as outlined in Section 2.11.3.2.

Supply of Power to the Project via 132kV Transmission Line

Discussions have been held with energy providers Endeavour Energy and Essential Energy regarding the options that would be available for the provision of power for the Project. The bulk of the initial discussions with Endeavour Energy focussed upon the supply of power via a 132kV power transmission line from their Ilford substation with a line route generally following the 500kV power transmission line route towards Lue.

Discussions have also been held with various independent energy providers regarding connections to existing 132kV lines such as TransGrid's Feeder 94M between Ilford and Mudgee and other options from the north, again generally via the 500kV power transmission line route or from solar power projects.

A summary of the options currently available to Bowdens Silver for power supply is presented in **Appendix 9**. Discussions with the energy providers are ongoing and will culminate in one provider being the applicant for the Project's power supply and confirmation of their role as the determining authority for the application under Part 5 of the EP&A Act for the proposed power transmission line.

Wallerawang-Gwabegar Railway Line

Bowdens Silver has consulted with John Holland Rail Pty Limited (John Holland), manager of the Wallerawang-Gwabegar closed railway line (on behalf of the Australian Rail Track Corporation) that would be traversed by the route of the proposed relocated Maloneys Road. The discussions and related correspondence culminated in correspondence from John Holland on 16 April 2019 providing Approval in Principle for the proposed bridge overpass over the closed railway line subject to a range of conditions reflecting John Holland's requirements for the proposed bridge. Bowdens Silver has committed that works on the proposed bridge would not proceed until:

- all required information is provided, via a formal application; and
- the relevant legal agreement is executed between Bowdens Silver and Transport for NSW, as part of the construction application process.

3.2.2.3 Consultation with Government Agencies

NSW State and Local Government

The Bowdens Silver Project was first introduced to a number of Government agencies at a Planning Focus Meeting (PFM) and site inspection held in Mudgee and at the Bowdens Site on 6 February 2013. That meeting which was facilitated by Kingsgate enabled the respective agencies and the then Department of Planning and Infrastructure to issue the Director-General's Requirements for the EIS. It is noted that some of the agencies who provided their requirements for the EIS in 2013 have either not provided any updates to these requirements to Bowdens Silver or have cross-referenced to their 2013 requirements in their most recent correspondence to the former Department of Planning and Environment (DPE).

This EIS has been prepared with reference to the updated Secretary's Environmental Assessment Requirements (SEARs) issued by the Department of Planning, Industry and Environment (DPIE) on 21 June 2019. These SEARs incorporate input from the following State and local Government agencies.

- Environment Protection Authority
- Department of Planning & Environment – Division of Resources and Geoscience*
- Department of Primary Industries – Agriculture
- Department of Primary Industries – Fisheries

- Department of Industry – Natural Resource Access Regulator
- Office of Environment and Heritage*
- Roads and Maritime Services
- Mid-Western Regional Council

It is noted that since the updated SEARs were issued, those agencies identified with an asterisk (*) above have been incorporated as Divisions within the DPIE.

Bowdens Silver and its consultants have hosted visits to the Mine Site from representatives of the EPA, NRAR, the then DRG and MWRC. A range of discussions have also been held with the Crown Lands office since February 2017 regarding applications to close various Crown Roads within the Mine Site, general advice regarding Aboriginal land claims and arranging access for ecological and archaeological surveys of Crown Land within the corridors for the relocated Maloneys Road and the water supply pipeline.

Appendix 3 presents a consolidated list of the requirements from the SEARs dated 21 June 2019 and from the above agencies. The requirements provided by other government agencies listed below are also included in **Appendix 3**.

- Department of Trade & Investment, Regional Infrastructure and Services (Division of Resources and Energy)
- Department of Primary Industries – Crown Lands
- Department of Primary Industries (Office of Water)
- Greater Western Area Health Service
- Department of Health (Western NSW Local Health District)
- Department of Education and Communities
- NSW Heritage Council
- TransGrid

Reference is made in **Appendix 3** to where each of the above agencies' requirements are addressed in the EIS.

Federal Government

The Project, including the construction of the water supply pipeline, was referred to the then Commonwealth Department of the Environment and Energy (DoEE) in accordance with the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) in December 2018. Bowdens Silver submitted a referral to DoEE in December 2018, accompanied by all relevant information required in the referral and received notification on 5 April 2019 that the Project has been determined to be a controlled action as a result of potential impacts upon listed threatened species and ecological communities. The DoEE subsequently provided their assessment requirements, which form part of the SEARs (see **Appendix 2**), and confirmed that the Project would be assessed under the assessment bilateral agreement with the NSW government.

3.2.3 Relevant Legislation, Planning Issues, Policies and Guidelines

3.2.3.1 Introduction

A range of Commonwealth and State legislation and regional/local planning instruments apply to the Project. The legislation and planning instruments were reviewed to identify the suite of environmental aspects that need to be addressed in the EIS. A brief summary of each relevant piece of legislation and planning instrument is provided in the following subsections. The application and relevance of the individual planning instruments as they relate to specific environmental issues have been addressed in the relevant specialist consultant assessments.

The SEARs also identify a number of guideline documents to be referenced/reviewed during the preparation of the EIS. **Appendix 3** (**Table A3.2**) provides a summary of these guidelines and a cross reference to the relevant section(s) of the EIS and/or Specialist Consultant Report where they are discussed and addressed.

3.2.3.2 Commonwealth Legislation

Native Title Act 1993

The *Native Title Act 1993* (Cth) (NT Act) establishes a mechanism to determine claims to native title. A native title determination application (or native title claim) may be made pursuant to the NT Act. Upon lodgement of a native title claim, the National Native Title Tribunal (NNTT) is required to apply a registration test and either accept the native title claim for registration or reject it. The NNTT maintains a register of native title claims.

Native title rights and interests can only exist if they have not been extinguished by a prior valid grant of a right which is inconsistent with the continuation of native title rights and interests such as the grant of freehold title. Within the Application Area, Bowdens Silver's initial investigations indicate that native title has not been extinguished over:

- one Crown land lot within the Mine Site;
- one Crown land lot and land within the bed of a waterway traversed by the relocated Maloneys Road; and
- a number of Crown land lots traversed by the water supply pipeline.

Proposed acts that may affect native title are called 'future acts'. In relation to the Project, such acts may include the grant of a mining lease as is proposed for the Mine Site, the relocation of Maloneys Road, and the construction of the water supply pipeline.

A future act is only valid under the NT Act if it complies with certain requirements of the NT Act. For example, if a native title claim is accepted for registration, the native title claimant may be entitled to negotiate about particular future acts over the land that is subject to the native title claim.

A regional native title claim NC2017/001 (Warrabinga-Wiradjuri #7) was accepted for registration on the Register of Native Title Claims on 1 September 2017.

As required, Bowdens Silver will address native title for the Project in accordance with the NT Act.

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act covers 'matters of national environmental significance' (MNES). Potentially relevant MNES to the Project include:

- listed threatened species and ecological communities;
- listed migratory species protected under international agreements; and
- National heritage places.

Under the EPBC Act, if a project has the potential to have a significant impact on MNES, it is required to be referred to the DoAWE for assessment as to whether it represents a 'controlled action' and therefore requires approval from the Commonwealth Minister for the Environment.

National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* (Cth) (NGER Act) establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production. Scope 1 and Scope 2 greenhouse gas emissions are required to be reported under the NGER Act.

Bowdens Silver's exploration activities currently do not trigger the thresholds for reporting under the NGER Act. However, it is expected that, once operational, the Project would result in Bowdens Silver triggering the thresholds for reporting under the NGER Act. Bowdens Silver would monitor the activities on site that generate greenhouse gas emissions and, if the threshold level is met, report appropriately in accordance with to the NGER Act.

3.2.3.3 NSW Legislation

Key Legislation

The key NSW legislation relating to the approvals, leases and licences required for the Project and their relevance to the Project are as follows.

- *Environmental Planning and Assessment Act 1979*
- *Mining Act 1992*
- *Protection of the Environment Operations Act 1997*
- *Water Management Act 2000*
- *Roads Act 1993*
- *Explosives Act 2003*

Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) provides the framework for the assessment and determination of development applications in NSW and is administered by the DPIE.

Development consent is required under the EP&A Act for the purposes of mining in NSW. The Project has been submitted for approval under Part 4, Division 4.7 of the EP&A Act as a State Significant Development (SSD) as the capital investment value for the Project would exceed the $30 million threshold for SSD. This is because of the effect of and Clause 8 and Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011*

The EP&A Act sets out the process for assessment of SSD applications. An EIS is required for all SSD development applications and must address the SEARs. The EIS must also comply with the requirements of Schedule 2 of the *Environmental Planning & Assessment Regulation 2000* (EP&A Regulation). The consent authority for the Project would be the Minister for Planning and Environment or the Independent Planning Commission acting under delegation from the Minister.

Section 4.41 of the EP&A Act identifies that, if development consent is granted for a SSD, the following potentially relevant authorisations are not required.

- A permit under section 201, 205 or 219 of the *Fisheries Management Act 1994*;
- An approval under Part 4, or an excavation permit under section 139, of the *Heritage Act 1977*;
- An Aboriginal heritage impact permit under section 90 of the *National Parks and Wildlife Act 1974*;
- A bushfire safety authority under section 100B of the *Rural Fires Act 1997;*
- A water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91 of the *Water Management Act 2000*.

However, the following authorisations would still need to be sought following the grant of development consent for the Project (with or without conditions as determined by the relevant authority).

- A mining lease under the *Mining Act 1992* (Mining Act).
- An environment protection licence under Chapter 3 of the *Protection of the Environment Operations Act 1997* (POEO Act).
- One or more permits under section 138 of the *Roads Act 1993* (Roads Act).

Section 4.42 of the EP&A Act provides that an application for these authorisations cannot be refused if it is necessary for the carrying out of SSD that is authorised by a development consent under this Division. Furthermore, when granted the authorisations are required to be substantially consistent with the development consent for the Project.

Mining Act 1992

The *Mining Act 1992* (Mining Act) is administered by the Division of Mining, Exploration and Geoscience (MEG) within the DPIE. The Mining Act provides the framework for exploration, development, operation and closure of mines, and provides for the management of exploration licences and mining leases to allow access to mineral resources. The Project would require a mining lease under the Mining Act prior to the commencement of operations. Bowdens Silver would make the mining lease application to the Minister for Regional New South Wales, Industry and Trade in accordance with the Mining Act.

Protection of the Environment Operations Act 1997

The *Protection of the Environment Act 1997* (POEO Act) is administered by the Environment Protection Authority (EPA) within the DPIE, which issues environment protection licences (EPLs) for wide-ranging scheduled activities, including mining.

The POEO Act also requires immediate reporting of pollution incidents, which cause or threaten to cause material harm to the environment. All holders of EPLs are required to prepare, implement and regularly test pollution incident response management plans.

The Project would require an EPL under the POEO Act to carry out 'mining for minerals'. The EPL would apply to the entire Mine Site including the open cut pits, processing plant, TSF, waste rock management structures and other infrastructure facilities. It is anticipated that an EPL would not be required for the water supply pipeline.

Any discharge of water from the Mine Site would need to be in accordance with the conditions of the EPL for the Project, which would specify the maximum permissible concentrations of relevant water quality parameters. The EPL would also specify noise and dust limits for the Project.

Water Management Act 2000

The *Water Management Act 2000* (WM Act) is administered by the Division of Water within the DPIE. The WM Act provides clear arrangements for controlling land-based activities that affect the quality and quantity of the State's water resources.

Given the Project is State Significant Development, it would require approval for an aquifer interference activity, which authorises the holder to carry out specified activities that affect an aquifer such as activities that intersect groundwater or take water from an aquifer in the course of carrying out mining below the regional groundwater table. An aquifer interference activity approval would be required when the relevant provisions of the WM Act commence.

Water Access Licences

The WM Act requires that all extraction of surface water or groundwater must be accounted for under the rules of any relevant water sharing plans. The following plans apply to the Project.

- *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012.*
- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011*
- *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011*

Water Sharing Plans specify the rules and limitations on water use in the region that is the subject of the plan and provide for equitable distribution of water in accordance with the limits of the setting, taking into account environmental requirements. The use (or 'take') of water under a Water Sharing Plan must be approved and the volume (or 'share) of that use limited through a water access licence. The licence requirements for the Project are assessed in Section 4.6 and 4.7.

It is noted that water capture, storage and use is permitted provided it is in accordance with the Maximum Harvestable Rights Capacity of the land, which is directly related to the location and size of the land. The following range of dams to be relied upon within the Mine Site are not subject to licence requirements or the Maximum Harvestable Rights Capacity requirements.

Aquifer Interference Policy

The NSW Government's *Aquifer Interference Policy* has been established under the WM Act to manage the water licensing and assessment processes for aquifer interference activities. The WM Act defines an aquifer interference activity as that which involves the:

- penetration of an aquifer;
- interference with water in an aquifer;
- obstruction of the flow of water in an aquifer;
- taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations; or
- disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations.

The Project would involve aquifer interference activities through the development of open cut pits and take of water from the regional groundwater table through groundwater inflows into the pits.

The Policy defines an agreed set of 'minimal impact' considerations that have been taken into account when assessing the Project and the potential for harm to occur to an aquifer and its dependent ecosystems, culturally significant sites, connected surface water sources and to existing water users. The Policy requires that the aquifer impact assessment consider potential impacts on water table levels, water pressure, and water quality in different types of groundwater systems. The Project has been assessed against the Aquifer Interference Policy in Section 4.6.7.5.

Roads Act 1993

The *Roads Act 1993* (Roads Act) applies to public roads in NSW, and depending upon the type of road, is administered by the Roads & Maritime Service (RMS) or local council. Consent is required under section 138 of the Roads Act for works or structures that disturb the surface of a public road, connect a road to a classified road or any other activity in a road reserve managed by the RMS or Council.

A series of permits under the Roads Act would be required to undertake the proposed relocation of Maloneys Road, intersection works and road upgrades and improvements for the Project. Mid-Western Regional Council would be the issuing authority for the required permits. A section of Maloneys Road which is proposed for relocation would be required to be formally closed by Mid Western Regional Council in accordance with Division 3 of Part 4 of the Roads Act.

It is not envisaged that it would be necessary to disturb the surface of any sealed public roads or connect to classified roads during the construction of the water supply pipeline as the pipeline would be under bored beneath all sealed public roads. The construction of the water pipeline would involve disturbance within a number of Council-managed unsealed public roads either through crossing the roads or the placement of the pipeline within or adjacent to the existing sections of road. Bowdens Silver has already consulted with Council and would continue discussions following the grant of development consent and prior to the required roadworks associated with the Project.

Explosives Act 2003

The *Explosives Act 2003* (Explosives Act) is administered by SafeWork NSW and the Resources Regulator and requires a person to hold a licence to handle, transport, store or use explosives and explosive precursors. Bowdens Silver would require the selected explosives supplier to transport all explosives, primers and detonators to the Mine Site on the day of the blast. A Dangerous Goods Licence would be sought for the on-site storage of explosives under the Explosives Act in the event a circumstance arises whereby explosive materials need to be stored on site overnight.

Other Legislation

The following NSW legislation either applies or has potential to apply to the Project at some stage(s) throughout its life and/or requires consideration as part of the EIS.

- *Biodiversity Conservation Act 2016*
- *Biosecurity Act 2015*
- *Contaminated Land Management Act 1997*
- *Crown Land Management Act 2016*
- *Crown Lands Act 1989*
- *Dams Safety Act 2015 and Dams Safety Act 1978*
- *Dangerous Goods (Road and Rail Transport) Act 2008*
- *National Parks and Wildlife Act 1974*

Biodiversity Conservation Act 2016

As substantial assessment of biodiversity was undertaken prior to the gazetting of the *Biodiversity Conservation Act 2016 (*BC Act), the former DPE confirmed, in correspondence dated 17 January 2019, that it would be appropriate to assess and offset any biodiversity impacts related to the Project in accordance with the transitional provisions of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*.

Biosecurity Act 2015

The Mid-Western Regional Council would be the regulating authority of the *Biosecurity Act 2015* in relation to weed management as it relates to the Project. It is noted that the management of invasive weeds has been prioritised by the Council and weed management would be conducted in accordance with the *Central Tablelands Regional Strategic Weed Management Plan 2017-2022.*

Contaminated Land Management Act 1997

The *Contaminated Land Management Act 1997* (CLM Act), administered by the EPA, establishes a process for investigating and remediating land that the EPA considers significantly contaminated. Based upon a review of previous land uses within the Application Area, Bowdens Silver understands that there is no known contaminated land present on the site of the Project.

Crown Land Management Act 2016

The *Crown Land Management Act 2016*, administered by Crown Lands within DPIE, applies to any Crown lands, Crown roads or Crown road reserves. Crown lands have been identified:

- within the Mine Site, including Lot 7007, DP1029353 and Lot 7008, DP1029652[1] and six Crown road reserves;
- within the relocated Maloneys Road, including one lot (Lot 7002 DP 1029653) and one waterway (Lawsons Creek); and
- within the water supply pipeline including a number of lots, Crown road reserves and waterways.

An approval for works over the subject Crown Land would be obtained prior to development.

Dams Safety Act 2015

The *Dams Safety Act 2015* (Dams Safety Act) was assented on 28 September 2015 and commenced on 1 November 2019. The objects of the Dams Safety Act are to ensure that risks arising in relation to dams are maintained at a level considered acceptable to the community, to promote transparency in regulating dam safety, to manage matters relating to dam safety, and to encourage the application of risk management in relation to dam safety.

The Dams Safety Act requires a proposed mining operation within a notification area to be referred to Dam Safety NSW. The consent authority must take into consideration any matters raised by Dams Safety NSW. The TSF and leachate management dam would be a 'declared dam' under the Dams Safety Act and would need to be designed, constructed, commissioned and operated in accordance with requirements specified by Dams Safety NSW. Due to the size and nature (i.e. partly in-ground) of a number of the proposed water management dams within the Mine Site, these dams would not be declared under the *Dams Safety Act* (in accordance with Part 2 of the *Dams Safety Regulation 2019*). There are no existing prescribed dams in the vicinity of the Mine Site.

Dangerous Goods (Road and Rail Transport) Act 2008

The *Dangerous Goods (Road and Rail Transport) Act 2008*, administered by the EPA, applies to the transport of dangerous goods, including explosives and certain chemicals, over land and the handling, unloading, receipt, transfer and storage of those dangerous goods.

Bowdens Silver would ensure that each contractor transporting sodium cyanide and blasting agents complies with any relevant requirements of this Act.

[1] The opportunity exists to exclude both lots from the Mine Site and hence the granted mining lease.

National Parks and Wildlife Act 1974

Aboriginal places and objects are protected under the *National Parks and Wildlife Act 1974* (NP&W Act). Whilst an Aboriginal Heritage Impact Permit (AHIP) issued under Section 90 of the NP&W Act is usually required to destroy, deface or damage an Aboriginal object or Aboriginal place, as the Project is SSD, under Section 4.41 of the EP&A Act, this requirement does not apply once development consent is received. Rather, the management of the identified Aboriginal objects would be undertaken in accordance with an Aboriginal Cultural Heritage Management Plan prepared in consultation with the Biodiversity and Conservation Division and Aboriginal community representatives. Further detail regarding the assessment and management of Aboriginal heritage is provided in Section 4.14.

3.2.3.4 State Planning Issues

The following six State Environmental Planning Policies (SEPPs) have been identified which apply or could potentially apply to the Project.

- SEPP (State and Regional Development) 2011
- SEPP (Infrastructure) 2007
- SEPP (Mining, Petroleum Production and Extractive Industries) 2007
- SEPP 33 – Hazardous and Offensive Development
- SEPP (Koala Habitat Protection) 2019 (and the former SEPP 44 – Koala Habitat Protection)
- SEPP 55 – Remediation of Land

State Environmental Planning Policy (State and Regional Development) 2011

This SEPP was gazetted on 1 October 2011 and applies to all projects satisfying nominated criteria made following that date. The purpose of this SEPP is to define those projects of State Significance or proposed on State Significant Sites and therefore require Ministerial approval under the provisions of the EP&A Act 1979.

The Project, which includes the development of the water supply pipeline as related works, satisfies the threshold capital investment value for a mining project of greater than $30 million as nominated in Clause 5(1)(c) within Schedule 1 of the SEPP as SSD.

State Environmental Planning Policy (Infrastructure) 2007

The Infrastructure SEPP identifies, amongst other things, the matters to be considered in the assessment of development adjacent to particular types of infrastructure including electricity transmission or distribution infrastructure, railways and rail infrastructure and road infrastructure.

Electricity Transmission or Distribution

Clause 45 of the Infrastructure SEPP identifies that where development would be carried out within or immediately adjacent to an easement for electricity purposes, immediately adjacent to an electricity substation or within 5m of an exposed overhead electricity power transmission line the consent authority must give written notice to the electricity supply authority, inviting comments about potential safety risks and take into consideration any response received.

Bowdens Silver acknowledges that the Project would require the realignment of a 500kV power transmission line that traverses the Mine Site (see Section 2.11.3.2 and **Figure 2.1**). As outlined in Section 3.2.2.2, TransGrid has identified there is *"no engineering reason for the line relocation to be unfeasible"* and that *"outages, constructability and design can all be managed"*.

Railways and Rail Infrastructure Facilities

Clause 85 of the Infrastructure SEPP identifies that, where development is in or adjacent to a rail corridor, the consent authority must give written notice to the rail authority for the rail corridor and take into consideration their response.

Bowdens Silver proposes to construct a new railway crossing across the closed Wallerawang-Gwabegar Railway Line (see Section 2.9.2.2 and **Figure 2.18**). The crossing would involve the construction of a bridge providing at least 5.8m clearance above the railway line.

As outlined in Section 3.2.2.2, Bowdens Silver has consulted with John Holland, manager of the Wallerawang-Gwabegar closed railway line who have provided Approval in Principle for the proposed bridge overpass subject to a range of conditions.

Road Infrastructure

Clause 101 of the Infrastructure SEPP identifies that where a development has a frontage to a classified road, development consent must not be granted unless the consent authority is satisfied that:

- vehicular access to the land is provided by a road other than the classified road;
- the safety, efficiency and ongoing operation of the classified road would not be adversely affected by the design of the vehicular access to the land, the emission of smoke or dust from the development or the nature, volume or frequency of vehicles using the classified road to gain access to the land; and
- the development is of a type that is not sensitive to adverse impacts from the classified road.

The Project includes a separate mine access road providing access from the proposed relocated Maloneys Road. Assessment of the safety and efficiency of the classified road network has been assessed by The Transport Planning Partnership (see Part 10 of the SCSC) and air quality has been assessed by Ramboll (see Part 2 of the SCSC). Given that dust levels are predicted to comply with deposited dust criteria, dust emissions are not considered likely to have any significant impact upon the classified road network. The Project is also not considered sensitive to adverse impacts from the classified road network.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP)

The Mining SEPP was gazetted on 17 February 2007 in recognition of the importance to New South Wales of mining, petroleum production and extractive industries. The Mining SEPP specifies matters requiring consideration in the assessment of any mining, petroleum production and extractive industry development. A summary of the matters that the consent authority needs to consider when assessing a new or modified proposal is presented in **Table 3.1** together with a reference to where each matter is addressed in this document.

Table 3.1
Application of SEPP (Mining, Petroleum Production and Extractive Industries (2007)

Relevant SEPP Clause	Description	Coverage in EIS Section
12AB: Non-discretionary development standards	Consideration is given to development standards that, if complied with, prevents the consent authority from requiring more onerous standards for those matters. These standards related to:	
	• cumulative noise level;	4.2.2.4 & 4.2.2.7
	• cumulative air quality level;	4.4.2.1 & 4.4.2.5
	• airblast overpressure and ground vibrations; and	4.3.3 & 4.3.6
	• aquifer interference.	4.6.7.5
12: Compatibility with other land uses	Consideration is given to: • the existing uses and approved uses of land in the vicinity of the development;	4.1.4.2, See SCSC Part 14 (7.4.7)
	• the potential impact on the preferred land uses (as considered by the consent authority) in the vicinity of the development; and	4.13.3, 4.18.2
	• any ways in which the development may be incompatible with any of those existing, approved or preferred land uses.	4.13.2, 4.13.5
	The respective public benefits of the development and the existing, approved or preferred land uses are evaluated and compared.	4.1.4.2, See SCSC Part 14 (7.4.7)
	Measures proposed to avoid or minimise any incompatibility are considered.	4.2.2.5, 4.2.2.7
12A Voluntary land acquisition and mitigation policy	Before determining an application for consent for State significant development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider any applicable provisions of the voluntary land acquisition and mitigation policy and, in particular: a) any applicable provisions of the policy for the mitigation or avoidance of noise or particulate matter impacts outside the land on which the development is to be carried out, and b) any applicable provisions of the policy relating to the developer making an offer to acquire land affected by those impacts.	4.2.2.5, 4.4.2.4,
13: Compatibility with mining, petroleum production or extractive industry	Consideration is given to whether the development is likely to have a significant impact on current or future mining, petroleum production or extractive industry and ways in which the development may be incompatible.	No other mining nearby
	Measures taken by the Applicant to avoid or minimise any incompatibility are considered.	
	The public benefits of the development and any existing or approved mining, petroleum production or extractive industry must be evaluated and compared.	

Table 3.1 (Cont'd)
Application of SEPP (Mining, Petroleum Production and Extractive Industries (2007)

Page 2 of 2

Relevant SEPP Clause	Description	Coverage in EIS Section
14: Natural resource and environmental management	Consideration is given to ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure: • impacts on significant water resources, including surface and groundwater resources, are avoided or minimised to the greatest extent practicable;	4.6.7, 4.6.8, 4.7.4, 4.7.5, 4.7.7.3, 4.7.7.4
	• impacts on threatened species and biodiversity are avoided or are minimised to the greatest extent practicable; and	4.10.5, 4.10.6.1, 4.10.7
	• greenhouse gas emissions are minimised to the greatest extent practicable.	4.5.3, 4.5.4
	Consideration is given to an assessment of greenhouse gas emissions (including downstream emissions)	4.5.3
	Consideration is given to any certification by the Office of Environment and Heritage or the Director-General of the Department of Primary Industries that measures to mitigate or offset the biodiversity impact of the proposed development will be adequate.	4.10.7
15: Resource recovery	The efficiency of resource recovery, including the reuse or recycling of material and minimisation of the creation of waste, is considered.	2.4, 2.14
16: Transportation	The following transport-related issues are considered. • The transport of some or all of the materials from the site by means other than public road.	2.9.1
	• Limitation of the number of truck movements that occur on roads within residential areas or roads near to schools.	2.9.2
	• The preparation of a code of conduct for the transportation of materials on public roads.	4.12.4.1,
17: Rehabilitation	The rehabilitation of the land affected by the development is considered including: • the preparation of a plan that identifies the proposed end use and landform of the land once rehabilitated;	2.16
	• the appropriate management of development generated waste;	2.14
	• remediation of any soil contaminated by the development; and	4.7.4.4
	• the steps to be taken to ensure that the state of the land does not jeopardize public safety, while being rehabilitated or at the completion of rehabilitation.	2.15.1

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33)

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'.

In order 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. 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.

Based on the proposed quantities of blasting agents (explosives) (Class 5.1) and sodium cyanide to be used and/or stored on site at any one time, the Project is classified as 'potentially hazardous' and a PHA was undertaken for the Project (see Section 4.16 and Part 4 of the SCSC). A route evaluation study was also undertaken for the transportation of sodium cyanide to the Mine Site (see Section 4.16 and Part 4 of the SCSC). In summary, the PHA concluded that the risk of potential off-site safety effects to surrounding land uses or environmental effects to surrounding ecosystems is very low and all risk criteria would be met by the Project. The transport route for sodium cyanide to the Mine Site was also assessed to be a low risk to the biophysical and human environment.

State Environmental Planning Policy (Koala Habitat Protection) 2019 and the former State Environmental Planning Policy No. 44 – Koala Habitat Protection

At the time that the SEARs for the Project were received and the assessments undertaken for the Project, SEPP 44 was the relevant State policy regarding Koala habitat protection. This policy was repealed on 1 March 2020 and replaced with the SEPP (Koala Habitat Protection) 2019. Both of these SEPPs aim to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline. The SEPP (Koala Habitat Protection) 2019 updates the definition of core Koala habitat and the Koala feed tree species present in the various Koala management areas. The SEPP (Koala Habitat Protection) 2019 therefore has a broader definition of koala habitat recognising the variety of trees and locations that provide habitat for the species.

The Mid-Western Regional Local Government Area is listed under Schedule 1 of the SEPP (Koala Habitat Protection) 2019. The former Rylstone LGA (now incorporated into the Mid-Western Regional LGA) was also identified in Schedule 1 of the former SEPP 44. The Mid-Western Regional Local Government Area is located within the Northwest Slopes Koala Management Area (KMA). Currently, no Koala Plan of Management has been prepared for the Northwest Slopes KMA. Notwithstanding, both policies require an investigation to be carried out to determine if any Koala feed trees are present within the Application Area and whether the land is core Koala habitat. Schedule 2 of SEPP (Koala Habitat Protection) 2019 provides a list of tree species that are favoured feed tree species of Koalas.

An assessment of the potential for Koala habitat, including review of feed trees and Koala presence, has been undertaken by EnviroKey Pty Ltd. The results of the assessment are presented in Section 4.10.6.4 and EnviroKey (2020).

State Environmental Planning Policy No. 55 – Remediation of Land

SEPP 55 aims to promote the remediation of contaminated land for the purpose of reducing the risk of harm to human health or any other aspect of the environment. In particular, this policy requires consideration of whether a development requires a consent for remediation works or not and, where warranted, requires that remediation works meet certain standards and notification requirements.

As the areas proposed for disturbance within the Application Area have previously been used for grazing and/or exploration activities, it is highly unlikely any contamination is present that requires remediation work prior to undertaking the proposed mining operation. It is noted that areas historically used for the storage of chemicals for agricultural applications are located beyond the proposed limit of disturbance. Hence, based upon preliminary investigations, SEPP 55 is not relevant to the consideration of the Project and is not considered further.

3.2.3.5 Regional Planning Issues

Central West and Orana Regional Plan 2036

The *Central West and Orana Regional Plan 2036* (CWO Regional Plan) was prepared by the NSW State Government to act as a key policy response to manage competing land uses within the Central West and Orana region (the region). The CWO Regional Plan was released in June 2017, with the implementation of the plan overseen and coordinated by the Central West and Orana Delivery, Coordination and Monitoring Committee.

A key direction of the CWO Regional Plan is to protect the region's diverse and productive agricultural land by managing the interface between important agricultural land and other land uses. Mapping of Biophysical Strategic Agricultural Land (BSAL) is one action that has been taken in order to facilitate the protection of agricultural land in the region. It is noted that the sustainable management of mineral resources, including the protection of areas with potential mineral and energy resources, is also identified as a key direction within the CWO Regional Plan.

As the Project is classified as a State Significant Development, Clause 50A of the *Environmental Planning and Assessment Regulation 2000* requires that the development application must be accompanied by either a "Site Verification Certificate", which certifies that the land on which the proposed development is to be carried out is not BSAL, or a "Gateway Certificate" is required. Bowdens Silver sought and obtained a Site Verification Certificate on 8 November 2017 which confirms that there is no contiguous BSAL within the boundary of the Mine Site[2]. A review of regional BSAL mapping data indicates that the water supply pipeline corridor does not intersect any land mapped as BSAL.

Dark Sky Planning Guideline

The Siding Spring Observatory, situated on the eastern boundary of Warrumbungle National Park near Coonabarabran approximately 168km from the Mine Site, requires the night sky to be free from light pollution as it reduces the ability of the optical telescopes at the observatory to operate effectively.

The *Dark Sky Planning Guideline* (DPE, 2016) was released to provide guidance and technical information on lighting design requirements for developments within the Dark Sky Region – an area which comprises the land within a 200km radius of Siding Spring Observatory. Three radii have been defined within the Dark Sky Region (0-12km, 12-18km and 18-200km from Siding Spring Observatory, respectively) with a set of requirements in regard to light disturbances defined for each radius. Determining authorities must consider these requirements before a development consent can be granted to Projects located within the Dark Sky Region. The Director of Siding Spring Observatory must also be consulted for State significant developments located within the Dark Sky Region.

As the Mine Site is located within the Dark Sky Region, the potential impacts of the Project on the Siding Spring Observatory were assessed within the results of the Lighting and Sky Glow Assessment (LAS, 2020) presented in Section 4.9 of this document and Part 8b of the SCSC. Consultation was also undertaken with the Director of Siding Spring Observatory to establish the quantum of any potential impacts from the Project on astronomical operations at the Siding Spring Observatory.

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[2] A copy of the issued Site Verification Certificate is reproduced as Annexure E in the Land and Soil Capability Assessment (SMD, 2020)

3.2.3.6 Local Planning Issues

This document is required to outline how the Project complies with the provision of the Mid-Western Regional Local Environmental Plan 2012 (Mid-Western Regional LEP) and a series of strategic plans prepared and released by the MWRC.

Mid-Western Regional Local Environmental Plan

Mine Site and Relocated Maloneys Road

The Mine Site and relocated Maloneys Road are located wholly within Zone RU1 – Primary Production with open cut mining indicated as permissible with consent within this zone (see **Figure 3.1**). The planning objectives of this zone are:

- *To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.*
- *To encourage diversity in primary industry enterprises and systems appropriate for the area.*
- *To minimise the fragmentation and alienation of resource lands.*
- *To minimise conflict between land uses within this zone and land uses within adjoining zones.*
- *To maintain the visual amenity and landscape quality of Mid-Western Regional by preserving the area's open rural landscapes and environmental and cultural heritage values.*
- *To promote the unique rural character of Mid-Western Regional and facilitate a variety of tourist land uses.*

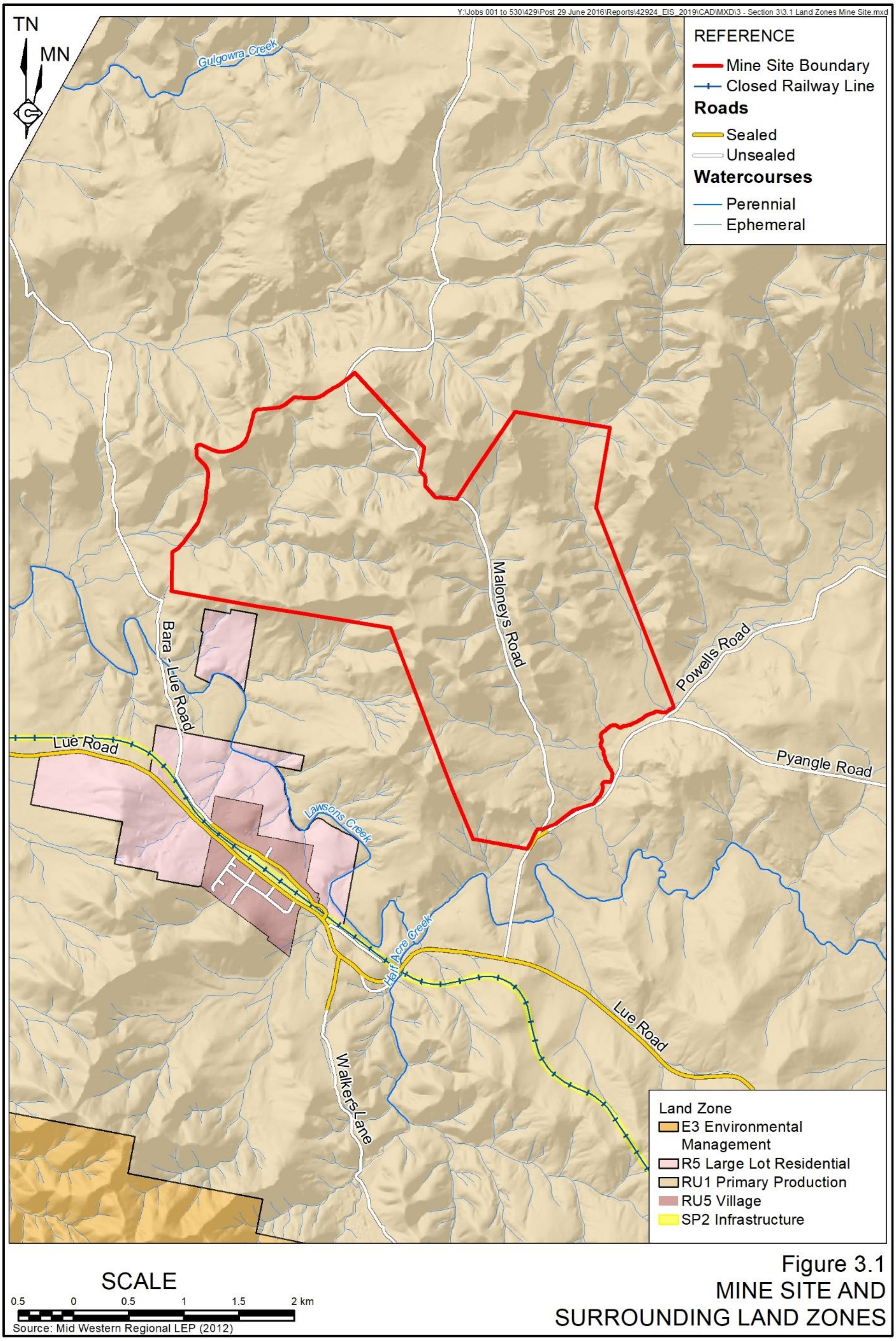
The Project would remove a maximum of approximately 1 384ha of land currently used for agriculture (principally low value grazing) out of production throughout the Project life due to land use changes. The total amount of land that would be permanently removed from agricultural production after rehabilitation would be approximately 745ha, the bulk of which would be biodiversity offsets. It is noted that agricultural production would be maintained as far as practicable throughout the Project life on land owned by Bowdens Silver with land uses largely re-established for grazing purposes following the completion of rehabilitation activities. Section 4.18 addresses potential impacts on agricultural productivity throughout the Project life as well as the proposed management and mitigation measures that would be implemented to minimise these impacts. Potential impacts on visual amenity are considered in Section 4.9 of this document.

The Mine Site comprises land mapped as vulnerable (Clause 6.4) and biodiversity sensitive (Clause 6.5) within the Mid-Western Regional LEP.

The objectives of Clause 6.4 of the Mid-Western Regional LEP are:

a) *to maintain the hydrological functions of key groundwater systems,*

b) *to protect vulnerable groundwater resources from depletion and contamination as a result of development.*



Source: Mid Western Regional LEP (2012)

Figure 3.1
MINE SITE AND SURROUNDING LAND ZONES

The Project would not adversely impact upon these objectives and any potential impacts on groundwater systems and groundwater users have been comprehensively considered in the groundwater assessment (Section 4.6).

The objective of Clause 6.5 of the Mid-Western LEP is to maintain terrestrial biodiversity by:

a) *protecting native fauna and flora*, *and*

b) *protecting the ecological processes necessary for their continued existence*, *and*

c) *encouraging the conservation and recovery of native fauna and flora and their habitats.*

It is acknowledged that the Project has the potential to impact upon fauna and flora through the direct clearing of approximately 383.4ha of native vegetation and through indirect impacts such as the introduction of pests and weeds, habitat fragmentation and the exposure of wildlife to contaminated water. It is noted that potential impacts to biodiversity have been avoided or minimised to the greatest extent practicable through the design of the Project with residual impacts to be offset as part of the Project's Biodiversity Offset Strategy. Section 4.10 addresses the potential for the Project to impact on biodiversity as well as the ongoing management and mitigation measures that would be implemented throughout the Project life.

Water Supply Pipeline

The water supply pipeline would traverse land zoned RU1 – Primary Production and R5 – Large Lot Residential (see **Figure 3.2**). Water supply systems are permissible with consent on land zoned RU1 – Primary Production, however, they are prohibited on land zoned R5 – Large Lot Residential. It is noted that consent may still be granted by the Minister for the development of the water supply pipeline on land zoned R5 – Large Lot Residential as only part of the development is prohibited by the Mid-Western LEP. This is in accordance with section 4.38(3) of the EP&A Act which states that "*development consent may be granted despite the development being partly prohibited by an environmental planning instrument*".

The water supply pipeline would traverse land mapped as groundwater vulnerable (Clause 6.4) and biodiversity sensitive (Clause 6.5) within the Mid-Western LEP. The construction of the water supply pipeline would not limit the achievement of the objectives of Clause 6.4 as the pipeline would be laid in a trench up to approximately 1.4m deep and would not intersect any groundwater systems. Furthermore, potential impacts to biodiversity would be avoided, minimised and mitigated to the greatest extent practicable in accordance with the transitional provisions of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*. Further details regarding biodiversity management are provided in Section 4.10.5.

Mid-Western Region Towards 2030 Community Plan

The Mid-Western Region Towards 2030 Community Plan (Towards 2030 Community Plan) outlines the strategic direction for the Mid-Western Regional Local Government Area (LGA). This plan was developed in collaboration with the local community and identifies the following five areas of focus.

1. Looking after our Community – activities and initiatives that produce vibrant, healthy and proud towns.
2. Protecting our Natural Environment – conserving and promoting the natural beauty of the Region.

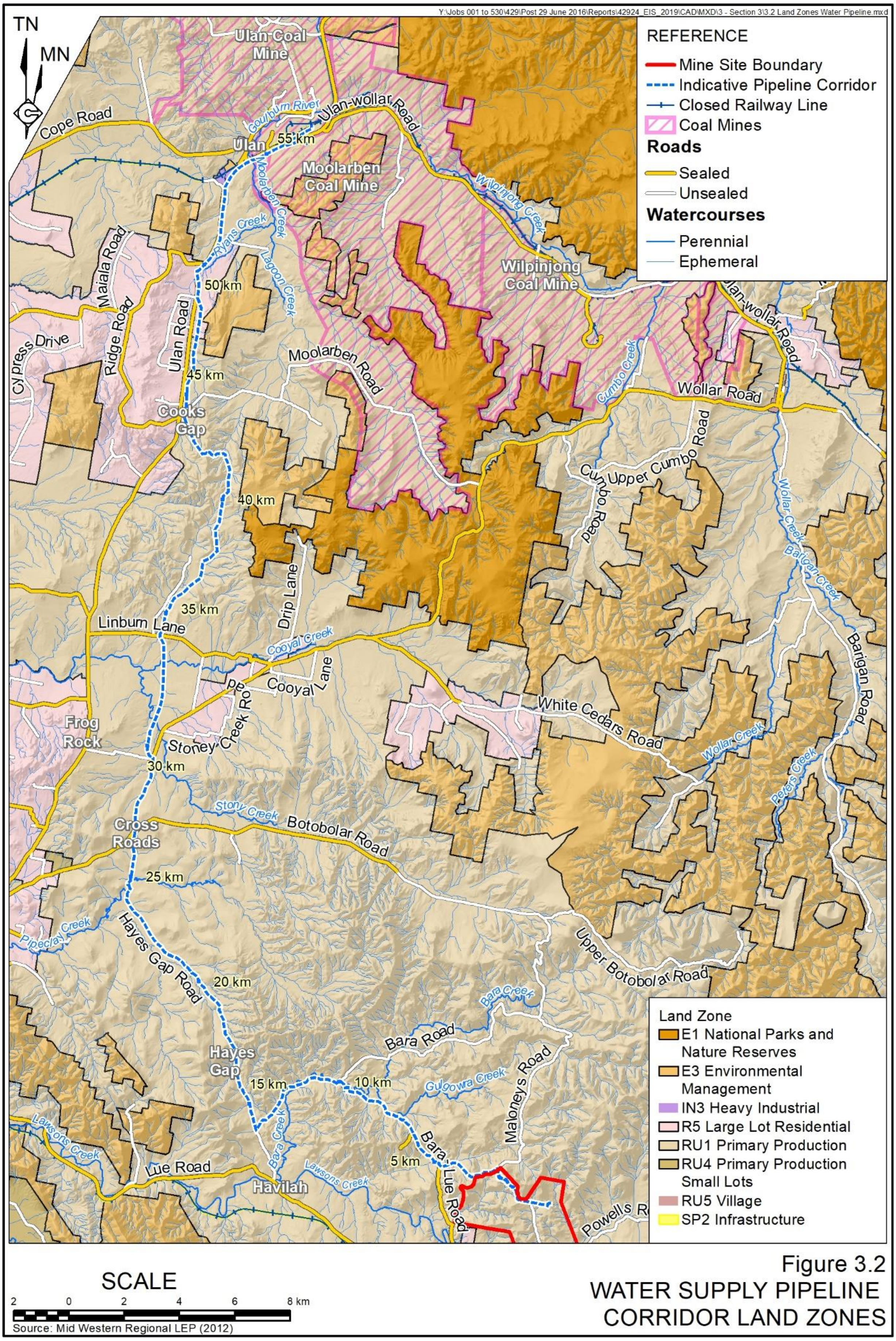


Figure 3.2
WATER SUPPLY PIPELINE CORRIDOR LAND ZONES

3. Building a Strong Local Economy – a focus on industry diversification, employment and economic growth.
4. Connecting our Region – linking towns and villages and connection to the rest of NSW.
5. Good Government – ensuring Council is representative of the community and effectively meeting community needs.

Key strategies identified within the Towards 2030 Community Plan that are relevant to the Project include:

- managing the impacts of mining operations in the region;
- minimising the impact of mining and other development on the environment, both natural and built;
- encouraging the development of a skilled and flexible workforce to satisfy local industry and business requirements; and
- supporting projects that create new jobs in the Region and help to build a diverse and multi-skilled workforce.

The Project would assist the region in achieving its goals in relation to economic and employment opportunities, especially given the significant investment it would bring to the region. The diversification of mining, i.e. to mines other than coal mines, would result in a range of difference skills training. Furthermore, the Project has been designed to mitigate, minimise or avoid potential impacts to the environment to the greatest extent practicable. As such, the Project would not limit the achievement of the strategic goals outlined in the Towards 2030 Community Plan.

The Mid-Western Regional Comprehensive Land Use Strategy 2010

The Mid-Western Regional Comprehensive Land Use Strategy (2010) provides a blueprint for the LGA to meet long term urban and rural growth needs. This plan positions Mudgee as the sub-regional service, commercial and tourism centre for the region, complemented by the smaller towns of Rylstone, Kandos and Gulgong, fourteen villages (including Lue) and other rural localities.

The Land Use Strategy (2010) identifies mining as a key driver of population, employment and economic growth within the Mid-Western Regional LGA. The Land Use Strategy highlights the need for Council to consider resource protection and management as well as environmental and community interests during the development of local land use controls. It is noted that the Mine Site is located wholly within Zone RU1 – Primary Production with open cut mining permissible with consent.

In 2017, the Mid-Western Regional Council released a revised version of the Land Use Strategy, which aims to predict expected demand and supply pressures on land usage across the LGA to 2031. This report, whilst primarily based on Projections first estimated from 2001 ABS data, provides an up to date summary of Council's strategic goals and existing Council land assets available to manage future housing needs associated with an increasing population.

The revised Land Use Plan (2017) identifies that whilst there would be a need for residential development to accommodate the growing population, this development must be progressively managed to balance the necessity of growth against current agricultural land use and the capacity of services and facilities to accommodate new residents. Control measures identified include:

- Maintaining a settlement hierarchy based on capacity and potential to grow, namely:
  - Develop a 'hard edge' limit on the future growth development boundary of the Mudgee urban area.
  - Concentrate development in locations with access to services and facilities (namely Mudgee, Gulgong, Rylstone and Kandos).
- Prevent inappropriate fragmentation of agricultural lands (through subdivision).
- Prevent development of inappropriate non-agricultural land uses including large lot residential development that would adversely affect the productivity of agricultural areas and result in inappropriate fragmentation.
- Retain the ability to seek development approval for a dwelling on lots that have been created by Council for that purpose.

The settlement hierarchy outlined in the Land Use Strategy proposes that most development should occur in Mudgee, with moderate growth Projected for Gulgong and Rylstone and some growth in Kandos. The report predicts that medium term growth (5 to 15 years) would require an additional 80 to 100 large lot residential plots and 1 100 to 1200 residential lots across the LGA. Estimates indicate that as of 2017, Council held approximately 1 100 potential lots based on land already zoned for residential development within the LGA. Based on these projections, it was determined that additional land would be required if large lot residential developments were to be allowed, and that additional land may also need to be rezoned to accommodate single lot residential developments.

A key strategic direction for Council is to increase diverse, sustainable and adaptive housing stock. In line with this, nine housing estates currently being developed close to Mudgee, with approximately 111 lots which would become available as the estates further progress. The Land Use Strategy (2017) identifies a small area of land to the south of Lue, which could be prioritised for rural lifestyle development under the lot size of 6ha to 12ha, deemed by Council to be in keeping with Lue's aesthetics. This area could afford the development of an additional 11 rural lifestyle lots in proximity to Lue.

Mid-Western Regional Contributions Plan 2019

The Mid-Western Regional Contributions Plan allows Council to impose conditions on development consents requiring contributions or fixed rate levies, in accordance with Section 7.11 and 7.12 of the EP&A Act, in order to source funding for new and upgraded infrastructure.

Bowdens Silver intends to rely upon a Planning Agreement negotiated with Council to cover the matters conventionally covered in the Contributions Plan.

3.2.4 Summary of Environmental Issues and Potential Impacts

3.2.4.1 Introduction

Table 3.2 presents a summary of the environmental issues identified by the various Commonwealth, State and local government agencies, along with the frequency with which each was identified. The frequency of identification provides an initial indication of those environmental aspects perceived to be at greatest risk and hence of greatest priority, with **Table 3.2** being ordered accordingly (from most to least frequently identified). The following subsections provide the reasoning for the numbers displayed in the source and frequency identification columns within **Table 3.2** which forms one part of the method used to determine the relative priority of each environmental issue discussed in detail in Section 4.

The following environmental issues of relevance to the Project have been identified based on the results of the consultation undertaken and a review of relevant planning instruments and environmental guidelines.

In addition to the environmental issues listed in **Table 3.2**, both government and community representatives raised numerous matters relating to the Project design and numerous general requirements.

Table 3.2
Summary of Identified Environmental Issues

	Source and Frequency of Identification		
Environmental Issue	**Government Consultation#**	**Community Consultation***	**Total**
Socio-economic Impacts / Benefits	12	202	214
Surface Water / Erosion / Flooding	47	75	122
Noise / Blasting / Vibration	20	79	99
Human Health / Lead	2	97	99
Traffic and Transport	27	61	88
Groundwater	32	53	85
Air Quality / Greenhouse Gas	24	57	81
Rehabilitation & Final Landform	31	23	54
Water - General	41	6	47
Hazards	15	12	27
Waste Management / Acid Mine Drainage	20	7	27
Visual Amenity / Lighting	3	22	25
Terrestrial Ecology	11	11	22
Aquatic Ecology	13	7	20
Soil and Land Resources / Management	15	4	19
Cultural heritage	15	2	17
Land Use / Planning / Permissibility	2	8	10
GDEs	5	0	5

Based upon questions raised by Lue and district community.
* Based upon SEARs and Government Agency Requirements.

For each of the environmental issues identified, potential environmental impacts associated with the Project have been identified through consideration of the type of impact and potential consequences.

3.3 ANALYSIS OF ENVIRONMENTAL RISK AND ISSUE PRIORITISATION

3.3.1 Analysis of Environmental Risk

This subsection prioritises the identified environmental issues, with respect to the potential for environmental impact. This is initially achieved through an analysis of the risk sources and potential environmental impacts. Once identified, an analysis of risk associated with each environmental issue has been undertaken. The analysis of risk has been completed generally in in accordance with international standards for risk management, "AS ISO 31000:2018 Risk management – Guidelines", "SA/SNZ HB 89:2013 Risk Management – Guidelines on risk assessment techniques" as well as Standards Australia "HB 203:2012 Managing environment-related risk", as well as through consideration of the likelihood and potential consequence(s) of the environmental impacts.

In order to analyse the environmental risks associated with the Project, a risk assessment involving representatives from R.W. Corkery & Co. Pty Limited and a number of members of the Specialist Consultant team was undertaken. The assessment included identification of:

- each of the likely risk sources;
- their potential consequences; and
- the likely receptors / surrounding environment.

A risk analysis of these identified risks was subsequently undertaken to review the potential consequence / hazard of each risk source and the subsequent risk ranking based upon consideration of both a consequence ranking and likelihood or probability ranking. The results of the risk assessment with the adoption of standard control measures is presented in **Appendix 7**.

3.3.2 Prioritisation of Key Environmental Issues

The prioritisation of the key environmental issues, and hence their general order of presentation in this document, has been established through reference to the following.

- The results of the issue identification process recorded in Section 3.2.
- The risk analysis outlined in Section 3.3.1 and tabulated in **Appendix 7**.
- The experience of the document's author in assembling Environmental Impact Statements.

In some cases, the order reflects the need to address one issue prior to another to assist in better understanding the latter issue.

The key environmental issues are presented in Section 4 in the following order.

- Noise
- Blasting and Vibration
- Air Quality

- Greenhouse Gas
- Groundwater
- Surface Water
- Health (including lead)
- Visibility
- Terrestrial Ecology
- Aquatic Ecology
- Traffic and Transportation
- Land and Soil Capability
- Aboriginal Cultural Heritage
- Historic Heritage
- Public Safety Hazards
- Local Infrastructure and Services
- Agricultural Lands and Enterprises
- Economic Impact Assessment
- Social Impacts

The waste rock characterisation assessment is relevant principally to the surface water and groundwater assessment and is discussed in Section 2.5 and Section A5.4 of **Appendix 5**.

It should be noted that the positioning of the economic and social assessments within the above order is not a direct consequence of the prioritisation assessment but rather positioned as such as a number of other environmental risk sources included economic or social risks and, as such, it was appropriate that those issues be addressed following the discussion of the contributing issues.

Section 4

Environmental Assessment and Management

PREAMBLE

This section describes the environmental setting within and surrounding the Mine Site and water supply pipeline corridor for the Bowdens Silver Project. Emphasis is placed in the initial subsection (Section 4.1) upon providing information about the environmental setting and the features that would contribute to or influence the assessment of a wide range of other environmental parameters. Information is provided on the regional and local topography, meteorology, land ownership and land uses.

This section also describes the specific environmental features of the Mine Site and its surrounds and the water supply pipeline corridor that would or may be affected by the Project. Information is provided on: existing conditions; relevant assessment criteria, where appropriate; potential impacts and the proposed management and mitigation measures to minimise or avoid those impacts; the assessment of residual impacts; and proposed monitoring strategies. The various issues in this section are addressed generally in the order prioritised in Section 3.3.

Given the absence of any other substantive mining operations within the vicinity of Lue, negligible opportunities would occur whereby cumulative impacts need to be addressed. The presence of the comparatively small, intermittently operated Bara Rhyolite Quarry approximately 2.4km northwest of the Mine Site is only assessed in the cumulative impacts relating to traffic as the scale of the operation is such that cumulative air quality or noise impacts with the Project would be negligible.

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4.1 REGIONAL AND LOCAL CONTEXT

4.1.1 Topography

4.1.1.1 Mine Site

Regional and Local Setting

The Mine Site is situated on the outer western flanks of the Great Dividing Range with the regional topography dominated by elevated rocky ridges separated by either broad and flat or partially confined alluvial valley settings. The topography generally ranges in elevation from approximately 770m AHD within peaks and ridges associated with the Great Dividing Range in the northeast, to elevations below 550m AHD within the alluvial valley of Lawsons Creek to the southeast of the Mine Site (**Figure 4.1.1**).

Mine Site Setting

Figure 4.1.2 displays the topography within and immediately adjacent to the Mine Site with the key ridges and watercourses within the Mine Site identified. The topography of the eastern and central sections of the Mine Site and its immediate surrounds is primarily influenced by three north/south orientated ridges with small intermediate valleys whilst three generally northeast/southwest orientated ridges influence the topography in the western section of the Mine Site. These ridges contain (from east to west) the confined valleys of the ephemeral Price Creek, an un-named watercourse, Blackmans Gully and Walkers Creek, plus valleys of minor drainage features.

The eastern ridge, located in the eastern section of the Mine Site, with a maximum elevation of approximately 770m AHD, is the highest landform within the northern part of the Mine Site. Elevations within the partially confined valley of Price Creek, situated to the east of this ridge, range between approximately 650m AHD in the north and approximately 590m AHD in the south, where the valley of Price Creek joins that of Hawkins Creek. Blackmans Gully lies to the west of the eastern ridge in a small valley containing the section of Maloneys Road which Bowdens Silver is proposing to relocate. Elevations within Blackmans Gully range from approximately 650m AHD in the north to approximately 590m AHD in the south. The central ridge (at an elevation of up to approximately 700m AHD) is located west of Blackmans Gully, in the centre of the Mine Site where the bulk of the main open cut pit would be located. The central ridge directs runoff into either Blackmans Gully or into the headwaters of Walkers Creek, in the western section of the Mine Site.

The three northeast/southwest orientated ridges located in the western section of the Mine Site have elevations ranging between approximately 680m AHD and 670m AHD. The valleys between these three ridges contain two ephemeral watercourses which form the headwaters of Walkers Creek. Within the Mine Site, these small valleys have a range of elevations between approximately 600m AHD and approximately 560m AHD. The southernmost of the northeast/southwest ridges is referred to as the southern ridge.

Adjacent to the Mine Site boundary, the western ridge extends southwards and joins a near northwest/southeast ridge which is a prominent local topographic feature between the Mine Site and Lue. This ridge is referred to locally as 'Bingman Hill' or "Bingman Ridge". The hill rises to elevations of between 630m AHD and 678m AHD. Elevations within Lue vary from approximately 550m AHD to 600m AHD and Lawson Creek flows in a northwesterly direction immediately north of Lue.

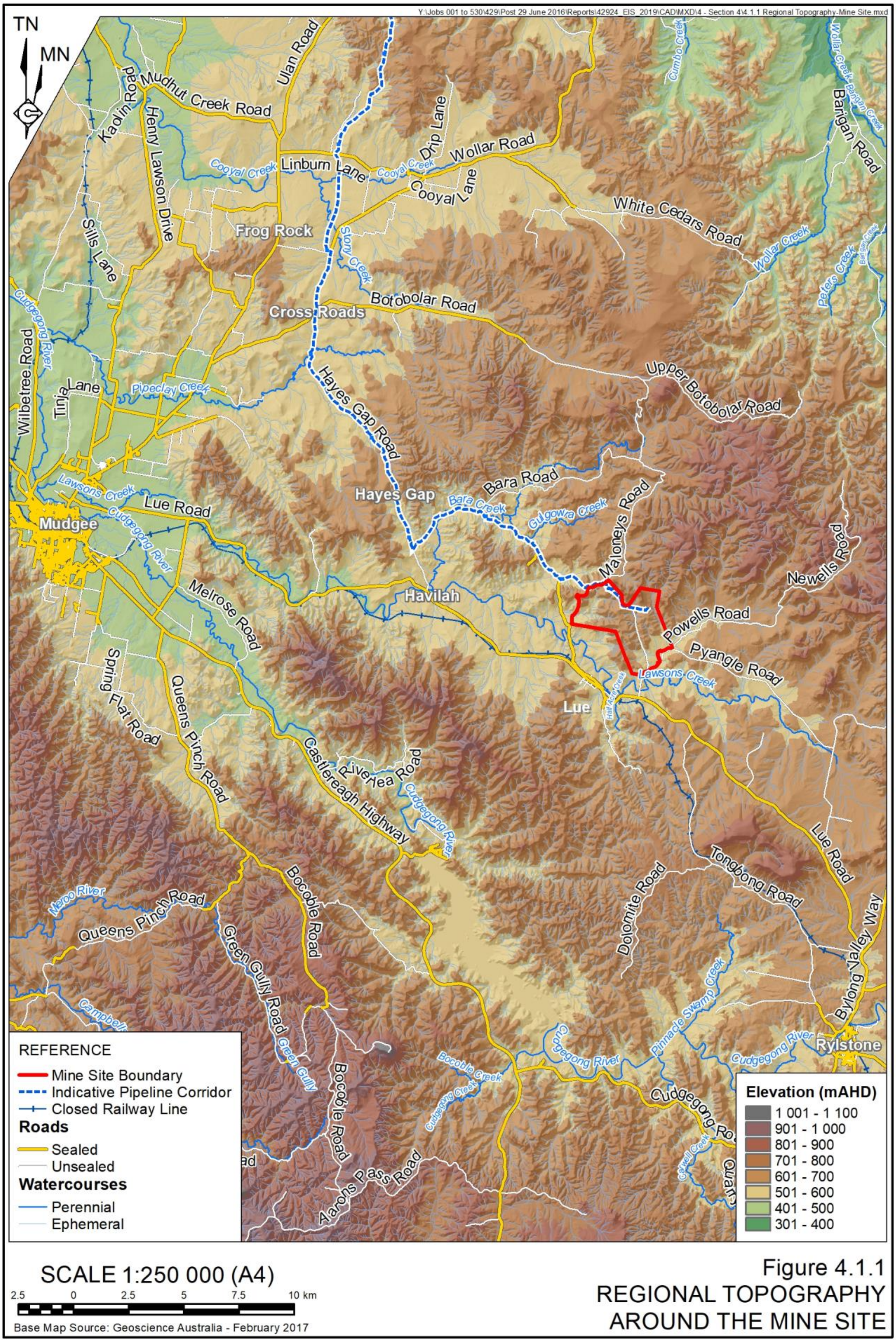


Figure 4.1.1
REGIONAL TOPOGRAPHY
AROUND THE MINE SITE

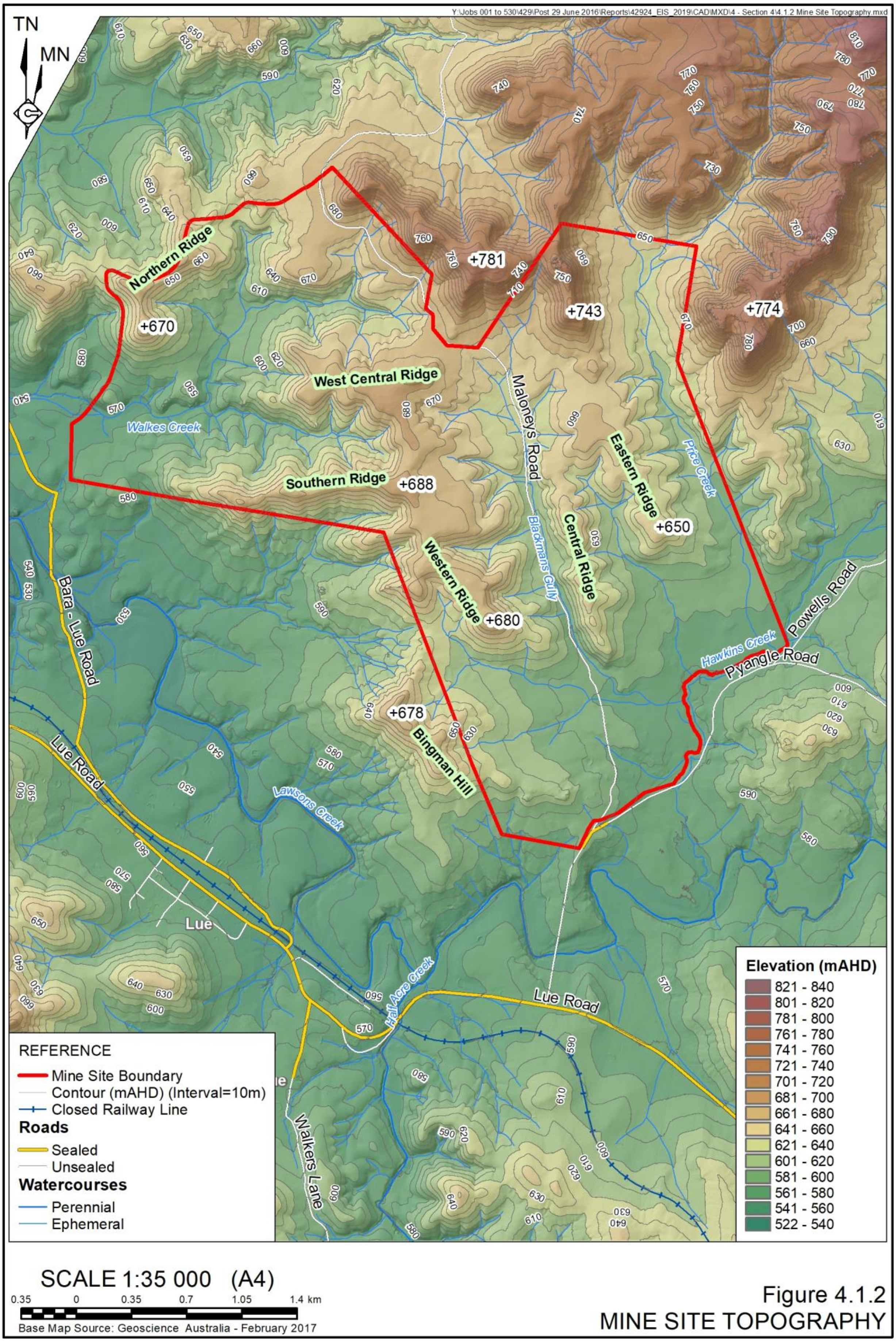


Figure 4.1.2
MINE SITE TOPOGRAPHY

Slopes throughout the Mine Site are generally 1:6 to 1:10 (V:H) with the exception of the northeastern corner of the Mine Site that contain relatively steep slopes approaching 1:3 (V:H) to 1:2 (V:H).

4.1.1.2 Water Supply Pipeline Corridor

Corridor Setting

Figure 4.1.3 displays the topography between the Mine Site and the Ulan Coal Mine and Moolarben Coal Mine commencing at about 640m AHD and traversing generally undulating topography downslope to Ulan where the elevation is approximately 420m AHD. The alignment of the water supply pipeline corridor has intentionally been positioned on land which has slopes predominantly less than 10% or 5.7°. The corridor traverses two topographically high areas, namely Hayes Gap (664m AHD) and Cooks Gap (631m AHD).

4.1.2 Meteorology

4.1.2.1 Introduction

Climatic conditions have the potential to influence a range of Project-related impacts at surrounding residences, receivers, and throughout the local environment. A review of Bureau of Meteorology (BoM) climate classification mapping in the Mudgee area identifies the climate is considered "temperate" i.e. warm to hot summers and mild to cool winters, with the rainfall pattern having a summer maximum.

This subsection focusses upon describing climatic conditions surrounding the Mine Site, particularly as they relate to aspects of the climate that are likely to influence the potential Project-related environmental impacts. Meteorology is unlikely to substantially influence the short duration impacts associated with the construction of the water supply pipeline.

4.1.2.2 Data Sources

Meteorological data have been sourced from the BoM station that is closest to the Mine Site, Mudgee Airport AWS (Station No. 062101), located approximately 26km west of the Mine Site and which provides long term climatic information suitable for use in describing local weather conditions and patterns.

Additional climate information has also been sourced from the two weather stations owned and operated by Bowdens Silver, i.e. Met01 in the eastern section of the Mine Site and Met02 in Lue, between March 2013 and December 2018 to provide locally derived weather data and conditions.

Table 4.1 provides the historical climate data from the BoM, Met01 and Met02. The locations of Met01 and Met02 are presented in **Figure 4.1.6**.

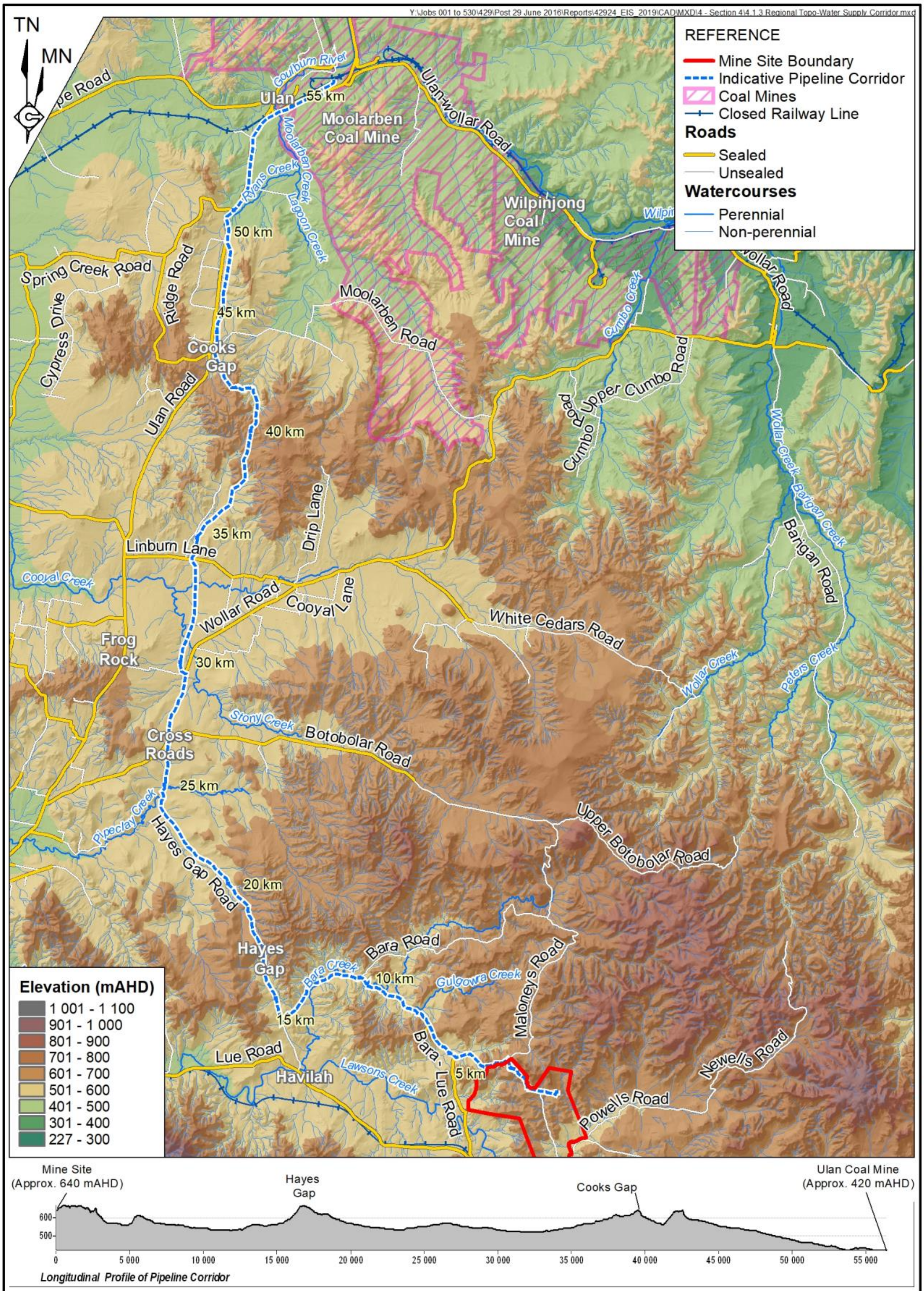


Figure 4.1.3
WATER SUPPLY PIPELINE CORRIDOR TOPOGRAPHY

Table 4.1
Historic Climatic Data*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature (°C) Mudgee Airport Station (Station # 062101) Period of Record 27 Years													
Mean maximum temperature	**31.0**	29.5	26.8	23.0	18.6	15.0	14.4	16.3	19.6	23.1	26.4	28.8	22.7
Mean minimum temperature	16.1	15.6	12.8	8.0	4.0	2.4	**1.1**	1.5	4.3	7.7	11.3	13.8	8.2
Relative Humidity (%) Mudgee Airport Station (Station # 062101) Period of Record 19 Years													
Mean 9:00am relative humidity	63	70	72	71	80	87	87	78	70	61	63	62	72
Mean 3:00pm relative humidity	37	42	42	41	49	57	55	47	44	41	40	37	44
Rainfall (mm) Mudgee Airport Station (Station # 062101) Period of Record 24 Years													
Mean monthly rainfall	67.6	63.1	58.9	33.2	37.9	45.0	43.4	35.2	54.6	51.1	75.4	**80.7**	663.2
Highest monthly rainfall	195.6	233.0	187.0	108.4	124.0	127.2	143.8	112.2	197.4	135.8	162.8	**241.6**	1152.4
Lowest monthly rainfall	10.0	2.2	**0.0**	**0.0**	0.4	1.4	2.6	1.0	0.8	0.2	9.4	15.0	349.6
Highest daily rainfall	65.0	**174.2**	72.0	46.2	44.4	37.0	51.2	51.2	61.0	51.0	57.2	100.8	-
Average Rain Days (>1mm)	7.3	6.9	6.9	4.8	6.3	10.1	9.9	7.6	7.4	8.0	9.3	8.6	93.1
Rainfall (mm) Mine Site Met01 - Period of Record 5 Years													
Mean monthly rainfall	41.2	57.2	**65.2**	38.6	36.4	58.2	36.6	29.1	53.4	39.6	53.0	61.5	635.3
Highest daily rainfall	45.2	**81.0**	50.6	31.4	26.8	29.2	41.6	19.0	50.0	24.6	49.2	51.6	-
Rainfall (mm) Lue Met02 - Period of Record 5 Years													
Mean monthly rainfall	34.3	56.2	58.0	31.6	31.1	59.2	44.4	32.4	57.8	45.0	56.6	**71.5**	632.2
Highest daily rainfall	41.8	**125.6**	52.0	32.4	25.8	29.8	41.2	20.8	60.8	30.6	56.0	58.2	-
Note *: Extreme monthly data is highlighted by bold text													

4.1.2.3 Temperature and Humidity

Temperature and humidity data were sourced from the Mudgee Airport AWS. The data shows that January is the warmest month with a mean maximum temperature of 31.0°C and mean minimum temperature of 16.1°C. July is the coldest month with a mean maximum temperature of 14.4°C and a mean minimum temperature of 1.1°C.

The lowest average relative humidity generally occurs in the summer months, with January and December sharing the lowest relatively humidity values throughout the year. The highest average relative humidity occurs in June.

4.1.2.4 Rainfall

Rainfall data were sourced both from Mudgee Airport AWS and the two on-site weather stations. Whilst the on-site and Lue weather stations have a limited dataset (2013-2018), the rainfall generally reflects the trends displayed in the Mudgee Airport AWS dataset, albeit at slightly lesser amounts with the exception of Met 01, which returns average monthly rainfall above that returned for Mudgee Airport AWS in March, April and May. Average annual rainfall at Mudgee Airport AWS is 663.2mm. The average annual rainfall generated for the two on-site stations is considered less reliable due to the short timeframe covered in the dataset.

Rainfall can be variable, with infrequent, high intensity rainfall events occurring. This is evidenced by the highest daily rainfall values shown in **Table 4.1** and the fact that the maximum daily rainfall values can be as high as two times the average monthly rainfall values (e.g. 125.6mm, Met 02, 25 February 2018). An example of this rainfall variability is the high intensity rainfall event recorded at Met 01 (81mm) and Met 02 (125.6mm) on 25 February 2018 whilst no rainfall was recorded at Mudgee Airport on the same date.

For the purposes of undertaking the surface water assessment for the Project, WRM (2020) relied upon long-term daily rainfall data for the Mine Site for a period of 130 years to December 2018. This data was obtained from the Queensland Department of Environment and Science's Scientific Information for Land Owners (SILO) data service. **Figure 4.1.4** displays the average monthly rainfall assembled for the Mine Site from 1889 to 2018. The average annual rainfall during this period was 673mm. WRM (2020) has also relied upon climate change adjusted SILO climate data for future changes in both rainfall and evaporation. Predicted changes in accordance with climate change models vary from +2.8% to -5.9% for rainfall and +10.8% to +14.5% for evaporation.

4.1.2.5 Evaporation

Evaporation data have been sourced from the SILO Climate Database calculated using Class A Evaporation (post 1970) and synthetic pan evaporation (pre 1970). **Figure 4.1.5** displays the average monthly rainfall and pan evaporation for the Mine Site.

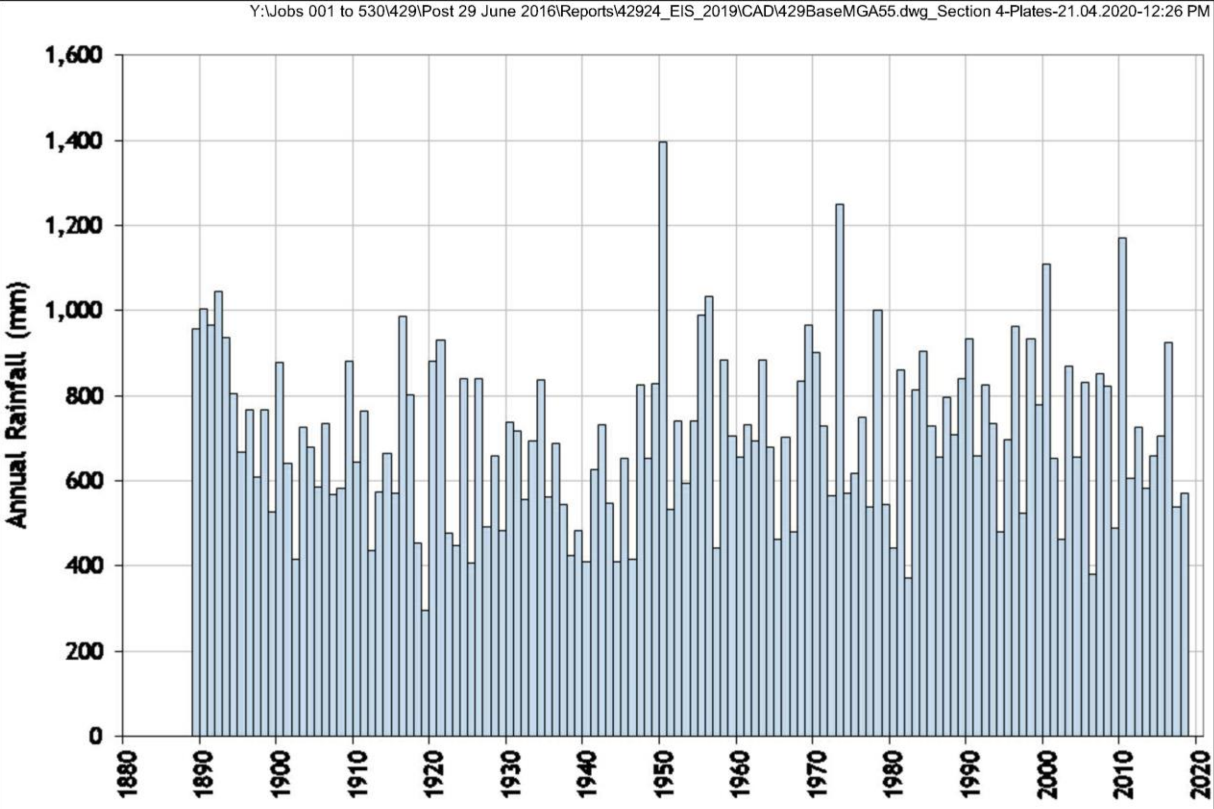
Mean monthly evaporation for the Mine Site varies throughout the year, from approximately 220mm in January and December to 42.6mm in June, typically following the seasons throughout the year (**Table 4.2**). The annual evaporation rate of 1 514.2mm exceeds the average annual rainfall averaged SILO data by a factor of approximately 2.3.

Table 4.2
Historic Climatic Data (SILO)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Class A Evaporation (mm) SILO Climate Data - Period of Record 128 Years (pre 1970: synthetic pan evaporation)													
Mean monthly evaporation	218.5	173.6	150.5	96.8	62.5	42.3	46.5	67.7	98.1	140.7	176.8	218.1	1492.2
Mean daily evaporation	7.0	6.1	4.9	3.2	2.0	1.4	1.5	2.2	3.3	4.5	5.9	7.0	-

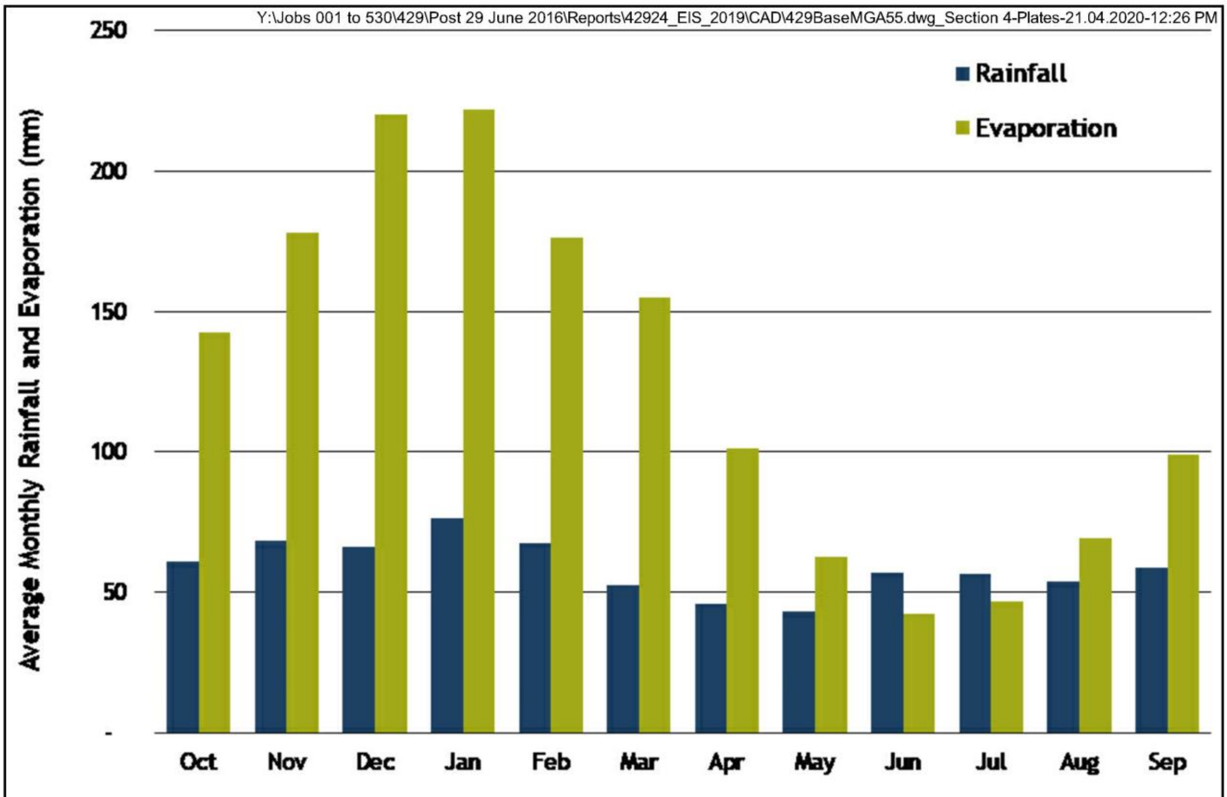
4.1.2.6 Wind

Figure 4.1.6 displays annual wind roses prepared from data recorded at both the weather stations operated by Bowdens Silver. The results display the effect that the local topographical features have the ability to affect the local climatic conditions, with the northeasterly wind profile in particular being affected by the northeasterly/southwesterly trending valley system. **Figure 4.1.7** displays the output compiled by Ramboll (2020) from CALMET showing wind vectors prepared from both data sets.



Source: SILO Climate Database

Figure 4.1.4
ANNUAL RAINFALL - MINE SITE 1889 TO 2018



Source: SILO Climate Database

Figure 4.1.5
AVERAGE MONTHLY RAINFALL AND PAN EVAPORATION - MINE SITE 1889 TO 2018

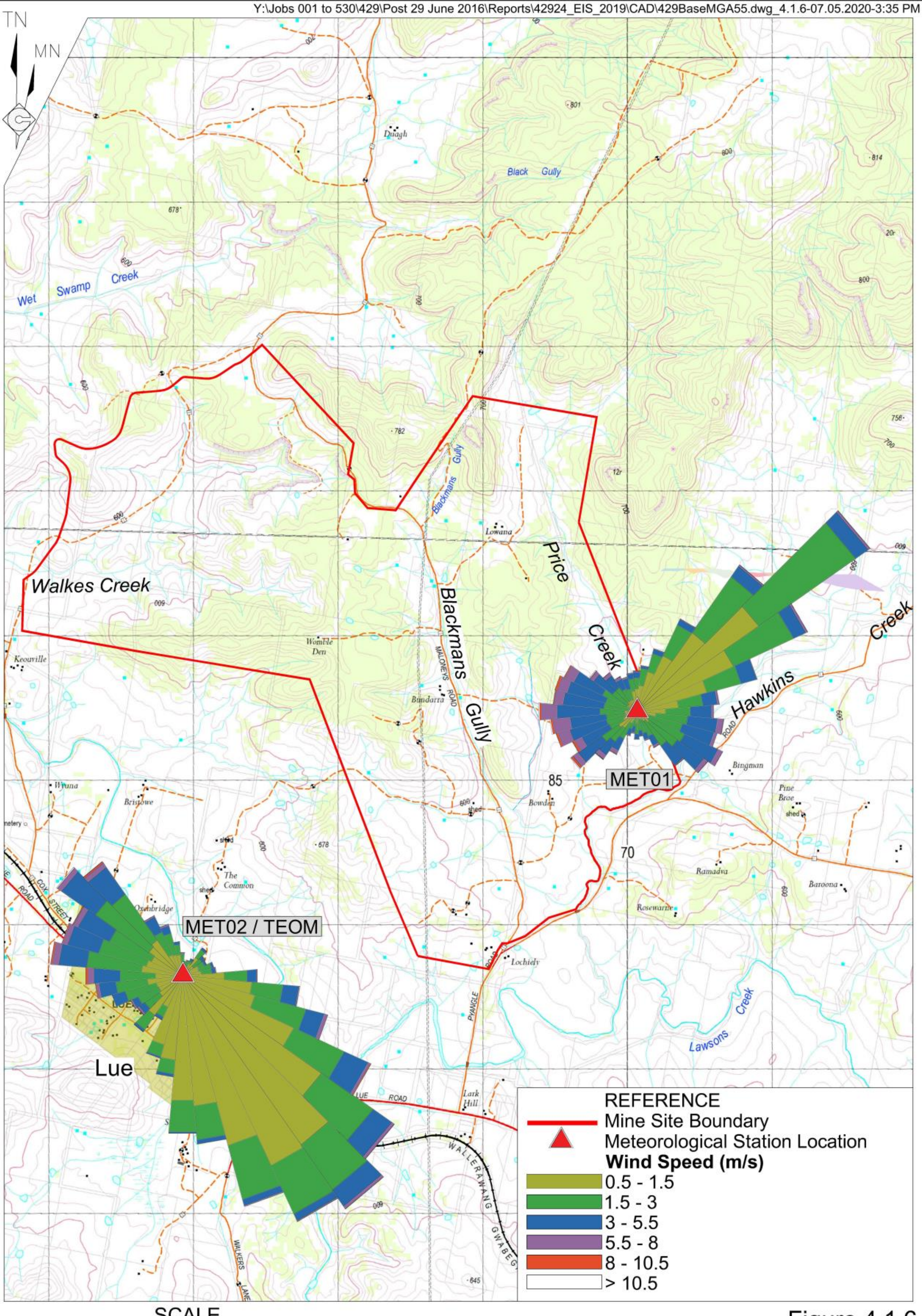
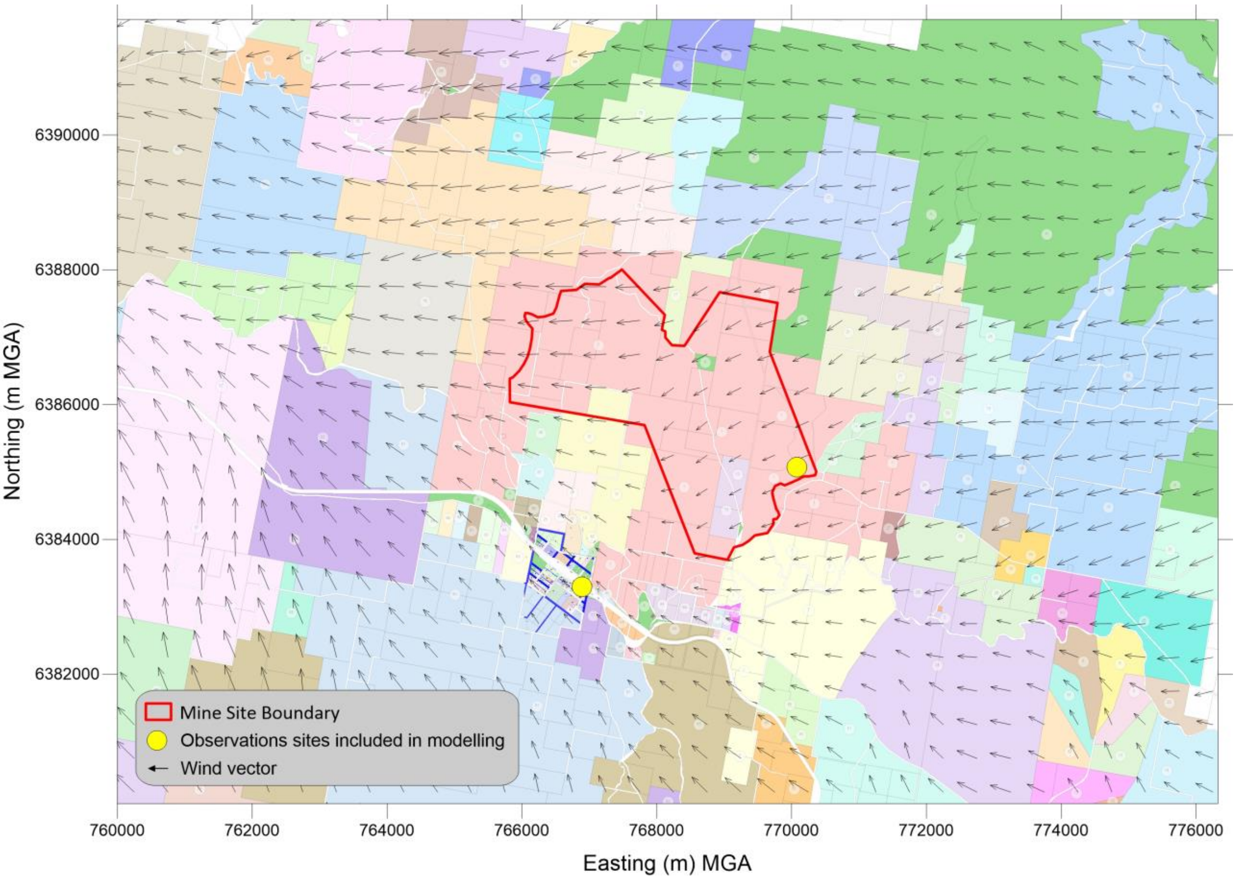


Figure 4.1.6
MINE SITE AND LUE
ANNUAL WIND ROSES



Source: Ramboll (2020) – modified after Figure 4.5

Figure 4.1.7
CALMET WIND VECTORS - MINE SITE AND SURROUNDS

Figures 4.1.8 and **4.1.9** present the seasonal and diurnal/nocturnal wind roses for the Mine Site (Met01) and Lue (Met02).

The notable differences between the wind speeds and directions can be attributed to the differing topographical features between the two stations, as winds experienced at the Mine Site are affected in the following manner.

- A general absence of southeasterly flow at the Mine Site (Met01) due to blocking by the elevated terrain immediately to the southeast of the station. A component of the flow is likely channelled into the dominant northeasterly flow currently experienced.
- A general absence of northeasterly flow and a dominance of southeasterly flow at Lue (Met02) due to winds from the northeastern direction being blocked by elevated terrain immediately to the northeast of the station.

As a consequence, wind blowing from the northeast of the Mine Site is generally diverted to the northwest before it reaches Lue. As shown by the data, the Mine Site is located in a valley orientated northeast to southwest and is hence associated with topographical interference. The wind regime at the Mine Site (Lue Met01) reflects the topography of the area with the predominant winds blowing from the north, northeast and southwest directions.

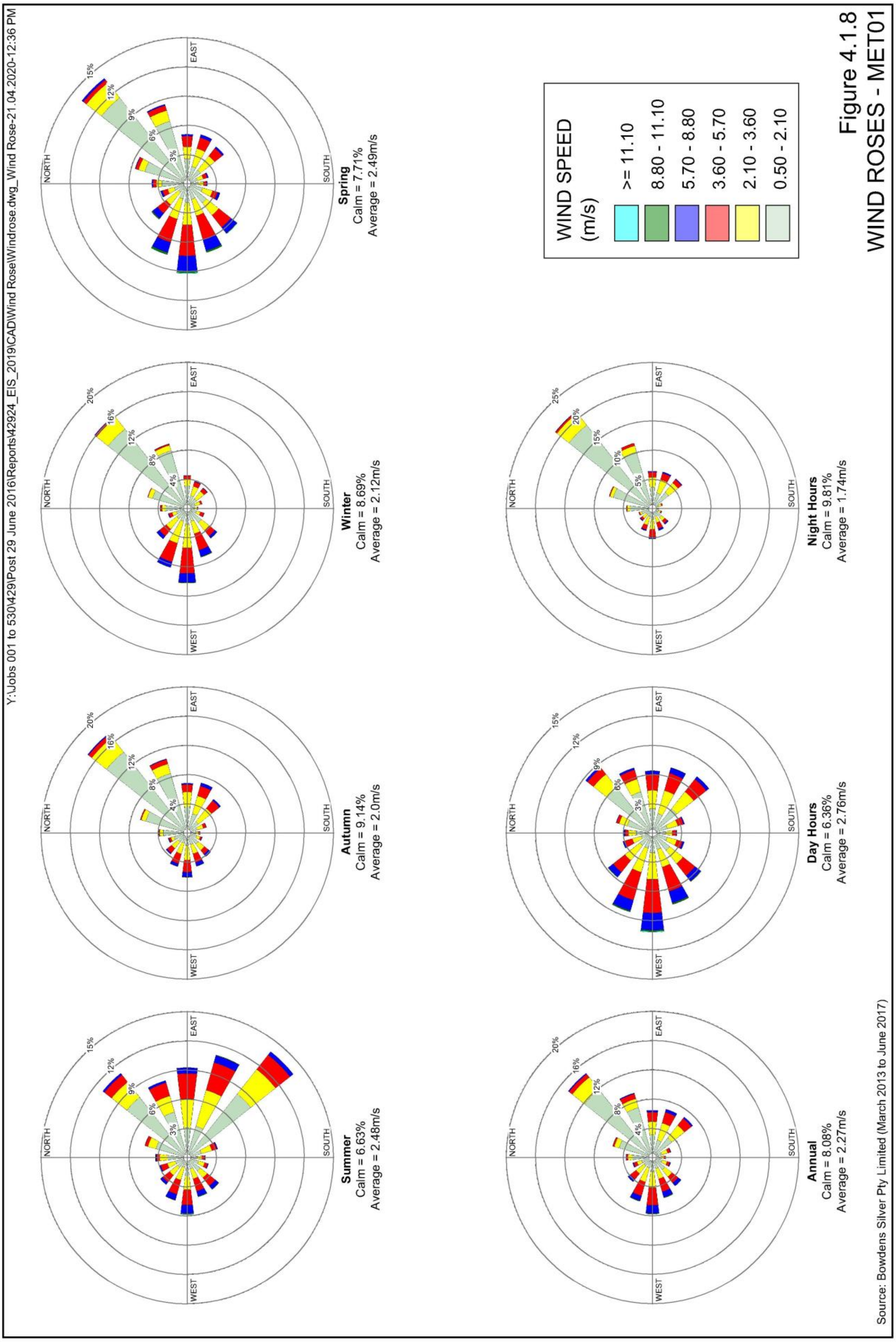


Figure 4.1.8
WIND ROSES - MET01

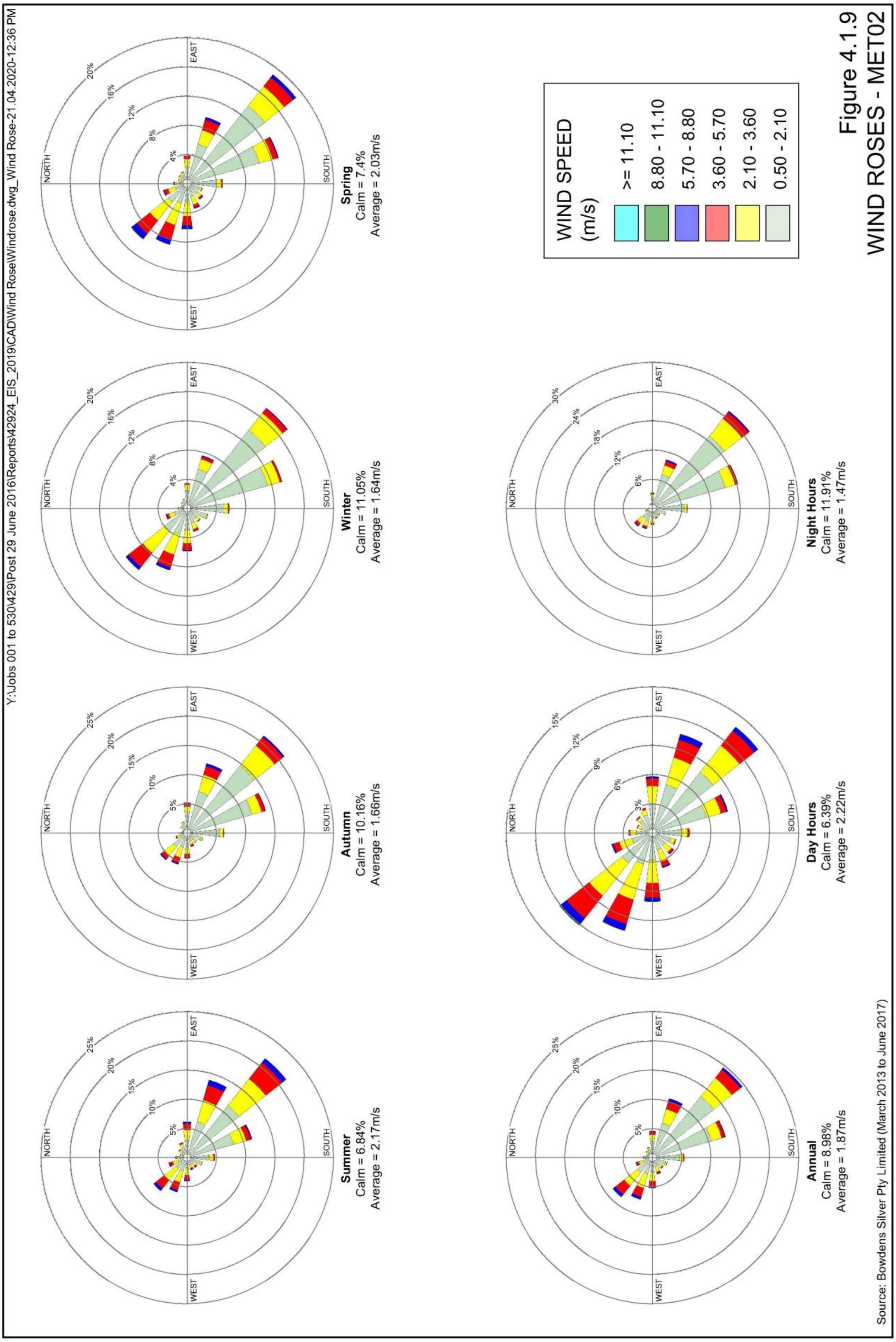


Figure 4.1.9
WIND ROSES - MET02

Source: Bowdens Silver Pty Limited (March 2013 to June 2017)

It is further noted that the gentle winds recorded at the Mine Site (Met01) blowing from the northeast occur principally of an evening whereas the stronger winds from the northwestern to southwestern quadrant occur principally of an afternoon. The principally light winds from the southeast that are recorded in Lue (Met02) occur during both day-time and evening periods with the stronger northwesterly winds principally occurring during the day-time.

4.1.3 Land Ownership and Residences

4.1.3.1 Mine Site Surrounds

Figure 4.1.10 displays the ownership of land and the locations of privately-owned and Project-related residences within and surrounding the Mine Site. A schedule of land ownership is included as **Table 4.3**. Bowdens Silver owns or has options to purchase approximately 2 016ha of land, all of which is referenced "1" on **Figure 4.1.10**.

The land within the Mine Site is owned predominantly by Bowdens Silver with the exception of the following.

i) Two lots of Crown land, one near the southern Boundary of the Mine Site (Lot 7008 DP 1029652 – 0.56ha) and one near the centre of the Mine Site (Lot 7007 DP 1029353 – 5.9ha). It is currently planned that both of these lots would be excised from the mining lease for the Project.

ii) Two lots in the south (Ref: No. 10) (owned by B. Winter). These lots (Lot 1 DP 835810 and Lot 121 DP 755435) cover approximately 49ha with Lot 21 DP 755435 currently planned to be excised from the mining lease for the Project.

iii) A part lot in the west (Ref: No. 12) (owned by G. & J. Lydiard).

Bowdens Silver holds a lease with the landowners of (ii) and (iii) for the duration of the Project life. The land surrounding the Mine Site is owned both by Bowdens Silver and privately, with the exception of land to the north east, which is Crown land. It is noted that Bowdens Silver intends to lease back Project-related properties to the local community wherever possible throughout the Project life.

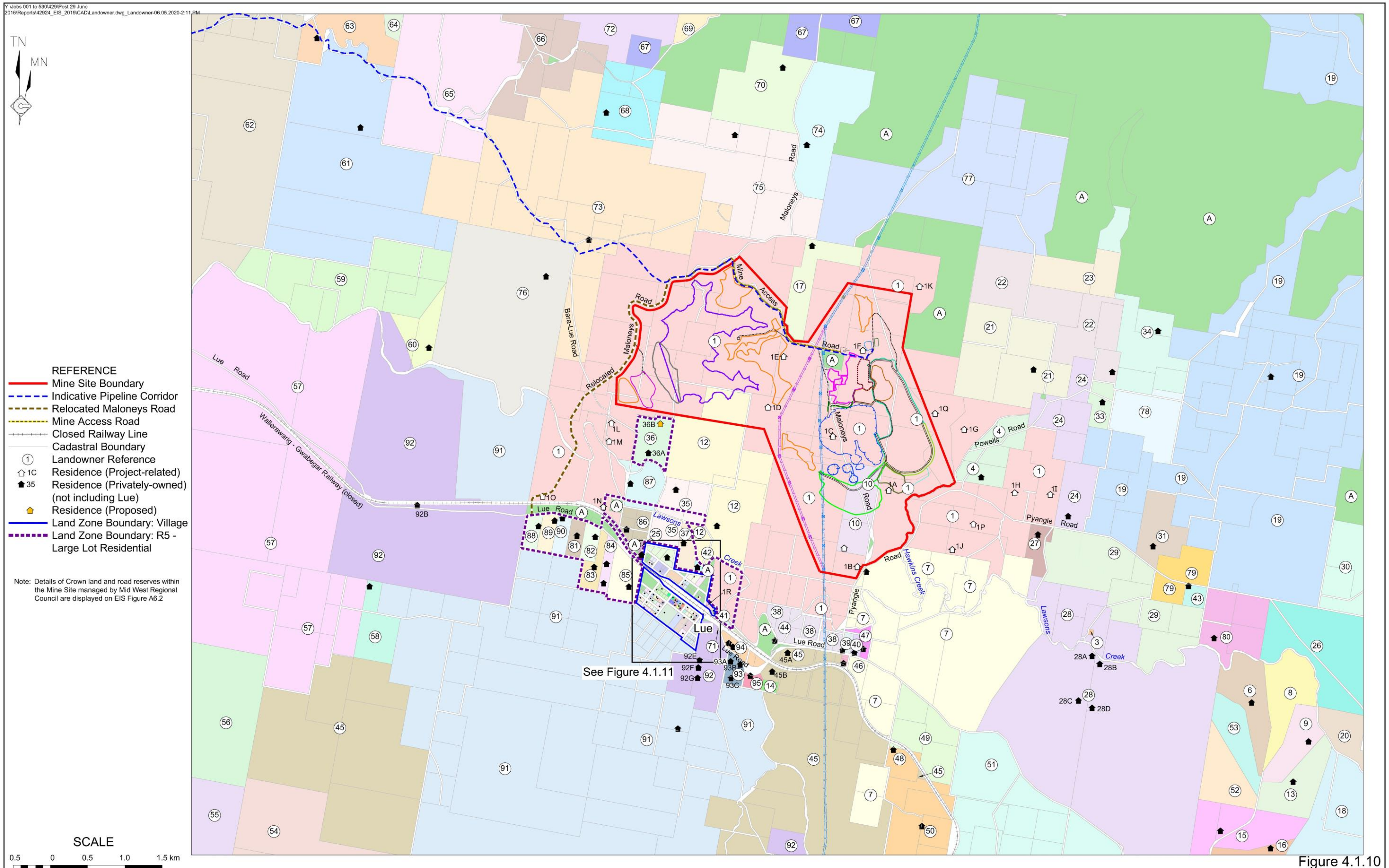
Table A6.2 in **Appendix 6** lists the distances between the privately-owned residences and a number of the key components within the Mine Site.

Figure 4.1.11 displays the ownership of land and the locations of privately-owned residences within Lue, i.e. the area zoned as "Village" within Mid-Western Regional Local Environmental Plan 2012 (MWR LEP 2012). **Table 4.4** lists the ownership of the land within Lue shown on **Figure 4.1.11**. Lue comprises 122 full lots and one part lot, 97 of which are privately owned with the remainder being Crown land or owned by Mid-Western Regional Council and the Department of Education. A total of 44 privately-owned residences are located in Lue, 25 of which are built on single lots and 19 built on two or more adjoining lots. Six privately owned lots are vacant. The lots within Lue range in area from 0.2 ha to 5.6 ha.

Table 4.3
Schedule of Land Ownership – Lue Surrounds

Ref[1]	Owner	Ref[1]	Owner
A	Crown Land	50	ACN 059 643 533 Pty Limited
1	Bowdens Silver Pty Limited[2]	51	
3	Monival Pastoral Company Pty Limited	52	
4		53	
6		54	Mudgee Local Aboriginal Land Council
7	Lochiely Pty. Limited	55	
8	Sam Lynch Electrical Pty Limited	56	
9		57	Havilah South Pty Limited
10[5]		58	
12		59	
13		60	
14		61	
15		62	
16		63	
17		64	
18		65	
19		66	
20		67	
21		68	
22		69	
23		70	Tugulawa Homestead Pty Ltd
24		71	State Rail
25[3]		72	
26		73	WJ Murdoch & Co Pty Limited
27		74	
28	Attunga 2850 Pty Ltd	75	
29		76	Merryvale Farm Pty Limited
30		77	
31		78	
33		79	Stanford (Botobolar) Pty Limited
34		80	
35[4]		81	
36		82[3]	
37[3]		83[3]	
38		84[3]	
39		85[3]	
40		86[3]	
41	Lue Hospitality Pty Ltd	87[4]	
42		88[3]	
43		89[3]	
44		90[3]	
45		91	Lue Station Pty Ltd
46		92	
47		93	
48	ACN 059 643 533 Pty Limited	94	
49		95	

Notes:
1. Some reference numbers have been removed as some properties have been acquired by Bowdens Silver Pty Ltd or existing landowners in the Lue District since the reference numbers were first assigned.
2. Or under purchase option.
3. This property is located in the R5 Large Lot Residential Zone (MWR LEP 2012) surrounding Lue.
4. This property is partly located in the R5 Large Lot Residential Zone (MWR LEP 2012) surrounding Lue.
5. Bowdens Silver Pty Ltd has an agreement with this landowner to undertake the Project on their property.



Landowner Source: Globalxterrain - December 2019
Cadastral Boundary Source: © NSW Department of Finance and Services
Panorama Avenue Bathurst NSW 2795 www.lpi.nsw.gov.au

Figure 4.1.10
LAND OWNERSHIP AND RESIDENCES - LUE SURROUNDS

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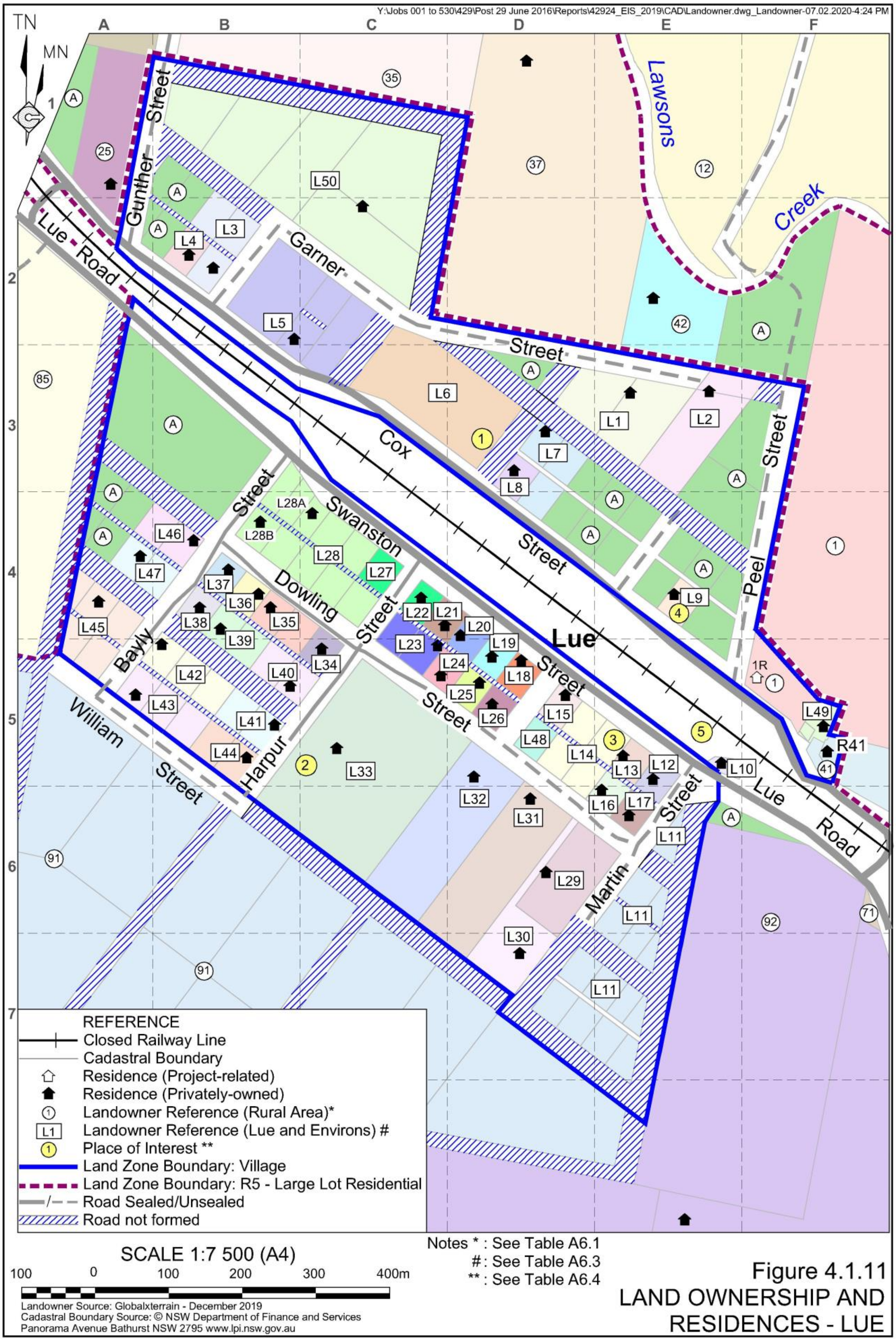

Figure 4.1.11
LAND OWNERSHIP AND RESIDENCES - LUE

Table 4.4
Schedule of Land Ownership – Lue (3 December 2019)

Ref	Owner	Ref	Owner
A	Crown Land	L26	
L1		L27*	
L2		L28	
L3		L29	
L4		L30	
L5		L31	
L6	Mid-Western Regional Council	L32	
L7		L33	
L8		L34	
L9		L35	
L10		L36	
L11	Lue Station Pty Limited	L37	
L12		L38	
L13		L39	
L14	Lue Public School	L40	
L15		L41	
L16		L42	
L17		L43	
L18		L44	
L19		L45	
L20		L46	
L21		L47	
L22		L48	
L23		L49	
L24		L50	
L25			
* Formerly St Lukes Anglican Church			

All residences in Lue lie between approximately 2km and 3km southwest of the closest open cut pit. The key place of interest within Lue, i.e. Lue Public School, is 2.5km southwest of the closest open cut pit noting that Bingman Hill between the school and the closest open cut pit is approximately 118m above the ground level at the school.

Lue is largely surrounded by an area zoned R5 (Large Lot Residential) under MWR LEP 2012 in which 14 privately-owned residences are located, all of which are built on single lots. The ownership of these lots is displayed on **Figure 4.1.10** and listed on **Table 4.3**. The lots within this zone range in area from 1.63ha to 28.9ha.

4.1.3.2 Water Supply Pipeline Corridor

Figure 4.1.12 displays the ownership of land and residences within the proposed water supply pipeline corridor. The bulk of the land is owned by 20 private landowners, inclusive of Bowdens Silver and three mining-related companies. The remaining land is either Crown land or land within road reserves managed by MWRC. Discussions with 17 of the 20 landowners along the alignment of the proposed pipeline have commenced with three unable to be contacted at the time of completion of the EIS. **Figure 4.1.12** displays a total of five and 116 privately-owned residences that are located within 50m and 1050m respectively of the water supply pipeline corridor, i.e. distances referred to in the noise impact assessment (see Section 4.2.3.6).

4.1.4 Land Uses

4.1.4.1 Introduction

This subsection provides an overview of the land uses surrounding and within the Mine Site and within and adjacent to the water supply pipeline corridor. Land uses were identified through a combination of site inspections and a review of land zoning and Australian Land Use Mapping (ALUM) data in order to appropriately reflect specific local land uses.

The impacts of the Project upon the range of land uses described are presented in Section 4.18.

4.1.4.2 Local Area around Mine Site

Figure 4.1.13 shows the existing land uses within the region surrounding the Mine Site.

Apart from Lue, all land immediately surrounding the Mine Site comprises a combination of grazing, lifestyle lots and heavily vegetated areas with minimal land use. Grazing is the predominant land use immediately surrounding the Mine Site.

Minor areas surrounding the Mine Site are utilised for horticultural activities, in particular, the Rylstone Olive Press and East Ridge Olives which are both notable olive growers. These two enterprises are located approximately 5.3km and 2.6km from the Mine Site, respectively. Viticulture enterprises are also established within the region, with Elephant Mountain Wines being the closest vineyard to the Mine Site (3.8km). Elephant Mountain Wines also operates a bed and breakfast (B&B), known as Elephant Mountain House and a wedding venue. Several vineyards are located on the Castlereagh Highway immediately south of Mudgee with the closest being approximately 13.3km from the Mine Site.

A notable component of the wider tourism sector throughout the Region is agri-tourism, principally comprising guesthouses and B&Bs catering to the Region's wine industry. Guesthouses and B&Bs are interspersed within and immediately surrounding the Lue district and include the 'WYUNA' Lue Farmstay (1.1km south), Odd Frog Lodges (1.1km south), the Old Bara Guesthouse (5.5km northwest), Rokbara Cottage (4.7km north) and Camphill Cottage (11.4km southeast). The numerous wineries and scenic nature of the area are the principal attractions for tourists. Tourist Drive 2 connects Capertee on the Castlereagh Highway with the towns of Kandos, Rylstone, Lue and Mudgee and is a popular drive which showcases the Capertee and Lue Valleys (Rylstone Kandos Chamber of Commerce, 2015).

The Louee Enduro and Motocross Complex is located approximately 3.0km south of the Mine Site. This complex is located within Lue Station, a working sheep and cattle property, and provides over 150km of off-road motorbike trails, a workshop, canteen and accommodation (Shearer's Quarters, Dungeree House, Lue Cottage, Louee Station and a campground). This complex is also a destination of visitors to the local area when staying at local guesthouses and B&Bs.

Other land uses that occur within the area immediately surrounding the Lue district include the extractive industry with three quarries located near the Mine Site. These quarries include the Mt Knowles Quarry, the Bara Quarry and a privately-owned quarry on the southern side of Lue Road opposite the Rylstone Olive Press. The Mt Knowles and Bara Quarries are located approximately 12.1km and 2.4km to the northwest of the Mine Site, respectively. The privately-owned quarry is located approximately 6.9km to the southeast of the Mine Site.

Large tracts of land also remain heavily vegetated within the Lue district, primarily on steep, hilly terrain. The closest forestry reserve is the Dungeree State Forest which is located in the area immediately surrounding the Lue district approximately 7.1km to the south of the Mine Site.

The Windamere Dam, which collects the natural flow of the Cudgegong River, is located approximately 10km southwest of the Mine Site. The dam supplies water for both agricultural production and town water within the Mid-Western Regional LGA. It also provides for flood mitigation and recreational activities.

4.1.4.3 Mine Site

Figure 4.1.14 displays the various land uses and their respective areas within and adjacent to the Mine Site on land referred to as "Bowdens Farm". **Table 4.5** lists the area of each land use within the Mine Site together with its proportion of the Mine Site.

Table 4.5
Existing Land Uses within the Mine Site

Land Use	Total Area (ha)	Proportion of Mine Site (%)
Grazing – Native Vegetation	428	42.8
Grazing – Modified Pasture (Improved)	333	33.3
Grazing – Modified Pasture (Not Improved)	150	15.0
Cropping	12	1.2
Dam	3	0.3
Exclusion Zone (Aboriginal Heritage)	25	2.5
Lifestyle Lot	49	4.9
Total	1000	100

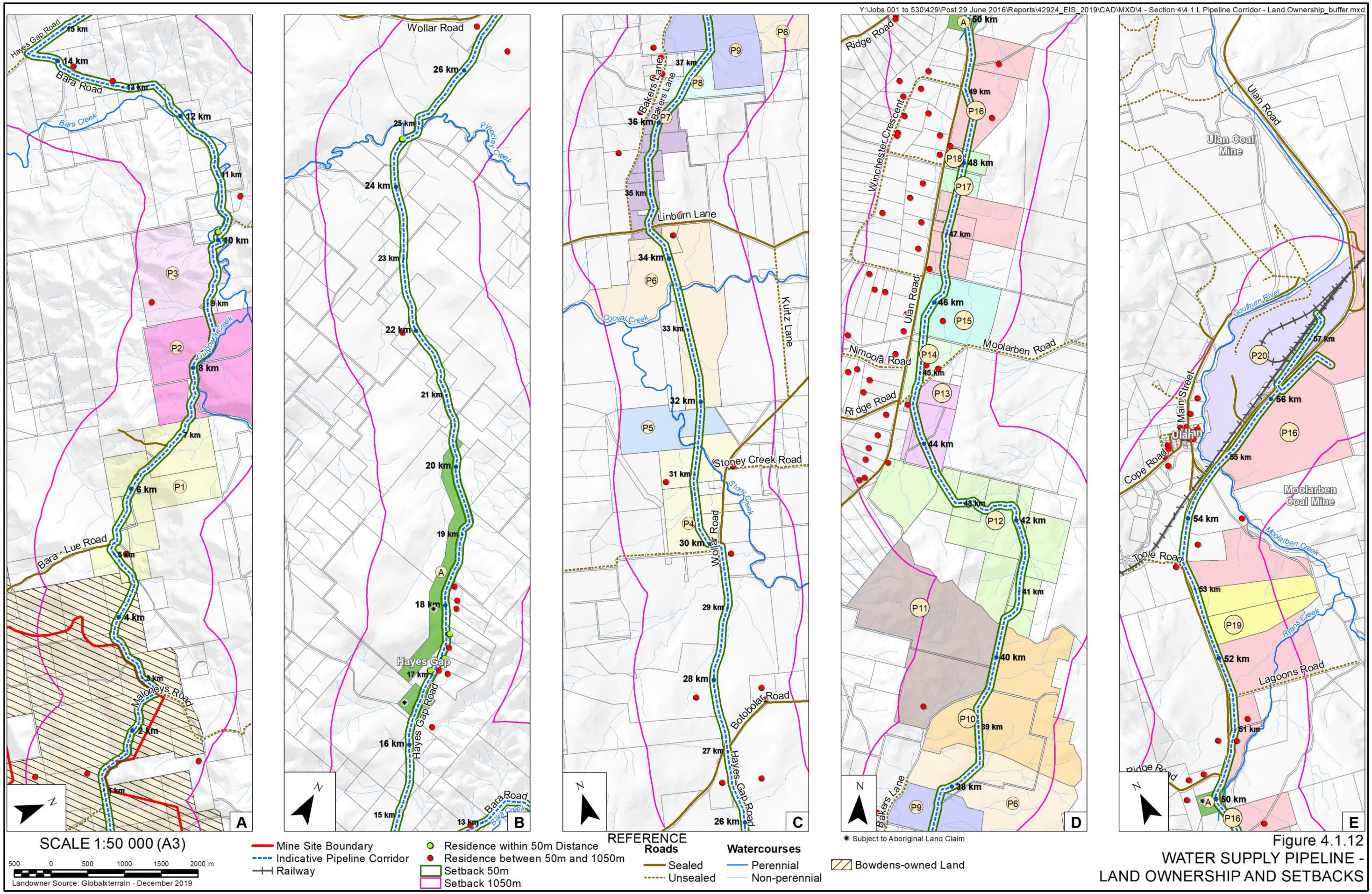

Figure 4.1.12
WATER SUPPLY PIPELINE - LAND OWNERSHIP AND SETBACKS

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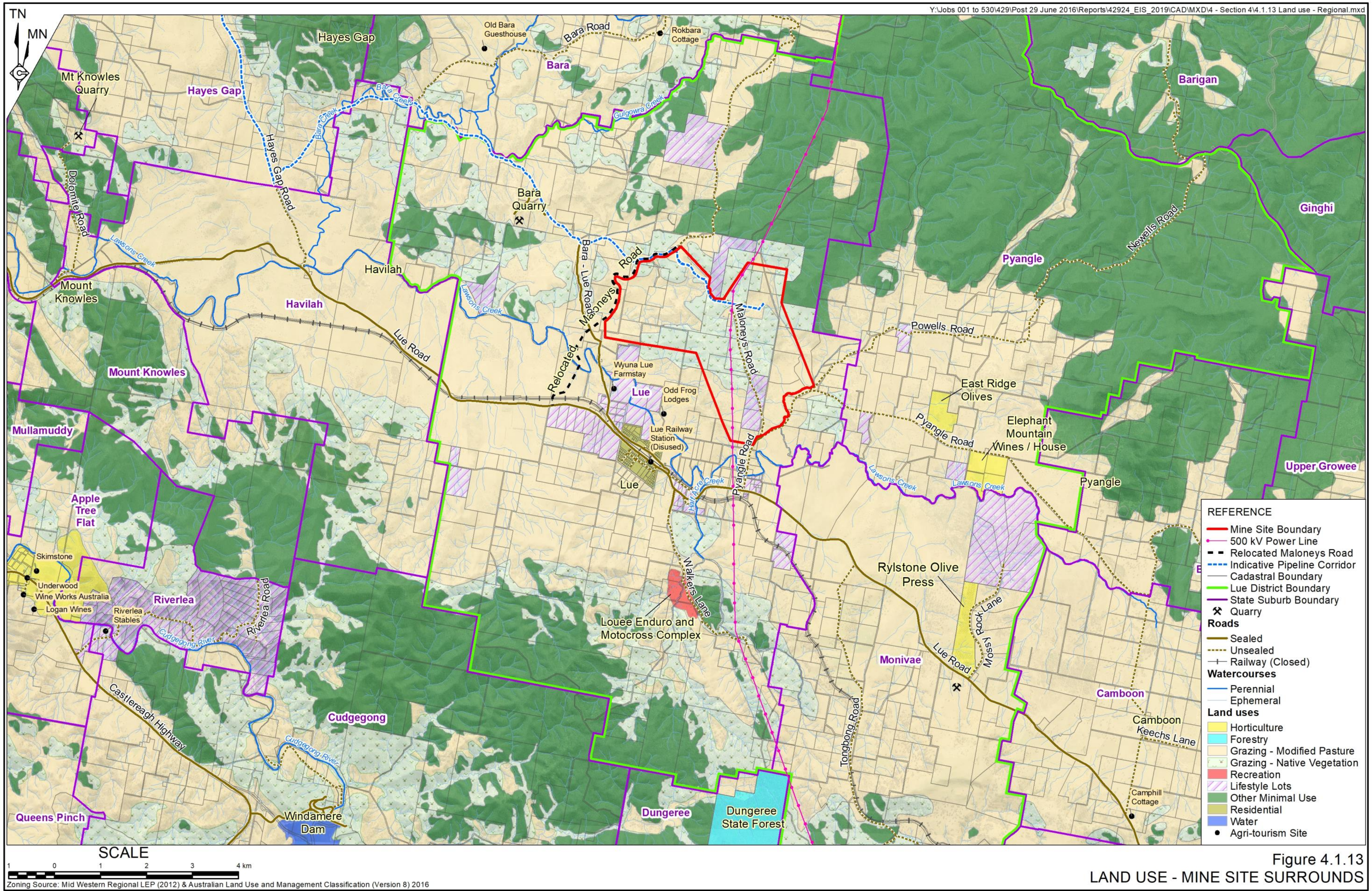
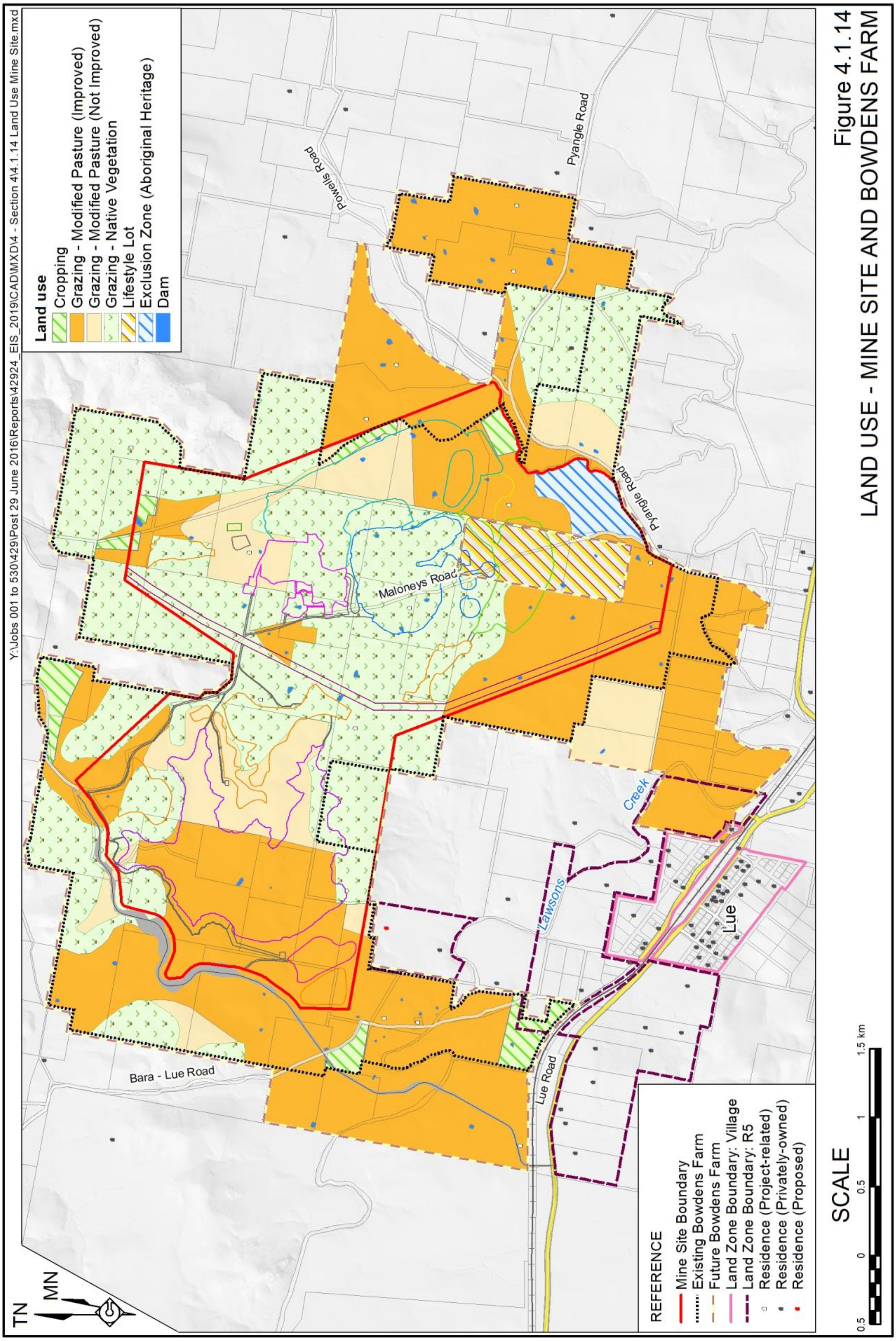


Figure 4.1.13
LAND USE - MINE SITE SURROUNDS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Land use
Cropping
Grazing - Modified Pasture (Improved)
Grazing - Modified Pasture (Not Improved)
Grazing - Native Vegetation
Lifestyle Lot
Exclusion Zone (Aboriginal Heritage)
Dam
Powells Road
Pyangle Road
Maloneys Road
Lawsons
Creek
Lue
Lue Road
Bara - Lue Road
REFERENCE
Mine Site Boundary
Existing Bowdens Farm
Future Bowdens Farm
Land Zone Boundary: Village
Land Zone Boundary: R5
Residence (Project-related)
Residence (Privately-owned)
Residence (Proposed)
SCALE
0.5
0
0.5
1
1.5 km
TN
MN
Figure 4.1.14
LAND USE - MINE SITE AND BOWDENS FARM

The majority of land within the Mine Site is currently used for agricultural activities with a single lifestyle lot (49ha) located in the southeastern quadrant. Agricultural activities conducted within the Mine Site are largely restricted to grazing of livestock on approximately 911ha of land. Grazing land comprises approximately 428ha of heavily vegetated and/or steeply sloping land with low agricultural capability (principally LSC Class 6) and approximately 483ha of modified pasture with a low to moderate agricultural capability (LSC Classes 3 to 6) (see SMD, 2020). Approximately 333ha of modified pasture is subjected to periodic pasture improvement which typically involves weed control and/or the selective application of fertiliser. Approximately 12ha within the Mine Site is used for cropping. The cropping program is directed towards winter forage crops to turn off fat lambs and steers as well as serving to "clean up" paddocks by removing weeds. It is noted that an area of approximately 25ha in the southeastern corner of the Mine Site has been excluded from agricultural activities in order to avoid disturbance to Aboriginal artefacts which have been identified in the area.

An additional 19ha of land currently used for agriculture is located within the footprint of the proposed relocated Maloneys Road. This land principally comprises grazing land with <1ha currently used for cropping and 3.5ha being heavily vegetated and/or steeply sloping land.

Bowdens Farm

Bowdens Silver owns and operates a farming operation (the "Bowdens Farm") which currently comprises approximately 1 609ha of land of which 951ha lies within the Mine Site (**Figure 4.1.14**). The farm is currently used for grazing approximately 1 329 Merino sheep and 16 Black Angus cattle comprising 11 yearling heifers and 5 weaner calves. The farm is managed by a farm manager employed by Bowdens Silver who also manages fencing, weeding and feral animals on the Company's landholdings.

4.1.4.4 Water Supply Pipeline Corridor

Figure 4.1.15 displays the land uses within the 56km long water supply pipeline corridor in five sections with chainages commencing at 0km at the proposed processing plant within the Mine Site. Each section traverses approximately 12km.

The land traversed by the water supply pipeline corridor is predominantly used for grazing with approximately 45km of the corridor used for this purpose. Of this grazing land, approximately 23.5km intersects modified pasture whilst 21km intersects land covered by remnant native vegetation. Approximately 2.5km of the water supply pipeline corridor is used for cropping with these areas likely to be used for a combination of forage crops and pasture improvement. It is noted that the corridor does not traverse any land used for viticulture or any other form of horticulture. Approximately 2.5km of the water supply pipeline corridor traverses land currently used as lifestyle lots.

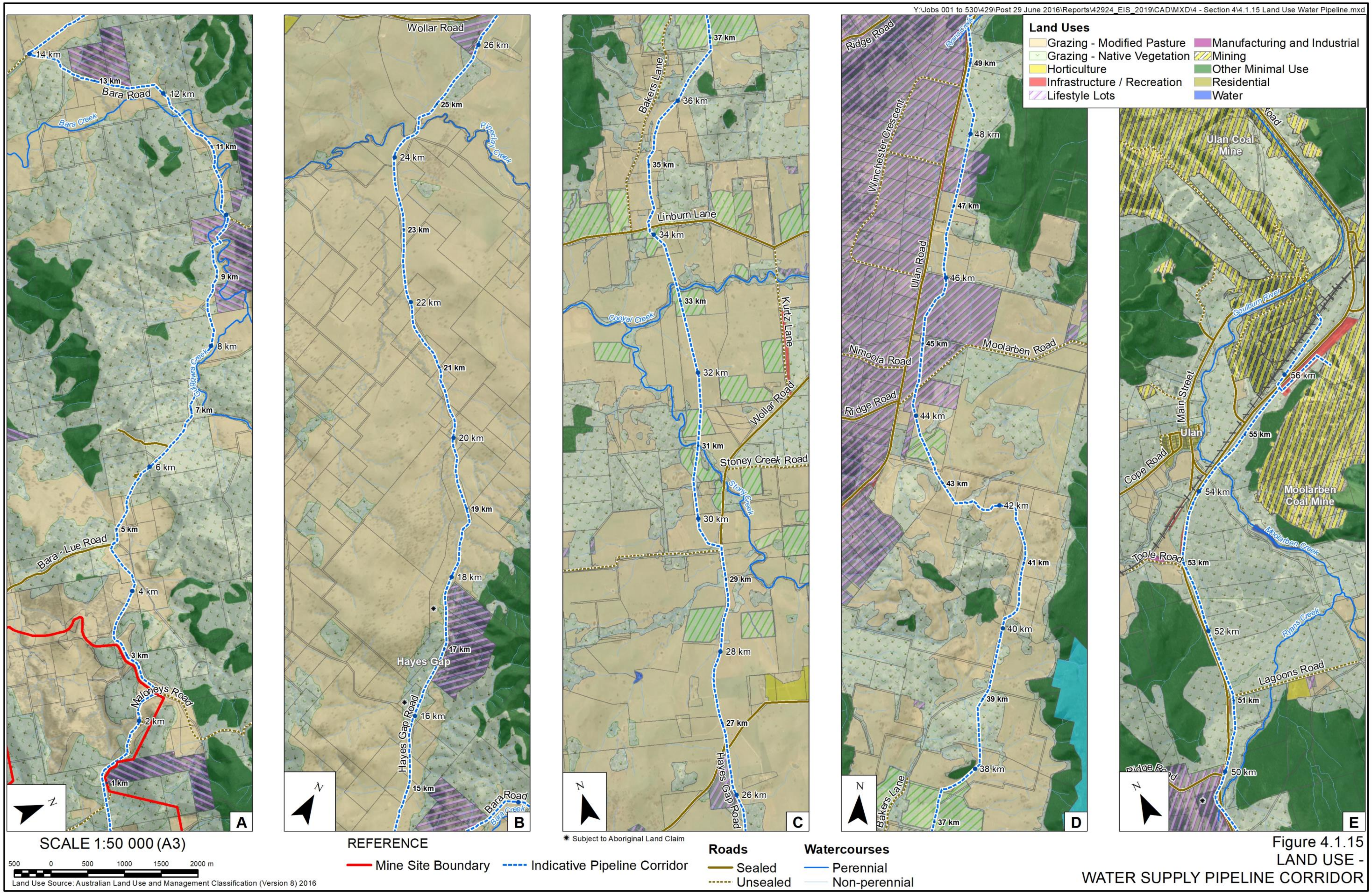

Figure 4.1.15
LAND USE - WATER SUPPLY PIPELINE CORRIDOR

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4.2 NOISE

The noise assessment of the Project was undertaken by SLR Consulting Australia Pty Ltd (SLR) as part of the overall Noise and Vibration Assessment. The full assessment is presented in Volume 1 Part 1 of the Specialist Consultant Studies Compendium and is referenced throughout this section as SLR (2020). A peer review of the noise assessment was undertaken by Mr Najah Ishac of EMM Consulting Pty Limited. A copy of the peer review is included as Annexure 19 in SLR (2020).

4.2.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in noise impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Site establishment and construction activities, both on and off site, resulting in noise emissions (High).
- Day-time and evening mining operations resulting in noise emissions (High).
- Night-time mining operations resulting in noise emissions (Medium).
- Day-time and evening processing operations resulting in noise emissions (Medium).
- Night-time processing operations resulting in noise emissions (Medium).
- Transportation of mobile equipment and processing plant components to the Mine Site together with workforce traffic resulting in noise emissions (High).
- Transportation of production consumables to, and concentrates from, the Mine Site together with workforce traffic resulting in noise emissions (Low).

In addition, the SEARs issued by the former DPE identified "noise" as a key issue requiring assessment. The principal assessment requirements identified by the DPE relating to noise included the following.

- An assessment of both construction and operational noise in accordance with the Noise Policy for Industry (NPfI) and the NSW Government's Voluntary Land Acquisition and Mitigation Policy (VLAMP).
- Justification of the period assessed in accordance with the Interim Construction Noise Guideline (ICNG).
- An assessment of likely road noise impacts of the Project in accordance with the NSW Road Noise Policy (RNP).

The EPA further requested that the noise assessment include seasonality assessments to address the impacts of temperature inversions and wind conditions. Other additional requirements nominated by the EPA related to:

- the need to assess all feasible and reasonable mitigation measures;
- the need to consult with the local community regarding the residual impacts assuming all feasible and reasonable mitigation measures are adopted;

- an assessment of low frequency noise; and
- a description of the noise monitoring program.

The NSW Department of Education requested an assessment of the potential internal classroom noise levels arising from vehicles passing the Lue Public School.

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC.

Section 4.2.2 focuses upon noise generated by construction activities proposed within and around the Mine Site and the surrounding road network (see Section 4.2.2). Coverage of noise along the water supply pipeline focuses upon the construction period (see Section 4.2.3).

The EPA nominates two periods relevant to construction noise, namely:

- Recommended Standard Hours:
  - – 7:00am to 6:00pm (Monday to Friday)
  - – 8:00am to 1:00pm Saturday
  - – No work on Sundays and public holidays)
- Outside recommended standard hours:
  - – Remaining time periods.

The EPA nominates three periods relevant to operational noise, namely:

- Day-time – 7:00am to 6:00pm (Monday to Saturday)
  - – 8:00am to 6:00pm (Sunday and public holidays)
- Evening – 6:00pm to 10:00pm
- Night-time – 10:00pm to 7:00am (Monday to Saturday)
  - – 10:00pm to 8:00am (Sunday and public holidays)

For road traffic noise, the EPA refers to two periods, namely:

- Day-time (15 hours) – 7:00am to 10:00pm (all days)
- Night-time (9 hours) – 10:00pm to 7:00am (all days)

4.2.2 Mine Site

4.2.2.1 Existing Noise Environment

Introduction

Noise which is currently audible at residences in the vicinity of the Mine Site is variously attributable to a range of sources including:

- traffic on Lue Road and local roads;
- domestic and rural noise from lawn mowers, tractors, etc.;

- rural fauna noise such as stock, insects and birds;
- rural natural noise such as wind in the trees;
- occasional light aircraft; and
- The Louee Enduro and Motocross Complex[1].

The existing noise environment around the Mine Site has been established through a comprehensive program involving unattended noise monitoring undertaken by both Bowdens Kingsgate Pty Ltd in September/October 2011, August 2012 and October/November 2013 and SLR Australia Consulting Pty Ltd in February 2017. Given there have not been any substantial changes in land use in the vicinity of the Mine Site since these measurements were recorded, the noise measurement results remain valid and applicable to the Project.

Unattended Noise Monitoring

Unattended noise monitors were placed at 12 locations within or in the vicinity of the Mine Site and within, or close to, Lue. The locations of the noise monitors are displayed on **Figure 4.2.1** and **Table 4.6** lists the months/years the background monitoring was undertaken at each location. Noise levels were continuously monitored at 15-minute intervals and the data analysed to determine the Rating Background Level (RBL)[2] and the long-term average, or $L_{Aeq(period)}$ noise level at each location. These values are relied upon to determine noise criteria, as described in Section 4.2.2.3. Meteorological data recorded at Nullo Mountain automatic weather station (35km east of the Mine Site) or the meteorological stations within the Mine Site and Lue were reviewed for each monitoring period to record both wind speed/direction and rainfall. Review of this data enabled the identification of unfavourable conditions for measured noise levels, i.e. periods of rain or periods when the wind speed exceeded 5m/s, and noise levels recorded under these conditions were excluded, as required under the NPfI.

Details of the monitoring results from the unattended monitoring are presented in Section 3.2 of SLR (2020).

Table 4.7 lists the measured background levels at all 12 locations. It is noted that in accordance with the NPfI, if the RBL is below 35dB(A) during the day-time, then 35dB(A) shall be the RBL. Similarly, if the evening or night RBL is below 30dB(A), then 30dB(A) shall be the assumed RBL during those periods.

It is noted that background noise levels are low and often recorded at 25dB(A), i.e. the lowest reportable noise level within the specified linearity range of the instrumentation used. It is possible that at times, the background noise level could be below 25dB(A). Equally, there are a number of times when the equivalent noise level (L_{Aeq}) is much higher, particularly during the day when noise levels of 44dB(A) to 66dB(A) have been recorded (see **Table 4.7**).

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[1] Whilst not a constant noise source, activities at the Louee Enduro and Motocross Complex occur mainly on weekends and during school holiday periods. From the results of community consultation, it is understood that the noise from the complex is periodically audible in Lue and a number of rural and rural residential residences within approximately 5km of the complex.

[2] Rating Background Level – the overall single-figure background noise level representing each assessment period (day / evening / night) over the whole monitoring period.

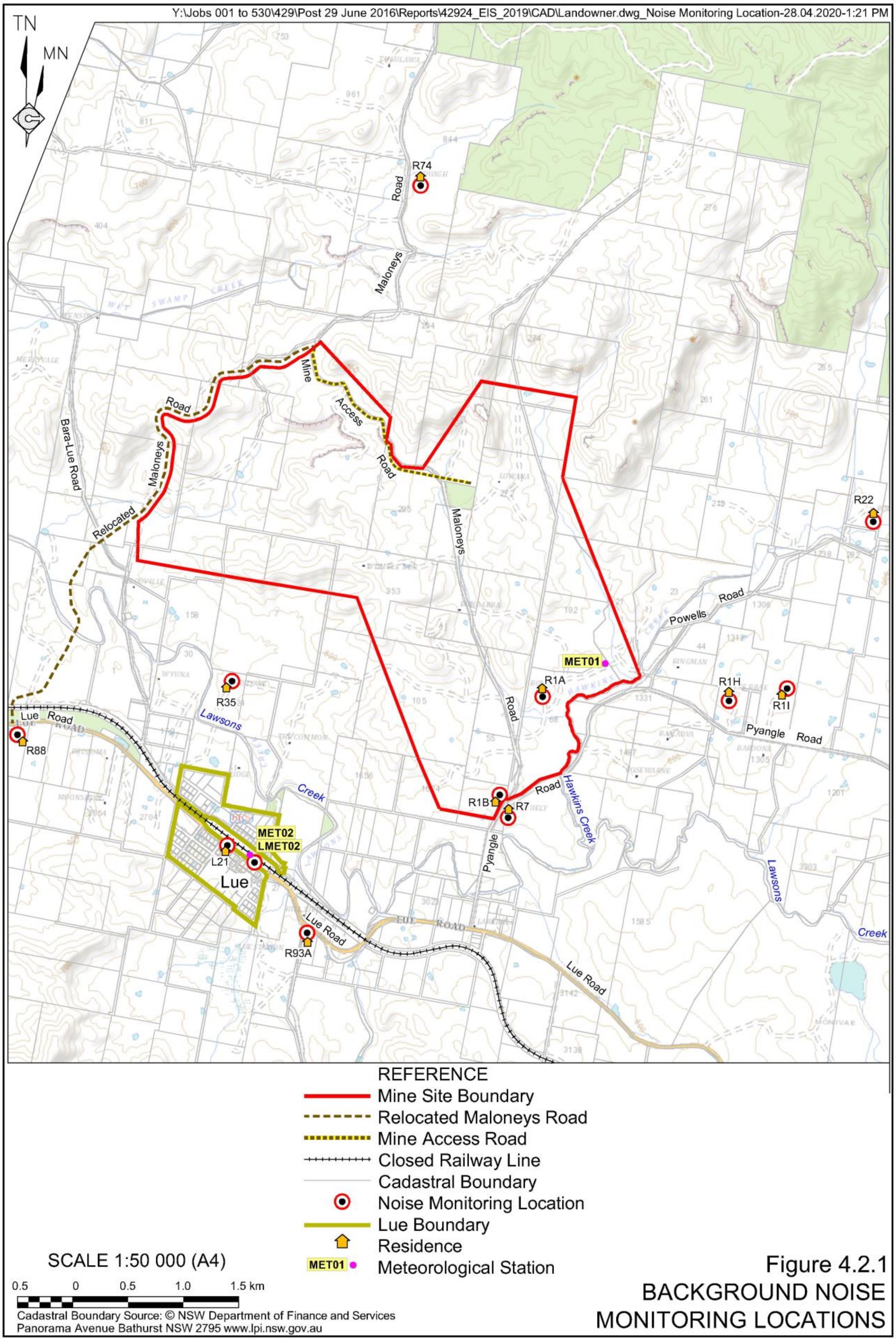

Figure 4.2.1
BACKGROUND NOISE MONITORING LOCATIONS

Table 4.6
Unattended Background Noise Monitoring

Location*	2011 (Sep/Oct)	2012 (Aug)	2013 (Oct/Nov)	2017 (Feb)
R1A	✓	✓		
R1B	✓			
R1H	✓	✓		
R1I			✓	
R7		✓		
R22	✓	✓		
R35	✓	✓		
R74			✓	
R88				✓
R93A			✓	
Lue				
L21	✓	✓		
LMet02				✓
* See **Figure 4.2.1**				

Table 4.7
Unattended Background Noise Results

Monitoring Location[1]	Rating Background Level (LA90)[2]			Equivalent Noise Level (LAeq)[3]		
	7:00am-6:00pm	6:00pm-10:00pm	10:00pm-7:00am	7:00am-6:00pm	6:00pm-10:00pm	10:00pm-7:00am
Rural Areas						
R1A	25	25	25	46	38	49
R1B	27	25	25	66	58	51
R1H	27	25	25	50	41	43
R1I	25	25	25	-	-	-
R7	25	25	25	44	38	38
R22	27	31[4]	25	49	51	52
R35	27	25	25	55	57	47
R74	27	25	25	-	-	-
R88	29	25	25	48	46	43
R93A	25	25	25	-	-	-
Lue						
L21	29	25	25	50	45	44
LMet02	28	25	25	47	54	42

1. See **Figure 4.2.1**
2. The nominated level is the lowest level recorded in the event multiple measurements were recorded.
3. The nominated level is the highest level recorded in the event multiple measurements were recorded.
4. Elevated level attributable to insect activity near monitoring location.

Source: SLR (2020) – Modified after Tables 15, 16, 17 and 19

Existing Traffic Noise

Noise attributed to existing traffic was established through the use of two unattended noise loggers positioned adjacent to Lue Road, one beyond the western boundary of Lue (R88) (100km/h speed zone) and one within Lue (LMet02) (opposite the Lue Public School) (60km/h speed zone). The equivalent noise levels of the day-time traffic ($L_{Aeq)}$ recorded at both locations, i.e. between 7:00am and 10:00pm were 47dB(A). During the night time, i.e. between 10:00pm and 7:00am, L_{Aeq} noise levels recorded were 42dB(A) at both measurement locations.

4.2.2.2 Existing Meteorological Environment

SLR (2020) has adopted a conservative approach when assessing the Project's noise impacts given the influence meteorological conditions have upon noise levels, i.e. either to enhance or suppress the noise being generated at a source. The conservative approach in effect considers noise levels for <u>all</u> assessment periods rather than selecting specific periods when particular meteorological conditions apply.

Table 4.8 lists the standard and noise enhancing meteorological conditions drawn from the NPfI that have been relied upon by SLR (2020) when predicting noise levels for the Project. Reliance has been placed upon the meteorological data collected at the two meteorological stations operated by Bowdens Silver and associated CALMET computations for the Project to enable the frequency of the nominated meteorology parameters in **Table 4.8** to occur at the surrounding rural residences and within Lue.

Table 4.8
NPfI Table D1 Standard and Noise Enhancing Meteorological Conditions

Meteorological Conditions	Meteorological Parameters
Standard	Day/evening/night: stability categories A-D with wind speeds up to 0.5m/s at 10m AGL
Noise-enhancing	Day/evening: stability categories A-D with light winds (up to 3m/s at 10m AGL) Night-time: stability categories A-D with light winds (up to 3m/s at 10m AGL) and/or stability category F with winds up to 2m/s at 10m AGL
Notes: m/s = metres per second m = metres AGL = above ground level Where a range of conditions is nominated, the meteorological condition delivering the highest predicted noise level should be adopted for assessment purposes. However, feasible and reasonable noise limits in consents and licences derived from this process would apply under the full range of meteorological conditions nominated under standard or noise-enhancing conditions as relevant. All wind speeds are referenced to 10m AGL. Stability categories are based on the Pasquil-Gifford stability classification scheme.	
Source: NPfI Table D1	

Further information on the data collected at the two meteorological stations is presented in Section 4.1.2 of this document.

4.2.2.3 Potential Noise Impacts

The various Project activities have the potential to generate noise-related impacts at the surrounding residences and sensitive receivers surrounding the Mine Site and within Lue. The following activities associated with the Project have been identified as sources of potential noise-related impacts.

- Construction activities (on site and off site) during the site establishment and construction stage. Off-site construction activities are those displayed on **Figure 2.5**, specifically with regard to the upgrading of Pyangle Road to the Mine Site and the construction of the relocated Maloneys Road from Lue Road to the mine access road (day-time only Monday to Saturday).
- The noise assessment draws a distinction between construction activities during Months 1 to 6 and Months 7 to 18. During Months 1 to 6 (day-time only Monday to Saturday), the construction activities would be confined to construction of roads and road intersections, preliminary land and vegetation clearing, soil removal and initial earthworks in the area of the processing plant i.e. effectively creating the access to the Mine Site and undertaking the preliminary activities in preparation for the main period of site establishment and construction. From Month 7 onwards (day-time only Monday to Sunday), the level of site establishment and construction activity would increase substantially, particularly with the commencement of extraction activities within the main open cut pit and the delivery of the extracted rock for use in the construction of the various on-site components such as the TSF, noise barriers and lower embankment haul road and the construction of the processing plant.
- Mining operations: Day-time – 7 days per week (Year 1 and possibly Year 2), Day-time and Evening – 7 days per week (Year 2 to possibly Year 3) and Night-time – 7 days per week (Year 3 onwards). The exact timing for the commencement of evening and night-time mining operations would be dependent upon Bowdens Silver demonstrating through monitoring that the evening and night-time noise criteria can be satisfied.
- Processing operations: 7 days per week, 24 hours per day excluding the use of the primary jaw crusher operating between 10:00pm and 7:00am (7 days per week).
- The re-alignment of the 500kV power transmission line during Year 3 of operations would generate additional noise associated with the erection of the new towers and dismantling the redundant towers (day-time only Monday to Saturday).
- Traffic on local roads (both light and heavy vehicle movements) predominantly day-time: 7 days per week with predominantly light vehicle traffic of an evening and night.
- Mine closure/rehabilitation activities (predominantly day-time: 7 days per week).

4.2.2.4 Assessment of Impacts Criteria

Introduction

The following subsections summarise the noise criteria relied upon by SLR (2020) to assess the noise impacts of the activities within the Mine Site at privately-owned residences and land within the vicinity of the Mine Site and within and surrounding Lue. An overview is also provided of the NSW Government's Voluntary Land Acquisition and Mitigation Policy (VLAMP) as it relates to those properties where the relevant noise criteria are unable to be satisfied with the adoption of all feasible and reasonable mitigation measures.

The approach to setting noise assessment criteria reflect two main factors.

1. Noise levels vary due to the changing location of mobile noise sources, the sound power level(s) of the noise source(s), meteorological conditions and the effectiveness of the intervening topography/ground conditions to attenuate noise.
2. The greatest impacts of noise at privately-owned residences and land invariably occur when the noise level is at its highest.

Given 2. above, the NPfI requires noise assessment criteria to be set at a level that is comparatively high compared with levels experienced for much of the time. In reality, the frequency of occurrence of the higher noise levels would vary such that for a proportion of the time, the noise levels would be at or below the background level and/or not noticeable.

Construction Noise Assessment Criteria

Noise generated throughout the first 6 months of the site establishment and construction stage as well as the off-site construction of the water supply pipeline has been assessed by SLR (2020) in accordance with the EPA's Interim Construction Noise Guideline (ICNG) (DECC, 2009), which nominates the following standard hours or time restrictions for construction activities that generate noise levels exceeding normal operational criteria.

- Monday to Friday – 7:00am to 6:00pm
- Saturday – 8:00am to 1:00pm[3]
- No work on Sundays or Public Holiday

This use of the ICNG for the first 6 months of construction activities (i.e. off-site construction of roads and road intersections, and on-site preliminary land and vegetation clearing, soil removal and initial earthworks in the area of the processing plant) as well as the off-site construction of the water supply pipeline is justified as follows.

1. The off-site construction activities are comparable to any standard road construction works undertaken by MWRC or a contractor on behalf of a road authority which are able to rely upon ICNG during those activities.

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[3] Bowdens Silver would undertake occasional construction activities during the first 6 months of a Saturday between 1:00pm and 6:00pm in recognition that these activities would need to satisfy the RBL +5dB(A) criterion.

2. The on-site construction activities are preliminary to the main site establishment and construction activities programmed to start in Month 7 and the number of items of earthmoving equipment is substantially less than during the following 12 months.

The Guideline recommends a 'construction noise management level' (CNML) equivalent to the day-time Rating Background Level (RBL) + 10dB(A) during the standard hours and RBL + 5dB(A) outside the standard hours. The guideline also nominates a "highly noise affected level" (HNAL) day-time intrusive $L_{Aeq(15min)}$ noise level of 75dB(A), a level that is invariably approached for only short periods of time.

Noise generated within the Mine Site from Months 7 to 18 of the site establishment and construction stage has been assessed by SLR (2020) in accordance with NPfI relevant project noise trigger levels (PNTLs).

Intrusive and Amenity Assessment Criteria for Operational Noise

The NPfI specifies a single noise criterion (i.e. PNTL) for operational noise, being the lower of the project intrusive noise level and project amenity noise level, generally as follows.

1. An intrusiveness criterion which requires that the equivalent continuous noise level over a 15 minute period ($L_{Aeq,15\ minute}$) from a specific source (such as a mine) at a privately-owned residence should not exceed the RBL by more than 5dB(A) or in circumstances where the RBL is below 35dB(A) during the day or 30dB(A) during the evening and night. These threshold levels of 35dB(A) and 30dB(A) are considered to be the RBLs for setting impact assessment criteria.
2. An amenity criterion which aims to maintain noise amenity throughout a community over the whole day-time, evening or night-time periods and considers cumulative noise from all industrial sources. The amenity noise level should not exceed the specified "recommended" criterion appropriate for the particular land use.

Given the absence of other continuous industrial noise sources in the vicinity of Lue[4], project amenity noise levels relating to cumulative noise are not considered in this document. However, the recommended amenity noise level plus 5dB(A) remains applicable for the assessment of impacts upon privately-owned rural land. For this land, the relevant $L_{Aeq(period)}$ day-time, evening and night-time criteria of 55dB(A), 50dB(A) and 45dB(A) respectively apply to when these project amenity noise levels impact more than 25% of the land of an individual landowner.

In order to establish the relevant noise criteria, the NPfI prescribes detailed calculation routines for establishing project noise trigger levels (PNTLs) at potentially affected privately-owned residences or sensitive receivers such as Lue Public School. The NPfI explains that the PNTL provides a benchmark or objective for assessing noise generated by a project.

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[4] It is noted that the only noticeable existing noise source in the Lue area is the Louee Enduro and Motocross Complex approximately 2km south-southeast of Lue. Although a noticeable source of noise, its operation is not continuous.

Sleep Disturbance Criteria

Based on the procedures set out in the NPfI, the applicable night-time sleep disturbance noise levels (SDNLs) for both rural and Lue privately-owned residences are:

- an intrusive ($L_{Aeq(15minute)}$) noise level of 40dB(A); and
- a maximum noise level ($L_{AF(maximum)}$) 52dB(A) (free field).

Low Frequency Noise Criteria for Operational Noise

Apart from satisfying the intrusiveness criteria (i.e. PNTL) for operational noise, it is also necessary to satisfy the criteria for certain noise characteristics including low frequency noise, i.e. noise with frequencies typically from 10 hertz (Hz) to 160Hz. The NPfI requires a 2dB to 5dB correction to be applied to the measured or predicted intrusive noise levels when the difference between the C and A weighted noise level is equal to or greater than 15dB and measured or predicted levels exceed the relevant one-third octave low frequency noise thresholds.

Voluntary Land Acquisition and Mitigation Policy (VLAMP)

The VLAMP describes the NSW Government's policy for voluntary land acquisition and mitigation to address noise (and dust) impacts from State significant mining, petroleum and extractive industry developments. The NSW Government has had long-standing processes in place for land acquisition and mitigation associated with mining developments and these procedures are formalised in the VLAMP, including:

- that industry needs to apply all feasible and reasonable measures to minimise noise (and dust) impacts;
- when noise (and dust) impacts are considered appreciable and warrant mitigation measures at the receiver and/or land acquisition rights upon request;
- mitigation measures that need to be offered to affected landowners when impacts are marginal or moderate; and
- requirements for negotiated agreements between applicants and landowners.

The NPfI states that the recommended noise amenity levels are based on protecting the majority of the community (90%) from being highly annoyed by industrial noise. Therefore, provided the PNTLs are achieved, the NPfI implies that most people would consider the resultant noise levels acceptable. In those cases where the PNTLs are not achieved, it does not automatically follow that all people exposed to the noise would find the noise "unacceptable". In subjective terms, the VLAMP characterises noise impacts resulting from residual noise exceedances of the PNTLs generally as follows, i.e. as it relates to the Bowdens Silver Project.

- If the residual noise exceedance is >5dB(A) above the PNTLs, then noise impacts are considered to be significant.
- If the residual noise exceedance is 3dB(A) to 5dB(A) above the PNTLs, , then noise impacts are considered to be marginal to moderate.
- If the residual noise exceedance is 1 to 2dB(A) above the PNTLs, then noise impacts are considered to be negligible.

In the event the noise generated by a development exceeds the PNTLs at any residence on privately-owned land by more than 5dB(A), a consent authority is able to apply voluntary acquisition rights for the owner(s) of the subject properties. This also applies when the >5dB(A) exceedance (of the NPfI's recommended noise amenity level) occurs over more than 25% of any privately-owned land where there is an existing residence or where a residence could be built under current planning controls.

The VLAMP also provides for the consent authority to apply mitigation rights to the owner(s) of residences at which noise levels are predicted to be moderate (i.e. 3dB(A) to 5dB(A) above the PNTLs). Potential mitigation measures that could be undertaken by Bowdens Silver on the nominated residences could include mechanical ventilation (air conditioning) to enable windows to be closed without compromising internal air quality/amenity or a range of architectural treatments such as upgraded facades, double glazing of windows facing the Mine Site, sealing doors or providing roof insulation.

The VLAMP records that when noise exceedances of 1 to 2dB(A) occur, the exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.

Road Traffic Noise Assessment Criteria

Criteria for the assessment of noise from project-related traffic on public roads are set out in the NSW Road Noise Policy (DECCW, 2011). Under this policy:

- Lue Road would be considered as a sub-arterial road;
- relocated Maloneys Road would be considered a new local used as a principal haulage route; and
- Pyangle Road would be considered a local road.

The relevant road traffic noise criteria for each road are set out in **Table 4.9**.

Table 4.9
Road Traffic Noise Criteria for Residential and Non-Residential Land Uses (dB(A) re 20 µPa)

Road	Project Type and Land Use	Total Traffic Noise Criteria[1,2,5]	Relative Increase Criteria[1,2,3,4]
Residential Land Use			
Lue Road	Land use developments generating additional traffic on existing sub-arterial roads	Day-time 60 $L_{Aeq(15hour)}$	Existing $L_{Aeq(15hour)}$ plus 12dB(A)
		Night-time 55 $L_{Aeq(9hour)}$	Existing $L_{Aeq(9hour)}$ plus 12dB(A)
Relocated Maloneys Road	Existing residences affected by noise from new local road corridors used as a 'principal haulage route'	Day-time 55 $L_{Aeq(15hour)}$	Existing $L_{Aeq(15hour)}$ plus 12dB(A)
		Night-time 50 $L_{Aeq(9hour)}$	Existing $L_{Aeq(9hour)}$ plus 12dB(A)
Pyangle Road	Land use developments generating additional traffic on existing local roads	Day-time 55 $L_{Aeq(1hour)}$	Not Applicable
		Night-time 50 $L_{Aeq(1hour)}$	
Non-Residential Land Use			
Lue Road	School Classrooms	50 $L_{Aeq(1hour)}$ (external) when in use[6]	Not Applicable

Note 1: L_{Aeq} = equivalent continuous noise level.
Note 2: Day-time 7:00 am to 10:00 pm, Night-time 10:00 pm to 7:00 am.
Note 3: "Existing" is the projected base (i.e. non-Project-related) traffic noise levels
Note 4: Relative increase noise level generated by the Project for comparison with the Criteria.
Note 5: Where the total traffic criteria are already exceeded, then limit any increase to 2dB(A) or less.
Note 6: External criteria equivalent to internal 40 $L_{Aeq(1hour)}$ criteria plus 10dB(A).

Source: SLR (2020) – Table 57

The Total Traffic Noise Criteria sets out assessment criteria to be applied to a particular type of road category and land use. Where the Total Traffic Noise Criteria is already exceeded due to projected base traffic, any increase in noise levels due to the Project should be limited to 2dB above the existing projected base traffic level.

The Relative Increase Criteria is primarily intended to protect quiet areas from excessive changes in amenity due to additional traffic generated by the Project on the existing and/or new road network. The 'existing' level refers to existing projected base road traffic noise levels, and where this is found to be less than 30dB(A), it is set to 30dB(A) for the purposes of assessing the level of relative increase due to the Project.

4.2.2.5 Management and Mitigation Measures

Introduction

Bowdens Silver, in conjunction with SLR, has identified a range of measures to contain the noise likely to be experienced, and potential noise impacts at locations around the Mine Site. to within the nominated criteria under as many operational scenarios as reasonably possible and at as many privately-owned residences as possible. This has involved a detailed review of the Mine Site layout (see **Figure 2.1**), particularly the main open cut pit layout, and the mining sequence. This process has also identified what type of equipment Bowdens Silver can operate in what general locations under the assessable meteorological conditions and comply with the PNTLs set out in Section 4.2.2.4. This was an iterative process that ultimately provided clarity for Bowdens Silver to finalise the design of the Project and achieve the required annual delivery of up to 2 million tonnes of ore to the ROM pad.

Table 4.10 provides a summary of the suite of feasible and reasonable mitigation measures that would be adopted both from a management perspective and through the use of specific noise controls to minimise noise levels at the surrounding privately-owned residences. Details of the design features and the management measures would be documented in two Noise Management Plans for the Project, i.e. one for the site establishment and construction stage and one for all mining and processing operations.

In addition to the above key noise management and mitigation measures, Bowdens Silver would ensure the following are adopted by all equipment operators.

1. Wherever possible, equipment would not be left idling unnecessarily.
2. Haul trucks would be operated behind barriers whenever possible to maximise noise attenuation.
3. Avoiding dramatic changes in operations, and hence noise emissions, during the evening and night time – such as through staggered meal breaks.
4. Strategically positioning the parking areas for earthmoving equipment during meal breaks in areas providing the greatest attenuation.
5. Selective shut-down procedures would be adopted, if required, to reduce the number of items of equipment to ensure the relevant noise criteria are satisfied particularly during very noise enhancing meteorological conditions.

Table 4.10
Proposed Reasonable and Feasible Noise Controls and Management Measures

Mitigation	Control or Management Measure
Noise Source Control - mobile equipment	Use of noise attenuated mobile equipment comprising low noise or extra quiet mobile equipment where practical with nominal design performance sound power levels for specific individual mobile equipment noise source control. Details of the source noise controls and the proposed sound power levels of the equipment is provided in Section 5.3 of SLR (2020).
	Restriction of all bulldozers to 1st gear operation when operating out of the open cut pits.
	Installation of broadband noise “quacker” style reversing alarms.
Noise Source Control - fixed plant	Use of full or partial enclosures to attenuate noise from fixed plant where practical with nominal design performance sound power levels for specific individual fixed plant noise source control. Details of the building enclosures are outlined in **Figure 2.12** and Section 5.3 of SLR (2020).
	Use of low noise specifications, low noise idlers, soft-flow chutes and silencers.
	Installation of mid-high frequency noise conveyor alarms.
Noise Propagation Path - mobile equipment	Progressive construction of the lower embankment noise barrier around the WRE and southern barrier.
	Relocation of the northern exit ramp from the main open cut pit to maximise topographic shielding at the northern open cut pit exit.
	Acoustic barriers adjacent to the main open cut pit haul road and northern exit to the ROM pad.
	Optimised evening waste rock haul route to maximise the barrier effect from the existing topography and temporary acoustic bunds within the active WRE areas.
	Optimised night-time ore haul route to maximise the barrier effect from the existing topography and acoustic barriers adjacent to the main open cut pit haul road to the ROM pad.
Noise Propagation Path - fixed plant	Processing plant relocated further north within the Mine Site with the placement of the primary jaw crusher at a lower elevation to minimize noise propagation in the direction of Lue.
	Nearfield acoustic barriers around the TSF crushing/screening plant.
Operational Management Controls	Scheduling of intrusive activities to less sensitive times of the day, for example TSF lifts, material emplacement on southern barrier and soil stockpiles would be limited to the day-time throughout the Project life.
	Reduced mining operations during the evening within restricted WRE areas.
	Further reduced mining operations during the night-time with only ore delivery to the ROM pad.
	Implementation of real-time noise monitoring network at key residential receivers to identify plant and equipment shutdowns (if required) during noise enhancing weather conditions.
	Enhance and maintain the continuous meteorological monitoring network for the Project.
Noise Receiver Control	Any residual noise impacts guided by the requirements of the VLAMP and Bowdens Silver Project Noise Impact Assessment Methodology.
Liaison with potentially affected residents	Discussions would be held with residents in close proximity to each construction site during the site establishment and construction stage to alert residents of planned activities and to address any feasible requirements during that period.
	Regular discussions would be held with all residents/occupiers of properties at which noise levels are predicted to exceed the Project Noise Trigger Level to discuss the perceptions regarding any noise that is audible.
Source: SLR (2020) – Modified after Table 30	

The equipment operators would be fully informed (at their inductions, re-inductions and through regular toolbox talks) regarding the sensitivities relating to noise, the expectations of local residents and Bowdens Silver's commitments. Emphasis would be placed upon undertaking a job safety and environmental analysis (JSEA) prior to the commencement of on-site and off-site activities to ensure all planning is streamlined and the appropriate resources/equipment are available to undertake the activities in the most efficient and least noisy manner possible.

Bowdens Silver proposes to require the transport contractor transporting concentrates from the Mine Site to their final destinations to induct all drivers to adopt all safety and operating procedures specified in a Driver's Code of Conduct. The code would address a range of practices including those relating to hours of travel on Lue Road, minimal use or avoidance of exhaust brakes and adherence to nominated speed restrictions.

Communications

Bowdens Silver would place considerable emphasis upon communications with landowners and occupiers in close proximity to all construction sites within the Mine Site, Pyangle Road and relocated Maloneys Road as well as the off-site construction of the water supply pipeline during the site establishment and construction stage. This would be achieved through the adoption of the following measures.

1. Occupants of residences, within a distance nominated in the Construction Noise Management Plan, would be provided with details ahead of time regarding the type of activities, their duration and the specific measures to be adopted to minimise noise.
2. Good communications would be maintained between personnel and surrounding landowners and occupiers during both the site establishment and construction stage and operations.
3. Surrounding landowners and occupiers would be made aware of the appropriate contact details for the most appropriate contact person for discussions/lodging complaints, if required.
4. Any substantiated complaint from a surrounding landowner or occupier would be responded to in a timely manner.

Voluntary Land Acquisition and Mitigation Policy (VLAMP)

Bowdens Silver recognises that despite the adoption of a comprehensive suite of feasible and reasonable mitigation measures, it would not be possible to satisfy the PNTLs at all residences surrounding the Mine Site. As a consequence of this, and following the initial assessment of predicted noise impacts, Bowdens Silver commenced discussions and negotiations with the landowners of the relevant properties to establish whether they would like to be considered under the NSW Government's Voluntary Land Acquisition and Mitigation Policy (VLAMP).

Bowdens Silver has approached landowners in the following manner.

Properties with Predicted Significant Exceedances

Bowdens Silver approached the owners of four properties at which noise levels were predicted to exceed the relevant PNTL by more than 5dB(A).

As a result of these discussions and negotiations, Bowdens Silver has entered binding agreements to purchase two of the four properties and lease a third. As a result the residences are no longer referred to as ‘privately-owned residences’ but as ‘Project-related residences’.

Properties with Predicted Moderate Exceedances

Four additional properties were predicted to exceed the relevant PNTL by 3dB(A) to 5dB(A).

Bowdens Silver proposes to enter agreements to mitigate predicted noise levels at the properties including installation of mechanical ventilation (air conditioning) and/or commissioning of a range of architectural improvements to their residence. The architectural improvements required would be determined during an inspection of the residence by an acoustic specialist and experienced builder.

Properties with Predicted Negligible Exceedances

A further six properties are predicted to exceed the relevant PNTL by 1 to 2dB(A) at their residence. Whilst the VLAMP does not provide these landowners with the opportunity to request noise mitigation works, Bowdens Silver has elected to offer to install relevant mitigation measures as agreed by the landowner.

Documentation

Bowdens Silver would document the procedures to be adopted to mitigate and minimise noise during the site establishment and construction stage within a Construction Noise Management Plan. Emphasis would be placed upon minimising the period of noise exceedances as much as possible.

The routine use of continuous real-time noise monitors during the operation of the Project would enable Bowdens Silver to manage the locations where the various items of the mining fleet are operating at any time. This flexibility would remove the need to prescribe detailed controls on the location and operation of equipment. Rather, noise management would be undertaken through a range of specific procedures incorporated within the Operations Noise Management Plan which would be updated annually or as required. These procedures would record the operational areas within the Mine Site and the preferred times and meteorological conditions for operations in each operational area.

4.2.2.6 Assessment Methodology

Introduction

The noise assessment methodology for the Project has involved the use of computer modelling to predict noise generated by all activities throughout the Project life (with the adoption of all feasible and reasonable mitigation measures) and comparing those predicted levels against the assessment criteria nominated by the EPA outlined in Section 4.2.2.4.

Noise modelling of the activities within the Mine Site was undertaken by SLR (2020) through the use of the software Environmental Noise Model (ENM) for Windows, Version 3.06) developed by Renzo Tonin and Associates for:

- on-site and off-site construction noise;
- site operational noise; and
- road traffic noise.

The approach to the modelling adopted by SLR (2020) to each of these noise sources and, where appropriate, the approach to assessing the implications of the predicted noise levels is outlined as follows.

Months 1 to 6: On-site and Off-site Construction Noise

SLR (2020) reviewed the activities planned during the first 6 months of the site establishment and construction stage and the period from Month 7 to Month 18 and determined that the second period would generate more noise than the first period.

The first 6 months of the site establishment and construction stage involves the off-site road network upgrades and initial on-site earthworks and infrastructure works as presented in Annexure 7 and Table 4 of SLR (2020). which has been modelled for the purposes of construction noise impact. The construction fleet used for the off-site relocated Maloneys Road construction works was modelled in typical locations representative of the construction fleet progressing along the road corridor throughout the construction period. The construction fleet for on-site earthworks and infrastructure works was modelled in typical locations representative of the construction of the internal Mine Access Road, vegetation clearing, soil stripping and stockpiling.

Months 7 to 18: On-site Construction Noise

An operational scenario was developed for the period from Month 7 to Month 18 (Scenario 1) that reflects the number, type and location(s) of mobile earthmoving equipment during this period. Details of the equipment types and their location for this scenario are presented in Annexure 15 (Figure A) and Table 26 of SLR (2020). Scenario 1 would occur during about Month 13 when most of the mobile equipment is operating on site to develop the main open cut pit and construct the TSF embankment/impoundment area and the processing plant. Therefore, the scenario represents the noisiest period during the site establishment and construction stage. It is noted that whilst the activities undertaken during Months 7 to 18 are considered as construction activities, the noise generated by these activities is assessed as operational noise under the NPfI given mining would be commencing in the main open cut pit in order to provide a number of materials for construction of the Project infrastructure.

Months 7 to 18: Off-site Construction Noise

The noise generated by the off-site construction activities involving the off-site water pipeline construction fleet presented in Table 5 of SLR (2020) was predicted for various representative stages of the pipeline construction including vegetation clearing and corridor preparation followed by trenching and back filling the pipeline.

Operational Noise

SLR (2020) has predicted operational noise levels at 75 rural and rural lifestyle privately-owned residences within approximately 3km to 4km of the Mine Site and at the 44 privately-owned residences and receivers within Lue through the use of three representative operational scenarios for activities to be undertaken within the Mine Site in Year 3, Year 8 and Year 10. A brief overview of the scale and location of activities for each scenario provided in **Table 4.11**. Details of the equipment used during the day-time, evening and night-time for each scenario and their locations and sound power levels are listed in Tables 27, 28 and 29 and Annexure 15 of SLR (2020).

Table 4.11
Key Activities in Operational Noise Scenarios*[1,2]

Period	Scenario 2	Scenario 3	Scenario 4
Day-time	**Figure B**	**Figure E**	**Figure H**
Mining in Main Open Cut Pit	Northeastern side (Mobile Equipment at or near surface)	Northeastern and eastern sides (100m below surface and near surface and near surface in western satellite pit)	Western side (mobile Equipment at or near surface)
Ore Transportation	To ROM pad and Low Grade Ore Stockpile	To ROM Pad and Low Grade Ore Stockpile	To ROM Pad and Low Grade Ore Stockpile
Waste Rock Transportation	To TSF, WRE, Southern Barrier	To TSF, WRE, Southern Barrier	To WRE, Southern Barrier (not TSF)
Processing	All processing equipment	All processing equipment	All processing equipment
TSF Embankment Construction[2]	Construction of embankment to 611mAHD (29 weeks)	Construction of embankment to 620mAHD (41 weeks)	Nil
Evening	**Figure C**	**Figure F**	**Figure I**
Mining in Main Open Cut Pit	Northeastern side Drilling only (1 drill) near surface and loading haul trucks	Northern Side Drilling only (1 drill) at depth (and drill in western satellite open cut pit and loading haul trucks)	Drilling only (1 drill) near surface and loading trucks
Ore Transportation	To ROM Pad and Low Grade Ore Stockpile	To ROM Pad and Low Grade Ore Stockpile	To ROM Pad and Low Grade Ore Stockpile
Waste Rock Transportation	To WRE only (placement behind temporary noise barrier)	To WRE only (placement behind temporary noise barrier)	To WRE only (placement behind temporary noise barrier)
Processing	All processing equipment	All processing equipment	All processing equipment
Night	**Figure D**	**Figure G**	**Figure J**
Mining in Main Open Cut Pit	Loading haul trucks only	Loading haul trucks only	Loading haul trucks only
Ore Transportation	To ROM pad only	To ROM pad only	To ROM pad only
Waste Rock Transportation	Nil	Nil	Nil
Processing	All processing equipment except jaw crusher	All processing equipment except jaw crusher	All processing equipment except jaw crusher
1. Figure references relate to Scenarios depicted in SLR (2020) – Annexure 15. 2. TSF embankment construction would be confined to day-time operations only.			

The noise model predicts the total intrusive noise level that would be experienced at each residence or receiver from the proposed mobile and fixed plant and equipment operating in the nominated locations or circuits (for haul trucks), with the predicted operational noise levels then compared against the day-time, evening and night-time criteria outlined in Section 4.2.2.4. The extent of impact is then determined by assessing the extent of the residual exceedances, if predicted.

For the rehabilitation component of the Project, SLR has assumed that the noise levels associated with those activities would be similar to those generated during the day-time in Year 8 (Scenario 3). The noise generated during the removal of the southern barrier (largely from its northern side) would be comparable with noise levels generated during the day-time in Year 10 (Scenario 4).

The topography within the Mine Site used in the noise modelling is based on the various scenarios included in Annexure 15 (SLR, 2020) with equipment generally placed in typical worst-case locations for noise propagation.

The NPfI requires that noise modelling takes into account meteorological conditions that are a feature of the area in which a noise is proposed to be generated. These conditions have previously been described in Section 4.2.2.2 i.e. for assessment under standard or noise enhancing meteorological conditions. Table 14 (SLR, 2020) provides further detail of the standard and noise-enhancing meteorological conditions relied upon in the noise modelling. It remains important for the noise assessment to also identify when noise-enhancing or standard meteorological conditions don't apply and result in lower noise levels than those predicted.

Low Frequency Noise

SLR (2020) selected four representative residences to undertake a low frequency analysis, namely Residences L20, R21, R47, and R87 (see **Figure 4.2.2**). The calculations considered the noise levels during day-time, evening and night-time periods under noise enhancing meteorological conditions.

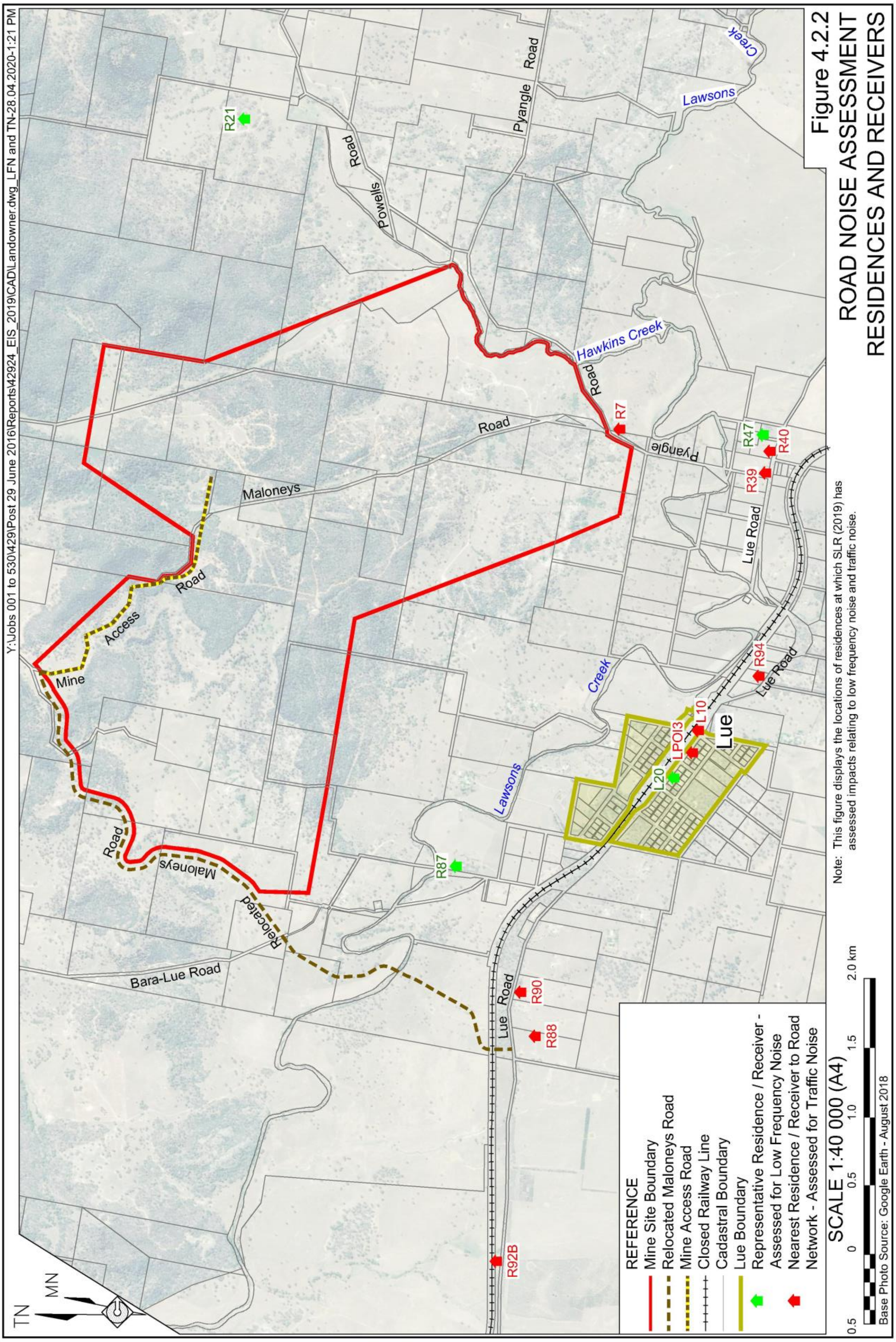
Road Traffic Noise

The approach adopted by SLR (2020) to establish the potential impacts of increased traffic levels on public roads in the vicinity of the Mine Site and Lue involved the following.

The Road Noise Policy requires the road noise assessment to be carried out in three steps.

Step 1. Calculate the total noise of the existing traffic and whether that complies with the total noise traffic criteria in **Table 4.9** for the road type/land use and period during the day.

Step 2. In the event the total traffic noise level for the existing traffic is compliant with the criteria, then establish what the total noise level would be through the addition of the project-related traffic and compare the combined noise level with the total traffic noise criteria in **Table 4.9**. In the event the combined existing and Project-related traffic noise satisfies the total traffic noise criteria, no further assessment is required.


Y:\Jobs 001 to 530\429\Post 29 June 2016\Reports\42924_EIS_2019\CAD\Landowner.dwg_LFN and TN-28.04.2020-1:21 PM
Figure 4.2.2
ROAD NOISE ASSESSMENT
RESIDENCES AND RECEIVERS
Lawsons Creek
Pyangle Road
Powells Road
Hawkins Creek Road
Maloneys Road
Mine Access Road
Relocated Maloneys Road
Bara-Lue Road
Lue Road
Lue
R21
R7
R47
R40
R39
R94
L10
LPOI3
L20
R87
R90
R88
R92B
TN
MN
Note: This figure displays the locations of residences at which SLR (2019) has assessed impacts relating to low frequency noise and traffic noise.
REFERENCE
Mine Site Boundary
Relocated Maloneys Road
Mine Access Road
Closed Railway Line
Cadastral Boundary
Lue Boundary
Representative Residence / Receiver - Assessed for Low Frequency Noise
Nearest Residence / Receiver to Road Network - Assessed for Traffic Noise
SCALE 1:40 000 (A4)
0.5 0 0.5 1.0 1.5 2.0 km
Base Photo Source: Google Earth - August 2018

Step 3. In the event that:

- the total traffic noise level for the existing traffic exceeds the relevant criterion nominated in **Table 4.9**; or
- the predicted total traffic noise level for the existing and proposed traffic exceeds the total relevant noise criterion nominated in **Table 4.9**,

an assessment then needs to be made of the relative increase to establish whether the increase in the traffic noise level attributable to a new project satisfies the relevant criteria (see Section 4.2.2.6).

SLR (2020) calculated the noise levels at the nearest privately-owned residences and receivers to the road network representing the nearest most potentially affected residences/receivers within and surrounding Lue (see **Figure 4.2.2**) and then calculated the noise levels at those locations based upon the proposed Project-related traffic levels (see **Tables 2.5** and **2.6**) **Table 4.12** lists the privately-owned residences/receivers assumed and their respective distances from the adjoining road.

Table 4.12
Nearest Privately-owned Residences and Sensitive Receivers to Study Area Road Network

Residence ID / Place of Interest[1]	Approximate Distance to Road Centre (m)	Residence ID / Place of Interest[1]	Approximate Distance to Road Centre (m)
Lue Road within Lue		**Pyangle Road**	
L10	13	R7	39
LPOI3 – Lue Public School	34		
Lue Road - East of Relocated Maloneys Road and West of Lue		**Lue Road - East of Lue and West of Pyangle Road**	
R90	50	R94	39
Lue Road - West of Relocated Maloneys Road		**Relocated Maloneys Road**	
R92B	30	R88	180
Lue Road East of Pyangle Road			
R40	24		
R39	18		
Note 1: see Land Ownership and Surrounding Residences and Land Ownership details in **Annexure 7**).			
Source: SLR (2020) – Table 58			

The predicted noise levels were then compared with the criteria set out in Section 4.2.2.7.

The calculations were undertaken for three scenarios, namely:

1. during the first 6 months of the site establishment and construction stage prior to the completion of the relocated Maloneys Road;
2. during Months 7 to 18 of the site establishment and construction stage after the construction of the relocated Maloneys Road; and
3. during operational Year 3 following the achievement of morning, evening and night-time mining operations.

It is noted that the traffic levels during operational Year 3 would be comparable with the traffic levels throughout the operational Project life.

4.2.2.7 Assessment of Impacts

Introduction

This subsection presents the predicted noise levels associated with the Project. Emphasis has been placed upon predicting noise levels at all privately-owned residences and receivers The results of the predictions arising from the noise modelling are provided for:

- the site establishment and construction stage;
- the three operational years namely, Years 3, 8 and10 (day, evening and night);
- low frequency noise at four selected representative receivers; and
- traffic noise.

Site Establishment and Construction Stage

Months 1 to 6

Table 32 in SLR (2020) presents the predicted noise levels at all considered residences/receivers for the on-site and off-site construction activities during the first 6 months of the site establishment and construction stage. SLR (2020) predicts that the construction activities undertaken within the Mine Site during the first 6 months would not generate noise levels in excess of the L_{Aeq} 45dB(A) construction noise management level (CNML) at any residences. However, the following exceedances of the CNML are predicted at the five closest residences during the construction of the southern section of the relocated Maloneys Road and its intersection with Lue Road.

- A marginal exceedance (<5dB(A)) at one residence (R82).
- A moderate exceedance (>5dB(A)) at the four closest residences (R81, R88, R89, R90). The predicted noise levels at these residences range from 50dB(A) to 57dB(A) under enhancing wind conditions.

It is noted that these noise exceedances, which would occur at times during a 1 to 2 month period are substantially lower than the highly noise affected level of 75dB(A).

Months 7 to 18

The 12 month period between Months 7 to 18 would be an intensive period of activity within the Mine Site to prepare the site for the commencement of concentrate production and despatch. The assessment of noise impacts during this period has been assessed in SLR (2020) as Operational Scenario 1. The predicted noise levels at all residences under standard and enhancing wind conditions are listed in Table 35 of SLR (2020).

SLR (2020) predicts the occupants of eight residences would experience noise levels (outside their residences) at various times during the day throughout the 12 month period that exceed the day-time PNTL of 40dB(A). The level of exceedance would vary from 2dB(A) to 5dB(A) under standard meteorological conditions to 2dB(A) to 10dB(A) under enhancing wind conditions. Apart from predicting the likely noise level to be experienced, SLR (2020) also presents the likely percentage occurrence of the standard and wind enhancing conditions. The percentage of time during the day when standard conditions exist would be typically 3% of the time and for noise enhancing conditions up to 21% of the time. Conversely, the noise levels would not be enhanced (and would be lower than the predicted levels) for almost 75% of the time.

During the noisiest period of the site establishment and construction stage, noise levels within the classroom at the Lue Public School are predicted to be 28dB(A), a level compliant with the 35dB(A) internal criterion.

Operational Noise

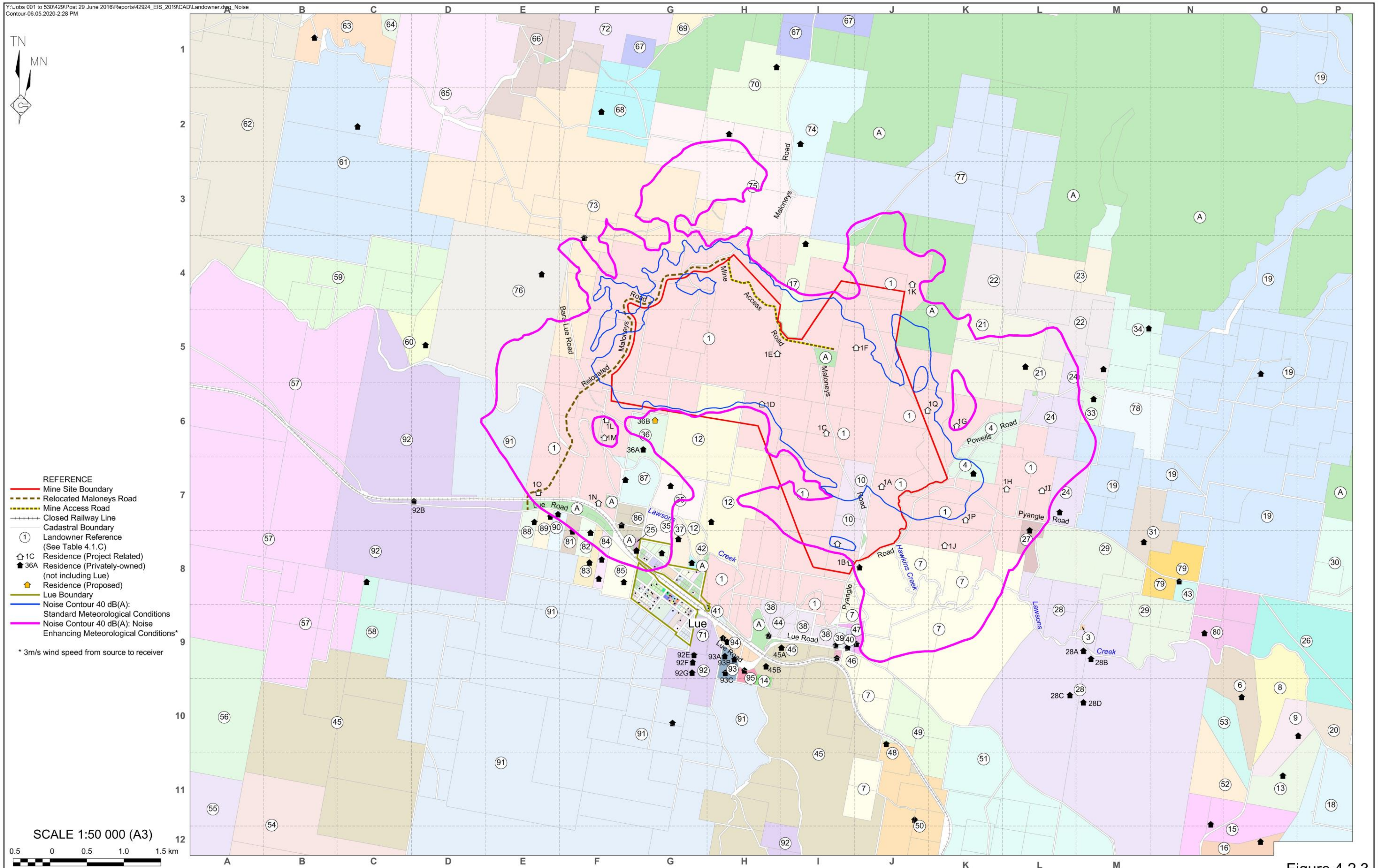
Tables 35, 37 and 39 in SLR (2020) respectively present the predicted noise levels at the various residences and receivers during the day, evening and night for Operational Scenarios 2, 3 and 4. **Table 4.13** displays a summary of the residences/receivers at which the PNTL is predicted to be exceeded throughout the Project life. During Year 3, when the 500kV power transmission line is realigned, the additional noise created would marginally increase noise levels at the closest residences for which a VLAMP agreement would be in place. **Table 4.13** similarly displays the exceedance of the sleep disturbance criteria at two residences close to the operational areas within the Mine Site.

Table 4.13
Privately-owned Residences with predicted PNTL and SDNL Exceedances

Receiver Area	Exceedance[1]	Day-time	Evening	Night-time	Maximum Exceedance in Any Period
Rural Residences	Negligible 1 to 2dB(A) above PNTL	R21; R27; R37	R21; R27; R35; R36A; R37; R39; R40; R47; R87	R2; R21; R27; R35; R36A; R37; R39; R40; R47; R87	R21; R27; R37; R39; R40; R47
	Marginal to Moderate 3 to 5dB(A) above PNTL	R7; R35; R36A; R87	R7	R7	R7; R35; R36A; R87
	Significant > 5dB(A) above PNTL	R4	R4	R4	R4
	Negligible 1 to 2dB(A) above SDNL[2]	-	-	R4	R4
Lue Residences	Negligible 1 to 2dB(A) above PNTL	-	-	-	-
	Marginal to Moderate 3 to 5dB(A) above PNTL	-	-	-	-
	Significant > 5dB(A) above PNTL	-	-	-	-
	Negligible 1 to 2dB(A) above SDNL	-	-	-	-
Lue Place of Interest	Negligible 1 to 2dB(A)	-	-	-	-
	Marginal to Moderate 3 to 5dB(A)	-	-	-	-
	Significant > 5dB(A)	-	-	-	-

Note 1: In accordance with the Project noise impact assessment methodology presented in SLR (2020) – Table 25.
Note 2: Exceedance of the intrusive ($L_{Aeq(15minute)}$) SDNL of 40 dB(A).
Source: SLR (2020) – Modified after Table 43.

Figures 4.2.3, **4.2.4** and **4.2.5** present the accumulated contours for the day-time, evening and night-time periods for Operational Scenarios 1, 2, 3 and 4. Tables 35, 37 and 39 in SLR (2020) list the predicted operational noise levels at all privately-owned residences for these scenarios and periods, and **Table 4.14** list the periods when exceedances are predicted for all operational scenarios.



Landowner Source: Globalxterrain - December 2019
Cadastral Boundary Source: © NSW Department of Finance and Services
Panorama Avenue Bathurst NSW 2795 www.lpi.nsw.gov.au

Figure 4.2.3
NOISE CONTOURS - DAYTIME

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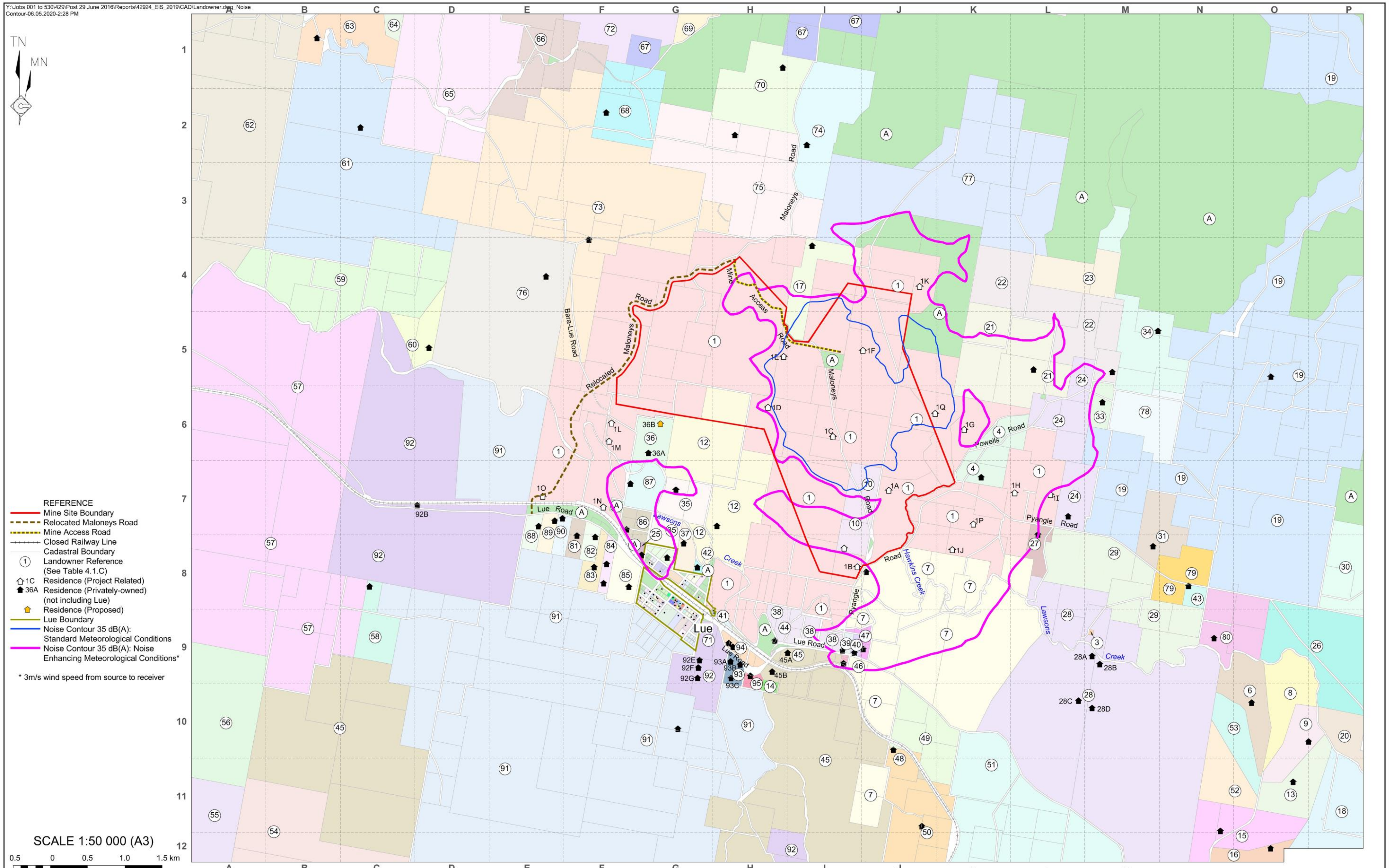

Figure 4.2.4
NOISE CONTOURS - EVENING

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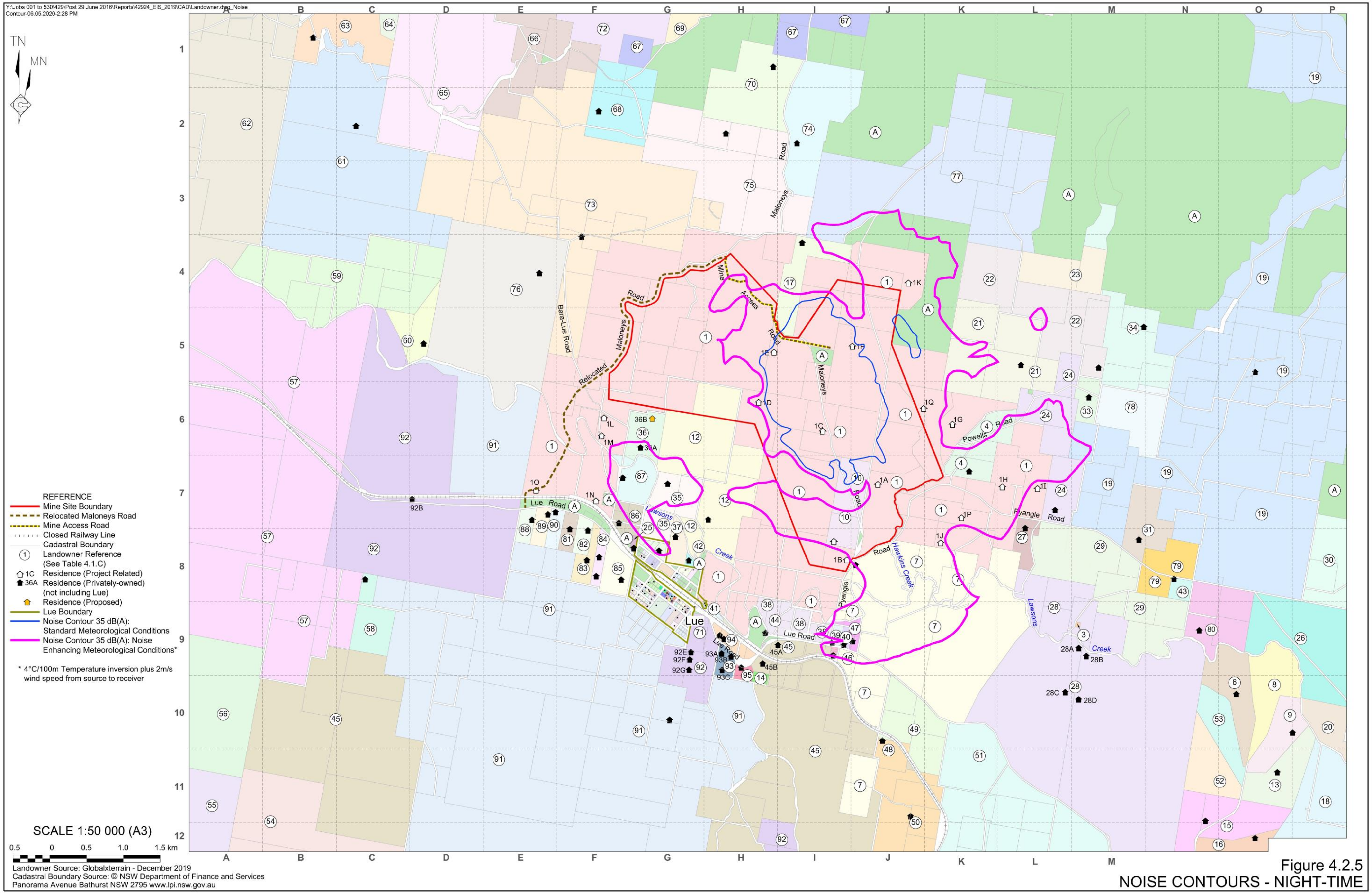

Figure 4.2.5
NOISE CONTOURS - NIGHT-TIME

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Table 4.14
Periods of Predicted Exceedances at VLAMP-affected Residences

Residence No.	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	D	E	N	D	E	N	D	E	N	D	E	N
Predicted Exceedances > 5dB(A)												
R4	×	✓	✓	×	×	×	×	×	×	×	×	×
Predicted Exceedances 3dB(A) to 5 dB(A)												
R7	×	✓	✓	×	×	×	✓	✓	✓	×	×	×
R35	×	✓	✓	✓	×	×	✓	✓	✓	✓	✓	✓
R36	×	✓	✓	×	×	×	×	✓	✓	✓	✓	✓
R87	×	✓	✓	✓	×	×	✓	✓	✓	✓	✓	✓
Predicted Exceedances 1dB(A) to 2 dB(A)												
R21	×	✓	✓	✓	×	✓	✓	✓	✓	✓	×	×
R27	×	✓	✓	✓	×	×	✓	✓	✓	✓	×	×
R37	×	✓	✓	✓	×	×	✓	✓	✓	✓	✓	✓
R39	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×
R40	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×
R47	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	×	×
D = Day				E = Evening								N = Night
× Predicted noise exceedances during the period ✓ No exceedance during this period												

It is noted that the presentation of the noise contours involves numerical interpolation of a noise level array with a graphical accuracy of up to approximately ±2dB(A). This means that in some cases, the noise contours differ slightly from the values for each residence/receiver listed in SLR (2020), which are calculated at the individual residential/receiver locations and are therefore the more accurate predictions.

A detailed review of the predicted noise levels on Tables 35, 37 and 39 SLR (2020) and the summary presented in **Table 4.14** reveal the following.

Day-time

At various times during the day in Year 3 (Scenario 2) the occupants of a total of three residences would experience noise levels (outside their residences) that exceed the PNTL of 40dB(A). In Year 8 (Scenario 3) and Year 10 (Scenario 4), the occupants of two privately-owned residences would experience noise levels that exceed the PNTL of 40dB(A). The level of exceedance would vary from 2dB(A) under standard meteorological conditions to 1dB(A) to 6dB(A) under enhancing wind conditions. It is noted that the typical difference between the noise level predicted under standard and enhancing wind conditions during the day ranges from 6dB(A) to 18dB(A). The higher differences typically occur at the more distant privately-owned residences, including those in Lue. Apart from predicting the likely noise level to be experienced, SLR (2020) also presents the likely percentage occurrence of the standard and enhancing wind conditions. The percentage of time during the day when standard conditions exist would be typically 3% and for noise enhancing conditions up to 21%. Conversely, the noise levels would not be enhanced (and would be lower than the predicted levels) for almost 75% of the time.

It is noted that during Year 3, when the 500kV power transmission line is being re-aligned, the construction activities would increase the predicted day-time noise levels at surrounding residences between 1dB(A) and 7dB(A) and typically between 4dB(A) and 6dB(A). The predicted increases in noise levels would increase the number of residences with exceedances above the 40dB(A) criteria from 7 to 21. Section 8 (SLR, 2020) provides further detail on the predicted noise during the re-alignment of the 500kV power transmission line.

Evening

At various times during the evening in Year 3 (Scenario 2) the occupants of a total of three residences would experience noise levels (outside their residences) that exceed the PNTL of 35dB(A). No exceedances would occur under standard meteorological conditions and the level of exceedance under enhancing wind conditions would vary from 1dB(A) to 6dB(A). It is noted that the typical difference between the noise level predicted under standard and enhancing wind conditions during the evening ranges from 11dB(A) to 26dB(A). Apart from predicting the likely noise level to be experienced, SLR (2020) also presents the likely percentage occurrence of the standard and wind enhancing conditions. The percentage of time during the evening when standard conditions exist would be typically 2% and for noise enhancing conditions up to 46%. Conversely, the noise levels would not be enhanced (and would be lower than the predicted levels) for almost 50% of the time.

Night

At various times during the night in Year 3 (Scenario 2) the occupants of a total of three residences would experience noise levels (outside their residences) that exceed the PNTL of 35dB(A). There are no exceedances predicted under standard meteorological conditions with exceedances ranging from 1dB(A) to 6dB(A) under enhancing inversion and drainage flow conditions. It is noted that the typical difference between the noise level predicted under standard and enhancing inversion and drainage flow conditions during the night ranges from 17dB(A) to 29dB(A). Apart from predicting the likely noise level to be experienced, SLR (2020) also presents the likely percentage occurrence of the standard and noise enhancing conditions. The percentage of time during the evening when standard conditions exist would be typically 4% and for noise enhancing conditions up to 58% . Conversely, the noise levels would not be enhanced (and would be lower than the predicted levels) for more than approximately 40% of the time.

For the day-time period, occupants within the 40dB(A) contour could experience noise levels above the day-time noise criteria depending upon the prevailing wind direction. Similarly, for the evening and night-time periods, the occupants of those residences within the 35dB(A) contour could experience noise levels above the evening and night-time criteria depending on the prevailing wind conditions and whether a temperature inversion is present.

The predicted noise levels essentially establish that under noise enhancing meteorological conditions, activities during the site establishment and construction stage and the operational stages within the Mine Site would be periodically audible external to residences typically within approximately 3km of the Mine Site. These distances include the bulk of Lue and a number of the surrounding rural lifestyle blocks. Mine noise levels may also be discernible external to residences beyond approximately 3km from the Mine Site subject to the prevailing background noise level, the extent of the intervening topography and disposition of the receiver (i.e. a resident going about their daily activities or standing silent endeavouring to detect any distant mine noise).

The fact that the Project-related noise would be periodically audible, albeit at levels below the noise criteria at most residences, would be a noticeable change to the occupants of those residences/receivers. That said, the actual magnitude of the mine noise would be at a level recognised by the EPA's policy as being acceptable to most people and unlikely to cause annoyance to receivers who may experience mine noise external to their residence. Where mine noise levels are predicted to exceed the noise criteria the approvals process triggers the implementation of noise mitigation at the residences so that noise impacts are also acceptable.

During the operation of the Project, the maximum noise levels within the classrooms at the Lue Public School (under noise enhancing weather conditions) would be 28dB(A) (Scenario 1), 26dB(A) (Scenario 2) and 22dB(A) (Scenario 3), i.e. well below the 35dB(A) internal criterion.

Mine Rehabilitation and Closure

As discussed in Section 4.2.2.6, SLR (2020) assessed that the noise levels associated with the day-time rehabilitation activities would be similar to the day-time noise levels in Year 8 (Scenario 3) and Year 10 (Scenario 4). Given the predicted noise levels for these scenarios established compliance with the day-time noise criteria at most residences and the exceedances would be managed through the VLAMP, there would be no change in the level of impact during the rehabilitation period.

Traffic Noise

Construction Period: Months 1 to 6

SLR (2020) assessed the change in traffic noise levels at residences adjacent to three roads namely, Lue Road (within and beyond Lue), Pyangle Road and at the Lue Road/Pyangle Road intersection, i.e. during the 6 months of the site establishment and construction stage, prior to construction of the relocated Maloneys Road.

The predicted day-time and night-time noise levels at all residences adjacent to Lue Road and Pyangle Road would satisfy the relevant criteria.

The traffic noise received externally at Lue Primary School would marginally exceed the day-time criteria for all traffic although the Road Noise Policy considers the level of increase due to the Project would be barely perceptible and investigation of noise mitigation measures is not warranted in accordance with the Policy. Section 11.3 of SLR (2020) provides further detail of the predicted noise levels during this period.

Traffic noise levels would comply with the day-time and night-time assessment criteria at the closest residence to the Lue Road/Pyangle Road intersection (R39). Whilst increased noise arising from braking and accelerating would occur at this intersection. SLR (2020) considers that the increased noise is unlikely to be appreciable given the relatively small volume of Project-related traffic entering and exiting Pyangle Road during this period.

Construction Period: Months 7 to 18

SLR (2020) assessed the change in traffic noise levels at locations adjacent to Lue Road and relocated Maloneys Road during Months 7 to 18 of the site establishment and construction stage, i.e. following the completion of construction of relocated Maloneys Road. The ongoing but limited levels of traffic on Pyangle Road would comply with the noise criteria at residences adjacent to the road.

The predicted day-time and night-time noise levels at all road-side residences would satisfy the relevant criteria.

A minor exceedance of the total noise level is again predicted at Lue Public School, albeit the minor increase attributable to the Project is less than during the first 6 months of the site establishment and construction stage. It is noted that the noise exceedance predicted to occur adjacent to Lue Public School is attributed to a lower criteria nominated in the Road Noise Policy which is already marginally exceeded during the day by existing traffic, i.e. without Project-related traffic. The key outcome from the assessment is the change in noise levels due to the Project would be barely perceptible.

Operations and Rehabilitation (Year 1 to End of Project Life)

The predicted day-time and night-time traffic noise levels throughout the operational Project life are predicted to satisfy the relevant criteria for residences adjacent to Lue Road and set back from relocated Maloneys Road. The minor exceedance of the noise criteria would continue throughout the Project life adjacent to Lue Public School, largely because of the existing traffic levels and the criteria used for the School.

Traffic Vibration

SLR (2020) predicts that Project-related road traffic vibration impacts and annoyance would be negligible particularly given all relevant criteria would be easily satisfied for the heavy vehicles travelling to and from the Mine Site on the public road network for all receivers with the exception of R39 and L10 which are located approximately 15m and 10m from Pyangle Road and Lue Road, respectively. Given that the Project-related traffic on Pyangle Road would only occur during construction months 1 to 6 (i.e. prior to the opening of the relocated Maloneys Road) traffic vibration levels would be monitored at residential property R39. Similarly, given the very close proximity of property L10 to Lue Road, it is reasonable to anticipate existing heavy road traffic movements may at times currently exceed the vibration annoyance risk criteria (while remaining below the relevant structural damage criteria). Traffic vibration levels would also be monitored at property L10 to determine whether the criteria are being exceeded.

4.2.3 Water Supply Pipeline

4.2.3.1 Existing Noise Environment

The existing noise environment in the vicinity of the water supply pipeline corridor has been assumed to be consistent with the rural setting around the Mine Site (see Section 4.2.2.1). For the purposes of the noise assessment, a day-time RBL of 35dB(A) has been assumed. Whilst some areas along the water supply pipeline are closer to the regional road network (e.g. Ulan Road), the assumption of an RBL of 35dB(A) is considered conservative.

4.2.3.2 Potential Noise Impacts

The following activities associated with the construction of the water supply pipeline have been identified as sources of potential noise impacts.

- Vegetation clearing.
- Excavation of the trench for the pipeline.

- Trench backfilling operation.
- Light and heavy vehicle traffic travelling to and from active construction sites.

4.2.3.3 Assessment of Impacts Criteria

Noise generated throughout the construction of the water supply pipeline has been assessed by SLR (2020) in accordance with the EPA's ICNG (DECC, 2009). The criteria are consistent with those relied upon for the Mine Site construction activities i.e. on $L_{eq\ (15\ mins)}$ of 45dB(A) – see Section 4.2.2.4.

4.2.3.4 Management and Mitigation Measures

The key mitigation measures to be implemented during the construction of the water supply pipeline would involve the use of noise attenuated earthmoving equipment and broadband noise 'quacker' style reversing alarms. Discussions would be initiated with all residents in close proximity to the water supply pipeline corridor prior to the construction activities to alert residents of planned activities and to address any requirements during that periods.

4.2.3.5 Assessment Methodology

The assessment of noise generated during the construction of the water supply pipeline was undertaken through the assembly of the total sound power levels of the noisiest combination of earthmoving equipment, namely the trencher, excavator and water truck and then calculating the distance at which the "construction noise management level" (CNML) of 45dB(A) and "highly noise affected level" (HNAL) of 75dB(A) would be exceeded. This then allowed an assessment of the number of residences within these two set back distances from the pipeline to be established.

4.2.3.6 Assessment of Impacts

SLR (2020) calculate that the highly noise affected level of 75 dB(A) would be satisfied at an offset distance of approximately 50m from the water supply pipeline. A review of **Figure 4.1.12** indicates that five residences are located within this offset distance. SLR (2020) similarly calculated that the CNML would be satisfied at an offset distance of between approximately 750m and 1.05km from the water supply pipeline. These distances are theoretical and likely to be excessive given they do not account for intervening topography and its noise absorption. For the occupants of residences adjacent to Ulan Road, noise from the construction of the pipeline would be audible during the periods when traffic levels are low on Ulan Road. **Figure 4.1.12** indicates that 126 residences lie between 50m and 1.05km of the centreline of the proposed water supply pipeline corridor.

Whilst these exceedances would be noticeable at the subject residences, the duration of noise at those levels is likely to occur over 1 or 2 days and as such the impacts are considered acceptable. In any event, as outlined in **Table 4.10**, Bowdens Silver would require the selected contractor to discuss the planned construction activities with the occupants of the nearest residences prior to the commencement of the construction activities to ensure impacts are minimised or avoided.

4.2.4 Monitoring

4.2.4.1 Mine Site

Permanent, continuous real-time noise monitors would be installed at a minimum of two locations, being representative of rural residences and residences in Lue. The noise monitoring system(s) selected would be capable of identifying noise from the Project, as distinct from extraneous noise such as traffic and provide real-time information to mine management in a simple, interpretable format.

Hand-held noise meters would be utilised during the Project life to record noise levels at the key representative residences. Details of the locations of attended noise monitoring would be outlined within the Operational Noise Management Plan.

The Operational Noise Management Plan for the Project would identify:

- the locations and protocols for noise monitoring;
- operations that may only be performed under particular meteorological conditions;
- a method for interfacing noise management with predictive meteorological systems;
- a system for sampling A-weighted and C-weighted noise levels to establish the extent of any low frequency noise content;
- the methods for monitoring the success of operational controls through continuous real-time noise monitoring, including the mechanism for feedback from such systems to influence operational decisions in the shortest timeframe practical; and
- noise trigger levels that prompt certain predetermined operational modes or require that the mine operationally respond in some manner to manage noise emissions.

Reliance would be placed upon monitoring externally at residences or receivers as preferred by the EPA.

Bowdens Silver would review and update, if necessary, the monitoring component of the Operational Noise Management Plan on an annual basis to reflect the experience/results of the monitoring undertaken during the preceding 12 months.

4.2.4.2 Water Supply Pipeline

Periodic noise measurements would be conducted at various offset distances from the water supply pipeline to validate predicted noise levels and inform Bowdens Silver of any changes to the predicted number and duration of residences and potential mitigation measures.

4.2.5 Conclusion

Management of potential noise impacts during the site establishment and construction stage and operation of the Project would involve the adoption of a range of mitigation measures. Bowdens Silver would also make a commitment to use a regime of continuous real-time noise monitoring, predictive meteorological systems and site management procedures to ensure that noise criteria are not exceeded under noise enhancing meteorological condition at the privately-owned residences surrounding the Mine Site that are not the subject of a VLAMP agreement. For those residences where compliance with noise criteria is not possible during some stages of the Project, Bowdens Silver would honour agreements prepared to satisfy the VLAMP.

Whilst noise generated within the Mine Site would be periodically audible at a number of residences around the Mine Site, the actual level of mine noise and associated impacts is considered generally acceptable based upon the numerous studies upon which the NPfI was based.

The peer review of the Noise Assessment has identified that the approach to the noise modelling, noise mitigation and management have been appropriately considered and that the predicted noise levels during the site establishment and construction stage would be short term and restricted to day-time only. The peer review acknowledges the predicted noise exceedances at 11 residences and that the Blast Noise and Vibration Assessment has been adequately completed.

4.3 BLASTING AND VIBRATION

The blasting assessment for the Project was undertaken by SLR Consulting Australia Pty Ltd (SLR) as part of the overall Noise and Vibration Assessment. The full assessment is presented in Section 10 in Volume 1 Part 1 of the Specialist Consultant Studies Compendium and is referenced throughout this document as SLR (2020).

4.3.1 Introduction

Blasting would be a key component of the Project to achieve the fragmentation of the ore to be processed and waste rock to be used to construct a range of on-site infrastructure or placed in the WRE. Section 2.4.3.2 provides a description of the proposed drilling and blasting practices planned within the Mine Site.

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in blasting impacts (i.e. airblast overpressure and ground vibration). These risk sources relating to airblast over pressure, ground vibration, and fly rock and their assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Rock propelled outside the designed blast envelope, i.e. flyrock (causing injury and/or death) (Medium).
- Rock propelled outside the designed blast envelope, i.e. flyrock (causing damage to privately-owned property) (Low).
- Ground vibration and airblast overpressure resulting in amenity impacts on residential or other sensitive receivers (Low).
- Trucks travelling on public roads causing vibration impacts (Low).

In addition, the SEARs issued by the former DPE identified "blasting" and "vibration" as key issues requiring assessment. The principal assessment requirements identified by the DPE relating to blasting and vibration included the following.

- Blasting impacts on people with regard given to the ANZEC (1990) guideline.
- Blasting impacts on animals (i.e. livestock), buildings, infrastructure and significant natural features with regard given to the relevant guideline.
- Vibration impacts from all activities including construction, operation and transportation.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from:

- the EPA (regarding the ANZEC (1990) guideline and blast notifications);
- Crown Lands (regarding access to Crown land during blasts);
- Department of Education (regarding noise and vibration from blasting at Lue Public School); and
- TransGrid (regarding the impact(s) upon the 500kV power transmission line).

A number of blast-related questions were also posed by the Lue and district community.

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where they are addressed within the EIS and/or the Specialist Consultant Studies Compendium.

Matters relating to dust and fume generation during blasting are addressed in Section 4.4.

4.3.2 Potential Blasting Impacts

The potential impacts from blasting relate to airblast overpressure, ground vibration, flyrock and fume emissions. Subject to their magnitude, these factors can, in turn, impact upon amenity, the structural integrity of surrounding buildings and infrastructure e.g. power transmission lines, and pose comfort or health risks to surrounding persons and livestock through a startle effect and/or flyrock and fume. Discussion regarding blast fume is presented in Sections 4.4.2.3 and 4.4.2.4.

4.3.3 Impact Assessment Criteria

4.3.3.1 Blasting

Criteria relating to blasting have been established by a range of organisations for the potential impacts discussed above. This subsection summarises the criteria relevant to each potential impact. A number of the criteria are referenced in Australian Standard (AS) 2187: Part 2 – 2006 Explosives – Storage and Use – Part 2: Use of Explosives.

1. **Human Comfort Ground Vibration and Airblast Overpressure Criteria**

   The EPA defers to the Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration prepared by the Australian and New Zealand Environment Council (ANZEC) (1990) for blast-related vibration. The human comfort or annoyance criteria for blasting for any privately-owned residence or other sensitive location require that the:

   – maximum overpressure due to blasting should not exceed 115dB(Lpk) for more than 5% of blasts in any period of 12 months at any occupied privately-owned residence, and should not exceed 120dB(Lpk) for any blast; and

   – maximum peak particle ground velocity (PPV) should not exceed 5 millimetres per second (mm/s) for more than 5% of blasts in any period of 12 months at any occupied privately-owned residence, and should not exceed 10mm/s for any blast. It remains the EPA's long - term regulatory goal for the maximum ground vibration level to be reduced to 2mm/s.

2. **Livestock Comfort Airblast and Vibration Criteria**

   SLR (2020) cite references for criteria considered appropriate for cattle, namely 125dB(Lpk) for airblast overpressure and 200mm/sec for ground vibration levels affecting animal health.

3. **Residence / Building Damage**

   AS 2187.2-2006 recommends the adoption of a maximum airblast overpressure criterion of 133dB(Linear) Peak. SLR (2020) has adopted a conservative vibration peak component particle velocity of 12.5mm/s for damage caused at all privately-owned residences in the vicinity of the Mine Site.

4. **Infrastructure Vibration Damage Criteria**

   Criteria to minimise vibration effects on railways, roadways and electricity infrastructure are drawn from a number of sources including the German Standard DIN 4150-3:2016 Vibrations in Buildings Part 3: Effects on Structures. SLR (2020) has adopted a vibration peak component particle velocity of 80mm/s for roadway infrastructure and 50mm/s for the assessment of impacts upon the 500kV power transmission line.

5. **Archaeological / Geological Vibration Damage Criteria**

   SLR (2020) has adopted a conservative safe blast design vibration criteria of 250mm/s (5% exceedance) for archaeological / geological and Aboriginal heritage sites.

It is noted that of all of the above criteria, the most stringent criteria relate to human comfort, i.e. 1 above. Hence, this would invariably be the controlling factor in the design of all blasts, i.e. with the possible exception of any mine infrastructure located near the open cut pits.

Flyrock Criteria

For the purpose of this assessment, flyrock is referred to as any solid material ejected beyond the designated blast envelope at a blast site.

In the absence of detailed blast designs, the DPIE Resources Regulator typically requires that public roads within 500m of blasting sites within a large mine be closed and public access restricted during blasting events, i.e. through the use of road closure signs and sentries at both ends of the roadway. For the Bowdens Silver Project, the design of the blasts would not require such a conservative criteria for flyrock and the closure of any public roads.

4.3.3.2 Road Vibration

Vibration from passing vehicles, particularly heavy vehicles, has the potential to cause both nuisance and, at higher levels, damage to structures. The EPA's 2006 *Assessing Vibration: A technical guideline* focuses on criteria for the protection of human comfort i.e. vibration levels associated with a "low probability of adverse comment". **Table 4.15** lists the applicable vibration velocity criteria for continuous day-time and night-time traffic.

Invariably, the vertical vibration criterion is the controlling criterion.

It is noted that the Road Noise Policy states that:

> *"Vehicles operating on a roadway are unlikely to cause a perceptible level of vibration unless there are significant road irregularities, particularly if the affected receiver is more than 20 metres from the roadway."*

Table 4.15
Continuous Vibration Velocity Levels Annoyance Risk Criteria

Receiver Area	Day-time Annoyance Risk[1] (mm/s)		Night-time Annoyance Risk[1] (mm/s)	
	Horizontal	Vertical	Horizontal	Vertical
Residences	1.2	0.45	0.6	0.2
Commercial/Offices	1.6	0.6	1.6	0.6
Industrial/Workshops	3.2	1.2	3.2	1.2

Note 1: BS6472-1992 "Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)"
Day-time = 7:00am to 10:00pm Night-time = 10:00pm to 7:00am
Source: SLR (2020) – Table 66

4.3.4 Management, Mitigation and Contingency Measures

4.3.4.1 Blasting

Privately-owned Residences

Bowdens Silver would control the adverse effects of blasting within the open cut pits principally through the design of each blast. The approach to the design of each blast and the variables to be considered in the design would be incorporated within a Blast Management Plan where the focus would be upon minimising both ground vibration and airblast overpressure, within practical and operational constraints, through measures such as:

- definition of appropriate burden distances and stemming lengths;
- design of blast sequences;
- controlling the Maximum Instantaneous Charges (MIC); and
- decking charges (where warranted).

Bowdens Silver would ensure that the initial blasts are conservatively designed such that the levels of both ground vibration and airblast overpressure from blasting are well within recommended criteria at all potentially-affected privately-owned residences (without VLAMP agreements) or receivers. It is proposed that blasting would initially be conducted in the northeastern corner of the main open cut pit, i.e. further away from the nearest potentially-affected privately-owned residences. It is noted that the closest privately-owned residences are located to the south and southwest of the main open cut pit and at distances greater than those relied upon for the assessment of blasting impacts (see Section 4.3.6). The ground vibration and airblast overpressure levels generated by the initial blasts would be monitored in a manner consistent with industry standards and any specific conditions within a development consent or environment protection licence. The outcome of this monitoring would then be used to develop and refine the specific site law for blasting within the open cut pits.

Bowdens Silver would adopt the following measures to complement the design-related issues for blasting. Many of these measures relate to providing further protection for privately-owned residences/receivers and Bowdens Silver's proactive approach to its communications with nearby residents.

- Maintaining a hotline advising nearby residents of blasting schedules.

- Undertaking structural surveys of all privately-owned residences within a 2km radius of the open cut pits, i.e. prior to the first blast, subject to landowners'/occupant's permission.

Bowdens Silver would monitor ground vibration and airblast overpressure levels for each blast throughout the Project life to confirm that all blast-related criteria are being satisfied at all privately-owned residences (without VLAMP agreements) or receivers. All blasts would also be recorded on video. Details of the approach to the monitoring of each blast would be set out in the Blast Management Plan. The Plan would be reviewed annually, or as required, to reflect the monitoring results and improved practices developed throughout the Project life.

Livestock

No specific management or mitigation measures would be required to avoid adverse impacts upon livestock given the considerable distance between privately-owned land with stock (>1km) and the proposed blasts.

Bowdens Silver would liaise regularly with the surrounding landowners and the Bowdens Farm manager who graze stock to discuss the stock's reactions to blasting to ensure all stock are not adversely impacted by blasting.

On-site Buildings

The buildings within the administration area, the processing plant, mining facility and roadside noise barriers would be routinely inspected to ensure the blast-related impacts are not excessive and likely to contribute to any damage to these mine components.

Infrastructure

There would be no need for any specific management or mitigation measures to protect the existing 500kV power transmission line (e.g. blasting mats) prior to its re-alignment as it would be at least 340m from the closest blast during the first 3 to 4 years of mining. This distance exceeds the 201m distance at which the 50mm/s criterion identified in Section 4.3.6.1 would be satisfied from the largest planned blast, i.e. with a maximum instantaneous charge of 216kg. Following re-alignment of the 500kV power transmission line, the closest distance between the open cut pits and the line would be at least 500m. No other public infrastructure is located within the Mine Site that requires protection from blasts.

Flyrock

The containment of rock propelled from the active blast beyond the designed blast envelope would be controlled principally through good blast design and practices. A video would be recorded of all blasts to identify potential causes of any rock propelled beyond the designed blast envelope should this occur.

4.3.4.2 Road Vibration

Following the relocation of Maloneys Road, Bowdens Silver would monitor the road surfaces to ensure that the roads used by vehicles travelling to and from the Mine Site are kept in good repair and, if necessary, draw Council's attention to maintenance work required.

Prior to the relocation of Maloneys Road (i.e. construction and site establishment stage months 1 to 6) traffic vibration levels would be monitored at residential properties L10 and R39 in accordance with Bowdens Silver's Traffic Noise and Vibration Management Plan.

4.3.5 Assessment Methodology

4.3.5.1 Blasting

SLR (2020) undertook the assessment of the potential ground vibration and airblast overpressure emissions arising from ore and waste rock blasts based upon the indicative blast design parameters summarised in **Table A5.5**. Predicted blast emission impacts from blasting within the proposed open cut pits were calculated with the key variable being the Maximum Instantaneous Charge (MIC) of either 117kg (ore) and 216kg (waste rock).

In order to determine the levels of ground vibration and airblast overpressure at the residences in the vicinity of the Mine Site, conservative 50%, 5% and 0.1% exceedance ground vibration and airblast site laws were established for the Project (see SLR, 2020 – Section 10.3.1).

4.3.5.2 Road Vibration

In order to establish whether the traffic travelling to and from the Mine Site satisfies the criteria nominated in Section 4.3.6.2, SLR (2020) calculated the nominal offset distances(s) from the centreline of the subject roads at which compliance would be achieved assuming a laden truck with a gross weight of 60t.

4.3.6 Assessment of Impacts

4.3.6.1 Blasting

Privately-owned Residences in the Vicinity of the Mine Site

The calculations undertaken by SLR (2020) have established the predicted ground vibration and airblast overpressure levels that would occur 50%, 5% and 0.1% of the time at the closest blast to each residence, based on the nominated indicative blast parameters. Whilst the blasting assessment has been undertaken based upon these indicative blast parameters, blasting personnel would design each blast to achieve ground vibration and airblast overpressure lower than the criteria to maintain the comfort of the residents at each privately-owned residence without VLAMP agreements, i.e. the blast design would be modified to avoid any exceedance at Residence R12.

SLR (2020) has also predicted safe distances with respect to ground vibration and airblast overpressure (5% likelihood of exceedance) for both the ore and waste rock blasts (assuming the nominated MIC values) for human comfort and stock (see **Table 4.16**). Exceedances of airblast overpressure and/or ground vibration are predicted to be exceeded at two residences (R4 and R7) for blasts initiated in ore, noting that both residences would be the subject of a VLAMP agreement (see Section 4.2.2.5). Exceedances are similarly predicted at Residences R4 and R7 as well as R12 for blasts initiated in waste rock.

Table 4.16
Human Comfort and Livestock Ground Vibration and Airblast Overpressure Level Safe Working Distances

Blast MIC	Residential Vibration[1] 5mm/s	Residential Airblast[1] 115 dBLpk	Stockyard Livestock Vibration[2] 200mm/s	Stockyard Livestock Airblast[2] 125dBLpk
Typical Ore Blast				
117kg	622m (5%)	1340m (5%)	62m (5%)	514m (5%)
Typical Waste Rock Blast				
216kg	846m (5%)	1645m (5%)	84m (5%)	630m (5%)
Note 1: The distance from blast to where the ground vibration or airblast overpressure is predicted to meet the relevant human comfort criteria.				
Note 2: The distance from blast to where the ground vibration or airblast overpressure is predicted to meet the relevant livestock disturbance criteria.				
Source: SLR (2020) – Table 55				

The predicted safe working distances listed in **Table 4.16** for a 5% exceedance identify that for the nominated blast design exceedances of the airblast overpressure would occur at surrounding residences closer than 1 645m from the closest edge of the open cut pit. However, as outlined in Section 4.3.4.1, Bowdens Silver would, however, modify the blast design to that used by SLR for both the ore and waste rock well in advance of reaching the closest point to surrounding residences to ensure compliance distances are less than those nominated by SLR (2020).

Livestock

Blasting is not proposed within 1km of the boundary of any privately-owned land used for beef cattle or sheep. Hence, there would be no requirement for any owner of any privately-owned property to move their stock while blasting is undertaken to avoid the possibility of flyrock impacts or excessive ground vibration or airblast overpressure levels.

Notwithstanding, it is the objective of Bowdens Silver to maintain the grazing cattle on parts of the Bowdens farm within and surrounding the Mine Site (see Section 4.18).

The planned monitoring of the cattle and sheep throughout the Project life would ensure that the welfare of the stock is not compromised by the blasting activities within the Mine Site.

Residences, Buildings and Infrastructure

SLR (2020) has predicted safe distances for both ore and waste rock blasts with respect to ground vibration for buildings, the 500kV power transmission line, road/rail infrastructure and archaeological/geological structures (see **Table 4.17**). The predicted levels of ground vibration are all lower than the criteria for all structures assessed.

Table 4.17
Heritage, Infrastructure and Geological Structures Ground Vibration Safe Working Distances

Blast MIC	Buildings including Sensitive/ Heritage Vibration[1] 12.5mm/s	500kV Power Transmission Line Vibration[1] 50mm/s	Roadway (Culvert) Vibration[1] 80mm/s	Railway (Line) Vibration[1] 100mm/s	Archaeological/ Geological Structure Vibration[1] 250mm/s
Typical Ore Blast					
117kg	351m (5%)	148m (5%)	110m (5%)	96m (5%)	54m (5%)
Typical Waste Rock Blast					
216kg	477m (5%)	201m (5%)	150m (5%)	130m (5%)	73m (5%)
Note 1: The distance from blast site to where the ground vibration level is predicted to meet the relevant damage criteria.					
Source: SLR (2020) – Table 54					

Notwithstanding compliance with the relevant ANZEC guideline criteria, SLR (2020) also records that, based upon the predicted airblast overpressure levels, people may at times hear (and/or feel) a blast initiated within the open cut pits at distances greater than 1 645m. The extent to which a blast would be heard (and/or felt) would depend principally upon the elevation of the blast in the open cut pits and prevailing wind conditions, i.e. wind direction/speed and cloud cover.

Criteria for the damage of residences and buildings are higher than those for human comfort. Satisfaction of the human comfort criteria would thereby ensure that no privately-owned buildings are predicted to experience vibration levels above building damage criteria.

As discussed in Section 4.3.3.1, criteria for the damage of rail and road infrastructure as well as power transmission lines have been established and are higher than those for residences and buildings. As a result, no blast impacts are predicted to occur to the nearest rail and road infrastructure. Similarly, no impacts would occur to the existing or realigned 500kV power transmission line.

Flyrock

Given that no blasts within the Mine Site would occur within 500m of any public road or privately-owned land without a VLAMP agreement, no issue would occur with flyrock. The style of blasting where emphasis would be placed upon in situ fragmentation would result in a blast envelope with dimension far less than 500m.

4.3.6.2 Traffic Vibration

The nominal offset distances to residences for compliance with the vibration annoyance risk criterion on public roads (i.e. Lue Road) from 60t capacity heavy vehicle movements are presented in **Table 4.18** based on the heavy vehicle vibration level contained in the Transportation Noise Reference Book (Nelson, 1987).

Table 4.18
Nominal Offset Distances to Residences to Comply with Vibration Annoyance Risk Criteria

Traffic Area	Day-time Residential Annoyance Risk		Night-time Residential Annoyance Risk	
	Horizontal	Vertical	Horizontal	Vertical
Public Road (60t capacity heavy vehicles)[1]	7m	12m	10m	20m
Note 1: Assumes 60t capacity heavy vehicle travelling at 60kph.				
Source: SLR (2020) – Table 67				

During the first 6 months of the site establishment and construction stage, when Project-related traffic is travelling through Lue to the Mine Site, vibration annoyance risk criteria attributable to truck traffic travelling on Lue Road would be exceeded on some occasions at two residences, namely L10 (on the eastern side of Lue) and R39 (adjacent to the intersection of Lue Road and Pyangle Road). It is noted that SLR (2020) acknowledge that it is reasonable to anticipate that existing heavy vehicle traffic movements currently exceed the vibration annoyance risk criteria at these residences, while remaining below the relevant structural damage criteria.

The extent of vibration impact(s) at Residences L10 and R39 would be monitored to establish the extent to which the criteria are being exceeded by all trucks travelling along Lue Road.

4.3.7 Monitoring

Monitoring of blasting is an important process to ensure that blast-related environmental objectives and criteria are achieved.

A permanent blast monitoring network would be established around the Mine Site to enable:

- monitoring of airblast overpressure in dBLpk peak using an appropriate low frequency microphone and meter; and
- measurement of ground vibration levels using a 3-directional transducer connected to the monitoring equipment.

With the agreement of residents, ground vibration and airblast overpressure monitoring would be carried out at a minimum of two selected residential locations with potential for being affected by the higher levels expected around the open cut pits.

A video would be maintained for each blast to obtain general information about flyrock and fume emissions.

The results of each blast would be summarised in a brief report which would be retained on site throughout the Project life.

4.3.8 Conclusion

Ground vibration and airblast overpressure would be controlled to meet the criteria recommended in the Australian & New Zealand Environment Council Guideline by well controlled blast design and execution, and by restrictions on the MIC where this is found necessary. Initial blast designs would be conservative and, from these the appropriate blast design, including MIC limits, would be developed to satisfy the blast criteria for individual blasts.

Notwithstanding compliance with the relevant ANZ guideline criteria, based upon the predicted airblast overpressure levels, people may at times hear (and or feel) a blast initiated within the open cut pits at distances greater than 1 645m.

The type of blasts proposed within the open cut pits would ensure that flyrock from blasting would not cause damage to property or injury to persons or stock.

The movement of trucks to and from the Mine Site on public roads would not generate vibration levels with potential to cause damage to buildings.

4.4 AIR QUALITY

The air quality assessment of the Project was undertaken by Ramboll Australia Pty Ltd (Ramboll). The full assessment is presented in Volume 1 Part 2 of the Specialist Consultant Studies Compendium and is referenced throughout this document as Ramboll (2020). A peer review of the air quality assessment was undertaken by Ms Jane Barnett of ERM Australia Pty Ltd. A copy of the peer review is included as Annexure 7 to Ramboll (2020).

4.4.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in air quality impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Emissions of TSP/PM_{10}/$PM_{2.5}$/Deposited dust from site establishment and construction activities resulting in health and/or amenity impacts on nearby privately-owned residences and other sensitive receivers (Low).
- Generation of gaseous emissions and blasting fumes resulting in health and/or amenity impacts on nearby privately-owned residences and other sensitive receivers (Low).
- Emissions of TSP/PM_{10}/$PM_{2.5}$/Dust from mining and processing operations resulting in Health and/or amenity impacts on nearby privately-owned residences and other sensitive receivers (Low).
- Generation of gaseous cyanide emissions resulting in health and/or amenity impacts on nearby privately-owned residences and other sensitive receivers (Low).
- Emissions of metals attached to particulate emissions and crystalline silica as a component of particulate emissions resulting in health and/or amenity impacts on nearby privately-owned residences and other sensitive receivers (Low).

In addition, the SEARs issued by the former DPE identified "air quality" as a key issue requiring assessment. The principal assessment requirements identified by the DPE relating to air quality included the following.

- The likely air quality impacts of the development in accordance with the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*, having regard to EPA's requirements.
- The likely greenhouse gas impacts of the development.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the EPA, Greater Western Area Health Service, Department of Education and Mid-Western Regional Council. A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC.

Further consideration of greenhouse gas emissions and impacts are summarised separately in Section 4.5 whilst issues relating to human health risks, including lead and other metals, are addressed in Section 4.8.

4.4.2 Mine Site

4.4.2.1 Relevant Environmental Air Quality Criteria and Goals

Particulate Matter and Dust Deposition

Particulate matter (PM) has the capacity to affect health and to cause nuisance effects and is categorised by its size and/or by chemical composition. The particulate size ranges are commonly described as follows.

- Total suspended particulates (TSP) – refers to all suspended particles in the air. In practice, TSP typically refers to particulates smaller than 30 to 50 micrometres (µm) in diameter.
- PM_{10} – refers to all particles with equivalent diameters of less than 10µm. PM_{10} particles are a sub-component of TSP.
- $PM_{2.5}$ – refers to all particles with equivalent diameters of less than 2.5µm. These are often referred to as the fine particles and are a sub-component of PM_{10}.

The 2016 update to the ‘Approved Methods’, gazetted on 20 January 2017, includes particle assessment criteria that are consistent with revised National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) National reporting standards (National Environment Protection Council [NEPC], 1998; NEPC, 2015). These criteria are presented in **Table 4.19**.

Table 4.19
Impact Assessment Criteria for Particulate Matter

PM Metric	Averaging Period	Concentration (µg/m³)
TSP	Annual	90
PM_{10}	24 hours	50
	Annual	25
$PM_{2.5}$	24 hours	25
	Annual	8
Source: Ramboll (2020) – Table 2.2		

These criteria are applied at the nearest existing or proposed privately-owned residence or receiver and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts are considered (in conjunction with existing ambient background concentrations).

The Approved Methods also prescribes nuisance-based goals for dust deposition, which relate to amenity type impacts such as soiling of exposed surfaces. These criteria are presented in **Table 4.20**.

Table 4.20
Impact Assessment Criteria for Dust Deposition

Metric	Maximum Increase in Dust Deposition	Maximum Total Dust Deposition Level
Deposited dust (assessed as insoluble solids)	2 g/m²/month	4 g/m²/month
Source: Ramboll (2020) – Table 2.3		

Voluntary Land Acquisition and Mitigation Policy

As outlined for noise (see Section 4.2.2.4), in addition to the Approved Methods, the Voluntary Land Acquisition Policy (VLAMP) describes the NSW Government's approach to voluntary mitigation and the acquisition of land to address dust and noise impacts, and outlines the mitigation and acquisition criteria for PM. Essentially, the VLAMP formalises the acquisition criteria that have previously been outlined in conditions of approval for major mining and extractive industry projects.

Under the VLAMP, if an applicant cannot comply with the relevant impact assessment criteria, or if the mitigation or acquisition criteria are predicted to be exceeded, an applicant should consider a negotiated agreement with the affected landowner or acquire the land. In doing so, the land is then no longer subject to the impact assessment, mitigation or acquisition criteria, although provisions do apply to "use of the acquired land", primarily related to informing and protecting the health of existing occupants or prospective tenants.

Voluntary mitigation rights apply when a development contributes to exceedances of the criteria set out in **Table 4.21**. The criteria for voluntary acquisition rights are the same, with the exception of the number of allowable days above the short-term impact assessment criteria for PM_{10}. Acquisition criteria apply if more than five exceedances of 24 hour PM_{10} would occur over the Project life at a residence or receiver.

Table 4.21
VLAMP Mitigation Criteria

Metric	Averaging period	Criterion		Impact Type
$PM_{2.5}$	24 hour	25µg/m^3 *		Human Health
	Annual	8µg/m^3 **		Human Health
PM_{10}	24 hour	50µg/m^3 *		Human Health
	Annual	25µg/m^3 **		Human Health
TSP	Annual	90µg/m^3 **		Amenity
Deposited Dust	Annual	2 g/m^2/month *	4 g/m^2/month **	Amenity
Notes: * Incremental increase due to development alone, with zero allowable exceedances over the Project life. ** Cumulative impact due to the development plus background from other sources.				
Source: Ramboll (2020) – Table 2.4				

Voluntary mitigation rights apply to any residence on privately-owned land or any workplace on privately-owned land where the consequences of the exceedance, in the opinion of the consent authority, are unreasonably deleterious to worker health or the carrying out of business.

Voluntary acquisition rights also apply when an exceedance occurs or is predicted to occur across more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.

Metals

The Approved Methods also includes impact assessment criteria for a range of metals as listed in **Table 4.22**. It is noted that lead is classified as a 'criteria pollutant' with the criteria applied at the nearest off-site sensitive residence or receiver and compared against the 100th percentile (i.e. the highest) annual average dispersion modelling prediction for the cumulative concentration. For the remaining metals, the impact assessment criteria are specified in accordance with toxic air pollutants and must be applied at and beyond the boundary of the emitting source, with the incremental impact (i.e. predicted impacts due to the pollutant source alone) for each pollutant reported as the 99.9th percentile concentration for an averaging period of 1 hour.

Table 4.22
Impact Assessment Criteria for Metals

Substance	Averaging period	Concentration (µg/m³)
Arsenic and compounds	1-hour (99.9th percentile)	0.09
Cadmium and compounds	1-hour (99.9th percentile)	0.018
Copper	1-hour (99.9th percentile)	18
Chromium III and compounds	1-hour (99.9th percentile)	9.0
Chromium VI and compounds	1-hour (99.9th percentile)	0.09
Lead	Annual (100th percentile)	0.5*
Manganese and compounds	1-hour (99.9th percentile)	18
Mercury organic	1-hour (99.9th percentile)	0.18
Mercury inorganic	1-hour (99.9th percentile)	1.8
Nickel and compounds	1-hour (99.9th percentile)	0.18
Silver	1-hour (99.9th percentile)	1.8
Zinc (as zinc oxide)	1-hour (99.9th percentile)	0.09
* Cumulative concentration including background and predicted increase.		
Source: Ramboll (2020) – Table 2.6		

Respirable Crystalline Silica

Silica (SiO_2 - silicon dioxide) is a naturally occurring mineral which can exist in crystalline or amorphous (non-crystalline) forms depending on the structural arrangement of the oxygen and silicon atoms. The most common form of crystalline silica is quartz, which is a basic component of sand and many rocks. Only the crystalline forms of silica are known to increase scar tissue in the lungs and only the respirable particles (those which are capable of reaching the gas exchange region of the lungs) are considered in determining health effects – i.e. respirable crystalline silica.

Australia has industrial exposure criteria, limiting the allowable concentration of crystalline silica in the workplace environment. However, there are no National or NSW limits for crystalline silica in the ambient air.

In lieu of a National or NSW limit, the EPA Victoria assessment criterion of 3µg/m^3 for mining and extractive industries (EPA Victoria, 2007) has been adopted by the NSW EPA. The criterion is for chronic exposure and is therefore expressed as an annual average and applied to the $PM_{2.5}$ size fraction.

Gaseous Pollutants

Sodium cyanide (NaCN) is proposed to be used as a reagent in the processing plant (as a sphalerite and pyrite depressant), which may lead to fugitive emissions of hydrogen cyanide (HCN) through volatilisation from storage tanks and the TSF. Therefore, assessment has been made against the Approved Methods criteria as presented in **Table 4.23**.

Table 4.23
Air quality Criterion for HCN

Substance	Averaging period	Concentration (µg/m³)
HCN	1-hour (99.9th percentile)	200
Source: Ramboll (2020) – Table 2.7		

4.4.2.2 Existing Environment Relevant to Air Quality

Surrounding Receivers

The Air Quality Assessment considered all surrounding residences, both privately owned and Project-related (including receivers owned by the Applicant or with which a negotiated agreement is held with the landholder). In addition to the surrounding residences, five 'places of interest' were also assessed, namely:

- Lue/Havilah Rural Fire Brigade
- Lue Pottery
- Lue Public School
- Lue Hall
- Lue Railway Station Buildings

Collectively, all assessed locations that are not residences are referred to as "receivers".

Local Topography and Meteorology

The local topography and meteorology are discussed in Sections 4.1.1 and 4.1.2 and are utilised as key inputs in the meteorological and dispersion modelling undertaken for the Air Quality Assessment.

Existing Sources of Particulates

The existing ambient air quality environment in the vicinity of the Mine Site is mostly influenced by:

- Wind-generated dust from exposed areas;
- fugitive dust emissions from agricultural activities, particularly during dry conditions;
- dust entrainment due to vehicle movements along unsealed and, to a lesser extent, sealed roads;
- seasonal emissions from household wood heaters;
- episodic emissions from vegetation fires; and
- long-range transport of fine particles into the region.

Existing Particulate Levels

An extensive air quality monitoring network has been established for the Project in order to characterise the existing ambient air quality environment. The network contains the following components, the locations of which are presented on **Figure 4.4.1**.

- Two tapered element oscillating microbalance (TEOM) monitors for PM_{10} and $PM_{2.5}$, namely:
  - BAM1 – located in the southeastern corner of the Mine Site. Continuous PM_{10} concentrations were monitored at this location between 2012 and 2018; and
  - BAM2 – located in Lue. Continuous PM_{10} and $PM_{2.5}$ concentrations were monitored between 2013 and 2018.
- Two high volume air samplers (HVAS[5]) measuring TSP concentrations on a one-in-six day run cycle, namely:
  - BHV1 – located in the southeastern corner of the Mine Site; and
  - BHV2 – located in Lue.

  The samples collected from the HVAS were utilised to establish lead concentrations in the ambient air.
- Twelve dust deposition gauges for recording monthly dust deposition rates between 2012 and 2018 and metals (arsenic, lead and zinc) in the deposited dust.

Given the extensive data collected, baseline air quality monitoring was superseded after 30 June 2018. Monitoring would recommence prior to the commencement of any approved operations (see Section 4.4.4).

Using this baseline air quality monitoring data, Ramboll (2020) has adopted the baseline air quality as presented in **Table 4.24** for cumulative impact assessment purposes.

Table 4.24
Adopted Background for Cumulative Assessment

Pollutant	Averaging period	Adopted background value
PM_{10}	24-hour average[1]	Daily varying with a maximum of 43.7µg/m³
	Annual average[1]	13.6µg/m³
$PM_{2.5}$	24-hour average	Daily varying with a maximum of 15.4µg/m³
	Annual average	3.9µg/m³
TSP	Annual average	30.7µg/m³
Dust deposition	Annual average	1g/m²/month

Note: 1. Calculated based on the highest measured concentration across each site for each day, except for the two days that the BAM1 measurement was already at or above the impact assessment criterion due to regional dust storms.

Source: Ramboll (2020) – Table 5.3

A full review of the measured air quality data is provided in Section 5 of Ramboll (2020).

[5] HVAS monitoring was halted in November 2014 and restarted in October 2016

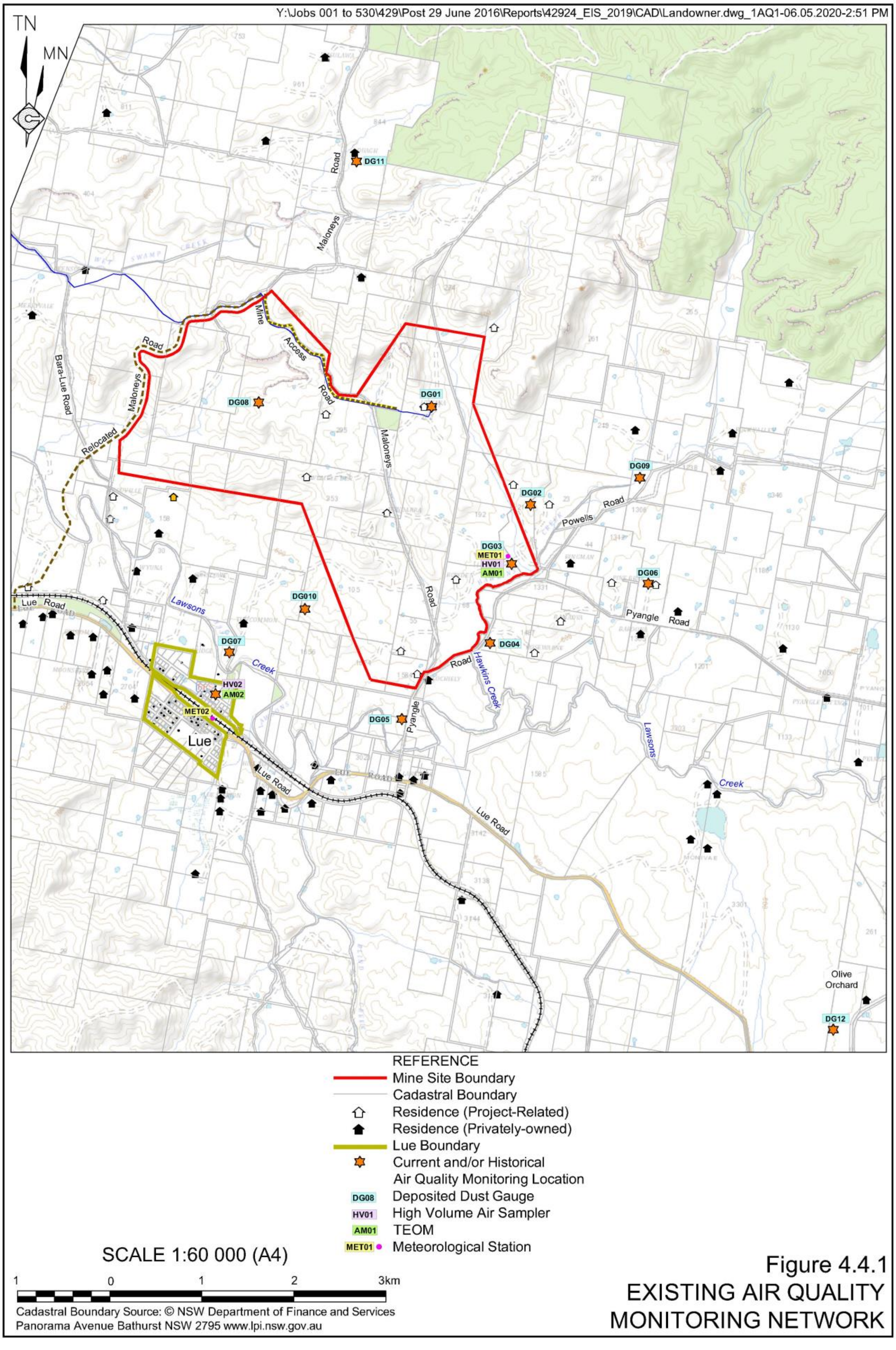

Figure 4.4.1
EXISTING AIR QUALITY MONITORING NETWORK

Other Air Quality Pollutants

Analyses of arsenic, lead and, zinc within the deposited dust samples collected show that, on average, the concentrations of arsenic, lead and zinc were 0.002g/m^2/month, 0.001g/m^2/month and 0.002g/m^2/month respectively. Analysis of lead was also undertaken on the collected HVAS TSP samples, and for a short period of time for PM_{10} and $PM_{2.5}$ samples. The maximum measured lead concentration was 0.002µg/m^3 with an average concentration of 0.001µg/m^3.

Analysis of HVAS samples for concentrations of arsenic, cadmium, chromium, copper, nickel, zinc and selenium was also undertaken during July and August 2017 and February 2018. The analyses reported ambient concentrations of arsenic, cadmium and selenium below the respective limits of detection, while average concentrations of chromium, copper, nickel and zinc were 0.001µg/m^3, 0.007µg/m^3, 0.001µg/m^3 and 0.009µg/m^3 respectively.

When compared with the NSW EPA's impact assessment criterion, the existing ambient levels of the monitored metals are considered to be negligible. Further discussion of baseline metal concentrations is provided in Section 4.8 and within the Human Health Risk Assessment (enRiskS, 2020).

No local monitoring is conducted for ambient concentrations of respirable crystalline silica or other individual toxic air pollutants. Due to the general absence of notable emission sources in the local area, existing ambient concentrations for these pollutants are assumed to be negligible. Notwithstanding, impact assessment criteria specified for toxic air pollutants are applied to the incremental impact (i.e. predicted impacts due to the pollutant source alone).

4.4.2.3 Management and Mitigation Measures

Introduction

The following subsections summarise the proposed management, mitigation and contingency measures to reduce the impact of the Project's air quality emissions at surrounding privately-owned residences or receivers. It is noted that the management measures applied to reducing particulate emissions equally apply to reducing metals and respirable silica given that their emissions from Project activities would be associated with particulates. Management measures relating to blast fume and hydrogen cyanide are also presented.

Dust (Particulate) Management Measures

An Air Quality Management Plan would be prepared for the Project in accordance with the applicable conditions of any development consent granted. The management plan would be regularly reviewed and include details of air quality monitoring (see Section 4.4.4), management measures and a trigger action response plan.

Management measures which have been applied as part of the air quality assessment include the following.

- Application of a site-wide vehicle speed limits and confinement of vehicle travel to designated routes to reduce wheel-generated dust.
- Haul roads would be actively maintained and watered with water trucks to reduce wheel-generated dust.

- Progressive rehabilitation (both temporary and long-term) of disturbed areas (see Section 2.16.7 and **Figure 2.27**).
- Minimisation of travel speed and the distance travelled by bulldozers and coordination of activities to reduce push and haul distances and double handling.
- Minimising drop heights when loading ore, waste rock and soil material.
- Enclosure of the ROM feed hopper on three sides and operate water sprays during ore placement into the hopper.
- Apply water during crushing operations.
- Use of water sprays and/or dust aprons/collectors for drill rigs.
- Wetting down all drill cuttings from drill rigs.

In addition to these management measures, a proactive air quality management system would be adopted using a combination of the following.

- Meteorological forecasts - to predict when the risk of dust emissions may be high (due to adverse weather) in specific directions around the Mine Site and allow procedures and preparatory measures to be implemented.
- Visual monitoring - to provide an effective mechanism for proactive control of dust at source, before it leaves the Mine Site. For example, using the NSW EPA Dust Assessment Handbook, visual triggers for unacceptable dust at source (e.g. wheel-generated dust above tray height) are established to determine the need for action and response.
- Real-time meteorological and air quality monitoring – to provide alerts for appropriate personnel when short-term dust levels increase, to allow management of the location and intensity of activities or increased controls.

An example of how a proactive dust management system could be used to minimise the likelihood of these potential exceedances occurring is outlined in **Table 4.25**.

It is noted that the management measures throughout the Project life would be regularly reviewed and adjusted to achieve best practice based on the site conditions, industry practices and available technologies. Updates to the management measures would be reflected within the Air Quality Management Plan.

Blast Fume

A Blast Management Plan would be prepared for the Project which would include blast fume prevention measures, developed in accordance with the *Code of Good Practice: Prevention and Management of Blast Generated NOx Gases in Surface Blasting* (Australian Explosives Industry and Safety Group Inc., 2011). These measures would address factors known to contribute to fume generation, including geology, meteorological conditions, blast design, product selection and quality, blast crew education, on-bench practices, and emergency response procedures. The blast management plan would also outline the monitoring requirements for blast fume, including identification and rating of visual blast fume, in accordance with Appendices 2 and 3 of the Code of Practice.

Table 4.25
Example of Proactive Dust Management for Haul Roads

Aspect	Description	Example of action/response
Meteorological forecast	Daily review of the 3-day forecast to identify potential for adverse weather for the following day. In the case of waste rock or ore transportation, this might include elevated temperature, high evaporation potential, no rainfall, wind direction aligning with haul roads and towards sensitive receivers.	Prepare for increased water application intensity.
Visual monitoring	Using the dust assessment handbook, identify when triggers are reached. In the case of waste rock or ore transportation, for example, when wheel dust exceeds the height of the wheel or tray.	Call for additional haul road watering.
Real-time monitoring	Air quality triggers identified that take into account wind speed, direction and distance from source to receiver. SMS alarms would be sent when triggers are reached, to notify appropriate site personnel that concentrations are increasing and investigation is warranted.	Review operations, meteorological conditions, regional dust levels. Call for additional dust suppression, limit haul distances, shut down non-essential haul roads, limit grading.
Source: Ramboll (2020) – Table 9.1		

Hydrogen Cyanide

Whilst the concentration of cyanide within the tailings that would be discharged to the TSF would be low (see **Appendix 5** – Section A5.7.2), a Cyanide Management Plan would be prepared prior to the utilisation of cyanide on site. The management plan would include cyanide management measures and monitoring as well as contingencies for cyanide reduction in the event that was required.

Processing Plant Odours

The use of the xanthates as a mineral collector within the processing plant would generate decomposition by-products such H_2S and mercaptans with the mercaptans likely to create the most odour in the vicinity of the plant or the discharge points into the TSF.

4.4.2.4 Assessment Methodology

The Air Quality Assessment presents a quantitative assessment of potential air quality impacts, using a Level 2 assessment approach in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA, 2016).

Full details of the assessment methodology and approach are outlined within Section 2 of Ramboll (2020). However, an overview of the approach to the assessment is as follows.

Emission Sources and Estimates

The Project was reviewed for potential emission sources with four representative years selected to assess the air quality impacts of worst-case operational conditions. In selecting these representative scenarios, consideration was given to, for example, where material movement and equipment use is highest, where disturbance or wind erosion areas are largest, and where operations are located closest to residences or receivers. The selected representative assessment scenarios were as follows.

- Scenario 1 – representative of the site establishment and construction stage activities when total extraction of waste rock is highest and the initial TSF embankment construction is undertaken.
- Scenario 2 – mining operations in Year 3, representing a year when total extracted material (ore and waste rock) is highest and the Stage 2 TSF raise is undertaken.
- Scenario 3 – mining operations in Year 8, representing the year with the maximum extent of the southern barrier construction and the final (Stage 3) TSF raise is undertaken.
- Scenario 4 – representative of mining operations in Year 9, which has the second highest waste rock extraction rate and where non-acid forming (NAF) waste rock transport to the TSF has ceased.

Detailed emissions inventories were developed for each of these scenarios and quantifying the particulate generation for the various sources. A flow chart of the principal emission sources that have been addressed within the inventory are presented as **Figure 4.4.2**. Further information regarding the development and inputs to the emission inventories are presented in Section 6.2 and Annexure 4 of Ramboll (2020).

Meteorological and Dispersion Modelling

Dispersion modelling was used to predict ground-level concentrations for key pollutants from the Project, at surrounding residences and receivers (both private and Project-related). Modelling relied upon the use of the meteorological modelling software CALMET and TAPM and dispersion modelling software CALPUFF. Modelling was completed for the representative scenarios using the emission inventory developed for each scenario. Further detail regarding the model development and inputs are presented in Section 4.5 and Annexure 3 of Ramboll (2020).

Metals

Elemental assays have been undertaken for the ore and waste rock to be extracted within the Mine Site. Analyses included the metal composition for 12 key metals. Additionally, an extensive soil sampling program was completed in 2012 which also included analysis of metals. Further discussion of these sampling programs and results are provided within Section 4.3 of the Human Health Risk Assessment (enRiskS, 2020). The median results of these analyses were used to allocate a metal composition of the PM emissions included within the emissions inventory based on the type of material being handled or processed (i.e. waste rock, ore or soil).

Silica

A review of accumulated mineralogy data was compiled to identify the silica content within the Bowdens deposit, including the relative concentrations of silica in ore and waste rock. Similar to metals, this composition analysis was then used to scale the $PM_{2.5}$ emission estimates for each relevant activity, based on the type of material being handled or processed (i.e. waste rock or ore).

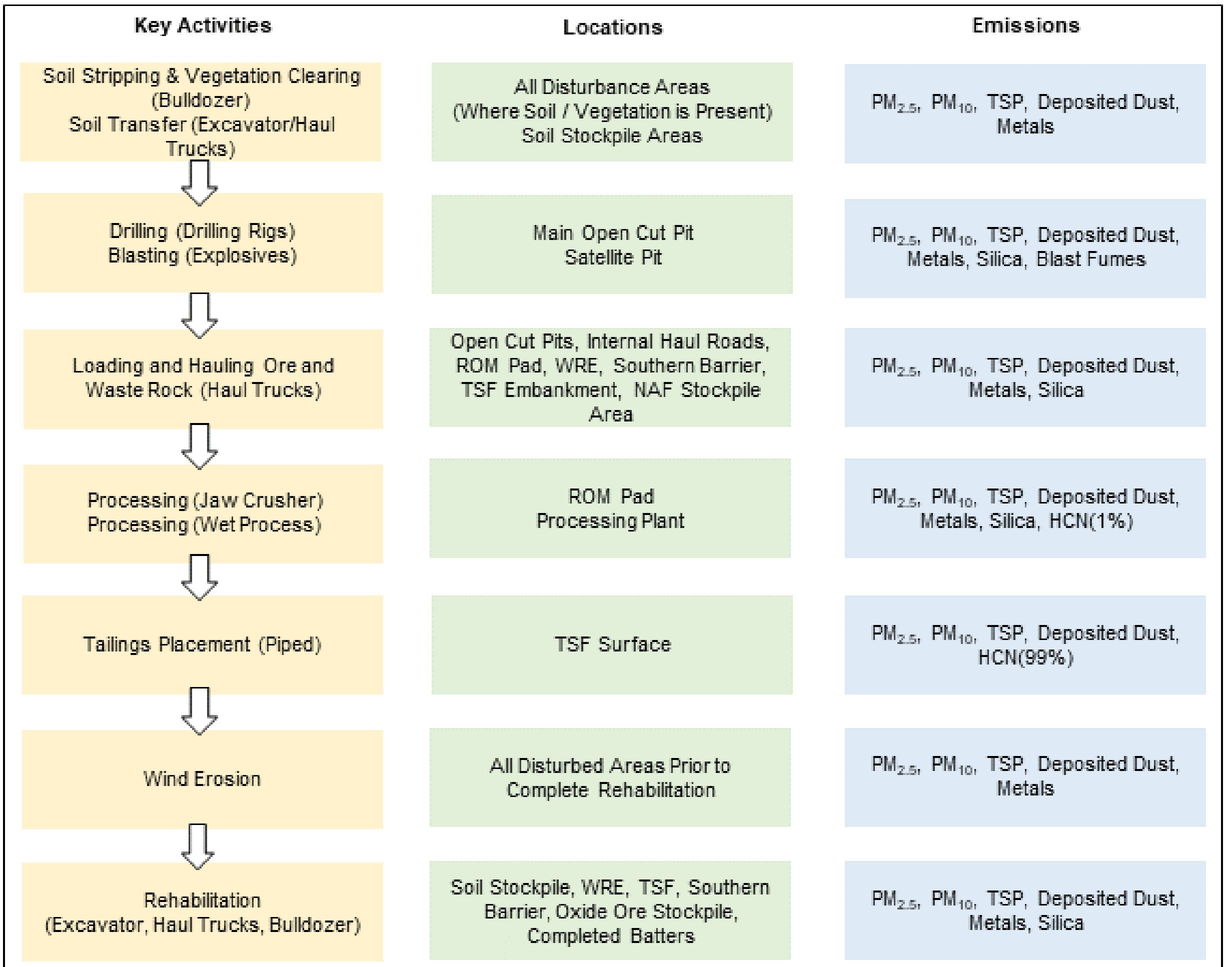

Figure 4.4.2
Key Emission Sources and Locations

Emissions of quartz were assumed to occur from activities including mechanical grinding / crushing activity that might liberate emissions of fine silica particles. However, once an activity was determined to result in emissions for fine silica dust, all subsequent downstream handling of that material was also assumed to generate emissions. In effect, all sources / activities except hauling and wind erosion (excluding crushed ore stockpiles) were assumed to liberate fine silica dust.

Hydrogen Cyanide

Fugitive emissions of HCN by volatilisation were estimated for the processing area and the TSF.

Emissions of HCN from the processing area were derived using the NPfI Emission Estimation Technique Manual for Lead Concentrating, Smelting and Refining (1999). Based on the estimated annual usage of 190 tonnes of sodium cyanide (NaCN – a solid salt which is dissolved to form HCN) and applying a 1% loss of total cyanide through volatilisation results in the emission of 0.03g/s of HCN from the processing area.

Cyanide emissions from the surface of the TSF were estimated from Section 6.2.2 of the NPfI (2006), using the following formula.

HCN (kg/yr) = free cyanide concentration (kg/m^3) x volume of slurry (m^3/yr) x volatilisation rate

The free cyanide concentration in the TSF return water is estimated as 0.0025 kg/m^3 while the volume of slurry throughput to the TSF is estimated as 2 522 880m^3/yr. Assuming a volatilisation rate of 80% (based on an assumed pH of 8) emissions of HCN from the TSF are estimated as 0.15g/s.

Blast Fume

Given that it has been demonstrated within the mining industry that adoption of measures outlined in the *Code of Good Practice: Prevention and Management of Blast Generated NOx Gases in Surface Blasting* effectively controls blast fume, no additional assessment of blast fume was undertaken. However, PM emissions from blasting were included in the emission inventories.

4.4.2.5 Assessment of Impacts

Introduction

The following subsections provide a summary of the results from the air quality impact assessment. For particulate matter, detailed tabulated results are presented for seven surrounding representative residences, i.e. six rural residences and one residence within Lue, and for the Lue Public School. The rural residences were selected as the closest surrounding non-Project related residences at a range of compass points around the Mine Site. The residence in Lue was selected as the closest residence within Lue to the Mine Site and the Lue Public School as a key point of interest to the community. This subsection contains a contour plot for the site establishment and construction stage, i.e. the scenario generally with the highest predicted project-only levels of PM_{10} and $PM_{2.5}$ (annual average and 24hr), TSP (annual average) and deposited dust (annual average). It is noted that detailed results for all assessed surrounding residences and receivers and contour plots for all scenarios are presented within Ramboll (2020).

Annual Average PM_{10}

The predicted annual average PM_{10} concentrations at the selected representative receivers are presented in **Table 4.26** and shown in **Figure 4.4.3** for the site establishment and construction stage. The highest predicted increment (Project-only contribution) in annual average PM_{10} at any privately-owned residence is 3.3µg/m^3 (R7 in Year 9) whilst the highest predicted cumulative (background plus Project) annual average PM_{10} at any privately-owned residence is 16.9µg/m^3 (R7 in Year 9). Therefore, there are no predicted exceedances of the cumulative annual average PM_{10} criteria of 25µg/m^3 at any privately-owned residence.

Table 4.26
Predicted Annual Average PM_{10} (µg/m³) at Representative Receivers

Receiver	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
R4	1.5	1.3	1.6	2.0	15.1	14.9	15.2	15.6
R7	2.1	1.7	2.3	3.3	15.7	15.3	15.9	16.9
R17	0.8	0.4	0.4	0.3	14.4	14.0	14.0	13.9
R21	0.7	0.6	0.7	0.6	14.3	14.2	14.3	14.2
R36A	0.9	0.6	0.6	0.6	14.5	14.2	14.2	14.2
R76	0.8	0.4	0.4	0.3	14.4	14.0	14.0	13.9
L50	0.7	0.6	0.6	0.7	14.4	14.2	14.2	14.4
Lue Public School	0.6	0.5	0.5	0.6	14.2	14.1	14.1	14.2
SE&CS = site establishment and construction stage								
Source: Ramboll (2020) – Modified after Table 7.1								

Maximum 24-hour Average PM_{10}

The predicted 24-hour average PM_{10} concentrations at the selected representative residences and receivers are presented in **Table 4.27** and shown in **Figure 4.4.4** for the site establishment and construction stage. The highest predicted increment in maximum 24-hour average PM_{10} at any privately-owned residence is 15.6µg/m³ (R21 in Year 9) whilst the highest predicted cumulative maximum 24-hour average PM_{10} at any privately-owned residence is 48.1µg/m³ (R4 in the site establishment and construction stage). Therefore, there are no predicted exceedances of the cumulative 24-hour average PM_{10} criteria of 50µg/m³ at any privately-owned residence.

Table 4.27
Predicted Maximum 24-hour Average PM_{10} (µg/m³) at Representative Receivers

Receiver	Project-only				Cumulative			
	SE&CS	Year 3	Year 8	Year 9	SE&CS	Year 3	Year 8	Year 9
R4	11.6	9.1	11.7	14.1	48.1	46.5	47.2	47.6
R7	9.0	8.1	10.1	14.0	46.3	45.6	46.2	47.2
R17	9.0	4.7	5.3	5.1	43.7	43.7	43.7	43.7
R21	8.6	10.0	14.0	15.6	43.7	43.7	43.7	43.7
R36A	4.1	2.6	2.5	2.7	44.5	44.1	44.1	44.3
R76	6.3	2.5	2.4	2.1	44.0	43.7	43.7	43.7
L50	5.1	3.6	3.4	3.8	44.3	44.0	44.0	44.0
Lue Public School	5.0	4.3	4.4	4.6	44.8	44.6	44.6	44.7
SE&CS = site establishment and construction stage								
Source: Ramboll (2020) – Modified after Table 7.2								

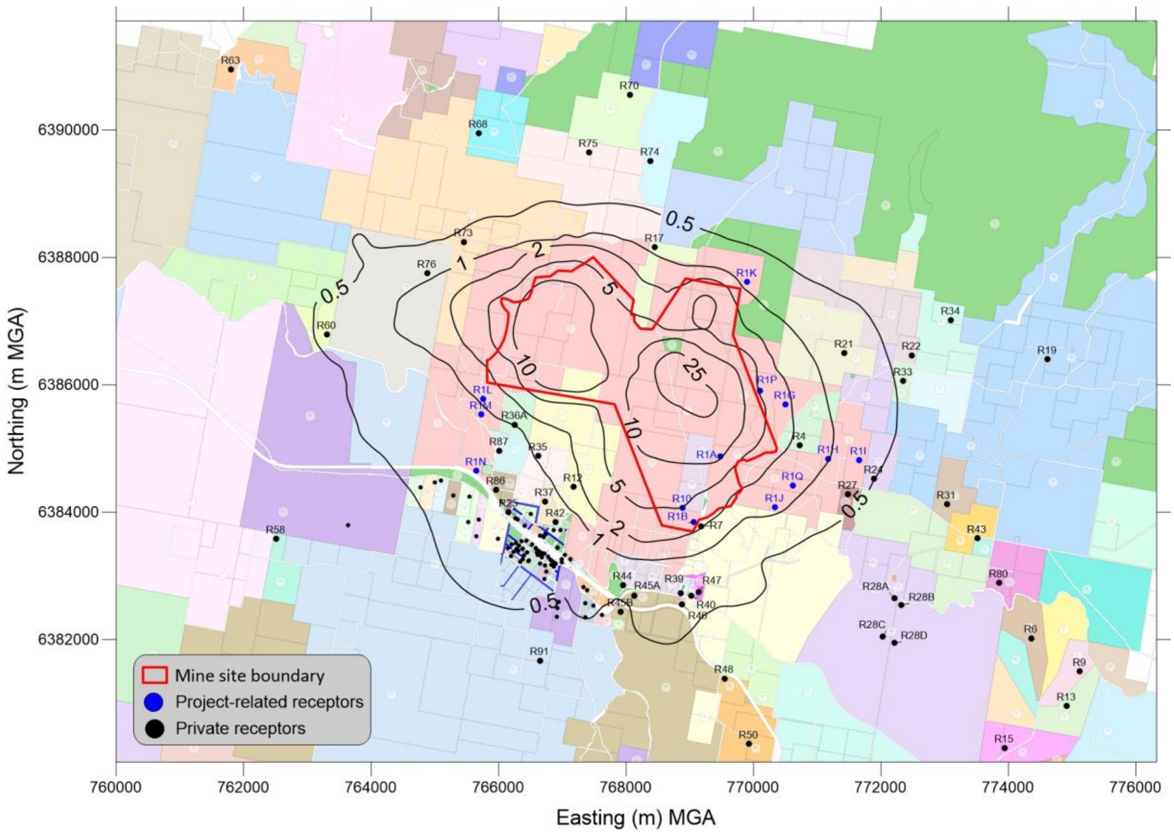

Figure 4.4.3
PROJECT ONLY ANNUAL AVERAGE PM$_{10}$ – SE&CS

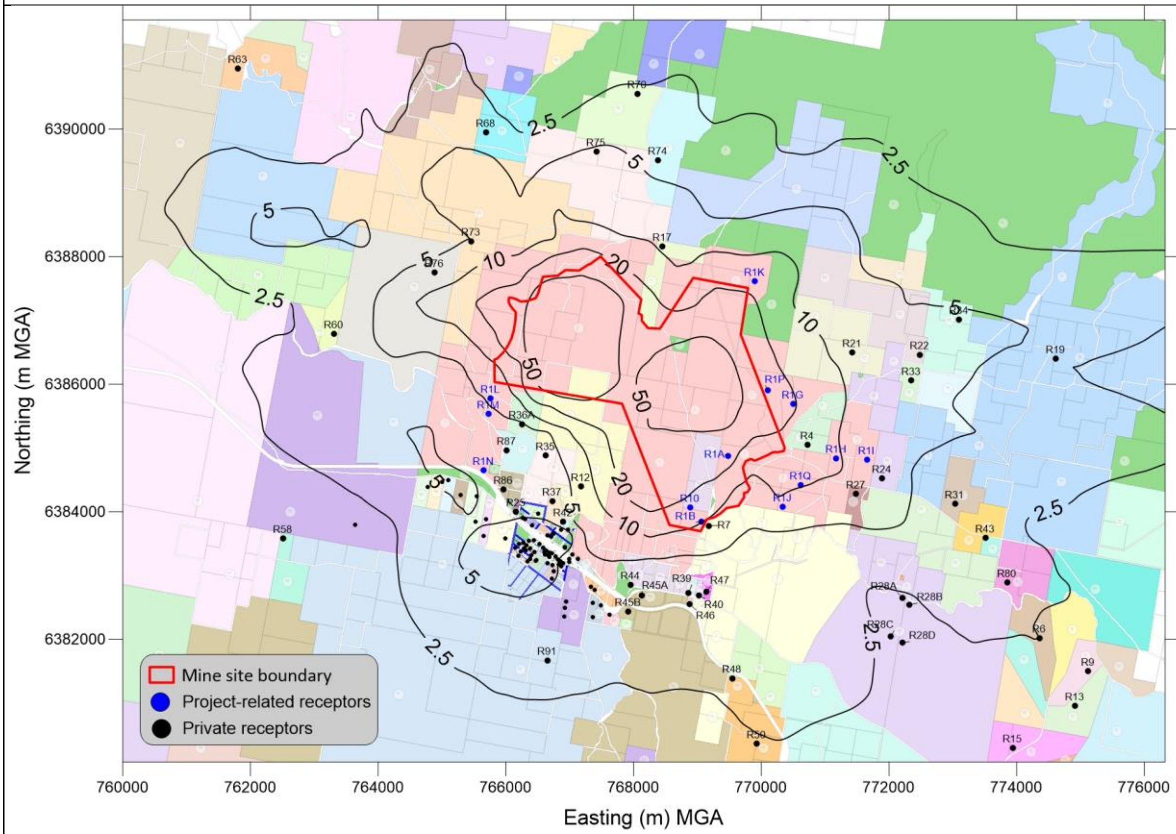

Figure 4.4.4
PROJECT ONLY MAXIMUM 24-HOUR AVERAGE PM$_{10}$ – SE&CS

Annual Average $PM_{2.5}$

The predicted annual average $PM_{2.5}$ concentrations at the selected representative receivers are presented in **Table 4.28** and shown in **Figure 4.4.5** for the site establishment and construction stage. The highest predicted increment in annual average $PM_{2.5}$ at any privately-owned residence is 0.8µg/m³ (R7 in Year 9) whilst the highest predicted cumulative annual average $PM_{2.5}$ at any privately-owned residence is 4.7µg/m³ (R7 in Year 9). Therefore, there are no predicted exceedances of the cumulative annual average $PM_{2.5}$ criteria of 8µg/m³ at any privately-owned residence.

Table 4.28
Predicted Annual Average $PM_{2.5}$ (µg/m³) at Representative Receivers

	Project-only				Cumulative			
Receiver	**SE&CS**	**Year 3**	**Year 8**	**Year 9**	**SE&CS**	**Year 3**	**Year 8**	**Year 9**
R4	0.4	0.3	0.3	0.4	4.3	4.2	4.3	4.4
R7	0.6	0.4	0.5	0.8	4.5	4.4	4.5	4.7
R17	0.2	0.1	0.1	0.1	4.1	4.0	4.0	4.0
R21	0.2	0.1	0.2	0.1	4.1	4.1	4.1	4.1
R36A	0.2	0.2	0.2	0.2	4.2	4.1	4.1	4.1
R76	0.2	0.1	0.1	0.1	4.1	4.0	4.0	4.0
L50	0.2	0.2	0.2	0.2	4.1	4.1	4.1	4.1
Lue Public School	0.2	0.1	0.1	0.1	4.1	4.1	4.0	4.1
SE&CS = site establishment and construction stage								
Source: Ramboll (2020) – Modified after Table 7.3								

Maximum 24-hour Average $PM_{2.5}$

The predicted 24-hour average $PM_{2.5}$ at the selected representative receivers are presented in **Table 4.29** and shown in **Figure 4.4.6** for the site establishment and construction stage. The highest predicted increment in maximum 24-hour average $PM_{2.5}$ at any privately-owned residence is 3.6µg/m³ (R7 in Year 9) whilst the highest predicted cumulative maximum 24-hour average $PM_{2.5}$ at any privately-owned residence is 16.2µg/m³ (R76 in the site establishment and construction stage). Therefore, there are no predicted exceedances of the cumulative 24-hour average $PM_{2.5}$ criteria of 25µg/m³ at any privately-owned residence.

Table 4.29
Predicted Maximum 24-hour Average $PM_{2.5}$ (µg/m³) at Representative Receivers

	Project-only				Cumulative			
Receiver	**SE&CS**	**Year 3**	**Year 8**	**Year 9**	**SE&CS**	**Year 3**	**Year 8**	**Year 9**
R4	2.9	2.0	2.7	2.9	15.4	15.4	15.4	15.4
R7	2.4	2.1	2.7	3.6	15.7	15.6	15.6	15.7
R17	1.7	1.0	1.0	0.9	15.8	15.6	15.6	15.6
R21	1.8	1.9	2.7	3.0	15.4	15.4	15.4	15.4
R36A	1.2	0.7	0.7	0.7	15.7	15.7	15.7	15.8
R76	1.6	0.6	0.6	0.5	16.2	15.8	15.7	15.6
L50	1.2	1.0	0.9	0.9	15.5	15.6	15.5	15.6
Lue Public School	1.3	1.2	1.2	1.3	15.5	15.5	15.5	15.5
SE&CS = site establishment and construction stage								
Source: Ramboll (2020) – Modified after Table 7.4								

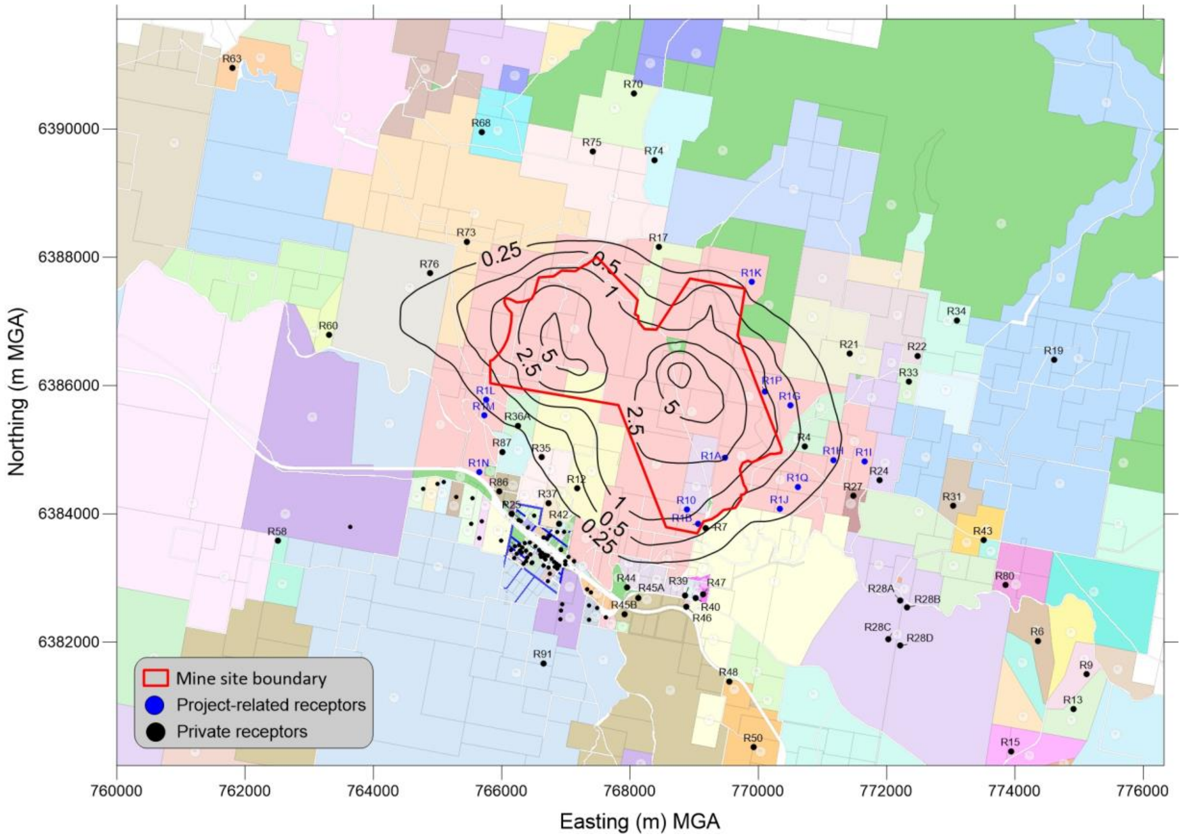

Figure 4.4.5
PROJECT ONLY ANNUAL AVERAGE $PM_{2.5}$ – SE&CS

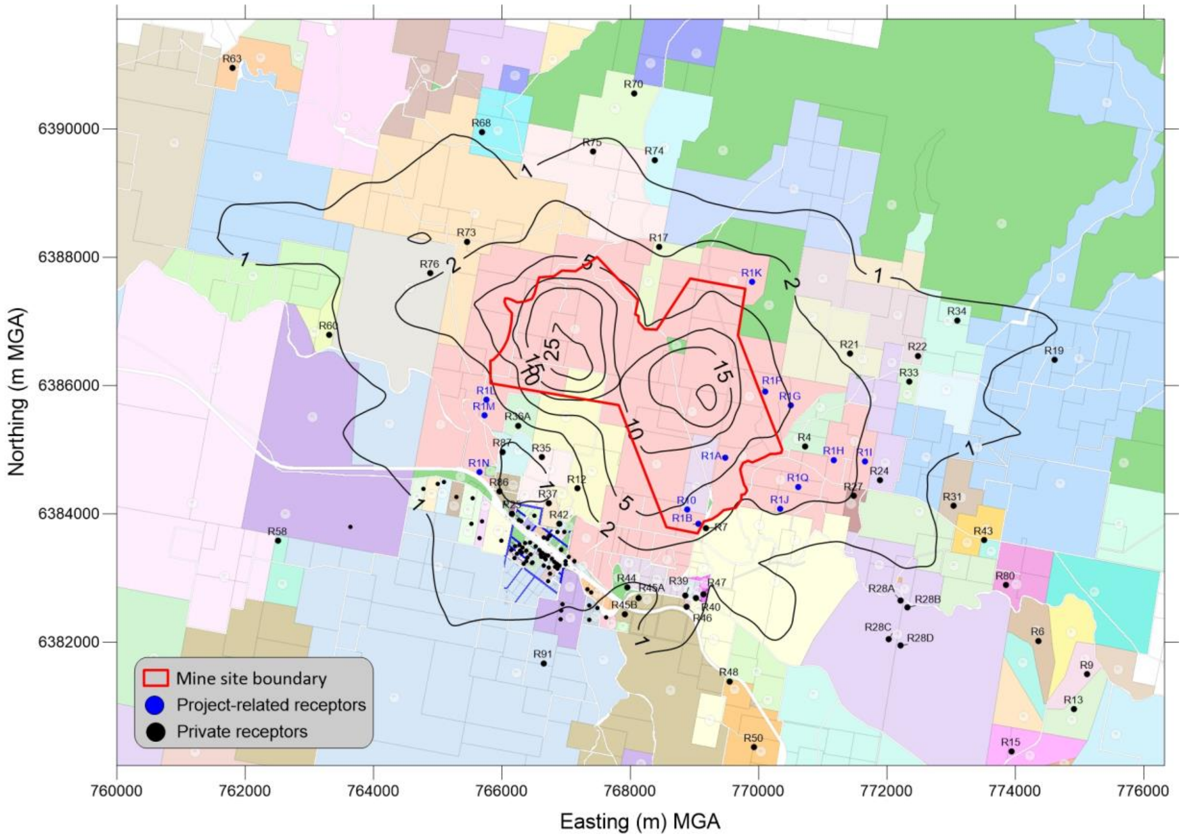

Figure 4.4.6
PROJECT ONLY MAXIMUM 24-HOUR AVERAGE $PM_{2.5}$ – SE&CS

Annual Average TSP

The predicted Annual Average TSP concentrations at the selected representative receivers are presented in **Table 4.30** and shown in **Figure 4.4.7** for the site establishment and construction stage. The highest predicted increment in annual average TSP at any privately-owned residence is 7.4µg/m³ (R7 in Year 9) whilst the highest predicted cumulative annual average TSP at any privately-owned residence is 38.4µg/m³ (R7 in Year 9). Therefore, there are no predicted exceedances of the cumulative annual average TSP criteria of 90µg/m³ at any privately-owned residence.

Table 4.30
Predicted Annual Average TSP (µg/m³) at Representative Receivers

	Project-only				Cumulative			
Receiver	**SE&CS**	**Year 3**	**Year 8**	**Year 9**	**SE&CS**	**Year 3**	**Year 8**	**Year 9**
R4	3.3	2.8	3.6	4.8	34.3	33.8	34.6	35.8
R7	4.4	3.7	5.0	7.4	35.4	34.7	36.0	38.4
R17	1.7	0.8	0.7	0.4	32.7	31.8	31.7	31.4
R21	1.4	1.2	1.3	1.2	32.4	32.2	32.3	32.2
R36A	2.0	1.3	1.3	1.2	33.0	32.3	32.3	32.2
R76	1.9	0.9	0.8	0.5	32.9	31.9	31.8	31.5
L50	1.4	1.2	1.3	1.4	32.4	32.2	32.3	32.4
Lue Public School	1.1	0.9	1.0	1.2	32.1	31.9	32.0	32.2
SE&CS = site establishment and construction stage								
Source: Ramboll (2020) – Modified after Table 7.5								

Annual Average Deposited Dust

The predicted annual average deposited dust concentrations at the selected representative receivers are presented in **Table 4.31** and shown in **Figure 4.4.8** for the site establishment and construction stage. The predicted incremental increase in dust deposition is less than 1g/m^2/month at all private residences for all years (less than 50% of the impact assessment criteria of 2g/m^2/month). Similarly, predicted cumulative dust deposition is less than 2g/m^2/month at all private residences for all years (less than 50% of the impact assessment criteria of 4g/m^2/month).

Table 4.31
Predicted Annual Average Dust Deposition (g/m^2/month) at Representative Receivers

	Project-only				Cumulative			
Receiver	**SE&CS**	**Year 3**	**Year 8**	**Year 9**	**SE&CS**	**Year 3**	**Year 8**	**Year 9**
R4	0.15	0.14	0.17	0.23	1.2	1.1	1.2	1.2
R7	0.10	0.09	0.11	0.16	1.1	1.1	1.1	1.2
R17	0.15	0.06	0.05	0.03	1.1	1.1	1.1	1.0
R21	0.08	0.07	0.07	0.06	1.1	1.1	1.1	1.1
R36A	0.09	0.06	0.05	0.05	1.1	1.1	1.1	1.1
R76	0.11	0.05	0.04	0.02	1.1	1.0	1.0	1.0
L50	0.04	0.03	0.03	0.03	1.0	1.0	1.0	1.0
Lue Public School	0.03	0.02	0.02	0.02	1.0	1.0	1.0	1.0
SE&CS = site establishment and construction stage								
Source: Ramboll (2020) – Modified after Table 7.6								

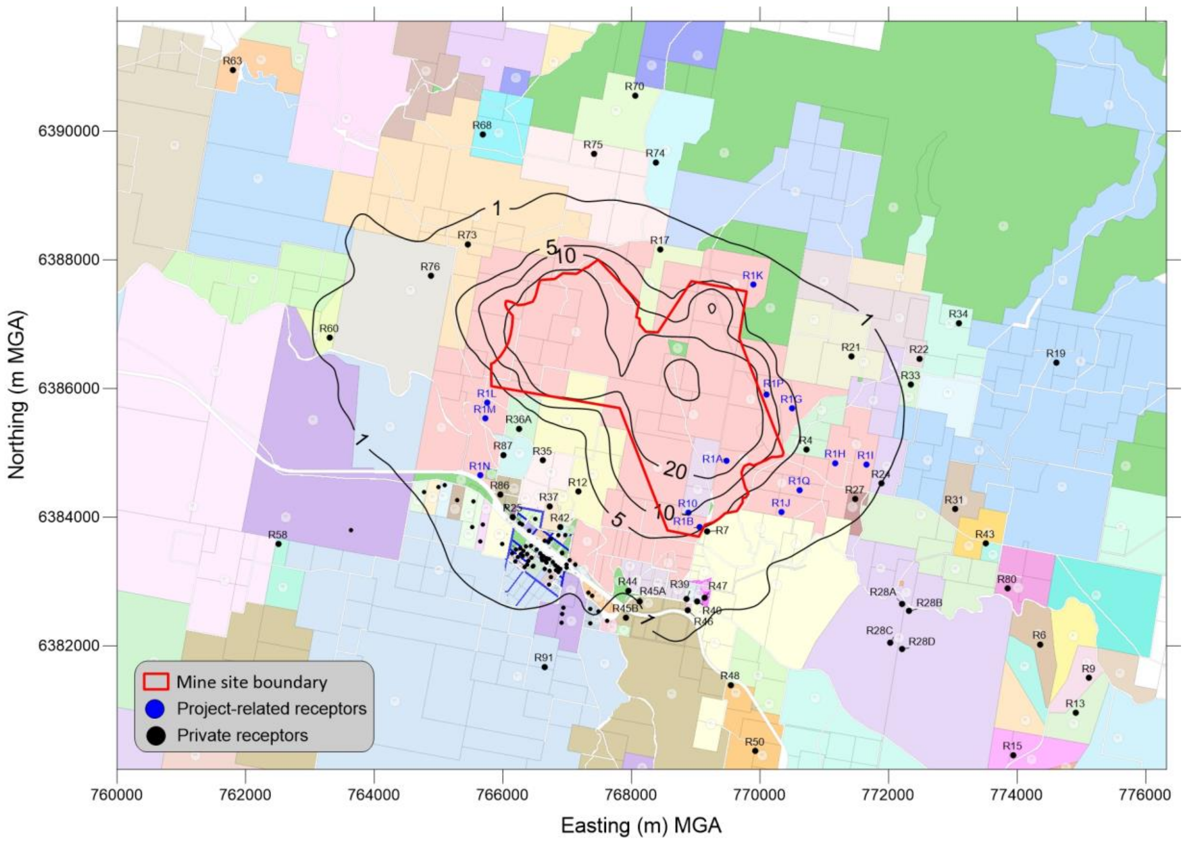

Figure 4.4.7
PROJECT ONLY ANNUAL AVERAGE TSP – SE&CS

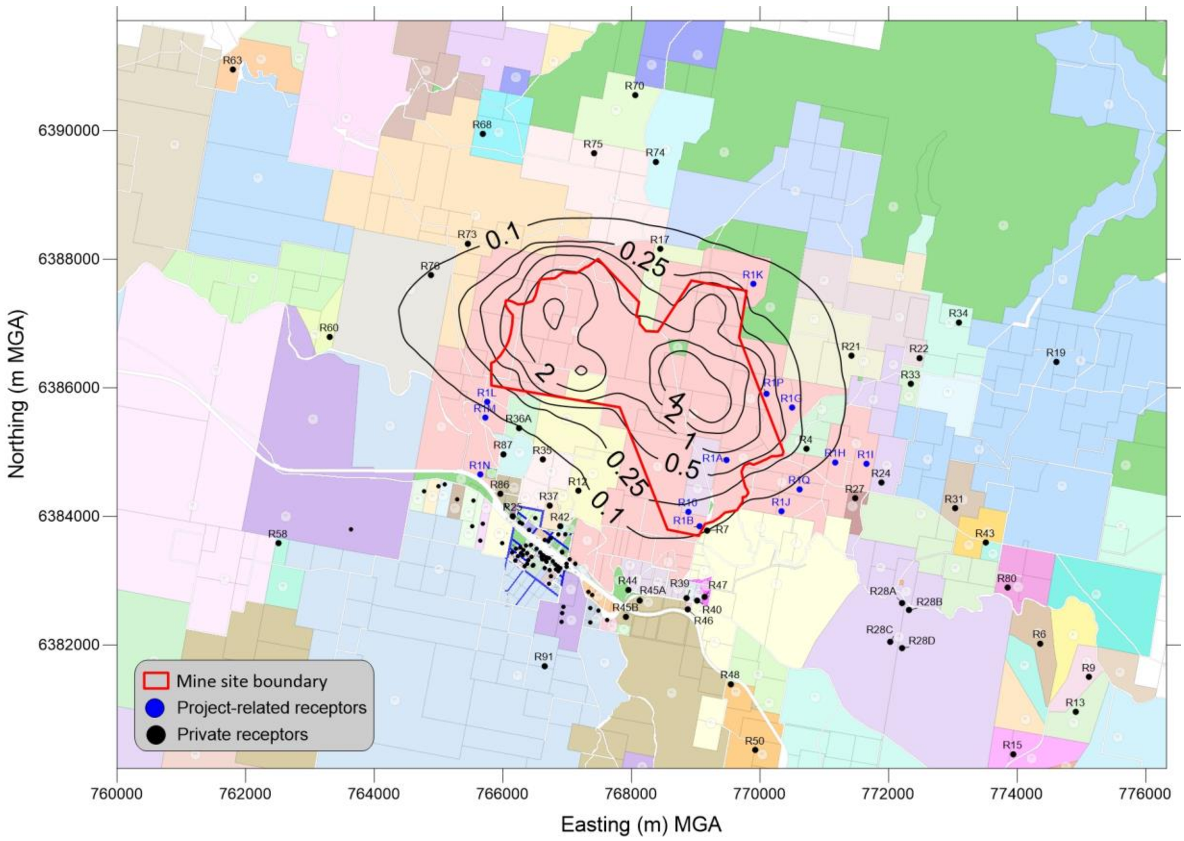

Figure 4.4.8
PROJECT ONLY DEPOSITED DUST – SE&CS

Metals

The predicted incremental 1-hour average metal concentrations in the $PM_{2.5}$, PM_{10} and TSP size fractions are presented in **Table 4.32**. Results are presented as the maximum 1-hour average (100% percentile) at residences and receivers located beyond the Mine Site. The predicted maximum incremental increases in metal dust concentrations are well below the applicable impact assessment criteria for all pollutants.

Table 4.32
Predicted 1-hour Average Metal in Dust Concentration (µg/m³)

Pollutant	Size Fraction	Criteria	SE&CS	Year 3	Year 8	Year 9
Silver (Ag)	$PM_{2.5}$	1.8	0.011	0.006	0.008	0.008
	PM_{10}		0.002	0.001	0.001	0.001
	TSP		0.015	0.010	0.012	0.013
Arsenic (As)	$PM_{2.5}$	0.09	0.031	0.024	0.036	0.031
	PM_{10}		0.005	0.004	0.006	0.005
	TSP		0.045	0.041	0.063	0.052
Cadmium (Cd)	$PM_{2.5}$	0.018	0.002	0.001	0.002	0.002
	PM_{10}		0.000	0.000	0.000	0.000
	TSP		0.003	0.002	0.003	0.003
Copper (Cu)	$PM_{2.5}$	18	0.011	0.006	0.007	0.008
	PM_{10}		0.002	0.002	0.001	0.001
	TSP		0.015	0.010	0.012	0.013
Manganese (Mn)	$PM_{2.5}$	18	0.007	0.002	0.001	0.002
	PM_{10}		0.001	0.000	0.000	0.000
	TSP		0.016	0.005	0.003	0.003
Zinc (Zn)	$PM_{2.5}$	18	0.402	0.259	0.347	0.332
	PM_{10}		0.076	0.044	0.057	0.055
	TSP		0.567	0.427	0.589	0.542
Cobalt (Co)	$PM_{2.5}$	N/A	0.000	0.001	0.001	0.001
	PM_{10}		0.000	0.000	0.000	0.000
	TSP		0.001	0.001	0.002	0.001
Chromium (Cr)	$PM_{2.5}$	9	0.011	0.007	0.009	0.008
	PM_{10}		0.002	0.001	0.001	0.001
	TSP		0.015	0.011	0.014	0.014
Iron (Fe)	$PM_{2.5}$	N/A	2.483	2.951	5.111	3.961
	PM_{10}		0.524	0.483	0.814	0.649
	TSP		3.672	5.209	9.229	6.847
Mercury (Hg)	$PM_{2.5}$	0.18	0.000	0.001	0.001	0.001
	PM_{10}		0.000	0.000	0.000	0.000
	TSP		0.001	0.001	0.002	0.001
Lithium (Li)	$PM_{2.5}$	N/A	0.005	0.006	0.011	0.008
	PM_{10}		0.001	0.001	0.002	0.001
	TSP		0.008	0.011	0.019	0.014
Nickel (Ni)	$PM_{2.5}$	0.18	0.000	0.001	0.001	0.001
	PM_{10}		0.000	0.000	0.000	0.000
	TSP		0.001	0.001	0.002	0.002
SE&CS = site establishment and construction stage						
Source: Ramboll (2020) – Table 7.7						

The predicted incremental annual average lead dust concentrations are presented in **Table 4.33**. When considered with the existing negligible background concentrations for lead, there would be no exceedances of the cumulative impact assessment criteria for lead. In fact, the highest predicted annual average lead level in dust is two orders of magnitude (100 times) lower than the criteria.

Table 4.33
Predicted Annual Average Lead Dust Concentration (µg/m³)

Pollutant	Size Fraction	Goal	SE&CS	Year 3	Year 8	Year 9
Lead (Pb)	$PM_{2.5}$	0.5	0.001	0.001	0.001	0.001
	PM_{10}		0.0003	0.0003	0.0002	0.0002
	TSP		0.001	0.001	0.001	0.001
Goal = NSW EPA Impact assessment criteria SE&CS = site establishment and construction stage						
Source: Ramboll (2020) – Table 7.8						

Respirable Crystalline Silica

The predicted incremental annual average silica dust concentrations are presented in **Table 4.34**. Results are presented for the $PM_{2.5}$ size fraction and compared against the impact assessment criteria of 3.0µg/m³. No exceedances of the impact assessment criteria are predicted at any surrounding residences or receivers.

Table 4.34
Predicted Annual Average Silica Dust Concentration (µg/m³)

Pollutant	Receiver type	Goal	SE&CS	Year 3	Year 8	Year 9
Silica	Project-related receivers	3.0	0.05 (R1K) to 0.54 (R1A)	0.02 (R1K) to 0.34 (R10)	0.02 (R1K) to 0.51 (R10)	0.02 (R1K) to 0.76 (R1A)
	Privately-owned rural residences		0.01 (R16) to 0.14 (R7)	0.00 (R16) to 0.12 (R12)	0.00 (R70) to 0.15 (R7)	0.00 (R70) to 0.21 (R7)
	Privately-owned Lue residences		0.05 (L10) to 0.06 (L50)	0.04 (L10) to 0.05 (L50)	0.03 (L10) to 0.04 (L50)	0.04 (L10) to 0.05 (L50)
Goal = EPA Victoria assessment criterion for mining and extractive industries SE&CS = site establishment and construction stage						
Source: Ramboll (2020) – Table 7.9						

Hydrogen Cyanide

The predicted incremental 1-hour average HCN concentrations are presented in **Table 4.35**. Results are presented as the maximum 1-hour average (i.e. 100th percentile) and compared against the impact assessment criteria of 200µg/m³. No exceedances of the impact assessment criteria are predicted at any surrounding residences or receivers.

Odour

The bulk of the odours attributable to the chemicals used in the flotation sections of the processing plant would be detectable within approximately 50m of the flotation cells or the discharge points into the TSF. Beyond this distance, odours attributable with these chemicals would be negligible – as such, there would be no odour detectable beyond the Mine Site boundary.

Table 4.35
Predicted 1-hour Average HCN Concentration (μg/m³)

Pollutant	Receiver type	Goal	Concentration Range (μg/m³)
HCN	Project-related receivers	200	1.8 (R1I) to 5.9 (R1K)
	Privately-owned rural residences		0.3 (R16) to 4.1 (R82)
	Privately-owned Lue residences		1.6 (L49) to 2.2 (L45)
Goal = NSW EPA Impact assessment criteria			
Source: Ramboll (2020) – Table 7.10			

Consideration of Privately-owned Land

Voluntary land acquisition criteria also apply if the development contributes to an exceedance of the criteria listed in **Table 4.21** on more than 25% of privately-owned land upon which a dwelling could be built under existing planning controls. Ramboll (2020) analysed the contour plots for 24-hour PM_{10} and $PM_{2.5}$ concentrations (see **Figures 4.4.4** and **4.4.6**) and concluded they are unlikely to exceed either incrementally or cumulatively the respective 50μg/m³ or 25μg/m³ criteria across more than 25% of any privately-owned properties. Similarly, for dust deposition, the Project-only contribution does not exceed 2g/m²/month across more than 25% of any privately-owned property and the cumulative contribution does not exceed 4g/m²/month across more than 25% of any private property.

4.4.3 Water Supply Pipeline

Given the minor and short-term nature of any dust generation resulting from the water supply pipeline, a qualitative review and assessment of the potential impacts is provided as follows.

Potential Dust Sources

The potential for dust generation associated with the water supply pipeline would principally be during its construction. The following key activities have the potential to generate dust during the construction of the water supply pipeline.

- Vegetation clearing.
- Excavation of the trench for the pipeline.
- Trench backfilling operation.
- Light and heavy vehicle traffic travelling to and from active construction sites.

These activities would be undertaken over approximately a 10 month period. However, over the 55.2km length of the water supply pipeline these activities would only occur in any one location for a short duration with an average of 400m of pipeline expected to be placed per day. Further details regarding the activities associated with the construction of the water supply pipeline are outlined in Section 2.10.4 and **Appendix 5** – Section A5.9.

During operation the potential for dust emissions would be negligible and generally limited to vehicle movements associated with inspections and any maintenance works.

Management Measures

The key management measures to manage dust generation during construction of the water supply pipeline would be the use of a water cart and progressive rehabilitation. A water cart would be used to wet down the soil material prior to stripping if conditions are dry and, if necessary, any access roads or trafficked areas likely to generate dust. As outlined in **Appendix 5** – Section A5.9, progressive revegetation would occur as each 200m section of pipeline is backfilled with each section scarified and either seeded with a pasture mix agreed with the respective landowner or MWRC or rehabilitated to the pre-disturbance condition. In those areas to be seeded, placement of seed would be concentrated upon the surface of the trench and any other disturbed areas where vegetation had been removed.

Additional management measures would include the following.

- Notification of nearby residents when construction activities are planned in their vicinity.
- Daily review of forecast weather conditions and visual monitoring of dust generation.
- Ceasing dust generating activities during adverse weather conditions (e.g. dry and wind) where watering alone is not effective.
- Ensuring that all vehicle movements are restricted to the designated routes.

Assessment of Impacts

Given the limited footprint of disturbance and fact that construction activities would only be occurring at any one location for a limited period of time, with the implementation of the proposed management measures, the potential for dust impacts from the water supply pipeline are considered very low.

4.4.4 Monitoring

The existing air quality monitoring network described in Section 4.4.2.2 as well as the existing real-time meteorological monitoring network would be reviewed and augmented (if required) for the operation of the Project and outlined in the Air Quality Management Plan. This network would be essential to the proactive dust management system discussed in Section 4.4.2.3 Monitoring would recommence prior to commencement of ground-disturbing activities and continue throughout the Project life.

As part of the air quality monitoring program, testing for lead and other metals would initially be undertaken, for example on a monthly basis, to measure any increase from baseline concentrations. The results of this monitoring and the frequency of ongoing metal testing would be reviewed on a regular basis.

Monitoring would be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* and the results summarised on the Applicant's website on a regular basis and utilised in the assessment of performance and compliance outlined within each respective Annual Review.

4.4.5 Conclusion

Air quality modelling completed by Ramboll (2020) predicts that there would be no exceedance of the relevant air quality criteria for particulate matter (TSP, PM_{10}, $PM_{2.5}$) at any privately-owned residences or receivers, either from the Project alone or cumulatively. It is also predicted that there would be no exceedance of the impact assessment criteria at any receivers (Project-related or private) for metal dust concentrations, respirable crystalline silica or HCN.

The predictions presented in the air quality assessment incorporate a high level of conservatism through a number of conservative assumptions applied in the model input data and model settings, including:

- the dust emission estimates do not account for natural mitigation due to rainfall; and
- the model does not incorporate wet deposition (removal of particles due to rainfall).

As a result, it is expected that actual ground-level concentrations would in many cases be lower than those predicted.

Notwithstanding the predicted levels, it is proposed that the potential impacts would be managed using a range of management measures that would be regularly reviewed and updated within an Air Quality Management Plan. Furthermore, a proactive management dust management system is proposed utilising predictive meteorological data, visual monitoring, and a network of real-time meteorological and particulate monitoring which would enable mine personnel to respond to elevated dust levels prior to reaching set trigger levels below relevant criteria, and modify activities, their location or increase controls as required to avoid exceedances.

The peer review of the Air Quality Assessment concluded that the air quality and greenhouse gas assessment is consistent with the necessary requirements, the methodology includes an acceptable level of conservatism, and the assessment conclusions are consistent with what would be expected for a project such as this.

4.5 GREENHOUSE GAS

The greenhouse gas assessment of the Project was undertaken by Ramboll Australia Pty Ltd (Ramboll) as a component of the air quality assessment. The full assessment is presented in Volume 1 Part 2 of the Specialist Consultant Studies Compendium and is referenced throughout this document as Ramboll (2020).

4.5.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies Scope 1 (on site), Scope 2 (off site generation) and Scope 3 (off site impacts) greenhouse gas (GHG) emissions as a key risk source. The assessed risk of impacts associated with GHG emissions after the adoption of standard mitigation measures was low.

In addition, the SEARs identified the "assessment of the likely greenhouse gas impacts of the development" as a key issue to be addressed. No other specific assessment considerations relating to GHG were raised by DPE/DPIE or other government agencies.

Consideration of other air quality matters are addressed separately in Section 4.4.

4.5.2 Emission Sources and Estimates

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoE, 2015). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream use of products and services or the upstream extraction and production of raw materials.

Scope 3 is an optional reporting category (Bhatia et al, 2010) and should not be used to make comparisons between organisations, for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations.

The GHG emission sources for both direct and indirect emissions are summarised in **Table 4.36** whilst the estimated annual GHG emissions for each source are presented in **Table 4.37**. These represent the most significant sources associated with the Project.

Table 4.36
Scope 1, 2 and 3 Emission Sources from the Bowdens Silver Project

Page 1 of 2

Scope	Source
Scope 1	Direct emissions from fuel combustion (diesel) by on-site plant and equipment.
	Emissions from explosives usage.
	Emissions associated with vegetation stripping
Scope 2	Indirect emissions associated with the consumption of purchased electricity.

Table 4.36 (Cont'd)
Scope 1, 2 and 3 Emission Sources from the Bowdens Silver Project

Page 2 of 2

Scope	Source
Scope 3	Indirect upstream emissions from the extraction, production and transportation of diesel fuel.
	Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network.
	Downstream emissions generated from transportation of silver / lead concentrate by road from the Mine Site to Parkes or Kelso.
	Downstream emissions generated from transportation of silver / lead concentrate by rail from Parkes or Kelso to Port Pirie.
	Downstream emissions generated from transportation of zinc concentrate by road from Mine Site to Port of Newcastle or Port Botany.
	Employee travel
	Downstream emissions generated from international transportation of product by ship
Source: Ramboll (2020) – Table 8.1	

Table 4.37
Summary of GHG emission estimates (tonnes CO_2-e)

Project Year	Scope 1			Scope 2	Scope 3					
							Product transport			
	Diesel – on site	Explosives	Vegetation clearing[1]	Electricity	Diesel – on site (extraction, processing, distribution)	Electricity (T&D loses)	Road	Rail	Shipping	Employee travel
1	34 711	192		3 876	1 780	554	0	0	0	80.5
2	18 040	242		59 465	925	8 495	540	426	1 205	248.7
3	18 040	243		65 039	925	9 291	590	466	1 318	248.7
4	22 544	244		58 037	1 156	8 291	527	416	1 176	248.7
5	17 869	246		66 658	916	9 523	605	478	1 351	248.7
6	17 869	244		68 530	916	9 790	622	491	1 389	248.7
7	17 869	210		70 560	916	10 080	640	506	1 430	248.7
8	17 869	209		69 824	916	9 975	634	501	1 415	248.7
9	23 484	204		50 369	1 204	7 196	457	361	1 021	248.7
10	16 864	190		16 982	865	2 426	154	122	344	248.7
11	16 864	199		44 777	865	6 397	406	321	907	248.7
12	16 864	201		46 942	865	6 706	426	337	951	248.7
13	16 864	206		57 240	865	8 177	519	410	1 160	248.7
14	16 864	151		56 632	865	8 090	514	406	1 148	248.7
15	16 864	134		51 162	865	7 309	464	367	1 037	248.7
16	16 864	56		26 225	865	3 746	238	188	531	248.7
17	5 015				257					
18	3 902				200					
19	3 769				193					
20	5 015				257					
21	1 266				65					
Max annual	**34 711**	**246**		**70 560**	**1 780**	**10 080**	**640**	**506**	**1 430**	**249**
Average annual	**15 491**	**198**	**7 248**	**50 770**	**794**	**7 253**	**459**	**362**	**1 024**	**238**
LOM total	**325 309**	**3 168**	**115 965**	**812 319**	**16 683**	**116 046**	**7 337**	**5 797**	**16 381**	**3 811**

Note: 1. Areas cleared of vegetation are life-of-mine (LOM) and therefore emissions are only presented as a LOM total and average annual emissions (assuming clearing occurs evenly across the LOM).

Source: Ramboll (2020) – Table 8.4

The total estimate GHG emissions for the Project over the lift of the mine (LOM) are as follows.

- Scope 1: 444 442t CO_2-e (~31% total)
- Scope 2: 812 319t CO_2-e (~57% total)
- Scope 3: 166 055 CO_2-e (~12% total)
- Total: 1 422 816 CO_2-e

It is noted that the emission estimates are considered conservative as they do not account for the offset of GHG emissions through the increase in vegetative biomass that would be achieved within the biodiversity offset areas to be established for the Project (see Section 4.10.7) or the return of vegetative biomass through progressive rehabilitation. Therefore, the inclusion of GHG emissions from vegetation clearing without inclusion of the subsequent emission offsets provides a highly conservative estimate of the Scope 1 emissions.

Furthermore, in relation to Scope 3 emissions, allowance has not been provided for the use of silver in the production of 'green' power generation, such as the production of photovoltaic (solar) cells and other electrical applications. Based on world silver supply/demand data (see **Appendix** 4 – Section A4.1.2), approximately 7% to 8% of total silver demand is for use in photovoltaic production and 21% to 23% for other electrical fabrication purposes.

4.5.3 Assessment of Impacts

Without taking into account the potential emission offsets discussed in Section 4.5.2, the calculated annual average Scope 1 emissions represent approximately 0.02% of total GHG emissions for NSW and 0.004% of total GHG emissions for Australia, based on the *National Greenhouse Gas Inventory for 2016*. The Project's contribution to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions. Given Australia's contribution to global greenhouse gas emissions is approximately 1.3%, the contribution of the Project to global emissions is approximately 0.000052%.

In order to put the emissions from the Project in perspective, the GHG emission intensity for the Project can be compared against Australian Scope 1 emissions for other mining operations, as reported in the 2015-2016 National Greenhouse and Energy Reporting (NGER) scheme. **Table 4.38** presents the Australian total 2015-2016 Scope 1 emissions for both metal ore mining and coal mining and the number of facilities that reported for that year.

Table 4.38
Australian Scope 1 emissions by ANZSIC category

ANZSIC category	2015-2016 Scope 1 emission (t CO_2-e)	Number of facilities	NGER facility average Scope 1 emission (t CO_2-e)	Project Scope 1 emissions as % of facility average
Coal Mining	34 450 013	168	205 060	11%
Metal Ore Mining	11 358 788	226	50 260	46%
Source: Ramboll (2020) – Table 8.5				

When compared to NGER facility average Scope 1 emissions, the Project's emission intensity is less than half that of the average metal ore mine and significantly lower than coal mining, with Scope 1 emissions of only 11% the average coal mine.

As Scope 3 emissions are an optional reporting category, this comparison cannot be accurately made for reported Scope 3 emissions. However, a review of GHG assessments for NSW coal mine projects as available on the DPIE Major Project Portal indicates that the Scope 3 emissions for coal mines generally represent >95% of their total emissions. To compare, the total emissions (Scope 1, 2 and 3) per tonne of ore processed for the Project is 0.047t CO_2-e. In comparison the emissions per tonne of Run of Mine coal ranged from 1.60t to 1.81t CO_2-e. It should also be taken into account that the silver produced by the Project is largely recyclable with approximately 15% of the global annual silver produced is supplied from 'scrap' silver (see **Appendix 4** – Section A4.1.2). Therefore, the Project would produce a product that would provide ongoing benefits.

4.5.4 Management and Mitigation Measures

The proposed greenhouse gas management measures for the Project include the following.

- Areas cleared of vegetation would be rehabilitated and supplemented with additional biodiversity offset areas which would be improved through ongoing management of the vegetation.
- Energy efficiency would be considered during the design of processing plant with energy efficient systems installed where reasonable and practicable.
- Plant and equipment would be operated and maintained to maximise efficiency and reduce emissions, with mine planning used to minimise vehicle wait times and idling.
- Locally produced goods and services would be procured where feasible and cost effective to reduce transport fuel emissions.
- Cut and fill balances for earthworks would be reviewed to make sure that material is transported the least possible distances.

4.5.5 Conclusion

Based upon conservative assumptions, the GHG assessment has calculated that the Project would result in annual average Scope 1 emissions represent approximately 0.02% of total GHG emissions for NSW and 0.004% of total GHG emissions for Australia. In comparison to other metal ore mining projects, the Project's Scope 1 emissions are less than half of the average and significantly lower than emissions from coal mining operations. Whilst the Project would result in some GHG emissions, the Project would also produce a product that is an important component of 'green' power generation in the form of photovoltaic cells and which can be recycled for ongoing use and benefit.

4.6 GROUNDWATER

The groundwater assessment of the Project was undertaken by Jacobs Group (Australia) Pty Ltd (Jacobs). The full assessment is presented in Volume 2 Part 5 of the Specialist Consultant Studies Compendium and is referenced throughout this document as Jacobs (2020). A peer review of the groundwater assessment was undertaken by Dr Noel Merrick of SLR Consulting Australia Pty Ltd trading as Hydrosimulations. A copy of the peer review is included as Annexure 10 within Jacobs (2020).

4.6.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in groundwater impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Interception of the local groundwater system by open cut mining resulting in reduced groundwater levels and groundwater availability for existing groundwater users (High).
- Interception of the local groundwater system by open cut mining resulting in reduced baseflow contribution to Hawkins Creek or Lawsons Creek impacting on streamflow and aquatic ecosystem health (Medium).
- Impacts to groundwater dependent ecosystems (GDEs) due to reduced baseflow contribution to a watercourse (Hawkins Creek and Lawsons Creek) or contaminated discharge / groundwater (Medium).
- Reduced water quality in groundwater systems due to seepage of contaminated water from tailings stored in the TSF (Medium).
- Reduced water quality in groundwater systems due to contamination of water infiltrating to shallow aquifers from contaminated water storage structures (Low).
- Reduced water quality in surface water systems due to discharge of contaminated groundwater into the terrestrial environment (Low).
- Open cut mining resulting in changes to structural geology in the vicinity of the open cut pits and the subsequent impact to the groundwater system (Low).
- Reduction in recharge to alluvium (shallow groundwater) due to infrastructure development (Low).
- Impacts on groundwater biota (stygofauna) (Low).[6]

[6] Addressed in Section 4.11 and Cardno (2020)

In addition, the SEARs issued by the former DPE identified "water" as a key issue requiring assessment. The principal assessment requirements relating to groundwater included the following.

- The likely impacts of the development on the quantity and quality of the region's surface and groundwater resources (including, but not limited to, Lawsons Creek and Price Creek), having regard to the EPA's, DPI's[7] and OEH's[8] requirements.
- The likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to SEARs from the EPA, the then DoI-Water and Natural Resources Access Regulator, the then OEH and from consultation with members of the Lue and district community. These requirements are summarised as follows.

- A description of the existing groundwater setting.
- Water take from the groundwater setting and licencing requirements including identification of an adequate and secure water supply for the Project life.
- Assessment of impacts on surface water and groundwater sources, related infrastructure, adjacent water users, basic landholder rights, watercourses, riparian land and GDEs.
- Assessment of impacts of the development on groundwater quality.
- Assessment in accordance with the relevant NSW legislation, guidelines and policies including but not limited to the minimal impact considerations of the NSW *Aquifer Interference Policy 2012*.
- Groundwater modelling with a peer review of the model and outcomes.
- Assessment of cumulative impacts on water resources.
- Details of the proposed water management strategies.

It is noted that some of the assessment requirements specified by Government agencies and the Lue and district community overlap with the requirements for the surface water assessment and the aquatic ecology assessment. A detailed summary of all assessment requirements and where these have been addressed in the EIS or specialist consultant studies is provided as **Appendix 3**.

This section focuses on the assessment of potential groundwater-related impacts arising from Project-related activities conducted. As the construction and operation of the Water Supply Pipeline is not likely to intercept groundwater an assessment of this component of the Project is not necessary. Risks associated with spills and subsequent contamination of the surface and groundwater setting along the pipeline corridor has been considered in relation to surface water impacts of this infrastructure and are discussed in Section 4.7.7.3.

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[7] DPI is now the Division of Water
[8] OEH is now the Division of Biodiversity and Conservation Division (BCD) within DPIE

4.6.2 Previous Groundwater Investigations

The Groundwater Assessment prepared by Jacobs (2020) has relied upon groundwater monitoring that has been occurring within and surrounding the Mine Site since March 2012. In addition, there have been a range of groundwater investigations undertaken since 1998 that have varied in scope and outcome. These investigations have included the following.

- Bowdens Silver Project Pre-Feasibility Water Supply Study prepared by Coffey Partners International Pty Ltd in 1998.
- Hydrogeological Investigation, Groundwater Supply prepared by Hydroilex in 2003.
- Hydrogeological Assessment prepared by CM Jewell and Associates Pty Ltd in 2003.
- Assessment of Existing Groundwater Conditions at the Bowdens Silver Mine Site near Lue, NSW prepared by Noel Merrick in 2011.
- Bowdens Groundwater Monitoring Network, Bore Installation undertaken by Sinclair Knight Merz Pty Ltd in 2013.
- Bowdens Project Aquifer Testing undertaken by Jacobs in 2014.

Section 3 of Jacobs (2020) describes the findings and conclusions of the above investigations that have informed the Groundwater Assessment.

4.6.3 Existing Groundwater Setting

The existing groundwater setting needs to be considered in determining both the potential impacts of any changes to the system associated with the Project and in determining the parameters to be applied for groundwater modelling undertaken to predict the behaviour of the setting under modelled conditions (such as open cut development). A comprehensive summary of the existing environment that has informed the Groundwater Assessment prepared by Jacobs (2020) is provided in Section 4 of that assessment report. **Table 4.39** presents a summary of the components of the existing environment that have been considered in a review of potential impacts and constructing the groundwater model, with a commentary on the setting in the vicinity of the Mine Site also provided.

Groundwater Levels and Flow

Comprehensive groundwater monitoring has been undertaken within the Mine Site and throughout the surrounding area since March 2012. The monitoring network is presented in **Figure 4.6.1** and includes a network of private bores in addition to the monitoring bores within the Mine Site.

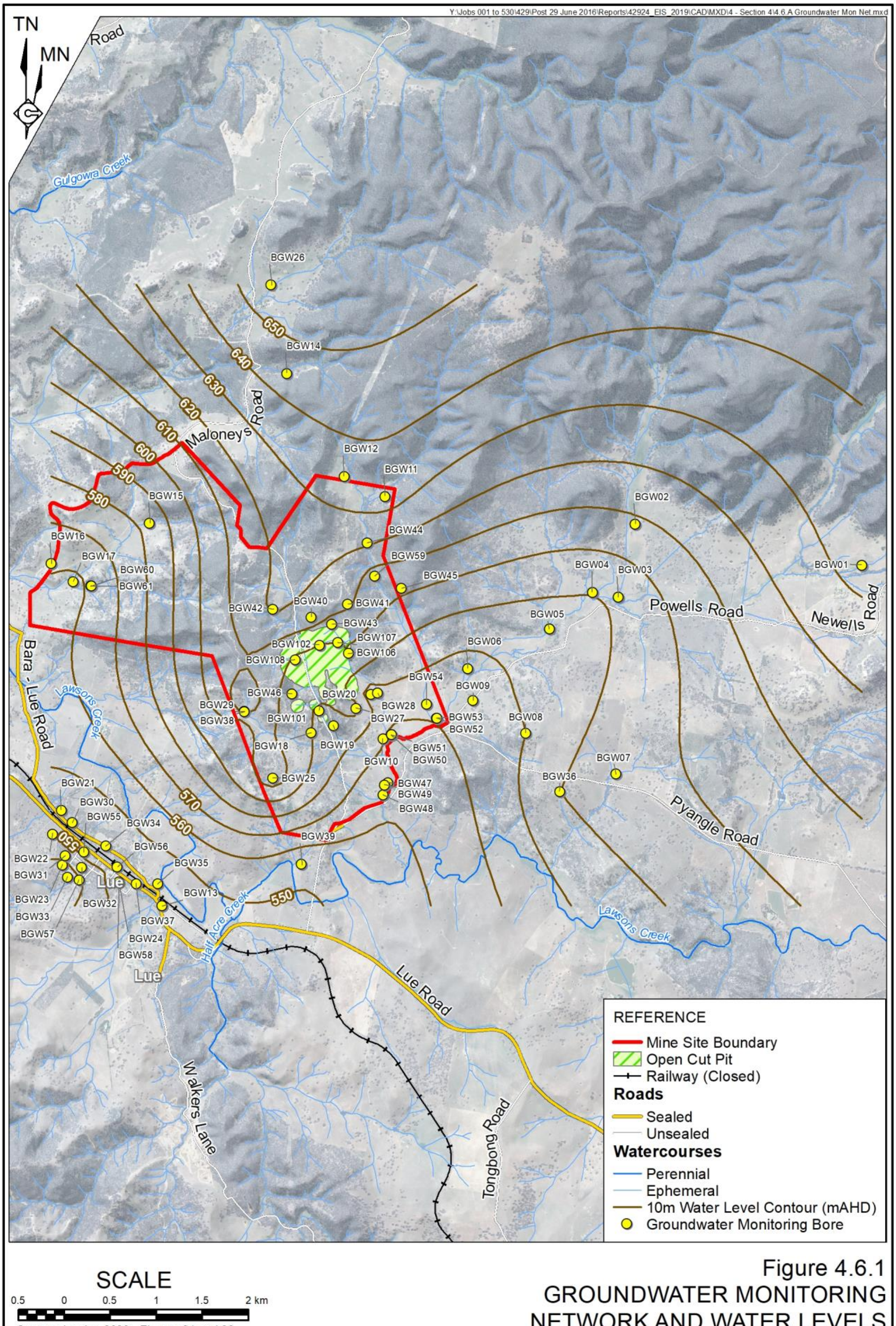


Figure 4.6.1
GROUNDWATER MONITORING NETWORK AND WATER LEVELS

Table 4.39
Existing Groundwater Setting

Page 1 of 3

Existing Environment Component	Influence on the Groundwater Setting	Summary / Comments
Climatic conditions	Local and regional climate influences the availability of rainwater for recharge of the groundwater setting and evaporation levels provide an indication of water that may be lost naturally.	Rainfall and evaporation both peak in summer months with an average annual evaporation rate of 1 514mm per year and average annual rainfall rate of 606mm per year applied for assessment. These are indicative of a moisture deficit for the local setting.
Topography and drainage	Local topography influences rainfall runoff behaviour, groundwater flow conditions and zones of aquifer discharge/recharge. Drainage patterns indicate likely surface water and groundwater interactions including zones of groundwater discharge/recharge.	The local topography and drainage is influenced by a series of ridges and associated valleys which effectively controls drainage features in the vicinity of the Mine Site. Streamflow in Hawkins Creek and Lawsons Creek is considered to be ephemeral to semi-perennial (WRM, 2020). Monitoring of streamflow in Hawkins Creek indicates that recorded flows are typically very low to no flow, with the exception being in response to periods of high rainfall and runoff.
Geological setting	The geological setting influences the physical characteristics of the aquifers and is the most significant determinant of hydrogeology. The geological setting also influences the likely presence of the mineralisation that is the target of extraction and which may influence groundwater quality.	The geological setting is comprised of alluvium of varying thickness in the vicinity of drainage features and form the basis for localised aquifer systems. The broader stratigraphy consists of the Sydney Basin and Lachlan Fold Belt geological units and which form the basis of the regional groundwater systems. The silver mineralisation is present within the siliceous volcanic rocks of the Rylstone Volcanics.
Structural geology	The structural geology of the setting determines where features or defect in the rock mass may influence groundwater flow.	The local geology is heavily fractured. There are two main fracture systems that are evident from geological records. The identified veins and fractures appear moderately welded and tight, however there is evidence of some clayey alteration, weathering or precipitation deposits that may have been influenced by groundwater flow.
Aquifer types	The aquifer type would be the principal determinant of the hydraulic properties of the setting.	There are five different aquifer types present in the setting including: • alluvial/colluvial aquifers; • porous rock aquifers; • fractured rock aquifers; • shear/fault controlled aquifers; and • regolith transition zone aquifers.
Groundwater users and Water Access Licences	Local and regional reliance on the groundwater setting is an important consideration for potential impacts.	106 groundwater bores are registered within 10km of the Mine Site. These include 24 monitoring bores managed by Bowdens Silver. 6 of the 106 registered bores are associated with water access licences with allocations that vary from 6ML to 60ML per year.

Table 4.39 (Cont'd)
Existing Groundwater Setting

Page 2 of 3

Existing Environment Component	Influence on the Groundwater Setting	Summary / Comments
Groundwater Dependent Ecosystems (GDEs)	The location and susceptibility of ecosystems that rely on groundwater is an important consideration for potential impacts.	Potential GDEs in the vicinity of the Mine Site include the following. • High potential GDE sites mapped in the Bureau of Meteorology GDE Atlas. • High Priority GDEs associated with wetlands, springs and karsts listed in Water Sharing Plans. • Other potential GDEs including those within river baseflow systems, springs and seeps. No high priority GDEs have been identified within the Mine Site and its immediate vicinity (<10km). Mapping indicates there are some areas where terrestrial GDEs may occur.
General groundwater occurrence	This component refers to the elevations of groundwater occurrence relative to the regional groundwater table with higher/variable elevations indicating varying permeability or perched water.	The presence of groundwater is estimated from drilling records with 70% of groundwater strikes occurring shallower than 60m below natural ground level.
Hydraulic Conductivity	The hydraulic conductivity of the various aquifer types is the capacity of the rock to transmit water.	A range of hydraulic conductivities have been established through a range of tests undertaken within the Mine Site including the following. • Records from drilling programs. • Permeability testing and pump testing within monitoring bores. • Long-term (72-hr) pump tests. • Packer tests • Airlift recovery tests • Falling head tests. The outcomes of the various assessments have established estimates of hydraulic conductivity at depth (metres below ground level) and for the various lithologies.
Porosity	Porosity is the ratio of void (or space) in the aquifer material which may hold water to the total volume.	Estimates of formation porosity have been derived from the core samples for each formation or lithology through assessment of the total sample volume and saturated water content (saturated weight less dry weight). It is apparent from the results that porosity reduces with depth.
Specific Storage	Specific storage is a measure of the volume of water released from a portion of the aquifer in response to a change in pressure in the system.	Specific storage values have been estimated for each lithology type from laboratory testing of core samples that were undertaken for geotechnical investigations completed in 2012 (AMC, 2012).

Table 4.39 (Cont'd)
Existing Groundwater Setting

Page 3 of 3

Existing Environment Component	Influence on the Groundwater Setting	Summary / Comments
Groundwater levels and flow	Monitoring records of groundwater levels provide an indication of the depth of groundwater in the various aquifers and the variation (seasonal or climate trend influenced) over time.	The outcomes of groundwater level monitoring are considered below.
Groundwater quality	Monitoring of groundwater quality in the vicinity of the Mine Site provides an indication of natural influences on water quality in the setting and provide an indication of how mining processes may influence the groundwater setting and availability of water to other users including ecological systems.	The outcomes of groundwater quality monitoring are considered below.
Source: Jacobs (2020) – Modified after Section 4		

Groundwater levels within the alluvial aquifers have historically shown a close correlation to cumulative rainfall deviation but this correlation is less evident in bores located in hard rock aquifers. A series of paired groundwater bores within the monitoring network (one deep and one shallow) have been used to demonstrate the presence of perched water that may be cut-off from the regional groundwater system. Jacobs (2020) identified the potential for downward or upward flow of groundwater between the shallower alluvial aquifer and the deeper groundwater, and in some paired locations the shallow and deeper aquifers appeared to be highly connected.

Groundwater level monitoring results inform estimates of regional groundwater contours which in turn indicate groundwater flow direction, as presented in **Figure 4.6.1**. It is inferred from monitoring results that groundwater levels generally correlate with the local topography with groundwater flow from areas of higher elevation to areas of lower elevation. As a result, groundwater flow directions appear to be variable except in the vicinity of the TSF and main open cut pit where a general south-easterly flow direction is indicated. The monitoring data indicates that groundwater flow beneath the area of the open cut pits appears to flatten, indicating a highly connected fracture network and proximity to the major fault structures. However, these results may also be influenced by the high density of drill holes in this location.

The monitoring data also indicates that Hawkins Creek is a groundwater sink, therefore the creek and its adjoining alluvial areas are likely to be a point of regional groundwater discharge.

Elevations of the groundwater table in the main open cut pit area range from around 610m AHD in the north to 585m AHD in the south to southeast. Depth below ground level is highly variable and dependent on topography, but typically ranges from approximately 2m below ground level (2mbgl) in the lower reaches of Blackmans Gully to 60mbgl beneath the elevated ridges in the Mine Site. Groundwater elevations beneath the TSF area range from approximately 600m AHD beneath the upper valley areas (10mbgl to 60mbgl) to approximately 560m AHD beneath the lower embankment, which is near ground level in the middle of the Walkers Creek valley.

Groundwater Quality

Comprehensive groundwater quality monitoring has been undertaken from alluvial and hard rock aquifers, springs, and surface water systems within the regional monitoring network on a quarterly basis since January 2014. A comprehensive summary of water quality sampling results for the period between January 2014 and August 2018 is presented in Section 4.5.12 and Annexure 6 of Jacobs (2020).

In summary, the following conclusions have been made regarding existing groundwater quality.

- Electrical Conductivity (EC) – Average regional EC levels (1 820µS/cm) are slightly higher than the average records within the Mine Site (1 420µS/cm). Average EC levels within the alluvium (802µS/cm) and springs (150µS/cm) are indicative of fresher water sources or recharge influence in these locations.
- pH – The majority of measurements fall in the range 6.8 to 7.6, however, pH results for Mine Site monitoring bores show the greatest range, from 5.2 to 8.9, with the alluvial bores showing the lowest range, from 5.6 to 7.1. Median pH values from all groundwater and spring samples were within a similar range, from 6.7 to 7.2. Variations in pH have been recorded for individual bores but this is typically less than 1 pH unit.
- Water Types – Review of records of normalised anion and cation concentrations indicate there is a broad range of water types represented within the monitoring network, with no one sample group displaying distinct characteristics. Sulphate concentrations are dominant in most groundwater samples and may be the result of natural sources such as gypsum within the soil profile or from mineralisation (which is consistent with characterisation assessments for the Project).
- Hydrogeochemical Characterisation – Groundwater chemistry is influenced by physical factors such as whether the aquifer is confined and proximal to recharge/discharge points as well as the formation mineralogy and local climate. The three major influences to groundwater chemistry include:
  - rainfall dominance, resulting in recharge and dilution;
  - rock weathering, resulting in ion exchange of sodium and chloride; and
  - evaporative concentration.

  Diagrammatic representations of each of these influences in the groundwater setting indicate that water quality is heavily influenced by the formation mineralogy and, therefore, ion exchange within the matrix. In some locations water quality is heavily influenced by evaporative pressures. Evaporative pressures intensify mineral concentration. Water quality monitoring at surface water locations indicates that some locations have a strong influence from formation minerology and therefore suggests a groundwater contribution. In some locations, this is complemented by rainfall influence indicating mixing of groundwater and surface water. Indicators of recharge influence from results at local springs suggest that these springs result from interflow through the soil profile rather than groundwater discharge.

The outcomes of groundwater quality monitoring have been compared to relevant guideline values within the ANZ Guidelines, and the Australian Drinking Water Guidelines (ADWG, 2011) (the Drinking Water Guidelines). The following conclusions have been made as a result of this review.

- The large number of exceedances of the ANZ Guidelines within the baseline data indicate that site specific trigger values, reflecting the geological formation influences on groundwater chemistry, should be developed for ongoing monitoring.
- Consistent exceedance of ANZ Guidelines of total nitrogen, total phosphorus, nitrates of nitrogen, and EC indicate a predominantly disturbed local catchment, with the disturbance likely to be anthropogenic.
- The trigger values for the dissolved metals (copper, lithium, nickel and zinc) are consistently exceeded by median concentrations in most groundwater samples, with frequent exceedances of cadmium, lead and manganese.
- Modification of dissolved metal results to account for the hardness of the water (an influence to bio-availability), in accordance with the ANZ Guidelines, reduces the frequency of trigger level exceedances in the baseline data.
- Exceedances of the health-based Drinking Water Guidelines in the baseline data are observed for arsenic, cadmium, lead and manganese.

Groundwater Supply Potential

In addition to mine dewatering (whether via in-pit sump pumping or perimeter dewatering bores), there is potential to access supplementary groundwater supply, if required, via the installation of additional groundwater bores within the Mine Site and surrounding land. Previous investigations have identified that enhanced permeability and useful yields are possible from fractured rock aquifers in the vicinity of the major geological structures. In addition, deeper exploration drilling at the Mine Site and beyond 600m in depth has confirmed large regional structures with significant porosity, that have the potential to accommodate productive aquifers. Jacobs (2020) has identified indications of groundwater potential through review of exploration activities with test pumping at BGW108 and BGW10 demonstrating short-term sustainable pumping yields of approximately 5L/s. These bores are likely to provide water for during the preliminary site establishment and construction activities.

Prospective groundwater supply bores located within the Mine Site may provide an opportunity for advanced mine dewatering (that is, supply of groundwater via groundwater bores consistent with the licenced entitlement held by Bowdens Silver to account for future dewatering requirements). However, advanced mine dewatering can only be relied upon until the open cut pit is developed. Ongoing supplementary water supplies may also be sourced from similar hydrogeological environments within land surrounding the Mine Site or at depth in deeply seated aquifers.

The siting of any prospective water supply bores would be dependent on successful investigation results and would be subject to the appropriate water supply works and water use approvals.

4.6.4 Potential Groundwater Impacts

Potential groundwater impacts may include impacts to water supply bores, streamflow and natural ecosystems that are dependent on groundwater. The *Aquifer Interference Policy 2012* establishes the minimal impact considerations for groundwater sources that have guided consideration of potential impacts. The following potential impacts have been considered for assessment.

- Groundwater level drawdown as a result of inflow to, and dewatering of the open cut pits, thus limiting the availability of groundwater for:
  - licenced groundwater users;
  - baseflow contribution to streamflow; or
  - GDEs and other sensitive environmental receptors.
- Changes to groundwater quality as a result of mining activities such as through extraction, waste rock placement or storage or processing that leads to reduced suitability of groundwater resources for current uses.
- Contamination of the local groundwater setting through seepage from the TSF, WRE or hydrocarbon / reagent spills.
- Discharge of poor-quality groundwater to the surface water or terrestrial environment.
- Post-mining changes to regional groundwater availability and quality.

Cumulative groundwater impacts may result where the impacts of other groundwater users within the model domain is considered to influence the regional system when assessed in conjunction with the Project's impacts. Other mining operations, which have the potential to exert such an influence, lie between 32km and 44km from the Mine Site and therefore it is considered highly unlikely that cumulative groundwater impacts associated with mining at these operations would occur.

4.6.5 Groundwater Modelling Assessment

4.6.5.1 Conceptual Hydrogeological Model

Comprehensive data collected from previous investigations (Section 4.6.2) and for the preparation of this assessment has been used the establish an understanding of the existing groundwater setting (Section 4.6.3) which has been applied in preparation of a conceptual hydrogeological model in the vicinity of the Mine Site. The conceptual model forms the basis for the numerical groundwater flow model. **Figure 4.6.2** presents the conceptual hydrogeological model with indicated changes from the existing, operational and post-mining phases.

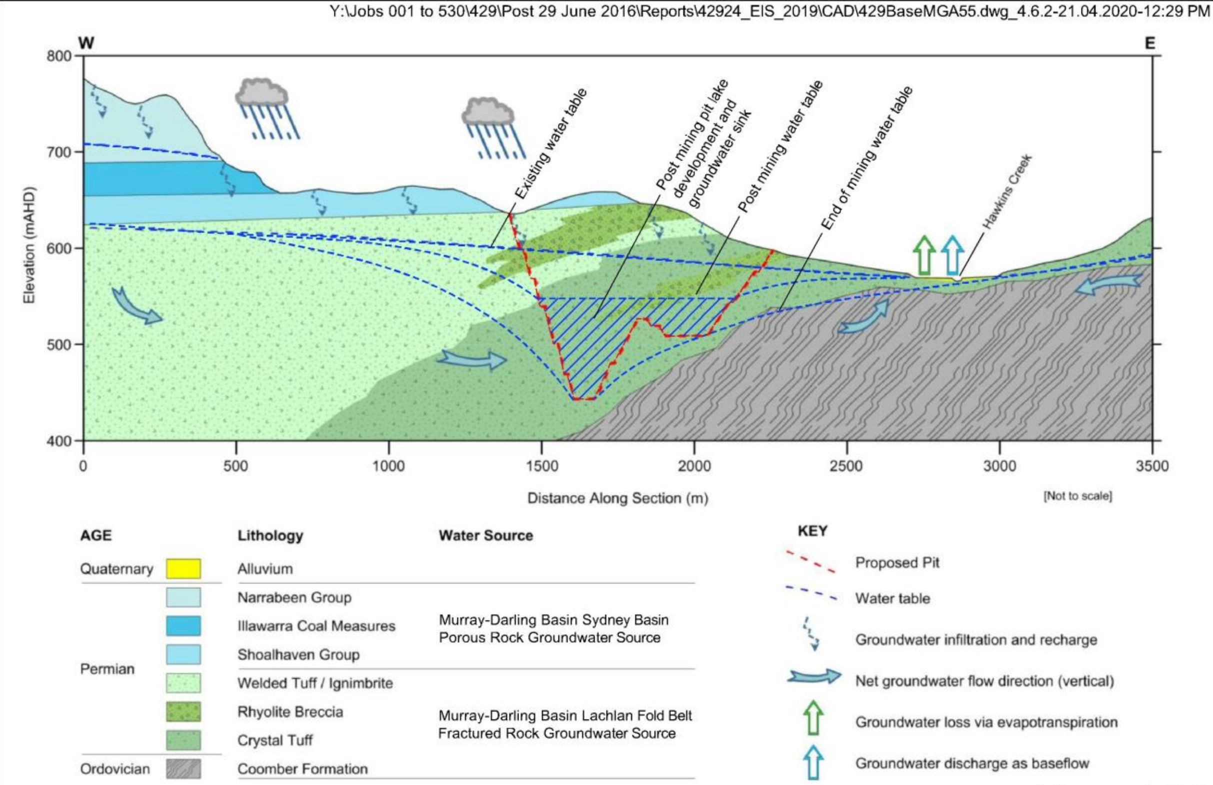


Figure 4.6.2
CONCEPTUAL HYDROGEOLOGICAL MODEL (VIEW LOOKING NORTH)

Source: Jacobs (2020) Figure 39 and Figure 40

In summary, the following key elements of the conceptual hydrogeological model have been inferred and applied for the numerical modelling assessment.

- The conceptual model domain has been established to cover an area that is 12km from the main open cut pit at its closest point and approximately 28km from the main open cut pit at its most distant point.
- The main hydro-stratigraphic units include the following.
  - Alluvium – mostly associated with Hawkins Creek and Lawsons Creek and to an inferred depth of 4m to 6m. This unit has the highest hydraulic conductivity of the units assessed (1m/d to 10m/d).
  - Sydney Basin sediments (Narrabeen Group, Illawarra Coal Measures and Shoalhaven Group) – this unit comprises sandstone sub-units with limited primary porosity and permeability. Groundwater flows in this unit are likely to be dominated by fracture flows. Hydraulic conductivity values range from 0.05m/d to 0.15m/d.
  - Rylstone Volcanics (Rhyolite Breccia, Welded Tuff / Ignimbrite and Crystal Tuff) – contains a high density of fractures and sub-orthogonal fractures. Sub-units display varied hydraulic characteristics but given the predominance of fracture flow, these minor differences are unlikely to cause significant differences in overall behaviour. Hydraulic conductivity values range from 0.01m/d to 0.1m/d.

  - Lachlan Fold Belt / Coomber Formation – the hydrogeological basement of the groundwater setting. Groundwater in this unit is also dominated by fracture flows. Hydraulic conductivity values are estimated to range between 0.001m/d and 1.0m/d and up to 6.5m/d in shallow weathered zones.

- Major geological structures in the groundwater setting limit but do not prevent groundwater flow while also enhancing localised vertical and lateral groundwater flow parallel to the strike.
- Groundwater recharge is dominated by infiltration of rainfall runoff and ephemeral streamflow on outcropping and sub-cropping hard rock lithologies and regolith, and directly onto the alluvium. Major drainage features, such as Hawkins and Lawsons Creeks, are likely to alternate between being zones of groundwater recharge and groundwater discharge, depending on streamflow conditions and topography.
- Groundwater discharge is expected locally from alluvial aquifers in lower lying areas, periodically to drainage features, and via evapotranspiration.
- No high priority GDEs have been identified within the conceptual hydrogeological model domain. Broader assessment of impacts to GDEs is considered in Section 4.6.7.2.
- Key mining infrastructure that would influence the groundwater setting include:
  - progressive development of the open cut pits;
  - progressive development of the WRE; and
  - the TSF.

4.6.5.2 Groundwater Modelling

Jacobs (2020) developed a numerical groundwater model which is a computer-based three-dimensional simulation of the groundwater system that may be used to predict groundwater flow. The modelling provides predictive assessments of potential groundwater inflows and drawdown due to mining activities and mounding of groundwater beneath the TSF. Potential impacts to the groundwater environment, local groundwater users, local surface water systems and GDEs may be assessed by considering groundwater responses to the proposed mining activities within the modelling domain. In accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), the intended model confidence class is Class 2 – Impact Assessment.

The numerical groundwater model was prepared using the United States Geological Survey (USGS) modelling code, MODFLOW (a variant MODFLOW-USG was applied) with the model executed in the saturated flow mode.

The model was developed in eight layers with the upper layer representing the alluvium in valley locations and regolith in the hills and the bottom layer representing the basement metasediments (Coomber Formation). Each layer was assigned zone numbers to assist in correlating with the model geometry. Hydraulic parameters were applied for each zone based on the known groundwater setting and the conceptual hydrogeological model.

The numerical model domain covered a 43.5km east to west by 44km north to south extent. The domain extent was selected to ensure that the model is representative of the setting without constraining regional influence. The model grid was developed comprising cells that range from 31.25m (for higher resolution in the vicinity of the open cut pits) to 250m.

The following boundary conditions were applied to the model to replicate sources of groundwater discharge or recharge that influence groundwater flow patterns.

- Rivers – The River (RIV) boundary condition was used for major watercourses that represent sources of recharge or discharge from groundwater to the surface water system (baseflow).
- Drains – The Drain (DRN) boundary condition was used for minor watercourses within the model domain that respond to seasonal conditions and are another source of recharge or discharge from groundwater to the surface water system.
- Wells – Groundwater works within the model domain were designated pumping wells in the model domain using the MODFLOW Well Package (WEL). These included registered bores with abstraction estimated from licensed entitlements or in the case of basic landholder rights, an abstraction rate of 2ML /year was assumed. Seasonal distribution of works under basic landholder rights (higher use in warmer months and little use in winter) was also applied.
- Recharge – Rainfall recharge to the groundwater model was represented using the Recharge (RCH) boundary condition. For the purposes of the groundwater modelling assessment, the dominant recharge process incorporated into the model was rainfall infiltration. Rainfall data was obtained from the SILO climatic database. Zones of recharge were derived based on land use and topography within the model domain, and included hilltops, foothills, floodplains and lakes.
- Evapotranspiration – Discharge through evapotranspiration within the groundwater model domain was represented using the Evapotranspiration (EVT) boundary condition with evapotranspiration data obtained from the SILO climatic database. Zones for evapotranspiration were also derived from land use and topography within the model domain, and included hilltops, foothills, floodplains and lakes.

Jacobs (2020) conducted steady-state and transient calibration on the model against actual measured groundwater data for groundwater levels and baseflow. A sensitivity analysis was also performed to confirm that the model inputs and assumptions were appropriate and that the model was fit for purpose.

Two predictive scenarios were modelled using the calibrated groundwater model.

- No active mining (null case) – This scenario provides predictions of groundwater flow and baseflow contribution without mining for comparison with the mining case to estimate likely impacts.
- Active mining (mining case) – This scenario provides drawdowns and inflows in the presence of mining operations. This scenario has assumed a period of one-year pre-development, 15.5 years of mine operations and 200 years post mining.

Groundwater inflows due to open cut pit development were obtained directly from the 'mining case' scenario while groundwater drawdown and baseflow reduction was obtained through comparison of the 'mining case' to the setting under the 'null case' scenario over the same period.

Once mining operations are completed, dewatering of the main open cut pit would cease and groundwater levels would slowly rebound. Net influx to the main open cut pit would include groundwater inflows, rainfall, runoff from the main open cut pit catchment and water pumped from the TSF until that facility is fully rehabilitated, while evaporative losses would continue to draw water from the open cut pit lake. The water level in the open cut pit lake would increase until an equilibrium level is reached (inflows equivalent to outflows). The 'mining case' scenario was extended out to 200 years to investigate post-mining recovery.

The groundwater assessment for the Project has benefitted from the long history of data collection and assessment that supported the development of the groundwater model. Jacobs (2020) consider the data is adequate to simulate and assess the potential impacts to the groundwater setting. This confidence in the model is supported by Dr Noel Merrick, who undertook a peer review of the model inputs and development, as well as the outcomes of calibration, sensitivity analysis and the uncertainty analysis on predicted outcomes. Dr Merrick suggested several refinements to the model that have been incorporated (as detailed in the peer review report – see Annexure 10 in Jacobs (2020).

4.6.5.3 Groundwater Modelling Results (Mining)

Mine Dewatering

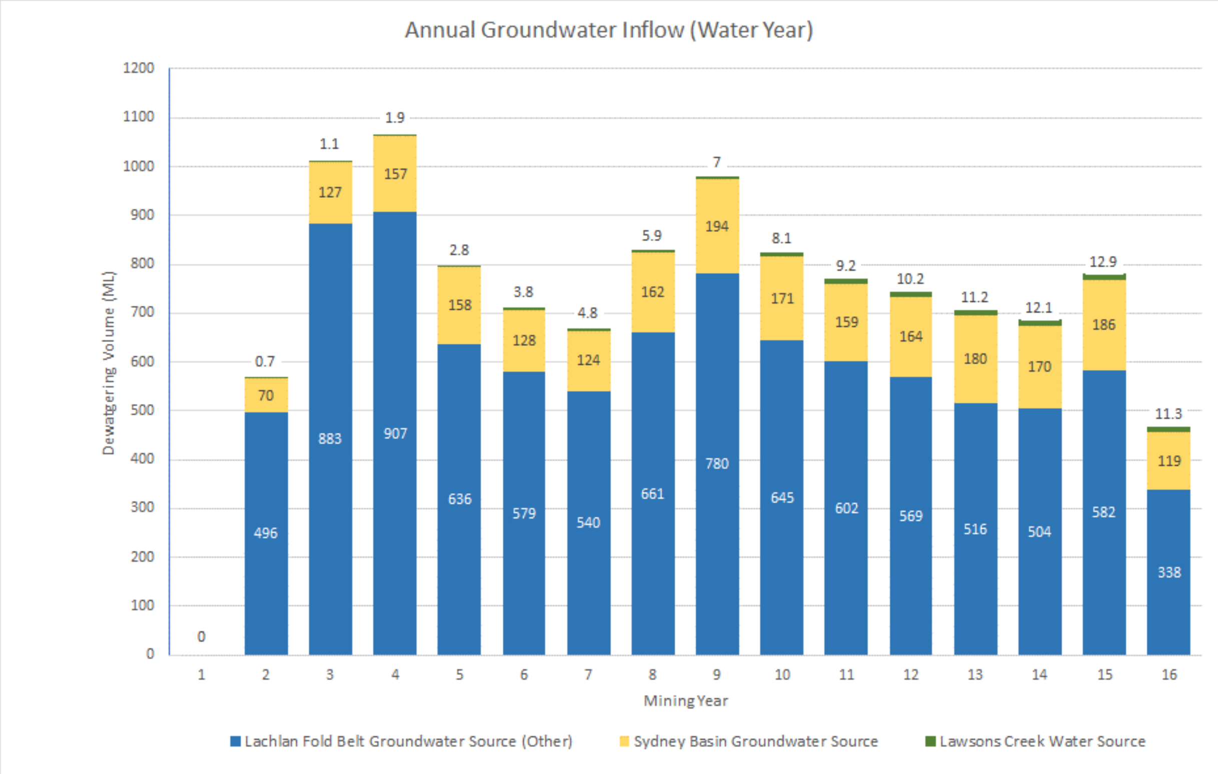
Groundwater inflow to the main open cut pit would occur once it is developed below the regional groundwater table. That water would be temporarily captured in sumps and eventually pumped to the open cut pit dewatering pond within the processing area for use in processing.

Figure 4.6.3 presents the predicted annual groundwater inflow/dewatering rate during mining operations, with predicted take from each groundwater source included for reference. Groundwater inflow would peak in Year 4 (1 066ML/year) consistent with development of the main open cut pit to an intermediate depth of 525m AHD. Inflows during this period would reach a peak of approximately 3.50ML/day. Inflow levels would decrease as extraction activities expand laterally at higher elevations with two more peaks during mining operations i.e. in Year 9 as extraction in the open cut pit is developed to its lowest elevation of 456m AHD; and then in the final year of mining as extraction in the western section of the main open cut pit reaches a floor elevation of 460m AHD.

The average rate of dewatering during the mine life is predicted to be 2.40ML/day although it is estimated that the quantity of water recovered from the sump would be approximately 1.75ML/day as a proportion of the inflowing groundwater would evaporate from the exposed open cut pit faces or accumulate in areas that do not require active dewatering.

Groundwater Drawdown

Inflows of groundwater to the main open cut pit would result in drawdown of groundwater levels in the surrounding regional groundwater system. Predicted drawdown of the regional groundwater system at the completion of mining (15.5 years) is shown in **Figure 4.6.4**.



Source: Jacobs (2020) – Modified after Table 43

Figure 4.6.3
INFLOW/DEWATERING CHART

Jacobs (2020) identified that as mining reaches its maximum depth by Year 9, there would not be a significant change in water levels between this time and end of mining. At the end of mining, propagation of drawdown (as represented by the predicted 1m drawdown contour in **Figure 4.6.4**) would typically be in the order of 1.5km to the east and south, 2km to the west and 2.2km to the north. Drawdown to the northwest would be attenuated due to mounding beneath the TSF, with maximum mounding of the order of 8m.

The extent of drawdown during the mine life would extend beneath Hawkins Creek, with drawdown in the order of 1m to 2m at the end of Year 9 over a 1.9km section of the creek and typically in the order of 2m at the end of mining over a 2.8km section of the creek (**Figure 4.6.4**). The sections of the creek that would be impacted would predominantly be located on land owned by Bowdens Silver.

It is noted that the groundwater modelling is likely over-predicting drawdown in the Sydney Basin lithologies (north of the Mine Site) as the hydraulic connectivity between this unit and the Rylstone Volcanics and Coomber Formation would in reality be limited due to the stratified nature of the sediments. As a result, drawdown in these areas is unlikely to be fully realised as predicted by the model.

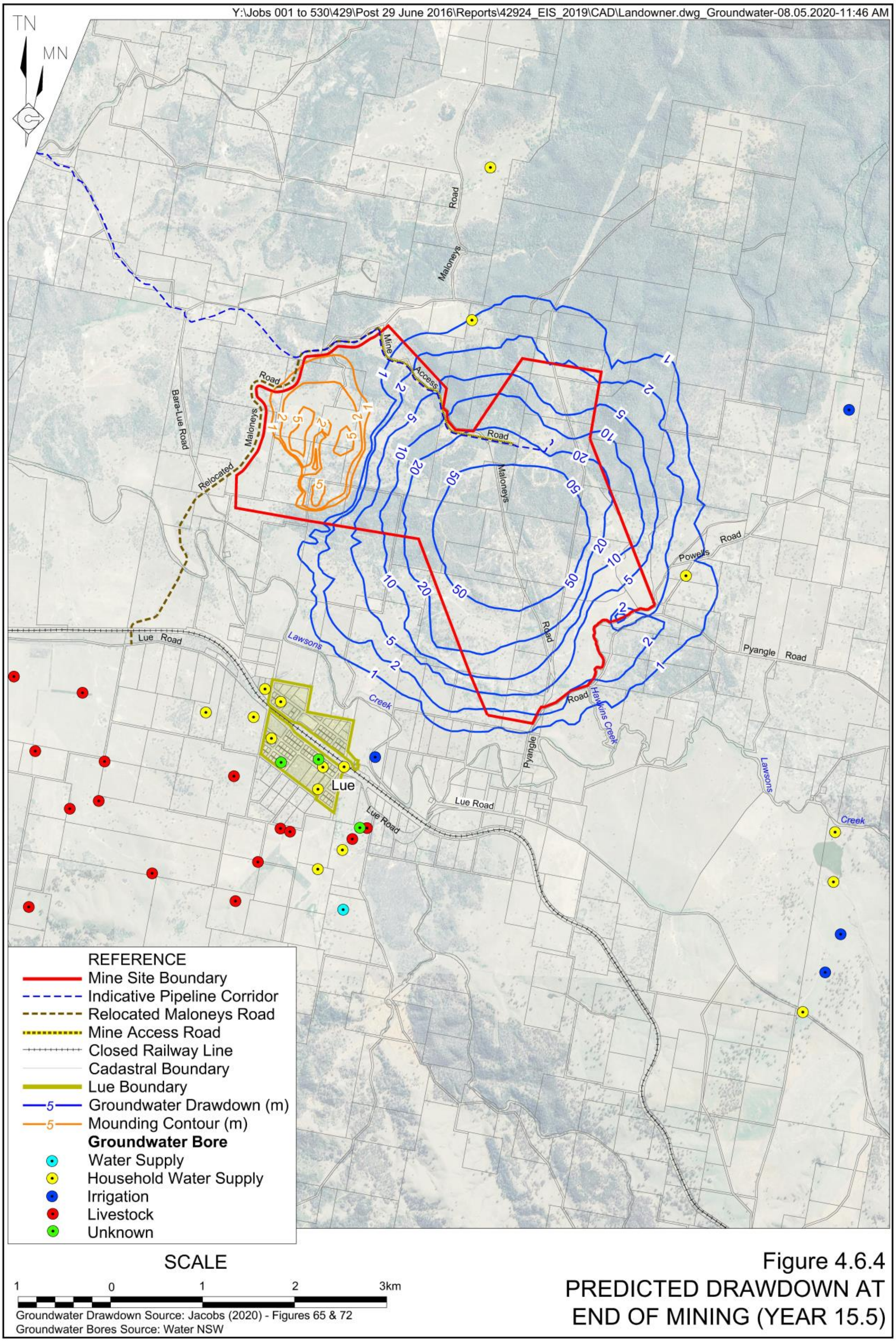


Figure 4.6.4
PREDICTED DRAWDOWN AT END OF MINING (YEAR 15.5)

Tailings Storage Facility

As recharge in the vicinity of the TSF decant pond is predicted to be higher than the surrounding substrate (though still very small), the groundwater model predicts mounding of groundwater in the vicinity of this structure. A conservative maximum rise of 8m has been predicted beneath the TSF impoundment area taking into account the mitigation provided by the low permeability grout curtain that limits down valley migration of seepage. The mounding effect diminishes post-mining as the TSF is capped and any recharge reduces (predicted to occur over 200 years) with the TSF area encompassed by the final cone of drawdown (that is, the floor of the TSF would be above the regional groundwater table).

Waste Rock Emplacement

As the WRE would be fully lined and encapsulated, and would not hold water, it has not been simulated in the model during mining. In the post mining period, the WRE has been modelled as an area of reduced recharge consistent with the design of the structure (that is, designed to maximise runoff and minimise infiltration).

Baseflow Contribution

A reduction to baseflow contribution would occur through direct stream depletion or through intercepting groundwater that would otherwise discharge to surface water. Estimated baseflow reduction in Hawkins Creek and Lawsons Creek was calculated from the change in flux for these features between the ‘mining case’ and ‘null case’ model scenarios.

The modelled baseflow (Null Case) to Hawkins Creek and Lawsons Creek was found to be relatively low with the groundwater contribution to streamflow at Hawkins Creek being less than half that to Lawsons Creek with contributions of approximately 0.072 ML/day to Hawkins Creek and 0.184 ML/day to Lawsons Creek.

During the Project life, the baseflow contributions would decrease as the extent (or cone) of drawdown expands. Reductions in baseflow increase post-mining to a peak approximately 28 to 34 years from the commencement of mining (or approximately 12 to 18 years post mining).

A maximum baseflow reduction of approximately 0.030ML/day is predicted for Hawkins Creek. This prediction principally relates to the total reduction that would be experienced over the area within the propagation of drawdown (the 1m contour on **Figure 4.6.4**) but has been assessed from approximately 6km to the northeast of the Mine Site in the upper catchment of Reedy Creek and Horse Gully tributaries, and the confluence with Lawsons Creek.

Similarly, a maximum baseflow reduction of approximately 0.024ML/day is predicted for Lawsons Creek with baseflow contribution increasing slightly following an initial peak before stabilising. This is the cumulative reduction predicted within the area assessed that includes areas approximately 3.5km southeast of the Mine Site to 4 km west of the Mine Site.

The modelling is conservative with regards to predictions of baseflow as it considers average flows and therefore does not take into account variations due to low or no flow periods. The extent to which this baseflow would impact downstream flow would be dependent on whether the creek was flowing (with flow generally more reliant on rainfall). That is, during periods of no flow the impacts would be localised, while during flow periods the baseflow reduction would impact downstream flow.

4.6.5.4 Groundwater Modelling Results (Post-Mining)

Introduction

For the period related to post-mining operations the 'mining case' model scenario was extended up to 200 years post-mining operations. Jacobs (2020) applied the following parameters to the groundwater model to account for cessation of dewatering and to replicate the progressive increase in water levels (development of the open cut pit lake and eventual equilibrium).

- A high hydraulic conductivity of 1 000m/d to represent a level of conductivity consistent with a void filled with water.
- The specific storage is set to equal $5x10^{-6}$/m to match the compressibility of water. The specific yield in the main open cut pit area was set to 1.
- Mean annual rainfall was assumed to accumulate in the void each year post-mining.
- A maximum evaporation rate of 4.15mm/day (equivalent to the mean daily evaporation from the SILO data) was applied in the main open cut pit lake.
- The recharge rate in the vicinity of the TSF was reduced gradually assuming the TSF would be capped and would drain over time. A very low recharge rate was applied from six years after the end of the mine life.
- A lower recharge rate ($1.15x10^{-7}$m/day) was applied in the vicinity of the WRE to account for encapsulation and lining of this feature and therefore leading to the expected reduction in recharge in this location.

While not considered in post-mining modelling, water that is captured in the TSF following the completion of processing activities would be pumped to the main open cut pit and there also exists potential for runoff captured within Blackmans Gully to be diverted to the main open cut pit to expedite pit void equilibrium and to help mitigate post mining drawdown expansion.

Post-Mining Recovery

Groundwater inflow would continue post-mining as groundwater inflows to the main open cut pit approach equilibrium with the water lost through natural processes (mainly evaporation). After approximately 100 years the open cut pit lake would have reached an equilibrium level with minor fluctuations occurring due to seasonal weather patterns. **Table 4.40** presents the predicted groundwater take post-mining.

Table 4.40
Groundwater Take – Post-Mining

Post Mining Year	Total Water Take (residual inflow) (ML/yr)	Post-Mining Water Take (ML/yr)		
		Lachlan Fold Belt Groundwater Source	Sydney Basin Groundwater Source	Lawsons Creek Water Source
5	626	386	223	17
10	554	330	206	18
15	520	371	131	18
45	240	108	116	16
90	147	69	59	19
200	133	59	52	22

Source: Jacobs (2020) – Modified after Table 44

Post-mining the cone of drawdown in the vicinity of the open cut pit lake would continue to expand for approximately 16 years, with further minor expansion expected to 50 years after active mining has ceased. Drawdown propagation at 50 years post mining is presented in **Figure 4.6.5**. The extent of drawdown (the 1m contour in **Figure 4.6.5**) is typically less than 2km to the east and south, up to 3km to the west and 2.5km to the north with drawdown to the south attenuated by Lawsons Creek.

Residual drawdown 50 years post-mining is considered to be indicative of long-term residual drawdown with the open cut pit lake acting as a groundwater sink. Jacobs (2020) considers that any further variations that may occur at greater than 50 years are insignificant with respect to the inherent uncertainty of the model and time span of predictions.

Drawdown post-mining at Lawsons Creek would typically be less than 1m (along an approximately 1.5km section of the creek) and typically 2m at Hawkins Creek (along an approximately 2.8km section of the creek), although isolated areas of 3m to 4m drawdown may occur (along sections of Hawkins Creek within land owned by Bowdens Silver). As noted above, potential baseflow reductions would peak 12 to 18 years post mining and eventually stabilise.

Final Void

The 'mining case' model scenario was continued through to 200 years post-mining in order to inform the final water balance assessment for the open cut pit lake (prepared by WRM, 2020). It is predicted that the long-term equilibrium water level in the open cut pit lake would fluctuate between 571m AHD and 577m AHD after 100 years, with an average water level of approximately 574m AHD. This is approximately 17m to 27m below the pre-mining water table, and between 20m and 26m below the open cut pit crest spill height of 597m AHD. It is therefore predicted that the open cut pit lake would not discharge post-mining. Further detail on the final void water balance and salinity over time is presented in Section 4.7.5.6.

4.6.5.5 Groundwater Model Uncertainty Analysis

An uncertainty analysis was undertaken to assess the effect of variations to the groundwater model parameters on the predicted outcomes. Uncertainty analysis models were developed for the following parameters.

- High and low hydraulic conductivity scenarios.
- High and low storage parameter scenarios.
- High and low recharge scenarios.

As would be expected, outcomes varied according to the increase or decrease in parameters with the greatest change to groundwater inflows predicted under the high hydraulic conductivity scenario. Jacobs (2020) considers that that higher parameter conditions are extremely unlikely and when modelled did not calibrate well with observed groundwater data.

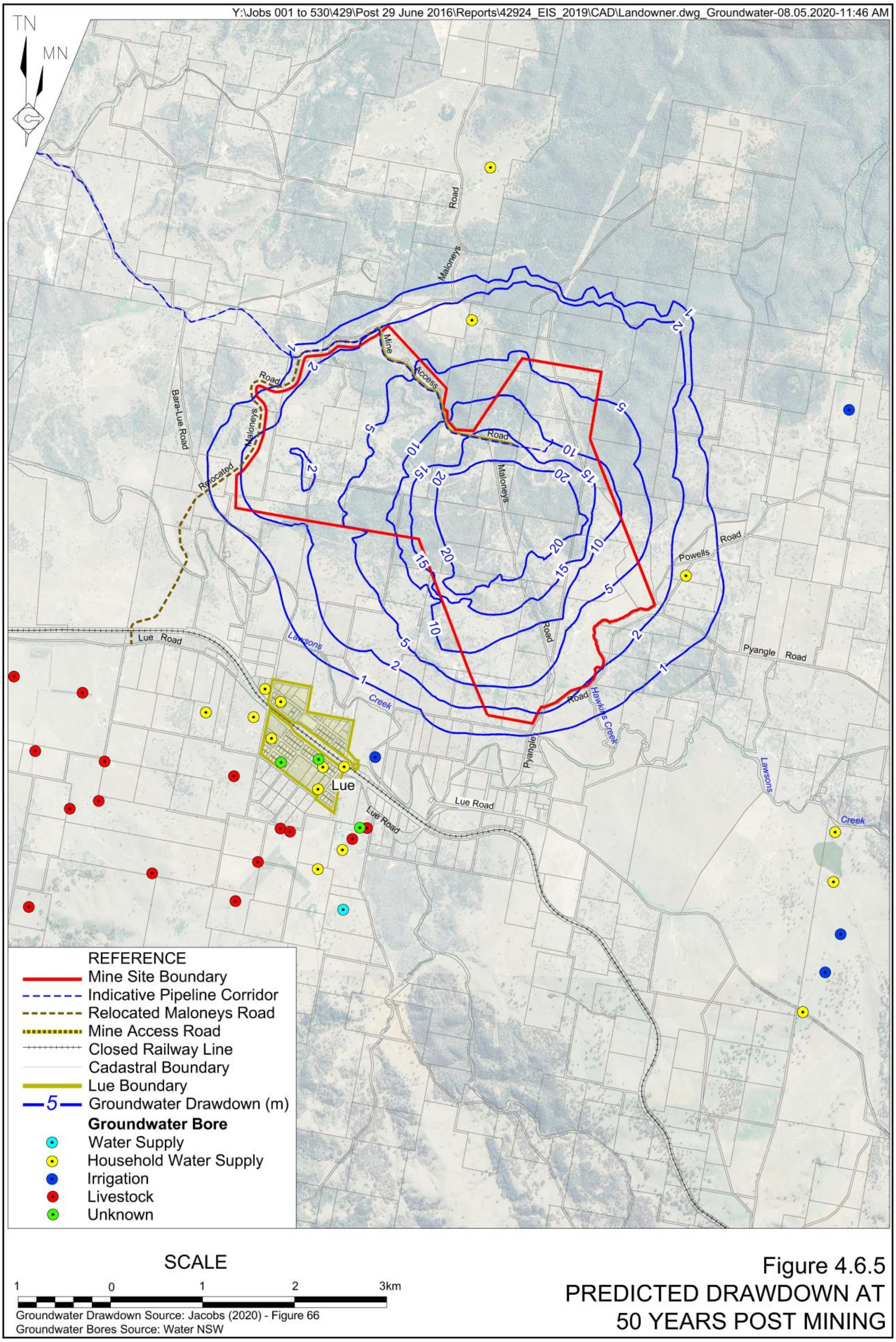


Figure 4.6.5
PREDICTED DRAWDOWN AT 50 YEARS POST MINING

4.6.6 Water Licensing

Bowdens Silver would be required to secure water access licences under the *Water Management Act 2000* (WM Act) from water sources managed under the following Water Sharing Plans and to the estimated volumes below. **Figure 4.6.3** presents the predicted annual groundwater inflows during the mine life with separate contributions from the three identified water sources. The predicted maximum annual groundwater inflow for each water source and therefore the peak requirement from each source during mining would be as follows.

- *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012* - Sydney Basin Murray Darling Basin Groundwater Source – 194ML.
- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011* Lachlan Fold Belt Murray Darling Basin Groundwater Source - (Other) Management Zone – 907ML.
- *Macquarie Bogan Unregulated and Alluvial Water Source 2012* – Lawsons Creek Water Source – 12.9ML.

Options to purchase the following entitlements were secured by Bowdens Silver during the 2018 and 2019 registration of interest periods under the *Controlled Allocation Order (Various Groundwater Sources) 2017*.

- Sydney Basin Murray Darling Basin Groundwater Source – 194 shares.
- Lachlan Fold Belt Murray Darling Basin Groundwater Source - (Other) Management Zone – 907 shares.

Should development consent be granted for the Project, these entitlements would be purchased for the Project. Bowdens Silver is also in the process of finalising an agreement to secure the necessary entitlements to account for groundwater baseflow reduction from the Lawsons Creek Water Source.

Water use under each of the individual Water Sharing Plans is subject to rules regarding the granting, management and trading (dealings) of that water. Each water access licence and the corresponding works approvals also contain formal conditions of use that must be adhered to.

Any water allocations required post-mining would be sought from future controlled order allocations over the Project life. The quantum of post-mining water requirements would be confirmed over the life of the Project through review of the groundwater model against actual inflow records. Jacobs (2020) has estimated that the following maximum entitlements would be required to be held post-mining.

- *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012* - Sydney Basin Murray Darling Basin Groundwater Source – 223ML.
- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011* Lachlan Fold Belt Murray Darling Basin Groundwater Source - (Other) Management Zone – 386ML.

- *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011*– Lawsons Creek Water Source – 22ML.

4.6.7 Assessment of Impacts

4.6.7.1 Groundwater Users

Potential groundwater drawdown may impact groundwater availability for registered users beyond the Mine Site. Drawdown predicted in modelling and presented in **Figure 4.6.4** and **Figure 4.6.5** indicates potential drawdown at 11 registered groundwater works that are recorded as being for water supply (domestic, stock, irrigation, or farming), nine of which are located on properties owned by Bowdens Silver. Potential impacts at the two remaining works include the following.

- GW061475 - Located to the north of the Mine Site on the Dryden property (R17). Records indicate the bore is 15m deep utilising supply from the Illawarra Coal Measures. Drawdown at the end of the mine life is predicted to be 1m, which increases to between 2m to 5m by 50 years post-mining (see **Figure 4.6.5**). Jacobs (2020) notes that if the upper range of drawdown is realised, there is potential for groundwater supply from this bore to be compromised.
- The bore is elevated significantly above the main open cut pit, and within the Sydney Basin sediments. Jacobs (2020) considers the groundwater model to be conservative with respect to predicted drawdowns within the Sydney Basin sediments due the highly stratified nature of the sediments, and it is considered unlikely that that drawdowns as predicted would eventuate in that formation.
- GW802888 - Located to the east of the Mine Site on the Robinson property (R4). Records indicate the bore is 51m deep and is inferred to be utilising supply from the Coomber Formation. Maximum predicted drawdown is of the order of 1m to 2m post-mining. Drawdown of this magnitude is not expected to significantly impact supply from the bore.

As impacts at these two bores are predicted to become evident post-mining (impacts at GW061475 may also be evident at the end of mining), contingency measures including 'make good' provisions would be required for these landowners. Regardless, monitoring of potential impacts at these bores would be an objective of the groundwater monitoring program for the Project. It is noted that the indicative strategy of diverting harvestable rights surface water volumes (from Blackmans Gully) and water captured within the decant pond of the TSF post-processing into the main open cut pit would reduce the extent of drawdown experienced at these registered bores.

4.6.7.2 Groundwater Dependent Ecosystems

There are no high priority GDEs within the area of predicted groundwater drawdown. However, the area of predicted drawdown includes areas mapped as having a high potential for terrestrial GDEs and those associated with baseflow conditions, particularly in the vicinity of Hawkins Creek and Lawsons Creek.

Predicted maximum drawdown beneath Hawkins Creek is typically in the range of 1m to 2m, with some isolated areas of increased drawdown (3m to 4m). Predicted maximum drawdown beneath Lawsons Creek is typically of the order of 1m or less. Predicted drawdown in areas adjacent to Hawkins Creek is not anticipated to impact terrestrial vegetation or riparian areas as this vegetation is predominantly cleared and, where present, would also receive water from rainfall or elevated creek flows and in extreme cases flooding. Due to the current hydrologic regime, the aquatic ecosystems within Hawkins Creek and Lawsons Creek would be accustomed to dry periods in which flows are reduced and with aquatic biota relying upon the pools of water that are a feature of the creeks. During dry periods, drawdown may reduce groundwater baseflow to these pools.

In relation to terrestrial GDEs, EnviroKey (2020) considers that the terrestrial vegetation present within the model domain are not likely to be obligate phreatophytes (i.e. groundwater dependent) and as such no terrestrial GDEs have been identified. Any remnant terrestrial vegetation is more likely to draw on rainfall infiltration that has been stored as soil moisture, or has reached the soil-rock interface. Therefore, the predicted drawdown in the regional groundwater system is unlikely to impact upon groundwater dependent ecosystems.

Jacobs (2020) notes that areas of ephemeral seepage in the vicinity of the Mine Site are maintained by rainfall fed sub-flow and therefore are not groundwater dependent. Springs associated with discharge from bedding planes within the Sydney Basin sediments are also unlikely to be impacted by drawdown.

4.6.7.3 Baseflow Contribution

It is noted that the Surface Water Assessment (WRM, 2020) refers to streamflow in Hawkins Creek and Lawsons Creek as ephemeral to semi-perennial (see Section 4.7.2.4). Low flow conditions are therefore relatively common in these watercourses with peaks in flow occurring in response to high rainfall events with flow slowly dwindling as bank storage is depleted. During low flow periods, streamflow is inconsistent, with the watercourses reducing to a series of disconnected pools.

A maximum reduction in baseflow to Hawkins Creek of 0.030ML/day is predicted over the 3.1km reach of Hawkins Creek located within the area of predicted drawdown. This is compared to an average flow of approximately 1.95ML/day (median flow is 0.09ML/day). In Lawsons Creek, the maximum reduction in baseflow is predicted to be 0.024 ML/day which is considered to be insignificant with respect to average flow (19.5ML/day). However, these predictions do not take into full account the existing setting, which is characterised by consistent flow only being achieved as a response to rainfall. As noted by Jacobs (2020)[9], while the numerical groundwater model achieved good calibration to calculated overall baseflow values, the model over predicts baseflow contributions during ongoing periods of low to no stream flow. Predicted baseflow impacts during periods of low to no flow are, therefore, also considered to be over predicted. For periods of median to high flow, it is concluded that the predicted baseflow reductions are not significant.

[9] See Section 5.3.3.6 and Figure 67 of Jacobs (2020) that refers to base flow model calibration in Hawkins Creek.

During periods of no flow when remnant pools are present and where these pools are a direct reflection of regional groundwater levels, there is potential for pool levels to decline inside the area of predicted drawdown (presented in **Figure 4.6.4** and **Figure 4.6.5**). For remnant pools that are isolated from the regional groundwater system (e.g. impounded by bedrock bars) or which are sustained by smaller perched groundwater systems, pool levels are unlikely to be impacted by mining-related groundwater drawdown. Where permanent pools within the area of predicted drawdown are utilised for water supply, the availability of water in these areas may be compromised. Where this is the case, additional investigations would be undertaken to ascertain their connectivity and reliance on the regional groundwater system and to establish the need for contingency measures.

During periods of flow in these creeks, streamflow would also receive a contribution from discharge of stored water in the banks and floodplain areas upstream and slow-moving interflow that all rely on rainfall and runoff. Therefore, in these instances, the predicted reduction in baseflow is likely to be a minor component of total flow.

4.6.7.4 Groundwater Quality

During mining, any changes to groundwater chemistry (for example, as a result of oxidation of acid forming ore and waste rock and subsequent mobilisation in groundwater inflows) would not impact the regional groundwater system as all water would be removed from the open cut pits for use in processing.

Post- mining, salinisation of the open cut pit lake due to evaporative concentration is expected to occur gradually over time. However, as the open cut pit lake would act as a groundwater sink, the direction of net flow of groundwater would be towards the open cut pit lake, preventing discharge of saline water to the regional groundwater system.

The following impacts of seepage from tailings over time have been considered by Jacobs (2020).

- The aqueous component of the tailings material would be considerably less saline than existing groundwater (850µS/cm as opposed to existing records that vary from 1 350µS/cm to 2 900µS/cm).
- Tailings seepage has potential for low pH and elevated metals concentrations, which would be mitigated by TSF design features that would include seepage interception and groundwater monitoring in the vicinity of the TSF.
- Any impacts would remain localised to areas of groundwater mounding, with predicted drawdown in the vicinity of the TSF eventually lowering the regional water table from the base of the TSF.

Jacobs (2020) concluded that any potential water quality impacts are not expected beyond 40m from the Mine Site boundary.

4.6.7.5 Compliance with the NSW Aquifer Interference Policy 2012

Bowdens Silver’s interception of groundwater beneath the Mine Site would require licensing under the WM Act. The WM Act is the key legislation for the regulation of groundwater-related impacts and water use limits. A summary of the legislation and how it applies to the development and assessment as a whole is presented in Section 3.2.3.3. The *Aquifer Interference Policy 2012* (AIP) is administered under the WM Act and provides the requirements for assessment of aquifer interference activities in NSW. The key components of the AIP are as follows.

- All water use must be accounted for in accordance with the relevant Water Sharing Plan. Water use may include consumptive use (such as pumping from an aquifer) or incidental use (such as evaporative losses from groundwater that has discharged). Licensing is considered in Section 4.6.6.
- The definition and prescription of the concept of ensuring 'no more than minimal harm' through establishing minimal impact considerations relating to water levels, water quality and water pressure. Minimal impact considerations vary depending on the water source and whether the aquifer is considered 'highly productive' or 'less productive'.
- Planning for contingency or mitigating measures in the event that impacts are greater than predicted including monitoring programs. Contingency measures are discussed in Section 4.6.8.4.

The Sydney Basin Groundwater Source of the NSW Murray Darling Basin Porous Rock Groundwater Sources and the Lachlan Fold Belt Groundwater Source of the NSW Murray Darling Fractured Rock Groundwater Sources are both considered to be highly productive aquifers based on the AIP criteria (NSW Office of Water, 2012) of:

- has total dissolved solids of less than 1,500 mg/L; and
- contains water supply works that can yield water at a rate greater than 5 L/s.

Shallow alluvial deposits (4m to 6m) in the vicinity of Hawkins Creek and Lawsons Creek have variable levels of saturation and would not be classified as highly productive aquifers on the basis of the AIP criteria above. Notwithstanding this, thicker saturated sequences of alluvium have potential to be highly productive and the alluvial deposits have been considered as such for the purposes of assessments in accordance with the AIP.

The Level 1 Minimal Impact Considerations of the AIP are presented in **Table 4.41**. Annexure 1 of Jacobs (2020) provides a comprehensive assessment of the Project against the AIP and concludes that the Project would meet the Level 1 Minimal Impact Considerations for highly productive alluvial, porous rock and fractured rock aquifers.

4.6.8 Management and Mitigation Measures

4.6.8.1 Introduction

All operations within the Mine Site would be managed in accordance with a Water Management Plan that would be prepared prior to the commencement of mining in consultation with DPIE and NRAR. The following section provides a summary of management, mitigation and contingency measures that would be expanded in the groundwater management component of the broader Water Management Plan.

Table 4.41
Level 1 Minimum Impact Considerations – Highly Productive Groundwater Sources

Page 1 of 3

	Consideration	Comment
Water Source: Alluvial Aquifer		
Water Table	1. Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40 metres from any: (a) high priority GDE; or (b) high priority culturally significant site, listed in the schedule of the relevant water sharing plan, or A maximum of a 2m water table decline cumulatively at any water supply work.	No significant drawdown is predicted at alluvial water supply works that are not owned by Bowdens Silver.
Water Pressure	A cumulative pressure head decline of not more than 40% of the post-water sharing plan pressure head above the base of the water source to a maximum of a 2m decline, at any water supply work.	Not applicable as the alluvial aquifer is very shallow.
Water Quality	Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. No mining activity to be below the natural ground surface within 200m laterally from the top of high bank or 100m vertically beneath (or the three-dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a reliable water supply. Not more than 10% cumulatively of the three-dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200m laterally from the top of high bank and 100m vertically beneath a highly connected surface water source that is defined as a reliable water supply.	Acceptable outcomes are predicted for all considerations.

Table 4.41 (Cont'd)
Level 1 Minimum Impact Considerations – Highly Productive Groundwater Sources

Page 2 of 3

	Consideration	Comment
Water Source: Porous Rock Water Sources		
Water Table	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any (a) high priority GDE; or (b) high priority culturally significant site, listed in the schedule of the relevant water sharing plan. A maximum of a 2m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority GDE; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies (including the hydrogeology, ecological condition and cultural function) would be required to demonstrate to the Minister's satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or culturally significant site. If more than 2m decline cumulatively at any water supply work then make good provisions should apply.	Acceptable outcomes are predicted for all considerations It is noted that in excess of 2m decline is predicted at registered bore GW061475, however, given the elevation of the water supply work and its installation within the Illawarra Coal Measures, predicted impacts are considered to be conservative and unlikely to occur. Notwithstanding this, in the event that water supply is compromised and attributed to drawdown associated with the Project, make good provisions would apply (see Section 4.6.8.4).
Water Pressure	1. A cumulative pressure head decline of not more than a 2m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1. above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.	Acceptable outcomes are predicted for all considerations
Water Quality	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 2. If condition 1 is not met then appropriate studies would be required to demonstrate to the Minister's satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.	Acceptable outcomes are predicted for all considerations

Table 4.41 (Cont'd)
Level 1 Minimum Impact Considerations – Highly Productive Groundwater Sources

Page 3 of 3

	Consideration	Comment
Water Source: Fractured Rock Water Sources		
Water Table	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority GDE; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan. A maximum of a 2m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority GDE; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies would be required to demonstrate to the Minister's satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2m decline cumulatively at any water supply work then make good provisions should apply.	Acceptable outcomes are predicted for all considerations. It is noted that a decline in the order of 1m to 2m is predicted at GW802888. Given this bore is recorded as being 51m deep, a drawdown of this magnitude is not expected to impact on supply from the bore. Notwithstanding, in the event that water supply is compromised and attributed to drawdown associated with the Project, make good provisions would apply (see Section 4.6.8.4).
Water Pressure	1. A cumulative pressure head decline of not more than a 2m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1.(a) above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.	Acceptable outcomes are predicted for all considerations
Water Quality	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 2. If condition 1 is not met then appropriate studies would be required to demonstrate to the Minister's satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.	Acceptable outcomes are predicted for all considerations. Given baseline groundwater conditions, seepage from the TSF is not expected to lower the beneficial use of the aquifer. Any potential water quality impacts are not expected beyond 40m from the Mine Site boundary. The post-mining void would remain a groundwater sink. Salinification within the open cut pit lake due to evaporative concentration would be retained within the void.

4.6.8.2 Management Measures

The principal proactive management measure for groundwater resources would be a comprehensive groundwater monitoring program. The matters that would be recorded, the frequency of records and reporting are presented in **Table 4.42**.

Table 4.42
Groundwater Monitoring

Parameter	**Monitoring Frequency**	**Reporting**
Mine Dewatering Volumes Including flow meter records and hours for all water pumped from the open cut pits to the open cut pit dewatering pond	When pumping	Annually
Groundwater Level Monitoring A representative groundwater monitoring network would be established and would provide information on groundwater levels during mining operations and post-mining. Collected data would be added to the existing data for assessment of trends in groundwater levels (in order to identify unexpected impacts) and comparison of experienced changes to the groundwater system with modelling predictions.	Monthly with some bores equipped with high-frequency loggers for continuous data collection	Annually
Groundwater Quality Monitoring Groundwater quality monitoring would occur within the groundwater monitoring bore network. The details of the analytes and frequency of monitoring would be set out in the Water Management Plan, although initially it is proposed to monitor the following. • pH and electrical conductivity. • Major ions. • Dissolved metals • Nutrients	Quarterly	Annually

Groundwater monitoring bores would also be established downgradient of the TSF and WRE to monitor for any seepage migration. These would complement the proposed seepage detection and interception measures described in **Appendix 5** (Section A5.7.7). Additional monitoring bores would also be established between the TSF/WRE and sensitive receptors such as Hawkins Creek and Lawsons Creek as well as those bores for which groundwater drawdown is predicted to exceed the minimal impact considerations of the AIP.

Trigger levels and thresholds for further investigation would be established based on a detailed review of the historic baseline data. As noted in Section 4.6.3.2, the prevalence of natural exceedances of the ANZ Guidelines within the baseline data would indicate that site-specific trigger values are required to reflect the existing groundwater setting and to accurately identify any changes due to mining. Relevant groundwater level and chemistry trigger values would be documented in the Water Management Plan prepared prior to the commencement of mining. Any observed exceedance of those trigger values would be investigated, and a formal response developed in accordance with the Water Management Plan.

Annual assessments would be carried out to identify monitoring data trends that may indicate the need for more intensive monitoring, review of assessment outcomes or additional mitigation measures.

The groundwater monitoring program would continue beyond the end of the mine life and would be progressively curtailed to retain measurements from the bores providing relevant results relating to the re-establishment of the groundwater levels in the vicinity of the main open cut pit.

4.6.8.3 Mitigation Measures

Operational mitigation measures would involve the containment of potential groundwater contaminants present within operational areas such as the following.

- Diesel Fuel – Diesel would be stored in self-bunded above-ground tanks as described in Section 2.11.4.
- Chemicals/Hazardous Materials – As described in Section 2.7.3, a range of potentially hazardous materials would be stored at the Mine Site in accordance with a chemicals management system.
- Sewage – As described in Section 2.14.5, a pump-out sewage management system would be implemented and maintained by a licenced contractor.
- Brine – All brine generated by the proposed on-site reverse osmosis plant would be re-used in processing.

4.6.8.4 Contingency Measures

Contingency measures would be developed for the two private bores for which a potential for reduced groundwater level and subsequently groundwater availability is predicted. This would be important for those locations where impacts may only become apparent post-mining. The need for contingency measures at other locations would be assessed in the event the monitoring data determines that either groundwater inflows or groundwater chemistry deviate substantially from the conservative modelled predictions.

The predicted reduction to baseflow contribution along short sections of Hawkins Creek and Lawsons Creek would only be experienced as a reduction to the water level in remnant pools during persistent low flow periods. The availability of water within these pools[10] may be compromised during these periods. Where water sources exist along the sections of the creeks that are predicted to experience drawdown, contingency measures would be established to ensure that water is available to existing water users.

4.6.8.5 Final Void Management

As discussed in the Surface Water Assessment (WRM, 2020), it is planned that all rainfall runoff would be diverted away from the main open cut pit following the cessation of mining. It is noted that all water retained at the cessation of processing and which is captured in the TSF until it is fully rehabilitated would be pumped to the main open cut pit. It may be practical upon mine closure to divert surface water runoff into the main open cut pit via the re-instated

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[10] It is a requirement of Clause 53(2) of the *Macquarie Bogan Unregulated and Alluvial Sources Water Sharing Plan* that water cannot be taken from pools when there is no visible flow.

Blackmans Gully and accelerate water table recovery with diversion established once an equilibrium water level has been reached. The extent of diversion of surface water into the main open cut pit would need to match the prevailing licensing and harvestable right dam capacity at that time. The validity of this approach would be considered as closure approaches.

Prior to the cessation of mining activities, Bowdens Silver would prepare a Final Void Management Plan as part of the overall Mine Site Closure Plan that would detail the intended management of the final mine void over time. This plan would be informed by monitoring data collected during mining and review and recalibration of the groundwater model over time.

4.6.8.6 Groundwater Model Review

Within two years of extraction activities intercepting the groundwater table (indicatively by Year 4), Bowdens Silver would undertake a comprehensive review of the data collected and recalibrate the groundwater model against actual outcomes for groundwater inflow. Any necessary adjustments to groundwater management would be made as a result of this review.

4.6.9 Conclusion

Jacobs (2020) is confident that the existing groundwater setting is well understood and has developed a numerical groundwater model that reflects the existing groundwater setting. This data has permitted both steady-state and transient calibration. The result is the model that has been used to predict changes to groundwater flow as a result of the Project, principally through open cut mining. The data and development of the model has been subject to peer review by Dr Noel Merrick, who has recommended refinements to the model that have been incorporated.

Based on modelling predictions, the key residual impacts to the groundwater system as a result of the Project include the following.

- During the mine life, groundwater inflow rates are predicted at an average of 2.4ML/day, with a peak of 3.5ML/day and peak annual inflow of 1 066ML/year predicted in Year 4 of mining.
- Post-mining, the extent of drawdown would expand to an approximate maximum extent over 16 years, with further minor variations expected for 50 years. Post-mining inflows would progressively decrease over time as an equilibrium is reached in the open cut pit lake. Inflows of 133ML/year would be expected 200 years after mining has ceased due principally to evaporation from the surface of the open cut pit lake.
- In the final landform, the main open cut pit lake would act as a groundwater sink that would draw groundwater to the lake (as a result of evaporative pressure). As a result, salinisation of the water would intensify over time, however, would remain within the lake. Surface water would be diverted away from the open cut pit lake in the final landform with a final water level approximately 20m to 26m below any potential point of potential discharge.

- A potential decrease in water level of greater than 2m at two registered groundwater bores may occur. However, closer examination of these locations indicates that this level of impact is unlikely.
- There would not be any impacts to high priority GDEs. The terrestrial vegetation present in the vicinity of the predicted extent of drawdown is not likely to be obligate phreatophytes (i.e. groundwater dependent), and where it does draw on groundwater it is most likely rainfall infiltration that has seeped into the capillary zone, has reached the soil-rock interface, or is stored in perched aquifers. It is considered unlikely that terrestrial vegetation would be impacted by predicted drawdown within the regional groundwater table.
- Baseflow reductions at Hawkins Creek and Lawsons Creek would occur along relatively short sections of these creeks and would be most noticeable to water users in periods of drought when it would be experienced as a reduction in water levels in remnant pools.
- Potential changes to groundwater quality would be carefully monitored and managed throughout mining operations and in the final landform, including in the vicinity of the TSF, however, it is predicted that there would be no water quality impacts beyond 40m from the Mine Site boundary.

Water take through groundwater inflows and subsequent dewatering and reduced baseflow contribution to Hawkins Creek and Lawsons Creek would be accounted for in water licensing for the Project, including post-mining inflows to the main open cut pit lake.

Regular monitoring of water levels and water quality in the network of on-site monitoring bores and selected off-site private bores during the Project life would provide valuable real-time data to assess the amount and degree of any impacts and enable comparison against groundwater model predictions.

Based on the outcomes of the groundwater modelling and assessment, it is considered that potential impacts to the groundwater setting are well understood and would be subject to comprehensive monitoring and management. Potential impacts to groundwater availability at two registered bores would be subject to compensatory measures, should they be required. Remaining risks and potential impacts would be managed through implementation of a Water Management Plan for the Project.

Post-mining management of the final void would be established as mining closure approaches so that data collected over the mine life may be used to inform management.

The peer review of the Groundwater Assessment (HydroSimulations, 2019) concluded that the approach to modelling, degree of model complexity and modelling effort undertaken by Jacobs (2020) was appropriate. HydroSimulations (2019) agreed that there was very low risk of impact to private bores. Overall, the groundwater model was considered fit for purpose with regards to estimates of water take and prediction of the reduction in regional groundwater levels.

4.7 SURFACE WATER

The assessment of surface water within and surrounding the Mine Site was undertaken by WRM Water & Environment Pty Ltd. The full assessment is presented in Volume 2 Part 6 of the Specialist Consultant Studies Compendium and is referenced throughout this document as WRM (2020). A peer review of the surface water assessment was undertaken by Mr Tony Marszalek of Hydro Engineering & Consulting Pty Ltd. A copy of the peer review is included as Annexure C in WRM (2020).

The issues relating to surface water management within and surrounding the Mine Site are presented within Section 4.7.1 to 4.7.6. The assessment of surface water issues within the water supply pipeline corridor was undertaken by R.W. Corkery & Co. Pty Limited and is presented in Section 4.7.7.

4.7.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in surface water impacts. These risk sources and the assessed risk of impacts <u>after</u> the adoption of standard mitigation measures are as follows.

- Reduction in flows downstream of Mine Site as a result of construction of mine components within natural catchments (Medium).
- Damage to infrastructure and impacts on watercourse and aquatic ecosystem function arising from the partial or full failure of tailings storage facility (Medium).
- Impacts on aquatic ecosystem function as a result of the release of sediment-laden water to downstream watercourses (Medium).
- Rapid release of sediment-laden water into Hawkins and Lawsons Creek catchments as a result of the partial or full failure of a sediment dam (Low).
- Adverse impacts on aquatic ecosystem function and limitations upon use by current water users as a result of the release of contaminated water to downstream watercourses (Low).
- Loss of floodplain storage leading to flood impacts upon local infrastructure and privately-owned land and residences as a result of the construction of mine components within watercourse floodplains (Low).

In addition, the SEARs issued by the former DPE identified "surface water" as a key issue requiring assessment. The principal assessment requirements identified by the DPE relating to surface water include the following.

- An assessment of the likely impacts on the quality and quantity of the region's surface water resources, including:
  - Lawsons Creek and Price Creek;
  - impacts on watercourses, riparian land, water-related infrastructure and other water users including:
    - a detailed site water balance, including a sensitivity analysis;

- assessment of the reliability of the water supply; and
- management of excess water.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the EPA, DPI-Water and NRAR. These key requirements are summarised as follows.

- Geomorphic and hydrological assessment of watercourses.
- Details of new dams/storages and infrastructure that would interact with surface water.
- Assessment of discharges to surface waters.
- Management and mitigation measures for watercourses within and in the vicinity of the Mine Site.
- Management of stormwater and sizing of all dams.
- Contingency measures in extreme rainfall events.
- Identification of flood-prone land and existing/future flood behaviour.

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or *Specialist Consultant Studies Compendium*.

Emphasis is placed in this section upon the surface water impacts and their management within and in the vicinity of the Mine Site, given it is this area that would experience the greatest level of disturbance throughout the Project life.

4.7.2 Existing Surface Water Environment

4.7.2.1 Catchment Setting

Regional Setting

The Mine Site is located within the 507 km^2 Lawsons Creek catchment, in the eastern headwaters of the Macquarie River basin. **Figure 4.7.1** displays the catchment of the Macquarie River basin upstream of Burrendong Dam and the location of the Lawsons Creek catchment. Lawsons Creek flows in a northwesterly direction and flows into the Cudgegong River at Putta Bucca, immediately north of Mudgee. The Cudgegong River flows in a northwesterly direction from Mudgee before turning to the southwest near Gulgong and eventually flowing into Burrendong Dam which has a catchment area of approximately 13 900km^2.

Local Setting and Mine Site

Hawkins Creek, a tributary of Lawsons Creek with a catchment area of 61 km^2, flows in a southwesterly direction parallel to, but set back from, the southeastern boundary of the Mine Site. The Mine Site lies wholly within an area covered by the Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources (2012): Lawsons Creek Water Source.

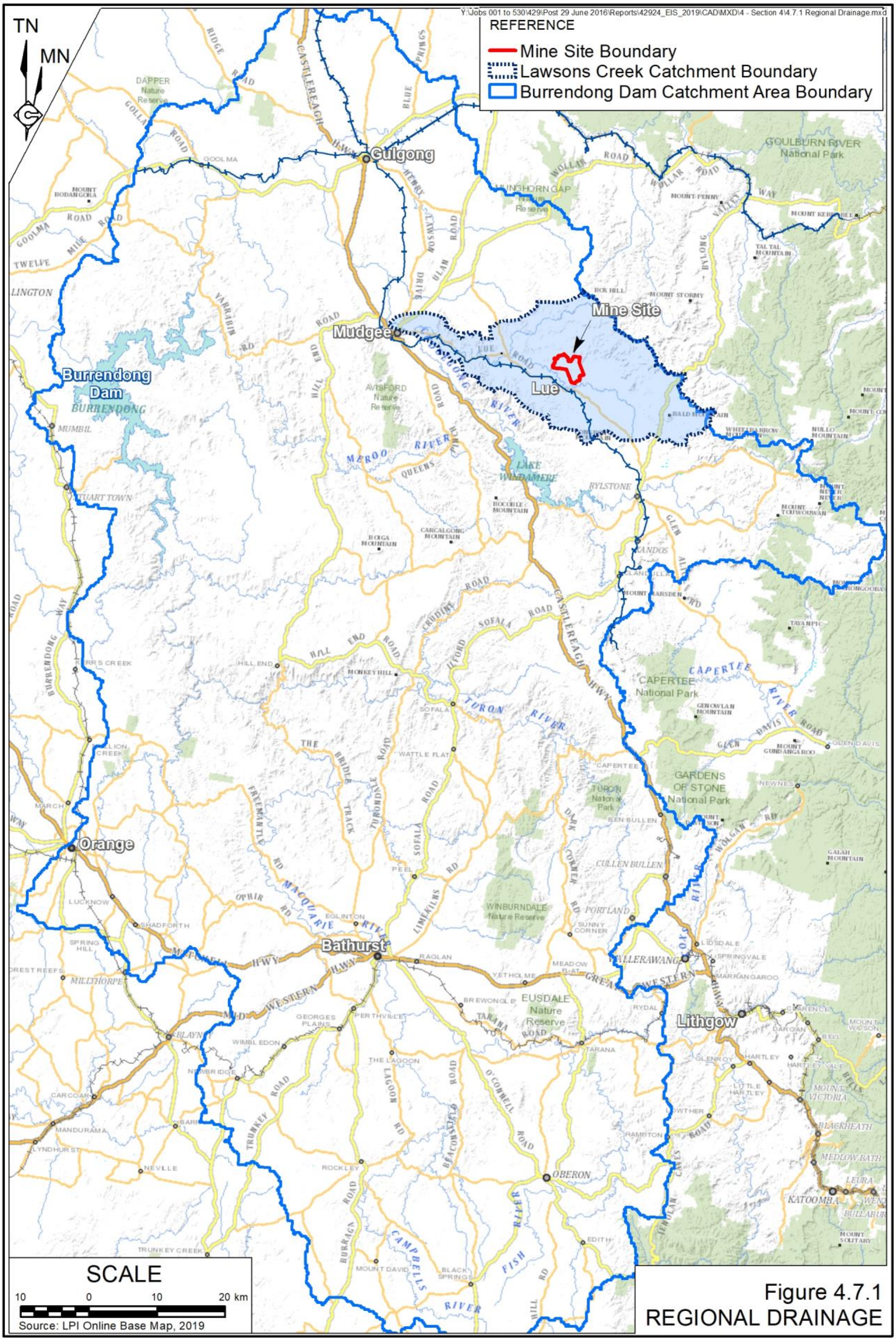


Figure 4.7.1
REGIONAL DRAINAGE

The Mine Site is traversed by the following named tributaries of Hawkins Creek and Lawsons Creek (see **Figure 4.7.2**).

- Price Creek (a south-flowing tributary of Hawkins Creek) with a catchment area of 5.2km^2 with its headwaters draining the sandstone escarpments northeast of the Mine Site. The proposed WRE would be situated on the western side of the Price Creek catchment.
- Blackmans Gully (a south-flowing tributary of Hawkins Creek) with a catchment area of 2.3km^2 and which flows through the centre of the Mine Site. The bulk of the proposed open cut pits and processing plant are located within the Blackmans Gully catchment.
- Walkers Creek (a west-flowing tributary of Lawsons Creek) with a catchment area of 4.9km^2 and comprised of a northern headwater and southern headwater which drain the western side of the Mine Site. The proposed TSF would be located in the upper section of the Walkers Creek catchment.

A number of minor unnamed drainage features also cross the Mine Site. Baseline geomorphological conditions in drainage features crossing the Mine Site were assessed as part of the *Watercourse Assessment for the Bowdens Silver Project* (RWC, 2020a), included as Annexure A in WRM (2020).

Figure 4.7.2 also shows the section of Lawsons Creek catchment in the vicinity of the Mine Site whilst the inset shows the Lawsons Creek catchment in its entirety.

The Lawsons Creek catchment downstream of its confluence with Hawkins Creek covers an area of 284.5km^2 whereas the Lawsons Creek catchment area downstream of its confluence with Walkers Creek is 272km^2.

4.7.2.2 Stream Order

In accordance with Schedule 2 of the *NSW Water Management (General) Regulation 2018*, the stream order classifications for the subject watercourses was undertaken using the Strahler system (Strahler, 1952) utilising the available topographic mapping. **Figure 4.7.3** displays the stream order of the watercourses within and surrounding the Mine Site.

A review of the published Lue and Botobolar 1:25 000 topographic maps[11] covering the Blackmans Gully and Walkers Creek catchments, identified each of these systems as being a third order stream under the Strahler system. However, upon inspection, it was identified that many of the lower order (i.e. first or second) intermittent watercourses, identified on the published topographic maps, were either absent or lacking some or all of those features that would normally be used to characterise a watercourse (Taylor and Stokes, 2005).

The above observations suggest that the watercourses shown on the published 1:25 000 topographic mapping have never been "ground-truthed" or subjected to site investigation to verify the accuracy of the original mapped interpretation.

[11] The watercourses displayed on these topographic maps are consistent with the hydro line spatial dataset published by DPIE Water in accordance with the Water Management (General) Legislation 2018.

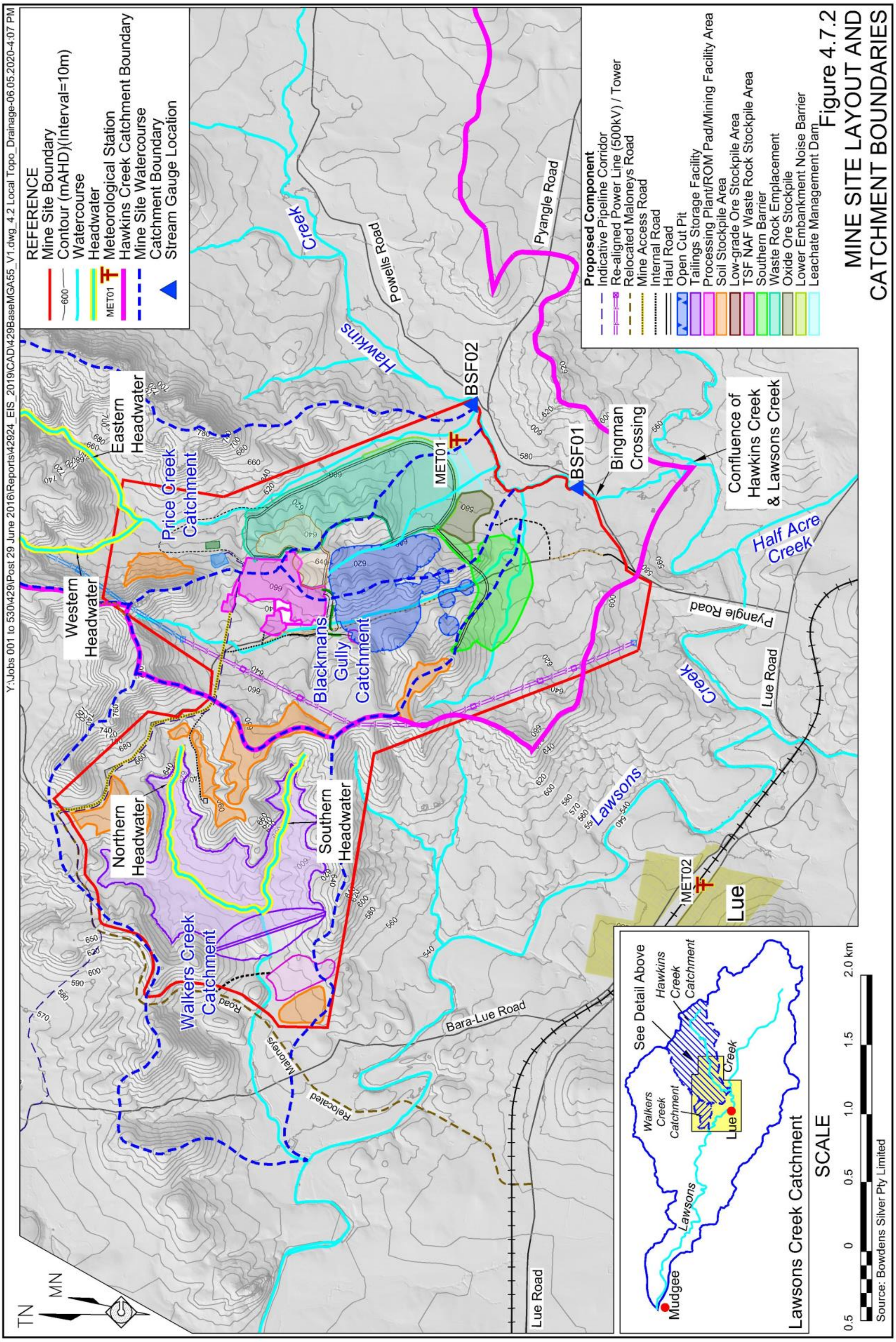


Figure 4.7.2
MINE SITE LAYOUT AND CATCHMENT BOUNDARIES
REFERENCE
Mine Site Boundary
Contour (mAHD)(Interval=10m)
Watercourse
Headwater
Meteorological Station
Hawkins Creek Catchment Boundary
Mine Site Watercourse
Catchment Boundary
Stream Gauge Location
Proposed Component
Indicative Pipeline Corridor
Re-aligned Power Line (500kV) / Tower
Relocated Maloneys Road
Mine Access Road
Internal Road
Haul Road
Open Cut Pit
Tailings Storage Facility
Processing Plant/ROM Pad/Mining Facility Area
Soil Stockpile Area
Low-grade Ore Stockpile Area
TSF NAF Waste Rock Stockpile Area
Southern Barrier
Waste Rock Emplacement
Oxide Ore Stockpile
Lower Embankment Noise Barrier
Leachate Management Dam
Eastern Headwater
Western Headwater
Northern Headwater
Southern Headwater
Price Creek Catchment
Blackmans Gully Catchment
Walkers Creek Catchment
Hawkins Creek
Powells Road
Pyangle Road
BSF02
BSF01
MET01
MET02
Bingman Crossing
Confluence of Hawkins Creek & Lawsons Creek
Half Acre Creek
Lawsons Creek
Lue Road
Lue
Bara-Lue Road
Relocated Maloneys Road
Lawsons Creek Catchment
See Detail Above
Hawkins Creek Catchment
Walkers Creek Catchment
Mudgee
SCALE
0.5 0 0.5 1.0 1.5 2.0 km
Source: Bowdens Silver Pty Limited
TN MN

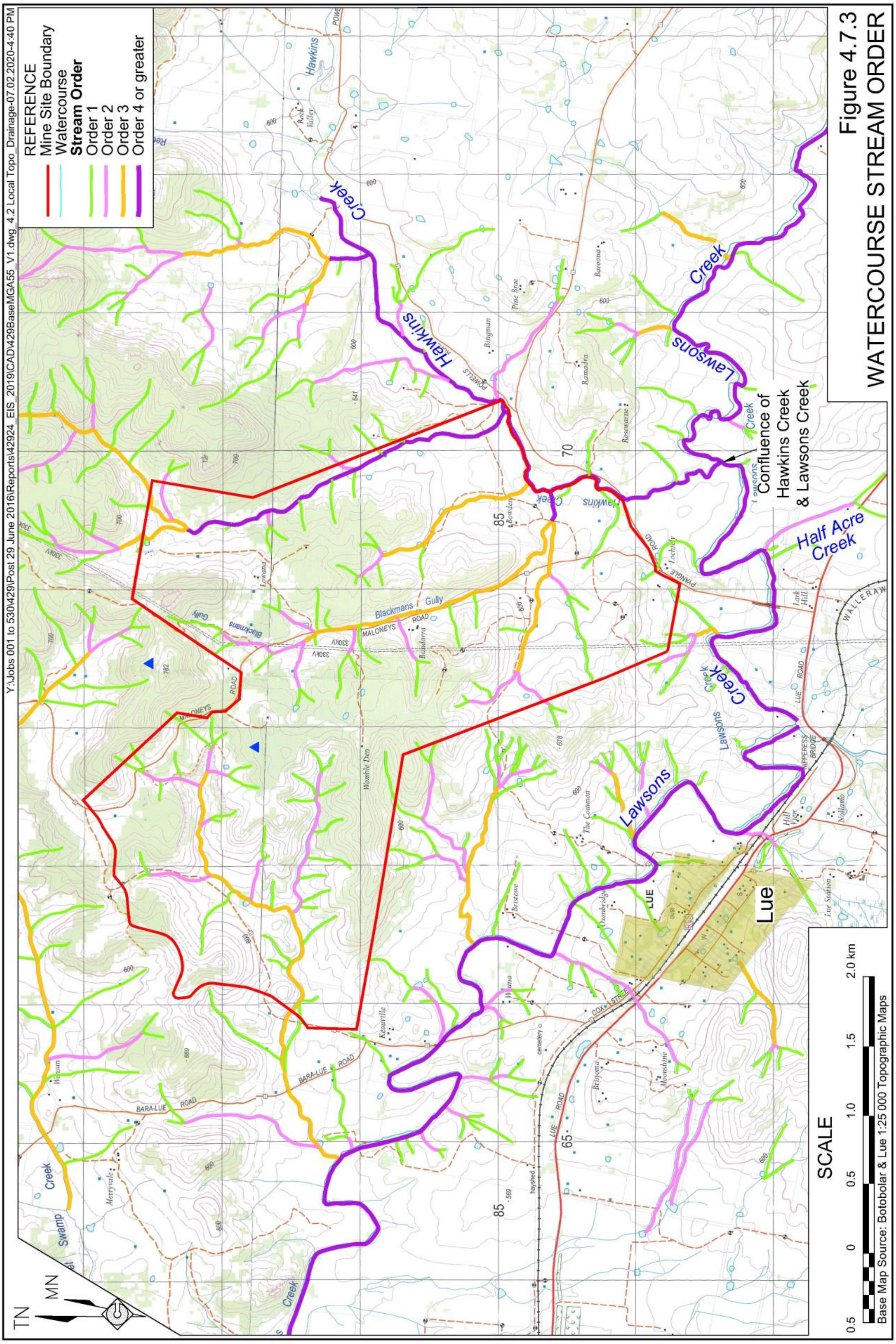


Figure 4.7.3
WATERCOURSE STREAM ORDER

4.7.2.3 Stream Geomorphology

Hawkins Creek and Lawsons Creek have historically experienced a flow regime which triggered channel mobility, as evidenced by the observed presence of reworked alluvial sediments in exposed banks. However, the frequency and magnitude of flow events has diminished over time as a consequence of reduced runoff volumes due to the capture and storage of overland flow in farm dams throughout the Lawsons Creek catchment.

A brief summary of the geomorphology of the watercourses in the vicinity of the Mine Site is as follows with further detail provided in RWC (2020a).

- **Lawsons Creek:** the section near the Mine Site is a meandering watercourse with a discontinuous floodplain in a partly confined valley setting.
- **Hawkins Creek:** a low/moderate sinuosity watercourse in an alluvial valley setting however, the build-up of sediment and reduced flows has resulted in numerous discontinuous waterholes in many locations.
- **Blackmans Gully:** whilst topographic mapping indicates that Blackmans Gully is a third order watercourse, an inspection by RWC (2020a) characterised Blackmans Gully as a first order watercourse in a confined valley setting with occasional floodplain pockets, principally in the lower reaches.
- **Price Creek:** the eastern and western headwaters of Price Creek are topographically controlled, incised flow paths which merge to form a moderate capacity channel. Earthworks, contour banks and shallow drains in the downstream reach of the watercourse have effectively removed the watercourse in this area, with the former channel overprinted by pasture and only visible from aerial imagery.
- **Walkers Creek:** the southern and northern headwaters of Walkers Creek are topographically controlled and collect runoff from erosional drainage features. The southern headwater of the Walkers Creek system is characterised as being a first order watercourse (by inspection) in a confined valley setting with occasional floodplain pockets. The second order northern headwater (by inspection) transitions from a confined valley setting to a partially confined, low sinuosity, planform-controlled system. Below the confluence of the two headwaters, the second order Walkers Creek system (by inspection) transitions again into a low sinuosity, gravel bed watercourse in an alluvial valley setting.

4.7.2.4 Streamflow Characteristics

There are no WaterNSW or Bureau of Meteorology (BoM) streamflow recording stations in the immediate vicinity of the Mine Site. Bowdens Silver records water levels at two continuous recording stations comprised of a v-notch weir mounted on a concrete weir in the channel of Hawkins Creek adjacent to the Mine Site (see **Figure 4.7.2**), as follows.

- Bingmans Crossing (BSF01) (Station No. 421194); and
- Powells Road (BSF02) (Station No. 421195).

Hawkins Creek

Based on the available flow data, WRM (2020) characterised Hawkins Creek streamflow as ephemeral to semi-perennial in the vicinity of the Mine Site. Data collected at the two stream gauges in Hawkins Creek showed considerable variations in flow rates from periods of no flow to peak flows exceeding 1m in height. Flow in Hawkins Creek is likely to be sustained by groundwater baseflow which Jacobs (2020) estimate is approximately 0.072ML/day. The average daily flow in Hawkins Creek over the period of records was approximately 1.95ML/day or 712ML/year. This quantity of water represents only 1.7% of the total rain falling in the catchment. This low percentage is likely to be attributable to the presence of some large farm dams within the catchment upstream from the Mine Site.

Lawsons Creek

The Watercourse Assessment in WRM (2020) records that historically, Lawsons Creek was likely to have been an ephemeral to perennially discharging watercourse. Landskape (2020) records that during research into local Aboriginal history, it was learnt the Wiradjuri clan called Lawsons Creek "Loowee", meaning "a chain of waterholes". Subsequent land use changes and the construction of farm dams and related structures to support agriculture have altered the hydrologic regime such that Lawsons Creek may now be described as an intermittent to ephemeral watercourse.

WRM (2020) simulated streamflow within Lawsons Creek given the absence of actual flow data within the catchment. Based upon calculations undertaken, the average daily flow in Lawsons Creek below its confluence with Hawkins Creek is approximately 19.5 ML/day or 7 136ML/year. Jacobs (2020) calculate that the baseflow groundwater contribution to the annual flow in Lawsons Creek is approximately 0.184ML/day or 67ML/year which represents approximately 1% of the creek's flow. Based on observations in adjacent catchments, runoff within the catchment is estimated to be approximately 4.9% of the total rain falling in the catchment.

WRM (2020) estimated that based on the flow characteristics of the gauged upper reaches of the nearby Cudgegong River, flows in Lawsons Creek downstream from Walkers Creek are currently greater than 1ML/day for approximately 81% of the time.

4.7.2.5 Flooding

A detailed assessment of flooding undertaken by WRM (2020) has established the existing flooding extents in the reaches of Hawkins Creek adjacent to the Mine Site and Lawsons Creek downstream, as well as the main tributaries crossing the Mine Site.

An XP-RAFTS hydrological model was developed for the catchments of Hawkins Creek and Lawsons Creek and their tributaries and calibrated using data from the Bowdens Silver recording stations on Hawkins Creek. Based on the calibrated hydrological model, a two dimensional TUFLOW hydraulic model was then developed to determine the flood behaviour based on existing conditions within and surrounding the Mine Site. The hydraulic model was then used to identify potential flood-related impacts as the result of mine-related infrastructure as well as the relative flood immunity of the Mine Site, in particular the WRE and leachate management dam.

The hydraulic modelling identified the following features in the watercourses within and surrounding the Mine Site.

- The area adjacent to the southeastern Mine Site boundary (on land owned by Bowdens Silver) is affected by flooding from Hawkins Creek.
- Flood behaviour of the tributaries of Hawkins Creek and Lawsons Creek within the Mine Site is characterised by shallow overland flows which are generally confined within the narrow floodplains, with no breakouts occurring except near the confluences of these tributaries with Hawkins Creek and Lawsons Creek.
- Predicted peak flood depths along the overbank areas of the Hawkins Creek and Lawsons Creek tributaries are generally below 1m for events up to and including 0.2% (1 in 500 year) AEP[12]. Peak flood depths of up to 1.5m for the probable maximum precipitation (PMP) design event were predicted in some sections along these tributaries.
- Predicted peak flood velocities in Hawkins Creek for most modelled events were generally less than 3m/s, although peak velocities greater than 4m/s were predicted in some sections.
- Predicted peak flood velocities in Lawsons Creek were relatively high for all modelled events with velocities greater than 4m/s predicted in many sections along the Lawsons Creek channel and floodplain.

Full details of the methodology and mapping of existing flood conditions are provided in the flood impact assessment report in Annexure B of WRM (2020).

4.7.2.6 Water Usage

Due to the prevailing land use in the vicinity of the Mine Site, it is anticipated that many landholders would utilise their basic rights as landholders under the *Water Management Act, 2000* for the collection of overland flow to support agricultural or pastoral production, i.e. in accordance with their harvestable rights. A review of the NSW Water Register identified a total of 1 496 share components have been issued under the Water Sharing Plan for the Macquarie-Bogan Unregulated and Alluvial Water Sources: Lawsons Creek Water Source, 2012 for extraction by water users downstream of the Mine Site.

The 1 496 share components are distributed amongst 47 water access licences (comprising 35 unregulated river licences and 12 domestic and stock licences) with water access licences ranging between one share component to 147 share components. Up to 1 014ML of water is extracted annually from Lawsons Creek by 27 landowners holding water access licences and work approvals downstream from Hawkins Creek principally for irrigation with limited stock watering.

Figure 4.7.4 displays the locations of the properties for which water access licences from the Lawsons Creek Water Source are held downstream from the Mine Site. Almost all of the share components held under these water access licences are used for irrigation.

[12] AEP = Annual Exceedance Probability

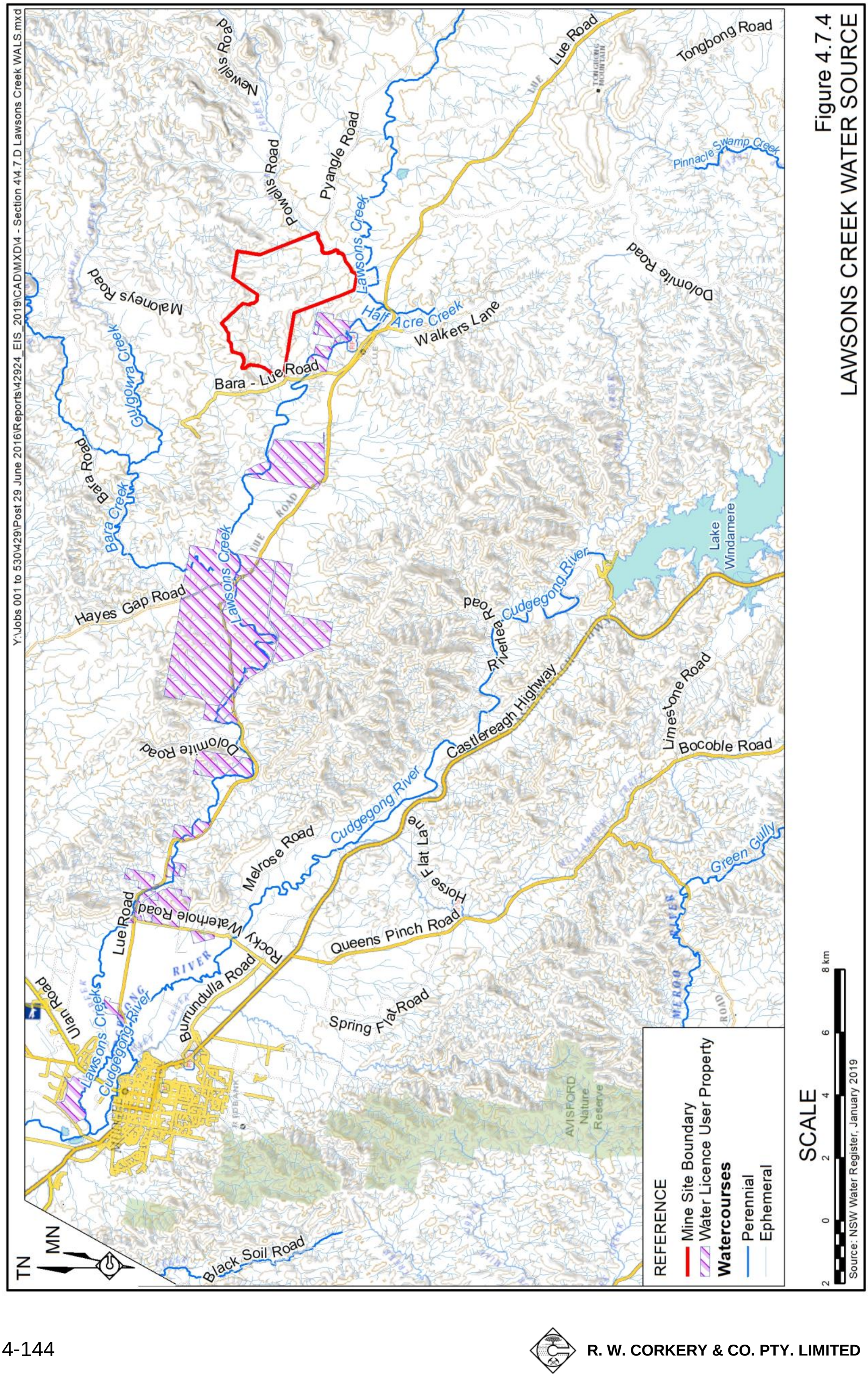


Figure 4.7.4
LAWSONS CREEK WATER SOURCE

4.7.2.7 Water Quality

Monitoring and sampling for surface water quality in Hawkins Creek and Lawsons Creek and their tributaries has been undertaken since 2012 to characterise the upstream, downstream and mid-chainage aquatic environment in the vicinity of the Mine Site. Baseline water quality monitoring has been undertaken at up to 36 locations within and surrounding the Mine Site **Figure 4.7.5** displays the locations of the main surface water monitoring locations along Hawkins Creek and Lawsons Creek with some locations within the Mine Site.

Statistical interpretations of the results of the surface water quality monitoring program, as recommended in ANZG for condition assessment, are presented in **Table 4.43**. With the exception of electrical conductivity, which reports the 75th percentile value, the data on **Table 4.43** is presented as 80th percentiles as ANZG (see ANZG (2018) Section 3.3.2.5) considers this statistic as being the upper bound of the measurable perturbations for the respective locations.

pH levels are near neutral to slightly alkaline within both Hawkins Creek and Lawsons Creek with electrical conductivity levels, an analyte indicative of salinity, varying from 215µS/cm to 1 400µS/cm. The water quality data record elevated nitrogenous and phosphorus compounds at most locations. Median dissolved concentrates of arsenic, cadmium, lead, manganese, nickel and zinc were mostly below the ANZG (2018) trigger levels. Elevated copper concentrations have been recorded at four locations.

4.7.3 Potential Surface Water Impacts

WRM (2020) identified a number of aspects of the Project which could potentially impact on the downstream surface water environment in Hawkins Creek and Lawsons Creek and their tributaries, namely:

Streamflow reduction through:

- interception of runoff by the mine water management system;
- changes in runoff characteristics in areas disturbed by the mining-related activities; and/or
- loss of baseflow recharge to streamflow due to impacts on the local groundwater profile (addressed in Section 4.6).

Water availability through:

- loss of access for existing water users as the result of streamflow reduction; and/or
- Mine Site water requirements placing additional demand on local surface water resources.

Water quality changes through:

- discharge of sediment-laden water to the downstream surface water environment; and/or

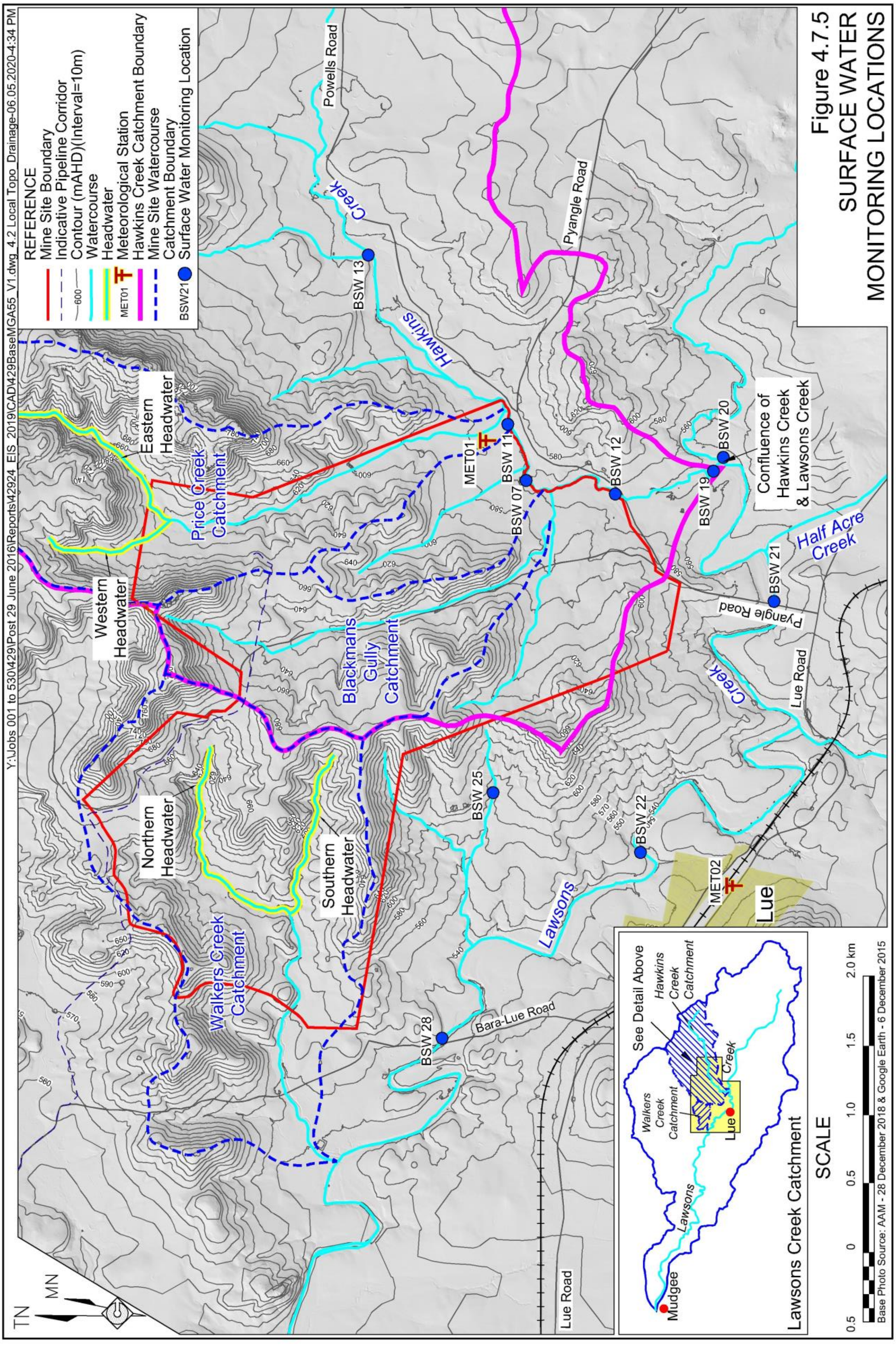


Figure 4.7.5
SURFACE WATER
MONITORING LOCATIONS
REFERENCE
Mine Site Boundary
Indicative Pipeline Corridor
Contour (mAHD)(Interval=10m)
Watercourse
Headwater
Meteorological Station
Hawkins Creek Catchment Boundary
Mine Site Watercourse
Catchment Boundary
Surface Water Monitoring Location
Y:\Jobs 001 to 530\429\Post 29 June 2016\Reports\42924_EIS_2019\CAD\429BaseMGA55_V1.dwg_4.2 Local Topo_Drainage-06.05.2020-4:34 PM
Powells Road
Pyangle Road
Hawkins Creek
Half Acre Creek
Lawsons Creek
Lue Road
Bara-Lue Road
Lue
Confluence of Hawkins Creek & Lawsons Creek
Eastern Headwater
Western Headwater
Northern Headwater
Southern Headwater
Price Creek Catchment
Blackmans Gully Catchment
Walkers Creek Catchment
MET01
MET02
BSW 07
BSW 11
BSW 12
BSW 13
BSW 19
BSW 20
BSW 21
BSW 22
BSW 25
BSW 28
TN
MN
Lawsons Creek Catchment
See Detail Above
Hawkins Creek Catchment
Walkers Creek Catchment
Mudgee
SCALE
0.5 0 0.5 1.0 1.5 2.0 km
Base Photo Source: AAM - 28 December 2018 & Google Earth - 6 December 2015

Table 4.43
Water Quality Summary#: Hawkins Creek and Lawsons Creek

			Monitoring Location BSW*								
			Hawkins Creek					Lawsons Creek			
Analyte	**Unit**	**Trigger**	**13**	**11**	**07**	**12**	**19**	**20**	**21**	**22**	**28**
Physico-chemical											
pH	pH Unit	**6.5-8.0**	**7.3**	**7.45**	**6.9**	**7.4**	**7.2**	**7.9**	**7.6**	**7.8**	**8**
Electrical Conductivity	µS/cm	**30-350**	**702**	**596**	**460**	**489**	**498**	**1120**	**1230**	**948**	**1090**
Total Suspended Solids	mg/L		8.0	13.5	10	5.5	12	16.5	7.5	6	16
Major Ions											
Total Alkalinity as $CaCO_3$	mg/L		75	116	100	90.5	85.5	227	297	248	Below LOR
Sulphate as SO4	mg/L		97.5	46	39	46	43.5	129	117.5	86	Below LOR
Chloride	mg/L		105	66.5	53	53	58.5	149	135.5	94	Below LOR
Calcium	mg/L	**1000**	20	22.5	26	22	19.5	49	65	54	Below LOR
Magnesium	mg/L		20	18	14	17	16	48	44	39	Below LOR
Potassium	mg/L		3	5	4	5	5	5	4	4	Below LOR
Sodium	mg/L		92	65	43	45.5	51	103.5	124	85.5	Below LOR
Dissolved Metals											
Arsenic	mg/L	**0.013**	0.001	0.002	0	0.001	0.0015	0.002	0.002	0.002	0.002
Cadmium	mg/L	**0.0002**	Below LOR	0.0001	0	**0.0002**	Below LOR	0.0001	0.001	0.0001	0.0001
Cobalt	mg/L	**ID**	0.003	0.002	0	0.002	0.004	0.001	0.001	0.001	0.002
Copper	mg/L	**0.0014**	**0.002**	**0.002**	0	0.001	0.001	**0.002**	0.001	**0.002**	**0.002**
Iron	mg/L	**ID**	0.22	0.0025	0.2	0.14	0.365	0.08	0.1	0.09	0.07
Lead	mg/L	**0.0034**	0.0015	**0.007**	Below LOR	Below LOR	Below LOR	**0.003**	Below LOR	Below LOR	0.002
Manganese	mg/L	**1.9**	0.5855	**0.2185**	0.2	0.1465	0.146	0.3285	0.29	0.0105	0.105
Nickel	mg/L	**0.011**	0.006	0.0035	0	0.0015	0.002	0.002	0.007	0.001	0.002
Zinc	mg/L	**0.008**	**0.009**	**0.009**	0	**0.01**	**0.014**	**0.071**	0.007	0.0065	0.007
Nutrients											
Ammonia	mg/L	**0.9**	0.03	0.06	0	0.03	0.025	0.02	0.02	0.02	0.025
Nitrite as N	mg/L	**30**	0.025	0.045	0	0.02	Below LOR	0.015	Below LOR	0.03	Below LOR
Nitrate	mg/L	**0.4**	0.03	**0.045**	0.1	0.03	0.03	0.025	0.03	0.03	0.04
Nitrite + Nitrate as N	mg/L	**430**	0.03	0.06	0.1	0.03	0.03	0.025	0.03	0.03	0.04
Total Kjeldahl Nitrogen (as N)	mg/L		0.5	0.95	0.4	0.4	0.55	0.8	0.5	0.5	0.6
Total Nitrogen	mg/L	**0.25**	**0.6**	**1**	**0.6**	**0.4**	**0.6**	**0.8**	**0.5**	**0.5**	**0.6**
Total Phosphorus	mg/L	**0.02**	**0.04**	**0.07**	0	**0.02**	**0.065**	**0.06**	**0.03**	**0.03**	**0.045**

* See **Figure 4.7.5** — ID = Insufficient Data
\# Median (50th Percentile Values) — LOR = Level of Reporting
Source: RWC (2020a) – summarised from Attachment 2

- the discharge of contaminated water containing dissolved metals such as zinc, lead and manganese, to the downstream surface water environment either via uncontrolled discharge from surface water management infrastructure or seepage to shallow groundwater systems connected to surface water systems.

Flooding within:

- existing watercourses such that adjacent land may experience an increase in the frequency, magnitude, velocity and water levels as a result; and/or
- areas of Project-related components, particularly those related to the management of PAF waste rock or runoff/leachate management.

4.7.4 Management and Mitigation Measures

4.7.4.1 Introduction

A conceptual design of the site water management system was developed by WRM (2020) to manage potential impacts on surface water in the downstream receiving environment within and around the Mine Site. The proposed strategy for the management of surface water within the Mine Site is based on the separation of water from different sources based on anticipated water quality. The water management system zones, the site water types and their associated water management method(s) are as follows.

- Clean Water Zone: This zone would contain clean runoff from areas undisturbed by mining operations and fully rehabilitated areas. This water type would be diverted away from areas disturbed by mining operations and allowed to discharge into the downstream receiving environment.
- Erosion and Sediment Control (ESC) Zone: This zone would contain sediment-laden runoff from areas that are disturbed by mining operations and includes out-of-pit NAF waste rock stockpiles such as the southern barrier and soil stockpiles. This water type would be managed to ensure adequate sediment removal prior to release to receiving waters.
- Containment Zone: This zone would contain mine-affected or contaminated water collected within the Mine Site which would be re-used within the processing plant, negating the need for its release to the receiving environment. This water type would include:
  - water from the open cut pits (i.e. both surface water and groundwater);
  - TSF decant water;
  - runoff from the processing plant area and mining facility;
  - WRE leachate and runoff from uncapped PAF waste rock; and
  - runoff from placed/stockpiled NAF waste rock.

It is noted that runoff from the NAF waste rock is expected to contain concentrations of dissolved metals comparable to or less than those which currently occur in Hawkins and Lawsons Creeks. However, given insufficient data is available to confirm this expectation at this stage, Bowdens Silver proposes that the NAF waste rock runoff would be retained within the containment zone until monitoring results confirm acceptable concentrations of dissolved metals which would allow the water to be discharged to the downstream environment.

The locations of the three water management system zones would vary throughout the mine life. Figures 4.4 to 4.7 in WRM (2020) respectively show the area of each zone during the site establishment and construction stage and during Years 3, 8 and 10. These years coincide with the years assessed for noise and air quality impacts.

In order to fully manage the mine-affected water, Bowdens Silver commissioned studies relating to the conceptual design of the proposed TSF (ATCW, 2020), WRE (Advisian, 2020a) and the required capping and cover system for the rehabilitation of the TSF and WRE (Advisian, 2020b) which consider current best practice design guidance for the proposed mitigation measures to limit risks arising from leachate and seepage.

A summary of the management and mitigation measures proposed for the Project is presented in the following subsections. **Figure 4.7.6** displays the locations of all key dams to be constructed during the Project life. Figure 4.2 in WRM (2020) displays how each of the dams would be integrated into the overall surface water management system.

4.7.4.2 Clean Water Management

A clean water diversion channel upslope of the mine access road is proposed to divert clean water from a 50ha area within the upper catchment of Blackmans Gully into Price Creek from which it would enter Hawkins Creek. This channel would be in place throughout the mine life and would largely follow the natural contours of the hill slopes with a gentle gradient to limit velocity and potential for erosion.

Clean water diversion channels are also proposed to divert Blackmans Gully and its associated tributary catchments away from the main open cut pit both during operations and after mine closure.

4.7.4.3 Sediment-laden Water Management

Sediment-laden runoff from disturbed areas within the Mine Site would be directed to sediment dams. Bowdens Silver's long-term objective is to discharge as much water collected within the sediment dams to the downstream environment to assist in maintaining environmental flows.

The sediment dams would be constructed to contain all water in their respective catchments, by providing sufficient storage capacity to contain a design 1 in 20 AEP 72 hour storm event, and sufficient pump capacity to dewater them to the containment system within 5 days. Ultimately, if the quality of water within the dams is confirmed to be suitable for discharge, the dams would be modified to enable discharge to occur within 5 days of the date of water capture.

A program of water quality monitoring would be undertaken to characterise runoff from all placed/stockpiled NAF waste rock. Discharges would not occur until it was confirmed that runoff water derived from the placed/stockpiled NAF waste rock is suitable for release, i.e. in accordance with the Project's EPL.

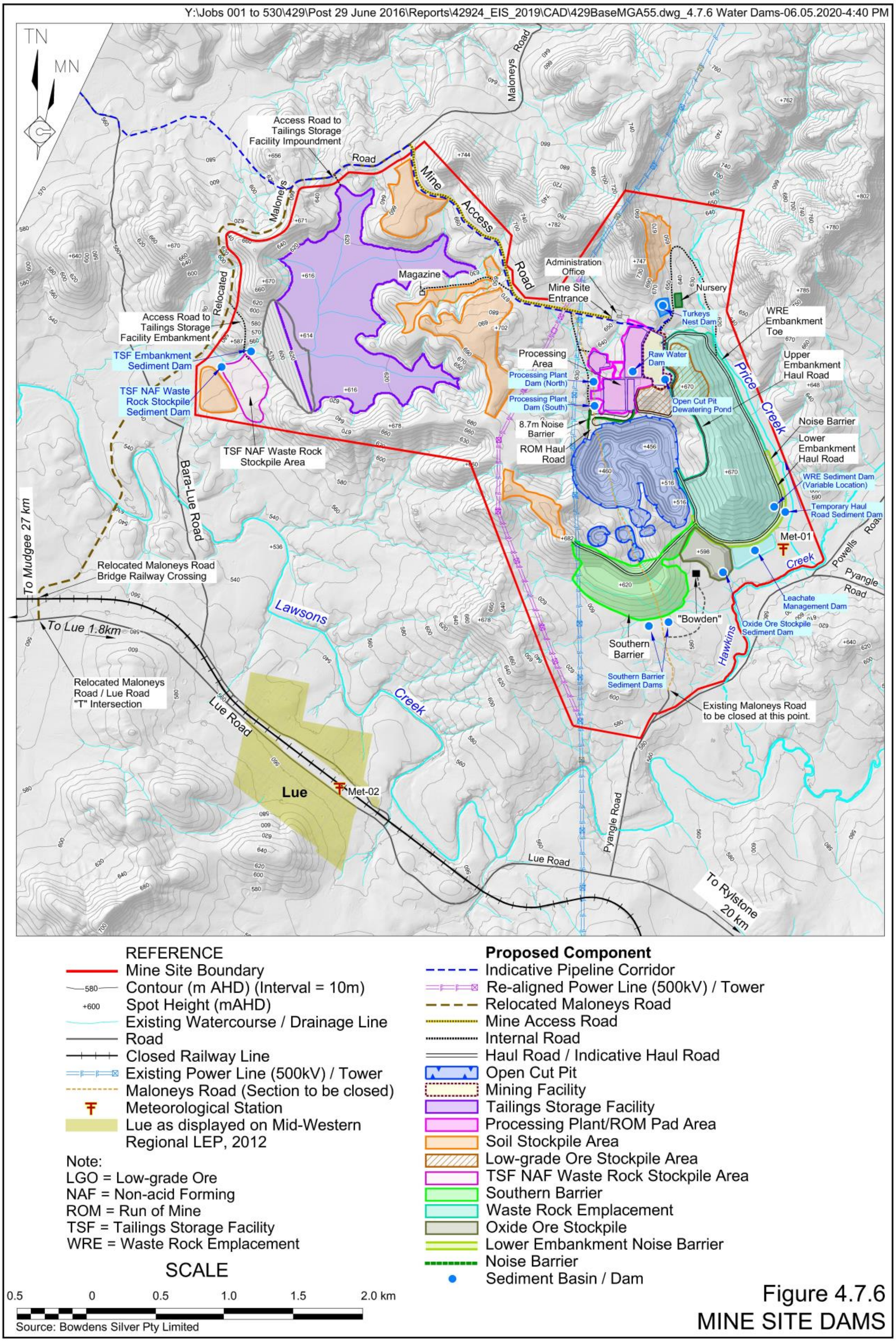


Figure 4.7.6
MINE SITE DAMS

In the event that the concentration of total suspended solids is the only contaminant that exceeds the EPL discharge limits, Bowdens Silver would use an environmentally inert flocculant such as a biopolymer to remove the suspended sediment. Details of the flocculant and its management would be included in the Project's Water Management Plan.

The key sediment dams within the Mine Site (and their approximate capacities) would be located:

- downstream from the TSF embankment:
  - north (4.5 ML (13 ML for containment));
  - south (4.5 ML (13 ML for containment));
- adjacent to the TSF NAF waste rock stockpile area (6.5 ML (19 ML for containment));
- downslope from the southern barrier (two dams):
  - east (13.5 ML (40 ML for containment));
  - west (8.5 ML (25 ML for containment));
- downslope from the oxide ore stockpile (4.5 ML (13 ML for containment));
- within the footprint of the WRE at variable locations (varies – typically 5 ML (15 ML for containment)); and
- adjacent to the lower embankment haul road around the perimeter of the WRE (temporary) (4 ML (12 ML for containment)).

Smaller sediment dams would be constructed, as required, to locally manage sediment-laden runoff adjacent to the mine components.

The outlets from the sediment dams would be rock-protected, and designed to promote the spread of flow, such that in the event water is discharged from the dams, velocities are non-erosive downstream.

It is proposed that if the water collected in the sediment dams could be released to the downstream environment, it would typically be released within 5 days of its capture, i.e. after the settlement of any suspended solids and following confirmation that the water quality is compliant with the limits specified in the environment protection licence for the Project.

4.7.4.4 Mine-affected Water Management

The key components of the Project within the containment zone that would result in the generation of water potentially containing a range of contaminants comprise the open cut pits, processing plant / mining facility, TSF and the WRE. The on-site management of these sources of water is important to avoid any unacceptable off-site impacts.

Open Cut Pits

The quality of the water accumulating within the open cut pits, particularly the main open cut pit, would generally reflect the quality of the combined natural groundwater and surface water inflows to the pits. Details of the groundwater quality are presented in Section 4.6.3.2 while the quality of the surface water likely to flow into the open cut pits would be consistent with the quality recorded to date for runoff within Blackmans Gully. The only other potential contaminated water sources that could be present within the open cut pits throughout the mine life would be direct rainfall that comes into with PAF waste rock or water that is pumped from the leachate management dam for temporary storage. Whilst the likelihood of water being pumped from the leachate management dam to the open cut pits is remote during the mine life, it remains an important component of Bowdens Silver's strategy to avoid any overflow of contaminated water from the leachate management dam into the downstream environment.

Table 4.44 lists the typical water quality data anticipated for both the groundwater and surface water throughout the mine life. The groundwater data is drawn from water quality records from six of the groundwater bores within the footprint of the open cut pits and the surface water data is drawn from four water sample sites within the Mine Site. The chemical composition of the mixed water would depend largely on the extent of rainfall and surface water runoff into the pits and the opportunities for the two water types to mix.

Table 4.44
Typical Quality of Groundwater and Surface Water Inflows to the Main Open Cut Pit

		Groundwater			Surface Water		
Analyte	**Units**	**Median**	**Minimum**	**Maximum**	**Median**	**Minimum**	**Maximum**
pH Value		6.6	5.7	8.7	6.0	4.9	7.0
Electrical Conductivity	µS/cm	1 420	295	2 640	250	63	634
Suspended Solids	mg/L	21	1	70	12	2	30
Sulphate as SO_4	mg/L	340	60	743	50	5	86
Chloride	mg/L	91	10	235	26	8	84
Dissolved Major Cations							
Calcium	mg/L	116	19	251	8	2	22
Magnesium	mg/L	49	8	120	9	1	26
Potassium	mg/L	33	4	57	4	1	17
Sodium	mg/L	71	3	228	21	4	47
Dissolved Metals							
Arsenic	mg/L	0.079	<LOR	1.35	<LOR	<LOR	<LOR
Cadmium	mg/L	0.0002	<LOR	0.0009	<LOR	<LOR	<LOR
Cobalt	mg/L	0.0017	<LOR	0.002	0.001	<LOR	0.002
Copper	mg/L	0.0037	<LOR	0.016	0.002	<LOR	0.004
Iron	mg/L	4.649	<LOR	24.5	0.49	<LOR	1.630
Lead	mg/L	0.013	<LOR	0.05	<LOR	<LOR	<LOR
Manganese	mg/L	9.187	0.003	37.8	0.49	0.017	1.400
Nickel	mg/L	0.009	<LOR	0.14	0.006	<LOR	0.011
Zinc	mg/L	0.122	<LOR	0.725	0.020	<LOR	0.055
Total Nitrogen as N	mg/L	0.556	<LOR	9.00	2.24	0.40	5.10
Total Phosphorus as P	mg/L	0.166	<LOR	0.98	0.023	<LOR	0.05

All surface water and potentially small quantities of groundwater accumulating in the two satellite open cut pits would be managed through pumping the water to the active sump within the main open cut pit which in turn would be pumped to the open cut pit dewatering pond adjacent to the southeastern boundary of the mining facility.

Processing Plant / Mining Facility

The processing plant would be operated with a range of reagents added to the ground ore in the processing plant to assist in concentrating the silver, zinc and lead minerals. **Table 2.4** lists a total of ten reagents that would be added at various stages of the process and their fate.

A range of procedures would be adopted to manage each reagent within the processing plant in such a way that the methods of storage, use and container disposal does not lead to any spillages that could enter the surface water environment. Notwithstanding these procedures, the plant would be constructed with internal bunding to locally manage any reagent spillages to avoid any adverse impacts on water quality.

Runoff from the processing plant area and mining facility would be directed to two dams referred to as the "processing plant dams". These dams, which would have a combined storage capacity of 100ML, would be located to the west of the ROM pad. The design capacity of these dams has been selected to avoid overflows to the open cut pits based upon the results of water balance modelling. Water accumulating in these dams would be pumped to the raw water dam to supplement the water supplied from other on-site sources.

In most cases, the residual concentrations of the reagents after processing would form part of the aqueous component of the tailings that would be pumped to the TSF. For the bulk of the reagents, the residual concentration would remain in the returned decant water that would be recycled from the TSF back to the processing plant. In the case of two reagents, sodium cyanide and methyl isobutyl carbinol, these reagents would progressively decompose such that their concentration in the returned decant water would be much lower. For cyanide, it is proposed that the WAD cyanide concentration in the tailings pumped to the TSF would be approximately 7mg/L whereas it is likely that through its volatilisation, decomposition in sunlight and its aeration, that the cyanide concentration within the decant water returned to the processing plant would most likely be less that 1mg/L, a comparatively small concentration and well below the 10mg/L concentration nominated as a safe level for fauna.

The key management measures to avoid any reagents, including cyanide, entering the downstream environment relate to the design and operation of the TSF (see Section 2.8.2).

The key potential contaminant used within the mining facility (and throughout the Mine Site) would be hydrocarbons. The mitigation measures to manage the storage, use and spill management of hydrocarbons would be as follows.

- All diesel would be stored in self-bunded above ground tanks.
- All fuelling of mobile equipment within the mining facility would be undertaken within a dedicated area with perimeter bunding and spill kits.
- All fuelling of mobile equipment within the open cut pits would be undertaken in accordance with specific procedures to avoid spillages.
- A dedicated bunded storage area within a building and/or containers would be used for the storage of hydrocarbon 205L and 20L drums.
- All waste oil would be collected and stored in a dedicated self-bunded tank with appropriate safeguards for filling and pumping out the tank.
- Any hydrocarbon-contaminated earth would be collected and remediated on site.

- An oil-water separator would be used to manage runoff generated within the workshop / maintenance areas.

Other potential contaminant sources to be managed within the processing plant / mining facility area include the following.

- Chemicals/Hazardous Materials – As described in Section 2.11.7, a range of potentially hazardous materials would be stored within bunded areas or containers at the Mine Site in accordance with a chemicals management system that would be in accordance with current standards and best practice.
- Sewage – As described in Section 2.14.5, a pump-out sewage management system would be implemented and maintained by a licenced contractor.
- Brine – All brine generated by the reverse osmosis plant would be re-used in processing.

Tailings Storage Facility

The management of surface water within the TSF and its immediate surrounds would include as a minimum the following aspects.

- Construction of an appropriate liner, toe drain and seepage collection ponds for the collection of any seepage that flows beneath the TSF embankment. Any seepage collected would be pumped to the decant pond.
- Maximising the recovery of decant water which would be subsequently returned to the processing plant via the return water pipeline for reuse.
- Tailings discharge operations and the staged TSF development would be managed and planned to maintain a sufficient storage volume (design storage allowance) and contingency freeboard (including wave run-up) in the tailings decant pond to retain rainfall runoff in the TSF for all but rainfall events exceeding a 1:100 year, 72-hour durations, throughout the operational life of the TSF in accordance with NSW DSC guidelines.
- The supply of water via the water supply pipeline would temporarily cease when TSF water levels reach within 4.25m of the spillway crest level (4.95m after Year 14). Pumping from the water supply pipeline would resume when water levels fall below 4.25m below the spillway crest levels (4.95m after Year 14).
- Construction of an emergency spillway as part of the initial TSF embankment and all subsequent raises to facilitate discharge of rainfall runoff during rare rainfall events to prevent overtopping of the embankment, thereby lowering the risk of the TSF failure.

When stored tailings volumes approach the design tailings capacity of each stage of the TSF, water levels in the TSF would need to be carefully managed to mitigate the risk of discharge following prolonged wet weather. At the end of the final TSF stage, a potential contingency measure would be the pumping of excess water within the TSF to the main open cut pit. The results of the water balance modelling shows that the TSF could be operated within the design freeboard under all historical climate scenarios.

Following the completion of tailings deposition at the end of the mine life, the TSF would be progressively rehabilitated and materials placed to establish a vegetated store-and-release cover to minimise rainfall infiltrating into the deposited tailings profile. Minimising infiltration would reduce the risk of mobilising potential contaminants and their subsequent transport in seepage from the base of the TSF. Further details of the rehabilitation of the TSF embankment and impoundment area is presented in **Appendix 5** (Section A5.11.7).

Waste Rock Emplacement

The WRE would be the sole repository of the PAF waste rock extracted from the open cut pits, a facility that has been conceptually designed to include a HDPE basal liner and a series of independent cells to assist in managing the leachate that would be generated from the interaction of rainfall upon the emplaced waste rock during the progressive construction of the WRE. The Section 2.5.4 and **Appendix 5** (Section A5.4.4) provide details of the conceptual design of the WRE with the focus placed upon the collection of leachate during project generation and pumping it to the leachate management dam and in turn preferentially pumping the leachate to the raw water pond for use in the processing operations.

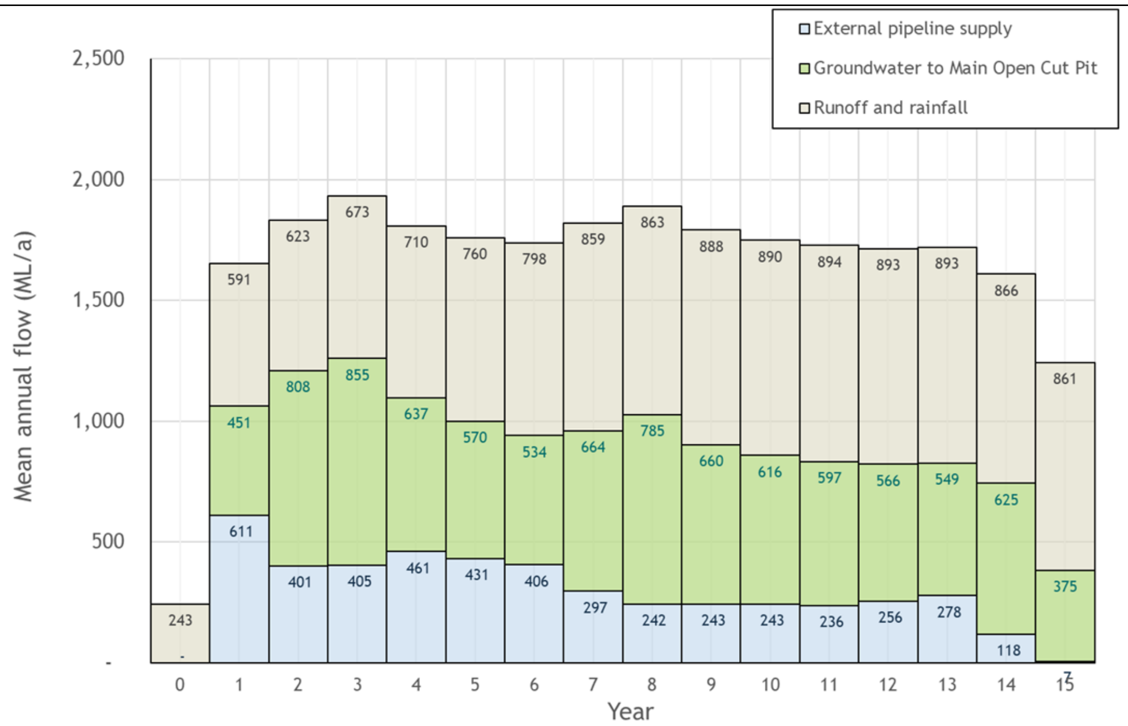
The detailed design of the TSF would proceed in the event development consent is granted for the Project. The design would need to be approved by the NSW Dam Safety Committee and its progress through the construction of the embankment and impoundment carefully monitored. The required factors of safety and regular surveillance and monitoring proposed are intended to avoid partial or full failure of the TSF. That said, once the detailed design is approved, Bowdens Silver would commission a Plan that documents actions and procedures that would be followed in the highly unlikely event a partial or full failure of the TSF occurred.

4.7.4.5 Water Sources and Priority for Use

Section 2.10.1 outlines each of the sources and quantities of water that Bowdens Silver intends to rely upon during the Project life. The sources of water and their priority for use are listed as follows.

1. Surface water collected by the leachate management dam for recycling and reuse in processing operations.
2. Groundwater and surface water accumulating within the open cut pit for recycling and reuse in processing operations.
3. TSF return decant water for recycling and reuse in processing operations.
4. Surface water collected within the sediment dams (but unsuitable for release) or authorised under harvestable rights entitlements for use in dust suppression activities. It remains an expectation of Bowdens Silver that the concentrations of dissolved metals in the water collected in the sediment dams would be sufficiently low for this water to be discharged.
5. External supply of excess water from the Ulan Coal Mine and/or Moolarben Coal Mine. It is noted that in order to satisfy the requirements of the *Water Sharing Plan for the Hunter Unregulated & Alluvial Water Sources 2009* (covering the Ulan Coal Mine), it is a requirement for this water to be first pumped to a storage facility without its own catchment, i.e. a turkeys nest dam. The turkeys nest dam to be used for the Project would have a capacity of approximately 65ML and be located north of the mining facility (see **Figure 4.7.6**).

The contribution of each of the above sources of water would vary throughout the mine life. **Figure 4.7.7** displays the estimated quantities of water from the main open cut pit, on-site rainfall and runoff and the water supply pipeline. Substantial volumes of water would be sourced from the TSF and, to a lesser extent, the leachate management dam, which indicates significant recycling of water resources (reducing Project demand from external sources) and which subsequently limits the potential for discharge from either the TSF or the leachate management dam.



Source: WRM (2020) – Figure 5.3

Figure 4.7.7
AVERAGE ANNUAL MAIN WATER SOURCE INFLOWS

4.7.4.6 Site Water Balance

A site water balance is an important management tool used to predict, through the use of a computer-based operational simulation model:

- the average inflows and outflows of the on-site water management system for a number of representative realisations;
- the quantity of water that would accumulate within the open cut pits, TSF decant pond and leachate management dam;
- the volumes of make-up water required to supplement on-site water demands;
- the risk of uncontrolled released from the surface water storages to the downstream receiving environment.

WRM (2020) provides details of how each of the inflows and outflows have been calculated.

Table 4.45 lists the key simulated inflows and outflows to the on-site water management system together with the annual average volumes relevant to each.

Table 4.45
Average Annual Site Water Balance – Years 1 to 14

Item	Inflow ML/a	Outflow ML/a
Rainfall and runoff	806	
Net groundwater inflows to open cut pit	637	
Imported pipeline water	331	
Ore moisture	83	
Retained tailings moisture		1 151
Evaporation		440
Dust suppression demands supplied		204
Product moisture		22
Dam overflows		0
Annual increase in stored volume		41
Total	**1 857**	**1 857**
Source: WRM (2020) – Table 5.5		

The site water balance covers the period from Months 7 to 18 of the site establishment and construction stage, the 15 years of processing and the initial year of final rehabilitation activities.

The key outcomes from the site water balance are as follows.

1. The Project can be reliably supplied with water throughout the Project life based on historical records.
2. The supply of make-up water would vary depending on the quantity of runoff captured in the water management system, and cease during various periods of wet weather.
3. Overflows from the TSF would be avoided when the water level in the TSF is maintained at greater than 4.6m below the TSF spillway level.
4. Water captured in the containment zone would be able to be contained within the zone without discharge or significant interruption to operations throughout the mine life.

4.7.5 Assessment of Impacts

4.7.5.1 Introduction

The impacts of the Project upon the surface water environments within and downstream of the Mine Site have been established by WRM (2020) through the use of computer modelling and reflecting the planned management and mitigation measures outlined in Section 4.7.4.

4.7.5.2 Downstream Flows

Downstream water flows would be influenced by the interception of runoff within the surface water management system within the Mine Site and through loss of baseflow contributions attributable to the localised lowering of the groundwater table. Details of the runoff interception and baseflow reduction during the operational period and post-mine closure are outlined as follows.

Operational Period

Runoff Interception

The interception of water within the containment zone (under average conditions) within the Mine Site would be a maximum of 177ML/year, i.e. based on the retention of rainfall and runoff within an area of approximately 550ha, i.e. 250ha within the Hawkins Creek catchment and 300ha within the Walkers Creek catchment. This combined area represents approximately 0.25% of the Lawsons Creek catchment downstream of its confluence with Hawkins Creek.

Baseflow Reduction

Jacobs (2020) predict that, as the groundwater table is lowered gradually during the mine life, the baseflow attributable to groundwater in Hawkins and Lawsons Creeks would reduce by up to 0.018ML/day and 0.024ML/day respectively. For the purposes of predicting impacts upon the baseflow in the two creeks (and the groundwater-related amount required for a water access licence), Jacobs (2020) predict a maximum take from the Lawsons Creek Water source of 12.9ML/year.

Combined Runoff Interception and Baseflow Reduction

Based upon the combined runoff interception and baseflow reduction, the Project would result in a total average annual loss of approximately 200 ML/year during the operational period.

During the operational period:

- the flow in Hawkins Creek for a distance of 3.5km from its confluence with Lawsons Creek would decrease by 4.4%;
- the flow in Lawsons Creek between the confluence of Hawkins and Walkers Creeks would decrease by 1.2%; and
- the flow in Lawsons Creek downstream from its confluence with Walkers Creek would decrease by 2.2%.

Post-Mine Closure

Runoff Interception

The rehabilitation of the WRE and TSF would result in the resumption of flow from both of these components into Hawkins Creek and Walkers Creek. Surface runoff would be retained within the 53.1ha area of the main open cut pit which would result in the retention of 17ML/year or approximately 10% of the surface water retained during the Project life.

Baseflow Reduction

Jacobs (2020) predict that the maximum baseflow reduction post-mine closure would be 22ML/year.

Combined Runoff Interception and Baseflow Reduction

Based upon the combined runoff interception and baseflow reduction, the Project would result in a total average annual loss of approximately 38ML/year post-mine closure.

Post-mine closure:

- the flow in Hawkins Creek for a distance of 3.5km from its confluence with Lawsons Creek would decrease by 1.4%.
- the flow in Lawsons Creek between the confluence of Hawkins and Walkers Creeks would decrease by 0.4%; and
- the flow in Lawsons Creek downstream from its confluence with Walkers Creek would decrease by 0.4%.

The relative impact on flows in Lawsons Creek would reduce significantly with increasing distance downstream due to the contribution of other tributaries to total streamflow.

4.7.5.3 Availability of Water to Downstream Surface Water Users

WRM (2020) established from a review of simulated daily flows in Lawsons Creek at its confluence with Walkers Creek that flows are on average greater than 1ML/day for approximately 81.0% of the time. As a result of the predicted reductions in flows attributable to the Project, flows greater than 1ML/day would occur for approximately 80.5% of the time, i.e. a reduction of 0.5% of the time or up to 2 days per year on average.

In light of this prediction, there would be a negligible change in availability of surface water for downstream users adjacent to Lawsons Creek. Similarly, the impact on cease-to-flow periods would be minimal, with flows greater than 0.1 ML/d reducing in frequency from 90.2% to 89.8% of the time during operations, and 89.6% of the time post-mine closure.

4.7.5.4 Downstream Water Quality

The potential for the Project to impact upon downstream water quality would exist through three sources.

1. Runoff containing sediment derived from exposed areas stripping of topsoil/subsoil or from soil stockpile areas. No changes in channel composition of the water is envisaged.
2. Runoff from exposed NAF waste rock stockpiled or used in construction of Project components on the margins of the Mine Site, potentially affecting the chemical composition of downstream water.
3. Release of contaminated water from the containment zone potentially affecting the chemical composition of downstream water with respect to pH levels and soluble metals.

NAF Waste Rock Runoff

The geochemical assessment of the NAF waste rock (GCA, 2020) suggests it would likely be relatively benign. However, based on the testing of leachate from kinetic testing of NAF waste rock samples, there is a possibility that runoff and seepage from NAF would contain small concentrations of dissolved metals. The principal metal likely to be dissolved in runoff from the NAF waste rock would be manganese. Table 4.1 in WRM (2020) summarises the median metal concentration that GCA (2020) established during kinetic testing of NAF waste rock samples. Potential exists for elevated concentrations of these metals to be present in runoff from the areas of the Mine Site where these materials are present and collected in some sediment dams. The median concentration of zinc, cadmium, copper and nickel exceeded the Australian and New Zealand Guideline values.

It is recognised that metal concentrations measured in laboratory-generated column leachates can overestimate concentrations in runoff because column testing tends to lead to the near-complete elution of solutes from the samples. In practice, this would be unlikely in real-world waste rock emplacements. As the median metal concentrations in Table 4.1 in WRM (2020) have been established over a comparatively short period of kinetic testing, there would be benefit in conducting testing upon NAF waste rock extracted from the main open cut pit during the early years of operation to understand the likely longer term dissolved metal concentrations in the NAF waste rock runoff.

During operations, runoff from the TSF outer embankment, TSF NAF waste rock stockpile area, WRE and southern barrier would be captured in sediment dams sized in accordance with Bluebook requirements for Type F basins (DECCW, 2008). However, if the ongoing program of geochemical testing and characterisation of runoff determines that runoff must be contained on site to ensure the water source is not contaminated, sufficient storage capacity would be provided to minimise the likelihood of discharge by returning captured runoff to the Containment Zone. The proposed design storage capacity would be sufficient to contain runoff resulting from the 1 in 20 AEP 72 hour design storm (with a design volumetric runoff coefficient of 0.75) (equivalent to 1.2 ML/ha). In addition, sediment storage equivalent to 50% of the water storage capacity would be provided with each dam. Pumping infrastructure would be provided to enable the water to be transferred into the containment system within 5 days.

All disturbed areas would be rehabilitated and revegetated as soon as practicable to reduce the potential for sediment-laden runoff generation. It is therefore anticipated that after the settlement of suspended sediment in these dams, the water would be suitable for release in accordance with the discharge conditions of the environment protection licence (EPL).

It is noted that manganese concentrations in surface water sampled within and around the Mine Site are elevated, and concentrations of readily mobilised metals in sediment in downstream watercourses are of similar quality to the leachate derived from NAF waste rock (as would be anticipated given the host geology in the contributing catchments).

Sediment-laden Water

Subject to confirmation of water quality, it is proposed to release water accumulating within the sediment dams to contribute to maintaining downstream flows.

A water quality monitoring plan would be implemented during operations to verify that the water quality of the water in the sediment dams is suitable for off-site release in accordance with the limits set in the environment protection licence for the Project, and to continue the current program that monitors receiving water conditions. Its suitability for release would relate to both suspended solid and metal concentrations. In the event the water quality is found to be unsuitable for release during operations, the relevant sediment dam(s) would be dewatered and the water used for use within the Mine Site.

Release of Contaminated Water

The proposed management and mitigation measures (i.e. liners, capping and cover systems) proposed for storing and encapsulating the tailings and PAF waste rock have been designed to limit seepage and managing leachate generated. As a consequence, the contaminated water generated on site would be retained within the Mine Site and not enter the downstream environment and cause any impacts on water quality.

4.7.5.5 Open Cut (Final Void) Pit Lake Behaviour

Based on the proposed open cut pit design, the final void within the main open cut pit would be up to 141m deep, with a floor level of 456m AHD and an overflow level of approximately 597m AHD. The theoretical total potential storage volume to this elevation is approximately 22GL.

WRM (2020) prepared a daily timestep water balance model for the main open cut (final void) pit lake which would form in the main open cut pit. The model used estimates of long-term groundwater inflows derived as part of numerical modelling undertaken to inform the groundwater impact assessment for the Project. Permanent drainage diversions would be provided to minimise the catchment runoff draining to the open cut pit lake. The findings of the analysis established that the open cut pit lake water level would rise to approximately 574m AHD after 125 years varying between 571 and 577m AHD. The maximum modelled water level of 577m AHD would be approximately 20m below the open cut pit lake overflow level of 597m AHD.

Under the modelled climate change scenarios, the equilibrium water level would be lower than the existing climate scenario. Under the climate change scenario closest to the average of all modelled climate scenarios, the equilibrium water level would fluctuate between 566.5m AHD and 572.5m AHD, i.e. lower than the above predicted levels. Over the period of simulation, the average groundwater inflow would be 102ML/year, average direct rainfall 183ML/year, and runoff of 24ML/year on average. These inflows would be balanced by average evaporation of 309ML/year.

On the basis of the analysis, the final void would not overflow to the surface and remain a groundwater sink post-mining.

4.7.5.6 Open Cut (Final Void) Water Quality

The salt balance undertaken for the final void (WRM, 2020) indicates that salts would gradually accumulate within the pit lake due to evaporative concentration. Based on an indicative groundwater inflow electrical conductivity of 1 420µS/cm, the following pit lake salinities are predicted to develop over time.

- 100 years – 2 000 µS/cm
- 200 years – 2 880 µS/cm
- 300 years – 3 725 µS/cm
- 400 years – 4 375 µS/cm
- 500 years – 5 375 µS/cm

4.7.5.7 Flooding

Mine Site

WRM (2020) undertook a detailed flood impact assessment for the Project focussing on flood levels and depths and peak velocities during a range of flooding events.

Figure 4.7.8 displays the peak flood levels and depths along Price Creek and Hawkins Creek during a 1% (1 in 100) AEP flood event.

The key outcomes relating to predicted peak flood levels and depths are as follows.

- The Project disturbance area is located outside of the predicted Lawsons Creek flood extent for all events up to the probable maximum precipitation (PMP) design event.
- The proposed open cut pits, WRE and leachate management dam are located outside of the predicted flood extent for Hawkins Creek for all design events.
- Flooding along the Hawkins Creek and Lawsons Creek tributaries within the Mine Site is characterised by shallow overland flows. Flows in these tributaries are generally confined within narrow flood flow paths, with no breakouts occurring except near the confluences of these tributaries with Hawkins and Lawsons Creeks. Due to the narrow flood flow paths, the difference in predicted flood extents along these tributaries between the 1% AEP (1 in 100) and PMP design events is not significant.
- Predicted peak flood depths along the overbank areas of the Hawkins and Lawsons Creek tributaries are generally below 1m for events up to and including 0.2% (1 in 500) AEP. Peak flood depths of up to 1.5m for the PMP design event are predicted in some sections along these tributaries.

Figure 4.7.9 displays the peak flood velocities along Price Creek and Hawkins Creek during a 1% (1 in 100) AEP flood event. The key outcomes relating to predicted peak velocities are as follows.

- Flows in the Hawkins Creek and Lawsons Creek tributaries are generally confined within narrow flood flow paths with relatively steep ground slopes. This results in relatively high predicted peak flood velocities of up to 2.5m/s along the channel and overbank areas of these tributaries for events up to and including 0.2% (1 in 500) AEP. The proposed eastern side of the WRE would increase flood velocities in localised areas, and mitigation works would be required to manage erosion risks along the lower perimeter embankment of the WRE during operations and after mine closure.
- Existing peak flood velocities in Hawkins Creek for events up to and including 0.2% (1 in 500) AEP are generally less than 3m/s, with peak velocities greater than 4m/s predicted in some sections. The Project would result in some redistribution of tributary inflows to Hawkins Creek, and as a result there would be a minor increase (less than 0.1m/s) in flood velocities immediately adjacent to the Mine Site.

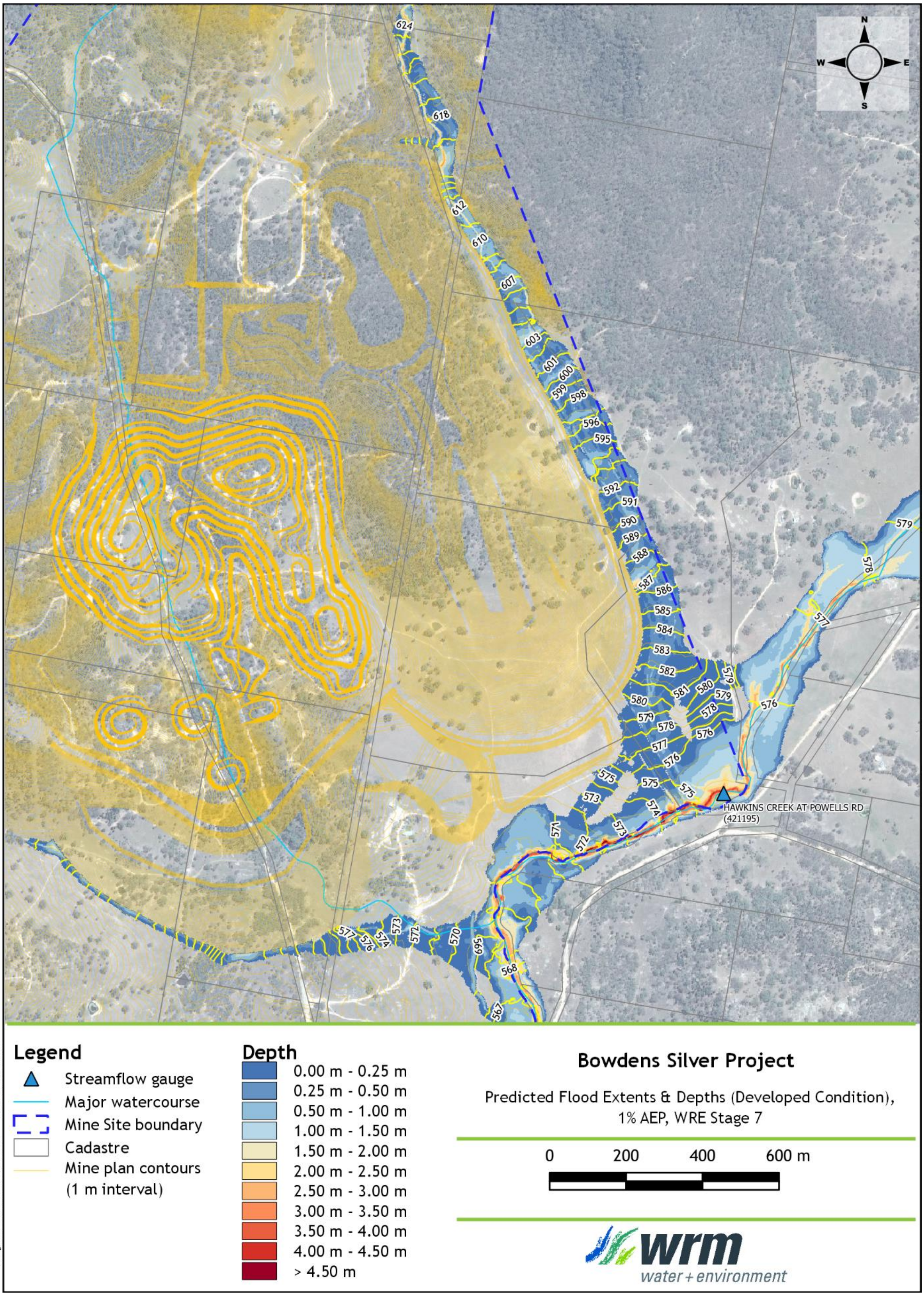


Figure 4.7.8 1% (1 in 100) AEP peak flood levels and depths in the vicinity of the proposed WRE – Maximum Disturbance Scenario

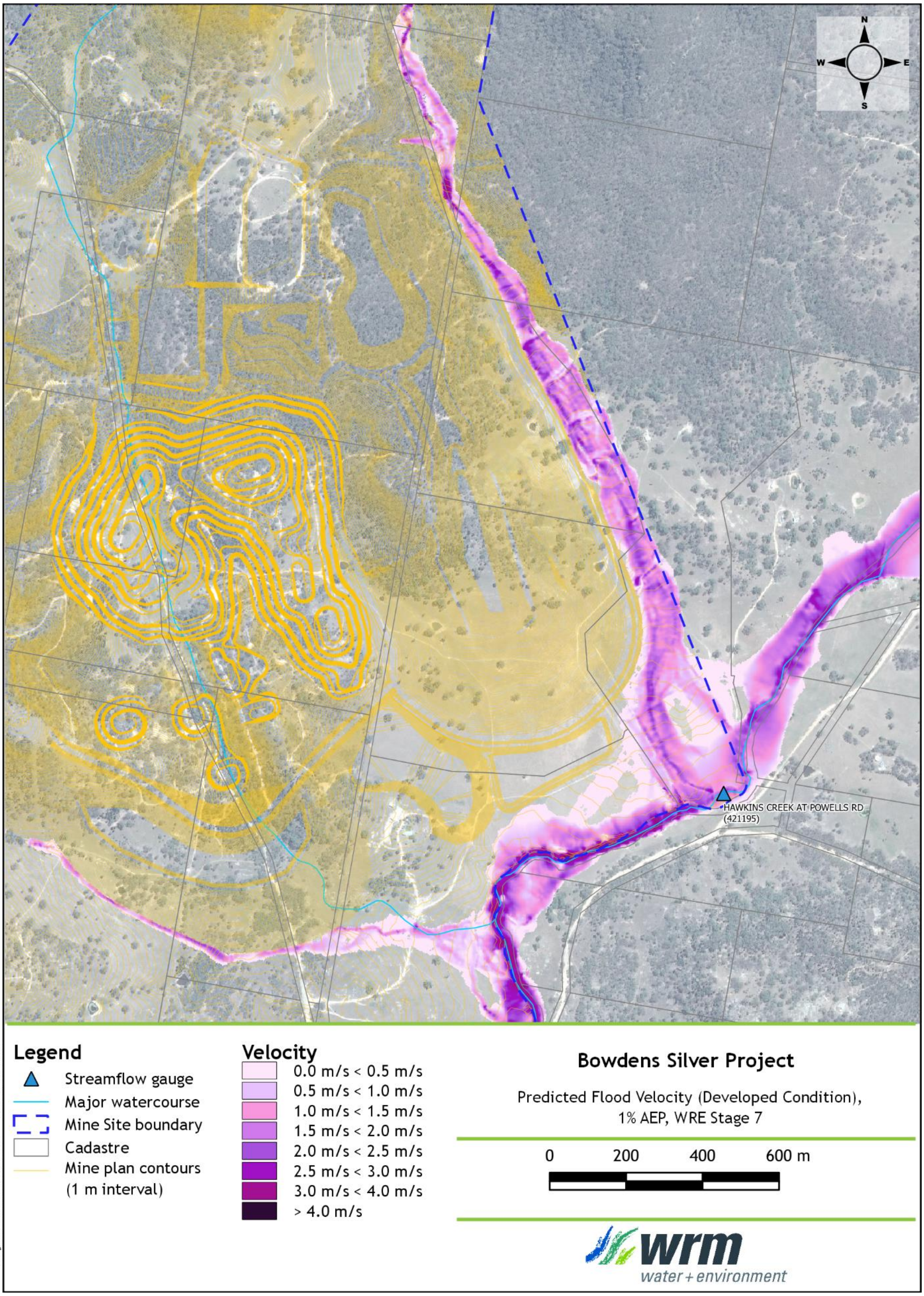


Figure 4.7.9 1% (1 in 100) AEP peak velocities along Price Creek adjacent to the proposed WRE – Maximum Disturbance Scenario

- Existing peak flood velocities in Lawsons Creek are relatively high for all modelled events. For events up to and including 0.2% (1 in 500) AEP, peak flood velocities greater than 4m/s are predicted in many sections along the Lawsons Creek channel and floodplain. The proposed mine infrastructure would have minimal impact on Lawsons Creek flood velocities.

WRM (2020) notes that the more significant flood level impacts associated with the Project development are constrained to within the Mine Site and land owned by Bowdens Silver, and would not result in significant impacts to other properties, assets or infrastructure. The proposed WRE would also locally increase flood velocities in its immediate vicinity. Any expected increases in flood velocities in Hawkins Creek and Lawsons Creek are negligible and would not adversely impact off-site property or infrastructure.

Relocated Maloneys Road Crossing of Lawsons Creek

WRM (2020) has predicted the following impacts as a result of the construction of the proposed floodway across Lawsons Creek (see **Figure 2.19**).

- The upstream impacts of the proposed crossing decrease with increasing flood magnitude.
- In the 10% (1 in 10) AEP design event, the proposed road crossing would increase peak water levels over the road and upstream of the road crossing by up to 1.2m. These water level impacts decrease in magnitude further away from the road crossing, dissipating to less than 0.01m approximately 1.4km upstream of the crossing, i.e. at the location of the existing Bara-Lue Road creek crossing.
- Due to the predicted increase in peak water levels upstream of the crossing, flows in Lawsons Creek would overtop the northern creek bank immediately upstream of the proposed road crossing. In the 10% (1 in 10) AEP design event, these overflows would drain to the northwest parallel to Lawsons Creek before re-joining Lawsons Creek about 680m downstream of the proposed road crossing. In larger flow events, a greater proportion of overflow would be directed along the northeastern floodplain, resulting in increased floodplain velocities.
- Reductions in peak 10% (1 in 10) AEP water levels of up to 0.03m would occur downstream of the Lawsons Creek crossing.
- The predicted increases in peak water levels and flood extents for the 10% (1 in 10) AEP event would not affect any existing dwellings. It is noted that Bowdens Silver either owns or holds the option to purchase all properties that are predicted to be affected by an increase in water levels as a result of the proposed road crossing.
- The proposed road crossing would be designed to manage the risk of scour induced by increased velocities, for example through the use of dumped rock or other erosion protection measures.

The flooding assessment has established that the proposed road crossing of Lawsons Creek would not be trafficable under a 10% (1 in 10) AEP flood although the duration of any road submergence at this location would be confined to a period of approximately 6 hours.

4.7.5.8 Transfer of Surplus Mine Water

As part of their operations, Ulan Coal Mines Limited and Moolarben Coal Operations Pty Ltd is licensed to take water from water sources that are regulated by the following water sharing plans:

- *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*
- *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*
- *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011*

The take of water is therefore accounted for through the water access licences held by each company. Following the initial take of water from the environment (through runoff interception, baseflow drawdown or other existing and approved extraction practices), the companies are then permitted to use this water in accordance with the relevant approvals and water management plans.

As the take of water at Ulan Coal Mine and Moolarben Coal Mine is already licensed, Bowdens Silver is able to accept this surplus mine water pumped directly via the water supply pipeline without the need for further licensing under the *Water Management Act 2000*. The pumping of the surplus mine water to the Mine Site would be via a Project specific pipeline that would be used to convey water for this sole purpose.

The proposed transfer of water (which is regulated by the above water sharing plans) to the turkeys nest dam on the Mine Site (which is regulated by different water sharing plans) is permitted under the relevant water sharing plans and access licence dealing rules without the need for further water access licences to be obtained. Further, all of the water pumped to the Mine Site would remain on site or be evaporated and not released into the Lawsons Creek catchment, thereby changing any flow dynamics in that catchment[13]. Therefore, this transfer of water is an appropriate mechanism for the Bowdens Silver to obtain a sustainable water supply to facilitate its processing operations from sources with existing approved extraction.

4.7.5.9 Compliance with Legislative Requirements

All of the legislative requirements principally relate to the provisions of the *Water Management Act 2000* and the associated water sharing plans.

Macquarie Bogan Unregulated Rivers Water Sharing Plan

Bowdens Silver recognise that it needs to acquire entitlements under the Water Sharing Plan for the Macquarie-Bogan Unregulated Rivers Water Sharing Plan (WSP) to account for the reductions in flow attributable to the Project. The flow reductions would be attributable to:

- Baseflow reduction caused by the drawdown to the groundwater table which is currently feeding into Lawsons Creek, albeit in a small way; and

[13] Noting that the Project would in any event be marginally reducing flows in the Lawsons Creek catchment.

- Runoff interception arising from the construction of mine components within the Lawsons Creek catchment that would prevent an amount of water (beyond the quantity accounted through harvestable rights) from entering Lawsons Creek.

Whilst Bowdens Silver recognises that it needs to acquire the requisite entitlements, the *Water Management (General) Regulation 2018* provides that a person is exempt from the requirement to obtain a water access licence if the person takes water from an "excluded work" as outlined in Schedule 4 of the *Water Management (General) Regulation 2018*. Schedule 4, lists a number of exemptions, two of which potentially apply to the Project:

1 Dams solely for the control or prevention of soil erosion —

(a) from which no water is reticulated (unless, if the dam is fenced off for erosion control purposes, to a stock drinking trough in an adjoining paddock) or pumped, and

(b) the structural size of which is the minimum necessary to fulfil the erosion control function, and

(c) that are located on a minor stream.

3 Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority (other than Landcom or the Superannuation Administration Corporation or any of their subsidiaries) to prevent the contamination of a water source, that are located on a minor stream.

For the purposes of the above exemptions, a minor stream means a first or second order stream (under the Strahler system) that does not maintain a permanent flow of water, and is defined in the hydro line spatial data published on the WaterNSW website. Based on the hydro line data that has not been ground-truthed (as discussed in Section 4.7.2.2).

- Walkers Creek is a third order stream where it would be crossed by the proposed TSF embankment.
- Blackmans Gully and the unnamed gully to the east are both third order streams where they would be crossed by the proposed open cut pits. However, these streams would be diverted around the open cut pits.
- All other proposed water storages would be off-stream storages.

In the event that it is confirmed that Walkers Creek and Blackmans Gully are minor streams, based on ground-truthing and updated hydro line spatial data, then the water taken by the "excluded works" located on these streams does not require licensing. Notwithstanding, WRM (2020) has identified that Bowdens Silver would need to obtain 123ML in entitlements under the *Macquarie Bogan Unregulated and Alluvial Water Source 2012* – Lawsons Creek Water Source to account for runoff interception resulting from the construction of the TSF. The volume of entitlements was calculated by WRM (2020) based on the 80th percentile of annual runoff from the pre-mine catchment area of up to 301.2ha.

Sediment Dams in the Erosion and Sediment Control Zone

All sediment dams proposed for the Project would be off-stream storages and as a minimum, sized to meet the intended erosion control function, and therefore the Excluded Works (1) exemption would apply to these dams when operated as part of the Erosion and Sediment Control system.

While it is proposed to release all water captured in sediment dams (in accordance with best practice), it is possible that poor water quality would prevent this release. If this was the case, the Excluded Works (3) exemption would apply to water captured in these dams that are located on minor streams.

Dams in the Containment Zone

The operation of the water management system for the open cut pit, leachate management dam, processing plant dams and the TSF would be for the "capture, containment and recirculation of drainage or effluent" as required under the conditions of any development consent granted for the Project.

However, based on the (un-ground-truthed) hydro line spatial data, the TSF would be located on a third order stream reaches of upper Walkers Creek, and (as the streams are not being diverted around) the excluded work exemptions would not apply to the TSF.

Discussions have been held with the NRAR to clarify the approach to the excluded works dams and their implications upon the quantum of entitlements required for the Project from the Lawsons Creek Water Source.

Harvestable Rights

Under the WM Act, Bowdens Silver is permitted to collect 10 percent of the average regional rainfall runoff for its landholding without requiring a licence and to store the water in dams up to a certain size. This is known as a 'harvestable right'. The harvestable rights provisions under the *Water Management Act 2000* provide that a water access licence is not required for the take of water in dams, if the capacity of the dams are less than the maximum Harvestable Rights Dam Capacity (HRDC) (which is 10% of the average regional rainfall run-off of the property).Harvestable rights dams must be located on a minor stream, i.e. on first or second order streams.

The WaterNSW Harvestable Rights calculator identifies that the HRDC multiplier at the Mine Site as being 0.07ML/ha. This capacity represents 10% of the mean regional annual runoff volume per hectare of 0.7 ML/ha or 70 mm. Using the Bowdens Silver landholding area of 2 016ha, the maximum permissible harvestable rights dam capacity to which Bowdens Silver is entitled to as a landholder is to a volume of 141.1 ML.

Bowdens' landholding currently includes approximately 76 existing farm dams, the total capacity of which is estimated at 49.6 ML. A total of 25 dams with a combined capacity of approximately 16.3 ML would be removed during the Project life. This would leave a total of 51 dams, with a total capacity of approximately 33.3 ML. The HRDC for the remainder of the Bowdens Silver property would therefore be 107.8 ML. The proportion of the maximum HRDC attributable to the 550ha of land within the Mine Site that would intercept normal flows would generate a HRDC of 38.5ML.

4.7.6 Monitoring

Bowdens Silver would undertake a program of water quality monitoring, principally through retaining and expanding the current water quality monitoring program. The program would involve:

i) the establishment of the quality of water being generated/collected on site within the containment zone;

ii) confirmation that concentrations of total suspended solids and metals satisfy the limits nominated in the conditions of the Project's environment protection licence, in order to allow water to be discharged; and

iii) the establishment of the extent (if any) to which runoff from the Mine Site, either from undisturbed areas or released from the on-site sediment dams is having on the water quality in Hawkins Creek and Lawsons Creek.

Water quality monitoring would be undertaken by Bowdens Silver personnel in a manner that is consistent with the National Water Quality Management Strategy. Samples would be initially collected monthly (in the case of ambient water quality) or during a discharge event, where possible. The monitoring program would be implemented in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (EPA). The sample locations, frequency of sampling and analytes tested would be reviewed annually.

The results of the water quality monitoring undertaken of sediment dams prior to discharging and within Hawkins Creek and Lawsons Creek would be published on Bowdens Silver's website on a monthly basis and a summary included in each Annual Review.

4.7.7 Water Supply Pipeline Corridor

4.7.7.1 Introduction

Bowdens Silver's proposal to construct and use a water supply pipeline to convey surplus treated mine water to the Mine Site would involve the crossing of six perennial watercourses and numerous ephemeral watercourses. This subsection reviews the drainage network traversed by the water supply pipeline, the required management and mitigation measures and likely impacts upon the surface water environment within and surrounding the corridor.

Details of the water supply pipeline design and construction are provided in Sections 2.10.3 and 2.10.4.

4.7.7.2 Drainage Network

Figure 4.7.10 displays the catchments of the various perennial and ephemeral watercourses traversed by the water supply pipeline corridor and the locations of the proposed underbored watercourses. **Table 4.46** lists the six perennial watercourses to be underbored and their catchments and estimated length of pipeline beneath the watercourse. It is noted that Bara Creek would be underbored in three locations.

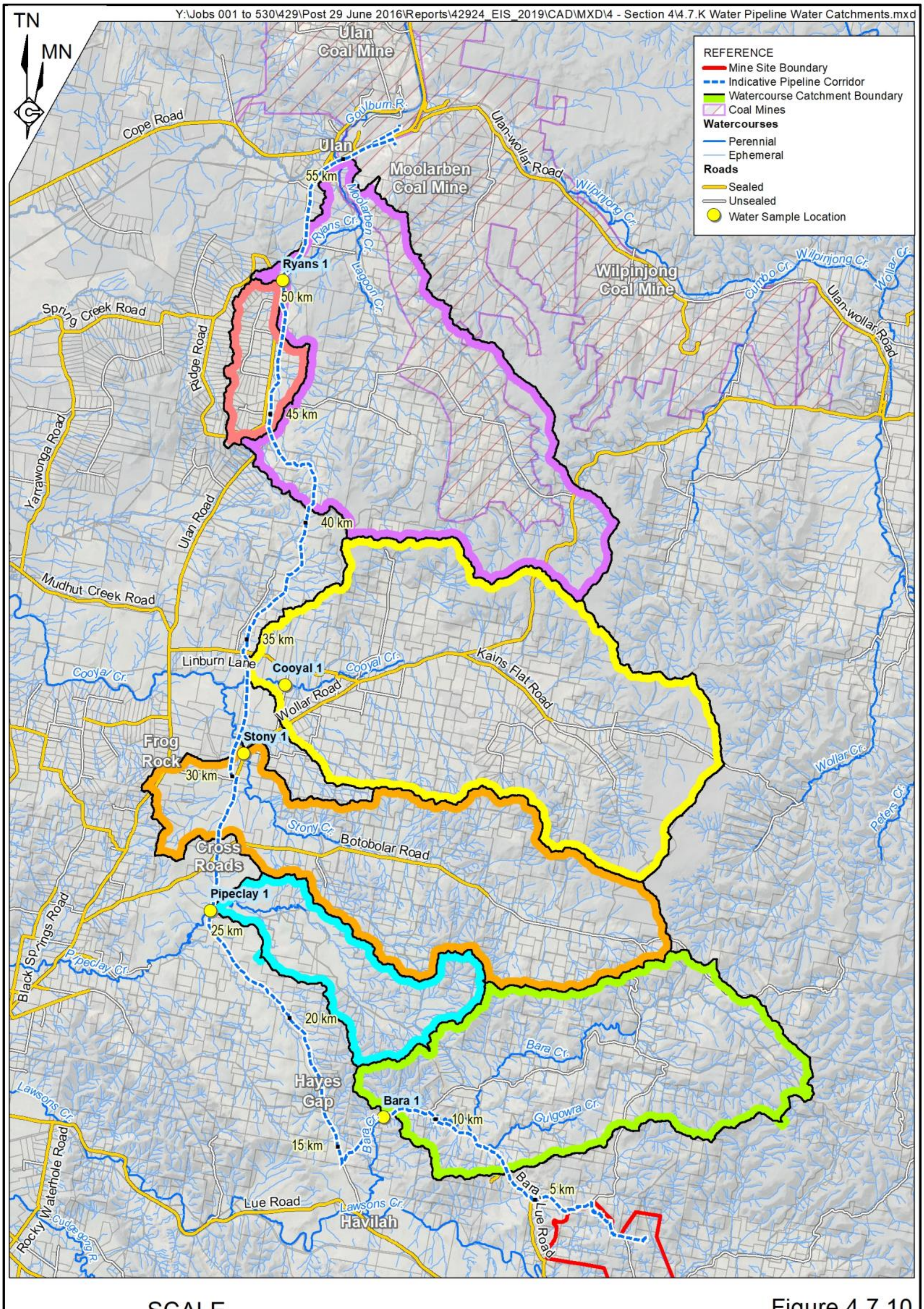


Figure 4.7.10
WATERCOURSE CATCHMENTS - WATER SUPPLY PIPELINE CORRIDOR

Table 4.46
Perennial Watercourses Traversed by Water Supply Pipeline

Chainage (km)	Watercourse Name	Catchment (km^2)	Approximate Pipeline Length (m)
9.0	Bara Creek	77.6	27
9.9	Bara Creek		35
11.0	Bara Creek		32
24.0	Pipeclay Creek	25.9	30
30.4	Stony Creek	80.9	35
32.6	Cooyal Creek	117.8	35
48.9	Ryans Creek	11.4	30
53.9	Moolarben Creek	98.4	60
* Upstream from water supply pipeline corridor			

Water quality data for the perennial watercourses is limited given the below average rainfall and drought conditions that have prevailed during the period since Bowdens Silver decided to include the water supply pipeline as part of the Project. Recent water quality data have been acquired for three of the six watercourses traversed by the water supply pipeline corridor. **Table 4.47** lists the field parameters measured at three of the subject watercourses following a rainfall event yielding 38mm (two locations remained dry).

Table 4.47
Water Quality on Watercourses Traversed by the Water Supply Pipeline Corridor

Analyte	Units	Sample Location				
		Bara 1	Pipeclay 1	Stony 1	Cooyal 1	Ryans 1
pH	pH Units	6.2	6.9	6.9	Dry	Dry
Electrical Conductivity	µS/cm	548	2 843	820	Dry	Dry
Total Dissolved Solids	%	51.8	46.3	56.1	Dry	Dry
Dissolved Oxygen	mg/L	274	1 422	410	Dry	Dry

Bowdens Silver will undertake further water sampling following the conclusion of the current drought to gain a more comprehensive appreciation of the water quality in the watercourses traversed by the water supply pipeline.

4.7.7.3 Management and Mitigation Measures

Treatment Prior to Pumping

It is the preference of Bowdens Silver to source make-up supply water after it is treated in a reverse osmosis plant. The treatment of the water to the quality nominated in Section 2.10.1 would ensure that the water quality in any of the creeks traversed by the pipeline would not be compromised in the unlikely event that a leak occurs along the pipeline. However, it is acknowledged that this would be subject to a commercial agreement with the relevant parties. Section 2.10.1 refers to options available for treatment of water sourced externally.

Leak Detection Measures

The water supply pipeline would be operated with a comprehensive leak detection system to alert the operators within the Mine Site of any leaks that occur so that they can be isolated and repaired.

Perennial Watercourses

The construction of the water supply pipeline beneath the perennial watercourses would involve the establishment of pits on both sides of the watercourse to enable directional drilling equipment to prepare the longitudinal hole for the pipeline. The pits and the excavated material and drill cuttings would be surrounded by a sediment fence for the duration of the underboring (before it is removed from site) and the area of disturbance minimised in accordance with the Construction Management Plan that would be developed for the water supply pipeline construction and installation.

The pipeline would be constructed with a leak detection system and a fibre optic cable for communicating any leaks. This system would assist to minimise the quantity of water lost from the pipeline and, in turn, the opportunity for any piped water to enter any of the watercourses traversed along the corridor.

Ephemeral Watercourses

The construction of the water supply pipeline beneath the ephemeral watercourses would involve the excavation process adopted throughout the remainder of the corridor in accordance with the Construction Management Plan. It is proposed that the excavation, placement and backfilling of the trenches across ephemeral watercourses would be undertaken on a single day to limit the opportunity or any disturbance over a longer period. The backfilled trench would be compacted to at least 95% compaction and the top 100mm completed with the topsoil which would be seeded and fertilised at the end of the day’s construction activity.

4.7.7.4 Assessment of Impacts

The proposed underboring of the perennial watercourses would be undertaken in a manner that would avoid impacts to the watercourses and their flow. Similarly, the proposed trenching through ephemeral watercourses would be undertaken using standard techniques and mitigation measures to minimise impacts to the ground surface and their surrounds.

In the event a leakage of water does occur from the pipeline, its water quality would not adversely impact the water quality in the watercourses traversed as the water would be treated before it is pumped to the Mine Site. In any event, the quantity of water entering any watercourse would be minimal given the planned use of a leak detection system.

4.7.8 Conclusion

The surface water assessment prepared by WRM (2020) has identified the extent to which the Project would alter the surface water regime within and downstream of the Mine Site and the manner in which the clean water, sediment-laden water and contaminated water need to be managed on site. The assessment has also established how the various water sources on site and externally need to be balanced to meet operational requirements yet avoid the discharge of any contaminated water into the downstream watercourses. Bowdens Silver's proposal to import surplus mine water as make-up water for processing and dust suppression for the Project would negate the need to seek water currently within the Cudgegong River Valley destined for agricultural or municipal uses.

The implications of the changed runoff conditions and the construction of a number of mine components would locally modify the flood behaviour in both Hawkins and Lawsons Creeks.

The key residual impacts to the surface water regime within and surrounding the Mine Site as a result of the Project are as follows.

The Project is predicted to marginally reduce downstream flows in both Hawkins and Lawsons Creeks through the interception and retention of runoff within the Mine Site and a reduction in baseflow in both creeks. During operations flow rates in Hawkins and Lawsons Creeks would reduce by 1.3% to 4.6% whereas post-mine closure, flow rates would reduce by 0.4% and 1.5%.

The reduction in flow in Lawsons Creek would cause the flows greater than 1ML/day to occur on two fewer days per year. Overall, the reductions in flow and changes in availability of water to downstream users would be negligible. Bowdens Silver would acquire the required WALs from the Lawsons Creek Water Source prior to the commencement of the Project.

The assessment established that the more significant flood impacts would be confined to within the Mine Site and land owned by Bowdens Silver. Any expected increases in flood velocities in Hawkins and Lawsons Creeks would be negligible and would not adversely impact off-site property or infrastructure.

The flood study also established that the proposed Lawson Creek crossing on the relocated Maloneys Road would be inundated in the 10% (1 in 10) AEP design event, thereby closing the road for up to 6 hours.

The construction of the water supply pipeline would have negligible impacts upon the watercourses either crossed or underbored.

The Surface Water Assessment (WRM, 2020) including the Watercourse Assessment (Annexure A of WRM, 2020) and Flood Impact Assessment (Annexure B of WRM, 2020) were subject to peer review by Mr Tony Marszalek, Director at Hydro Engineering and Consulting. The peer review is included as Annexure C of WRM (2020) and concluded that the assessment was sufficient and fit for purpose for the EIS. A range of recommendations were made as a result of the review, which have been noted for future consideration by the Applicant. However, it should be noted that the review accepts that the recommended additional assessment would be unlikely to significantly affect the modelling outcomes/conclusions of the current assessment.

4.8 HEALTH RISKS

The human health risk assessment (HHRA) of the Project was undertaken by Environmental Risk Sciences Pty Ltd (enRiskS). The full assessment is presented in Volume 3 Part 7 of the Specialist Consultant Studies Compendium and is referenced throughout this section as enRiskS (2020). A peer review of the human health risk assessment was undertaken by Professor Brian Priestly. A copy of that peer review is appended to enRiskS (2020) as Annexure I.

4.8.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in health impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Emissions of TSP/PM_{10}/$PM_{2.5}$, including particulates containing concentrations of lead or other metals, during site establishment and construction and operational activities impacting upon the health of the surrounding local population due to inhalation (Medium).
- Deposition of particulates / dust containing lead, or other metals during site establishment and construction and operational activities impacting upon the health of the surrounding local population due to deposition impacting soil quality, dust levels indoors, and tank water quality (Medium).
- Mobilisation of contaminants (including lead and other metals) during construction and operation of the Project which influence the water quality in the surface water environment of Hawkins and Lawsons Creeks and impacting upon the health of surface water users (Low).
- Mobilisation of contaminants (including lead and other metals) during construction and operation of the Project which influence the water quality in the groundwater environment and impact upon the health of surface water users (Low).
- Generation of noise during construction and operation of the Project impacting on the health of the local population (Low).

In addition, the SEARs issued by the former DPE identified "human health" as a key issue requiring assessment. The principal assessment requirements identified by the DPE relating to human health include the following.

- Addressing how the Project's environmental impacts in relation to air quality (including heavy metals) and noise may impact on the health of the local community.
- Monitoring and management measures to reduce risk to human health.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the Greater Western Area Health Service[14], Health Western NSW – Local Health District, Department of Education / Department of Education and Communities, and Mid-Western Regional Council. A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or Specialist Consultant Studies Compendium.

A range of matters have also been raised by the community throughout consultation. These matters are also summarised in **Appendix 3**. It is noted that a significant community concern is exposure to lead. Lead has been addressed as part of the human health risk assessment together with other metals. However, a useful summary of relevant health aspects relating to lead, including exposure pathways, absorption, distribution, metabolism and excretion of lead, health effects, and approaches to characterising toxicity are provided in Appendix B of the HHRA (enRiskS, 2020).

Further details regarding the specific impact assessments for noise, air quality, groundwater, and surface water are summarised Sections 4.2, 4.4, 4.6 and 4.7 respectively.

This section focuses on the assessment of potential health impacts associated with activities within the Mine Site. As the construction of the Water Supply Pipeline would be a comparatively low-intensity and short-term activity, an assessment of the health impacts of this component of the Project is not considered necessary.

4.8.2 Community Health Profile

When considering potential health impacts within any community, a HHRA considers the whole population, including sensitive or vulnerable groups within the population. These communities and their related sensitive or vulnerable groups include the following.

- Community groups
  - Residents (including rural, rural-residential and residential within towns and villages).
  - Recreational users (including bushwalkers, recreational swimming in local creeks/rivers).
  - Commercial and industrial (i.e. workplaces).
- Sensitive and vulnerable groups within the community groups.
  - Young children.
  - Older populations (>65 years of age).
  - Disabled and those with pre-existing medical conditions.
  - Disadvantaged (socio-economically disadvantaged).

[14] The Greater Western Area Health Service covers a total of 23 Local Government Area from Mid-Western Regional LGA west to Bourke and Cobar LGAs, north to Walgett LGA, and south to Oberon LGA.

These receptors may reside or access any areas within the community.

The health of the community, in general, is influenced by a complex range of interacting factors including age, socio-economic status, social capital, behaviours, beliefs and lifestyle, life experiences, country of origin, genetic predisposition and access to health and social care. While it is possible to review existing health statistics for the areas surrounding the Mine Site, and compare them with larger areas such as the LGA or NSW, it is not possible or appropriate to identify a causal source, particularly individual or localised sources.

Information relevant to the health of populations in NSW is available from various State and Australian government agencies including NSW Health, the Australian Institute of Health and Welfare and the Australian Commission on Safety and Quality in Health Care. The data sets relate to populations grouped by local government area or health district. It is noted that these data sets are not available for individual statistical suburbs and not all health data that may need to be considered in the completion of an HHRA is available for all areas.

A summary of the socio-economic profile is provided as part of the Social Impact Assessment and summarised in Section 4.20 whilst a summary of specific health factors is provided as follows.

Health-related behaviours

Information in relation to health-related behaviours linked to poorer health status and chronic disease including cardiovascular and respiratory diseases, cancer and other conditions that account for much of the burden of morbidity and mortality in later life is available for the Western NSW Health Area and NSW. **Figure 4.8.1** presents data for health-related behaviours with potential to adversely affect the health of the population.

Review of the data indicates that Western NSW has a higher rate of smoking and a higher prevalence of obesity than NSW, however for most other indicators Western NSW is (on average) similar to NSW.

Health Indicators

NSW Health provides data relevant to selected chronic diseases within the NSW population and which provide an understanding of the burden of disease. Chronic (long-lasting) diseases considered generally relevant to the assessment of health effects from mining activities include hypertension, heart disease, stroke and respiratory disease (including asthma). Available and relevant health data relating to these diseases for the Mid-Western Regional LGA, Western NSW Health District and NSW as a whole are presented in **Figures 4.8.2** to **4.8.4**.

Review of the available data in relation to mortality, the prevalence of disease and hospitalisation rates for the Mid-Western Regional LGA and the larger Western NSW Health Area, indicates the following.

- The prevalence of hypertension in Western NSW is significantly higher than the NSW average whilst hospitalisations for hypertension are a little higher than for NSW.
- The average prevalence of asthma in Western NSW is higher than the NSW average, however, the hospitalisation rate for asthma in both Mid-Western Regional LGA and Western NSW is lower than the NSW average.

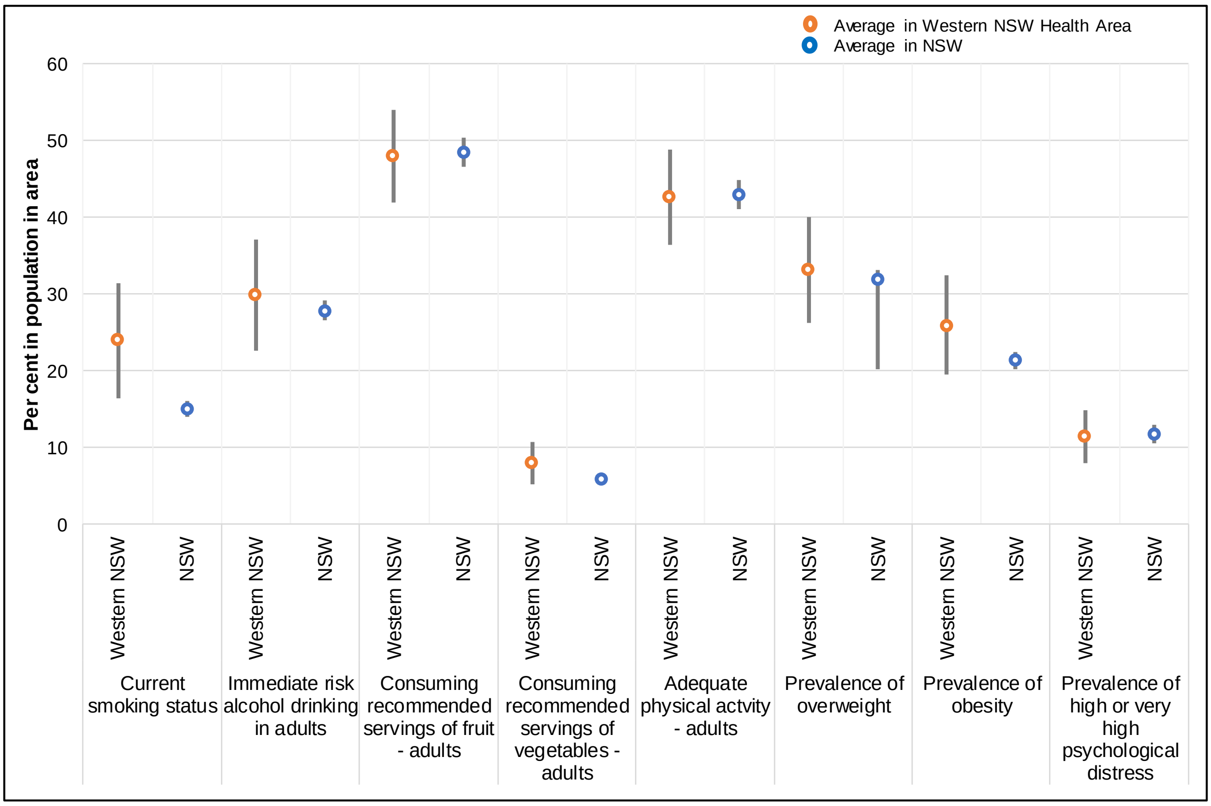


Figure 4.8.1 Summary of health-related behaviours for Western NSW (average and 95% confidence interval)
(Source: enRiskS (2020) – Figure 3.2)

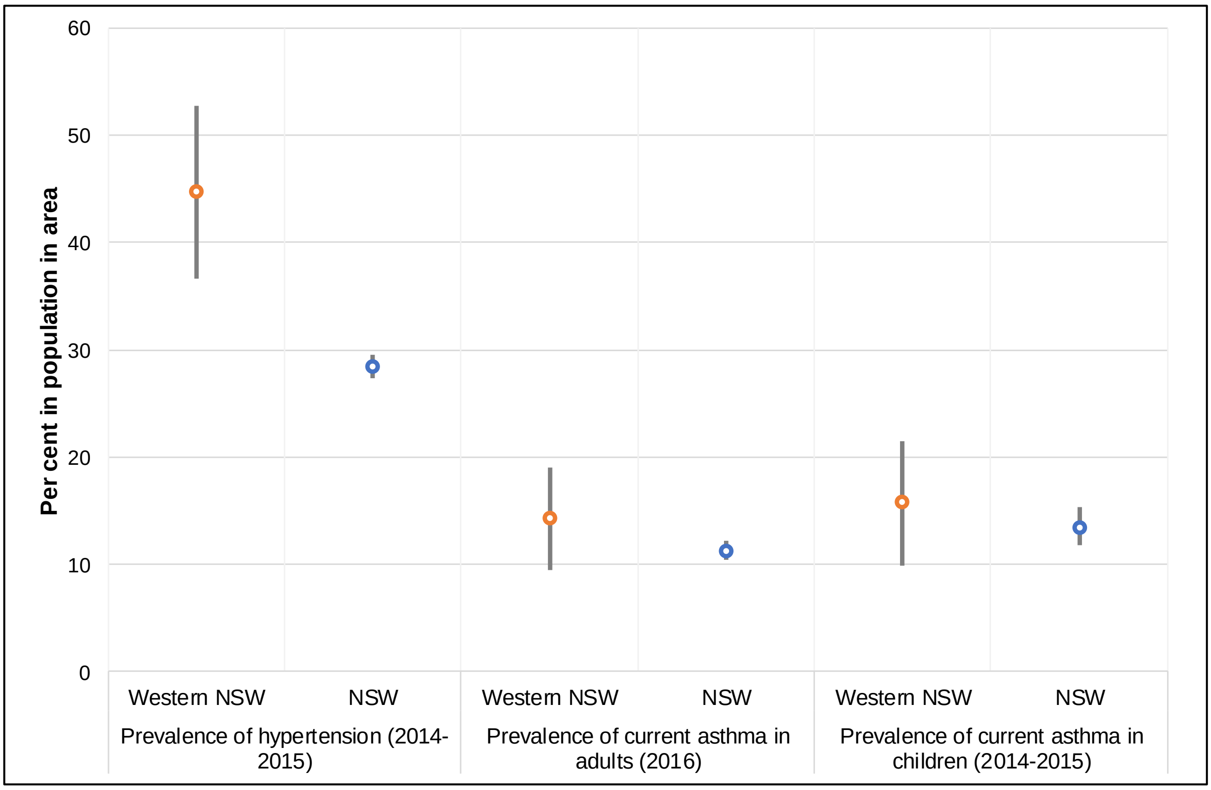


Figure 4.8.2 Prevalence of Hypertension and Asthma (average and 95% confidence interval)
(Source: enRiskS (2020) – Figure 3.3)

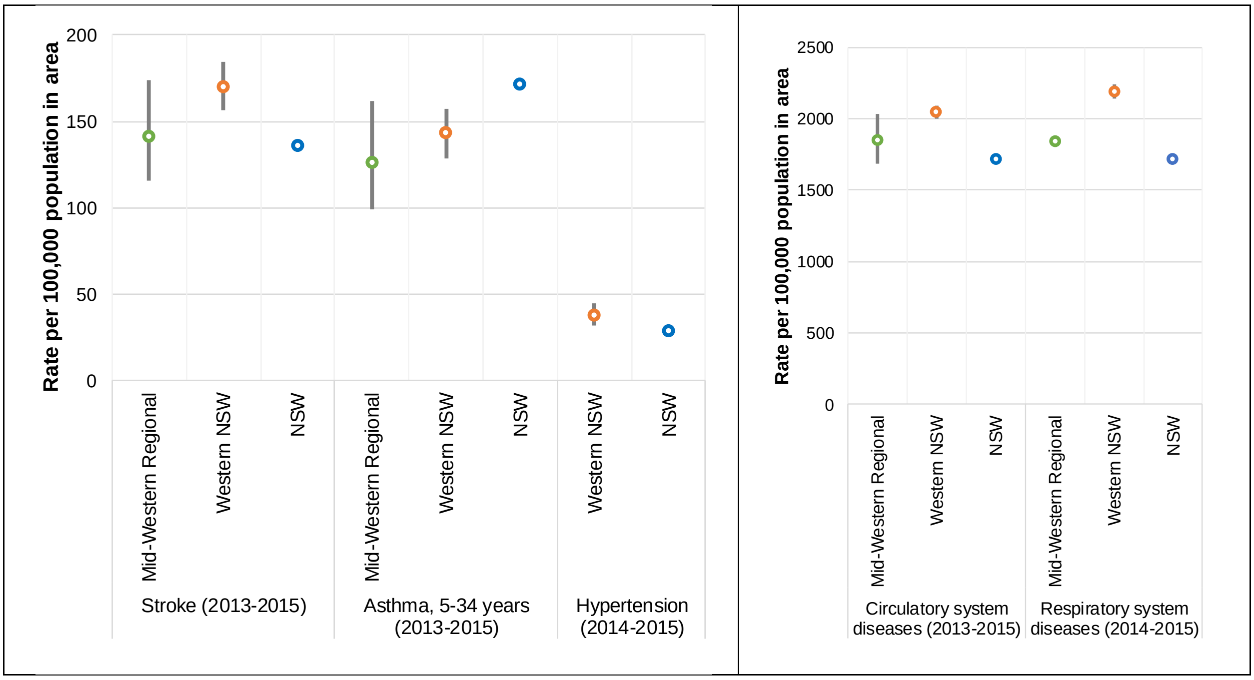


Figure 4.8.3 Hospitalisation Data for Hypertension, Respiratory and Cardiovascular Disease (average and 95% confidence interval)
(Source: enRiskS (2020) – Figure 3.4)

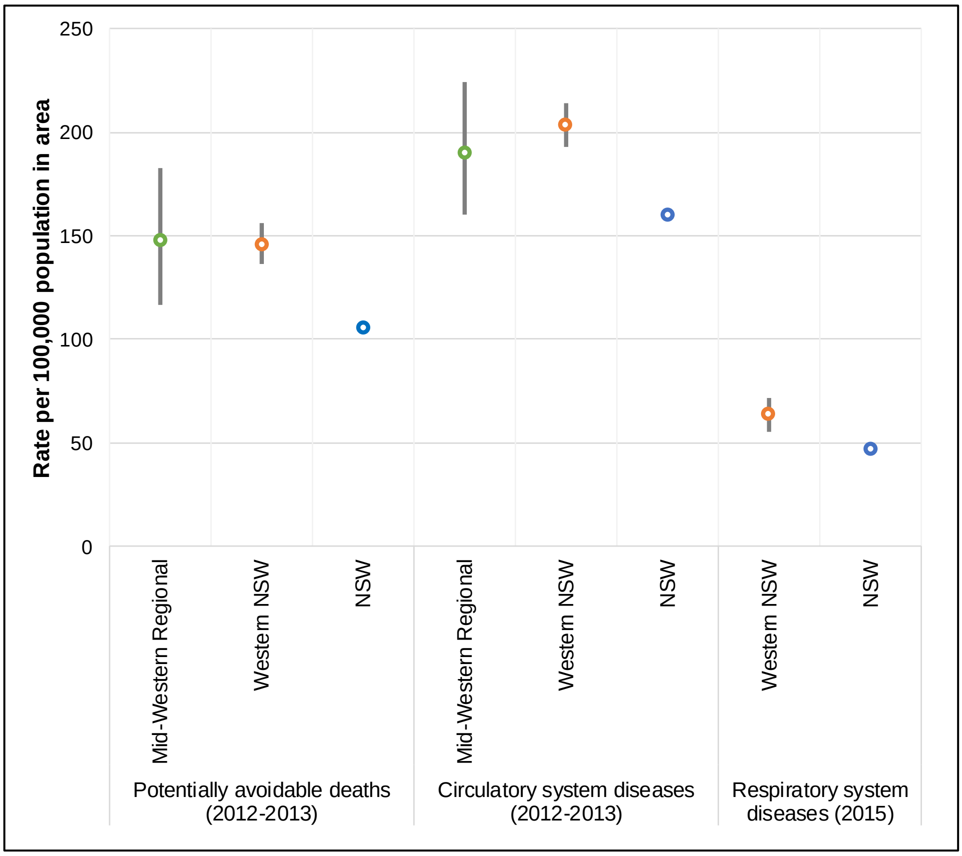


Figure 4.8.4 Mortality Data, Including Respiratory and Cardiovascular Disease (average and 95% confidence interval)
(Source: enRiskS (2020) – Figure 3.5)

- The rate of both hospitalisations and mortality for stroke and circulatory system diseases are higher in the Mid-Western Regional LGA and Western NSW, when compared with NSW. The hospitalisation and mortality rates are lower in the Mid-Western Regional LGA than the larger Western NSW Health Area,
- In relation to respiratory disease, limited data is available for the Mid-Western Regional LGA. Data from the larger Western NSW Health Area suggests that hospitalisations and mortality associated with respiratory disease are higher, compared with NSW. The rate of hospitalisations for respiratory system disease in the Mid-Western Regional LGA is higher than NSW, but lower than for the larger Western NSW health area.
- The rates of potentially avoidable mortality in the Mid-Western Regional LGA and the larger Western NSW health area are higher than for NSW.

The above indicates that the population in the areas surrounding the Project is expected to have higher than average rates of respiratory and cardiovascular disease, which may mean they may have some potential to being more susceptible to changes in exposures related to the Project. This has therefore been considered in the HHRA.

4.8.3 Existing Environment and Baseline Information

4.8.3.1 Overview

The assessment of health impacts associated with the Project, involves assessment of potential community exposures to a range of contaminants, pollutants and stressors, most of which are already present in the environment. As such, it is important to understand the existing environment, and what data is available to define the existing exposures that may occur within the community. The following subsections provide a brief summary relevant to the assessment of metals in the existing environment that contribute to existing levels of exposure within the community.

4.8.3.2 Geology and Soil

Given the nature of the geology within and surrounding the Mine Site (see Section 2.2), the presence of mineralised areas is expected to already have had some influence on the nature of natural soil materials within the Mine Site and surrounding areas, as well as sediments and water quality.

Soil samples have been collected from a number of areas, principally within the Mine Site and other prospective areas within Bowdens Silver's exploration licence areas, to understand the composition of these materials. Soil and dust samples were also collected from the Lue Public School and other buildings in the local area to establish concentrations of metals present in soil and dust indoors. **Tables 4.48** and **4.49** summarise the collected data with the data in **Table 4.49** focusing on lead concentrations. Relevant guidelines are also listed beneath each table.

Table 4.48
Soil and Dust Samples for Metals - Existing Environment

	Concentration Reported in Soil – Mine Site (and other licence areas) (mg/kg)				**Concentration Reported in Soil and Dust, range (mg/kg)**			**Soil guidelines – Low-density Residential Land Use (mg/kg)**
					Lue Public School		**Other local areas - dust**	
Metal	**Mean**	**Median**	**Minimum**	**Maximum**	**Soil**	**Dust**		
Silver (Ag)*	0.50	0.045	0.007	49.8				390 [U]
Aluminium (Al)	1.4	1.2	0.16	4.35				77000 [U]
Arsenic (As)*	15	6.5	0.26	**558**	4	4 - 12	6 - **120**	100 [N]
Boron (B)	0.051	0	0	10				4500 [N]
Barium (Ba)	151	129	12.8	667				15000 [U]
Beryllium (Be)	0.78	0.68	0.04	5.39				160 [U]
Cadmium (Cd)*	0.13	0.036	0	5.72	<0.5	<0.5 - 12	<0.5 – 11	20 [N]
Cobalt (Co)*	9.5	6.2	0.598	55.394				100 [N]
Chromium (Cr)*	21	15.54	2.4	204.3	29 - 40	31 - 110	10 - 190	100 [N] as Cr VI
Copper (Cu)*	21	8.32	1.37	140.5	24 - 30	32 - 33	22 – 180	6000 [N]
Iron (Fe)	2.4	1.75	0.53	8.14				55000 [U]
Mercury (Hg)*	0.029	0.022	0	0.31	<0.1	1.3 – 2.4	<0.1 – 7.1	40 [N]
Lithium (Li)*	5.7	4.45	0.3	27.6				160 [U]
Manganese (Mn)*	1113	594	37	**14 350**				3800 [N]
Molybdenum (Mo)	0.97	0.81	0.18	8.69				390 [U]
Nickel (Ni)*	12	6	0.9	157.5	9 - 13	6 - 11	5 - 270	400 [N]
Antimony (Sb)	0.25	0.042	0	10.05				31 [U]
Selenium (Se)	0.76	0.4	0.03	23.5				200 [N]
Tin (Sn)	2.1	0.9	0.25	13.895				47000 [U]
Strontium (Sr)	21	9.2	0.1	241				47000 [U]
Titanium (Ti)	0.014	0.007	0	0.087				140000 [U]
Vanadium (V)	14	6	0.009	139				390 [U]
Tungsten (W)	0.27	0.14	0	2.959				63 [U]
Zinc (Zn)*	24	5.9	0.005	863	43 - 410	4900 – **89 000**	680 – **24 000**	7400 [N]

Notes:

N = NEPM Health Investigation Levels for Low-Density Residential HIL-A (NEPC, 1999 amended 2013a)

U = USEPA Regional Screening Level for Residential Soil (US EPA, 2019)

C = CCME Soil guideline for both agricultural and residential soil http://st-ts.ccme.ca/en/index.html

* = Metals further considered in the modelling of dust emissions from the Project
Bold shaded values exceed nominated guidelines

Source: enRiskS (2020) – Modified after Table 4.1

The soil data has been compared against health-based guidelines relevant to low-density residential land use available from Australia (NEPC, 1999 amended 2013a) and the US (USEPA, 2016). These criteria include exposures via ingestion of soil and dust (indoors), dermal absorption from soil and dust, inhalation of dust and ingestion from homegrown produce (fruit and vegetables). The guidelines may not be adequately protective of all exposures that may occur on a rural property in relation to produce, however, the guidelines do assist in understanding the significance, or otherwise, of existing levels of metals in soil.

Table 4.49
Soil and Dust Samples for Lead: Existing Environment

Media/Measure	Lead Level (Range or Maximum)	Guideline
Dust Indoors		
Dust wipes from indoor surfaces - Lue	0.002 to **9.92** mg/m^2	5.4 mg/m^2 for interior window sills and ledges H 8.6 mg/m^2 for window troughs and exterior surfaces H No criteria for ceiling spaces
Dust wipes from indoor surface - Lue Public School where lead paint is present*	70 mg/m^2 in ceiling space	
Accumulated dust in ceilings and indoor surfaces - Lue	20 to 5600 mg/kg	300 mg/kg N for indoor surfaces No criteria for ceiling spaces
Accumulated dust in ceiling and indoor surfaces – Lue Public School where lead paint is present*	48 000 mg/kg in ceiling space	
Soil		
Soil on Mine Site (exploration licence areas)	< 50 mg/kg away from proposed main open cut pit (with 50 mg/kg assumed representative of existing lead concentrations in soil) 1.5 to **1 380** mg/kg in main open cut pit area	300 mg/kg N
Soil adjacent to building at Lue Public School where lead paint is present*	280 mg/kg adjacent to building 190 mg/kg, 1m away 36 mg/kg, 2m away 35 mg/kg, 3m away 42 mg/kg, 4 m away 12 mg/kg in another location	

Notes: **Bold shaded** values exceed nominated guidelines

Data provided in the following reports: JBS 2013c, JBS 2013b, JBS 2013a, JBS 2012

* Lead paint was confirmed to be present, with analysis of paint chips indicating lead content of 3% to 8.1%

H = Current guidelines of lead on indoor surfaces from NSW EPA and NSW Planning (2003), *Managing Lead Contamination in Home Maintenance, Renovation and Demolition Practices. A Guide for Councils* (NSW EPA and Planning NSW, 2003)

N = NEPM Health Investigation Levels for Low-Density Residential HIL-A (NEPC, 1999 amended 2013a)

Source: enRiskS (2020) – Modified after Table 4.2

A number of recorded concentrations exceed the adopted soil guidelines and are highlighted in **Tables 4.48** and **4.49**. These relate to exceedances of the maximum concentrations of arsenic, manganese and zinc in soil. None of the average or mean concentrations exceed the available health-based guidelines.

In relation to lead levels in the environment within the Mine Site and in Lue, the indoor data reflects the presence (known or otherwise) of lead paint and lead materials in roofing materials. In particular, lead paint was identified at the Lue Public School which has resulted in the presence of elevated levels of lead in dust indoors, and higher than average levels of lead in soil close to the school buildings.

Soil lead concentrations within the Mine Site are generally lower than the health-based guideline, with the exception of levels reported in the area of the proposed main open cut pit (consistent with the mineralisation in this area).

4.8.3.3 Groundwater and Surface Water Environment

A detailed summary of the existing groundwater and surface water environments is provided in Sections 4.6.3 and 4.7.2 respectively. For the purpose of the HHRA, focus is placed upon the water quality, in particular metals, recorded within surrounding groundwater bores and watercourses. **Table 4.50** presents a summary of the relevant monitoring data.

As some groundwater (and potentially spring water) is reportedly used to supplement drinking water, the alluvial aquifer, springs and domestic bores have been compared against drinking water guidelines. It is more likely that the community may have more incidental contact with groundwater and surface water during use for irrigation or stock watering, or recreational use of creeks. Hence, the concentrations have also been compared against recreational water guidelines. Concentrations that exceed either the health-based drinking water or recreational water guidelines are bold and highlighted in **Table 4.50**.

In general, the data collected on existing water quality relevant to human health risk indicates the following.

- For the alluvium, springs and domestic bores (being more likely to be used for drinking water), exceedances of drinking water guidelines were identified for arsenic, cadmium, cobalt, lead, lithium, manganese and nickel for some water samples tested.
- There are exceedances of recreational water quality criteria in all fractured rock groundwater monitoring sites within the Mine Site for arsenic, cobalt, lithium, manganese and nickel. However, within the regional fractured rock groundwater bores there were no exceedances of recreational water guidelines for any of the metals analysed.
- There were no exceedances of the health-based guidelines for surface water.

4.8.3.4 Tank Water

The occupants in residences surrounding the Mine Site, including within Lue, utilise rainwater tanks as the primary source of potable water, for drinking and other household uses. It is understood that water from rainwater tanks is supplemented with groundwater or water trucked in from Mudgee, when necessary. The quality of the water within the tanks can be influenced by a range of factors including the dust deposited onto the roof and subsequently being washed into the tank, the type and condition of roof materials, the type of material the tank is made from, and the amount of organic matter that enters the tank (from surrounding vegetation).

A rainwater tank sampling program was undertaken in 2012 involving 84 tanks located within a distance of up to 5.85km from the proposed Mine Site and involved:

- a preliminary water sample (prior to cleaning and sediment sampling) from the tank or outlet;
- cleaning of the tank to enable sediments to be sampled; and
- sampling of tank water post cleaning (at some locations).

Table 4.50
Summary of Existing Surface Water and Groundwater Concentrations

Metal or indicator	Concentration – Range of averages (mg/L)						Water quality guidelines (mg/L)	
	Alluvium*	Site (fractured rock aquifers)	Regional (fractured rock aquifers)	Springs*	Domestic Bores (9 locations)*^	Surface Water*	Drinking water	Recreational water
Electrical conductivity (µS/cm)	131 - 2320	294 – 4364	708 – 3095	107 – 174	35 - 3180	71.7 – 1449.6	Converted to and evaluated as TDS as below	
Palatability as TDS (mg/L)	83.7 - **1485**	191 - 1519	411 - 3032	68 - 112	22 - 2035	46 - 928	0 – 600 = good 600 – 900 = fair 900 – 1200 = poor >1200 = unacceptable No health criteria	
pH	5.98 – 7.23	5.4 – 7.94	6.78 – 8.13	4.68 – 7.54	3.9 – 9.0	4.0 – 7.8	6.5 to 8.5 for aesthetics[A] No health guideline	
Ammonia	0.02 – 2.4	0.024 – 0.475	0.02 – 0.33	0.027 – 0.24	-	<0.01-0.06	0.5 aesthetics[A] No health guideline	
Arsenic	0.002 – **0.02**	0.001 – **0.290**	0.001 – **0.07**	0.028 – **0.235**	<0.001 – 0.002	0.001 – 0.0025	0.01[A]	0.1
Cadmium	0.0001 – **0.0008**	0.0001 – 0.0003	0.0001 – **0.0042**	0.001-**0.007**	-	<0.0001 – 0.0002	0.002[A]	0.02
Chromium	0.001	0.001 – 0.002	0.0001 – 0.003	-	-	-	0.05[A]	0.5
Cobalt	0.002 – **0.0069**	0.001 – **0.15**	0.001 – 0.004	0.001 – **0.011**	-	0.001 – 0.004	0.006[U]	0.06
Copper	0.001 – 0.015	0.001 – 0.013	0.002 – 0.068	--	0.006 – 0.9	0.001 – 0.002	2[A]	20
Iron	0.08 – 14.4	0.087 – 143.2	0.085 – 3.2	0.19 – 1.2	<0.05 – 1.1	0.06 – 0.535	0.3 for taste[A]	
Lead	0.002 – 0.007	0.001 – **0.016**	0.001 – **0.068**	0.001 – 0.007	<0.001 – **0.03**	<0.001 – 0.007	0.01[A]	0.1
Lithium	0.002 – **0.704**	0.002 – **0.656**	0.001 – **0.287**	0.001-0.008	-	0.001 – 0.012	0.04 [U]	0.4
Manganese	0.006 – **1.916**	0.004 – **29.495**	0.004 – **1.354**	0.001	0.006 – **1.1**	0.0315 – 0.293	0.5[A]	5
Mercury	-	-	-	-	<0.0001 – 0.0001	-	0.001[A]	0.01
Molybdenum	0.002	0.002 – 0.013	0.002 – 0.013	-	<0.001 – 0.007	0.003 – 0.004	0.05[A]	0.5
Nickel	0.001 – 0.006	0.001 – **0.25**	0.001 – **0.038**	**0.032** – **0.423**	-	0.002 – 0.004	0.02[A]	0.2
Strontium	0.028 – 0.73	0.073 – 3.77	0.26 – 4.3	0.017 – 0.069	-	0.027 – 0.56	12 [U]	120
Zinc	0.006 – 0.039	0.007 – 1.112	0.017 – 0.285	0.013 – 0.054	0.008 – 2.9	0.006 – 0.014	3 for taste[A] 6 for health[U]	60
Nitrate	0.04 – 3.407	0.033 – 2.708	0.105 – 10.878	0.02 – 0.72		0.03 – 0.175	50[A]	500
Nitrite	0.02 – 0.42	0.01 – 0.27	0.01 – 0.064	-		<0.01 – 0.045	3[A]	30

Notes: **Bold shaded** values exceed nominated guideline values
A = Australian Drinking Water Guidelines (NHMRC, 2011 updated 2018), U = USEPA Regional Screening Levels for Tap Water (USEPA, 2019)
* Compared against drinking water criteria ^Data represents a selection of domestic bores within the surrounding area for which water quality data is available.
Source: enRiskS (2020) – Modified after Table 4.3

Table 4.51 presents a summary of metal concentrations recorded within the water for the different types of tanks sampled whilst **Table 4.52** presents a summary of the metals recorded within the sediments.

Table 4.51
Metals in Rainwater Tanks Water

Metal or indicator	Concentration in rainwater tanks, by tank type (mg/L)					Drinking Water Guideline (mg/L)
	Galvanised iron	Concrete	PVC or poly	Fibreglass	Average	
pH Value	4.5 - 8.1	5.7 – 8.2	3.9 – 7.7	4.6 – 7.5	--	6.5 – 8.5 for aesthetics (corrosion and taste)*
Arsenic	<0.001 - **0.053**	<0.001 – 0.005	<0.001	<0.001	0.0033	0.01
Cadmium	<0.0001 - 0.0017	<0.0001 – **0.005**	<0.0001 - 0.0019	<0.0001 – **0.0058**	0.00065	0.002
Chromium	<0.001 - 0.013	<0.001 – 0.006	<0.001 – 0.006	<0.001	0.0015	0.05
Copper	<0.001 - 0.3	<0.001 – 0.593	<0.001 – 0.624	<0.001 – 0.436	0.065	2
Iron	<0.05 - 0.66	<0.05 – 1.08	<0.05 – 0.86	<0.05 – 0.06	0.23	0.3 for taste*
Lead	<0.001 - **0.015**	<0.001 – **0.037**	<0.001 – **0.035**	<0.001 – 0.004	0.0059	0.01
Manganese	0.001 - 0.064	<0.001 – 0.061	<0.001 – 0.08	0.003 – 0.075	0.013	0.5
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001
Nickel	<0.001 - **0.029**	<0.001 – **0.039**	<0.001 – **0.05**	<0.001	0.014	0.02
Zinc	0.038 – 6.52	0.027 – 2.89	0.053 – 1.51	0.034 – 4.19	0.89	3 for taste*

* No Health Guideline — **Bold shaded** values exceed nominated health-based guideline values

Source: enRiskS (2020) – Modified after Table 4.4

Table 4.52
Metals in Rainwater Tanks Sediments

Metal or indicator	Concentration in Sediments in Tanks (mg/kg)			
	Galvanised iron	Concrete	PVC or poly	Fibreglass
Arsenic	5 – 21 2 450 at one property	5 – 23	6 – 156	65 – 57
Cadmium	<1 - 127	<1 – 93	<1 – 33	<1 – 43
Chromium	15 – 415	13 – 278	18 – 638	20 – 96
Copper	28 – 652 4 140 at one property	8 – 368	48 – 740	34 – 251
Iron	16 700 – 91 200	3 860 – 71 900	8 600 – 339 000	19 600 – 83 100
Lead	59 – 2 310	14 – 1 810	52 – 4 490	208 – 1 890
Manganese	78 – 2 530 17 200 at one property	198 – 2 390	91 – 2 980	118 – 1 830
Mercury	0.2 – 0.8	0.3 – 0.9	0.1 – 0.7 6.3 at one property	0.2 – 0.5
Nickel	10 – 64	3 – 35	6 – 86	10 – 15
Zinc	2 430 – 33 100	852 – 77 600	344 – 23 400	718 – 65 300

Source: enRiskS (2020) – Table 4.5

As rainwater tanks are used for drinking water, the concentrations reported in the water have been compared with current Australian Drinking Water Guidelines (NHMRC, 2011 updated 2018). Concentrations of arsenic, cadmium, lead and nickel exceed the drinking water guidelines in some tanks.

There are no guidelines relevant to human health for sediments in rainwater tanks relevant to human health, hence no guidelines have been included. It is noted that this data indicates that there was a range of metals present in sediments where concentrations were quite elevated. In the tank concentrations in four tanks (three separate properties) of arsenic, copper, manganese, or mercury were significantly higher than the range reported in other tanks. These anomalous data likely reflect specific building materials, and condition of these materials, on the roof or guttering at the specific property.

4.8.3.5 Air Quality

A detailed summary of the existing air quality environment is provided in Section 4.4.2.2 including a summary of metal concentrations recorded in deposited dust and particulate matter.

4.8.3.6 Other Sources of Exposure to Metals

Community exposures to metals also occur through the intake of produce. Food Standards Australia New Zealand (FSANZ) provides data on the levels of metals (and other chemicals such as pesticides) within food products consumed by the public. These intakes are from drinking water and other beverages and commercially purchased foods. **Table 4.53** provides a summary of data available from FSANZ for median intakes from all dietary sources and their percentage of the tolerable daily intake (where available).

Table 4.53
Median Intakes of Metals from all Dietary Sources

Metal	Intakes from all dietary sources (mg/kg/day) [% of TDI]	
	Children	Adults
Lead	0.00027 [--]	0.00013 [--]
Arsenic	0.0014 [--]	0.00055 [--]
Cadmium	0.00032 [40%]	0.00011 [14%]
Copper	0.054 [96%*]	0.021 [15%*]
Manganese	0.15 [--]	0.063 [--]
Zinc	0.40 [100%*]	0.15 [30%*]
Cobalt	0.00078 [--]	0.00038 [--]
Mercury	0.00013 [3%]	0.000047 [1%]
Nickel	0.0046 [--]	0.0016 [--]

-- No TDI adopted by FSANZ

* Based on an upper limit for nutrient intake as defined by FSANZ. No TDI has been determined by FSANZ for these metals.

Source: enRiskS (2020) – Table 4.7

4.8.3.7 Noise Environment

A detailed summary of the existing noise environments within the rural areas around the Mine Site and within Lue is provided in Section 4.2.2.1.

4.8.4 Methodology for Assessing Human Health Risk

The assessment of risks to human health associated with the Project was undertaken using the methodology and framework outlined by enHealth (2012), where the following four key tasks were undertaken.

1. Task 1 – Data Review, Evaluation and Issue Identification

   Review of existing information on the community, existing environmental exposures, and all information available on the potential impact of the Project on air quality, noise and water quality. The review is undertaken to understand who is, or may be, exposed to Project-related impacts, and whether these impacts are significant enough to warrant a more detailed assessment of health impacts.

2. Task 2 – Toxicity/Hazard Assessment

   Identifying and understanding how community exposures to the potential issues identified can result in adverse health effects (i.e. how toxic are the chemicals or stressors), what these health effects are and how they can be quantified. The quantification of potential hazards or toxicity is undertaken using quantitative guidelines or toxicity reference values. In some cases, this aspect is undertaken on a qualitative basis.

3. Task 3 – Exposure Assessment

   Exposure to the potential issues identified is quantified based on who may be exposed (receptors) and how they may be exposed (pathways). The quantification of exposure considers how the community may be exposed via a wide range of pathways including inhalation, ingestion and dermal contact with dust deposited on surface soil or as indoor dust, the accumulation of chemicals deposited onto surface soil into edible produce, the presence of chemicals (from the Project) in water used for recreational use (i.e. ingestion and dermal absorption during swimming), irrigation (using surface water or groundwater) or drinking water (including tank water).

   Where noise sources are considered, the exposure aspect is used to identify changes in noise (and vibration) levels during the day time and night time at key areas, such as privately-owned residences.

4. Task 4 – Risk Characterisation

   The findings of Tasks 1 to 3 are used to provide a quantitative assessment of human health risk. The health risk results are expressed as hazard quotients for key chemicals that are not genotoxic carcinogens, or where there are thresholds relevant to the assessment of impacts (such as noise guidelines). Assessment of genotoxic carcinogens is not relevant to the Project as no genotoxic carcinogens are associated with this Project.

Further details regarding the methodology and approach to the assessment and the various guidelines applied to the assessment is provided in Section 1 of enRiskS (2020).

4.8.5 Assessment of Air Quality Impacts

4.8.5.1 Introduction

Air quality impacts that have been assessed for the Project (see Section 4.4.2.5) include those associated with the following.

- Emissions of TSP, PM_{10} and $PM_{2.5}$ from both mechanical and combustion sources, with consideration of effects from the particle size only as well as the composition of metals on these particulates.
- Emissions of silica within $PM_{2.5}$, based on the free silica (quartz) content of the Bowdens deposit.
- Emissions of hydrogen cyanide from volatilisation within the processing area and on the active surface of the TSF.

Potential health impacts related to the above emissions are addressed in this section. It is noted that blast fume has been considered as part of the air quality assessment (Section 2.5 of Ramboll, 2020). Ramboll (2020) notes that adoption of the industry Code of Practice has been demonstrated to effectively control blast fume and no further assessment is required. Therefore, blast fume is not further considered as part of the human health risk assessment.

4.8.5.2 Dust – Particle Size Only

Evaluation of size alone as a single factor in determining the potential for particulate toxicity is difficult since the potential health effects are influenced by chemical composition of particulate matter. Notwithstanding, there is strong evidence to conclude that fine particles ($PM_{2.5}$) are more hazardous than larger ones (coarse particles - PM_{10} and larger). A significant amount of research has been conducted on the health effects of particulates with causal effects relationships identified for exposure to $PM_{2.5}$ (alone or in conjunction with other pollutants).

Particulate matter has been linked to adverse health effects after both short-term exposure (days to weeks) and long-term exposure (months to years). The health effects associated with exposure to particulate matter vary widely (with the respiratory and cardiovascular systems most affected) and include mortality and morbidity effects.

For the assessment of the Project, cumulative exposures (i.e. exposures from all sources – existing and the Project) have been compared against the NEPM ambient air guidelines (NEPC, 2016). The Air Quality Assessment (Ramboll, 2020) has presented an assessment of the Project based on cumulative $PM_{2.5}$ concentrations, with comparisons against the NEPM air guidelines. The results of this assessment have been summarised in detail in Section 4.4.2.5 with key points repeated as follows.

- There are no privately-owned residences where the cumulative annual average concentrations of $PM_{2.5}$ exceed the NEPM air guideline with the maximum cumulative predicted concentration of 4.7µg/m³ being well below the guideline of 8µg/m³ and the NEPM goal for 2025 of 7µg/m³.

- There are no privately-owned residences where the cumulative concentrations of $PM_{2.5}$ exceed the NEPM air guideline for a 24-hour average with the maximum predicted cumulative concentration 16.2µg/m³ well below the guideline of 25µg/m³ and the NEPM goal for 2025 of 20µg/m³.

It is noted that the above standards and goals available for the assessment of $PM_{2.5}$ are not based on a defined level of risk that has been determined to be acceptable. Rather, they are based on balancing the potential risks due to background and urban sources to lower impacts on health in a practical way. The available evidence does not suggest a threshold below which health effects do not occur. Accordingly, there are likely to be health effects associated with background levels of $PM_{2.5}$, even when the concentrations are below the current guidelines.

Therefore, in assessing potential health impacts, a calculation of incremental changes in $PM_{2.5}$ exposures from the Project alone has been undertaken, focusing on the key health endpoint, mortality (all causes). This health endpoint captures all other health effects found to be causally related to $PM_{2.5}$ exposure and is the most significant in terms of calculating risks related to changes in $PM_{2.5}$ exposures. The maximum incremental risk for exposure to changes in $PM_{2.5}$ at privately-owned residences is calculated to be $5x10^{-5}$ (or 1 in 50 000), which is lower than the 10^{-4} risk level (or 1 in 10 000) outlined in the NSW EPA Approved Methods as being unacceptable. Hence, health impacts related to exposure to $PM_{2.5}$ of all residents of Lue and surrounding the Mine Site, based on the particle size alone are considered to be acceptable.

4.8.5.3 Dust – Metals

Approach to Assessing Exposure Risk

The quantification of potential exposure and risks to human health associated with the emissions of metals from the Project has been undertaken by comparing the estimated intake from existing exposures and exposures related to the Project (or exposure concentrations) with the threshold values adopted that represent a tolerable intake (or concentration). The calculated ratio is termed a Hazard or Risk Index (HI or RI), which is the sum of all ratios (termed Hazard or Risk Quotients (HQ or RQ)) over all relevant pathways of exposure (e.g. inhalation, oral, and dermal).

In reviewing and interpreting the calculated RI, the following is noted.

- An RI less than or equal to a value of 1 (where intake or exposure is less than or equal to the threshold) represents no cause for concern as outlined in NEPM guidance (NEPC, 1999 amended 2013b).
- An RI greater than the value of 1 requires further consideration within the context of the assessment undertaken, particularly with respect to the level of conservatism in the assumptions adopted for the quantification of exposure and the level of uncertainty within the toxicity (threshold) values adopted.

Acute (Short-term) Exposure

The calculated RIs for project-related acute inhalation exposures to the maximum 1-hour average concentration of metals attached to $PM_{2.5}$ particulates predicted at both Project-related and privately-owned residences for each modelled Air Quality scenario, are presented in **Table 4.54**. The calculated RI relate to exposures by all members of the community, of all ages.

Table 4.54
Calculated Risk Indices – Acute Inhalation Exposures to Metals in Air ($PM_{2.5}$)

Project Scenario	Calculated RI – Lead		Calculated RI – Total for all metals	
	Max of all Receivers (Project-related and Privately-owned)	Max of all Privately-owned Residences	Max of all Receivers (Project-related and Privately-owned)	Max of all Privately-owned Residences
Scenario 1 (SE&CS)	0.0014	0.00017	0.015	0.0022
Scenario 2 (Year 4)	0.00051	0.00012	0.0057	0.0015
Scenario 3 (Year 8)	0.00044	0.00013	0.0050	0.0015
Scenario 4 (Year 9)	0.00047	0.00013	0.0049	0.0018
Acceptable RI	≤ 1	≤ 1	≤ 1	≤ 1

SE&CS – site establishment and construction stage RI – Risk Index

Source: enRiskS (2020) – Modified after Table 5.3

All calculated maximum RIs are well below 1 and hence there are no acute inhalation exposure risks of concern for the Project. It is noted that inhalation exposures at all other locations in the community, including Lue Public School are lower than those presented in **Table 4.54** and are therefore also not considered to be of concern.

Chronic (Long-term) Exposure

In assessing chronic metal exposure, consideration has been given to:

- existing exposures;
- inhalation exposure;
- multi-pathway exposures, including ingestion and dermal contact with soil, ingestion and dermal contact with water in rainwater tanks, and ingestion of homegrown produce; and
- exposures from all existing and Project-related sources (i.e. the cumulative exposure).

Table 4.55 presents the calculated RIs for existing exposures to metals. The existing intakes of the more abundant metals in the environment account for between 15% and 45% of the acceptable/tolerable daily intake (RI between 0.15 and 0.45) for adults. Existing intakes of metals in the environment for children are generally higher than for adults, mainly as a result of a greater intake of these metals from dietary sources. This is particularly relevant to manganese, where dietary intakes account for all of the tolerable daily intake with key sources in the diet including cereal products, such as breads, and vegetables. The data is only representative of potential dietary intakes and it is noted that, while an acceptable/tolerable daily intake has been adopted in this assessment for manganese, Food Standards Australia New Zealand (FSANZ) has indicated that no upper limit for manganese intakes has been determined.

Table 4.56 presents the calculated maximum RIs for chronic inhalation exposures from the Project at the most impacted Project-related and privately-owned residences. All calculated maximum RIs are well below 1 indicating that the incremental increase in exposure to metals from the inhalation of dust generated from the Project would be very low and considered negligible.

Table 4.55
Risk Indices for Existing Exposures to Metals

Metal	Calculated RI	
	Young children	**Adults**
Lead	0.28	0.35
Arsenic	0.79	0.33
Cadmium	0.51	0.25
Chromium	0.15	0.03
Cobalt	0.6	0.28
Copper	0.39	0.15
Lithium	0.019	0.0020
Manganese	1.1	0.45
Mercury	0.21	0.079
Nickel	0.47	0.21
Silver	0.00058	0.000063
Zinc	0.85	0.35
Acceptable RI	*≤ 1*	*≤ 1*
Source: enRiskS (2020) – Modified Table 5.4		RI = Risk Index

Table 4.56
Calculated Risk Indices – Chronic Inhalation Exposures to Metals in air ($PM_{2.5}$) from the Project

Project Scenario	Calculated RI – Lead		Calculated RI – Total for all metals	
	Max of all receivers (Project-related and privately-owned)	**Max of all privately-owned residences**	**Max of all receivers (Project-related and privately-owned)**	**Max of all privately-owned residences**
Scenario 1 (SE&CS)	0.015	0.00050	0.029	0.0011
Scenario 2 (Year 3)	0.014	0.00066	0.027	0.0013
Scenario 3 (Year 8)	0.012	0.00039	0.023	0.00086
Scenario 4 (Year 9)	0.012	0.00042	0.022	0.0010
Acceptable RI	*≤ 1*	*≤ 1*	*≤ 1*	*≤ 1*
SE&CS – site establishment and construction stage				RI = Risk Index
Source: enRiskS (2020) – Modified after Table 5.5				

Table 4.57 presents the calculated maximum RIs for young children's exposures to metals derived from the Project that may deposit onto soil and surfaces and result in exposure to soil, water in rainwater tanks, and produce that is homegrown. All calculated RIs for chronic exposures to all metals (including lead) that may be deposited to soil or other surfaces at privately-owned residences from dust emissions from the Project are all well below 1. This indicates that the incremental increase in exposure to metals via these multi-pathway exposures from dust generated from the Project would be very low and considered negligible.

Table 4.57
Calculated Risk Indices - Multi-pathway Exposures to Metal Deposited from the Project - Young Children

Project Scenario	RI for Each Exposure Pathway - Maximum Impacted Privately-owned Residence					
	Ingestion and dermal contact with soil	Ingestion and dermal contact with water in rainwater tanks	Ingestion of homegrown produce			
			Fruit and vegetables	Eggs	Meat	Milk
Exposure to lead in dust emissions						
Scenario 1 (SE&CS)	0.0026	0.0037	0.0030	0.000003	0.000009	0.0003
Scenario 2 (Year 3)	0.0025	0.0039	0.0028	0.000003	0.000009	0.00015
Scenario 3 (Year 8)	0.0029	0.0044	0.0033	0.000004	0.000010	0.00018
Scenario 4 (Year 9)	0.0030	0.0046	0.0034	0.000004	0.000010	0.00019
Exposure to all metals in dust emissions						
Scenario 1 (SE&CS)	0.0063	0.0050	0.0045	0.000011	0.00024	0.0036
Scenario 2 (Year 3)	0.0059	0.0054	0.0042	0.000010	0.00023	0.0032
Scenario 3 (Year 8)	0.0070	0.0061	0.0049	0.000012	0.00027	0.0038
Scenario 4 (Year 9)	0.0080	0.0065	0.0054	0.000015	0.00031	0.0047
Acceptable RI	*≤ 1*	*≤ 1*	*≤ 1*	*≤ 1*	*≤ 1*	*≤ 1*
SE&CS – site establishment and construction stage						RI = Risk Index
Source: enRiskS (2020) – Modified after Table 5.6						

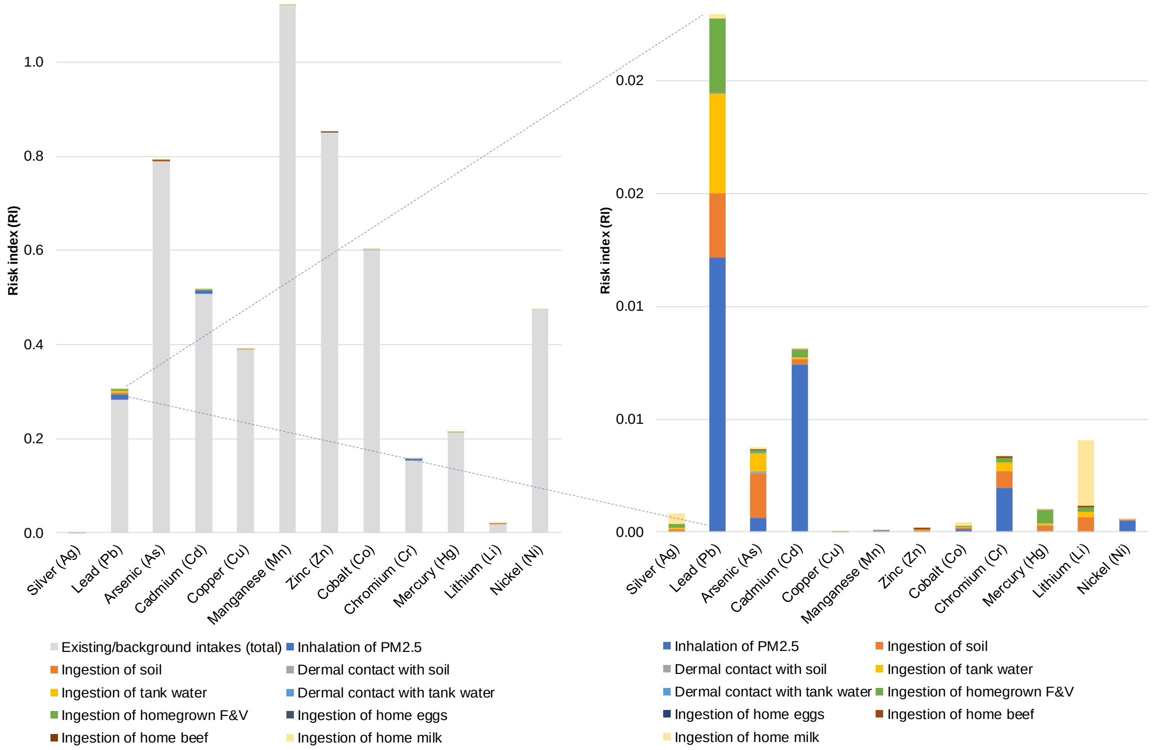
When evaluating the risks related to exposures to metals, all intakes of these metals are to be considered. **Figure 4.8.5** presents the calculated RIs for the maximum impacted privately-owned residence for each metal for young children and adults for Scenario 3 (Year 8). Emissions during Year 8 are similar to those in other years and therefore Year 8 is suitable to illustrate the contribution of the Project to the total RI. The figures show the total RI calculated, existing exposures plus all Project-related exposure pathways (assuming these all occur on the property, as well as the incremental RI from the Project (for each pathway).

The following can be concluded from **Figure 4.8.5**.

- The calculated RIs associated with all intakes remain dominated by the existing intakes of metals with Project-related emissions making a negligible change in the total RI calculated.
- The existing intakes of manganese for young children is already elevated with any incremental exposure from the Project being negligible.
- For lead exposures, the Project contributes a small amount to the total RI. The total RI associated with the combined existing and Project-related exposures is below the target RI of 1.
- For exposure to all other metals, the Project contribution to the total RI is negligible and no total RI (existing plus Project) results in the RI exceeding the target of 1.

Based upon the assessment of exposure at the maximum impacted privately-owned residence, enRiskS (2020) concluded that there should be no health risk issues of concern in the community in relation to emissions of metals in dust from the Project.

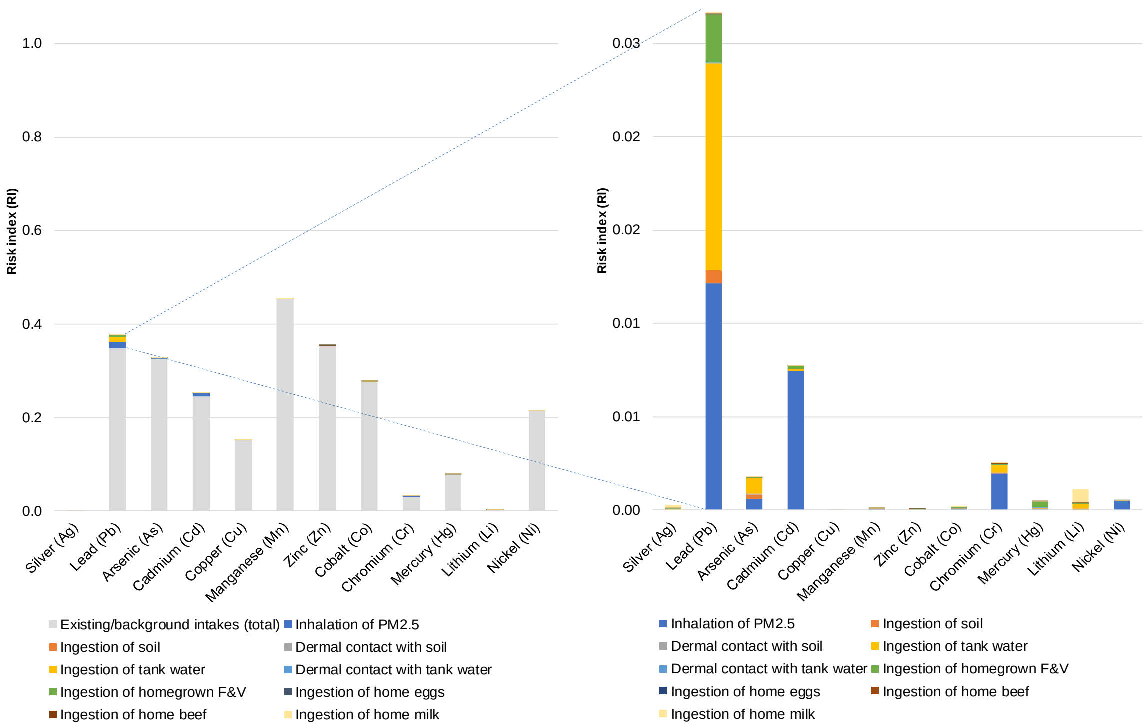
Figure 4.8.5
Calculated Risk Indices for existing and Project exposures (Scenario 3 – Year 8)



RI from existing exposures (grey) plus Project (colour)

Incremental RI from Project alone

YOUNG CHILDREN



RI from existing exposures (grey) plus Project (colour)

Incremental RI from Project alone

ADULTS

Source: enRiskS (2020) – Figures 5.4 and 5.5

Notwithstanding that no health risk issues of concern have been identified at the maximum impacted privately-owned residence, given the community concern in relation to lead, the calculated RI for lead for young children and adults at all assessed privately-owned residences is presented in **Figure 4.8.6**. The data is presented for the RI from existing exposures plus exposures from lead in dust from the Project in Year 8 (the representative year selected).

For context, at the Lue Public School, the calculated RI for exposures to lead from the Project via the inhalation of dust, ingestion and dermal contact with lead deposited to soil and dust on surfaces and lead that accumulates in rainwater tanks (assuming these are used to supply water at the school) is 0.001, which is 1000 times lower than the acceptable RI of 1. These Project-related impacts of lead in dust are therefore considered negligible.

4.8.5.4 Silica

Specific health effects of respirable crystalline silica are related to repeated and prolonged workplace exposure (typically over many years) to concentrations of respirable crystalline silica. These exposures may cause a lung disease called silicosis (fibrotic scarring of the lungs) and may also be associated with lung cancer. In relation to non-occupational exposures or exposures in a community, there are limited guidelines available. EPA Victoria (EPA, Victoria 2007) has established a guideline of 3µg/m³ for respirable crystalline silica (as $PM_{2.5}$, over an annual average). The Victorian guideline has been adopted for the purpose of the air quality assessment of the Project.

The range of predicted concentrations of respirable silica (as $PM_{2.5}$) predicted by Ramboll (2020) are as follows.

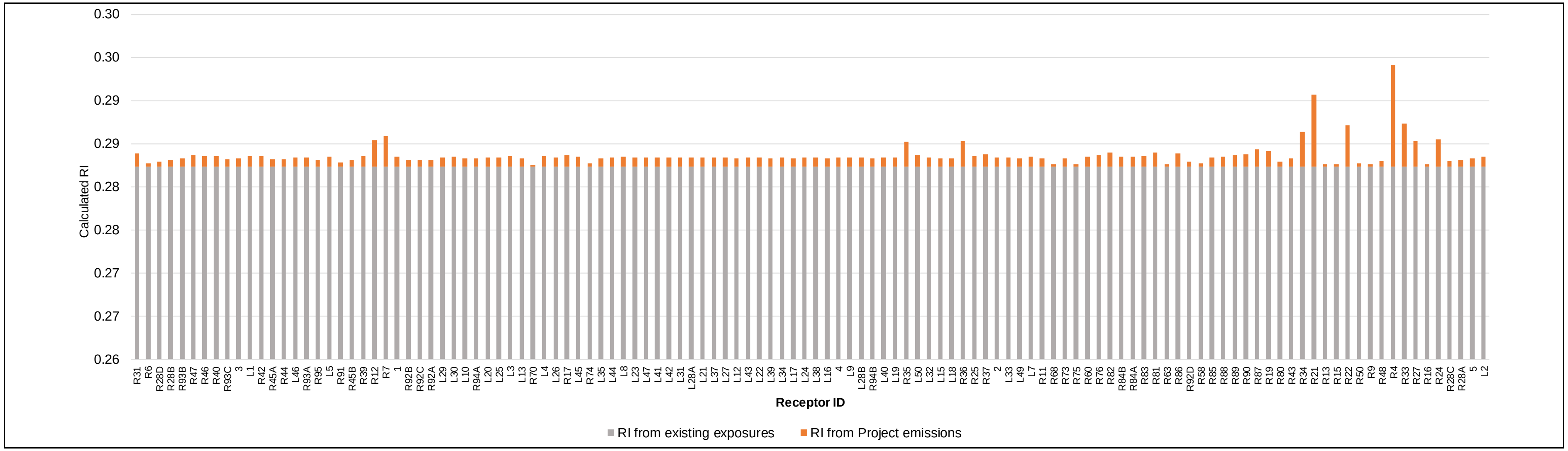
- Project-related receivers 0.02µg/m³ to 0.76µg/m³.
- Privately-owned rural residences 0.00µg/m³ to 0.21µg/m³.
- Privately-owned Lue residences 0.03µg/m³ to 0.06µg/m³.

The maximum concentrations of crystalline silica derived from the Project remains well below the available health-based guidelines at the both Project-related and privately-owned residences. On this basis, enRiskS (2020) conclude that there are no health risk issues of concern in relation to community exposures to respirable crystalline silica derived from Project operations.

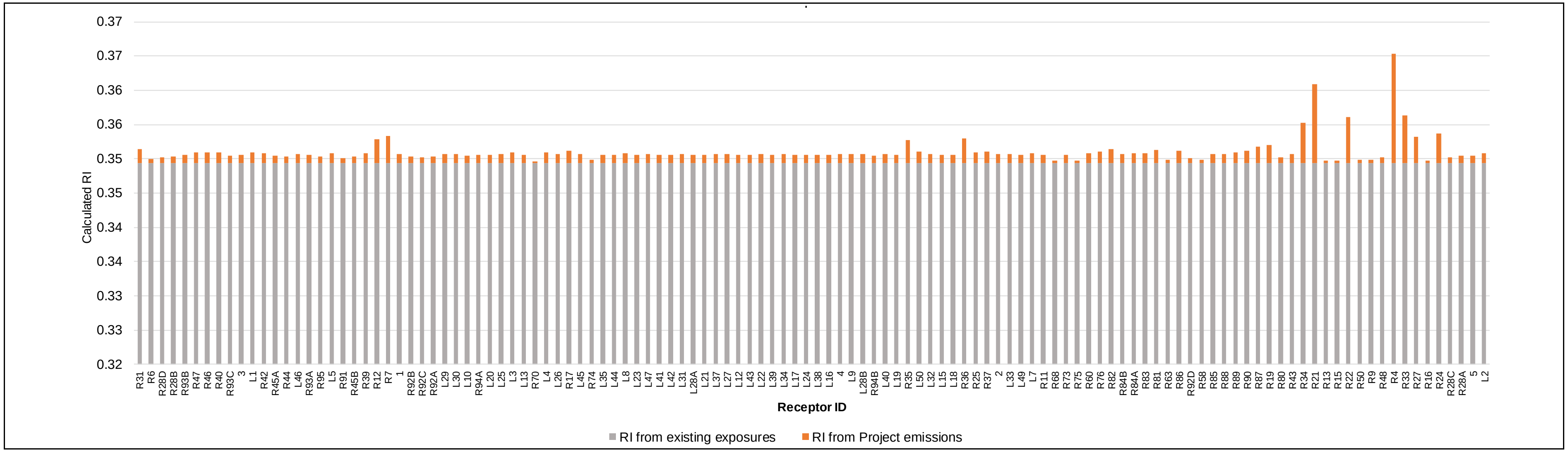
4.8.5.5 Hydrogen Cyanide

As discussed in Section 2.7, sodium cyanide (NaCN) is proposed to be used as a zinc depressant in the processing plant for the Project. Once dissolved in water, the cyanide component takes a number of chemical forms, including hydrogen cyanide (HCN). A small proportion of this will volatilise (become gaseous) during the processing operation (estimates based on the National Pollutant Inventory suggest ~1% of the total cyanide). The remainder of cyanide that is lost from the process is contained within the tailings pumped to the TSF. Cyanide would be present in a number of forms including: strongly complexed forms (e.g. bound with iron); weakly complexed forms; and free cyanide (in the form of HCN or the free cyanide ion CN^-). The weakly complexed forms and free cyanide are often measured as weakly acid dissociable (WAD) cyanide.

Young Children



Adults



Source: enRiskS (2020) – Modified from Figures 5.6 and 5.7 (note that an acceptable RI is ≤ 1)

Figure 4.8.6 Calculated Risk Indices for Exposure to Lead at Private Residences (Scenario 3 – Year 8)

The fate of cyanide within the TSF may follow several routes including volatilisation as HCN gas which is subsequently broken down through UV light (photolysis) or biological oxidation. Cyanide that is not volatised may also be broken down over time by biological processes (ultimately producing methane, ammonia and carbon dioxide) or form a stable complex which precipitates within the TSF sediments.

The cyanide ion (CN^-) is toxic because it inhibits cellular oxygen metabolism and energy production. The principal feature of the toxicity profile for cyanide is its high acute toxicity by all routes of exposure (inhalation, dermal contact or ingestion), however, cyanide does not bioaccumulate and is not carcinogenic. The toxicity of hydrogen cyanide gas is dominated by the acute health effects which commonly result in effects prior to determining any chronic health effects (WHO, 2004). Hence, the prevention of acute effects associated with inhalation of hydrogen cyanide is expected to be protective of chronic health effects (enRiskS, 2020).

It is noted that cyanide naturally occurs in the environment, being produced by various microorganisms, plants, algae, fungi and invertebrates, with free cyanide generally released as a result of ingestion of these organisms. Other natural sources include burning vegetation under certain combustion conditions (generally low-temperature smouldering fires). This source is considered the major source of HCN within the atmosphere (NICNAS, 2010).

In relation to Project-related exposures, as the cyanide would be fully contained in solution within the TSF, the exposure route of relevance to the surrounding community is inhalation. For gaseous HCN, a 1-hour guideline of concentration of 2 000µg/m³ is based on no adverse health effects in humans (NRC, 2002), with a lower value of 340µg/m³ established by OEHHA (2008).

The maximum 1-hour average concentrations of gaseous hydrogen cyanide predicted by Ramboll (2020) are as follows.

- Project-related receivers 1.8µg/m³ to 5.9µg/m³.
- Privately-owned rural residences 0.3µg/m³ to 4.1µg/m³.
- Privately-owned Lue residences 1.6µg/m³ to 2.2µg/m³.

The maximum concentrations of gaseous hydrogen cyanide at all surrounding Project-related and privately-owned residences would remain well below the most stringent health-based guideline of 340µg/m³ as well as the EPA Approved Methods criteria of 200µg/m³. On this basis, enRiskS (2020) concludes that there are no health risk issues of concern in relation to community exposures to hydrogen cyanide derived from Project operations.

4.8.6 Assessment of Water Quality Impacts

Impact on Downstream Water Quality

Due to their geochemical properties, both tailings and PAF waste rock have the potential to impact upon water quality. However, due to the proposed mechanisms for the storage and encapsulation of tailings and PAF waste rock, which are designed to minimise seepage and maximise runoff both during operations and post mine closure, no adverse impacts upon water quality are expected from these activities.

The other principal material with the potential to affect water quality is NAF waste rock. Based on the testing of leachate from kinetic testing of NAF waste rock samples, there is a possibility that runoff and seepage from NAF waste rock would contain dissolved metals particularly manganese (see Section 4.7.5.4).

During operations, NAF waste rock would be used to construct the TSF embankment, southern barrier, and placed around the margins of the WRE. Runoff from these areas would be captured and treated in sediment dams sized in accordance with Blue Book requirements for Type D basins (DECC, 2008) before release from the Mine Site in accordance with the requirements of the NSW EPA under the environment protection licence for the Project.

Following completion of operations, the southern barrier would be decommissioned, leaving the outer embankment of the TSF, and the store-and-release cover of the TSF and WRE as potential sources of runoff from NAF waste rock. Sediment dams would remain in place until vegetative cover is sufficiently established to control erosion from these areas. Notably, once the soil and vegetative cover is established, the potential for runoff to directly contact NAF waste rock would be significantly reduced.

As outlined in Section 4.7.5.4, prior to placement of soil and revegetation, runoff from the areas containing NAF waste rock would be managed as contaminated water until such time as it is confirmed that the concentration of soluble metals in the runoff from the NAF waste rock would satisfy the limits nominated in the Project's environment protection licence. Ultimately, it is anticipated that if the runoff from the placed / stockpile NAF waste rock would not be observably different from existing conditions, and hence there would be no health-related impacts identified for the community accessing and using these waterways for recreational purposes.

A site water quality monitoring plan would be implemented during operations to verify that the quality of water captured in the sediment dams is suitable for off-site release, and to monitor receiving water conditions. Although not expected to occur, should water quality be found in the sediment dams to be unsuitable for release, the water would be used for dust suppression instead of being discharged.

Potential Impacts Due to Flooding

A detailed flood impact assessment was carried out for the Project by WRM (2020) and is summarised in Section 4.7.5.7. In summary, the Project is not expected to result in increased flood hazards for the off-site community.

Impacts on Groundwater Quality

As outlined in Section 4.6.7.4, during mining, any changes to groundwater chemistry (for example, as a result of oxidation of acid forming ore and waste rock and subsequent mobilisation in groundwater) would not impact the groundwater system as all water would be removed from the open cut pits for use in processing.

Post-mining, the salinisation of the main open cut pit lake due to evaporative concentration is expected to occur gradually over time. However, as the main open cut pit lake would act as a groundwater sink, the direction of net flow of groundwater would be towards the main open cut pit lake and the saline water would not leave the system.

The impacts of seepage from tailings over time has also been considered by Jacobs (2020) with the conclusion that any impacts would remain localised to areas of groundwater mounding, which would be captured within the predicted cone of drawdown.

Jacobs (2020) concluded that any potential water quality impacts arising from groundwater are not expected beyond 40m from the Mine Site boundary. Therefore, no health risk issues of concern related to impacts from the Project are expected, regardless of the likely use of groundwater in the local area.

4.8.7 Assessment of Noise

4.8.7.1 Potential Health Effects from Noise

Noise has the potential for the following negative health effects.

- Sleep disturbance (sleep fragmentation that results in fatigue and affects psychomotor performance, memory consolidation, creativity, promote risk-taking behaviour and increase risk of accidents).
- Annoyance.
- Cardiovascular health.
- Hearing impairment and tinnitus.
- Cognitive impairment (effects on reading and oral comprehension, short and long-term memory deficits, attention deficit).

Other effects of health impacts considered to be important, but for which the evidence is weaker, include:

- effects on quality of life, well-being and mental health (usually in the form of exacerbation of existing issues for vulnerable populations rather than direct effects);
- adverse birth outcomes (pre-term delivery, low birth weight and congenital abnormalities); and
- metabolic outcomes (type 2 diabetes and obesity).

Perceptible vibration (e.g. from construction activities) also has the potential to cause annoyance or sleep disturbance and adverse health outcomes in the same way as airborne noise. However, the health evidence available relates to occupational exposures or the use of vibration in medical treatments. No data is available to evaluate health effects associated with community exposures to perceptible vibrations.

4.8.7.2 Noise Guidelines for Health Assessment

Construction Noise

Construction noise criteria have been adopted from the Interim Construction Noise Guideline (NSW DECC, 2009) which provide management levels relevant to the assessment of noise impacts above the RBL during standard hours (guideline is RBL + 10 dB(A) = 45 dB(A) for the

Project) with noise levels (total noise from all sources) above 75 dB(A) during standard hours considered to be highly noise affected (see Section 4.2.2.4). While these criteria may result in some construction noise being noticeable, the noise criteria adopted for the Project are protective of health and amenity, where they relate to outside noise levels.

Operational Noise

Noise guidelines adopted in the Noise and Vibration Assessment are those outlined in the Noise Policy for Industry (NPfI) (NSW EPA, 2017). While these noise trigger levels are sufficiently low to be protective of health, they are more conservative than the thresholds for health effects established by the WHO. This is because the NPfI utilises a short-duration time for averaging noise levels, 15-minutes, whereas the WHO guidelines relate to exposures over the day and evening combined (16 hours) or night-time (8 hours).

Table 4.58 presents thresholds that have been determined to avoid detrimental health effects for operational noise based on the relevant WHO guidelines and relate to noise levels outside a home/building (as per the modelling of noise presented by SLR (2020)). The guidelines for outside locations assume windows are left open, which may be the case during at least some of the year in the Lue area.

Table 4.58
Health Protective Noise Thresholds (Noise Levels Outside)

Environment and exposure time (T)	Critical (most sensitive health effect)	$LA_{eq,T}$ (dB(A))	LAmax (dB)
Residents			
Day and evening – 16 hours	Annoyance, cardiovascular effects and disturbance of conversation	50	NA
Night – 8 hours	Sleep disturbance	42	60
Schools			
Day – during class (6 hours)	Speech intelligibility, communication	50	NA
Source: enRiskS (2020) – Table 7.1			NA = Not Applicable

In relation to ‘noise fatigue’ as raised during community consultation, SafeWork Australia (2015) notes that, whilst safe levels to guard against fatigue and other effects have not yet been fully determined, noise levels below 50dB(A) are recommended for “*where work is being carried out that requires high concentration or effortless conversation*”. It also provides for 70dB(A) “*where more routine work is being carried out*”. Therefore, the adoption of 50dB(A) during day time periods is also considered an appropriate threshold for ‘noise fatigue’.

Road Noise

Road traffic noise was assessed on the basis of the NSW Road Noise Policy (NSW DECCW, 2011), as it applies to existing receivers affected by additional traffic (see Section 4.2.2.4). This provides a guideline of 55dB(A) to 60dB(A) as $LA_{eq,15\ hour}$ (day and evening) and 55dB(A) as $LA_{eq,9\ hour}$ (night) for residential and 50dB(A) for Lue Public School (relevant to school hours). These guidelines are higher than the health-based goals relevant to road noise traffic from the WHO (WHO, 2018) but consistent with the upper end of noise criteria established in previous WHO guidelines for outdoor noise predictions (WHO 1999, 2009).

Blasting

Blasting impacts have been evaluated in accordance with criteria established to protect human annoyance and structural damage (Australian Standard [AS] 2187: Part 2-2006 Explosives – Storage and Use (see Section 4.3.3)). Provided the human comfort criteria are met, there would be no concern in relation to health impacts.

4.8.7.3 Impacts from Construction Noise

Assessment of construction noise impacts (see Section 4.2.2.7) identified some exceedances of the Interim Construction Noise Guideline at privately-owned residences. Five exceedances were predicted during the construction of the new intersection between Lue Road and the proposed relocated Maloneys Road. For one property, the exceedance of the guideline was determined to be negligible to marginal (1 to 5 dB(A) above the guideline). For four properties, the exceedance of the guideline was determined to be moderate (>5 dB(A) above the guideline). These exceedances are expected to occur over a 1-2 month period. No properties were considered to be highly noise affected by construction activities.

Some noise impacts were also predicted at a number of properties during the power transmission line realignment works, during the operational Year 3 works, which were determined to be negligible (12 properties), marginal to moderate (5 properties) and significant (5 properties), also associated with the most intensive works related to the power transmission line realignment works which are expected to occur within the day-time (7:00am to 6:00pm), Monday to Saturday, over a 1-2 month period.

Some noise impacts were also predicted during the construction of the water supply pipeline. SLR (2020) calculate that the highly noise affected level of 75 dB(A) would be satisfied at an offset distance of approximately 50m from the water supply pipeline route. There are five residences located less than this distance from the water supply pipeline route. However, whilst noise exceedances would be noticeable at these residences, the duration of these noise levels would likely occur for 1 to 2 days at each residence. As such, the impact from these exceedances would be minimal, particularly with discussion of the planned activities with the occupants of each residence prior to the commencement of construction to ensure impacts are minimised or avoided.

The noise impacts identified would be managed by Bowdens Silver in accordance with an approved Construction Noise Management Plan (CNMP). Where noise impacts are appropriately managed during the noise intensive works, potential impacts on health would be minimised. It is noted, that while the potential for health impacts would be minimised, noise may be noticeable at some properties intermittently.

4.8.7.4 Impacts from Operational Noise

Site Noise

Predicted maximum noise levels at each privately-owned residence as $L_{Aeq,15\text{-minute}}$ during the day, evening and night-time periods, for the modelled scenarios for standard and worst-case meteorological conditions were provided by SLR (2020) for use in this assessment. Review of these results against amenity criteria is provided in Section 4.2.2.7. In order to compare these noise predictions with thresholds for health effects (see **Table 4.58**), the $L_{Aeq,period}$ was calculated for the day, evening and night-time periods. The results for the site establishment and construction stage with the representative worst-case scenario presented in **Figure 4.8.7**.

Source: enRiskS (2020) – Modified from Figures 7.2, 7.3 and 7.4

Figure 4.8.7
PREDICTED NOISE LEVELS FOR PRIVATELY-OWNED RESIDENCES AS LAEQ,DAY (dB(A))

As can be seen from **Figure 4.8.7**, modelled noise levels during the day, evening and night at all privately-owned properties, including places of interest such as Lue Public School, are below the health-based threshold.

On this basis, there are no health impacts of concern in relation to noise impacts from the Project. It is noted, that given the existing comparatively quiet noise environment of the area, it is likely that, at times, noise from the Project would be audible and distinguishable above background noise levels. While these noises may be distinguishable, they would remain too low to impact upon community health. Notwithstanding, the potential social impact of such noise is noted and further discussed in Section 7.6 of the social impact assessment (Umwelt, 2020) and Section 4.20.6.7.

Road noise

Road noise impacts were assessed from the expected road traffic volumes relevant to the Project, on Lue Road, Pyangle Road and the relocated Maloneys Road. The assessment determined that noise at all receptors along these roads would comply with the relevant noise guidelines with the exception of Lue Public School. While the predicted total noise level at the school exceeds the adopted guideline for road traffic noise, this exceedance mainly relates to existing traffic on Lue Road with the Project impacts contributing a 0.5dB(A) to 1dB(A) increase in noise. Such noise impacts are considered to be minor and would not be perceptible.

All noise impacts predicted at all privately-owned roadside residences meet the relevant noise criteria. As these noise criteria are protective of health, there would be no health impacts of concern in relation to road noise.

Overall, based on the available information, the potential for noise impacts to result in adverse health impacts within the community is considered to be negligible.

4.8.7.5 Impacts from Blasting

The assessment conducted by SLR (2020) determined that, based upon the blast assessment, the human comfort criteria relevant to blasting activities would be met at all locations except at three properties although the designs of the actual blasts would be varied to achieve compliance with the human comfort criteria at all privately-owned residences. These impacts would be managed through the implementation of a Blast Management Plan (BMP) to ensure impacts are minimised. Therefore, it is not expected that the impacts, where managed appropriately, would result in health impacts.

4.8.8 Mental Health Considerations

As part of the community engagement process, Umwelt (2020) records that respondents frequently raised issues that they perceived would impact on the health and wellbeing of the population (112 responses). Respondents were concerned about lead and dust particles contaminating the air (43), the potential for lead and other heavy metals to contaminate water systems (38), and the increased stress and anxiety as a result of the Project and its potential impacts (5).

The physical health impacts, particularly regarding dust, water, lead and other metals have been addressed in Sections 4.8.5 and 4.8.6. However, further consideration is also required for the potential impacts upon stress and anxiety levels These aspects can be considered as mental health matters, although it is noted that mental health also affects physical health.

It is acknowledged that, for some members of the community, the uncertainty regarding the approval, or otherwise, of the Project has resulted in an increase in stress and anxiety levels. This may be the result of perceived impacts if the Project is approved and, in some cases, concern that, if the Project is not approved, employment and income benefits to the locality would not eventuate. Therefore determination of the Project will have a significant mitigating effect on those uncertainties for many members of the community.

Notwithstanding, should the Project be approved, members of the community concerned about negative impacts may continue to experience stress and anxiety. It is likely that a lack of information and uncertainty about the extent of impacts that are actually occurring may be a significant contributor or misinformation circulated by opponents to the Project. Therefore, a range of management measures have been proposed to keep the community accurately informed about the activities and results of monitoring (see Section 1.8.3 and 4.20.5). As the Project progresses, and with demonstrated compliance with relevant air and water quality criteria, the level of stress and anxiety regarding these matters would be expected to reduce. Residual mental health effects would be further mitigated through proposed support for health services as part of Bowden Silver's Community Investment Program.

For other members of the community, the approval of the Project would result in positive mental health effects. Various research shows that economic downturns, resulting in unemployment and income decline, can exacerbate mental health issues. Umwelt (2020) recorded during the random community survey that unemployment was a significant perceived challenge facing the community, particularly given the loss of several local businesses in the LGA (e.g. the cement / lime works and the recent Bylong Coal Project refusal by the IPC). Furthermore, throughout the community engagement process managed by Umwelt, the opportunity for local employment was the most frequently identified positive social impact, with respondents in Round 1 (31) and Round 2 (30) identifying that the Project would:

- provide jobs locally and regionally;
- facilitate training of young people in the area; and
- provide a much needed boost to the Rylstone – Kandos area in particular, given the current economic climate.

With the proposed a range of measures to maximise the local benefit of employment and use of local businesses, the potential positive mental health benefits of the Project would be maximised.

4.8.9 Management and Mitigation Measures and Opportunities for Health Improvement

The management and mitigation measures for noise, air quality, groundwater and surface water are summarised in Sections 4.2.2.5 and 4.2.3.4, 4.4.2.3 and 4.4.3, 4.6.8, and 4.7.4 respectively. Notably, rather than applying a 'buffer zone' around the mine, the respective assessments have assessed the potential impacts at the nearest potentially affected privately-owned residences and developed management measures appropriate to these assessed impacts.

Whilst no physical health risk issues of concern have been identified through the Human Health Risk Assessment, should development consent be granted for the Project and prior to commencement of mining operations, a baseline blood lead level testing program would be offered to Lue and district residents to enable surrounding residents to understand their existing lead exposures. Blood lead level testing would also be offered at ongoing intervals during operations. Additionally, an information package providing an outline of the existing potential exposure pathways to lead and other metals and ways in which exposures can be reduced would be provided to all residents in the locality together with the lead monitoring results.

Given that the Project is assessed as having negligible incremental impact on exposure to metals, these measures represent opportunities for health improvement. In particular, the blood lead level testing and information package would improve people's understanding of their existing exposure pathways to metals in the environment and could provide long-term health benefits. As demonstrated through the baseline monitoring and testing, a range of opportunities existing for people to reduce their existing exposure to metals.

In relation to mental health, to help mitigate potential impacts, the following strategies are proposed.

- Regular publication of environmental monitoring results relating to lead in air and water so as to reduce uncertainty and related stress/anxiety regarding the extent of impacts.
- Support for health service programs in the region as part of Bowden Silver's Community Investment Program.
- Maintaining an open-door policy and implementing a good neighbour program involving regular and ongoing community engagement, providing opportunity to discuss and provide information in relation to impact monitoring and management.
- Maximising employment of persons residing in the Mid-Western Regional LGA to reduce drive-in/drive-out and possibly fly-in/fly-out employees thereby reducing the mental health issues (for both the employee and families) associated with employees living away from home.
- Management of noise impacts so as to reduce potential for sleep disturbance and associated mental health impact.

As discussed in Section 4.8.8, whilst it is acknowledged that some residual negative mental health impacts would likely remain, the implementation of these management measures would minimise these residual impacts. Furthermore, mental health benefits would likely be achieved through not only the economic and employment opportunities but also through the Community Investment Program and by preserving the character of Lue.

4.8.10 Conclusion

The HHRA considered potential impacts on community health in relation to the predicted / assessed changes in air quality, water (both surface water and groundwater) and noise and has considered the rural-residential nature of the existing community, as well as Lue where Lue Public School is located.

Air

The assessment of air quality has focused on dust emissions from the Project as this is an issue of key concern to some members of the Lue and district community. The presence of lead and other metals that may be present in these dust emissions has been evaluated in detail. The HHRA has addressed all exposures that may occur in the area, such as the inhalation of dust, the deposition of dust onto roofs and the washing of these dusts into rainwater tanks where water may be used for drinking/ household uses, the deposition of dust to soil and other surfaces where people may come into direct contact, and/or the accumulation of these metals into home-grown produce that may be consumed.

The HHRA has concluded that impacts derived from the Project make a negligible contribution to overall exposures to the assessed metals and there are no health risk issues of concern relevant to the Project (during both the site establishment and construction stage and operational stage). These conclusions apply to all members of the community, adults and children as well as sensitive individuals.

Water

Based on the assessments undertaken, the potential for adverse health impacts within the off-site community associated with impacts to surface water and groundwater as a result of the Project is considered to be negligible.

Noise

Based on the predicted noise levels and potential mitigation measures, the potential for adverse health impacts within the off-site community associated with noise generated during construction and operations is considered to be negligible.

Mental Health

In addition to physical health impacts, mental health impacts, including stress and anxiety, have been also considered. It is acknowledged that, should the Project be granted development consent, some members of the community would experience a degree of stress and anxiety whilst others would experience mental health benefits, particularly through the employment and income opportunities generated. A range of management and mitigation measures have been proposed to minimise the negative mental health impacts and to maximise the positive mental health benefits.

The peer review of the HHRA noted the following.

- The HHRA has been comprehensive and systematic in reviewing the geological characteristics of the region, as well as the geographic relationship of the proposed mine with nearby residential areas and the demographics of the region.
- Particular attention has been paid to the township of Lue where there has been a history of community concerns raised about the Project.
- It represents a comprehensive and fair assessment of likely health impacts associated with projected mine operations during both construction and operational phases.

A number of minor edits and suggested additional discussion matters were raised during the peer review which were subsequently addressed within the HHRA to the satisfaction of the peer reviewer.

4.9 VISIBILITY

The visual impacts assessment of the Project was undertaken by Richard Lamb and Associates (RLA). The full assessment is presented in Volume 3 Part 8a of the Specialist Consultant Studies Compendium and is referenced throughout this document as RLA (2020).

The approach to the mitigation measures to minimise lighting impacts and the assessment of potential sky glow and the Project's impacts on the astronomical operations upon the Siding Spring Observatory and other local astronomical observatories was undertaken by Lighting, Art & Science Pty Limited (LAS). The full assessment is presented in Volume 3 Part 8b of the Specialist Consultant Studies Compendium and is referenced throughout this document as LAS (2020).

4.9.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in visibility and lighting impacts. These risk sources and the assessed risk of impacts occurring <u>after</u> the adoption of standard mitigation measures are as follows.

- Amenity impacts through the change in content and composition of views from six privately-owned residences and the local public road network during the construction of the TSF embankment, southern barrier, oxide ore stockpile and the lower embankment haul road and barrier (High).
- Amenity impacts through the change in content and composition of views from six privately-owned residences and the local public road network during operations within the open cut pits (initially), WRE, southern barrier, oxide ore stockpile and low grade ore stockpiles (High).
- Visual intrusion or a reduction in scenic quality due to direct/indirect lighting or sky glow after dusk at nearby privately-owned residences and within Lue as a result of lighting or sky glow impacts after dusk (Low).
- Visibility of on-site traffic and earthmoving equipment operating within the Mine Site (during the day-time and after dusk due to equipment lights) and visibility of increased traffic on local roads (including heavy vehicles) (Low).
- Impacts on astronomical operations at the Siding Spring Observatory and local observatories due to night sky brightness above the observatories created by the Project lighting (Low).

In addition, the SEARs issued by the former DPE identified "visual impacts" as a key issue requiring assessment. The principal assessment requirements identified by the DPE relating to visual impacts included the following.

"Likely visual impacts of the Project on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to the creation of any new landforms and minimising the lighting impacts of the development."

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from Mid-Western Regional Council. These requirements are summarised as follows.

- Light modelling be carried out to demonstrate the likely impacts of light on neighbouring properties and Lue.

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC.

This section focusses upon the visual impacts relating to the activities within the Mine Site during both the day-time and after dusk, with brief reference to the relocated Maloneys Road and the water supply pipeline. Brief coverage of visual impacts during the construction of the water supply pipeline is provided in Section 4.9.5.5.

4.9.2 Existing Visual Environment

4.9.2.1 Introduction

The description of the existing visual amenity was undertaken by Dr Lamb following an extensive inspection of the local area around the Mine Site during which observations were made from the public road network and those private residences where access was granted to better understand the extent and features of the views towards the Mine Site. As a result of the visits to eight residences, Dr Lamb was able to establish whether sections of the Mine Site would be directly visible, partially visible or not visible from the residences visited. A series of photographs were taken at 53 viewing locations including residences within the potential visual catchment (see **Figure 4.9.1**) towards the Mine Site together with a range of observations from elevated areas within the Mine Site into the surrounding landscape to identify residences and public domain locations that equally would have direct or indirect views of areas within the Mine Site where Project components are planned.

4.9.2.2 Landscape Setting

Regional and Local Visual Setting

Regionally, the Mine Site is located on the interface between highly dissected sandstone plateaus and the underlying and nearby flatter erosional rural landscapes. The plateaux display steep topography and supports a range of native woodland and forest vegetation. The valley floors are predominantly cleared with the steeper residual hills generally supporting significant stands of native vegetation.

Locally, the eastern section of the Mine Site is located adjacent and to the north of Hawkins Creek which is fed by a few ephemeral watercourses that flow southwards in narrow valleys from the elevated rocky slopes within the Mine Site. Hawkins Creek joins Lawsons Creek approximately 1km south of the Mine Site which, in turn, flows westward towards Mudgee. A wider valley with a series of ephemeral watercourses, or small gullies on the western section of the Mine Site, referred to as Walkers Creek, flows from the site of the proposed TSF.

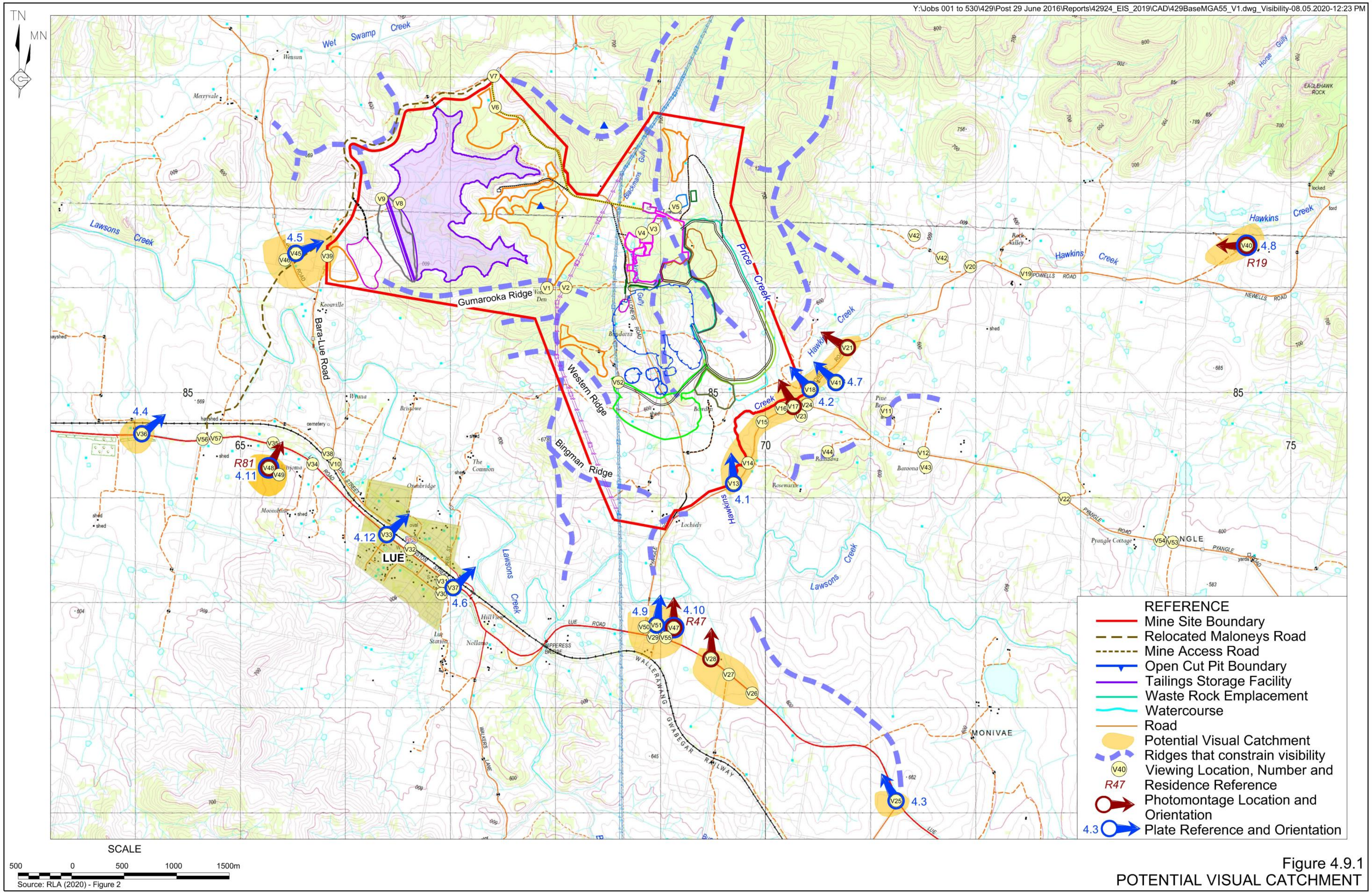


Figure 4.9.1
POTENTIAL VISUAL CATCHMENT

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The proposed open cut pits are located on a partly cleared hill on one of the ridges north of Hawkins Creek and also straddle Blackmans Gully, through which the existing Maloneys Road is positioned. A series of ridges occur to the southwest and south of the proposed open cut pits which obstruct views of the Mine Site from Lue and most of its surrounds. The locations of these ridges are displayed on the potential visual catchment for the Mine Site (**Figure 4.9.1**). The top of the most dominant ridge, Bingman Ridge, rises approximately 118m above Lue. **Figure 4.9.2** (Section AB) displays a section from Lue Public School towards the eastern section of the Mine Site and the extent to which the ridge prevents views of the Project components. **Figure 4.9.2** (Section AC) displays a section from Lue Public School towards the western section of the Mine Site and the effectiveness of the Gumarooka Ridge to shield views of the TSF from the school.

RLA (2020) describes a range of baseline factors that form the local visual context, each of which are briefly outlined below.

View Compositions and Visual Character

The composition of views towards the Mine Site are dominated by the elevated background topography of a vegetated dissected sandstone plateau in the north with gently sloping partly cleared or grassed rural areas in the foreground to the south. The existing 500kV power transmission line traverses elevated topography within the Mine Site from north to south with the 50m high lattice towers easily discernible when viewed from the east and south.

Scenic and Landscape Quality

The combination of the natural vegetated backdrops, complex topography and cleared/partly cleared rural land with some rock outcrops is considered by RLA (2020) to result in a moderate to moderate-high scenic quality, albeit part of a wider landscape with similar features.

4.9.2.3 View Place Sensitivity

RLA (2020) records the existing view place sensitivity within both the public domain and private residences.

Public Domain

The Mine Site has a low view place sensitivity from the public domain as it is not exposed to significant views at close or medium range from high usage roads, reserves or lookouts. The eastern section of the Mine Site is visible from sections of Lue Road approximately 2km to 5km to the south and southeast and from sections of Pyangle and Powell Roads less than 0.5km from the Mine Site (see **Figure 4.9.1**). The western section of the Mine Site is visible from the Bara-Lue Road and distant sections of Lue Road west of Lue, i.e. at distances at least 3km from the proposed TSF embankment. Pyangle, Powells and Bara-Lue Roads carry very little traffic, typically between 20 and 100 vehicles per day.

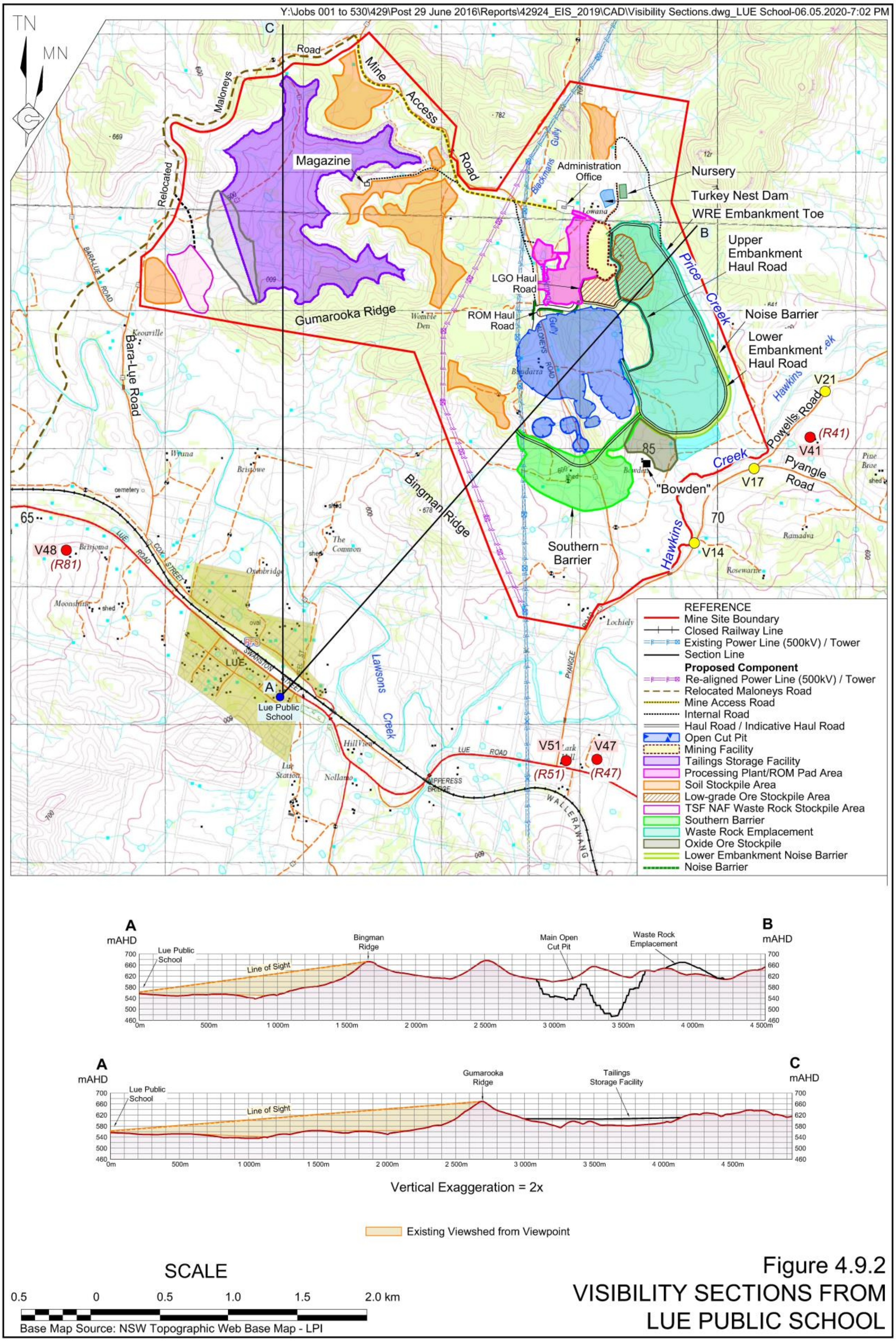

Figure 4.9.2
VISIBILITY SECTIONS FROM LUE PUBLIC SCHOOL

Figure 4.9.1 displays locations on the public road network where sections of the Mine Site are visible.

- Lue Road approximately 5km east of Lue (V25*)
- Lue Road approximately 3km east of Lue (V26 to V28)
- Lue Road approximately 2km east of Lue (V50* and V55)
- Lue Road approximately 2km west of Lue (V36*)
- Bara-Lue Road approximately 3km north-northwest of Lue (V45* and V46)
- Pyangle Road approximately 3km northeast of Lue (V13* to V17)
- Powells Road approximately 4km northeast of Lue (V18* and V21)

Plates 4.1 to **4.6** display photographs of the views from those viewing locations marked with an asterisk above. The locations and direction of view for each photograph are displayed on **Figure 4.9.1**.

Overall, the Mine Site has a small visual catchment in the public domain due to its bounding ridges, absence of visibility from Lue and closer range views from isolated sections of local roads.

Privately-owned Residences

Residences from which there would be close or medium distance range views affected by the Project when viewed from living rooms or outdoor recreational spaces are considered to be places of medium to higher viewer sensitivity. RLA (2020) identifies a total of five private residences that have direct views of sections of the Mine Site which would enable observations of a range of activities within the Mine Site throughout the Project Life. Five of these residences have views of the eastern section of the Mine Site whilst views of the western section of the Mine Site would be possible from one residence (R81). It is possible that views of sections of the Mine Site are possible from other residences, i.e. from those residences to which access was denied or potentially from more distant residences, i.e. greater than 5km from the Mine Site. It is also acknowledged that the subjectivity of views could be a factor for some occupants of privately-owned residences irrespective of the distance of their view.

Figure 4.9.1 displays the locations of the five residences and **Plates 4.7** to **4.12** display photographs of the views from these residences and from in Lue and **Table 4.59** lists the distances between the six residences and the key Project components that would be visible.

Table 4.59
Privately-owned Residences with Direct Views towards Sections of the Mine Site

Residence Reference#	Elevation (m AHD)	Distance to Mine Site Component* (m)				
		Open Cut Pit	Southern Barrier	WRE	Low Grade Ore Stockpile	TSF
R4	589.5	1 350	1 270	730	1 620	NV
R19	634.5	5 340	5 295	4 660	5 080	NV
R39	575.0	2 260	1 830	2 530	3 330	NV
R40	576.4	2 270	1 770	2 520	3 400	NV
R47	585.0	2 250	1 810	2 450	3 300	NV
R81	613.1	NV	NV	NV	NV	2 240

* NV = Not Visible #see **Figure 4.9.1**

Plate 4.1 **View towards the eastern section of the Mine Site from V13 on Pyangle Road**
(RLA Plate 15)

Plate 4.2 **View towards the eastern section of the Mine Site from V18 on Powells Road**
(RLA Plate 20)

Plate 4.3 **View towards the eastern section of the Mine Site from V25 on Lue Road, 5km east of Lue (near Tongbong Road)**
(RLA Plate 27)

Plate 4.4 **View towards the Mine Site from V36 on Lue Road, 2km west of Lue**
(RLA Plate 38)

Plate 4.5 **View towards the Mine Site from V45 on the Bara-Lue Road**
(RLA Plate 52)

Plate 4.6 **View towards the Mine Site from V37 within Lue**
(RLA Plate 39)

Note: Larger images of the above plates are presented in RLA (2020).

Plate 4.7 View towards the Mine Site from Residence R4 (V41)
(RLA Plate 43)

Plate 4.8 View towards the Mine Site from Residence R19 (V40)
(RLA Plate 42)

Plate 4.9 View towards the Mine Site from Residence R39 (V51)
(RLA Plate 58)

Plate 4.10 View towards the Mine Site from Residence R47 (V47)
(RLA Plate 54)

Plate 4.11 View towards the western side of the Mine Site from Residence R81 (V48)
(RLA Plate 55)

Plate 4.12 View towards the Mine Site from Lue (V33) (Corner Bayly/Swanston Streets)
(RLA Plate 35)

Note: Larger images of the above plates are presented in RLA (2020).

4.9.2.4 Astronomical Observatories

Siding Spring Observatory

The Mine Site is located approximately 168km from the Siding Spring Observatory and falls within the Observatory's Dark Sky Region. This region comprises the land within a 200km radius of the Siding Spring Observatory near Coonabarabran that was established under the Dark Sky Planning Guideline (DPE, 2016) to ensure lighting impacts from significant developments do not unreasonably disrupt the operation of the Observatory (see **Figure 4.9.3**).

Other Observatories

Two amateur observatories are located within 45km of the Mine Site, i.e. 10km southwest of Mudgee (Mudgee Observatory) and 9km southwest of Ilford (Wiruna Observatory). A further site where astronomical observations are undertaken using mobile telescopes is located approximately 10km east of the Mine Site near Breakfast Creek. The locations of all observatories which are displayed on **Figure 4.9.3** have intervening topography between the observatories and the Mine Site that would prevent direction observations of lighting within the Mine Site. The Mudgee and Wiruna Observatories and the Breakfast Creek area are located in areas with little noticeable night lighting nearby which have contributed to their siting at those locations in order to maximise minimal disruption to night-time astronomical observations.

4.9.3 Potential Visual Impacts

4.9.3.1 Day-time Potential Impacts

The potential visual impacts are described for the site establishment and construction stage, throughout the operational Project life and following the rehabilitation of the Mine Site. Emphasis is placed upon the visual impacts arising from the activities undertaken within the Mine Site with brief reference made to the construction of the relocated Maloneys Road and the water supply pipeline.

It is noted that a key factor influencing the visual impacts of the Project during the site establishment and construction stage and its operational life would be the colour of the ore and waste rock extracted (see **Plates 4.13** and **4.14**). The predominant rock colour of both the ore and waste rock is light cream to buff with local variations attributed to staining from iron (orange to red tones) and manganese (black tones).

Plate 4.13 Representative Ore

Plate 4.14 Representative Waste Rock

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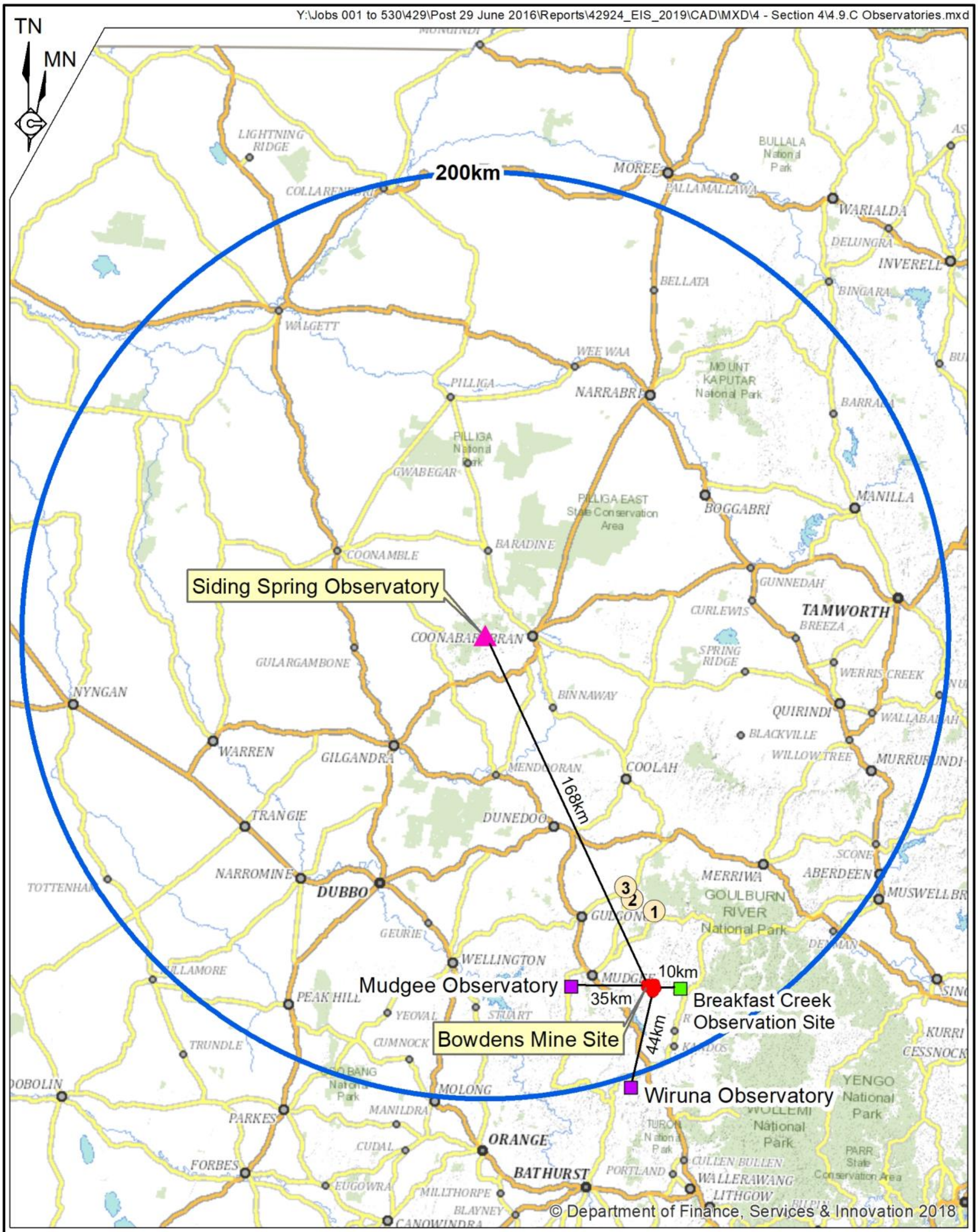

REFERENCE

- Siding Spring Observatory
- 200km Radius from Siding Spring Observatory
- Amateur Observatory
- Observation Site

1. Wilpinjong Mine
2. Moolarben Mine
3. Ulan Mine

SCALE

25 0 25 50 75 100 km

Source: Modified after LAS 2020 - Figures 1 and 3

Figure 4.9.3
ASTRONOMICAL OBSERVATORIES

Site Establishment and Construction Stage

All areas where vegetation, soil and rock would be disturbed during the site establishment and construction stage could potentially be visible from localised areas around the Mine Site, i.e. within the areas being developed for the open cut pit, processing area, TSF embankment, southern barrier and oxide ore stockpile area. The mobile earthmoving equipment operating in these areas would be visible, particularly during early in the site establishment and construction stage.

Earthmoving equipment would be present and visible, principally by motorists, during the construction of the relocated section of Maloneys Road and the water supply pipeline. Some residents would be able to observe the equipment constructing sections of the water supply pipeline when construction is underway near their residences, albeit for comparatively short periods.

Operational Stage

During the operational Project life, the placement of ore and waste rock would be visible at a range of locations within the Mine Site, albeit from a comparatively low number of viewing locations. As discussed in Section 2.16, emphasis would be placed upon progressively revegetating as much material as possible to limit visual impacts throughout the Project life. Parts of the upper faces within the main open cut pit would be visible from some areas during the early stages of the Project until the intervening southern barrier and WRE are sufficiently high to shield the upper faces.

The progressive construction of the key landforms within the Mine Site would be visible throughout the Project life, particularly the WRE, oxide ore stockpile and southern barrier. The visibility of the WRE would increase throughout the Project life as it is constructed from its northern end to its southern end. The key areas of the WRE that would be visible would be the southern exposed faces of each cell. These faces would be progressively covered as each subsequent cell is constructed. The embankment of the TSF would be most visible for the first 9 years or so until it is revegetated (see Section 2.16.7).

The re-alignment of the 500kV power transmission line would be visible during the construction period, i.e. in about Year 3 of operations principally due to the presence of the new towers and existing towers co-existing for a short period. The re-aligned transmission line would be located on elevated topography similar to the existing alignment and therefore generate a similar level of impact.

Post Operational Period

The key components of the Mine Site that would be visible following the closure of the Project would be the residual landforms constructed, namely the WRE/oxide ore stockpile, the TSF and the upper faces of the main open cut pit.

4.9.3.2 After Dusk Potential Impacts

Bowdens Silver intends to undertake processing operations 24 hours per day following the site establishment and construction stage and to progressively extend mining operations into the evening and night from about Year 2 or Year 3.

The extent of lighting impacts after dusk would depend upon:

- the type of lighting used, i.e. the colour temperature and luminance level of lighting;
- the quantity and disposition of lighting within the Mine Site;
- the presence of natural or man-made barriers either on or off site, i.e. intervening topography, light shields etc; and
- the presence or absence of fog, low cloud cover and/or airborne dust particles.

Lighting impacts could potentially occur in one of three ways.

- Direct Impacts – where light is directed towards a viewer.
- Indirect Impacts – where the source of light is not directed at a viewer but the spread of light is observable.
- Sky Glow – where light from one or more sources is reflected in the atmosphere. The extent of sky glow is a function of the presence or absence of fog, low cloud and/or airborne dust particles.

The lighting that would potentially be used during mining operations includes.

- headlights from mobile equipment operating within the open cut pits and on internal roads;
- lighting towers within the open cut pits, waste rock emplacement and processing area; and
- safety and operational lighting within and around the processing and administration areas.

Limited lighting would be present within the Mine Site throughout the site establishment and construction stage. This would occur in the area of the processing plant during the later months of the site establishment and construction stage during the plant completion and commissioning activities.

Static lighting would be used around the processing area and within the active extraction area of the main open cut pit. Headlights from haul trucks transporting waste rock and ore would be periodically visible from some local areas of an evening and night respectively when travelling outside the main open cut pit.

4.9.4 Management and Mitigation Measures

4.9.4.1 Introduction

The measures to manage and mitigate the visual impacts of the Project are both design and operational. This subsection outlines the key design features of the Project that would assist to minimise visual impacts both during the day time and after dusk. The design features focus upon the retention of vegetation between component areas, wherever possible, within the key areas of landform construction, whereas the operational measures focus upon progressively covering as much of the light colour rock as areas become available for covering.

4.9.4.2 Design Measures

Bowdens Silver would ensure that areas or strips of remnant native vegetation are retained in those areas of the Mine Site where, for example, cut/fill lines are present in the vicinity of the processing area, mining facility and administration area.

The WRE has been designed (see **Figure 2.8**) without geometric shapes and with a form resembling a ridge similar in orientation and elevation to other ridges within and surrounding the Mine Site. The landform would incorporate localised scalloping around the surface and would exhibit a final concave slope near its base and a convex slope near its upper surface (see **Appendix 5 - Figure A5.12**).

The initial barrier component of the southern barrier, once constructed, would assist to limit the visibility of extraction within the main open cut pit and two satellite pits from the south.

The alignment of the relocated Maloneys Road has been designed to limit the visibility of the TSF impoundment area for motorists travelling along the new road. The limited visibility would be achieved principally through construction of the road on the western side of the ridges in that area or through excavated road cuttings.

4.9.4.3 Day-time Mitigation Measures

Bowdens Silver would adopt the following mitigation measures to reduce the visibility of the Project components throughout the Project life, i.e. when viewed from the local road network and the few residences with direct views towards parts of the Mine Site.

1. **Progressive Revegetation of Interim or Final Slopes**

   The method of construction of a number of the Project components would enable the progressive covering and revegetation of the exposed light-coloured rock.

   Southern Barrier

   As each 10m (vertically) section of the initial barrier is constructed, the outer surface would be covered with subsoil and topsoil. It is planned that the subsoil and topsoil used would be transferred from areas being stripped of soil within the WRE footprint. The thickness of subsoil and topsoil placed on the outer slopes would be greater than conventionally required but it would effectively provide an additional area for soil stockpiling, rather than the dedicated soil stockpiles elsewhere in the Mine Site. As each 10m (vertically) section of the initial barrier is covered with subsoil and topsoil, it would be seeded with pasture grasses (see **Appendix 5** – Section A5.11.4).

   The same procedure would be adopted for the outer southern slopes of the extended barrier, with the subsoil and topsoil removed from the outer slopes of the initial barrier and transferred to the outer slopes of the extended barrier.

Waste Rock Emplacement

As each stage of the WRE is finalised, the designed cover would be constructed on the final eastern slope of Stages 1 to 6 to allow those sections to be revegetated to achieve both long term stability as well as reducing the visual impact of the exposed rock.

The method of progressive revegetation of the WRE would be modified for Stage 7 whereby the outer slopes would be rehabilitated in a similar manner to the southern barrier, i.e. as each 10m (vertically) section of Stage 7 is constructed, the cover would be constructed on that section which would enable the revegetation to proceed and the progressive reduction in visual impact.

TSF Embankment

Bowdens Silver proposes to revegetate the outer southern face of the TSF embankment following the third raise of the TSF in about Year 9 (see **Figure 2.27**).

2. Planted Visual Screens

Bowdens Silver proposes to enhance the existing planted visual screen on the northern side of Pyangle Road (**Plate 4.15**) to progressively limit the views to the north, particularly of the WRE, southern barrier and oxide ore stockpile. **Figure 4.9.4** displays the existing tree screen which already contains in excess of 2 130 planted trees and shrubs ranging in height from 0.8m to 2.5m. This screen would be enhanced through the planting of a further 3 000 plants propagated by Bowdens Silver from seed collected within the Mine Site.

Figure 4.9.4 also displays some additional areas that would be planted on the outer southern perimeter of the southern barrier and WRE. These tree screens would be permanent as they would remain after the end of the Mine Site rehabilitation program.

3. Vegetated Upper Benches in the Main Open Cut Pit

As each terminal bench above approximately 590m AHD is completed within the main open cut pit, it would be covered with 1m to 2m of NAF waste rock and planted with a variety of trees and shrubs to provide partial screening of the final exposed upper faces and to provide shade to the faces. The shrub and tree varieties would be selected to provide a variety of vegetation cover in height and density.

4. Buildings, Structures and Roadside Noise Barriers

All buildings, structures and roadside noise barriers to be used to attenuate noise adjacent to the internal haul roads would be painted (or supplied) with dark green/grey colours such as colourbond ironstone, woodland grey or monument.

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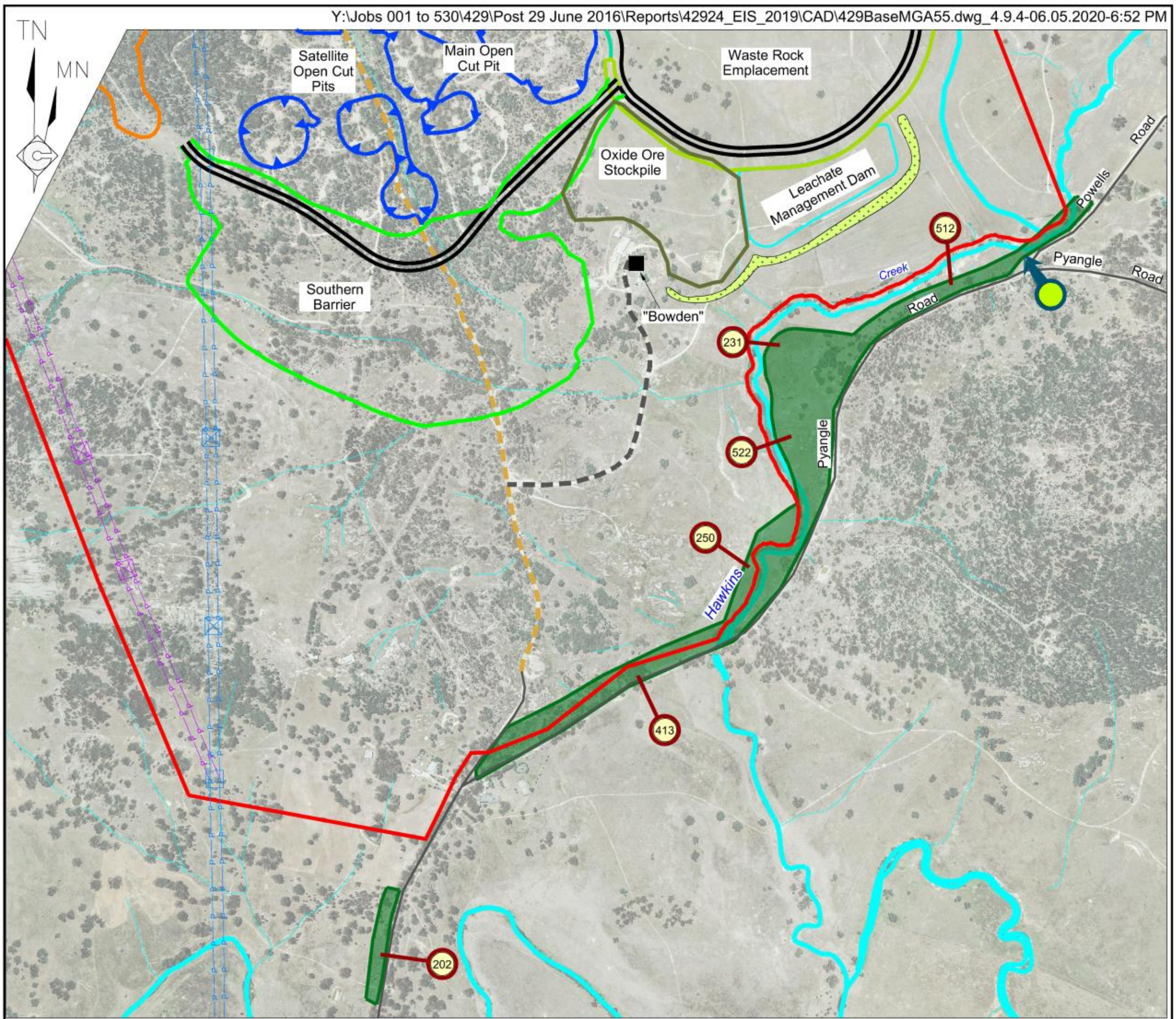

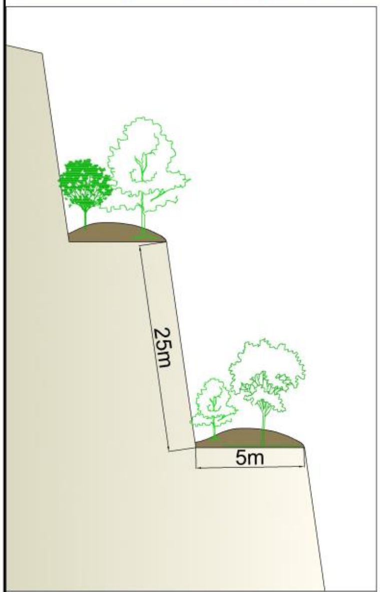

Vegetated Upper Benches
Not to Scale


Plate 4.15: Existing Tree Screen (Ref: RLA - Plate 19)

REFERENCE

- Mine Site Boundary
- Remnant Trees
- Existing Tree Screen (to be enhanced)
- Number of Trees/Shrubs in Defined Area
- Photo Location
- Proposed Tree Screen

SCALE

250 0 250 500 750 m

Source: Bowdens Silver

Figure 4.9.4
VISIBILITY MITIGATION MEASURES

No specific mitigation measures would be applicable to the construction activities along the relocated Maloneys Road and the water supply pipeline as the duration of the activities would be comparatively short. That said, the entire pipeline construction program would be undertaken with an emphasis placed upon tidiness and avoidance of any untidy work areas.

4.9.4.4 After Dusk Mitigation Measures

In order to mitigate lighting impacts on the local environment and at the Siding Spring Observatory and local observatories, Bowdens Silver would adopt the following measures within the Mine Site.

- All lighting within the Mine Site would be designed to comply with Zone A1 in AS/NZS 4282:2019 – Control of the Obtrusive Effects of Outdoor Lighting.
- All light sources would have a correlated colour temperature (CCT) of 3000K or less, except for the 2000Watt floodlights which would have a CCT of less than 4500K.
- All floodlights would be forward throw with a maximum upcast (tilt) of 10 degrees. Wherever possible, the upcast would be zero.
- Lights with diffusing covers or with visible bare lamps that emit light above the horizontal plane would not be used on the outside of buildings or structures.
- The use of floodlight towers would be restricted to periods of active operation.

The suppression of dust generated on the active haul roads would further assist to avoid or limit the impacts of sky glow above the Mine Site after dusk.

4.9.4.5 Long-term Mitigation Measures

The key long-term mitigation measures relate to the successful rehabilitation of the Mine Site in the manner described in Section 2.16, particularly the creation of non-geometric landforms and achieving the planned level of revegetation.

4.9.5 Assessment of Impacts

4.9.5.1 Day-time Impacts

The analysis of day-time visual impacts of the activities within the Mine Site undertaken by RLA (2020) relies upon a range of factors including:

- viewing locations;
- view compositions;
- scenic character and quality;
- viewing level and distance;
- viewing period;

- visual absorption capacity;
- visual compatibility; and
- an understanding of the subjective viewpoints and perceptions of those who would see components of the Project.

The contributions of each of these factors to the overall assessment are briefly outlined below. A comprehensive description of these factors is presented in RLA (2020) – Sections 6, 7 and 8 focussing upon the operational life of the Project. Emphasis is placed in the analysis of day-time visual impacts upon views experienced throughout the Project life, and regard is also given to post-Project views.

Viewing Locations

Distinction is made between locations with views towards the Mine Site that are either in the public or private domain. Section 4.9.2.3 presents an overview of the locations of these views.

View Compositions

The view composition of the eastern section of the Mine Site would change throughout the Project life with the lowering of a ridge as the main open cut pit is mined and as the southern barrier, oxide ore stockpile and WRE are constructed and increase in size and elevation.

For those structures, the view composition would comprise interim horizontal lines and changed visibility as a result of the colour and contrasting texture of the placed rock, particularly when viewed from Pyangle and Powells Road.

The view composition of the western section of the Mine Site would not change substantially with the elevation of the TSF embankment and spillway being the only change to the views within the Walkers Creek valley, i.e. within the first 9 years of the Project life.

The equipment and stockpiles within the processing area are not likely to have significant effects on view composition.

Scenic Character and Quality

There would be a high level of change to the scenic character of the eastern section of the Mine Site as a result of the removal of vegetation and the ridge where the main open cut pit would be located and the progressive construction of other landforms. Whilst it is planned to construct the landforms on site with a less geometric and more natural appearance, these components would retain a manufactured and engineered appearance during their construction and cause a localised significant and negative change to the scenic quality as a result of the Project. However, the change in visual effects would be small in the context of the sub-regional and regional landscapes and the scale of other open cut operations.

Viewing Level and Distance

A small number of viewing locations occur at a medium distance (<1km) or beyond and at an elevation below the height of the proposed components within the Mine Site which slightly increases the level of visual effects assessed.

Viewing Period

The longer the potential viewing period, experienced either from fixed or moving viewing places such as residences or roads respectively, the higher the potential visual effects of the Project.

Visual Absorption Capacity

The visual absorption capacity refers to the extent to which the existing visual environment can reduce or eliminate the perception of the visibility to the Project components. Contributing factors to the capacity and ability to physically hide, screen or disguise the components and the contrasts attributable to colours and textures.

The eastern section of the Mine Site would have a low visual absorption capacity given the extent of vegetation removal and exposure of light-coloured rock. The capacity would, however, vary throughout the Project life as constructed landforms increase in height, are progressively revegetated and reduce the visibility of on-site activities.

The western section of the Mine Site would have a high visual absorption capacity given the extent of the surrounding topography and particularly following the revegetation of the southern face of the TSF embankment. Similarly there would be a high visual absorption capacity for the relocated section of Maloneys Road.

Visual Compatibility

It is considered that the eastern section of the Mine Site is of medium compatibility given the Project, whilst clearly different to adjacent rural uses, is intrinsically compatible with other mining and extraction projects in the Mid-Western Regional LGA in a landscape that is not unique to the locality.

It is considered that the western section of the Mine Site (including the relocated Maloneys Road) is of high compatibility given the limited visual catchments of the TSF.

In order to determine the extent of the above factors upon views of the Project components during the day from both the public and private domain, reliance was placed upon a series of cross-sections and photomontages from representative viewing locations towards the various project components. Reliance was also placed upon the three-dimensional model prepared for the Project featuring the existing landform and key Project components during the site establishment and construction stage, Year 8 and Year 16 together with the final landform.

Annexures 2 and 3 in RLA (2020) present a series of visibility cross-sections and companion photomontages that identify the extent to which the various Project components would be visible from representative viewing locations: Both analytical and photorealistic photomontages were prepared based on the three-dimensional model. The analytical photomontages show the components of the Mine Site layout brightly coloured so that the location of each can be understood in relation to each viewing place. The photorealistic photomontages show realistic colour and texture of the components. Both kinds of photomontages were prepared at four stages (Years 1, 8, 16 and final landform).

The visual impacts of the construction of the relocated section of Maloneys Road would be negligible overall given the road would be located largely away from residences. Once constructed, the road would form an accepted part of the local road network.

During the construction of the water supply pipeline, the earthmoving and related equipment would be visible from the nearby public road network and some residences. However, its short duration would limit the overall visual impacts.

The increased use of local roads by traffic travelling to and from the Mine Site is likely to be noticeable to local residents, particularly during periods of shift change-overs and the increase in the number of heavy vehicles. However, the overall traffic levels would remain comparatively low and result in negligible visual impacts.

Post-Project Views

The approach by Bowdens Silver in designing the final landform, and its revegetation would achieve an acceptable long-term impact given the landforms on the eastern side of the Mine Site would be either shaped to blend with the final landform (in the case of the WRE) or be vegetated to shield for example, the final upper benches of the open cut pit. The final landform resulting from the revegetated TSF would remain a noticeable landform because of its steeper outer and somewhat geometric slope and the upper surface would be well vegetated. In both areas, particularly for long-term views of the TSF embankment, the number of persons viewing the final landform would be low.

4.9.5.2 Conclusion

RLA (2020) concluded the following levels of impact would occur as a result of the Project, i.e. assuming the adoption of the nominated management and mitigation measures, and the nominated visual absorption capacity and visual capability of the eastern and western sections of the Mine Site.

- No visual impacts of the Mine Site components would be possible from Lue given the substantial topography between Lue and the Mine Site.
- A high level of impact would be experienced by motorists travelling along Pyangle and Powells Road, albeit over a short distance. This impact would be enhanced for those local landowners that may travel these roads on a near-daily basis.
- An overall medium level of impact would be experienced by those occupants of residences typically greater than approximately 1.5km from the component areas within the Mine Site, i.e. principally to the south near the intersection of Lue and Pyangle Road.
- A low level of impact arising would be experienced by both motorists and occupants of at least six residences from the re-alignment of the 500kV power transmission line given its likely similar appearance to the existing line. Following the removal of the existing towers, the appearance of the transmission line would be similar to the existing line, therefore causing little impact.
- A low level of impact from the TSF would be experienced by the occupants of Residence 81 when observing views towards the TSF embankment, a distance of, 2.2km from the TSF embankment. A similar level of impact would occur for motorists travelling on Lue Road, Bara-Lue Road and the relocated section of Maloneys Road.

Beyond the end of the Project life, the visual impacts of the Project would progressively diminish as the revegetation of the final landform progresses. For those local residents who are familiar with the existing landforms, the changes to the area of the WRE, TSF and main open cut pit would remain noticeable, yet in time, these landforms would form part of the overall landform to be used and observed by future generations.

4.9.5.3 After Dusk Impacts

Conformance with AS/NZS 4282:2019

Lighting within the local environment would principally be controlled by the requirements of AS/NZS 4282:2019 – Control of Obtrusive Effects of Outdoor Lighting which recommends limits for specific light technical parameters based on the ambient lighting conditions. Table 7 in LAS (2020) presents the limits for dark rural environments (Zone A1) under AS/NZS 4282:2019 and a series of calculations undertaken by LAS (2020) using AGi32 Version 19.2 software to determine the conformance of the Project assuming various light fitting upcast angles.

The calculations undertaken by LAS (2020) indicate that the proposed lighting for the Project falls well within the limits specified in AS/NZS 4282:2019 with the exception of the luminous intensity from certain viewing angles. However, it is noted that direct lighting impacts are of limited relevance to the Project due to the intervening topography between the Mine Site and surrounding residences. Direct views of Project-related lighting would exist from the southeastern boundary of the Mine Site, however, with the adoption of the mitigation measures outlined in Section 4.9.4.4, the Applicant would effectively minimise the opportunity for direct lighting to be observed. LAS (2020) has assessed that the Project would have minimal lighting impacts on the surrounding environment and Lue.

Sky Glow

Sky glow would not be visible under clear conditions although there would be a faint glow on low cloud directly above the Mine Site. **Table 4.60** presents the calculated illuminance on the cloud, the estimated luminance of the cloud and the resulting illuminance at Lue.

Table 4.60
Predicted Luminance in Lue from Cloud Reflection

Height Above Ground Level	Illuminance on the Underside of the Cloud	Luminance of the Cloud	Vertical Illuminance at Lue
200m	8.49 lux	0.27 cd	0.0004 lux
500m	1.59 lux	0.051 cd	0.0009 lux
1,000m	0.622 lux	0.020 cd	0.0016 lux
5,000m	0.035 lux	0.0011 cd	-
10,000m	0.0000 lux	-	-
Source: LAS (2020) – Table 11			

These calculations indicate that there would be a slight increase in the illuminance at Lue as the height of the cloud increases primarily due to the decreased shading of the hills between the Mine Site and Lue.

The increase in illuminance level at Lue from reflection from cloud would be around 0.5%. The incremental increase in illuminance in Lue from the light reflected from the clouds would be around 0.3%. As the human eye can only discriminate a doubling or halving of illuminance the visual impact on the Lue would be imperceptible. It would also be unmeasurable as the increase in overall illuminance is less than the uncertainty of a high-quality light meter which typically has a minimum range of 0.1 lux and an accuracy of 2%.

In the rural areas surrounding the Mine Site, the incremental difference in illuminance would be greater as the base illuminance would be less, but the levels would still be too low to measure and would only be perceptible with a fully dark-adapted eye.

The luminance of the sky would only be noticeable under overcast conditions and then, it would only be a faint glow. The resulting impact on residents within Lue would be negligible. The lighting would therefore have negligible impact on night glow and the amenity of the residents in Lue and the rural area immediately surrounding the Mine Site.

The presence of airborne dust particles can also contribute to sky flow. Ramboll (2020) predicts mining operations would generate no more than 75ug/m^3 of PM_{10} (dust particulates with a diameter of less than 10µm) per hour at ground level after dusk. These concentrations would be significantly lower at altitude with concentrations at 100m and 200m predicted to be approximately 2% and 1% of ground level concentrations, respectively (Ramboll, pers comm). As such, airborne dust particles generated by the Project are expected to have a negligible impact on sky glow.

Siding Spring Observatory and Local Observatories

Section 5.5 of LAS (2020) presents a number of calculations undertaken to determine the total lumens, total upward lumens and the illuminance of sky particles at varying levels above the Mine Site. These calculations have been provided to the Siding Spring Observatory who has calculated that the night sky brightness above the observatory as a result of the Project would be negligible (see correspondence from the Siding Spring Observatory in Annexure D of LAS, 2018).

LAS (2020) considers that the Mine Site lighting would have negligible impacts on the observatories at Wiruna and Mudgee and minimal impact on observations from the Breakfast Creek Observatory when low elevation observations are made directly over the Mine Site.

Livestock and Wildlife

The lighting within the Mine Site would be sufficiently distant from surrounding properties with livestock, which should avoid any adverse impacts on livestock.

Lighting towers would seasonally attract a range of insects including moths and other flying invertebrates, which in turn would attract a range of bats and birds. Other nocturnal species may avoid well-lit areas given that these may increase vulnerability to predation (EnviroKey, 2020).

4.9.5.4 Conclusion

LAS (2020) determined that the Project would comply with the limits for dark rural environments as stipulated in AS/NZS 4282:2019 *Control of the Obtrusive Effects of Outdoor Lighting* with the implementation of the mitigation measures to be adopted for the Project.

Lighting impacts on the local environment were assessed to be minimal. Furthermore, the impacts of sky glow on the local environment were assessed to be insignificant under clear sky and cloudy conditions.

A number of calculations were undertaken to determine the total lumens, total upward lumens and the illuminance of sky particles at varying levels above the Mine Site. These calculations were provided to the Siding Spring Observatory who calculated that the night sky brightness above the observatory as a result of the Project would be negligible.

4.9.5.5 Water Supply Pipeline

The construction activities within the water supply pipeline corridor would be visible to varying extents throughout Months 7 to 16 within the site establishment and construction stage. The key activities observed would be vegetation clearing (in some areas), earthmoving equipment excavating and backfilling the required trench and equipment delivery and placing the pipe within the trench. The duration of activities that would be visible at any one location would be typically 2 to 3 days, i.e. other than the locations within the corridor that would be used as storage compounds for the pipelines and other consumables. The construction activities would be visible by the respective landowners, some adjoining neighbours and motorists travelling along the sections of local roads within which the pipeline would be positioned.

It is assessed that, although visible for short periods, the impacts of the construction activities associated with the water supply pipeline would be negligible.

Virtually no residual impacts would remain following the construction of the water supply pipeline. The only visible components related to its construction would be areas cleared of trees and shrubs and bollards erected around the regional inspection pits and the proposed off-takes for firefighting adjacent to some local roads.

4.10 TERRESTRIAL ECOLOGY

The terrestrial ecology assessment of the Project was undertaken by EnviroKey Pty Ltd. The full assessment is presented in Volume 3 Part 9a of the Specialist Consultant Studies Compendium and is referenced as EnviroKey (2020).

The biodiversity offset strategy for the Project was prepared by Niche Environment and Heritage (Niche). The full assessment is presented in Volume 3 Part 9b of the Specialist Consultant Studies Compendium and is referenced throughout this document as Niche (2020).

4.10.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identified key risk sources with the potential to result in terrestrial ecology impacts. These risk sources and the assessed risk of impacts <u>after</u> the adoption of standard mitigation measures are as follows.

- Clearing of vegetation communities within the Mine Site, Relocated Maloneys Road and/or water supply pipeline corridor leading to significant impact upon habitat for terrestrial fauna species, threatened or rare native vegetation or vegetation communities and biodiversity values (High).
- Clearing of vegetation communities within the Mine Site, Relocated Maloneys Road and/or water supply pipeline corridor leading to injuries to native fauna during clearing / earthworks (Medium).
- Changes to groundwater and surface water systems resulting in adverse impacts on groundwater dependent ecosystems (Low).
- Site establishment and mining operations resulting in indirect impacts to fauna communities due to light / noise / blasting (Low).
- Inappropriate management of weeds or pests impede successful rehabilitation (Low).
- Inappropriate management of weeds or pests impact the productivity of surrounding agricultural land or the biodiversity values of retained native vegetation communities (Low).

In addition, the SEARs issued by the former DPE identified "biodiversity" as a key issue requiring assessment. The principal assessment requirements identified by the DPE relating to biodiversity included the following.

- an assessment of the likely biodiversity impacts of the development, in accordance with the *Framework for Biodiversity Assessment* (FBA), and having regard to OEH's requirements; and
- a strategy to offset any residual impacts of the development in accordance with the *NSW Biodiversity Offsets Policy for Major Projects.*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the then Commonwealth DoEE and the then NSW OEH. These requirements are summarised as follows.

- Provide details of the scope, timing and methodology for studies or surveys used.
- Provide a description of the specific proposed avoidance and mitigation measures.
- Outline the nature, quantum and consequences of the impacts upon listed threatened species and community and migratory species.
- Provide a description of any offsets proposed to address residual adverse significant impacts.

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC.

This subsection of the EIS provides a summary of the terrestrial ecology assessment, concentrating on those matters raised in the SEARs and related requirements provided by the then DoEE and the then OEH. Issues relating to aquatic ecology are addressed in Section 4.11 and Cardno (2020) whilst further details regarding the proposed Biodiversity Offset Strategy are provided in Niche (2020).

For the purposes of the terrestrial ecology assessment, the Study Area refers to an area of approximately 2 141ha incorporating the Mine Site, the footprint of the relocated Maloneys Road, and the water supply pipeline corridor. The boundary of the Study Area is shown on **Figure 4.10.1**.

4.10.2 Background Research

4.10.2.1 Previous Studies

The following studies have previously been completed across portions of the Study Area.

- Ecological Australia (ELA) (2014). Biobanking plots/transects datasheets and vegetation mapping of the proposed Bowdens Silver Mine (ELA, 2014).
- Geoff Cunningham Natural Resource Consultants (2014). Flora Study of the Proposed Bowdens Silver Mine and Associated Relocation of Maloneys Road, via Lue, NSW (GCNRC, 2014).
- Biodiversity Monitoring Services (2013) Further Fauna Assessments (BMS, 2013).
- Biodiversity Monitoring Services (2012) Fauna Survey of Potential Development Area (BMS, 2012).

These assessments have collected substantial data across the Study Area and were considered in the preparation of the terrestrial ecology assessment. Additionally, data from ELA has been incorporated into the terrestrial ecology assessment and was utilised within BioBanking calculations, following on-ground validation by EnviroKey.

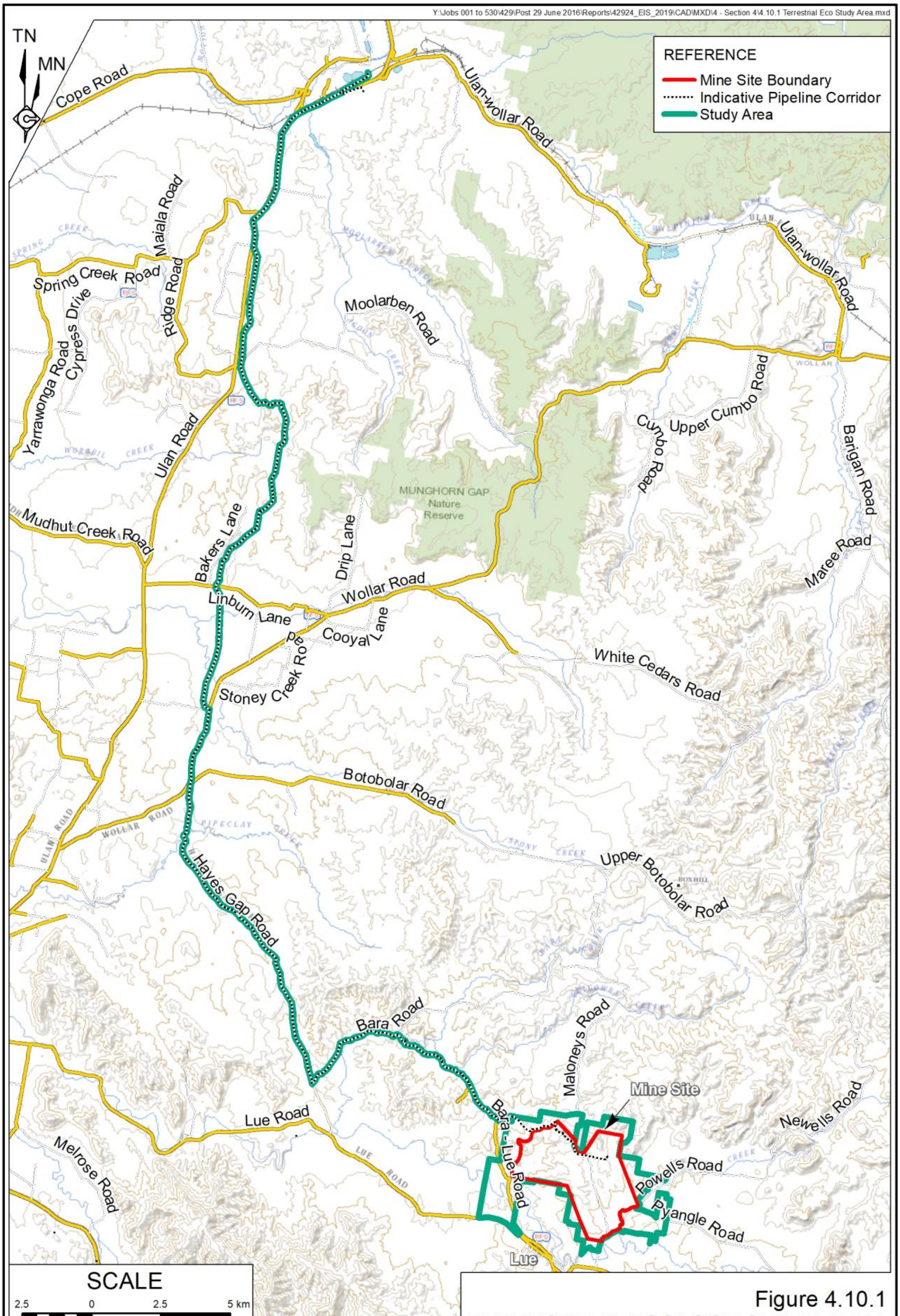

Figure 4.10.1
TERRESTRIAL ECOLOGY STUDY AREA

4.10.2.2 Database Searches

EnviroKey carried out the following database searches for listed species, populations and communities within and surrounding the Study Area.

- OEH BioNET Atlas of NSW Wildlife.
- EPBC Act Protected Matters Search Tool.
- OEH Threatened Species Predictor Tool for the Capertee and Wollemi Sub-regions within the Sydney Basin Bioregion, and the Upper Slopes Sub-region within the NSW South Western Slopes Bioregion.
- *Mid-Western Regional Local Environmental Plan 2012*.
- Bureau of Meteorology Groundwater Dependent Ecosystem Atlas (GDE Atlas).

EnviroKey also reviewed the most recent vegetation datasets for the locality including the State Vegetation Type Map: Central Tablelands Region VIS_4778 version 1.0. The vegetation mapping was considered when reviewing and validating the vegetation communities of the Study Area.

4.10.3 Survey Methodology

4.10.3.1 Introduction

EnviroKey undertook extensive field surveys over multiple seasons utilising a range of survey methods to assess the terrestrial biodiversity values of the Study Area. Surveys were completed over the following five survey periods.

- 4 to 9 December 2016 (6 days).
- 30 January to 3 February 2017 (5 days).
- 13 to 16 November 2017 (4 days).
- 29 January to 3 February 2019 (6 days).
- 3 to 7 April 2019 (5 days).

The surveys considered the relevant survey guidelines for general impact assessment and for specific threatened species. If information was not available on whether or not threatened species occur within the Study Area, then a precautionary approach was adopted, and species presence was assumed. This approach is consistent with the FBA and relevant impact assessment guidelines.

4.10.3.2 Flora Field Surveys

Verification of vegetation communities and the presence/absence of threatened ecological communities (TECs) and flora species was completed from a combination of floristic surveys. The field survey was designed using the existing regional vegetation mapping and then, based on ground-truthing of accessible portions of the Study Area, combined with air photograph interpretation.

Plant Community Types (PCT) were assigned through comparing the dominant canopy species recorded, the general description of location, soil type and other attributes as described in the OEH BioNet vegetation information system classification database. Condition categories were also assigned to a sub-condition class of poor, moderate or good to form vegetation zones.

The floristic surveys included a total of 170 biometric plot/transect surveys across the Study Area. Each plot/transect plot included a 20m by 20m full floristic plot, a 20m by 50m plot identifying the number of hollow-bearing trees and length of fallen timber and a 50m transect which was used to collect data on canopy cover, mid-storey cover and groundcover of native and exotic flora species.

Whenever travelling between biometric plot/transect surveys, and any of the fauna surveys, vegetation community surveys and threatened flora searches were completed over a period of 15 minutes. These random meander surveys resulted in identification of additional species not recorded during the formal surveys.

4.10.3.3 Fauna Field Surveys

An extensive set of fauna surveys and habitat assessments were also completed. A summary of survey types and the survey effort is provided in **Table 4.61**. A full description of the survey technics is provided in EnviroKey (2020).

Table 4.61
Summary of Fauna Survey Type, Effort and Target Fauna

Page 1 of 2

Survey Type	Total Survey Effort
Diurnal Birds	137 locations for 20 minutes each. Total survey effort: 2 740 minutes
Camera Trap Surveys	December 2016: Five sites over 5 nights / 6 days resulting in 25 camera nights / 30 camera days. February 2017: Five sites over 3 nights / 4 days resulting in 15 camera nights / 20 camera days. April 2019: Four sites over 3 nights / 4 days resulting in 12 camera nights and 16 camera days. Total survey effort: 52 camera nights / 66 camera days.
Herpetofauna Survey	85 sites in total for 30 minutes each. Total survey effort: 2 550 person minutes.
Call Playback	December 2016: Three sites in total. Three sites surveyed each night for 3 nights (9 surveys). February 2017: Three sites in total. Three sites surveyed on one occasion. April 2019: Four sites each surveyed on one occasion. Total survey effort: 16 hours.
Koala Transects	February 2017: Two transects each taking 2 person hours. Total survey effort, 4 person hours.

Table 4.61 (Cont'd)
Summary of Fauna Survey Type, Effort and Target Fauna

Page 2 of 2

Survey Type	Total Survey Effort
Spotlighting and Echolocation Call Recording	At Call Playback Sites: During each of the 16 survey occasions, 20 minutes of spotlighting was completed at the conclusion of call playback. Total survey effort: 320 minutes. December 2016 & February 2017: At three sites, 1 person hour of spotlighting and echolocation call recording = 2 person hours per survey period, giving a total of 6 person hours of spotlighting and echolocation call recording. December 2016: A single Anabat detector was placed beside a dam over 4 nights. April 2019: 2 person hours of spotlighting/echolocation call recording carried out at four locations giving a total of 8 person hours. Total echolocation call recording survey effort: 22 recording hours plus 4 nights of recording. Total spotlighting survey effort: 20 person hours.
Scat and Sign Search	137 searches totalling 10 minutes each. Total survey effort: 1 370 minutes
Riparian Surveys	6 sites over 30 minutes each. Total survey effort: 180 minutes
Source: EnviroKey (2020) – Table 3	

4.10.4 Survey Results

4.10.4.1 Introduction

EnviroKey (2020) presents a detailed list of all vegetation communities, species and habitats recorded within the Study Area. This subsection presents an overview of that information.

4.10.4.2 Vegetation Communities

Comprehensive field surveys identified a total of 11 PCTs occurring within the Study Area. A summary of the extent of each PCT, by condition class, within the Study Area and the area that would be disturbed as a result of the Project is provided in **Table 4.62**. Vegetation communities within the Study Area surrounding the Mine Site and relocated Maloneys Road are shown on **Figure 4.10.2** whilst detailed figures of the vegetation communities within the water supply pipeline are provided as Maps 17 to 26 in EnviroKey (2020).

Of the 11 PCTs recorded, three (PCT277, PCT281, PCT266) meet the definition of TEC. Under the NSW BC Act, these PCTs are consistent with the listing for *White Box, Yellow Box, Blakely's Red Gum Woodland*, which is listed as an endangered ecological community. Under certain identification criteria, these PCTs also meet the definition of *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland*, listed as a critically endangered ecological community under the Commonwealth EPBC Act. Collectively these listed ecological communities are referred to as Box-Gum Woodland (BGW). The location and classification of BGW within the Study Area surrounding the Mine Site and relocated Maloneys Road are shown on **Figure 4.10.3** whilst detailed figures of the BGW within the water supply pipeline are provided as Maps 28 to 37 in EnviroKey (2020). A full breakdown of the areas of BGW within the entire Study Area is provided in **Table 4.63**.

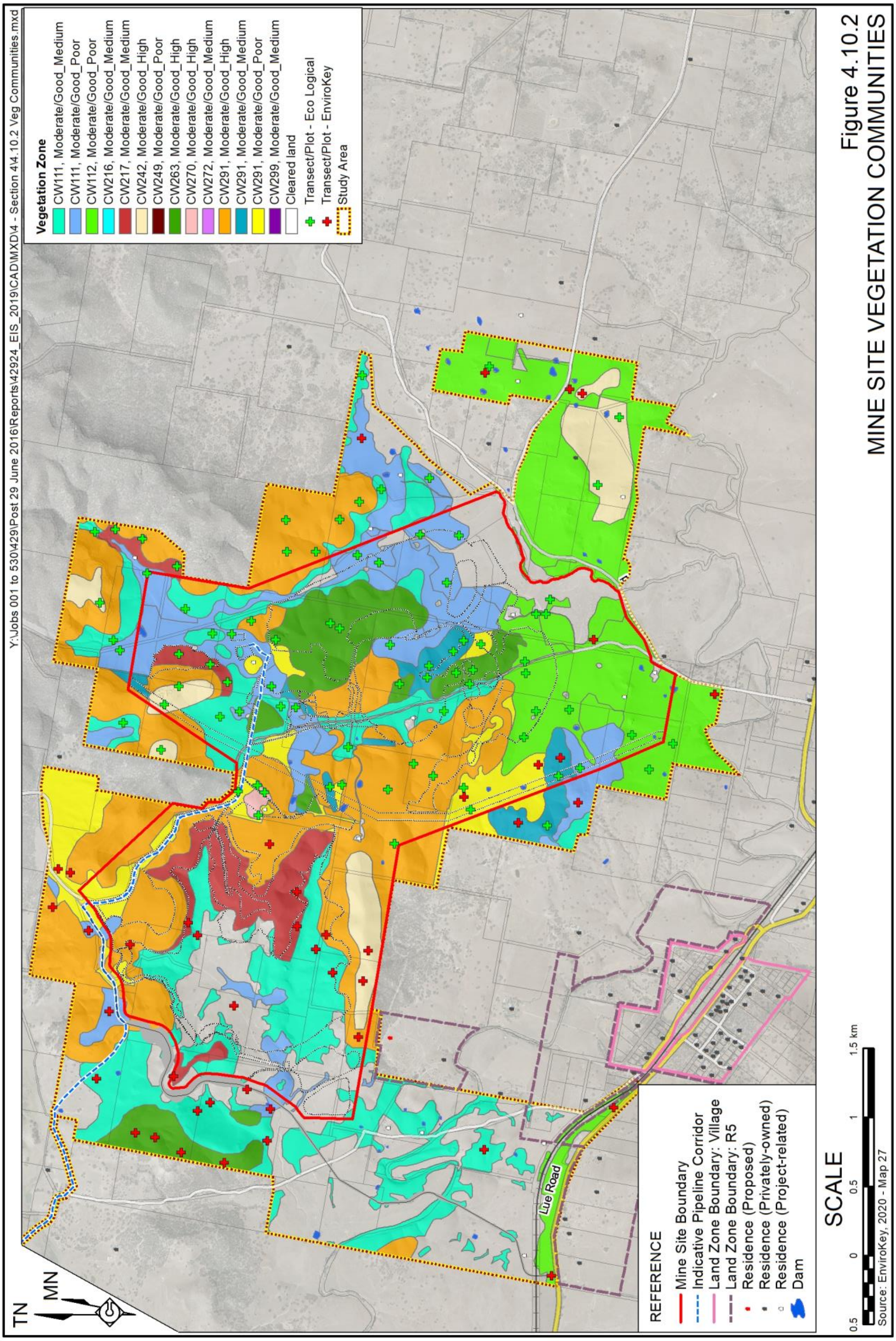

Figure 4.10.2
MINE SITE VEGETATION COMMUNITIES

Table 4.62
Summary of PCT Areas within the Study Area and Disturbance Footprint

Biometric Vegetation Type	PCT No.	Condition	Study Area (ha)	Disturbance Footprint (ha)	Disturbance Subcomponents		
					Mine Site and Relocated Maloneys Road (ha)	Water Pipeline (ha)	Transmission Line (ha)
CW217 White Box shrubby open forest on fine grained sediments on steep slopes in the Mudgee region of the central western slopes of NSW	273	Moderate / Good_medium	69.42	21.68	21.68	0	0
CW 112* Blakely's Red Gum – Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	277	Moderate / Good_poor	273.15	21.80	19.73	0	2.07
CW 111* Rough-barked Apple – Red Gum – Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	281	Moderate / Good_medium	336.30	92.85	85.97	4.53	2.35
		Moderate / Good_poor	201.71	66.38	61.92	2.36	2.10
CW 216* White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	266	Moderate / Good_medium	9.18	1.24	0	1.24	0
CW 291 Red Stringybark – Inland Scribbly Gum open forest on steep hills in the Mudgee – northern section of the NSW South Western Slopes Bioregion	323	Moderate / Good_high	420.69	81.90	79.18	0.21	2.50
		Moderate / Good_medium	39.19	12.00	10.37	0.19	1.44
		Moderate / Good_poor	96.32	18.81	16.81	0	2.00
CW 263 Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes	324	Moderate / Good_high	102.57	56.65	56.65	0	0
CW 242 Blue-leaved Stringybark open forest of the Mudgee region NSW central western slopes	325	Moderate / Good_high	71.86	1.04	1.04	0	0
CW 270 Mugga Ironbark – Red Box – White Box – Black Cypress Pine tall woodland on rises and hills in the northern NSW South Western Slopes Bioregion	358	Moderate / Good_high	3.2	0.77	0.77	0	0
CW 249 Derived grassland of the NSW South Western Slopes	796	Moderate / Good_poor	21.87	5.18	0	5.18	0
CW 299 Rough-barked Apple – Blakely's Red Gum – Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	401	Moderate / Good_medium	2.87	0.76	0	0.76	0
CW 272 Narrow-leaved Ironbark – Black Cypress Pine +/- Blakely's Red Gum shrubby open forest on sandstone low hills	468	Moderate / Good_medium	2.59	0.65	0	0.65	0
		Sub-Total	**1 650.91**	**381.71**	**354.12**	**15.12**	**12.46**
Cleared Land			486.73	113.83	74.29	39.54	0.0
		Total	**2,137.64**	**495.54**	**428.41**	**54.66**	**12.46**

* Meet the definition of BGW, a Threatened Ecological Community.

Source: EnviroKey (2020) –Table ES1

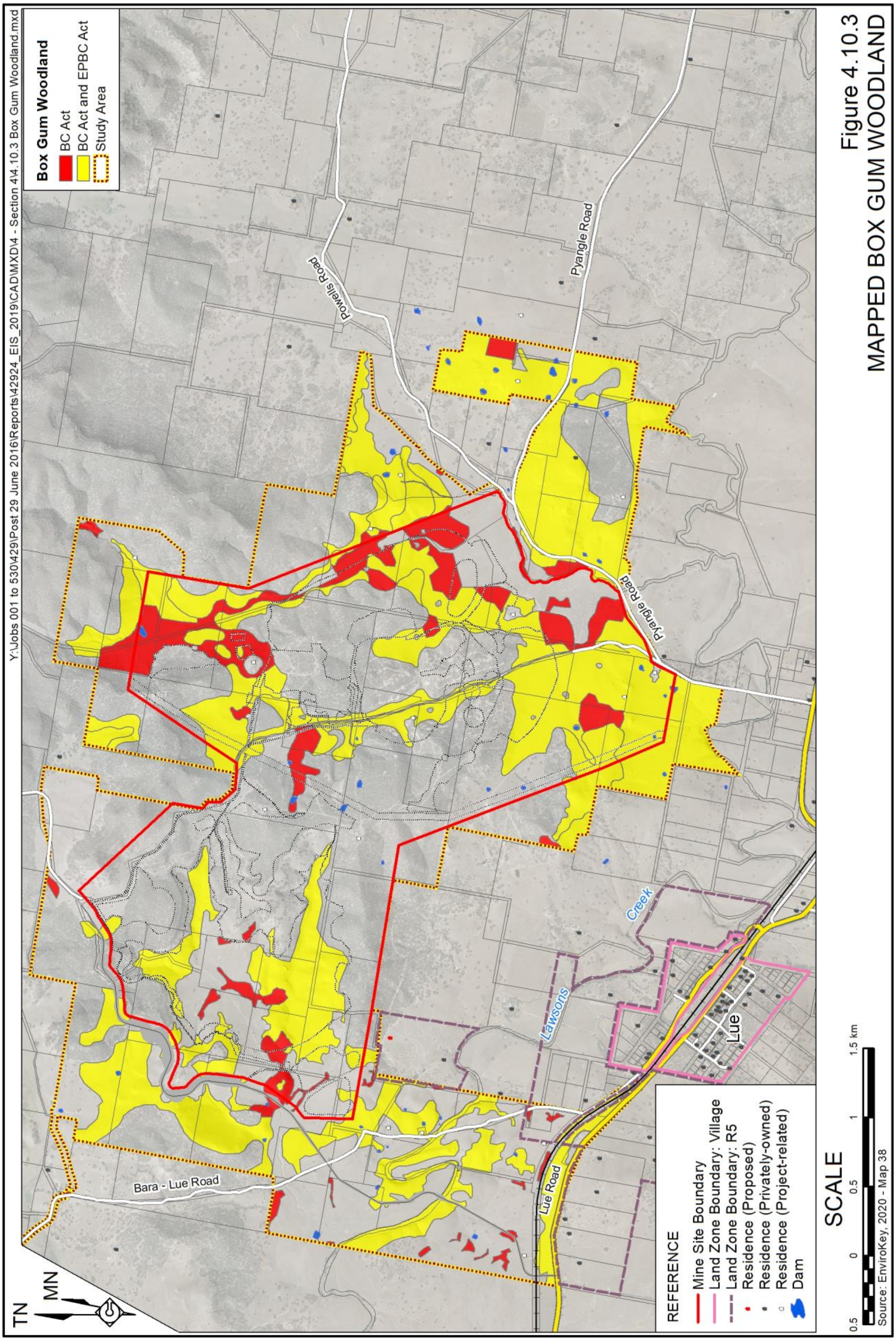

Figure 4.10.3
MAPPED BOX GUM WOODLAND

Table 4.63
Box-Gum Woodland Classification Summary

BGW Legal Classification	Study Area (ha)	Disturbance Footprint (ha)	Disturbance Subcomponents		
			Mine Site and Relocated Maloneys Road (ha)	Water Pipeline (ha)	Transmission Line (ha)
Meets the classification requirements of the BC Act only	146.6	34.45	29.50	4.35	0.59
Meets the classification requirements of both the BC Act and EPBC Act	673.74	147.82	138.13	3.77	5.92
Total	**820.34**	**182.27**	**167.63**	**8.12**	**6.51**
Source: EnviroKey (2020) – Modified after Table 22					

4.10.4.3 Flora Species

The field surveys identified a total of 370 flora species, of which 267 are native flora species and 103 are exotic flora.

Of the individual flora species recorded, two are listed as Vulnerable under the BC Act, namely:

- Ausfeld's Wattle (*Acacia ausfeldii*); and
- Silky Swainson-pea (*Swainsona sericea*).

The locations of these species are shown in **Figures 4.10.4** and **4.10.5**.

The Ausfeld's Wattle was recorded within the northern part of the water pipeline corridor but was not recorded within the Mine Site or the area for the relocated Maloneys Road. An estimated population size of 239 individuals at eight locations was recorded, however, the population at some locations is likely to extend beyond the boundaries of the Study Area.

Whilst the Silky Swainson-pea was recorded by Bowdens Silver personnel at three locations within the Study Area, these locations are beyond the area of proposed disturbance. As a result, it is not considered likely the Silky Swainson-pea would be impacted by the Project.

No flora species listed under the EPBC Act were recorded or assessed as likely to occur.

4.10.4.4 Fauna Species

The field surveys identified a total of 168 fauna species including:

- 123 species of bird;
- 21 species of mammal;
- 18 species of reptile; and
- six species of frog.

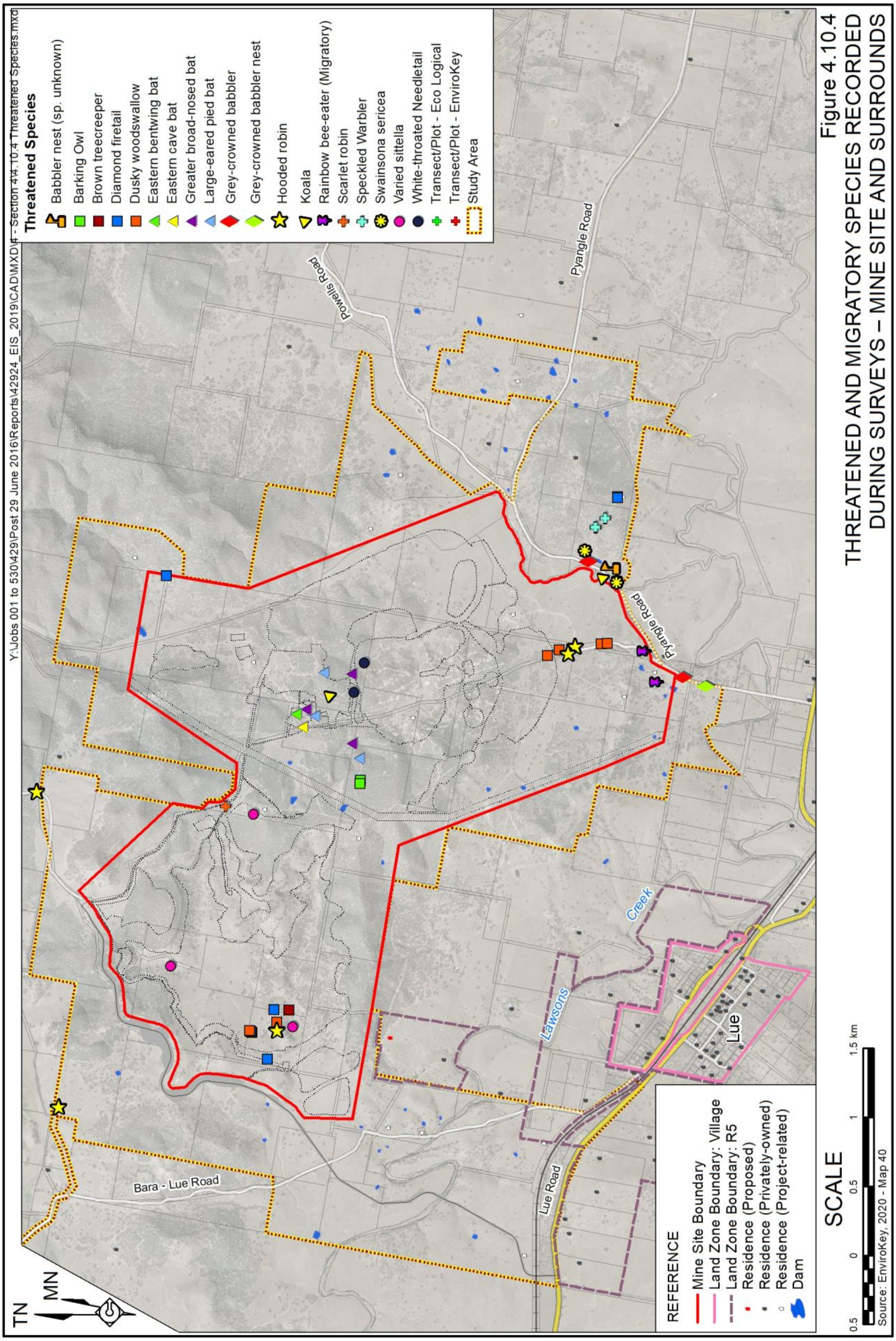

Figure 4.10.4
THREATENED AND MIGRATORY SPECIES RECORDED DURING SURVEYS – MINE SITE AND SURROUNDS

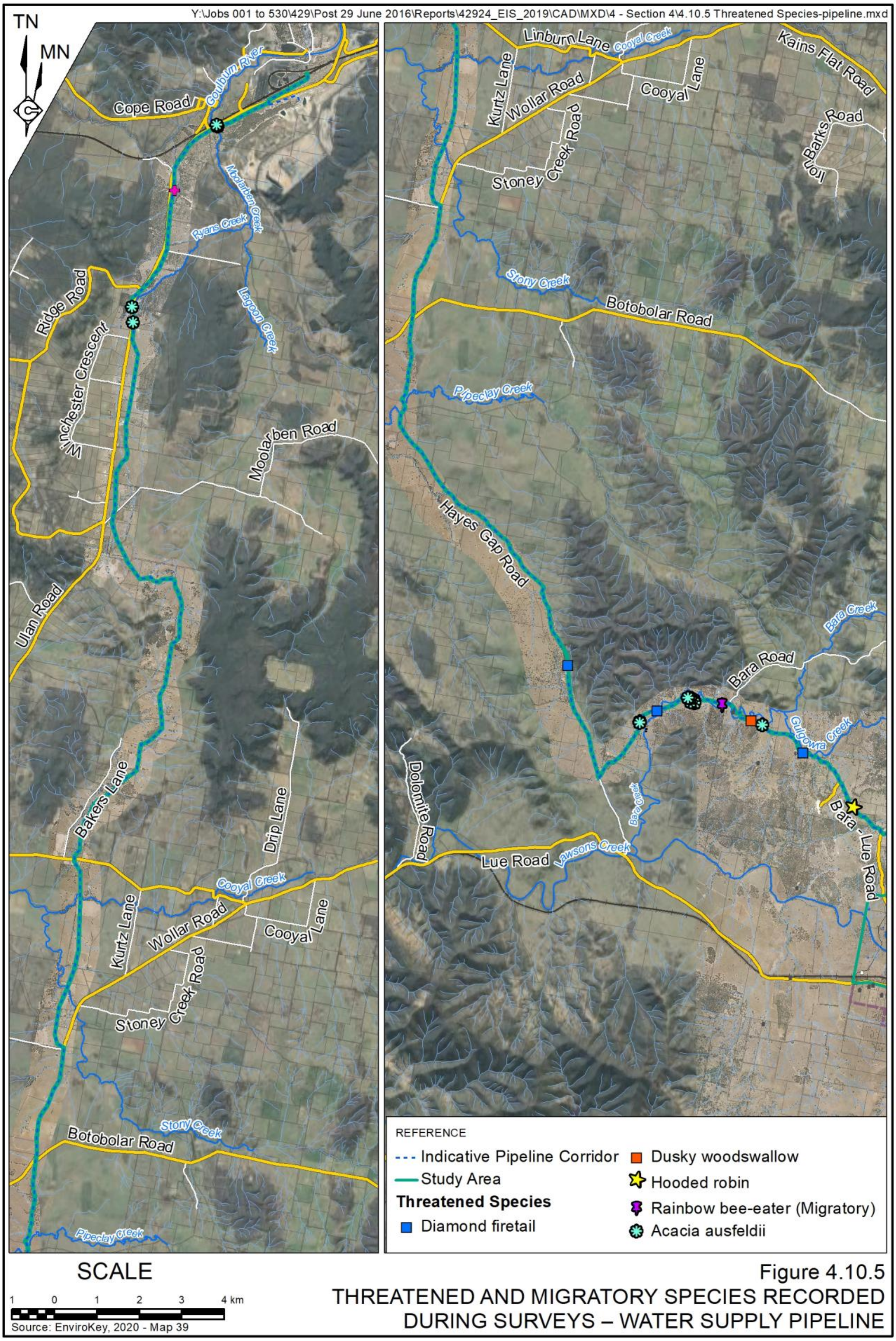

Figure 4.10.5
THREATENED AND MIGRATORY SPECIES RECORDED DURING SURVEYS – WATER SUPPLY PIPELINE

Of the individual fauna species, 14 are threatened species listed under the BC Act and/or EPBC Act. Two EPBC Act migratory species were also recorded during the field surveys (see **Figures 4.10.4** and **4.10.5**).

A number of previous records for threatened species not recorded during the field surveys are located within proximity of the proposed Mine Site, relocated Maloneys Road, or water supply pipeline corridor. Of these, four species listed under the BC Act and/or EPBC Act and two EPBC Act migratory species are also presumed to occur due to suitable habitat being present.

Table 4.64 provides a summary of these species, their legal status and an overview of the survey results.

Table 4.64
Listed and Migratory Fauna Recorded or Likely to be Present

Page 1 of 2

Species	Legal Status	Overview of Survey Results
Birds		
Barking Owl	Vulnerable under the BC Act.	Recorded on two separate nights from the same location within the Mine Site and within the disturbance footprint. It is uncertain if this was the same individual, or two individuals. No breeding site has been located within the Study Area, despite extensive searches of hollow-bearing trees. It is probable that the woody vegetation portions of the Study Area provide foraging habitat and potentially breeding habitat.
Dusky Woodswallow	Vulnerable under the BC Act.	Frequently recorded along the southern section of the existing Maloneys Road where open woodland and cleared land occurs. Breeding activity was also recorded in this area. This species was also recorded in the western portion of the Mine Site and along the water supply pipeline corridor on Bara-Lue Road. Based on the frequency of sightings, it is likely that this species occurs across the general locality.
Hooded Robin	Vulnerable under the BC Act.	The Study Area contains habitat for this species, which appears to be mostly confined to lightly wooded country. The five sightings within the Study Area are mostly outside of the disturbance footprint. One sighting has also occurred on Bara-Lue Road, near an active quarry.
Diamond Firetail	Vulnerable under the BC Act.	Eight sightings in total, all of which, except one, were in open woodland. The exception was a single bird in a gully in the northeast corner of the Study Area in the vicinity of the Mine Site.
Varied Sittella	Vulnerable under the BC Act.	Three sightings within the Study Area, all within the disturbance footprint. Given the relatively sedentary nature of this species, it is most likely that any individuals observed are resident within the Study Area, confirming breeding and foraging habitat is present.
Scarlet Robin	Vulnerable under the BC Act.	Recorded on a single occasion, next to the existing Maloneys Road in dense Cypress Pine regrowth within the disturbance footprint. This record confirms that foraging habitat and most likely, breeding habitat is present.
Speckled Warbler	Vulnerable under the BC Act.	Recorded three times in the Study Area; twice in the southeast corner, east of Pyangle Road, and along Ulan Road near Ulan.
Brown Treecreeper	Vulnerable under the BC Act.	Recorded on a single occasion in the Study Area, with a single sighting in the disturbance footprint in open woodland in the western portion. An existing record is also mapped with the Study Area from BioNET records.
Grey-crowned Babbler	Vulnerable under the BC Act.	It is thought that two family troupes occur within the Study Area, both outside the disturbance footprint. At least five birds comprise the family troupe along the existing Maloneys Road (in the far south of the Study Area), while at least three birds occur as a family troupe along Pyangle Road.

Table 4.64 (Cont'd)
Listed and Migratory Fauna Recorded or Likely to be Present

Page 2 of 2

Species	Legal Status	Overview of Survey Results
Birds (Cont'd)		
Regent Honeyeater*	Critically Endangered under the BC Act and EPBC Act.	No Regent Honeyeater were recorded despite comprehensive surveys and surveys being completed during appropriate sampling months. However, it is considered probable that the Regent Honeyeater uses the woodland areas within the Study Area from time to time but went undetected. Species credit species.
Swift Parrot*	Endangered under the BC Act and Critically Endangered under the EPBC Act.	No Swift Parrots were recorded despite some surveys during the suitable season. However, suitable habitat is present, there are previous records in the locality, and the Study Area is located at the northern extent of the Capertee Important Bird Area. Therefore it is possible that Swift Parrot could use the Study Area from time to time but went undetected.
Migratory Birds		
White-throated Needletail	Migratory under the EPBC Act.	Recorded during field survey and has previously been recorded in the locality.
Rainbow Bee-eater	Migratory under the EPBC Act.	Recorded during field survey and has previously been recorded in the locality.
Cattle Egret*	Migratory under the EPBC Act.	Not recorded during the field survey. However, the species has been recorded previously within the locality, and it may use the Study Area from time to time given its highly mobile nature.
Latham's Snipe*	Migratory under the EPBC Act.	Not recorded during the field survey. However, the species has been recorded previously within the locality, and it may use the Study Area from time to time given its highly mobile nature.
Bats		
Eastern Cave Bat (foraging only)	Vulnerable under the BC Act.	The only record within the Study Area is from previous surveys by ELA pre-December 2016. The source and date of this record is unknown. Given that the species is reliant on specific features for roosting and maternity sites, they are most likely only to forage within the Study Area.
Greater Broad-nosed Bat	Vulnerable under the BC Act.	Recorded during surveys by ELA (source and date unknown). There are no other records in the locality, and EnviroKey are uncertain as to the level of accuracy of this record particularly if it was through echolocation call recording analysis.
Eastern Bentwing Bat (foraging only)	Vulnerable under the BC Act.	Recorded in the Study Area by EnviroKey by echolocation call recording. Eastern Bentwing Bat are also known from previous records across the locality, so their presence within the Study Area is not surprising but it more likely to be foraging habitat only given the absence of caves.
Large-eared Pied Bat (foraging only)	Vulnerable under the BC Act and EPBC Act.	Recorded in the Study Area by EnviroKey by echolocation call recording. The Study Area contains woodland foraging habitat but not potential breeding habitat.
Mammals		
Spotted-tail Quoll*	Vulnerable under the BC Act and Endangered under the EPBC Act.	Whilst not recorded by the comprehensive field surveys, two records of Spotted-tailed Quoll occur in relatively close proximity to the Study Area.
Arboreal Mammals		
Squirrel Glider*	Vulnerable under the BC Act.	Not recorded during field survey but have previously been recorded in the locality and BGW is known habitat. Species credit species.
Koala	Vulnerable under the BC Act and EPBC Act.	Recorded twice within the Study Area with one of these within the disturbance footprint. Species credit species.
*Species not recorded through survey but presumed to occur.		
Source: EnviroKey (2020) – Compiled from Section 5		

4.10.5 Management and Mitigation Measures

4.10.5.1 Introduction

The Applicant has designed the Project to avoid impacts on biodiversity to the extent feasible, to mitigate the unavoidable impacts and to offset the residual impacts. The following subsections present the process followed to avoid impacts, outlines the proposed mitigation measures and summarises the biodiversity offset strategy.

4.10.5.2 Avoidance of Impacts

Biodiversity surveys have been undertaken by EnviroKey for a total of 26 days over a period of 3 years (2016 to 2019) and builds upon previous survey work undertaken by Ecological Australia, Geoff Cunningham Natural Resource Consultants, and Biodiversity Monitoring Services between 2012 and 2014. This has provided a comprehensive understanding of the biodiversity within the Study Area. In particular, these surveys have identified and defined the areas of native vegetation, including areas of the threatened BGW community.

To assist in the development of a final design footprint for the Project a 'traffic light model' was first developed for the Study Area in March 2017. Red, orange and green were applied to visualise the level of potential biodiversity value and assist the design team during the planning phase to avoid and minimise impacts to biodiversity, where possible. The definition of each of the 'traffic light' colours is provided as follows.

- Red: presence of native vegetation that qualifies as a critically endangered TEC under the schedules of the BC Act or EPBC Act.
- Orange – presence of native vegetation that does not qualify as above.
- Green – presence of vegetation that is dominated by introduced flora species.

As a result of the traffic light model a range of alterations were made to both the Mine Site layout and positioning of the water pipeline corridor, reducing the area of disturbance within the Red and Orange areas. The key adjustments to the Mine Site layout related to the locations and boundaries of the soil stockpiles. In light of the traffic light model, most soil stockpiles were confined to low and moderate impact areas and the area of soil stockpile reduced by increasing the thickness of subsoil stockpiled from 3m to 5m, thereby reducing the area for soil stockpiling.

4.10.5.3 Mitigation of Impacts

Biodiversity Management Plan

An overarching Biodiversity Management Plan would be prepared prior to commencement of the Project addressing the following.

- Delineation of areas of native vegetation that are to be removed to prevent accidental damage or removal of retained vegetation.
- Restrictions for vehicles, persons and machinery from entering areas of retained vegetation (unless for required environmental monitoring or other valid purpose) to avoid unnecessary impacts to vegetation and habitat.

- Inclusion of a Pre-clearance Survey Protocol for areas of native trees and shrubs including a two-stage clearing protocol for all hollow-bearing trees.
- Marking all hollow-bearing trees to be removed and cataloguing their species and approximate dimensions so that hollows or nest boxes can be added to similar standing trees.
- A seed collection plan including measures and procedures to collect, maintain and propagate from native seed sources.
- A weed management plan, including an inspection program to monitor for weed invasion and identification information for key weed species.
- A feral animal management plan including an inspection program to monitor for feral animal issues.

Rehabilitation Management Plan

A Rehabilitation Management Plan would be prepared in accordance with the latest NSW Resources Regulator requirements and guidelines. The plan would be consistent with the rehabilitation objectives and approach as outlined in EIS Section 2.16.

Cyanide Management

The proposed use of cyanide in processing would result in a concentration of <10ppm WAD cyanide in the tailings entering the TSF. Therefore, in accordance with the Commonwealth *Priority Existing Chemical Assessment Report No. 31 Sodium Cyanide* (NICNAS, 2010) the TSF would be classified as Category 1. NICNAS (2010) states that for concentrations <10ppm "*no acute mortalities and minimal sublethal effects are expected*".

Notwithstanding, NICNAS (2010) recommends that, as a contingency precaution, measures should be implemented to minimise fauna visitation and for monitoring. A Cyanide Management Plan (CMP) would be prepared prior to commencement of cyanide use in processing operations. The CMP would outline the following.

- Measures to contain cyanide containing waste entirely within the Mine Site.
- Measures to maintain cyanide levels to within limits prescribed by the development consent.
- Contingency measures for cyanide reduction.
- Details of a cyanide monitoring program.

Construction and Operation of Tailings Storage Facility

The following measures would be undertaken to the extent feasible to minimise the risk of fauna interactions with the TSF.

1. The TSF would be constructed in a way that minimises the risk of shallow ponds forming on uneven ground after rain events.
2. The floor of the TSF would be contoured during construction to avoid island formation.

3. Vegetation would be removed and loose topsoil stripped within the TSF to minimise the risk of vegetation re-establishing (prior to being covered with tailings and ultimately capped).
4. Bare ground within the TSF would be covered with tailings as soon as practical.

4.10.5.4 Offsetting of Residual Impacts

The Biodiversity Offset Strategy (BOS) for the Project is presented in Section 2.17 including the assessed offsetting requirements and how these would be satisfied for the Project.

In accordance with the *NSW Biodiversity Offsets Policy for Major Projects,* the following options are available to satisfy the offset requirements for the Project.

- Credit purchase and retirement from offset sites secured by biobanking (now Stewardship) agreements. Purchase of credits provides funding for in-perpetuity management and protection for conservation purposes.
- Rehabilitation of mine sites.
- Contributing money to supplementary measures.
- Payments into the Biodiversity Conservation Trust fund.

The Applicant proposes to implement a BOS that meets the offset requirements principally through establishment of Biodiversity Stewardship Agreements on land owned by the Applicant within and surrounding the Mine Site and other private landholdings within the applicable bioregions, either through purchase or agreement with the landowner. A portion of the offset requirement may also be met through purchase of credits from third parties who have established Stewardship Agreements and/or payment directly into the Biodiversity Conservation Trust.

The *NSW Biodiversity Offsets Policy for Major Projects* commenced on 1 October 2014 and, under transitional provisions of the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*, the policy continues to apply to the Project. The policy is underpinned by six principles which have been addressed as follows.

Principle 1: Before offsets are considered, impacts must first be avoided, and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.

Bowdens Silver have made all reasonable attempts to avoid impacts to biodiversity through the development of a traffic light model and subsequent application to the ultimate site layout. This is discussed further in Section 4.10.5.2.

Principle 2: Offset requirements should be based on a reliable and transparent assessment of losses and gains.

The terrestrial ecology assessment has been prepared in accordance with the FBA using the Biobanking Assessment Method. This assessment has been confirmed by the former OEH as the appropriate assessment pathway for the Project.

Principle 3: Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities.

A substantial portion of the BOS utilises on-site offsets with vegetation communities similar to and within proximity to those being disturbed. The off-site offset sites also target BGW and key threatened species habitat.

Principle 4: Offsets must be additional to other legal requirements.

The requirements of the Stewardship Agreements would be in addition to any other legal requirements for those landholdings and would provide greater biodiversity protection in perpetuity.

Principle 5: Offsets must be enduring, enforceable and auditable.

Ongoing management of the Stewardship Sites, whether established on land owned by Bowdens Silver or other private landholdings, would be funded through the Biodiversity Stewardship Payments Fund and would be subject to auditing by the Biodiversity Conservation Trust and/or Biodiversity and Conservation Division. Therefore, the biodiversity offsets would be enduring, enforceable and auditable.

Principle 6: Supplementary measures can be used in lieu of offsets.

It is currently proposed to meet the biodiversity offset requirements through creation and retiring of credits created through biodiversity offset sites and Stewardship agreements. It is not expected that any supplementary measures would be required in lieu of offsets.

4.10.6 Assessment of Impacts

4.10.6.1 Introduction

This subsection presents an assessment of the anticipated Project-related impacts on listed flora and fauna species and communities. Both direct and indirect impacts are considered together with relevant legislative considerations.

4.10.6.2 Direct Impacts

The total disturbance footprint of the Project would be 495.54ha of which 381.71ha is native vegetation with the remaining 113.83ha being existing cleared land dominated by non-native species. Of the native vegetation to be disturbed, 182.26ha classifies as the BC Act listed BGW, of which 147.82ha also meets the classification of the EPBC Act listed BGW. In total 88.18ha (48%) of the BGW comprises only derived grassland and not trees and shrubs, having already been cleared by past agricultural activities. The disturbance would occur progressively over the Project life and, whilst rehabilitation would occur, these impacts would remain, to a lessening extent, over the medium to long-term. In particular, development of habitat features, such as hollows can take 100 years or greater to form. Additionally, a proportion of the impact would be irreversible, in particular vegetation communities would not be re-established within the retained void covering approximately 53ha. Notwithstanding, it is noted that the biodiversity offset for this disturbance would be established progressively as the disturbance occurs such that the impact is offset prior to the direct impacts occurring.

4.10.6.3 Indirect Impacts

Cyanide

Cyanide at unmanaged and inappropriate levels may present a risk to local fauna. Whilst the Project would utilise cyanide during processing, the concentrations required are comparatively low and would result in cyanide levels at the discharge point to the TSF of <10ppmWAD cyanide. Therefore, in accordance with NICNAS (2010), no acute mortality and minimal sublethal effects would be expected from fauna interaction with the TSF materials. Notwithstanding, the implementation of the management measures outlined in Section 4.10.5.3 would reduce the risk of interaction with cyanide-bearing waste. Therefore, it is unlikely that any significant indirect impacts would occur as a result of cyanide use. Furthermore, the duration of these potential impacts would be short-term with the capping of the TSF, following completion of processing, removing the potential exposure risk.

Pests and Weeds

The Study Area is already known to provide habitat for feral animals including cats, foxes and rabbits. Native vegetation removal as a result of the Project proceeding, may increase both habitat and landscape suitability for feral animals. Weeds are also present in the Study Area and have potential to be transported into the Study Area.

However, with the implementation of the Biodiversity Management Plan, including monitoring for weeds and pests and, if required, implementation of control measures, the potential for an increase in feral animals and weed invasion could be adequately managed.

The risk of increased suitability for feral animals and weeds would reduce significantly following completion of successful rehabilitation and would largely be reversed. It is also noted that land management practices within the biodiversity offset areas within and surrounding the Mine Site would act to reduce the risk of feral animals and weed invasion compared to the previous land management practices. As the offsets would be in perpetuity, this improvement would similarly be in perpetuity.

Connectivity and Habitat Fragmentation

The Project would result in some loss of connectivity and habitat fragmentation. However, the Study Area occurs at the southern extent of a large expanse of native vegetation, which then opens onto an existing fragmented landscape which is best described as variegated. While some level of connectivity would be lost and levels of habitat fragmentation would increase, the landscape would still retain features suitable for landscape connectivity. Similar to the direct impact of vegetation clearing, this fragmentation would be largely reversible over time with the rehabilitation of the disturbance areas, The establishment of the biodiversity offset areas within and surrounding the Mine Site would provide in perpetuity protection of vegetation that may have otherwise been subject to disturbance from ongoing agricultural and other activities. Therefore, in considering the rehabilitation and establishment of biodiversity offsets, the Project has the potential to result in long-term protection of habitat connectivity. However, it is noted that some areas, such as the retained void, would remain irreversibly altered.

Injury and Mortality

Fauna injury or mortality can occur during the clearing phase of construction, during the removal of habitat, and from collision with vehicles during the operation of the Project. This would be mitigated to the extent possible through the Pre-clearance Survey Protocol, however, some injuries and mortalities are likely. These impacts would be of a short-term duration, principally occurring during clearing activities, and to a lesser extent during active operations. Following completion of operations and rehabilitation, this risk would be removed.

Inadvertent Impacts to Adjacent Vegetation and/or Habitat

Impacts from machinery, materials and persons entering areas of retained vegetation and habitat could be adequately managed through the Biodiversity Management Plan which would include restrictions for accessing retained and adjacent vegetation. The potential for these inadvertent impacts would be limited to the life of the Project.

Groundwater Drawdown

As outlined in EIS Section 4.6.7.2, the terrestrial vegetation present within the Study Area is not likely to be obligate phreatophytes (i.e. groundwater dependent). Notwithstanding, terrestrial vegetation that does draw on subsurface groundwater is unlikely to draw water from the regional groundwater table. Rather, it is more likely to draw on water that is in the capillary zone or at the soil-rock interface, from rainfall infiltration and storage in perched aquifers, or surficial groundwater within drainage lines. Therefore, the predicted drawdown in the regional aquifer is unlikely to impact upon groundwater dependent ecosystems.

Noise and Vibration

Sections 4.2 and 4.3 outline the noise and vibration levels that would result from the Project. Whilst no multi-species study has found all species to be sensitive to noise and vibration, it is generally agreed that, for species which vocalise frequently such as birds and amphibians, there is some potential for negative effects over the long-term. In the context of the Project, avoidance behaviour may result during blasting. However, for general industrial, whilst this can have some impacts, there are many examples of fauna, co-existing (foraging and breeding) on active mine projects. The potential for impacts would be limited to the mine life.

Lighting

Light pollution is likely to have both positive and negative effects. As demonstrated in a number of assessments, some species of nocturnal birds and bats will frequently hunt around lighting towers given that the light attracts insects including moths and other flying invertebrates. Other nocturnal species may avoid well-lit areas given that these may increase vulnerability to predation. However, it is important to note that lighting within the Mine Site would be directed towards operational areas not surrounding vegetated areas. The potential for impacts would be limited to the mine life.

4.10.6.4 Koala Habitat Assessment

As discussed in Section 3.2.3.4, the Project is located within a local government area to which the SEPP (Koala Habitat Protection) 2019 and as such an assessment of Koala habitat is required. EnviroKey (2020) recorded a number of trees species, including Rough-barked Apple, White Cypress Pine, White Box, Blakelys Red Gum, Ribbon Gum, and Scribbly Gum within the Study Area, all of which are listed as Koala feed tree species under Schedule 2 of this SEPP. Given the presence of Koala feed tree species and recent records within and adjacent the Mine

Site (not recorded as part of the terrestrial ecology assessment), it is considered likely that the Study Area contains Core Koala Habitat as defined by the SEPP (Koala Habitat Protection) 2019.

EnviroKey (2020) completed a significance assessment for the Koala in accordance with the EPBC Act. Whilst two Koala have been recorded within the Study Area and the Project would result in the loss of 139.59ha of suitable habitat, it was concluded that the Project would not result in a significant impact due to:

- the relatively localised nature of the disturbance when compared to the wider local and regional distribution of Koala; and
- the greater extent of habitat in the locality known to be used by Koala.

Management of Koalas would be addressed through the Biodiversity Management Plan.

4.10.6.5 Matters of National Environmental Significance (MNES)

As outlined in Section 3.2.3.2, MNES include listed threatened species and ecological communities as well as listed migratory species. The EnviroKey surveys (see Section 4.10.4) recorded the following MNES within the Study Area.

- Large-eared Pied Bat (vulnerable).
- Rainbow Bee-eater (migratory).
- White-throated Needletail (migratory).
- Box-Gum Woodland (critically endangered ecological community).
- Koala (vulnerable).

Whilst not recorded during the surveys, the Study Area is considered to contain suitable habitat for the following MNES. These species have also previously been recorded in the locality.

- Regent Honeyeater (critically endangered).
- Cattle Egret (migratory).
- Latham's Snipe (migratory).
- Swift Parrot (critically endangered).
- Spotted-tailed Quoll (endangered).

In accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DotE, 2013), a significance assessment was completed for each of the above MNES. The full assessment is included as part of EnviroKey (2020). In summary, EnviroKey concluded that the Project would not impact on the Rainbow Bee-eater, White-throated Needletail, Latham's Snipe, Cattle Egret or any migratory species.

It has also been concluded that the Project is unlikely to result in a significant impact upon the Koala, Large-eared Pied Bat, Spotted-tail Quoll, Swift Parrot. For both the BGW and Regent Honeyeater, despite all reasonable attempts to avoid impacts, the Project has the potential to have a significant impact in the absence of suitable biodiversity offsets. Consequently, both Box-Gum Woodland and the Regent Honeyeater are key components in the proposed Biodiversity Offset Strategy (see Section 4.10.5.3).

4.10.7 Conclusion

The Project would result in the removal of a total of 383.4ha of native vegetation of variable condition. This includes 182.26ha of BC Act listed Box-Gum Woodland, of which 147.82ha also meets the classification under the EPBC Act. Notably, out of the 182.26ha of Box-Gum Woodland, 88.18ha comprises derived grassland only, having had the trees and shrubs cleared by past agricultural activities. A total of 19 threatened species (two flora and 17 fauna species) have also been recorded or are predicted to occur within the impact footprint.

In assessing the potential for significant impacts, EnviroKey (2020) concludes that, excluding the Regent Honeyeater, the Project would not result in significant impacts upon migratory or threatened species. In assessing the potential for impacts, in the absence of any mitigation measures, the Project could have a significant impact upon the Regent Honeyeater. Notwithstanding, EnviroKey (2020) considered the Project would:

- not lead to a long-term decline in the size of a population of the species;
- not reduce the area of occupancy to the detriment of the species; and
- be unlikely to result in the introduction of species or diseases that are potentially harmful to the Regent Honeyeater.

Similarly, for Box-Gum Woodland, in the absence of any mitigation measures, the Project could have a significant impact. However, a range of mitigation measures have been developed to avoid and mitigate impacts to biodiversity with residual impacts to be offset through the BOS. The BOS utilises on-site offsets with vegetation communities similar to and within proximity to those being disturbed, including Box-Gum Woodland and habitat for the Regent Honeyeater and other key threatened species. The off-site offset sites also target Box-Gum Woodland and other key threatened species. The BOS would provide in-perpetuity protection, enhancement and management of the offset sites through establishment of Biodiversity Stewardship Agreements funded through the Biodiversity Stewardship Payments Fund and be subject to auditing by the Biodiversity Conservation Trust and/or Biodiversity and Conservation Division.

Notably, the impact assessment has conservatively been undertaken without formally considering the fact that approximately 344ha would be revegetated to native vegetation (153ha native woodland and 191ha native grassland) using species consistent with the existing vegetation communities. In the long-term, these rehabilitation areas would further reduce impacts to biodiversity and are in addition to the BOS.

4.11 AQUATIC ECOLOGY

The aquatic ecology assessment of the Project was undertaken by Cardno (NSW/ACT) Pty Ltd. The full assessment is presented in Volume 4 Part 10 of the Specialist Consultant Studies Compendium and is referenced throughout this section as Cardno (2020).

4.11.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in aquatic ecology impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Displacement of ephemeral watercourses due to the development of the open cut pits, TSF and other ancillary Mine components (Medium).
- Loss of subterranean habitat and subsequent impacts to stygofauna species due to groundwater drawdown following inflow of groundwater into the main open cut pit void (Medium).
- Temporary or permanent barrier to fish passage in Lawsons Creek or loss of aquatic habitat due to the construction of the relocated Maloneys Road (Low).
- Changes to geomorphology and flow regimes of watercourses impacting aquatic ecology and riparian assemblages (Low).
- Reduced water quality in Hawkins and Lawsons Creek catchments and impacts to local biota as a result of mobilisation of sediments and unplanned discharges (Low).
- Impacts on groundwater biota, aquatic ecological biodiversity, stygofauna and biota within Hawkins and Lawsons Creeks due to possible exposure of unweathered PAF waste rock or ore (Low).
- Proliferation and spread of aquatic pest species in water bodies due to unmanaged discharge of existing dams on site (Low).
- Reduced biodiversity values in Hawkins and Lawsons Creeks due to Key Threatening Processes (Low).

In addition, the SEARs issued by the former DPE identified “biodiversity” as a key issue requiring assessment. Impact of groundwater biota, aquatic ecological biodiversity, stygofauna and biota of surface waters of the Hawkins and Lawsons Creeks The principal assessment requirements identified by NSW Office of Water (NOW), the Department of Primary Industries (Fisheries) (NSW Fisheries), the Environment Protection Authority (EPA), the Office of Environment and Heritage (OEH) and the Mid-Western Regional Council relating to aquatic ecology included the following.

- a series of general requirements for assessing and mapping impacts to the aquatic environment including identifying existing and likely aquatic populations and habitats and the extent of potential impacts;

- considerations for assessing:
  - activities that may block fish passage;
  - threatened aquatic species; and
  - impacts to Groundwater Dependent Ecosystems (GDEs);
- identification of waterway crossings and structures, e.g. bridges, culverts, water pipelines, etc. that may affect the aquatic ecology; and
- management measures required to mitigate potential impacts.

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC.

This subsection of the EIS provides a summary of the aquatic ecology assessment, concentrating on those matters raised in the SEARs and related requirements provided by various government agencies in relation to the Mine Site and the relocated Maloneys Road.

It is noted that the water supply pipeline would be constructed below perennial watercourses and other watercourses where significant water flows are present at the time of construction underboring techniques. Whilst trenching would be used to cross watercourses without significant flows of water, the pipeline would be buried and the watercourse profile would remain unchanged. In the event temporary watercourse diversions or coffer dams are required to manage minor flows, NSW DPI (Fisheries) would be consulted on appropriate methodology. Consequently, impacts to fish passage and aquatic habitat within the water supply pipeline corridor are expected to be no more than minor and temporary and no further consideration of these issues is required.

4.11.2 Methodology

4.11.2.1 Introduction

Following a review of aerial photography and a desktop assessment regarding known or likely aquatic habitats and biota, field surveys were undertaken targeting the various features of the surface water and groundwater environment, and the habitat and biota within both environments.

For the purposes of the aquatic ecology study and assessment, the Study Area includes the catchment of Lawsons Creek from immediately upstream of its confluence with Hawkins Creek downstream to Lue, and the catchment of Hawkins Creek from its confluence with Lawsons Creek to approximately 5km upstream. The Study Area also comprises the tributaries of Hawkins and Lawsons Creeks that traverse the Mine Site (including Blackmans Gully, Price Creek and Walkers Creek) and potential groundwater dependent ecosystems (GDEs) located within and directly adjacent to the Mine Site. **Figure 4.11.1** displays the aquatic ecology Study Area and survey sites.

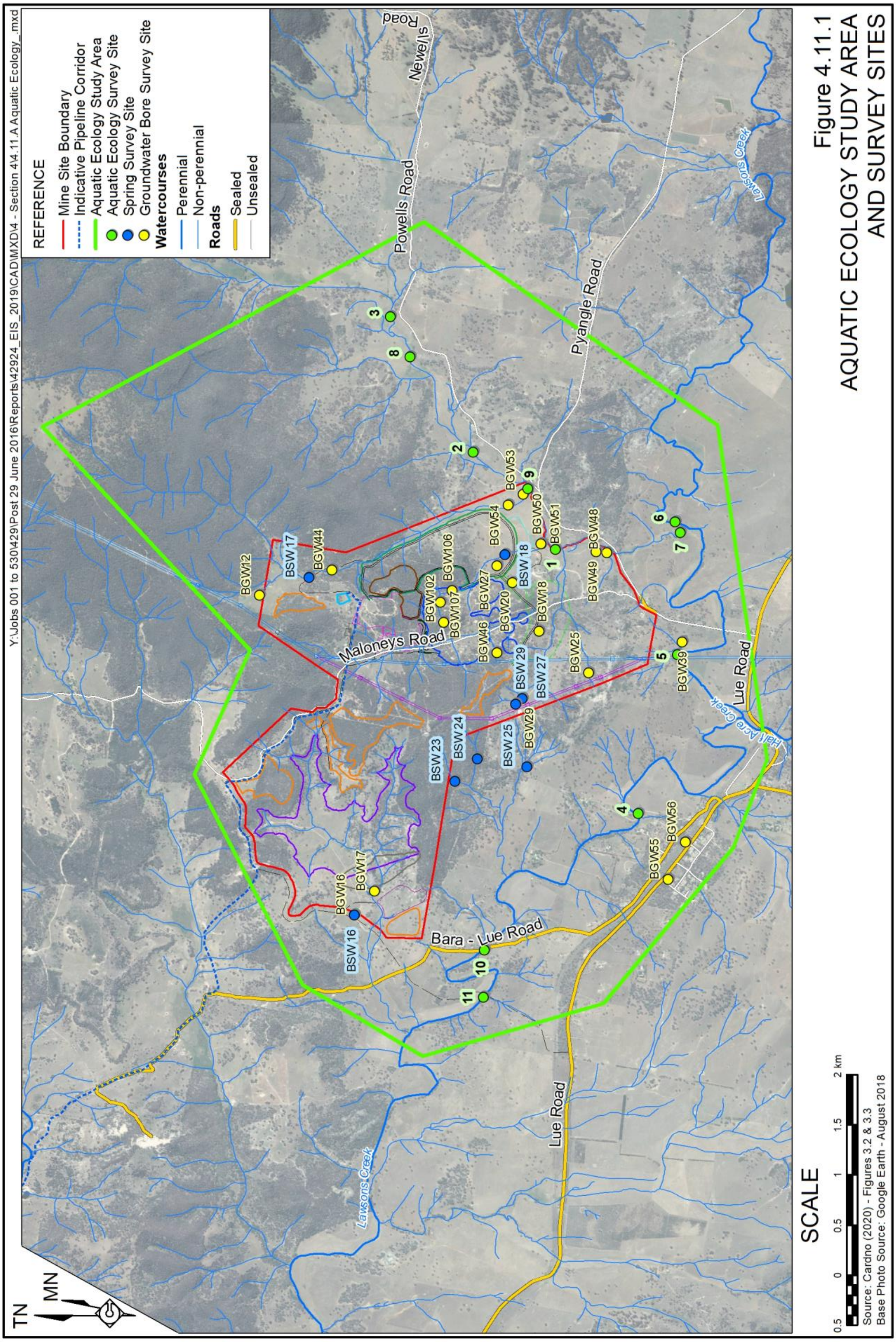

Figure 4.11.1
AQUATIC ECOLOGY STUDY AREA AND SURVEY SITES

4.11.2.2 Desktop Assessment

Cardno (2020) undertook a desktop review (including a literature review and database searches) of threatened aquatic species, populations and ecological communities that could potentially occur within Study Area. The following databases were searched for potential occurrences within a 10km radius of the Study Area.

- BioNet (Atlas of NSW Wildlife)
- Threatened Species Profile Database (BCD)
- Fish Communities and Threatened Species Distribution of NSW (NSW DPI)
- Listed Threatened Species, Populations and Ecological Communities (NSW DPI)
- Protected Matters Search Tool (DoAWE)
- Atlas of Living Australia (ALA)

Threatened Species, Populations and Communities

Table 4.65 presents a summary of the candidate species, populations and communities listed as threatened under State and Federal legislation and their likelihood of occurrence within the Study Area.

Table 4.65
Potential Occurrences of Threatened Species, Populations and Communities

Species or Population	BC Act Status	FM Act Status	EPBC Act Status	Likelihood of Occurrence
Fish				
Australian grayling			Vulnerable	Unlikely
Flathead galaxias		Critically Endangered	Critically Endangered	Unlikely
Macquarie perch		Endangered	Endangered	Unlikely
Murray cod			Vulnerable	Possible
Silver perch		Vulnerable		Unlikely
Southern Purple Spotted Gudgeon		Endangered		Possible
Southern pygmy perch		Endangered		Unlikely
Trout cod		Endangered		Unlikely
Invertebrates				
Giant dragonfly	Endangered			Unlikely
Murray crayfish		Vulnerable		Unlikely
Darling River snail		Critically Endangered		Unlikely
Hanley's River snail		Critically Endangered		Unlikely
Populations				
Western population of olive perchlet		Endangered		Unlikely
Murray-Darling Basin population of eel tailed catfish		Endangered		Possible
Communities				
Lowland Darling Ecological Community		Endangered		Does not occur
Source: Cardno (2020) – Table 3.13				

Groundwater Dependent Ecosystems

According to the Atlas of GDEs, Hawkins and Lawsons Creeks are surface water systems with a moderate potential for groundwater interaction. These ecosystems are likely to be reliant on groundwater and surface expression of groundwater and, therefore, would be classified as GDEs. Blackmans Gully is also considered to have a high potential for groundwater interaction, and thus would be relatively more reliant on the surface expression of groundwater. Other watercourses within the Study Area are not identified on the Atlas of GDEs.

There have been no known previous stygofauna studies undertaken in the Study Area.

Key Threatening Processes

A key threatening process (KTP) is a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, population or ecological community. KTPs are listed under the *Fisheries Management Act 1994* (FM Act), *Biodiversity Conservation Act 2016* (BC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Broadly, the KTPs include threats to threatened species, populations and ecological communities as well as cause species, population or ecological communities to become threatened.

The KTPs listed under the FM Act that may be relevant to the potential impacts of the Project on aquatic ecology are:

- removal of large woody debris from NSW rivers and streams;
- degradation of native riparian vegetation along NSW watercourses; and
- installation of instream structures and other mechanisms that alter natural flows.

The KTPs listed under the BC Act that may also be relevant are:

- alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands;
- clearing of native vegetation; and
- predation by *Gambusia holbrooki* (eastern gambusia).

Two KTPs listed under the EPBC Act that may be relevant to the Project with respect to aquatic ecology are:

- loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants; and
- novel biota and their impact on biodiversity.

These KTPs relate to the potential for invasive organisms to spread at the detriment of native ecosystems. The risk to aquatic ecosystems associated with these KTPs is considered to be low due to the nature of the Project, however, these are addressed in Section 4.11.6 as a precautionary measure.

4.11.2.3 Field Surveys

The following survey sites were established or assessed in order to describe the existing aquatic ecology environment and identify any potential constraints (**Figure 4.11.1**).

- Hawkins Creek and Lawsons Creek (Sites 1 to 11).
- Walkers Creek, Blackmans Gully and Price Creek.
- Eight springs (BSW17, 18, 23, 24, 25, 27, 29 and the spring associated with BGW16).
- A total of 22 groundwater bores both within the Study Area (both within and beyond the Mine Site).

The aquatic ecology field investigations included descriptions of aquatic habitats, measurements of water quality, and assessments of aquatic biota including macrophyte (aquatic plants and algae), macroinvertebrate and fish assemblages. A total of 22 groundwater bores were also selected for stygofauna sampling.

Section 3.2.3 of Cardno (2020) provides a detailed description of the methods used during the field surveys.

4.11.3 Existing Environment

4.11.3.1 Hawkins and Lawsons Creeks

Physical Condition

A standardised description of the condition of river banks, channel, bed and adjacent land was undertaken by Cardno (2020) using a modified version of the "Riparian, Channel and Environmental Inventory" (RCE) (Chessman et al., 1997) a method used to scale and quantify the environmental state of particular locations based on surrounding land use, geomorphology, channel bed forms, and riparian and in-stream vegetation. The highest possible score (52) is assigned to streams with no obvious physical disruption while the lowest score (13) is assigned to heavily disturbed streams. Additionally, the potential to provide fish habitat was graded according to criteria developed by NSW Fisheries.

Sites assessed during the field surveys of Hawkins and Lawsons Creeks recorded low overall RCE scores (ranging between 20 to 26) (**Table 4.66**) with consistent low scores in categories associated with the health of riparian vegetation and bank stability. Cardno (2020) records that both Hawkins and Lawsons Creeks flow through pasture/farmland for much of their reach within the Study Area with the historic clearing of riparian vegetation resulting in few bankside trees and other bank-stabilising plants. The lack of significant root systems provided by riparian vegetation has resulted in extensive bank erosion and slumping along the extent of both creeks.

Hawkins and Lawsons Creeks are classified as Key Fish Habitat by NSW DPI (Fisheries) and contain Type 1 – Highly Sensitive Key Fish habitats (native aquatic plants and some large wood debris) (**Table 4.66**). For the purpose of determining the suitability of waterway crossings, both Hawkins and Lawsons Creeks are classified as Class 2 – Moderate Fish Habitat due primarily to their intermittent flow (**Table 4.66**). Bridges, arch structures, box culverts and fords are considered suitable crossing structures for this class of creeks.

Table 4.66
Riparian, Channel and Environmental Inventory (RCE) Score, Fish Habitat Classification and Sensitivity within Hawkins and Lawsons Creeks

Site*	Watercourse	RCE Score	Fish Habitat Classification	Fish Habitat Sensitivity Type
1	Hawkins Creek	22	Class 2 Moderate fish habitat (Non-permanently flowing (intermittent) stream)	Type 1 (supports native aquatic plants and large wood debris)
2	Hawkins Creek	23		
3	Hawkins Creek	20		
7	Hawkins Creek	23		
8	Hawkins Creek	23		
9	Hawkins Creek	23		
4	Lawsons Creek	26		
5	Lawsons Creek	25		
6	Lawsons Creek	24		
10	Lawsons Creek	26		
11	Lawsons Creek	26		
Source: Cardno (2020) – Modified after Tables 3.3 and 3.12				

Cardno (2020) identified two crossings on Lawsons Creek within the Study Area including a box culvert upstream of Site 5 (Battens Road) and a ford just downstream of Site 4. A ford was also observed on Hawkins Creek (Bingman Crossing). Water levels during the December 2011 survey were below the level of the structures at Battens Road and Bingman Crossing, indicating that fish would be unable to navigate these structures during normal flows. Whilst these structures may impede or prevent fish passage during normal flow, fish would be able to navigate upstream and downstream during high flow events. It is noted that several other crossings are located on sections of Hawkins and Lawsons Creeks upstream and downstream of the Study Area.

Water Quality

The *in situ* water quality at Hawkins and Lawsons Creeks was recorded by Cardno (2020) at Sites 1 to 7 at various times between December 2011 and December 2018. Water quality data suggest that the water quality of Hawkins and Lawsons Creeks is moderate to poor, with low dissolved oxygen and elevated turbidity and electrical conductivity levels. A summary of these results is presented in **Table 4.67**.

Electrical conductivity levels ranged between 347µS/cm and 2 541µS/cm and exceeded the upper (ANZG 2018) Default Trigger Value (DTV) at each site with the exception of Site 7 in December 2011. Elevated electrical conductivity levels may be due to runoff containing high levels of dissolved salts, or local geology. The absence of riparian vegetation and associated root systems may also reduce the retention of runoff in sediments, resulting in increased rates of runoff entering watercourses, especially during high rainfall events when surrounding land may become saturated with water.

pH values were generally within the ANZG threshold limits (pH 6.5 – 8.0) and ranged between 6.9 and 8.1. A single exceedance of a DTV was recorded at Site 2 in April 2013 (pH = 8.1).

Table 4.67
Summary of *in situ* Water Quality Data from Hawkins and Lawsons Creeks between December 2011 and December 2018

Site*	Watercourse	Mean Electrical Conductivity (µS/cm)		Mean pH		Mean Dissolved Oxygen (% sat.)		Mean Turbidity (NTU)	
ANZG Default Trigger Value:		30 - 350		6.5 - 8.0		90 - 110		2 - 25	
2011 Field Investigations									
Site 1	Hawkins Creek	497	↑	6.9	✓	90.6	✓	30.4	↑
Site 2	Hawkins Creek	1085	↑	7.4	✓	93.1	✓	32.3	↑
Site 3	Hawkins Creek	1517	↑	7.0	✓	64.8	↓	31.2	↑
Site 4	Lawsons Creek	782	↑	7.1	✓	92.4	✓	29.3	↑
Site 5	Lawsons Creek	758	↑	7.2	✓	88.8	↓	31.5	↑
Site 6	Lawsons Creek	774	↑	7.2	✓	80.5	↓	33.7	↑
Site 7	Lawsons Creek	347	✓	7.2	✓	105.5	✓	34.3	↑
2013 Field Investigations									
Site 1	Hawkins Creek	494	↑	7.4	✓	64.5	↓	8.4	✓
Site 2	Hawkins Creek	2541	↑	8.1	↑	101.6	✓	0.0	↓
Site 3	Hawkins Creek	996	↑	7.4	✓	63.0	↓	12.7	✓
Site 4	Lawsons Creek	879	↑	7.8	✓	76.4	↓	0.0	↓
Site 5	Lawsons Creek	863	↑	7.9	✓	89.3	↓	0.0	↓
Site 6	Lawsons Creek	946	↑	7.8	✓	80.5	↓	1.3	↓
Site 7	Lawsons Creek	428	↑	7.7	✓	61.5	↓	0.0	↓
2017 Field Investigations									
Site 1	Hawkins Creek	448	↑	7.5	✓	63.5	↓	17.1	✓
Site 2	Hawkins Creek	1190	↑	7.2	✓	87.6	↓	22.4	✓
Site 3	Hawkins Creek	1361	↑	7.2	✓	65.0	↓	39.7	↑
Site 4	Lawsons Creek	686	↑	7.4	✓	87.3	↓	17.5	✓
Site 5	Lawsons Creek	851	↑	7.4	✓	81.5	↓	17.1	✓
Site 6	Lawsons Creek	1013	↑	7.6	✓	60.5	↓	15.1	✓
2018 Field Investigations									
Site 1	Hawkins Creek	1259	↑	7.5	✓	55.2	↓	22.2	✓
Source: Cardno (2020) – Modified after Annexure D									

Dissolved oxygen concentrations ranged between 55.2% and 93.1% saturation and were below the lower DTV on several occasions. In April 2013, dissolved oxygen concentrations ranged between 63.0% and 101.6% and were below the lower DTV at each site except for Site 2. Low dissolved oxygen concentration may be indicative of elevated nutrient levels. Fertilisers and/or faecal matter from livestock contain nutrients such as nitrates and if these pollutants enter aquatic ecosystems they can encourage the growth and proliferation of oxygen-consuming algae.

Turbidity levels ranged from 0.0ntu to 39.7ntu and were above the upper DTV on several occasions. Elevated turbidity levels may be due to rainfall, which can mobilise sediments and result in elevated turbidity levels. Bank erosion may also contribute to elevated turbidity levels due to the release of sediment that may be exacerbated during high flows and relatively high water velocities following rainfall. Trampling by livestock, lack of riparian vegetation and surrounding land use may also influence turbidity levels.

A more comprehensive assessment of the water quality of these watercourses is provided in Section 4.7.2.7.

Macrophytes

Aquatic macrophytes often occupied a significant proportion of each site surveyed and primarily comprised native species. In total, twelve species of macrophytes and two species of algae were identified across the December 2011, April 2013, March 2017 and December 2018 surveys. River clubrush (*Schoenoplectus validus*), common spike-rush (*Eleocharis acuta*), and cumungi (*Typha orientalis /* domingensis) were amongst the most abundant macrophytes identified along creek edges. An unidentified filamentous alga was also abundant at each site and frequently covered submerged portions of macrophytes and the surface of substrata. Table 3.4 of Cardno (2020) identifies the aquatic and non-aquatic plant species identified within the channels of Hawkins and Lawsons and Creeks.

Macroinvertebrates

Hawkins and Lawsons Creeks support a diverse macroinvertebrate fauna, and, although this appears to be dominated by pollution tolerant taxa, these taxa were predicted to be present by the AUSRIVAS model and pollution sensitive taxa were present also. In total, 51 taxa were identified in edge samples collected in December 2011, 37 from those collected in April 2013, 35 from those collected in March 2017 and 18 from those collected in December 2018. Annexure E of Cardno (2020) presents a full list of macroinvertebrate taxa identified from AUSRIVAS edge samples.

Fish

In total, four native and three introduced fish species were caught in Hawkins and Lawsons Creeks along with three macroinvertebrate taxa. None of the species identified are listed as threatened, although one native species, river blackfish (*Gadopsis marmoratus*), appears to be experiencing a reduction in numbers and occurrence across its range due to anthropogenic disturbance to its habitat. Other native species were Australian smelt (*Retropinna semoni*), mountain galaxias (*Galaxias olidus*) and carp gudgeon (*Hypseloetris* spp.). Australian smelt and carp gudgeons are common and widespread in the Murray-Darling Basin. Mountain galaxias, while widespread, have experienced reductions in numbers in lowland and upland streams, likely the result of predation from introduced salmonids (such as rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), though salmonids were not caught in the surveys. Carp gudgeons are a relatively undescribed genus and genetic studies have shown that at least four taxa are present, as well of a range of hybrids (MDBA 2011).

The invasive eastern gambusia (*Gambusia holbrooki*) was by far the most abundant fish species, occurring in large numbers at each site sampled during each survey. Predation by eastern gambusia is listed under the BC Act as a KTP. This KTP is primarily associated with predation on frogs or their tadpoles, including threatened species, though eastern gambusia would also prey on invertebrates and the young of native fish.

4.11.3.2 Walkers Creek, Blackmans Gully and Price Creek

Walkers Creek, Blackmans Gully and Price Creek are ephemeral watercourses and provide very limited aquatic ecology. A single pool was observed in Walkers Creek in March 2017. Price Creek supports some hydrophilic vegetation (sedges) which are common and widespread and not of conservation significance. Blackmans Gully was dry during each of the site visits and would likely only flow for a short period after rainfall. These watercourses are unlikely to provide any substantial habitat for fish but would provide some habitat for aquatic macroinvertebrates and potentially refuge for amphibians.

Blackmans Gully and Walkers Creek are Type 3 (minimally sensitive Key Fish Habitat) due to their ephemeral flow and absence of wetland and in-stream aquatic plants. Price Creek and a dam on Price Creek are Type 2 (Moderately sensitive Key Fish Habitat) due to the presence apparent intermittent flow and wetland plant species (albeit no in-stream aquatic plants). All three creeks are Class 3 watercourses due to their connection to Hawkins Creek or Lawsons Creek.

4.11.3.3 Springs and Associated Waterbodies

A total of eight springs were surveyed by between 2011 and 2018. Four of these springs (BSW16, BSW25, BSW27 and BSW29) appeared to support permanent freshwater dams which in turn provided some aquatic habitat. Aquatic macrophytes (such as *Juncus sp.*, *Eleocharis sp.*, *Potamogeton tricarinatus* and *Myriophyllum sp.*) were present to varying degrees, in terms of species and coverage, suggesting these dams are relatively permanent features. Eastern gambusia was observed in the dam associated with BSW29. These dams would also provide habitat for aquatic macroinvertebrates, birds and possibly also some native fish species.

The aquatic habitat supported by the other springs surveyed (BSW17, BSW18, BSW23 and BSW24) was very limited.

4.11.3.4 Groundwater Dependent Ecosystems

Stygofauna were observed in nine bores of the 22 bores (BGW18, BGW20, BGW39, BGW56, BGW48, BGW49, BGW54, BGW16 and BGW17) with five stygofauna taxa identified. *Psammaspides sp.* (Family: Psammaspididae) and Clyclopidae (a family of crustaceans of the sub class Copepod) were the most widespread taxa and were found in five of the surveyed bores. Paramelitidae (a family of amphipods) and Candonidae and Cyprididae (families of ostracods) were also found. All stygofauna taxa identified are typical of alluvial aquifers in eastern Australia.

4.11.4 Potential Impacts on Aquatic Ecology

Potential impacts to aquatic ecology that could occur during the Project life are as follows.

- Direct displacement of aquatic habitat, biota and any riparian vegetation beneath the footprint of the open cut pits, tailings storage facility and various other Project components.

- Temporary or permanent barrier to fish passage in Lawsons Creek due to the construction of the relocated Maloneys Road crossing.
- Alteration to natural flow regimes and changes to flow inputs to Hawkins and Lawsons Creeks and other surface water features due to the removal and/or realignment of connected watercourses, groundwater drawdown following excavation of the open cut pits and interception of surface water.
- Changes in water quality in watercourses due to the following.
  - Release of sediment-laden water from disturbed areas, soil stockpiles and rehabilitated areas from which sediments may be mobilised during wet weather and transported to watercourses.
  - Introduction of sediments due to unplanned discharges.
  - Accidental release of potentially toxic reagents and flocculants stored on site and used in the processing plant.
  - Accidental release of chemicals and fuels (e.g. oils, hydraulic fluids and fuel from plant) and sewage resulting in the input of hydrocarbon, metal contaminants and / or nutrients into watercourses.
  - Accidental release of silver/lead concentrate and zinc concentrate from the processing plant.
  - Runoff containing sediments and contaminants such as fertilisers and herbicides associated with the rehabilitation works entering watercourses during rainfall events.
  - Input of water with low pH that has leached or accidently been released from the WRE or of water with low pH or toxicants that has leached or been accidentally released from the TSF or the tailings delivery pipeline from the processing plant to the TSF.
- Changes in groundwater quality due to excavation of the open cut pits, possibly from exposure of unweathered PAF waste rock or ore.
- Reduced groundwater availability to stygofauna due to groundwater drawdown following inflow of groundwater into the main open cut pit void.
- Proliferation and spread of aquatic pest species in water bodies (e.g. raw water pond and pit dewatering pond associated with the processing plant) established to supply water during the site establishment and construction activities and operations.
- KTPs as listed under the FM Act, BC Act and EPBC Act.

4.11.5 Management and Mitigation Measures

The key management, mitigation and contingency measures required to retain or improve aquatic ecological values of the watercourses in the vicinity of the Mine Site relate principally to the management of surface water and groundwater.

A comprehensive range of surface water and groundwater management and mitigation measures would be incorporated into the Project to mitigate its potential impacts (see Sections 4.6.8 and 4.7.4). Given both the surface water and groundwater assessments conclude that the likelihood of impacts would be minimal, no further direct mitigation measures are proposed to protect or manage the native aquatic ecology in the vicinity of the Mine Site. However, Cardno (2020) identifies one species of invasive fish (eastern gambusia) requiring management. This species already appears to be widespread throughout the Study Area, being present in streams and at least one dam on site. The Applicant would visually inspect dams for the presence of eastern gambusia prior to dewatering activities. If these fish are observed, and if practical, they would be euthanized and/or the intake or offtake would be screened to prevent release of these fish to Hawkins and Lawsons Creeks.

4.11.6 Assessment of Impacts

4.11.6.1 Habitat Displacement

Hawkins and Lawsons creeks would not be directly affected by the project (except for a very small area (6.5 m^2) of Lawsons Creek at the location of the realigned Maloneys Road crossing). Approximately 10km of first or second order watercourses and 5km of third order or greater watercourses would be displaced as a result of the construction of the various mine components. The majority of the watercourse habitat that would be displaced is not classified as Key Fish Habitat (KFH). The third order and higher watercourse habitat that would be displaced is classified as Type 3 – Minimally sensitive KFH (ephemeral habitat not supporting native aquatic or wetland vegetation). Due to the abundance of the habitat in the local and regional area, and as similar habitat would be provided by clean water diversions within the Mine Site, the loss of this habitat represents a very minor to negligible impact to the availability of this KFH and any associated fish populations in the Study Area. It is noted that the ephemeral and intermittent watercourse pool habitats are unlikely to provide habitat for threatened biota and associated impacts on any potential threatened species and populations of fish are not expected to occur due to displacement or other modification of this habitat. Given that the realigned sections of watercourses containing Type 3 KFH would provide a comparable amount (e.g. linear length) of similar habitat (e.g. similar channel width and similar, or improved condition, riparian vegetation) associated offsets are not required.

Hawkins and Lawsons Creeks are KFH and contain Type 1 – Highly sensitive KFH (native aquatic plants and large wood debris). The construction of the new crossing over Lawsons Creek would result in the modification of a small area of KFH and may result in the displacement of Type 1 – Highly sensitive KFH. The area of KFH that would be disturbed would, however, be negligible in the context of the watercourse and is not expected to result in any more than negligible associated impacts to any potential eel-tailed catfish, southern purple spotted gudgeon and Murray cod (those threatened species or populations considered to have a possibility of occurring in Lawsons Creek).

4.11.6.2 Barriers to Fish Passage

The construction of a floodway crossing on Lawsons Creek (comprising a series of reinforced box culverts) as part of the relocated Maloneys Road is expected to result in minimal impact on fish passage in the creek. Although there is potential for such a crossing to be a barrier to fish passage during low and moderate flows, provided the invert of the crossing is tied into the creek invert. any impediment to fish passage would be limited. It is noted that Lawsons Creek has intermittent flow and naturally consists of a series of disconnected pools that would result in minimal fish movement through the watercourse. Such a crossing would also satisfy NSW DPI (Fisheries) guidelines for crossing requirements. It is also noted that none of the native species of fish caught in the surveys or the threatened species that have the potential to occur in the Study Area require long distance migrations and are unlikely to be affected by the installation of the crossing. Similarly, any temporary barriers to fish passage occurs as a result of diversions or coffer dams required to construct the water pipeline these would be located in intermittent or ephemeral watercourses and are not expected to result in any more than minor associated impacts to fish populations. NSW DPI (Fisheries) would be consulted if any disturbance to creek channels and banks were to occur.

4.11.6.3 Natural Flow Regimes

The interception of surface flow on site and groundwater drawdown as a result of the excavation of the open cut pit would result in a minor (a few %) reduction in surface flow in Hawkins and Lawsons Creeks. Cardno (2020) has assessed that the likely impacts to aquatic habitat and biota in these creeks would be minor. Although reductions in surface flow would be more appreciable during drought conditions, Hawkins and Lawsons Creeks are intermittent and consist naturally of a series of disconnected pools. Any additional and temporary reduction in connectivity would not be expected to have significant impacts on aquatic habitat and biota due to their predisposed tolerance to intermittent flow conditions.

4.11.6.4 Water Quality

The most significant potential impact to aquatic habitat and biota presented by the Project would be associated with the accidental release of poor quality water (potentially containing elevated suspended sediments following mobilisation of sediments from disturbed areas during rainfall, chemicals (including sodium cyanide), heavy metals, hydrocarbons or water with low pH due to interaction with waste rock or tailings). These potential impacts would be effectively managed by the implementation of the inherent components of the Project design and ongoing monitoring aimed at preventing the release of such water to watercourses. The release of water with any elevated levels of dissolved metals or suspended solids would also need to satisfy the Project's environment protection licence. In particular, controls aimed at preventing the release of sediment-laden water during the construction and operation of the Project would be incorporated as part of the Erosion and Sediment Control Plan. These controls would also ensure that impacts to Key Fish Habitat and any threatened species that may occur in Hawkins and Lawsons Creeks would be avoided.

Concerns regarding the potential for deposited dust containing heavy metals to impact on aquatic ecosystems has also been raised by some members of the community. Due to the number of factors (including rates of dust deposition, potential for mobilisation by rainfall, role of vegetation and soil type in influencing rates of mobilisation and the dissolvability of metals) associated with quantifying any changes in the concentrations of metals in watercourses due to input of dust during rainfall events, informed assessment of impact to aquatic ecology could not be undertaken at this time. Ongoing monitoring would include the quantification of any elevation in metal concentrations in nearby watercourses and assessment of associated impacts to aquatic biota, if any.

4.11.6.5 Stygofauna Habitat

The loss of stygofauna and their habitat within the footprint of the open cut pit would be expected to result in a relatively minor impact to stygofauna due to the unsuitability of the associated aquifer for stygofauna as compared to the aquifers present within the Hawkins and Lawsons Creek alluvium. Predicted groundwater drawdown in the alluvial aquifers associated with Hawkins and Lawsons Creeks would result in a reduction in the availability of stygofauna habitat. However, given that the predicted drawdown is smaller than the thickness of the alluvial aquifers, a complete loss of stygofauna and their habitat is not expected.

4.11.6.6 Spread of Aquatic Pest Species

The potential for eastern gambusia to proliferate on site via accidental spread to existing or newly created water storages has been identified as a potential impact of the Project. It is also conceivable that these fish could be inadvertently transported to Hawkins and Lawsons Creek. However, as there would be no planned release of water to these watercourses and several control measures would be implemented (see Section 4.11.5) it is unlikely that the Project would result in the proliferation or spread of these or other pests on site or in Hawkins and Lawsons Creeks.

4.11.6.7 Key Threatening Processes

This subsection outlines how the Project would avoid or minimise the impacts of the KTPs introduced in Section 4.11.2.2 under the respective legislation.

Fisheries Management Act 1994

- Removal of large woody debris from NSW rivers and streams

  There would be no removal of large woody debris from Hawkins and Lawsons Creeks due to the Project. The removal of any wood debris in ephemeral watercourses as part of construction activities would result in negligible associated impacts to aquatic ecology.

- Degradation of native riparian vegetation along New South Wales watercourses

  It is proposed that the crossing over Lawsons Creek would be subject to a management plan to minimise harm to riparian vegetation. This would require detailed mapping of vegetation prior to construction (e.g. by a terrestrial ecologist or landscape expert), and a detailed plan to avoid any unacceptable damage during reconstruction and re-planting as required following the completion of construction activities.

- Installation of instream structures and mechanisms that alter natural flow

  The crossing over Lawsons Creek may result in an alteration to localised flow around the structure by creating disconnected pools immediately upstream and / or downstream. However, Lawsons Creek is intermittent and consists of a series of disconnected pools naturally. The installation of this crossing is expected to have negligible impact on flow in Lawsons Creek.

Biodiversity Conservation Act 2016

- Alteration to natural flow regimes of rivers and streams and their floodplains and wetlands

  Groundwater drawdown due to excavation of the open cut pit would result in only minor reductions in baseflow to Hawkins and Lawsons Creeks. No more than minor impacts to aquatic habitat and biota would be expected.

- Clearing of native vegetation

  As described above, crossing over Lawsons Creek should be subject to a management plan to minimise harm to riparian vegetation.

- Predation by eastern gambusia (*Gambusia holbrooki*)

  As there would be no planned release of water to Hawkins or Lawsons Creeks, and several control measures would be implemented (see Section 4.11.5), it is unlikely that the Project would result in the proliferation or spread of these or other pests.

Environment Protection and Biodiversity Conservation Act 1999

- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

  No in-stream, non-native aquatic plants were identified in the Study Area. Some non-native riparian and emergent aquatic plants were identified in Hawkins and Lawsons Creeks. However, these are currently widespread throughout the Study Area and the Project is unlikely to result in their further spread or proliferation.

- Novel biota and their impact on biodiversity

  As there would be no planned release of water to Hawkins or Lawsons Creeks, and several control measures would be implemented (see Section 4.11.5), it is unlikely that the Project would result in the proliferation or spread of novel biota.

4.11.7 Monitoring

While the design of the Project indicates that impacts to aquatic ecosystems can generally be managed through design and implementation of water management planning, it remains important that specific aquatic ecological factors are monitored throughout the Project life.

It is proposed that the monitoring program would be undertaken at a selection of sites within Hawkins and Lawsons Creeks and suitable reference creeks within the area. Monitoring would be initiated prior to the commencement of construction activities to supplement the existing comprehensive baseline data against which any future changes can be measured in the context of natural variability.

Given that groundwater drawdown is predicted to occur in the vicinity of Hawkins and Lawsons Creeks that could potentially affect stygofauna which are present in associated alluvial aquifers, the monitoring program would also include stygofauna present in these aquifers. Suitable bores outside of the potential drawdown area would also be identified and sampled to provide reference data.

4.11.8 Conclusion

Investigations within the Study Area have shown that the aquatic environment is variable in condition, water quality and biota. It has also shown that it is unlikely that substantial numbers of stygofauna are present within or adjacent to the open cut pit.

Given the design of the Project and the mitigation measures to be adopted, adverse impacts on the aquatic environment are considered unlikely. In particular, no impacts to KFH and threatened species of fish (if they occur) in Hawkins and Lawsons Creeks are expected. The most significant potential risk to aquatic ecology is associated with the accidental release of poor quality water to watercourses. However, this risk would be mitigated and/or minimised through the adoption of the proposed mitigation measures. Monitoring is proposed to ensure the impacts to aquatic habitats, flora and fauna are identified and appropriately managed should they occur.

4.12 TRAFFIC AND TRANSPORTATION

The traffic and transportation assessment of the Project relating to traffic travelling to and from the Mine Site was undertaken by The Transport Planning Partnership Pty Ltd (TTPP). The full assessment is presented in Volume 4 Part 11 of the Specialist Consultant Studies Compendium and is referenced throughout this document as TTPP (2020). Information relating to the roads to be used and/or traversed during the construction of the water supply pipeline has been compiled by R.W. Corkery & Co. Pty Limited in conjunction with Bowdens Silver.

4.12.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in traffic and transportation impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Increased traffic on local and regional roads resulting in vehicle accidents on the local and regional road network (High).
- Increased traffic on local and regional roads resulting in impacts on the capacity of the local and regional road network affecting travel times for motorists (Low).
- Increased traffic on local and regional roads resulting in deterioration of road condition and serviceability as a result of increased traffic (Low).
- Site establishment and construction traffic resulting in disruption to local and regional traffic as a result of over mass transport movements (Medium).

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from Mid-Western Regional Council (MWRC) and the Roads and Maritime Service (RMS). These requirements are summarised as follows.

- Assess the potential impact of traffic movements (type and frequency) anticipated for the Project life, including commuter traffic as well as the transport of equipment and mineral concentrate.
- Assess the likely transport impacts of the development on the capacity, condition, safety and efficiency of the local and State road network, having regard to Mid-Western Regional Council's and RMS's requirements.
- A traffic impact study be prepared in accordance with the methodology presented in Section 2 of the "Guide to Traffic Generating Developments (RTA, 2000).

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where each is addressed within the EIS and/or Specialist Consultant Studies Compendium. It is noted that only matters relevant to the project are addressed.

Sections 4.12.2 to 4.12.5 draw upon information presented in TTPP (2020) and describe the existing traffic environment, predicted changes to the traffic environment as a result of traffic travelling to and from the Mine Site, proposed management and mitigation measures and an assessment of traffic-related impacts. Section 4.12.6 presents all relevant information relating to the traffic and road-related matters for the proposed water supply pipeline.

4.12.2 Existing Traffic Environment

4.12.2.1 Description of the Existing Road Network

The following existing roads and road infrastructure would provide the principal access to and from the Mine Site for local and regional traffic.

- Lue Road
- Pyangle Road
- Maloneys Road
- Bara-Lue Road
- Ulan Road

Whilst the transportation of mineral concentrate would potentially involve various interstate and intrastate routes which would be dependent upon the location of the end customer, the above roads would also be utilised for the transport of mineral concentrate in addition to the following roads within Mudgee.

- Short Street
- Douro Street
- Horatio Street
- Sydney Road

Figures 4.12.1 and **4.12.2** displays the locations of the key regional and local roads and road infrastructure that would use traffic travelling to and from the Mine Site, whilst a brief description of the roads is provided below.

Lue Road

Lue Road is a two-way, two-lane local road which is the responsibility of the MWRC and provides a link between Ulan Road (MR208) near Mudgee in the west and Bylong Valley Way (MR215) near Rylstone in the east (see **Figure 4.12.1**) and which forms the primary access to Lue. Through Lue, Lue Road is known as Swanston Street. Lue Road has a general sign posted speed limit of 100 km/h which reduces to 80 km/h on the approaches to Lue, and 60 km/h within Lue. A 40 km/h school speed zone operates on Lue Road in the vicinity of the Lue Public School during the morning and afternoon school periods (i.e. 8:00 am to 9:30 am and 2:30 pm to 4:00 pm). A widened sealed shoulder area is provided adjacent to the school, which allows for parking off the road.

Lue Road is an RMS approved B-double route for general mass limit (GML) 25 m long B-double vehicles between Ulan Road and Bylong Valley Way. However, use of Lue Road by B-double vehicles is subject to a speed limit of 80 km/hr and only permitted outside of school bus operation times. It is noted that this restriction is currently not signposted at either end of Lue Road.

Lue Road would form part of the principal access route to the Mine Site throughout the Project life, although once the relocated Maloneys Road has been constructed, the majority of heavy vehicles would not travel through Lue.

Pyangle Road

Pyangle Road is a local road which is the responsibility of the MWRC. It extends northwards towards the Mine Site from an intersection with Lue Road approximately 2.5 km east of Lue (see **Figure 4.12.2**). Pyangle Road, with the exception of the short distance at its approaches to Lue Road and Maloneys Road, has an unsealed surface. The road has recently been speed limit signposted at 100 km/h. Pyangle Road crosses Lawsons Creek approximately 0.35 km north of its intersection with Lue Road with this crossing signposted as being subject to flooding.

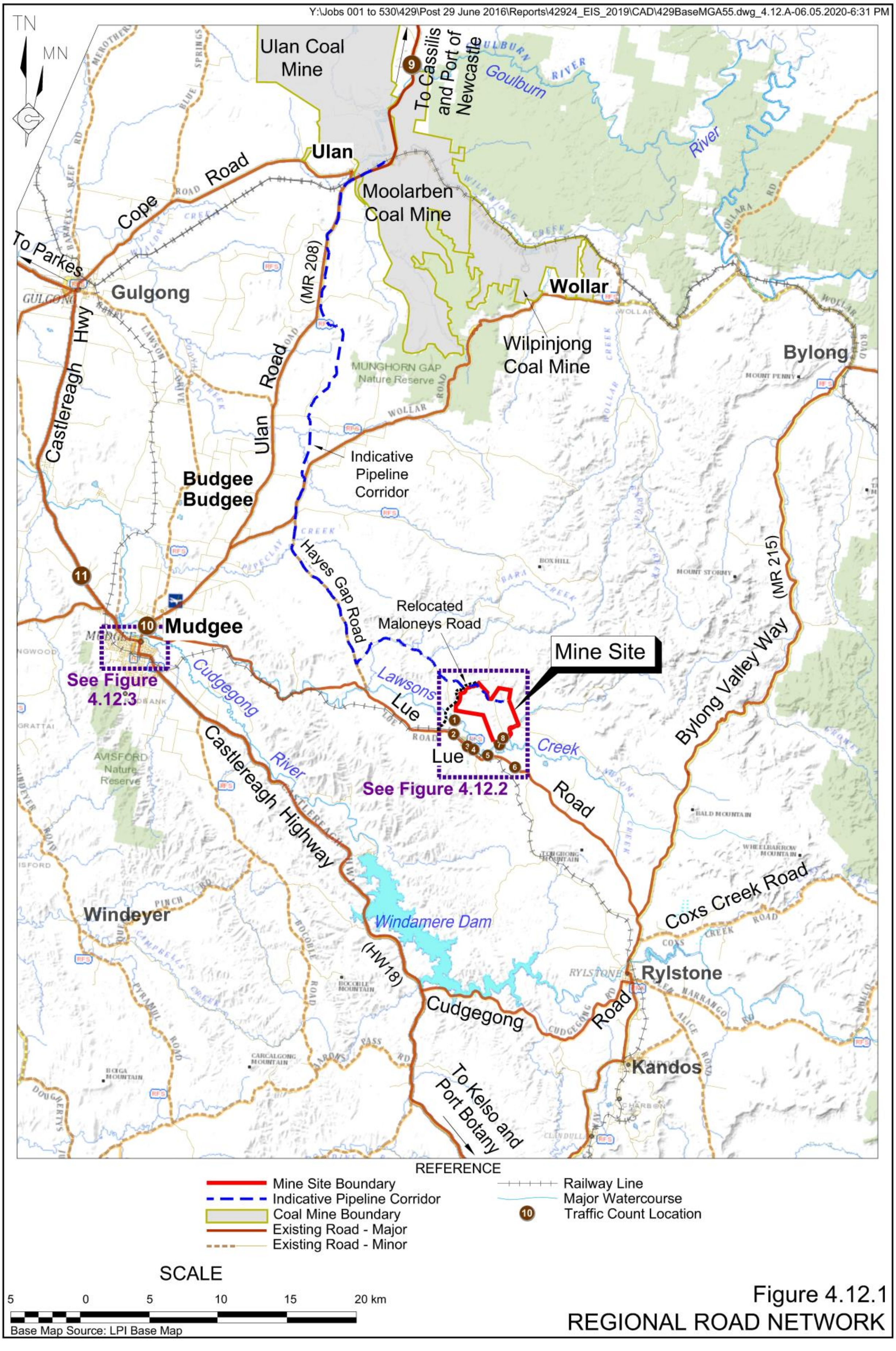

Figure 4.12.1
REGIONAL ROAD NETWORK

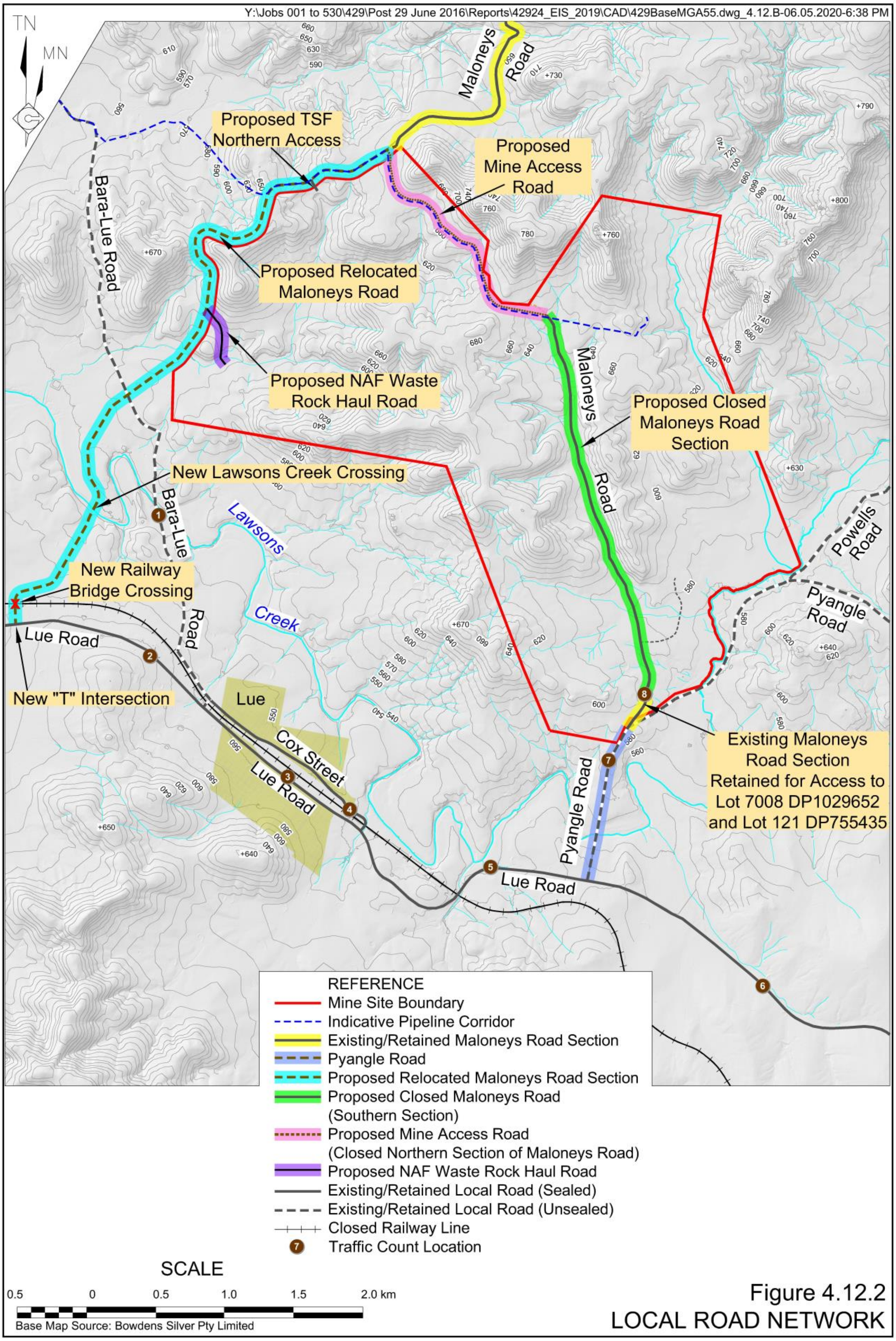

Figure 4.12.2
LOCAL ROAD NETWORK

Pyangle Road would form part of the principal access route to the Mine Site throughout the initial six months of the site establishment and construction stage and thereafter for Bowdens Silver's exploration team travelling to and from the Bowdens exploration office.

Maloneys Road

Maloneys Road is an unsealed local road that is also the responsibility of the MWRC. It extends northwards from Pyangle Road, through the Mine Site and intersects with Bara Road approximately 7.6 km north of the Mine Site, near Bald Hill. The intersection of Maloneys Road and Pyangle Road is a T-intersection, with Maloneys Road aligned at an acute angle to Pyangle Road (see **Figure 4.12.1**).

Maloneys Road has no sign posted speed limit however, as an unsealed road, the speed would typically be limited to 80 km/h.

Maloneys Road would form part of the principal access route to the Mine Site throughout the initial six months of the site establishment and construction stage. A 4.5 km section of the road would be closed at the end of the six months from a point approximately 0.35 km north of Pyangle Road to the point where the relocated Maloneys Road intersects the mine access road.

Maloneys Road would be relocated to the west of the Mine Site and would intersect with Lue Road to the west of Lue. The relocated Maloneys Road would form the principal access route to the Mine Site (via a mine access road).

Bara-Lue Road

Bara-Lue Road is an unsealed road which is the responsibility of the MWRC. It is located west of Lue and intersects with Cox Street in the south (**Figure 4.12.2**), and extends to Bara Road, approximately 9.4 km northwest of Lue.

A 2km section of Bara-Lue Road would be used within the initial six months of the site establishment and construction stage to provide access for earthmoving equipment to be used in the construction of the relocated Maloneys Road.

Ulan Road

Ulan Road (MR208 and MR214) is a regional road connecting Mudgee to the south and the Golden Highway at Cassilis to the north via Budgee Budgee and Ulan (see **Figure 4.12.1**).

Ulan Road is mostly a two-lane, two-way undivided rural road with some overtaking lanes, with bitumen seal and unsealed shoulders and typically with a posted speed limit of 100 km/h although this reduces to 80 km/h and further to 50 km/h towards the town of Mudgee. Between Mudgee and the entrance to the Ulan Mine Complex underground and surface facilities, the road has been the subject of some upgrading with the MWRC having plans to progressively upgrade this section in order to address road delineation and pavement conditions as well as improving the safety of this road for all road users.

Ulan Road is an approved B-double route for GML 25m B-double vehicles between Mudgee and the Golden Highway (HW27) at Cassilis, with no specific restrictions along that route. The intersection of Ulan Road and Lue Road is controlled with a single lane roundabout which has been designed not to permit B-doubles travelling southwards to turn left from Ulan Road into Lue Road, i.e., B-double access to and from Ulan Road is restricted to right-in, left-out and right-out movements only.

Ulan Road or specific sections of it, would form part of the proposed mineral concentrate transport routes throughout the Project life. Bowdens Silver also anticipates that Ulan Road would be a key route for the transport of equipment and consumables during both the site establishment and construction stage and operational stage of the Project.

Market Street, Short Street, Douro Street, Horatio Street and Sydney Road

These roads are all located within Mudgee and, together with Market Street, form part of the GML 25 m B-double vehicles route between Lue Road north of Mudgee and the Castlereagh Highway (HW18) southeast of Mudgee (see **Figure 4.12.3**). Short Street, Douro Street and Market Street form part of the GML 25 m B-double route between Lue Road north of Mudgee and the Castlereagh Highway (HW18) northwest of Mudgee. There are no specific travel restrictions on HW18 through Mudgee. The general speed limit along these roads is 50 km/h, with a 40 km/h school speed zone (8.00 am to 9.30 am and 2.30 pm to 4.00 pm) on Douro Street adjacent to Mudgee Public School and Mudgee High School. The Castlereagh Highway southeast and northwest of Mudgee is also an approved route for GML 25 m B-double vehicles, with no specific travel restrictions.

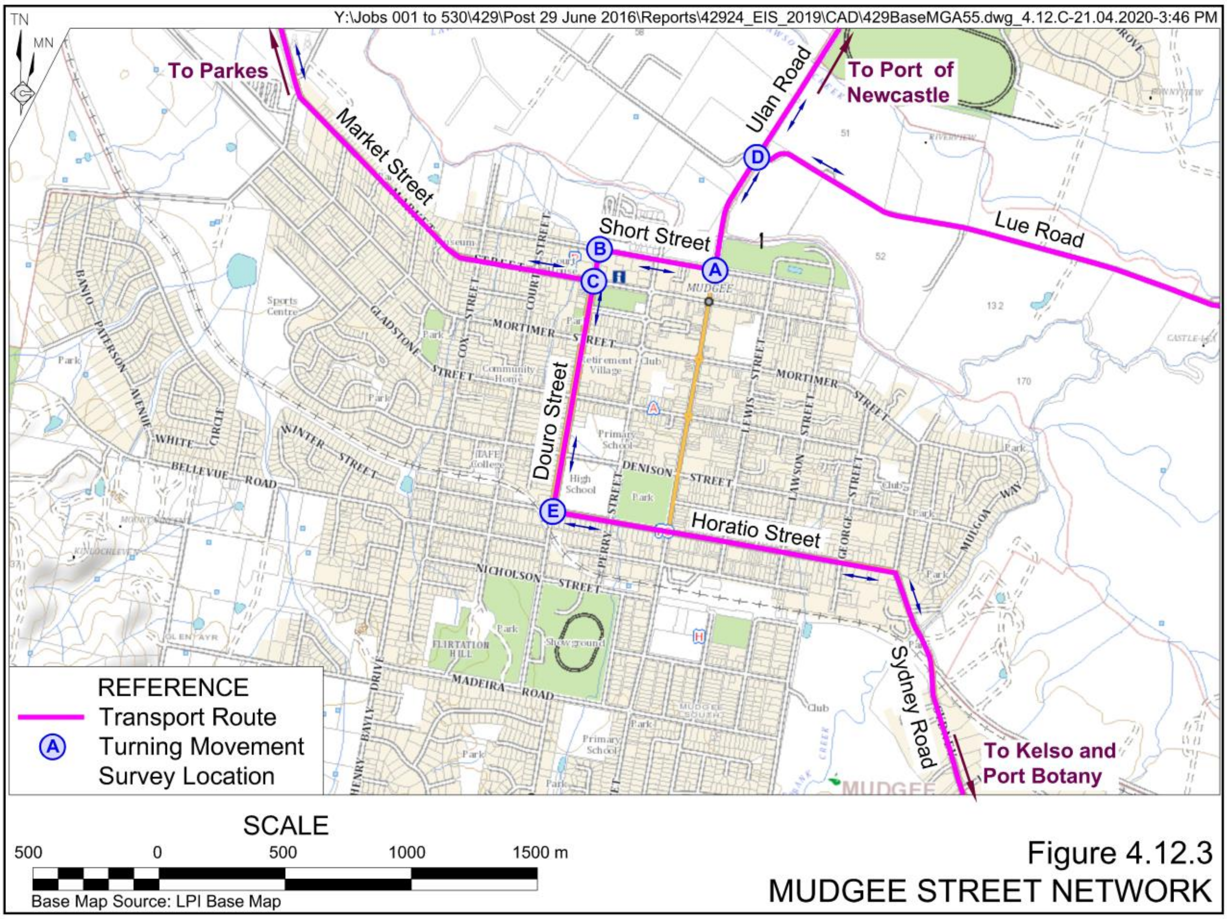

Figure 4.12.3
MUDGEE STREET NETWORK

The specific sections of each of these roads which form HW18 through Mudgee would be utilised as the proposed mineral concentrate transport routes and would be in use throughout the Project life, dependent upon the destination of the mineral concentrate. The Company also anticipates that the Castlereagh Highway would be a key route for the transport of equipment and consumables during both the site establishment and construction stage and the operational stage of the Project.

4.12.2.2 Historic Traffic Volumes

TTPP reviewed available RMS Annual Average Daily Traffic volume data on roads in the vicinity of the Mine Site from 2002 to 2013 (see Table 3, TTPP, 2020). This review was undertaken to identify the changes to historic daily traffic volumes that have occurred on these roads over the 11-year period.

The reviewed data identified that there is generally an upward trend in traffic volumes with the average annual linear growth rate being approximately 1.8 % per annum, however TTPP (2020) noted that this varied from road to road. For the purpose of assessment, a 2% per annum growth rate has been applied for estimates of future non-Project-related traffic levels.

4.12.2.3 Existing and Projected Traffic Volumes

Traffic counts were commissioned by TTPP (2020) in the vicinity of the Mine Site and Mudgee as part of the traffic assessment to establish traffic volumes and vehicle types using the existing road network. Traffic counts were recorded over seven days between 15 to 21 February 2017 (Sites 1 to 10 below) and between 4 and 10 May 2017 (Site 11). The traffic counts were undertaken at the following locations (see **Figures 4.12.1** and **4.12.2**).

1. Bara-Lue Road northwest of Lue
2. Lue Road west of Lue
3. Lue Road (Swanston Street in Lue)
4. Cox Street in Lue
5. Lue Road east of Lue
6. Lue Road east of Pyangle Road
7. Pyangle Road north of Lue Road
8. Maloneys Road north of Pyangle Road
9. Ulan Road 6km north of Ulan
10. Ulan Road north of Lue Road
11. Castlereagh Highway west of Hill End Road

Figure 4.12.4 presents a graphic summary of the average weekday, and average weekend daily traffic and percentage breakdown of average daily traffic by vehicle type (light or heavy) which have been calculated using the traffic volumes counted at Sites 1 to 11. In addition, **Figure 4.12.4** also presents the average weekday AM and PM peak hour traffic by vehicle type, as counted in 2017.

Intersection turning movements were recorded at the following five key intersections along the transport route through Mudgee during the weekday morning and afternoon peak periods on: 4 May 2017 (Site A, B & C); 15 February 2017 (Site D); and 3 and 4 July 2018 (Site E).

A. Church Street and Short Street;
B. Short Street and Douro Street;
C. Douro Street and Market Street;
D. Lue Road and Ulan Road; and
E. Douro Street and Horatio Street.

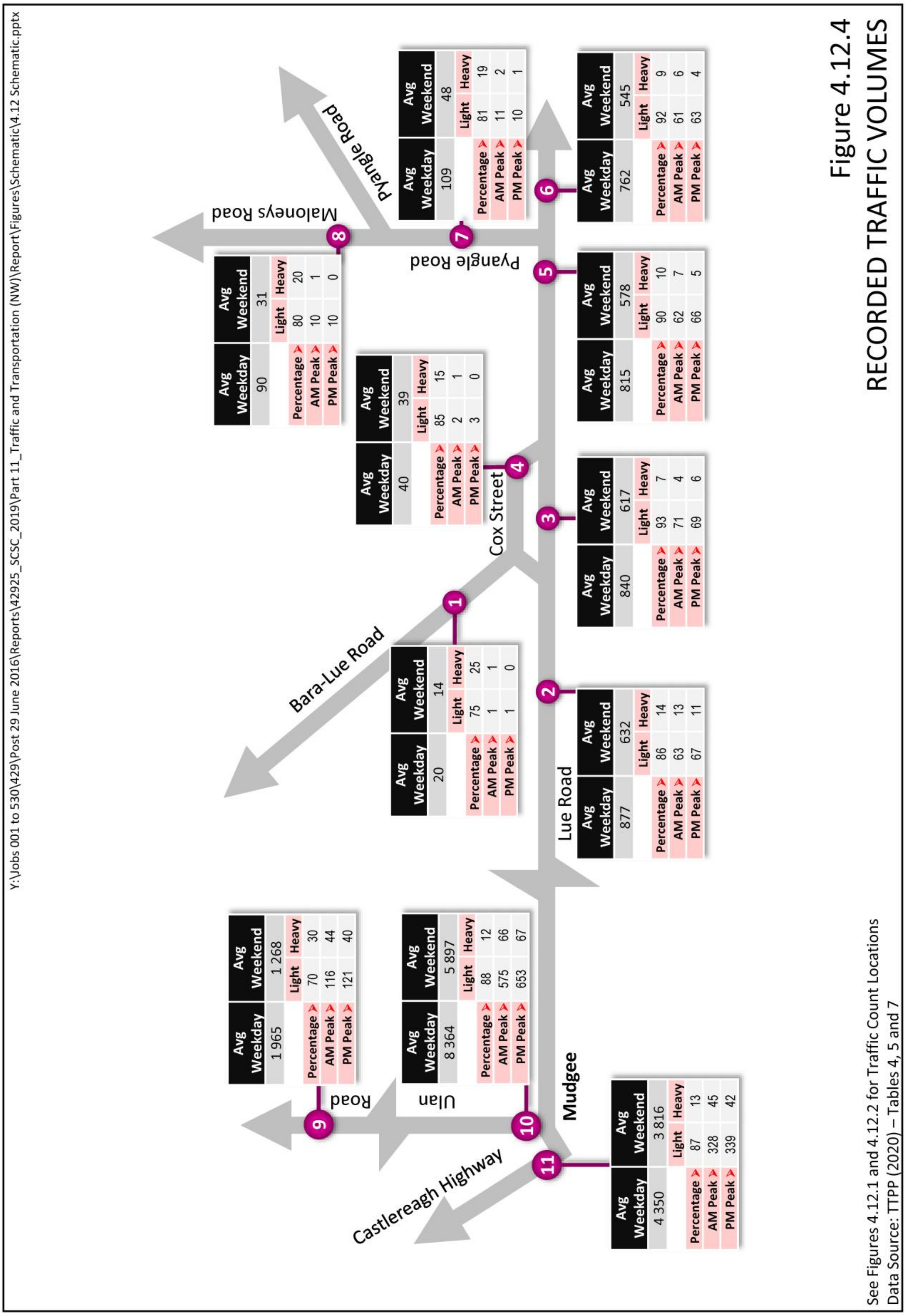

Figure 4.12.4
RECORDED TRAFFIC VOLUMES

The intersection survey results indicated that total vehicle movements are higher during the afternoon peak period whereas the percentage of heavy vehicles is higher during the morning peak period.

Full details of the existing traffic volumes and turning movements, including the methods, locations and results are presented in Section 3.10 and Annexure 2 of TTPP (2020).

4.12.2.4 Roadway Capacity and Efficiency

Roadway capacity is the maximum hourly rate at which vehicles can be expected to pass a point on the road during a given time period under the prevailing traffic conditions before unacceptable delays are experienced. The Level of Service (LOS) is a qualitative measure used to describe the operational conditions within a traffic stream as perceived by drivers and/or passengers. A LOS definition generally describes these conditions in terms of factors such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience and safety. LOS A provides the best traffic conditions, with no restriction on desired travel speed or overtaking. LOS B to D describes progressively worse traffic conditions. LOS E occurs when traffic conditions are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre in the traffic stream. The service flow rate for LOS E is taken as the capacity of a lane or roadway. In rural situations, LOS C is generally considered to be acceptable. At LOS C, most vehicles are travelling in platoons (i.e., in relatively close proximity to each other such that following vehicles travel at the speed of the lead vehicle) and travel speeds are curtailed. At LOS D, platooning increases significantly, and the demand for passing is high, but the capacity to do so is low.

The LOS experienced by drivers on two-way rural roads is dependent on the drivers' expectations regarding the road, whilst the Austroads *"Guide to Traffic Management Part 3: Traffic Studies and Analysis"* refers to three classes of road, as defined in the Highway Capacity Manual (Transportation Research Board, 2016) and which are as follows.

- Class I: roads on which motorists expect to travel at relatively high speeds (i.e. for long distance travel).
- Class II: roads on which motorists do not necessarily expect to travel at high speeds (i.e. scenic or recreational routes).
- Class III: roads in moderately developed areas (i.e. portions of a Class I or Class II road that pass through small towns or developed recreational areas).

The majority of surveyed roads serving the Mine Site would typically be considered as Class II roads as drivers could expect some level of restriction to their freedom of movement along the routes, such as limits on the opportunities for overtaking (e.g. lack of overtaking lanes). Although it is noted that drivers' expectations may not necessarily agree with this functional classification. Overall, Lue Road would generally be considered a Class II road whilst within Lue it may be considered as a Class III.

4.12.2.5 Public Transport and School Bus Services

Ogden's Coaches provides bus routes 560, 561, 562 and 563 around Mudgee, however, these services are infrequent with one or two services in the morning, and two or three services in the afternoon. Route 563 traverses the approved B-double route along Ulan Road, with a bus stop located south of Henry Lawson Drive. Details of these routes are presented in Section 3.3 of TTPP (2020).

Ogden's Coaches also provides school bus services along Lue Road, servicing various schools in Mudgee, and operating during school terms from Monday to Friday only and between the following times.

- Morning: depart Lue (first stop, corner Lue Road and Pyangle Road) at 7:50am and arriving in Mudgee at 8:33am.
- Afternoon: depart Mudgee at 3:40pm and arriving in Lue (last stop, corner Lue Road and Pyangle Road) at 4:23pm.

Ogden's Coaches also provide school bus services along Ulan Road, the details of which are presented in Section 3.3 of TTPP (2020).

Lithgow Buslines provides a school bus service between Kandos and Rylstone to and from Lue Public School. The morning bus departs Rylstone at 8:15am and arrives at Lue Public School at 8:48am. The afternoon bus departs Lue Public School at 3:03pm arriving at Rylstone at 3:35pm.

Based on the above, it is expected that a school bus may be present on Lue Road between Rylstone and Mudgee commencing at approximately 7:50 am until 8:50 am, and between 3:00 pm and 4:30 pm, noting that restrictions apply for 25 m long B-double vehicles on Lue Road during these school bus operation times.

4.12.2.6 Pedestrian Facilities

TTPP (2020) records that there are no formal pedestrian footpaths on either side of the roads in the vicinity of the Mine Site, nor in or around Lue. Pedestrian activity along Maloneys Road and Pyangle Road is also negligible.

4.12.2.7 Road Safety Review

Crash Data

Validated crash data was obtained from RMS for the most recent five-year period available, being from 1 October 2013 to 30 September 2018, and also including provisional data for the period to August 2019. The data includes those crashes which conform with the national guidelines for reporting and classifying road vehicle crashes based on the following criteria:

- The crash was reported to the police.
- The crash occurred on a road open to the public.
- The crash involved at least one moving vehicle.

- The crash involved at least one person being killed or injured or at least one motor vehicle being towed away.

A total of 89 crashes were documented and investigated over the period along the routes expected to be used by Project-generated traffic. The outcomes of the review are summarised as follows.

- There is no indication that any of the crashes resulted from geometry or road controls at the location of the accident.
- The presence of fog or mist and loose gravel or snow/ice were considered factors in two of the crashes.
- Inappropriate driver speed was a factor in nearly a quarter of the crashes recorded.
- Fatigue was considered a factor in 11 of the crashes recorded.
- Single vehicle crashes typically resulted in a vehicle striking an object such as a tree, animal or road feature.

The reported characteristics of the crashes along each key route relevant to the Project are tabulated in Annexure 3 of TTPP (2020) and discussed in Section 3.12 of TTPP (2020).

Road Safety Audit

An independent road safety audit on the existing road conditions on Lue Road between Mudgee and Lue was conducted prior to the preparation of TTPP (2020). This road safety audit report is included as Annexure 4 of TTPP (2020) and presents a summary of the existing condition of the road network. The road safety deficiencies identified in the audit principally involved:

- insufficient centre line and edge line delineation particularly at night time;
- inconsistent treatments for guiding drivers through curves;
- unprotected roadside hazards within the clear zone, including substantive trees and slopes that are not traversable;
- pavement damage; and
- fretted seal edge.

Since the preparation of the road safety audit, MWRC has undertaken a range of road upgrading and line marking activities along Lue Road. A further road safety audit would be undertaken following the grant of development consent prior to the finalisation of the planning agreement with MWRC.

4.12.3 Potential Project-related Traffic Impacts

The Project has the potential to impact the local and regional road network through the generation of additional light and heavy vehicle traffic that would be travelling to and from the Mine Site during the site establishment and construction stage and the operational stage. The additional Project-related traffic could impact road capacity, efficiency, travel times for existing road users and the amenity of residents of Lue.

Tables 2.5 and **2.6** list the proposed daily traffic movements for vehicles travelling to and from the Mine Site during both the site establishment and construction stage and operations.

4.12.4 Management and Mitigation Measures

4.12.4.1 Traffic Management Plan

Bowdens Silver would develop and implement a Traffic Management Plan which would apply to all light and heavy vehicles operated on the public road network by employees or contractors engaged by Bowdens Silver for transport tasks associated with the Project.

All truck drivers would be required to operate their trucks in accordance with a Traffic Management Plan that incorporates a Driver's Code of Conduct. The Traffic Management Plan would form part of the employee contract or transport contractual arrangements and would include direction and preferences for the following matters.

- Use of preferred transportation routes, including when passing through Mudgee.
- Road rules, laws and regulations, including the use of mobile phones.
- Driver licensing requirements for the relevant vehicle.
- Respecting the rights of other road users and displaying courtesy to other motorists.
- Maintaining safe following distances between vehicles and increasing separation in poor weather.
- Vehicle condition and maintenance.
- Use of a wheel wash to limit tracking of dirt onto the public road.
- Medical fitness of the driver including advice for the management of fatigue.
- Securing and overhang of loads.
- Heavy vehicle convoy travel.
- Reporting of any unsafe driving practices or incidents.
- Passenger behaviour.
- Appropriate use of headlights, cruise control, etc.
- Driver behaviour expectations at any specific locations or situations on the public road network including near schools.
- Appropriate parking of vehicles.
- Use of private vehicles to perform work activities for Bowdens Silver.

4.12.4.2 Proposed Changes to the Existing Road Network

Bowdens Silver proposes to permanently relocate a 4.5 km section of Maloneys Road to a new location west of its current alignment and west of Lue, thus forming a new section of public road and negating the need for the majority of Project-related traffic to travel through Lue throughout the Project life. During the first six months of the site establishment and construction stage, whilst the relocated Maloneys Road is being constructed, traffic access to the Mine Site would be via Pyangle Road and the existing alignment of Maloneys Road.

Once the relocated section of Maloneys Road is open to traffic, access to the Mine Site would be via the mine access road, i.e. a closed 2.2 km section of the former Maloneys Road that would join Maloneys Road where the relocated section joins the retained (northern) section of Maloneys Road.

A brief summary of the proposed changes to the road network is provided below, along with the cross-reference to the relevant sections where further detail is provided in the EIS.

Lue Road

The relocated section of Maloneys Road would connect with Lue Road via a newly constructed T-intersection located 1.8 km west of Lue. The relocated Maloneys Road/Lue Road T-intersection would be designed in accordance with Austroads design guidelines including requirements for approach sight distance and safe intersection sight distance. Further detail on the design elements provided in Section 2.9.2.1.

The traffic volumes estimated during the site establishment and construction stage, when access to the Mine Site would principally be via Pyangle Road and the existing Maloneys Road, would require a Basic Auxiliary Left (BAL) and Basic Auxiliary Right (BAR) treatment in Lue Road at its intersection with Pyangle Road. The existing intersection has a widened unsealed shoulder for left turns to Pyangle Road meeting the requirements of a BAL. To achieve a BAR treatment, the shoulder on the southern side of Lue Road would be widened in accordance with Austroads requirements. It is noted that this preferred minimum treatment is warranted without the Project-related traffic.

Existing Maloneys Road

Bowdens Silver proposes to permanently close this southern section of Maloneys Road to the public. The proposed closure would commence at approximately 0.3 km north of the existing intersection with Pyangle Road and continue to the point where the relocated section of Maloneys Road intersects with the mine access road. The section of Maloneys Road north of the mine access road would be retained in its existing form.

Relocated Maloneys Road

Details concerning the design of the relocated Maloneys Road are presented in detail in Section 2.9.2. The relocated Maloneys Road, totalling 5.2 km in length[1] would be constructed beyond the western extent of the Mine Site and would include the following.

- A new railway bridge crossing of the closed Wallerawang-Gwabegar Railway Line that would be constructed in accordance with Australian Standard, AS 5100:2017 (Bridge Design) and Country Rail Network construction standards (see Section 2.9.2.2).

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[1] The relocated section of road would be 0.7 km longer than the section of road closed through the Mine Site.

- A new crossing of Lawsons Creek that would be constructed approximately 1.2 km downstream of the current Bara-Lue Road crossing of Lawsons Creek (see Section 2.9.2,3).
- Three new intersections including:
  - an intersection with the mine access road incorporating a BAR treatment in Maloneys Road for traffic turning into the Mine Site;
  - an intersection with the TSF embankment access road incorporating a BAL treatment in Maloneys Road for access to the TSF during transport of NAF waste rock to the TSF for construction of the embankment; and
  - an intersection with Lue Road as described above and in Section 2.9.2.1.

  The intersections would be constructed in accordance with the Austroads requirements including for intersection sight distance. Indicative intersection treatments are presented in Section 6.10 of TTPP (2020).

4.12.4.3 Mineral Concentrate Transport and Heavy, Oversize and Overmass Vehicle Movements

Bowdens Silver proposes that the despatch of mineral concentrates in sealed containers and the delivery of equipment and consumables necessary for the construction and operation of the Project would occur outside of the heavy vehicle restriction periods during school bus operation times on Lue Road.

On this basis, the movement of heavy, oversize or overmass vehicles would not occur between 7:30am and 8:30am, nor between 3:30pm and 4:30pm on weekdays during school terms.

The proposed movement for any oversize or overmass vehicles would be negotiated with RMS and MWRC on a case-by-case basis. All oversize or overmass loads would be transported with the relevant permits obtained in accordance with *Additional Access Conditions for oversize and overmass heavy vehicles and loads* (RMS, 2017), and any other licences and escorts as required by the regulatory authorities.

Bowdens Silver proposes to enter into a planning agreement with MWRC that would address the maintenance of the local roads used by the trucks transporting mineral concentrates from the Mine Site.

4.12.4.4 Transport of NAF Waste Rock for TSF Embankment Construction

The key measure to be adopted to minimise the impacts of the trucks transporting NAF waste rock for the TSF embankment construction would be the installation of a wheel wash facility on a section of the mine access road to the west of its intersection with the internal haul road from the main open cut pit. This would limit the tracking of dirt from the Mine Site onto the public road network.

4.12.4.5 Operational Shift Times

Bowdens Silver would structure the operations of the Project such that the operational shift commencement and finish times would be spread at different times throughout the day, evening and night in order to limit traffic-related impacts to local and road-side residents. These shift arrangements are presented in **Table 2.10**.

4.12.4.6 Personnel Transport

In order to reduce the number of personnel travelling to and from the Mine Site in light vehicles and thereby mitigate potential traffic impacts, Bowdens Silver would provide a bus service for the workforce. Bowdens Silver anticipates that this service would be utilised by approximately 65% of the workforce. Bus services would coincide with the planned shift start and end times. Those workers not travelling by bus would typically drive to and from the Mine Site by car. It is likely that some car-pooling for those workers travelling by car would occur. TTPP (2020) notes that its experience with similar projects suggests that each car would carry an average of 1.1 people per car.

4.12.4.7 Car Parking

During the site establishment and construction stage, temporary car parking facilities for the workforce would be located within the Mine Site, generally in proximity to the respective area of construction (e.g. TSF or processing plant).

Car parking for employees and visitors during the operational stage would be located within the administration area of the Mine Site, together with set-down and pick-up facilities for the buses. Car parking would be provided to meet the anticipated peak demand of approximately 60 light vehicles.

4.12.4.8 Dangerous Goods

Dangerous goods required for the Project would be transported in accordance with the *Australian Code for the Transport of Dangerous Goods by Road and Rail* and the current State legislation, including the *Dangerous Goods (Road and Rail Transport) Act 2008* and the *Dangerous Goods (Road and Rail Transport) Regulation 2014*. More information on the management of public hazards is presented in Section 4.16.1 and the assessment undertaken by Sherpa Consulting Pty Ltd (see Volume 1 Part 4 of the SCSC).

4.12.5 Assessment of Impacts – Mine Site-Related Traffic

4.12.5.1 Introduction

The following subsections provide an overview of the traffic impacts relating to the Mine Site following the adoption of the proposed management and mitigation measures identified in Section 4.12.4. Detailed tables recording the number and types of vehicles travelling on the roads to and from the Mine Site are included in TTPP (2020) – Tables 17 to 20 (site establishment and construction stage) and Tables 23 to 26 (operational stage).

4.12.5.2 Site Establishment and Construction Stage Traffic

Figure 4.12.5 displays the changes in traffic volumes at each of the 11 traffic counting locations during Month 13 of the site establishment and construction stage, i.e. likely to be the busiest month. The traffic volumes shown on **Figure 4.12.5** include Project-related traffic and a forecast 2021 non-Project-related traffic or future baseline volume which has been calculated principally using the 2017 traffic volumes and applying an average annual growth rate of 2%. Section 5 of TTPP (2020) provides details of the calculations of the future baseline traffic conditions.

Project-related traffic during this stage can be expected to contribute:

- approximately 10% of the daily traffic on Lue Road east of and within Lue and 15% of daily traffic on Lue Road towards Mudgee;
- approximately 25% of the daily traffic on Pyangle Road; and
- less than 1% of the daily traffic on Ulan Road and Castlereagh Highway.

4.12.5.3 Operational Stage Traffic

The forecast total daily traffic movements for the operational stage are presented on **Figure 4.12.6**. The traffic volumes shown on **Figure 4.12.6** include Project-related traffic and a forecast 2031 non-Project-related traffic volume which has been calculated using the 2017 traffic volumes and applying an average annual growth rate of 2%. **Figure 4.12.6** displays the changes in the traffic volumes at each of the 11 counting locations during the operation of the Project.

A key change to the road network during the operational stage would result from the relocation of Maloneys Road and its intersection with Lue Road to the west of Lue. The majority of heavy vehicle traffic from the Mine Site would use this road and turn right at Lue Road, therefore avoiding Lue. It is also expected that a large proportion of traffic that currently accesses Lue via Bara-Lue Road and Cox Street would also use the relocated Maloneys Road as an alternative.

Figure 4.12.6 indicates that during operations there would be an increase in traffic through Lue, with the Project-related contribution to the morning and afternoon peaks as the result of the Project being 22% and 19% of all traffic, respectively. The Project-related traffic would contribute approximately 7% of the total daily traffic on Lue Road within Lue and to the east of Lue. However, it is notable that the bulk of this traffic would be comprised of either light vehicles or buses. The proposed changes to the road network reduce the need for the majority of Project-related traffic to travel through Lue (eight of ten daily heavy vehicle movements would avoid Lue). In addition, the structure of the shifts and other operational controls related to heavy vehicles during the operational stage of the Project is such that Project-related traffic is further reduced during peak periods to avoid impacting the amenity of local road users.

Project-related traffic would contribute approximately 22% of the daily traffic on Pyangle Road and approximately 1% of the daily traffic on Ulan Road and Castlereagh Highway.

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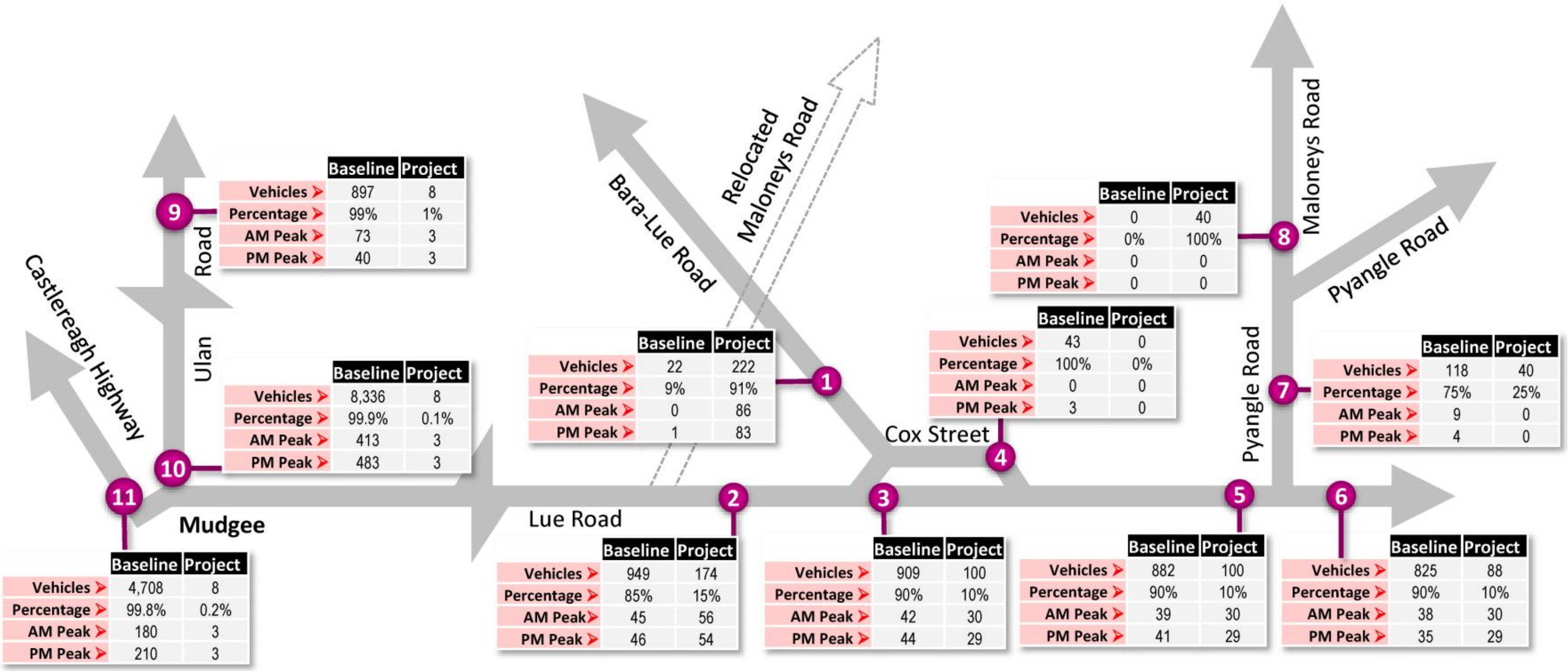

Location 1

	Baseline	Project
Vehicles	22	222
Percentage	9%	91%
AM Peak	0	86
PM Peak	1	83

Location 2

	Baseline	Project
Vehicles	949	174
Percentage	85%	15%
AM Peak	45	56
PM Peak	46	54

Location 3

	Baseline	Project
Vehicles	909	100
Percentage	90%	10%
AM Peak	42	30
PM Peak	44	29

Location 4

	Baseline	Project
Vehicles	43	0
Percentage	100%	0%
AM Peak	0	0
PM Peak	3	0

Location 5

	Baseline	Project
Vehicles	882	100
Percentage	90%	10%
AM Peak	39	30
PM Peak	41	29

Location 6

	Baseline	Project
Vehicles	825	88
Percentage	90%	10%
AM Peak	38	30
PM Peak	35	29

Location 7

	Baseline	Project
Vehicles	118	40
Percentage	75%	25%
AM Peak	9	0
PM Peak	4	0

Location 8

	Baseline	Project
Vehicles	0	40
Percentage	0%	100%
AM Peak	0	0
PM Peak	0	0

Location 9

	Baseline	Project
Vehicles	897	8
Percentage	99%	1%
AM Peak	73	3
PM Peak	40	3

Location 10

	Baseline	Project
Vehicles	8,336	8
Percentage	99.9%	0.1%
AM Peak	413	3
PM Peak	483	3

Location 11

	Baseline	Project
Vehicles	4,708	8
Percentage	99.8%	0.2%
AM Peak	180	3
PM Peak	210	3

See Figures 4.12.1 and 4.12.2 for Traffic Count Locations
Data Source: TTPP (2020) – Tables 34 and 38

Figure 4.12.5
FORECAST CHANGE IN TRAFFIC VOLUMES MONTH 13 – SITE ESTABLISHMENT AND CONSTRUCTION STAGE

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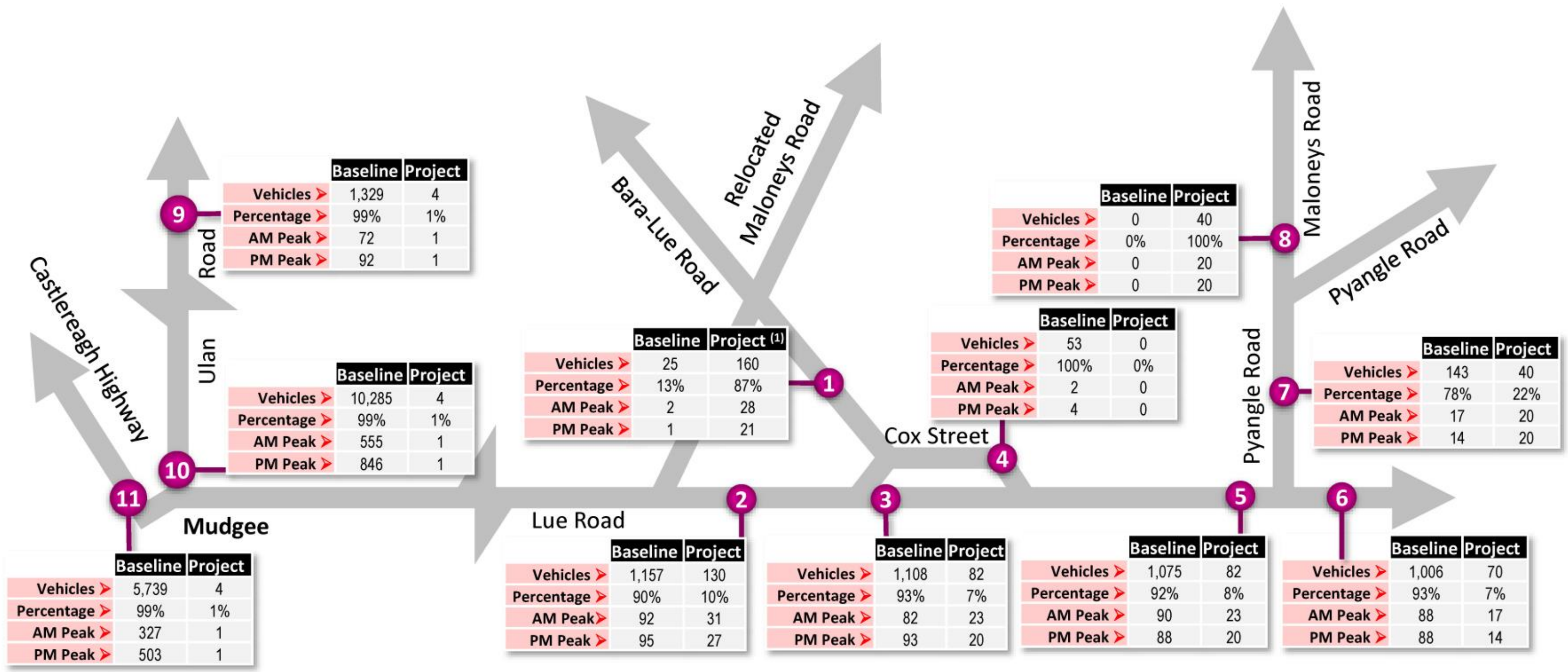


Note 1: Operational traffic would use the Relocated Maloneys Road. It is also assumed that much of the existing traffic currently using Bara-Lue Road would use this route to Lue Road.

See Figures 4.12.1 and 4.12.2 for Traffic Count Locations
Data Source: TTPP (2020) – Tables 34 and 39

Figure 4.12.6
FORECAST CHANGE IN TRAFFIC VOLUMES DURING OPERATIONS

TTPP (2020) also assessed the capacity and efficiency of the local and regional road network during the morning and afternoon peak hours as the cumulative result of future baseline traffic growth and Project-related traffic. The results of the assessment indicate that during the operational stage, the forecast peak hours for Project-related traffic generation, and taking into account other developments in the region, would not result in unacceptable loss of service on Lue Road or Ulan Road. TTPP (2020) concluded that based on LOS from the forecast peak hour conditions, no additional midblock road capacity is required as a result of the Project-related traffic. It is therefore concluded that travel times for road users would remain acceptable for the Project life.

Cumulative traffic impacts taking into account the presence of coal mining operations including the Wilpinjong Coal Project, Moolarben Coal Project and the Ulan Coal Complex indicated that as those operations were project to decrease traffic levels in the future, it is likely that from a regional cumulative perspective, cumulative traffic during the operational stage would decrease. It is also noted that the Bara Quarry is understood to use Bara-Lue Road and Cox Street to access Lue Road for its deliveries. While the level of traffic generated by the Bara Quarry is generally low it is anticipated that trucks would use the relocated Maloneys Road once constructed to avoid local roads in Lue and to make use of the constructed intersection with Lue Road. However, should this not occur, there is unlikely to be a significant cumulative impact as a result given the traffic generated by the Bara Quarry is generally low and Project-related heavy vehicle traffic would not generally use Cox Street or Bara-Lue Road during the operational stage of the Project.

4.12.5.4 Road Condition

Only low levels of heavy vehicle traffic would be generated by the Project and travel on the public road network during operations (no more than ten heavy vehicle movements per day are anticipated). The majority of Project-related traffic would use the relocated Maloneys Road, which would be designed to accommodate the intended traffic. Lue Road, Ulan Road and the Castlereagh Highway are approved B-double vehicle routes, and are therefore suitably designed for use by the Project heavy vehicles. Bowdens Silver proposes to enter into a planning agreement with MWRC that would address the maintenance of the local roads used by the trucks transporting mineral concentrates from the Mine Site.

4.12.5.5 Road Safety

As noted in Section 4.12.2.7, apart from some sections of Lue Road east of Mudgee, there are no locations which appear to demonstrate an inherent safety issue. Based on this review, TTPP (2020) considered that the roads in the local area have no particular accident pattern or causation factors which may be exacerbated by increased use of the road system resulting from the Project.

All heavy vehicles (including the B-double vehicles that would be generated by the Project) are restricted from using Lue Road during the before and after school periods. The Project-generated traffic would therefore be expected to have very limited opportunity to interact with the school-generated traffic around Lue Public School.

The assessments undertaken by TTPP (2020) indicate there is very little pedestrian activity on the road network, however the growth of cycling-based tours and recreation is acknowledged. Preferred driver behaviour in the presence of these and other road users would be incorporated into the Transport Management Plan.

4.12.5.6 Conclusion

Traffic generated for the Project would principally comprise light vehicles and buses used to transport personnel to work. Heavy vehicles use of the public road network would not be a feature of the Project at the low levels anticipated. In addition, Bowdens Silver has proposed to relocate Maloneys Road and avoid the need for much of the Project-related traffic to travel through Lue. Improvements to the local road network would benefit all road users and any negative impacts would be most likely experienced as a change to the capacity and efficiency of the local road network. However, TTPP (2020) have concluded that, with the implementation of the proposed mitigation and management measures, the traffic travelling to and from the Mine Site would be accommodated on the surrounding road network with virtually no adverse impacts to road users, the condition of the road network and the amenity of the residents of Lue.

4.12.6 Assessment of Impacts – Water Supply Pipeline

4.12.6.1 Introduction

This subsection presents a range of information relating to the sealed road network that would be underbored to install the proposed water supply pipeline.

4.12.6.2 Road Network

Table 4.68 lists the approximate chainages and pipeline lengths for each sealed road crossing. It is noted that it is proposed to install suitable valves and standpipes at some of these crossings to be moved for the recovery of water for fire-fighting purposes.

Table 4.68
Proposed Sealed Road Underboring Locations along the Water Supply Pipeline Corridor

Chainage (m)	Road Name	Approximate Pipeline Length (m)
26016	Botobolar Road	25
28829	Wollar Road	20
48834	Ulan Road	76
49240	Ulan Road	60
55254	Ulan Road	55

Table 4.69 lists the chainages along unsealed and sealed roads along the water supply pipeline corridor in which the pipeline would be buried within the road verge adjacent to either the sealed surface or roadside drains. Occasionally, the existing geometry of the road would necessitate a section of the pipeline to be placed within a trench excavated through the unsealed road surface. Where this approach is required, the backfilled section would be fully compacted

to the final road surface. It is noted that each of the sealed and unsealed roads would similarly provide access either directly or indirectly to the water supply pipeline corridor for the construction of the pipeline.

Table 4.69
Road Network to be Used/Traversed for Water Supply Pipeline

Road Name	Chainage (m)		Surface	Comment
	From	To		
Bara-Lue Road	9380	13415	Unsealed	Within road verge and road surface.
Hayes Gap Road	13415	26010	Unsealed	Within road verge and road surface.
Wollar Road	26040	28760	Sealed	Within road verge.
Ulan Road	52430	53090	Sealed	Within road verge.

4.12.6.3 Management and Mitigation Measures

A key component of the management of traffic and the minimisation of delays for traffic travelling along the subject roads would be communications with the regular motorists and nearby landowners. Reliance would be made upon the use of notification boards/advanced warning signs, letterbox leaflet drops to nearby landowners, community advertisements in the Mudgee Guardian and importantly face-to-face discussions with roadside neighbours. All efforts would be made to accommodate traffic movements during busy periods and limit the duration of stoppages.

4.12.6.4 Assessment of Impacts

With the adoption of the comprehensive communications strategy and minimising the periods and their duration when traffic needs to be stopped, the impact of the pipeline construction program would be minimal.

4.13 SOILS AND LAND CAPABILITY

The soils and land capability assessment of the Project was undertaken by Soil Management Designs. The full assessment is presented in Volume 4 Part 12 of the Specialist Consultant Studies Compendium and is referenced throughout this section as SMD (2020).

4.13.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in soils and land capability impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Land use changes leading to a downgrading of the Land and Soil Capability within the Mine Site (Medium).
- Inadequate soil available for closure and rehabilitation purposes leading to less successful rehabilitation and increased rehabilitation costs and maintenance (Low).
- Inappropriate soil management resulting in degradation of soil in stockpiles leading to less successful rehabilitation and increased rehabilitation costs and maintenance (Low).
- Inappropriate management of soil stockpiles resulting in erosion and loss of material from soil stockpiles (Low).

In addition, the SEARs issued by the then DPE identified "soils and land capability" as a key issue requiring assessment. The principal assessment requirements identified by the former DPE relating to soils and land capability included the identification of the likely impacts of the development on soils and land capability of the site and surrounds.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the OEH and NSW Department of Primary Industries-Agriculture. These requirements are summarised as follows.

- An assessment of biophysical strategic agricultural land (BSAL) within the Mine Site is required using the *Interim protocol for site verification and mapping of biophysical strategic agricultural land*
- Describe the mitigation and management options that would be used to prevent, control, abate or minimise identified soil and land resource impacts associated with the Project

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC. Relevant soils information is also discussed in Section 4.18 with respect to agricultural resources within the Mine Site. It is noted that a BSAL assessment of the Mine Site in 2017 confirmed that there is no BSAL within the Mine Site. A Site Verification Certificate, confirming the absence of BSAL within the Mine Site, was issued by the former DPE on 8 November 2017 (see Figure 11 of SMD (2020)).

4.13.2 Existing Land Uses, Soil Types and Land Capability

4.13.2.1 Land Uses

Section 4.1 presents an overview of the land uses within and surrounding the Mine Site and water supply pipeline corridor. In summary, regional land uses are largely agricultural with grazing comprising the single most significant land use.

4.13.2.2 Local Soil Landscape Units and Capability

SMD (2020) reviewed available information (Murphy and Lawrie, 1998a) and identified the following six soil landscape units (SLUs) mapped within and surrounding the Mine Site.

- Barrigan Creek Yellow Podzolic Soils
- Lees Pinch Shallow Soils
- Rylstone Siliceous Sands
- Botobolar Non-Calcic Brown Soils
- Munghorn Plateau Siliceous Sands Soils
- Bald Hill Soils

Figure 4.13.1 shows the SLUs as mapped and described by Murphy and Lawrie (1998b). **Table 4.70** presents information relating to the mapped SLUs within and surrounding the Mine Site and potential land capability constraints.

It is also noted that no acid sulphate soils are mapped within the vicinity of the Mine Site.

4.13.2.3 Mine Site Soil Landscape Units and Land Capability

A detailed site soil survey was carried out across the Mine Site in mid-February 2017 by accredited soil scientists, Dr David McKenzie and Mr Adrian Harte of SMD.

The site soil survey was designed to:

- establish the presence or otherwise of BSAL considering the requirements of the Interim Protocol; and
- determine the physical and chemical characteristics of the soils within the Mine Site to identify soil types and assess their suitability for use in rehabilitation. Knowledge of these characteristics assists in the design and implementation of suitable soil stripping, handling and stockpiling strategies.

Further details on the methodology employed, the specific objectives of the site soil survey are presented in Section 3.2 of SMD (2020).

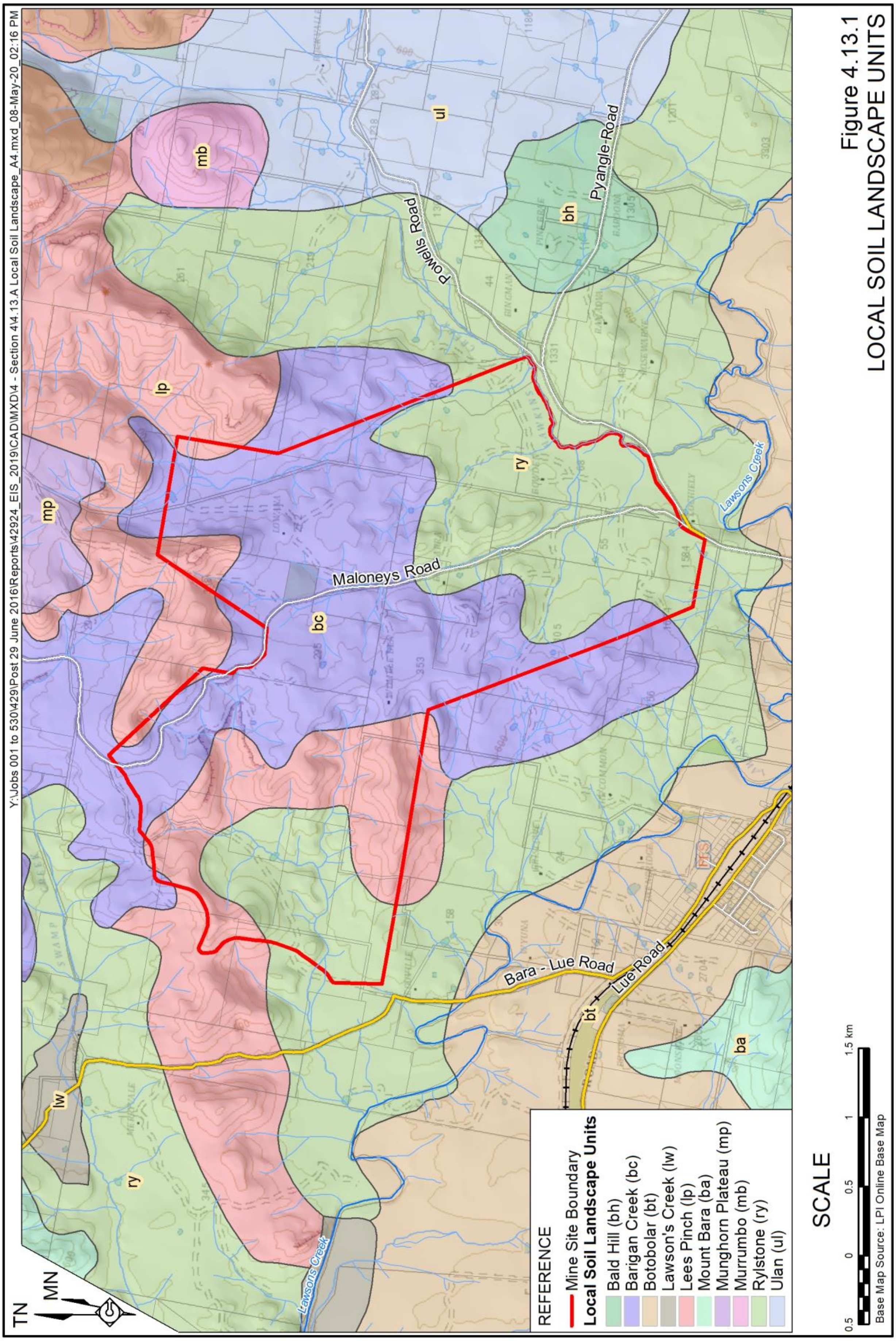


Figure 4.13.1
LOCAL SOIL LANDSCAPE UNITS

Table 4.70
Soil Landscape Units Mapped in the Vicinity of the Mine Site and Land Capability Constraints[1]

SLU	Parent Materials and Soil Types Present	Land Capability Constraints
Barrigan Creek Yellow Podzolic Soils (bc)	Shale, sandstone, siltstone, conglomerate, chert. Common soils are Yellow Podzolic Soils on lower slopes and along drainage lines. Red Podzolic Soils on higher colluvial slopes, benches and rises.	LSC Class 5 – High limitations High erosion hazard under cropping or where there is low surface cover. Salinity in localised areas in drainage depressions.
Lees Pinch Shallow Soils (lp)	Shallow Siliceous Sands. Some Yellow and Brown Earths on footslopes. Yellow and Grey Soloths in breaks of slope. Yellow Podzolic Soils and Earthy Sands on some upper slopes.	LSC Class 7 – Severe limitations Very poor water holding capacity, acidity and a lack of nutrients. Prone to water erosion when bare. No salinisation.
Rylstone Siliceous Sands (ry)	Rhyolite and dacitic tuff. Mainly shallow siliceous sands and bleached sands. Some Yellow and Red Podzolic Soils on sloping areas and Solodic Soils / Soloths in drainage lines.	Class 6 – Very high limitations Shallow soils, rock outcrop, low waterholding capacity, seasonal waterlogging, sodic subsoils in depressions, very high erosion hazard under cultivation. Low levels of salinity.
Botobolar Non-Calcic Brown Soils (bt)	Slate, phyllite, limestone, rhyolite, dacite, shale, sandstone and minor alluvial and colluvial derivatives. Soils include Non-Calcic Brown Soils, Shallow Soils near hill tops and Yellow Podzolic-Solodic Soils on poorly drained soils.	Class 4 – Moderate to high limitations High to very high erosion hazard and low surface cover. Weakly structured surface soils. Moderate waterholding capacity.
Munghorn Plateau Siliceous Sands (mp)	Narrabeen Sandstone. Mainly shallow siliceous sands. Yellow Earths and Yellow Podzolic Soils on lower slopes and in depressions.	LSC Class 8 – Very severe limitations Low waterholding capacity, rock outcrop, seasonal waterlogging, high permeability, acid surface soil. Low salinity.
Bald Hill (bh)	Basalt: Euchrozems on crests; Brown Clays on lower slopes.	LSC Class 4 – Moderate to high limitations Steep slopes, rock outcrop and stoniness, but moderate to high fertility and waterholding capacity. Low salinity.
Note 1: Source Murphy and Lawrie (1998a)		
Source: SMD (2020) – Modified after Table 4		

A total of 41 soil test pit locations were identified and investigated based on their underlying geology and landscape location. Of the 41 soil test pit locations, 29 were located within the Mine Site with 14 of those soil test pit locations being within areas of disturbance associated with open cut pit development, the TSF, internal roads, the processing plant, stockpiling of topsoil, subsoil and NAF waste rock and the WRE.

An additional soil test pit was located in an area of disturbance associated with the development of the relocated Maloneys Road. The remaining soil test pit locations were situated outside of the Mine Site as they were previously relied upon for the BSAL verification certificate investigations that covered a larger area than the Mine Site.

Figure 4.13.2 shows the location of all soil test pits investigated as part of the site soil survey.

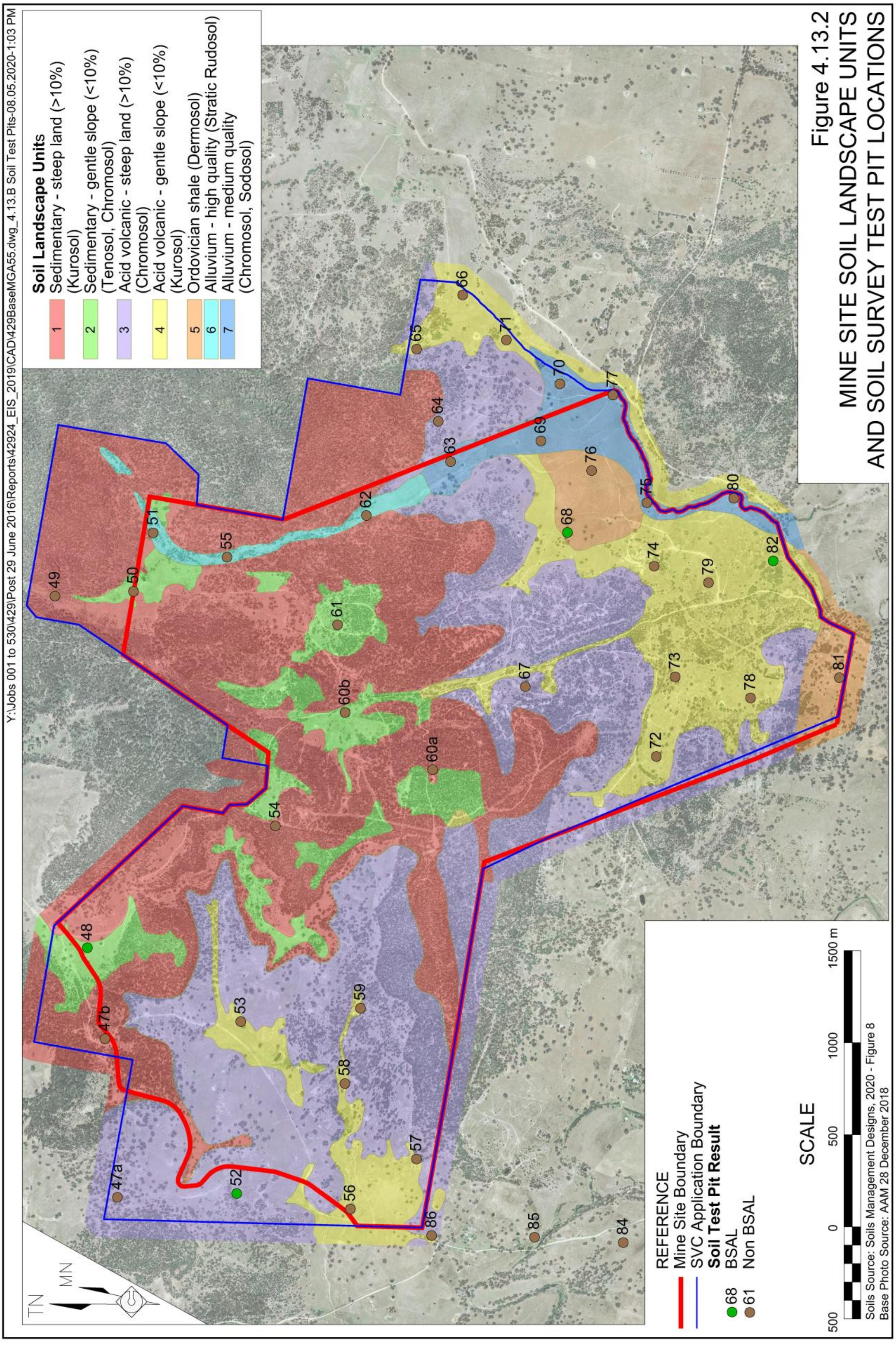


Figure 4.13.2
MINE SITE SOIL LANDSCAPE UNITS AND SOIL SURVEY TEST PIT LOCATIONS

Based on the results of the site soil survey, SMD (2020) identified 7 SLUs within the Mine Site which host the Australian Soil Classification types (Isbell, 2002) and which are described, along with land capability constraints in **Table 4.71** and presented in **Figure 4.13.2**. SMD (2020) considered the terminology of the SLUs used by Murphy and Lawrie (1998b) was too broad for the assessment and proposed revised SLUs, based on the results of the site soil survey.

Table 4.71
Mine Site Soil Landscape Units, Soil Type and Land Capability Constraints

SLU	Number of soil test pits	Dominant soil type(s)	Sub-Dominant soil type(s)	Land Capability Constraints
Sedimentary – steep land	3	Kurosol (2 of 3 soil test pits)	Tenosol (1)	Strong water erosion hazard; Acidity; Stony soil with poor water holding capacity
Sedimentary – gentle slope (<10%)	5	Tenosol (2) Chromosol (2)	Kurosol (1)	Water erosion hazard; Acidity
Acid (felsic) volcanic – steep land	4	Chromosol (2)	Dermosol (1) Rudosol (1)	Strong water erosion hazard; Acidity; Poor waterholding capacity
Acid (felsic) volcanic – gentle slope (<10%)	14	Kurosol (4)	Sodosol (3) Dermosol (3) Tenosol (2) Chromosol (1) Rudosol (1)	Water erosion hazard; Acidity; Poor water holding capacity
Ordovician shale	3	Dermosol (3)		Despite shallowness of the soil, the water holding capacity would be favourable because of steeply dipping and partially decomposed shale parent material
Alluvium – high quality	3	Stratic Rudosol (3)		Deep young soil with favourable physical subsoil conditions for root growth; derived from alluvium associated with Price Creek
Alluvium – medium quality	6	Chromosol (2) Sodosol (2)	Dermosol (1) Hydrosol (1)	Deep; slow drainage associated with subsoil sodicity. The alluvium is derived mainly from Hawkins Creek.

Source: SMD (2020) – Table 6

Further details on the Australian Soil Classification types identified within the Mine Site are presented in Section 4.2 of SMD (2020).

SMD (2020) applied the *Land and Soil Capability Assessment Scheme – Second Approximation* (OEH, 2012) to derive the LSC class for the Mine Site SLUs. The LSC classes for the Mine Site SLUs are shown on **Figure 4.13.3**. It is noted that, in accordance with the methods described in the Interim Protocol, no Mine Site SLUs were classed as BSAL. Further details relating to the LSC class and BSAL are presented in SMD (2020), Section 6.

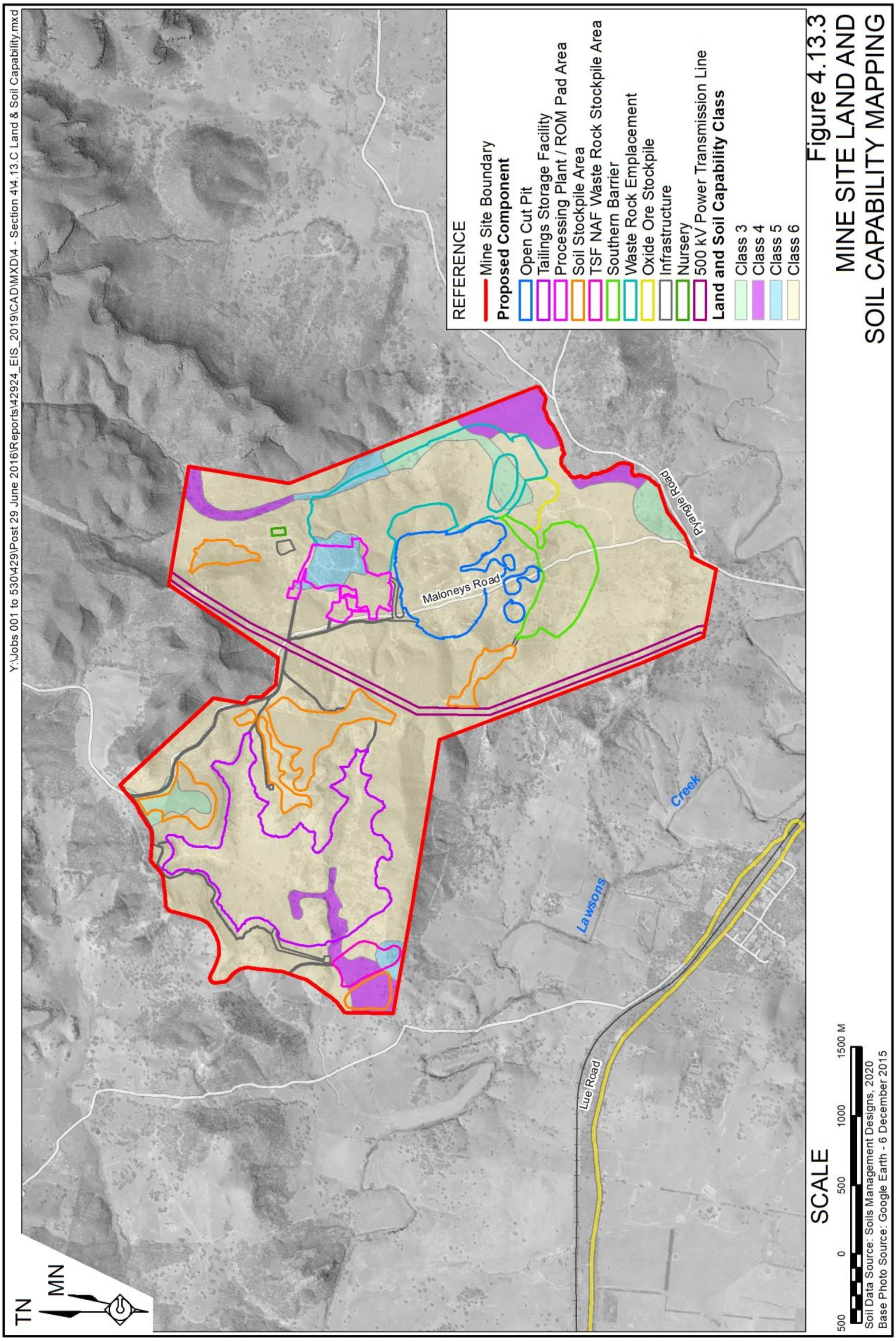


Figure 4.13.3
MINE SITE LAND AND SOIL CAPABILITY MAPPING

Table 4.72 presents the Land and Soil Capability (LSC) values within the proposed disturbance areas. It is noted that approximately 86% of disturbance within the Mine Site would occur on land situated on soils with a LSC class of 6 (i.e. low capability land with very high limitations for high-impact land uses and which is restricted to low-impact land uses such as grazing, forestry and nature conservation).

Table 4.72
Land and Soil Capability Classes within Proposed Disturbance Areas

Component	Total Area (ha)	Approximate LSC Areas			
		Class 3	Class 4	Class 5	Class 6
Open Cut Pits	52.0				52.0
Processing Plant / Mining Facility	22.3			10.4	11.8
Waste Rock Emplacement*	87.1	12.7	1.7	5.0	67.6
Tailings Storage Facility	117.4		6.6		110.8
Southern Barrier	32.1				32.1
Oxide Ore Stockpile	7.5	1.1			6.4
TSF NAF Waste Rock Stockpile	9.2		4.6	2.1	2.5
Re-aligned 500kV Power Transmission Line	21.2				21.2
Roads and Water Infrastructure	9.3	0.4	0.0		8.9
Nursery	0.5				0.5
Soil Stockpiles					
S1	6.4		6.0		0.4
S2	12.8	7.0			5.8
S3	7.1				7.1
S4	6.4				6.4
S5	22.8				22.8
S6	6.4				6.4
Total	**420.5**	**21.2**	**18.9**	**17.6**	**362.8**
* Includes the low grade ore stockpiles and leachate management dam					
Source: SMD (2020) – Table 11					

4.13.2.4 Water Supply Pipeline Corridor Soil Landscape Units and Land Capability

The SLUs traversed by the water supply pipeline are shown on **Figure 4.13.4**. The water supply pipeline corridor intersects a number of soil types and landscapes. **Table 4.73** presents information relating to the mapped SLUs traversed by the water supply pipeline corridor and potential land capability constraints.

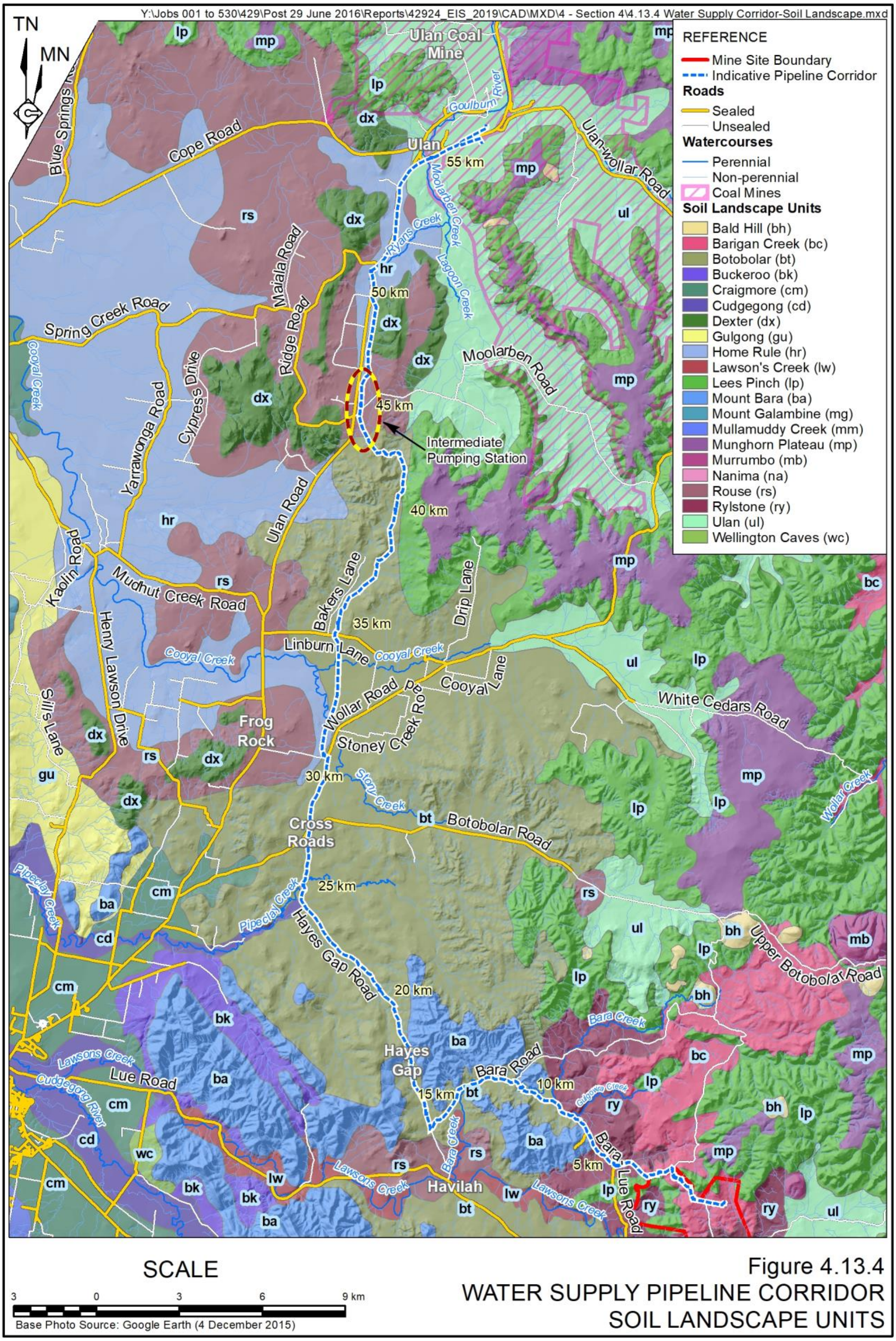


Figure 4.13.4
WATER SUPPLY PIPELINE CORRIDOR
SOIL LANDSCAPE UNITS

Table 4.73
Soil Landscape Units Mapped in the Vicinity of the Pipeline and Land Capability Constraints[1]

Page 1 of 2

Soil Landscape Unit	Parent Materials and Soil Types Present	Land Capability Constraints
Barigan Creek (bc)	Shale, sandstone, siltstone, conglomerate, chert. Common soils are Yellow Podzolic Soils on lower slopes and along drainage lines. Red Podzolic Soils on higher colluvial slopes, benches and rises.	LSC Class 5 – High limitations High erosion hazard under cropping or where there is low surface cover. Salinity in localised areas in drainage depressions.
Lawson's Creek (lw)	Sediment and alluvium derived from metasediments from the Capertee Rise. Much of the gravel is angular phyllite and quartz. No full profile record is available. Soil profiles typically consist of dark, greyish-brown overbank alluvium which may be reddish brown at depth, overlying various depositional units such as gravels, sands and fines.	LSC Class 3 – Moderate limitations Moderate fertility with a moderate to high available water holding capacity. Weakly structured surface soils and streambank erosion are common. Generally has high rural capability for cropping.
Lees Pinch (lp)	Sediment derived from sandstone, conglomeratic sandstone, red-brown and green mudstone, shale, conglomerate, chert, coal and torbanite. Soils consist of shallow siliceous sands, shallow acid soils and yellow earths.	LSC Class 7 – Severe limitations Soil fertility is very low with acidic surface soils. Surface soils are typically sandy with low to very low waterholding capacity. No salinisation. Land is generally not suitable for agriculture.
Mount Bara (ba)	Sediment derived from metasediments and acid volcanics with parent rocks including sandstone, phyllite, slate, rhyolite, dacite, tuff, shale, conglomerate, red slate, red and brown quartz, arenite and siltstone. Soils consist of shallow loams.	LSC Class 8 – Very severe limitations Soils fertility is low with slightly acidic surface soils. Soils are susceptible to degradation and have low waterholding capacity. Very high to extreme erosion hazard when surface cover is low. Land is generally not suitable for agriculture.
Home Rule (hr)	Sediment derived from the Gulong and Rouse Granites. Mainly Siliceous Sands and Earthy Sands on upper and mid-slopes. Yellow Podzolic Soils and yellow Solodic Soils on lower slopes and flats. Layered Siliceous Sands in some larger drainage lines.	LSC Class 5 – High limitations Soil fertility is very low and surface soils are acidic. Waterholding capacity is low to very low. Erosion hazard is high when surface cover is low or flows are concentrated. Low levels of soil salinity.
Rylstone Siliceous Sands (ry)	Rhyolite and dacitic tuff present. Outcrop common on upper slopes and crests. Mainly shallow Siliceous Sands and bleached sands. Red Podzolic Soils and blocky rocks of rhyolite and chalcedony float occur between bedrock outcrops. Some shallow Yellow Podzolic Soils on lower crests and yellow Solodic Soils/Soloths in drainage lines.	LSC Class 6 – Very high limitations Shallow soils, rock outcrop, low waterholding capacity, seasonal waterlogging, sodic subsoils in depressions, very high erosion hazard under cultivation. Low levels of salinity are apparent and localised across the landscape.
Botobolar Non-Calcic Brown Soils (bt)	Slate, phyllite, limestone, rhyolite, dacite, shale, sandstone and minor alluvial and colluvial derivatives. Soils include Non-Calcic Brown Soils, Shallow Soils near hill tops and Yellow Podzolic-Solodic Soils on poorly drained soils.	LSC Class 4 – Moderate to high limitations High to very high erosion hazard and low surface cover. Weakly structured surface soils. Moderate waterholding capacity. Isolated low levels of salinity along drainage lines.

Table 4.73 (Cont'd)
Soil Landscape Units Mapped in the Vicinity of the Pipeline and Land Capability Constraints[1]

Page 2 of 2

Soil Landscape Unit	Parent Materials and Soil Types Present	Land Capability Constraints
Rouse (rs)	Gulgong Granite, biotite granite, adamellite, granodiorite. Mainly shallow Siliceous Sands and Earthy Sands on mid-slopes and upper slopes. Yellow Soloths and yellow Solodic Soils on lower slopes and in depressions. Other soils include bleached sands, and Non-calcic Brown Soils and Red Earths on small areas of less siliceous rock.	LSC Class 5 – High limitations Soil fertility is very low and surface soils are acidic. High to very high erosion hazard under cultivation. Waterholding capacity is low to very low. Low levels of salinity are apparent and common.
Dexter (dx)	Shallow Siliceous Sands, Siliceous Sands and Earthy Sands on upper and mid-slopes. Yellow Solodic Soils on lower slopes and along major drainage lines.	LSC Class 6 – Very high limitations Very low to low soil fertility and surface soils are often very acidic. Very high erosion hazard. Low available water holding capacity. No salinity problems.
Ulan (ul)	Shale, sandstone, conglomerate, chert, coal and torbanite seams. Yellow Podzolic Soils on lower slopes and drainage lines with patches of yellow Solodic Soils/Solonetz in association with salt scalds. Yellow and Brown Earths on footslopes with minor areas of Earthy Sands on low rises.	Class 5 – High limitations Soil fertility is low. Surface soils are slightly acidic. High levels of soil salinity.
Source: Murphy and Lawrie (1998)		

It is noted that the entire length of the water supply pipeline would traverse SLUs with an LSC Class of between 3 and 8 (i.e. land with moderate to very severe limitations). The majority (approximately 34km) of the pipeline would be constructed within land with an LSC Class of 4 (i.e. moderate capability land) with land uses within this LSC Class typically restricted to grazing with restricted cultivation, pasture cropping, grazing, some horticulture, forestry and nature conservation. Approximately 0.6km of the WSPC would intersect Lawson's Creek SLU which has an LSC Class of 3. It is noted that the Lawson's Creek SLU comprises land mapped as BSAL within the *Central West and Orana Regional Plan 2036*. However, the WSPC would be restricted to within the road corridor for Bara-Lue Road within this area and would not impact upon agricultural land.

It is noted that no acid sulfate soils are mapped within the vicinity of the water supply pipeline corridor.

4.13.3 Potential Impacts to Soil Resources and Land Capability

SMD (2020) considered the potential impacts to the soil resources and land capability as the resulting soil degradation arising from the Project would be as follows.

- Poor plant growth and unsatisfactory groundcover associated with soil acidity and nutrient deficiencies and resulting in the loss of soil resources as the result of erosion.

- Physical damage to soil structure during the removal of soils from disturbance areas, soil stockpiling and/or replacement of soil during rehabilitation activities.
- Loss of soil biological activity through unsatisfactory stockpiling of soils.
- Reduced or poor capacity for the rehabilitated landscape of the Mine Site to tolerate drought due to poor soil waterholding capacity and/or poor root growth in the planted vegetation.

4.13.4 Management and Mitigation Measures

4.13.4.1 Mine Site

The following subsections present an overview of the management and mitigation measures to be adopted to maximise the value of the soils as a resource for rehabilitation purposes and to minimise losses through erosion related to the practices of soil stripping and stockpile management. The management of sediment-laden runoff throughout the Project life is also addressed.

Soil Stripping

The topsoil and subsoil resources requiring stripping would be managed to ensure that soil health and structure is maintained during stockpiling through the adoption of the following management measures.

- Topsoil and subsoil would be selectively stripped and separately handled prior to stockpiling.
- Lime would be added to the soil prior to stripping to overcome acidity and dispersion/sodicity constraints, thereby, maximising the chances of the soil being more suitable for plant growth upon placement during rehabilitation activities than the pre-development soil. In addition, the application of lime would make the soil less prone to erosion during stockpiling. The application of lime prior to scraping would also ensure thorough mixing of the lime with topsoil and subsoil prior to stockpiling.
- Application of coarse grade gypsum prior to stripping and stockpiling of the 'Alluvium – medium quality' SLU where required to assist with the maintenance of soil structure.
- Avoidance of dry earthmoving of soil in elevated areas of the Mine Site as these soils exhibit characteristics which indicate that they are prone to being pulverised when dry. This would limit dust generation and loss of soil resources as the result wind erosion.
- Avoidance of mechanical working of the soil when wet to limit soil dispersion which may make soils more prone to erosion.
- Avoidance of excessive compaction and/or moulding of the soil by heavy machinery under wet conditions.

Indicative depths for topsoil and subsoil stripping for the SLUs and volumes to be stripped from the areas of proposed disturbance are shown in **Table 4.74**. **Figure 4.13.4** shows the disturbance area boundaries superimposed on the SLU map.

Table 4.74
Indicative Stripping Depths for the Mine Site Soil Landscape Units

SLU	Area of Topsoil Stripping (ha)	Indicative Topsoil Depth (m)	Indicative Stripped Topsoil Volume (m^3)	Area of subsoil Stripping (ha)	Indicative Subsoil Depth (m)	Indicative Stripped Subsoil Volume (m^3)
Sedimentary – steep land	93.7	0.2	187 391	55.8	0.45	251 030
Sedimentary – gentle slope (<10%)	31.4	0.15	47 162	13.9	0.55	76 422
Acid (felsic) volcanic – steep land	170.7	0.25	426 652	151.9	0.6	911 234
Acid (felsic) volcanic – gentle slope (<10%)	65.4	0.2	130 750	36.4	0.45	163 614
Ordovician shale	18.2	0.15	27 234	18.2	0.45	81 703
Alluvium – high quality	1.9	0.6	11 693	1.9	1.4	27 284
Alluvium – medium quality	4.1	0.2	8 109	4.1	1.8	72 982
Other Areas*	35.1	0.0	0	138.3	0.0	0
Total	**420.5**		**838 992**	**420.5**		**1 584 269**
* Areas not requiring soil stripping						
Source: SMD (2020) – Table 12						

Soil Stockpile Management

Based on the approximate stripping depths shown in **Table 4.74**, approximately 840 000m^3 of topsoil and 1 580 000m^3 of subsoil would be stripped from the proposed disturbance areas and either directly transferred to an active rehabilitation area or stockpiled for use during progressive rehabilitation and closure activities. These topsoil and subsoil resources would be managed in a way that avoids degradation of the soil resources when stockpiled. Where possible, scraped subsoil and topsoil would be transferred directly to rehabilitation areas so that soil biological activity is maintained in the best possible condition. **Figure 2.1** presents the indicative locations of six proposed soil stockpiles across the Mine Site. **Table A5.4** presents the indicative volumes and areas of each stockpile. It is also proposed to increase the thickness of topsoil and subsoil placed on the southern barrier to effectively provide an additional area to stockpile soil and minimise the clearing of native vegetation for the stockpile.

Topsoil only stockpile heights would be limited to under 2m and would be sown with a well-fertilised non-persistent cover crop to encourage organic carbon accumulation, promote microbial activity and minimise erosion. Subsoil stockpiles would be no higher than 5m and would be overlain by 1m of topsoil which, similar to topsoil only stockpiles, would also be sown with a well-fertilised non-persistent cover crop.

Based on the progressive rehabilitation of the WRE, which would reduce the required volumes of long-term soil stockpiles, it is anticipated that a total of six soil stockpiles would be required over the Project life.

The following management measures would be implemented during the stockpiling of soils on the Mine Site.

- Wherever practicable, soil would not be trafficked, deep ripped or removed in wet conditions to avoid breakdown of the soil structure.
- No vehicle access would be allowed on soil stockpiles, except where required for monitoring, seeding, addition of soil ameliorants or should weed control be required.
- Soil stockpiles would be located in areas away from surface water flow.
- Silt-stop fencing would be placed immediately down-slope of all stockpiles until stable vegetation cover is established. All material recovered from the silt stop fencing would be returned to the stockpile.
- Should unacceptable weed generation be observed on soil stockpiles, a weed eradication program would be implemented.
- An inventory of topsoil and subsoil resources (available and stripped) on the Mine Site would be established, regularly maintained and reconciled with rehabilitation requirements.

Sediment-laden Runoff

Sediment-laden runoff from disturbed areas within the Mine Site and outside of the containment or mine-affected zone would be directed to sediment dams. All sediment dams have been sized to contain all runoff from the respective catchment. Subject to confirmation that the water quality in these dams is acceptable, water would be discharged from these dams into the downstream environment.

Further information regarding the sediment-laden water management is included in Section 4.7.4.3.

4.13.4.2 Water Supply Pipeline Corridor

The following management and mitigation measures would be implemented during the construction of the water supply pipeline.

- The proposed 10m width of the disturbance would be cleared of any substantial vegetation to enable the storage of excavated materials, pipeline sections, placement of topsoil, subsoil and any other excavated materials.
- Lime would be added to the soil prior to stripping to overcome acidity and dispersion/sodicity constraints, thereby maximising the chances of the soil being more suitable for plant growth upon placement during rehabilitation activities than the pre-development soil. In addition, the application of lime would make the soil less prone to erosion during stockpiling.
- Topsoil would be excavated from above the trench with the material placed adjacent to one boundary of the easement. The remainder of the trench would be excavated with either a trencher or excavator to remove the subsoil and possibly rock to the proposed base of the trench.

- Soil stockpiles would be located in areas away from surface water flows, as far as is practicable.
- Silt-stop fencing would be placed immediately down-slope of all stockpiles located on slopes greater than 1:10 (V:H). All material recovered from the silt-stop fencing would be returned to stockpiles.
- As each 200m section of the trench is excavated to its required depth, that section of the trench would be backfilled with approximately 0.25m of sand.
- Once the pipeline is placed in the trench, sand or screened subsoil (if suitable) would be placed around and above the pipeline and lightly compacted. The remainder of the trench would be backfilled with a proportion of the stockpiled subsoil and moderately compacted. All stockpiled topsoil would be replaced onto the top section of the trench without compaction.
- All excess subsoil and any other excavated materials not used would be loaded onto trucks and transported to the Mine Site for use and/or stockpiling on the Mine Site.
- All disturbed areas would be scarified and either seeded with a pasture mix agreed with the respective landowner or MWRC or rehabilitated to the pre-disturbance condition. The approach to rehabilitation along the pipeline corridor would reflect the topography, soils and vegetation within and adjacent to the corridor. In those areas to be seeded, placement of seed would be concentrated upon the surface of the trench and any other disturbed areas where vegetation had been removed. An appropriate quantity of an agreed fertiliser would be applied to the seeded area. A water truck with a side spray would be used to irrigate the planted area, as required.
- The status of revegetation within the pipeline corridor would be monitored regularly throughout the pipeline construction program to ensure that there are no unacceptable areas of subsidence/collapse or substantial revegetation. Any areas requiring follow-up attention would be maintained, as required.

4.13.5 Assessment of Impacts

4.13.5.1 Mine Site

The following impacts upon the soil resources and land capability of the Mine Site are drawn from the Land and Soils Capability Assessment undertaken by SMD (2020).

- No biophysical strategic agricultural land would be impacted as none was identified within the Mine Site.
- Apart from the final void area, the soils in the rootzones of the modified landscapes would retain or improve their qualities required for the long-term rehabilitation of the Mine Site.
- The topsoil and subsoil resources throughout the Mine Site would enable suitable substrates to be created on the final landform to sustain an appropriate level of vegetation across the Mine Site for minimisation of the risk of soil erosion.

- No soil resource impacts from the Project are anticipated on adjoining agricultural lands.
- The existing land within the Mine Site is predominantly LSC class 6 with subordinate areas being class 4 or class 5 and minor areas being class 3. A similar level of LSC would be maintained following the rehabilitation of the land disturbed within the Mine Site i.e. with the exception of the final void that would be retained as a lake.

4.13.5.2 Water Supply Pipeline Corridor

The following impacts upon soil resources and land capability within the water supply pipeline corridor would occur as a result of the construction of the pipeline.

- No biophysical strategic agricultural land would be impacted by the construction of the water supply pipeline.
- Negligible impacts on soil resources would occur as all topsoil would be replaced on the top section of the trench without compaction. All subsoil would either be returned to the trench or transferred to the Mine Site for stockpiling or immediate use in rehabilitation.
- All disturbed land would be returned to its previous use and the existing level of LSC would be maintained upon rehabilitation.
- Erosion of soil stockpiles during the construction of the pipeline would be managed by positioning stockpiles away from watercourses and installing silt-stop fencing downslope of any stockpiles located on slopes greater than 1:10 (V:H). Particular emphasis would be placed along those sections of the corridor where soil erosion potential is high.
- As LSC would be maintained, changes in soil salinity is not expected.

4.14 ABORIGINAL CULTURAL HERITAGE

The Aboriginal cultural heritage assessment of the Project was undertaken by Landskape Natural and Cultural Heritage Management. The full assessment is presented in Volume 4 Part 13 of the Specialist Consultant Studies Compendium and is referenced throughout this section as Landskape (2020).

4.14.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in Aboriginal cultural heritage impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Inadvertent removal or destruction of known Aboriginal sites and/or artefacts resulting in loss of Aboriginal cultural heritage values and reduction of in situ archaeological record (Low).
- Destruction of known Aboriginal artefacts during salvage and storage resulting in the loss of Aboriginal cultural heritage values and reduction of archaeological record (Low).
- Removal or destruction of currently unidentified Aboriginal sites and/or artefacts resulting in loss of Aboriginal cultural heritage values and reduction of in situ archaeological record (Low).

In addition, the SEARs issued by the then DPE identified "Aboriginal cultural heritage" as a key issue requiring assessment. The principal assessment requirements identified by the former DPE relating to Aboriginal cultural heritage included the following.

- an assessment of the potential impacts on Aboriginal heritage (cultural and archaeological), including evidence of appropriate consultation with relevant Aboriginal communities/parties and documentation of the views of these stakeholders regarding the likely impact of the development on their cultural heritage

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the then OEH. These requirements are summarised as follows.

- identify and describe Aboriginal cultural heritage values across the area that would be affected by the Project
- consult with Aboriginal stakeholders and include an assessment of impacts to Aboriginal cultural heritage objects.

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC.

This subsection describes the existing ethnohistory and environmental setting relevant to the potential for sites, places and values of Aboriginal heritage significance to be present and describes the predictive model used for the assessment and the consultation undertaken with the local Aboriginal community. The results of multiple field surveys of the Mine Site and its surrounding area, as well as the results of field surveys of the water supply pipeline corridor are presented. An assessment of potential impacts and heritage management measures is provided. Finally, an assessment of the significance of residual impacts to Aboriginal heritage is presented including the views of the local Aboriginal community concerning the identified sites of Aboriginal cultural heritage value. The assessment of the significance of all identified sites within the Mine Site and the water supply pipeline corridor considers the scientific, cultural, educational and aesthetic significance of the site that would be removed.

4.14.2 Existing Environment

This subsection presents the known ethnohistory of the local areas and the outcomes of previous archaeological surveys within the Mine Site and water supply pipeline corridor.

Landscape Context

The Mine Site and water supply pipeline corridor are located in the upper catchment of the Macquarie River, in the southwest slopes region of central western NSW. The Mine Site comprises hills and ridges of Palaeozoic sedimentary and volcanic bedrock, which slope down to Quaternary (less than a few million years old) alluvial plains in the south. Overall, the environment of the Mine Site and the water supply pipeline corridor has been extensively modified by past European land use practices. The alluvial valleys and lower hill slopes have been cleared for agricultural cropping and sheep and cattle grazing following European settlement.

Ethno-Historical Context

The Aboriginal people of the Wiradjuri language group occupied the southwest slopes region at the time of first contact with Europeans (Landskape, 2020). The Wiradjuri were traditionally hunter-fisher-gatherers who led a semi-sedentary lifestyle in the region encompassing the Macquarie, Lachlan and Murrumbidgee Rivers and bounded in the south by the Murray River. Prior to European settlement, large localised clans of Aborigines inhabited the Upper Macquarie, with a total regional population of 500-600 people (Pearson, 1984). Pearson (1984) speculated that there may have been three distinct clan territories centred on Bathurst, Wellington and Mudgee/Rylstone with natural boundaries such as creek and river valleys separating these territories. The Mudgee/Rylstone grouping, (known as *Mowgee*), lived along the Cudgegong River and its tributaries, with one such tributary, Lawsons Creek, south of the Mine Site, being called in Wiradjuri "*Loowee"*, meaning a chain of waterholes.

During normal conditions, these clans divided into bands of up to twenty people, who may have used a territory with a radius of 20-30 kilometres. Periodically, these bands would have coalesced into groups of 80-150 people to take advantage of a guaranteed or desirable resource, such as seasonal food resources, with the material record of this occupation preserved in the archaeological sites of the southwest slopes. All that remains at many of these sites are flakes of stone debris from the making and resharpening of stone tools which were made both at Aboriginal open and closed habitation areas (campsites and rock shelters) or special activity areas such as axe grinding groove sites. As well as being the sites of manufacture and maintenance of stone implements, habitation areas usually contain evidence of domestic and other activities such as cooking and food preparation. Campfires or oven hearths are common, marked by charcoal and heat retaining stones or hearthstones. In addition, it is also possible that modified trees, showing where bark may have been removed by Aboriginal people to manufacture canoes, shelters and dishes may also still be present.

Interaction between Europeans and the Wiradjuri led to violent conflict in the area with a period of martial law declared in 1824 by Governor Brisbane (repealed in December of the same year). At this time the Aboriginal people were led by Windradyne a senior Wiradjuri guerrilla leader, who travelled to Parramatta and was pardoned at the end of the conflicts. Within a decade of European contact, the Aboriginal people were living adjacent to pastoral homesteads and working on farms in a semi-traditional existence. Grants of land were made from the 1830s for Aboriginal reserves and a series of missions were established, including the Wellington Mission at the Macquarie River at Wellington. Aboriginal people now comprise approximately 6% of the population in central western NSW (ABS, 2016) with regional centres the focus of residence.

Whilst it is possible, based on the results of previous archaeological surveys in similar landscapes of the southwest slopes, to predict the types and topographic contexts of Aboriginal cultural heritage sites in the Lue area, the occurrence and survival of these sites is also dependent on other factors including micro-topography and the degree of land surface disturbance.

Previously Recorded Aboriginal Cultural Heritage in the Vicinity of the Mine Site and Water Supply Pipeline Corridor

There have been few systematic regional investigations of records of Aboriginal cultural heritage, however information has been gathered through isolated survey and assessment, mostly from a number of studies. These include the following surveys.

- Survey of the Goulburn River National Park by Haglund between 1980 and 1984.
- Survey for assessment of the Ulan and Moolarben coal mines.
- Surveys of the Mine Site (Appleton, 1996; Maynard, 1998).
- Flood’s (1980) broad-scale study of the uplands further east of the Mine Site, which identified general features of the regional archaeological record of the southwest slopes.

A search of the NSW AHIMS site database conducted on 16 May 2019 (search number 421345) and additional literature surveys have identified 44 sites of Aboriginal cultural heritage significance previously recorded within the Mine Site, with a further two sites recorded immediately adjacent to the water supply pipeline corridor. In summary, apart from AHIMS 36-6-0004 which is an imprecise historical recording (1889) of a shelter that could not be re-identified during the 1996, 1998 and most recent surveys, the remaining 44 sites identified within the proposed Mine Site included the following:

- 14 isolated finds of stone artefacts and 13 stone artefact scatters exposed on the flat surfaces of rhyolitic outcrops on the flanks of Hawkins Creek in the southeast of the Mine Site;
- 6 stone artefact scatters and 1 isolated find of stone artefacts on the western footslopes of Blackmans Gully in the centre of the Mine Site;

- 6 stone artefact scatters and 1 isolated find of stone artefacts on sandstone bedrock in the headwaters of the Price Creek in the northeast of the Mine Site;
- 1 isolated find of stone artefacts and 1 stone artefact scatter in the alluvial valley of Price Creek, in the southeast of the Mine Site;
- 1 stone artefact scatter in the bedrock hills overlooking Lawsons Creek in the southwest of the Mine;

Two stone artefact scatters, BL2 and BL20 which were identified in the vicinity of Hawkins Creek, have already been salvaged under Aboriginal Heritage Impact Permit number 1132211. The items were salvaged in accordance with the permit and stored within the Bowdens Silver site office enclosed in plastic bags and stored in a locked cabinet as a temporary location until long term management is agreed. This would occur subject to the outcomes of the Project application. The Wellington Valley Wiradjuri Aboriginal Corporation objected to salvage of the items in a letter dated 9 February 2013, however the permit was approved on 3 May 2013.

The two previously identified sites identified adjacent to the proposed water supply pipeline corridor included the following.

- 1 stone artefact scatter exposed on an erosional scald east of Ulan Road at Ulan (MC OS 19); and
- 1 isolated find of a stone artefact exposed on an erosional scald east of Ulan Road at Ulan (CE-32-IF).

4.14.3 Predictive Model

Previous archaeological studies (recorded in AHIMS) indicate that the most frequently recorded Aboriginal cultural heritage sites on the southwest slopes are open occupation areas represented by scatters of stone artefacts and culturally modified trees. However, the potential for encountering Aboriginal cultural heritage on the Mine Site and along the water supply pipeline corridor is mitigated by the degree of previous disturbance (e.g. historical tree clearance or modification of the land surface to facilitate agricultural production).

Based on past observations of Aboriginal cultural heritage site types and their distribution and landscape setting, Landskape (2020) identified the following predictive model of Aboriginal cultural heritage site locations for the field survey element of the assessment.

- **Trees scarred or carved by Aboriginal people** are considered possible wherever mature Eucalypt and Cypress Pine trees are present. However, given the extent of vegetation clearance, the probability of encountering culturally modified trees was not considered high.
- **Stone artefact scatters** and **isolated finds** of stone artefacts were considered possible over the entire Mine Site and associated water supply pipeline corridor. These were considered most likely to be encountered on the margins of the Hawkins Creek, Blackmans Gully, Walkers Creek and other ephemeral streams in the vicinity of the Mine Site and also possible around natural depressions such as ephemeral swamps.

- **Burial sites** were considered as being unlikely, given that the acidic soils of the area are not suited to preserving bone and other organic material.
- **Freshwater shell middens** were considered as possibly occurring on the margins of Hawkins Creek.
- **Earthen features** including **mounds**, **ovens** and **hearths, stone arrangements** and **ceremonial rings** were considered as being unlikely as they are normally restricted to level ground and, had these site types originally occurred in the Mine Site and associated water supply pipeline corridor, they would have been subjected to previous land disturbance such as earthworks associated with grading roads and fence lines and ploughed cultivation during agricultural cropping and pasture improvement.
- **Axe-grinding grooves** were considered possible on sandstone surfaces and therefore outcrops within the Mine Site and associated water supply pipeline corridor were targeted for particular attention during the field survey.
- **Rock shelters** and **rock art sites** were considered possible in caves and overhangs in sedimentary and volcanic bedrock in the low hills and ridges of the Mine Site.

4.14.4 Aboriginal Stakeholder Consultation

Liaison with members of the local Aboriginal community with regard to the Bowdens Silver Project, was initiated by RWC, on the behalf of previous proponents of the Project in 1996.

In 2011, relevant stakeholders from the Aboriginal community were identified for the Project using a process consistent with the *Aboriginal Cultural Heritage Community Consultation Requirements for Proponents* (DECCW, 2010), with further renotification and effort to identify additional stakeholders undertaken in 2019.

Further information on the process is provided in Landskape (2020), with a brief overview as follows. Notification and requests for registrations of interest were undertaken using the following methods.

- Letters of notification sent to various Aboriginal organisations, Commonwealth, State and Local Government agencies on 8 September 2011 and 2 January 2019 requesting the identification of relevant Aboriginal stakeholders (see Landskape, 2020, Annexure 1).
- Letters of notification sent to the identified relevant Aboriginal persons/parties on 23 September 2011 and 18 January 2019 (see Landskape, 2020, Annexure 1).
- Public advertisement placed in *The Mudgee Guardian* (26 September 2011 and 18 January 2019) inviting interested persons/parties to register an interest in the Project (see Landskape, 2020, Annexure 2).

Following the letters and advertisements, the following Aboriginal parties registered their interest in the Project.

- Mudgee Local Aboriginal Land Council.
- Murong Gialinga Aboriginal and Torres Strait Islander Corporation.
- Mingaan Wiradjuri Aboriginal Corporation.
- Wellington Valley Wiradjuri Aboriginal Corporation.
- North Eastern Wiradjuri Company Limited.
- Warrabinga Native Title Claimants Aboriginal Corporation.
- Gallanggabang Aboriginal Corporation.
- Mr Bradley Bliss.
- Mr Paul Brydon.

Prior to the field surveys, Dr Matt Cupper (Landskape) held telephone discussions and meetings with the registered Aboriginal parties (RAPs) to explain the proposed works associated with the Project and the planned Aboriginal cultural heritage assessment. During this period the RAPs were also provided with written copies of the methodology proposed for the cultural and archaeological assessment of the Project (see Annexure 4 of Landskape, 2020). Throughout the Aboriginal cultural heritage assessment for the Project, the opinions of the registered Aboriginal stakeholders regarding the management and mitigation of potential impacts to items of Aboriginal cultural heritage significance were sought whilst any concerns or queries were addressed.

A meeting was held at the Bowdens Silver site office on 23 May 2019 at the completion of the field surveys. Attendees at this meeting were Larry Foley and Debbie Foley (Directors, Murong Gialinga ATSIC), Brendon Doherty (Wellington Valley Wiradjuri Aboriginal Corporation), Shanae Martin (Gallanggabang Aboriginal Corporation), Kelsey Williams-Fawcett (North Eastern Wiradjuri Company Limited) and Paul Brydon (individual stakeholder). Also in attendance were Matt Cupper (Landskape), Tom Purcell and Blake Hjorth (Bowdens Silver).

A draft copy of the Aboriginal and Historical Cultural Heritage Assessment was provided to RAPs on 2 August 2019. There were five written responses to the draft report. The feedback from the RAPs is summarised as follows.

- Generally, the RAPs were concerned that survey of the entire water supply pipeline corridor had not been completed.
- Queries were raised regarding impacts to natural environmental features such as groundwater.
- Concerns were raised regarding the cumulative impacts occurring in the region to Aboriginal cultural heritage values.
- Some RAPs requested additional meetings or objected to the meetings that had taken place.

- Additional information on the cultural significance of the identified sites and the location of a burial area were provided.
- Drafts of previous Aboriginal Cultural Heritage Reports were requested.

As the result of this consultation, the following social and cultural information informed the assessment.

- Aboriginal people of the southwest slopes are concerned about any development that might impact upon Aboriginal heritage and other values on land that is traditionally theirs.
- All land has high cultural significance for individual Aboriginal people and for the Aboriginal community collectively.
- The RAPs identified the Mine Site, relocated Maloneys Road and water supply pipeline corridor as areas that Aboriginal people had inhabited in the past.
- The Mudgee Local Aboriginal Land Council, Murong Gialinga Aboriginal and Torres Strait Islander Corporation, North Eastern Wiradjuri Company Limited, Warrabinga Native Title Claimants Aboriginal Corporation and Mr Paul Brydon agreed that Bowdens Silver should arrange to salvage the Aboriginal objects that would be impacted within the Mine Site and ancillary infrastructure disturbance areas.
- A suitably qualified archaeologist and representatives of the local Aboriginal community should be engaged to record and collect the Aboriginal objects. These items should be properly curated and stored in an on-site "Keeping Place". Following the relinquishment of the mining lease and/or the completion of all relevant rehabilitation activities for the Project, artefacts should be replaced within rehabilitated areas in consultation with local Aboriginal groups.
- The Wellington Valley Wiradjuri Aboriginal Corporation and Gallanggabang Aboriginal Corporation did not support the recommendation to salvage the Aboriginal objects, requesting that they remain *in situ* and not be disturbed by the proposed development. Mr Bradley Bliss is the director for both these groups and registered as an individual stakeholder. He did not formally respond to the draft report as an individual stakeholder.

4.14.5 Field Survey

4.14.5.1 Survey Events

To support the Aboriginal cultural heritage assessment, five survey events were undertaken by Dr Cupper, with the assistance of the Aboriginal community representatives over a total period of 17 days between 2011 and 2019.

Surveys were undertaken on the following dates within the Mine Site.

- 21 to 25 November 2011.
- 19 to 21 March 2013.
- 1 and 2 July 2013.
- 24 to 26 March 2017.

Field surveys along the proposed water supply pipeline corridor occurred between 9 and 11 April 2019 and the field survey along the proposed relocated Maloneys Road was undertaken on 12 April 2019.

It is noted that access to the entire water supply pipeline corridor and relocated Maloneys Road was not possible at the time of the surveys. It is estimated that approximately 80% of the total area was covered. The access issues were discussed with DPIE at the time of the surveys and it was confirmed that this level of survey would be sufficient for the purpose of the EIS and Aboriginal cultural heritage assessment as long as the surveys were undertaken prior to any ground disturbance (see Section 4.14.9). Landskape (2020), considers that the likelihood of finding additional sites in the remaining 20% of the corridor would be consistent with the results from areas surveyed.

The Aboriginal community representatives were involved on a rotational basis, such that each day the fieldwork team comprised the Project archaeologist and two to four Aboriginal community representatives. Full details of the field survey program are provided in Section 5.2 of Landskape (2020).

4.14.5.2 Survey Methods

The proposed disturbance areas within the Mine Site and sections of the water supply pipeline corridor were inspected on foot by the field survey team walking approximately 10m apart. The survey area was comprised of a series of closely spaced transects whilst the ground surface was visually examined for archaeological traces. Particular attention was paid to areas with high ground surface visibility such as stock and vehicle tracks, gullies and other eroded areas. In addition, all mature trees in the surveyed areas were inspected for scarring or carving by Aboriginal people. Sites of Aboriginal cultural heritage significance were defined as a concentration of stone artefacts, a rock shelter or scarred tree. Stone artefacts that were not part of a concentration were recorded as isolated finds.

Access was available to all of the Mine Site and most (approximately 80%) sections of the water supply pipeline corridor. Weather conditions during the surveys were generally fine.

4.14.5.3 Survey Coverage

Visibility

The ground surface visibility for the five field survey events were typically around 10-60 % due to moderate grass and herbaceous plant growth with areas of the ground surface exposed by erosion, gullying and stock and vehicular traffic.

Coverage Analysis

Approximately 27% of the surface areas of the proposed areas of disturbance for the Project were inspected on foot as a result of the intensive nature of the field survey and the conditions of surface visibility. Landskape (2020) considered this to be relatively high survey coverage.

4.14.5.4 Survey Results

As noted in Section 4.14.2, 44 Aboriginal archaeological sites have previously been identified within and adjacent to the Mine Site and two Aboriginal archaeological sites have previously been identified adjacent to the water supply pipeline corridor. Searches were undertaken for these sites with the majority reidentified during the survey. Some isolated artefacts could not be reidentified.

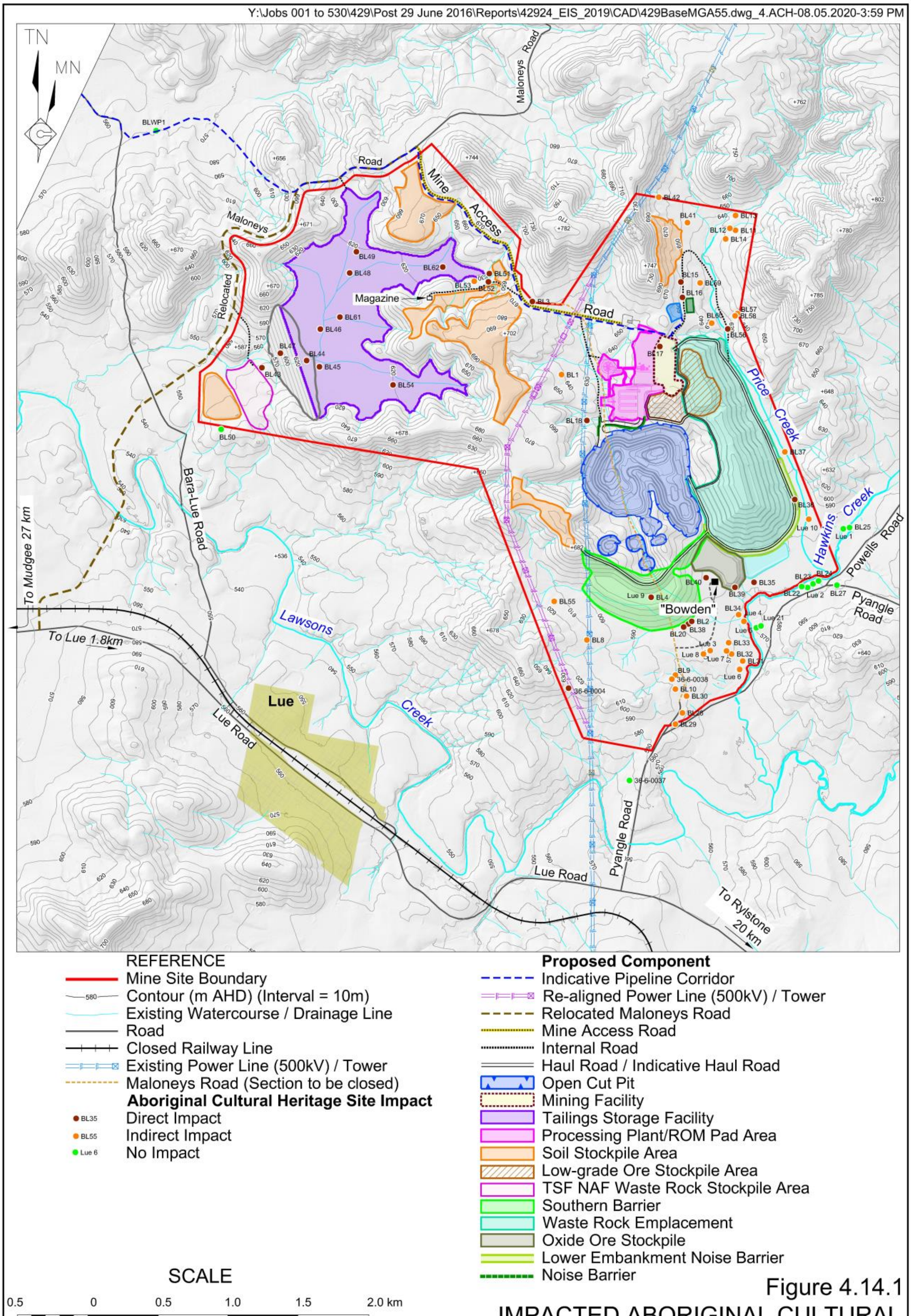
Thirty-one Aboriginal cultural heritage sites were newly identified during the field assessments undertaken by Landskape. These comprised 19 stone artefact scatters, nine isolated finds of stone artefacts, two scarred trees and a rock shelter with potential archaeological deposits and stone artefacts. Sites identified within the Mine Site included the following.

- 1 stone artefact scatter exposed on the flat surfaces of a rhyolitic outcrop north of Hawkins Creek in the south of the Mine Site;
- 2 stone artefact scatters in the vicinity of the Bowdens Silver office, in the south of the Mine Site;
- 1 isolated find of a stone artefact west of the proposed Southern Barrier;
- 3 stone artefact scatters and 3 isolated finds of stone artefacts in the alluvial valley of Price Creek in the northeast of the Mine Site;
- 10 stone artefact scatters and 3 isolated finds of stone artefacts in the northern headwater, southern headwater and main valley of Walkers Creek in the west of the Mine Site;
- 1 rock shelter with a stone artefact scatter and potential archaeological deposits in the southern headwater of Walkers Creek in the west of the Mine Site;
- 1 fallen tree with possible cultural scar in the northern headwater of Walkers Creek in the west of the Mine Site;

The following sites were identified within the water supply pipeline corridor.

- 3 stone artefact scatters exposed on exposed areas in the vicinity of Bara Road, in the southern section of the water supply pipeline corridor;
- 1 isolated stone artefact on an exposed area in the vicinity of Hayes Gap Road, in the southern section of the water supply pipeline corridor;
- 1 living tree with a possible cultural scar in the vicinity of Hayes Gap Road, in the southern section of the water supply pipeline corridor; and
- 1 stone artefact scatter exposed on an exposed area in the vicinity of Ulan Road, in the northern section of the water supply pipeline corridor.

Figure 4.14.1 and **Figure 4.14.2** show the respective locations of each previously identified and recently identified site within the Mine Site and water supply pipeline corridor, respectively. A total of 58 sites are located within the Mine Site and eight sites adjacent to the water supply pipeline corridor that may be impacted under the Project. There were no sites identified during survey of the proposed relocated Maloneys Road.



Source: Bowdens Silver Pty Limited
Heritage Source: AHIMS - May 2019 & Landskape (2020)

Figure 4.14.1
IMPACTED ABORIGINAL CULTURAL HERITAGE SITES WITHIN THE MINE SITE

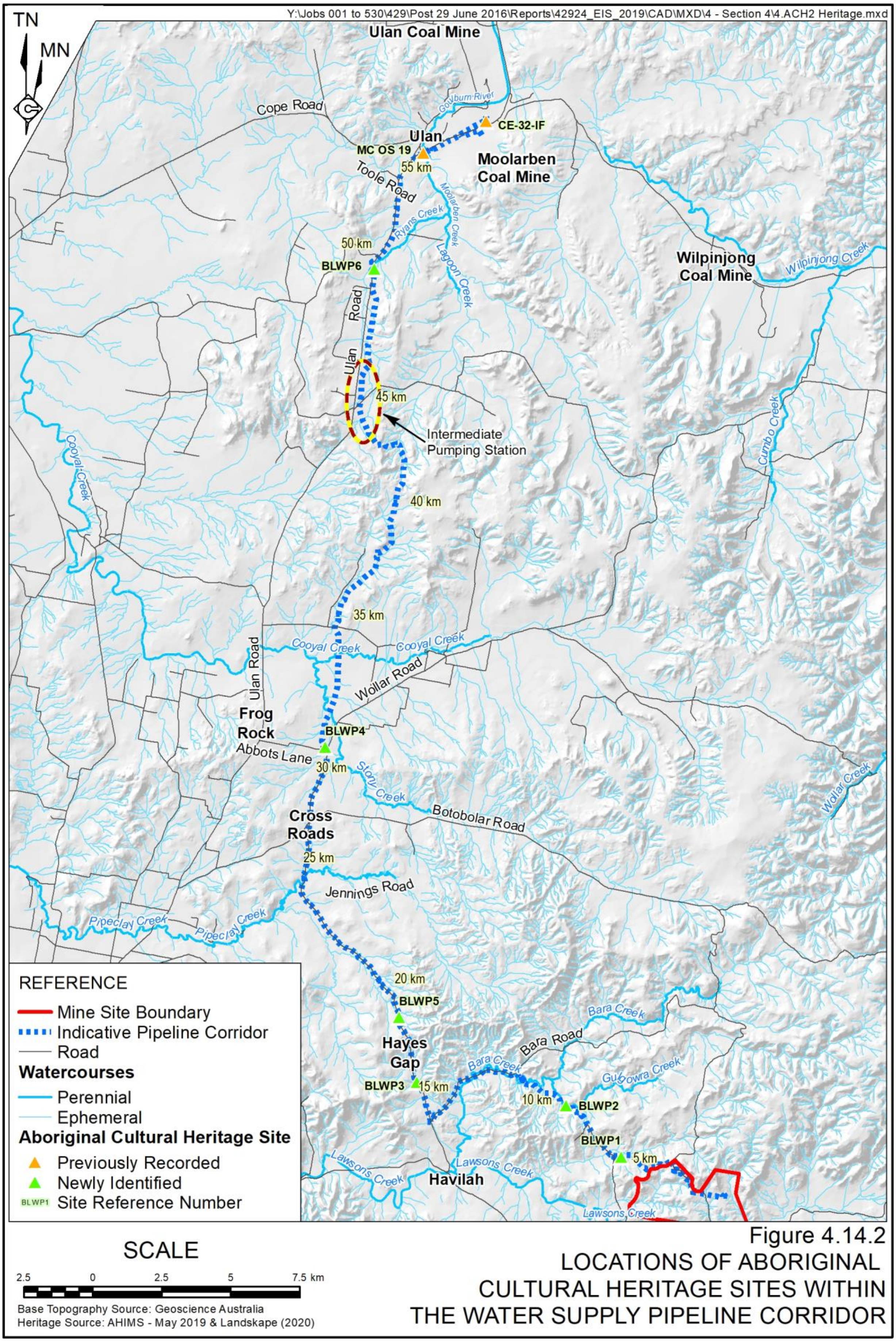


Figure 4.14.2
LOCATIONS OF ABORIGINAL CULTURAL HERITAGE SITES WITHIN THE WATER SUPPLY PIPELINE CORRIDOR

4.14.6 Potential Impacts on Aboriginal Heritage Sites

The Project would directly and indirectly impact upon Aboriginal cultural heritage sites. Direct and indirect impacts may result from the development of the proposed open cut pits, WRE, southern barrier, topsoil and subsoil stockpiles, TSF, processing area and ancillary infrastructure and could include the destruction of the sites via earthmoving or indirect physical effects (e.g. dust deposition) or aesthetic effects. In addition, of those areas surveyed, there remains the potential for Aboriginal cultural heritage sites to be located within this area during construction and mining operations.

4.14.6.1 Direct Impacts

Activities associated with the Project would potentially disturb the land surface and directly impact Aboriginal cultural heritage sites associated with the affected landforms and its landscape context.

Such impacts on cultural heritage values typically fall into three categories:

- the loss of information which could otherwise be gained by conducting research now;
- the loss of the cultural heritage resource for future research using methods and addressing questions not available today; and
- the permanent loss of the physical record.

4.14.6.2 Indirect Impacts

In areas where activities required for the development of the Project would not involve significant earthmoving, impacts may be limited to minor surface disturbance, limited disturbance of the associated substrates or landforms and no significant alteration of the landscape context.

Potential indirect impacts to cultural heritage sites could include.

- deposition of dust generated by mining;
- damage from blasting and vibration from operations and potential instability as a result of open pit operations and layout;
- accidental disturbance by peripheral activities; and
- inappropriate visitation including the unauthorised removal of cultural heritage objects.

4.14.6.3 Cumulative Impacts

The Project is located within a region with a number of currently approved or operational mines and other large-scale infrastructure projects. These existing operations have caused adverse heritage impacts to a range of Aboriginal cultural heritage sites, principally archaeological ones. For the most part, these adverse impacts have been associated with the disturbance or destruction of Aboriginal and historical cultural heritage sites subsequent to archaeological investigation and assessment.

4.14.7 Assessment of Significance

The significance of Aboriginal cultural heritage sites such as those identified as part of this assessment are usually assessed in terms of their importance to archaeologists (i.e. their scientific significance), their importance to contemporary Aboriginal people (cultural significance) and their importance to the general public (educational or aesthetic significance). A number of criteria are used to assess the scientific significance of a site including the integrity of a site, its structure and contents. The rarity of a site in the location or to the archaeological record is an important consideration of its scientific significance. It is also noted that cultural significance can only be determined by the Aboriginal community. Once the significance of a site has been assessed, it can be ranked against others and specific recommendations formulated. Criteria for assessing significance are set out in Section 6.1 of Landskape (2020).

A summary of the archaeological significance assessment of the identified sites that would be directly or indirectly disturbed is presented in **Table 4.75**. In summary, all sites have been identified by the registered Aboriginal parties to be of high cultural significance. The majority of sites are considered by Landskape (2020) to be of low scientific, educational and aesthetic significance, excepting:

- Lue 8, BL40, BL41, BL43, BL45 and BL53 that are of low to moderate scientific significance.
- BL44 (the rock shelter site) that is of moderate scientific, education and aesthetic significance.

4.14.8 Assessment of Impacts

Table 4.75 presents a summary of impacts to the 58 identified sites within the area of the Landskape (2020) study that would be subjected to either direct or indirect impacts as well as the assessed significance of each site. The Project would require the salvage of items of Aboriginal cultural heritage significance from 25 identified sites within the Mine Site, one of which (the rock shelter identified as site BL44) would require test excavation. Two sites have already been salvaged under Aboriginal Heritage Impact Permit No. 1132211, issued by OEH in May 2013. All salvaged items would be properly curated and stored in an on-site “Keeping Place”. A further 31 identified sites within the Mine Site, whilst not directly impacted, would require protection from inadvertent disturbance via the installation of protective barriers.

All six identified sites within the water supply pipeline corridor have been avoided by minor adjustments to the corridor. The two sites previously identified in the vicinity of the Ulan Coal Mine would not be directly impacted. No sites were identified within the proposed relocated Maloneys Road.

As impacts to identified sites within the water supply pipeline corridor would be avoided, only identified sites within the Mine Site would either be directly or indirectly impacted. Field survey and assessment of the previously unsurveyed sections of the proposed water supply pipeline corridor would be completed following the receipt of agreements with the subject landowners well in advance of any construction. The likelihood of encountering Aboriginal objects during these future surveys is mitigated by previous land disturbance by agricultural land use and the fact that Aboriginal objects were sparsely represented in the previously surveyed sections. It is considered likely that minor adjustments to the water supply pipeline corridor would also be possible to avoid direct impacts to any sites identified in future surveys.

Table 4.75
Archaeological Significance and Management Strategies for the Impacted Aboriginal Cultural Heritage Sites within the Mine Site and Water Supply Pipeline Corridor

Site Name	Type	Contents	Scientific Significance				Aboriginal Cultural Significance	Educational Significance	Aesthetic Significance	Potential Impacts	Proposed Management Measures
			Integrity	Structure	Contents	Rarity					
BL1	Artefact scatter	9 mudstone flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL2	Artefact scatter	10 chert flakes and flaked pieces, 6 silcrete flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	None	Aboriginal objects already salvaged
BL3	Artefact scatter	10 mudstone cores and flakes	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL4	Artefact scatter	8 chert flakes	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL8	Artefact scatter	13 chert flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL9	Artefact scatter	7 chert flakes and flaked pieces, quartz flaked piece	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL10	Isolated artefact	Chert flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL11	Artefact scatter	Chert core	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL12	Artefact scatter	Chert flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL13	Artefact scatter	Chert core	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL14	Artefact scatter	5 chert flakes	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL15	Artefact scatter	19 mudstone and chert flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL16	Artefact scatter	31 mudstone and chert flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL17	Isolated artefact	Chert flake	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects

Table 4.75 (Cont'd)
Archaeological Significance and Management Strategies for the Impacted Aboriginal Cultural Heritage Sites within the Mine Site and Water Supply Pipeline Corridor

Site Name	Type	Contents	Scientific Significance				Aboriginal Cultural Significance	Educational Significance	Aesthetic Significance	Potential Impacts	Proposed Management Measures
			Integrity	Structure	Contents	Rarity					
BL18	Isolated artefact	Chert flake	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL20	Artefact scatter	10 chert flakes and flaked pieces, 6 silcrete flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	None	Aboriginal objects already salvaged
BL21	Artefact scatter	13 chert flakes, quartz flake, silcrete flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL28	Artefact scatter	7 mudstone and chert flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL29	Isolated artefact	Mudstone flaked piece	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL30	Isolated artefact	Metasedimentary flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL31	Isolated artefact	Mudstone flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL32	Isolated artefact	Mudstone core	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL33	Isolated artefact	Mudstone flaked piece	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL34	Isolated artefact	Mudstone flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL35	Isolated artefact	Mudstone flaked piece	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal object
BL36	Artefact scatter	5 mudstone and chert flakes	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL37	Isolated artefact	Chert flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL38	Artefact scatter	10 chert flakes and flaked pieces, 6 silcrete flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects

Table 4.75 (Cont'd)
Archaeological Significance and Management Strategies for the Impacted Aboriginal Cultural Heritage Sites within the Mine Site and Water Supply Pipeline Corridor

Site Name	Type	Contents	Scientific Significance				Aboriginal Cultural Significance	Educational Significance	Aesthetic Significance	Potential Impacts	Proposed Management Measures
			Integrity	Structure	Contents	Rarity					
BL39	Artefact scatter	2 chert flakes	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL40	Artefact scatter	2 chert flakes	Low	Moderate	Moderate	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL41	Artefact scatter	32 chert flake, flaked pieces and angular fragments and 6 quartz angular fragments on rhyolite outcrops	Low	Moderate	Moderate	Low	High	Low	Low	Indirect	Erect protective barrier
BL42	Isolated artefact	1 chert flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL43	Artefact scatter	100s chert, fine grained volcanic and quartz blades, points, scrapers, cores, flakes, flaked pieces and angular fragments	Moderate	Moderate	Moderate	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL44	Rock shelter	Rock shelter with three chert and quartz flakes, potential archaeological deposits	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	Direct	Test excavate and salvage Aboriginal objects
BL45	Artefact scatter	100s chert, fine grained volcanic and quartz blades, points, scrapers, cores, flakes, flaked pieces and angular fragments	Moderate	Moderate	Moderate	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL46	Artefact scatter	20 chert and quartz flakes, and flaked pieces	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL47	Artefact scatter	6 chert, fine grained volcanic and quartz cores, flakes, and flaked pieces	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL48	Artefact scatter	2 chert flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL48	Artefact scatter	2 chert flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects

Table 4.75 (Cont'd)
Archaeological Significance and Management Strategies for the Impacted Aboriginal Cultural Heritage Sites within the Mine Site and Water Supply Pipeline Corridor

Site Name	Type	Contents	Scientific Significance				Aboriginal Cultural Significance	Educational Significance	Aesthetic Significance	Potential Impacts	Proposed Management Measures
			Integrity	Structure	Contents	Rarity					
BL48	Artefact scatter	2 chert flakes and flaked pieces	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL49	Scarred tree	Possible scarred tree. Scar measures 700 x 220 mm	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL51	Artefact scatter	8 chert and quartz flakes	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL52	Artefact scatter	15 chert flakes	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL53	Artefact scatter	45 chert, fine grained volcanic and quartz blades, cores, flakes and flaked pieces	Low	Moderate	Moderate	Low	High	Low	Low	Indirect	Erect and maintain protective barrier
BL54	Isolated artefact	1 chert flake	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal object
BL55	Isolated artefact	1 sandstone hammerstone	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL56	Artefact scatter	1 chert flake	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL57	Artefact scatter	1 quartz angular fragment	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL58	Artefact scatter	5 quartz flakes, core	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL59	Artefact scatter	25 quartz and tuff flakes, angular fragments and cores, sandstone axe	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL60	Artefact scatter	10 quartz and tuff flakes, angular fragments and core	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BL61	Artefact scatter	14 chert and quartzite flakes	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
BL62	Artefact scatter	1 quartz flake	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects

Table 4.75 (Cont'd)
Archaeological Significance and Management Strategies for the Impacted Aboriginal Cultural Heritage Sites within the Mine Site and Water Supply Pipeline Corridor

Site Name	Type	Contents	Scientific Significance				Aboriginal Cultural Significance	Educational Significance	Aesthetic Significance	Potential Impacts	Proposed Management Measures
			Integrity	Structure	Contents	Rarity					
Lue 3	Isolated artefact	Mudstone flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
Lue 4	Isolated artefact	Mudstone core	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
Lue 6	Isolated artefact	Quartz flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
Lue 7	Artefact scatter	Silcrete flake, quartz flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
Lue 8	Artefact scatter	27 silcrete and chert flakes and flaked pieces, chert core	Low	Moderate	Moderate	Low	High	Low	Low	Indirect	Erect protective barrier
Lue 9	Artefact scatter	8 chert flakes	Low	Low	Low	Low	High	Low	Low	Direct	Salvage Aboriginal objects
Lue 10	Isolated artefact	Mudstone flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect protective barrier
BLWP1	Artefact scatter	11 tuff, chert, quartz, quartzite angular fragments, flakes, flaked pieces, blades	Low	Low	Low	Low	High	Low	Low	Indirect	Erect temporary protective barrier#
BLWP2	Artefact scatter	6 tuff, chert angular fragments	Low	Low	Low	Low	High	Low	Low	Indirect	Erect temporary protective barrier#
BLWP3	Isolated artefact	1 chert flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect temporary protective barrier#
BLWP4	Isolated artefact	1 chert flake	Low	Low	Low	Low	High	Low	Low	Indirect	Erect temporary protective barrier#
BLWP5	Scarred tree	Scarred Bimble (?) Box scar 880 mm long, 260 mm wide	Low	Low	Low	Low	High	Low	Low	Indirect	Erect temporary protective barrier#
BLWP6	Artefact scatter	2 tuff, quartz flakes	Low	Low	Low	Low	High	Low	Low	Indirect	Erect temporary protective barrier#

For the duration of the pipeline construction and rehabilitation

Source: Landskape (2020) – Modified after Tables 8, 10 and 12

4.14.9 Management and Mitigation Measures

Additional Archaeological Field Survey and Aboriginal Community Consultation

Those sections of the water supply pipeline corridor and relocated Maloneys Road, not accessible for field survey as part of the current assessment would be subjected to detailed field survey and Aboriginal cultural heritage assessment prior to any surface disturbance in those locations. It may be that the outcomes of these surveys require adjustment to the route of the proposed water supply pipeline corridor, however these adjustments would be minor in nature.

Heritage Management Plan

All proposed proactive and reactive management strategies relating to Aboriginal cultural heritage would be collated in a Heritage Management Plan (HMP) for the Project that would be prepared in consultation with the registered Aboriginal parties. The HMP would reflect the proposed management of the Aboriginal cultural heritage within the Mine Site and along the water supply pipeline corridor, including the following.

- Management of identified sites within the Mine Site and along the water supply pipeline corridor.
- Cultural awareness training for all personnel and contractors with specific focus on those involved in surface disturbing activities.
- Protocols for the management of unexpected finds.
- Protocols for involvement of the Aboriginal community in the ongoing operation.

Management of Aboriginal Cultural Heritage within the Disturbance Areas

The potential areas of disturbance associated with the Project have been selected following a careful and thorough assessment of options and feasibility. Therefore, there is limited opportunity to avoid impacts on the Aboriginal cultural heritage sites within the Mine Site.

Based on the results of discussions with the RAPs, Bowdens Silver would arrange for the salvage of items of Aboriginal cultural heritage significance prior to the commencement of Project-related disturbance in the respective area (i.e. open cut pits, TSF or WRE). Test excavation at site BL44 would be undertaken to investigate and record any subsurface artefacts. Identified artefacts and those that may be identified would be salvaged in consultation with the RAPs. Bowdens Silver would engage a suitably qualified archaeologist and representatives from the RAPs to record and collect the salvaged stone artefacts. These artefacts would be properly curated and stored in an on-site “Keeping Place”. The artefacts would be replaced within rehabilitated areas in consultation with representatives of the local Aboriginal community and the Biodiversity and Conservation Division of DPIE.

The proposed strategies for managing direct and indirect impacts on the identified Aboriginal cultural heritage sites are shown in **Table 4.75**, however it is noted that the management outcomes would depend on feedback from RAPs at the time of salvage. It is noted that Bowdens Silver has already erected a protective barrier around 10 of the artefact scatters or isolated artefacts and also excluded grazing in a section of the Mine Site adjacent to Hawkins Creek in an area in which numerous artefacts have previously been identified.

Cultural Awareness Training

The effective application of Aboriginal cultural heritage management strategies would rely on an understanding and appreciation of the Aboriginal cultural setting and context for the Project.

Bowdens Silver would provide training to all on-site personnel regarding the HMP strategies relevant to their employment tasks.

Management of Previously Unidentified Aboriginal Cultural Heritage Sites

In the event that a previously unidentified Aboriginal cultural heritage site is encountered during construction or operation of the Project, work would stop immediately in the vicinity and the site would be protected from any further inadvertent impact. The find would be reported to BCD and a suitably qualified archaeologist would be commissioned to assess the significance of the site and determine measures for its management (in consultation with the registered Aboriginal stakeholders for Aboriginal cultural heritage). This may include salvage of the site or measures to retain the site in situ.

Should the unexpected site contain bones indicative of a burial (however unlikely given the soil conditions), the police would be contacted immediately, and the above procedure implemented.

In all instances, work would not recommence in the location of the site until BCD has confirmed the proposed management and consultation is acceptable.

Role of the Local Aboriginal Community

Bowdens Silver is committed to involving the local Aboriginal community as an integral participant in the management of Aboriginal cultural heritage values in the Mine Site and along the water supply pipeline corridor.

The recording, salvage, curation, storage and replacement of items of Aboriginal cultural heritage significance would occur with the invited participation of local Aboriginal community representatives.

4.14.10 Conclusion

The Project would result in the removal and salvage of items at 25 Aboriginal cultural heritage sites. Consultation with the stakeholders from the Aboriginal community has identified appropriate management strategies for salvage and storage of these sites, which would eventually be returned to the rehabilitated landscape. The majority of these sites represent isolated or scattered artefacts indicative of open occupation and are relatively common in the vicinity of the Mine Site. Bowdens Silver acknowledges the significance of these sites to the Aboriginal community and would implement management and mitigation measures to protect identified sites in the landscape that would not be directly disturbed and to appropriately manage unknown sites that may be identified.

The preparation of an HMP would ensure that Aboriginal cultural heritage sites and values would be protected in accordance with the requirements of the NSW Government and the expectations of the local Aboriginal and wider community.

4.15 HISTORIC HERITAGE

The historic heritage assessment of the Project was undertaken by Landskape Natural and Cultural Heritage Management. The full assessment is presented in Volume 4 Part 13 of the Specialist Consultant Studies Compendium and is referenced throughout this section as Landskape (2020).

4.15.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in historic heritage impacts. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Unauthorised destruction of known historic heritage sites (Low).
- Unauthorised destruction of unknown historic heritage sites within approved disturbance areas (Low).

In addition, the SEARs issued by the then DPE identified "historic heritage" as a key issues requiring assessment. The principal assessment requirements issued by the former DPE relating to historic heritage included the following.

- provide a heritage assessment including an assessment of the significance of any identified heritage items.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the then OEH. These requirements are summarised as follows.

- provide a heritage assessment including an assessment of the significance of any identified heritage items.

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC.

This subsection describes the historic heritage context and the results of multiple field surveys of the Mine Site and its surrounding area, as well as the results of field surveys of the water supply pipeline corridor. An assessment of the archaeological significance of all identified historic heritage items within the Mine Site and the water supply pipeline corridor are provided along with assessment of potential impacts as a result of the Project. Management and mitigation measures are also discussed.

4.15.2 Existing Environment

Historic Heritage Context

The first European to visit the southwest slopes was explorer and Surveyor-General of NSW Lieutenant John Joseph William Molesworth Oxley during his 1818 expedition of the Macquarie River (Johnson, 2001). In 1821-1822, James Blackman, George Henry Cox and William Lawson surveyed the area around Cudgegong River for grazing land. They gave their names to several features in or near the Mine Site, including Lawsons Creek and Blackmans Gully. Within a few years, pastoralists had occupied much of the land in the Mudgee region.

James Walker, who had earlier taken up the Wallerawang run near Rylstone, was granted the 1000-acre Loowee run in 1825 (Potts, 1984). Over the succeeding years, Walker expanded Loowee Station until it comprised over 21,000 acres of freehold land. Loowee was run as a sister property to Wallerawang by manager Andrew Brown. Convicts and Aboriginal shepherds tended flocks at remote outstations dispersed up to 50 kilometres apart across the holdings, with sheep driven back to Loowee or Wallerawang for shearing (Potts, 1984). Walker sold Loowee to James John Riley and H.W. Bloomfield in 1856. Riley donated land for an Anglican church and school, although the first town to develop in the area was Dungeree, two kilometres east of where Lue now stands (Potts, 1984).

Loowee was purchased by Dr James Charles Cox in 1862, at which time it comprised 39,346 freehold and leasehold acres and ran 30,000 sheep (Potts, 1984). A policy of closer settlement was pursued over the second half of the nineteenth century with the passing of the 1861 and 1884 Crown Lands Acts. Some of the leasehold sections of the old pastoral holding of Loowee were resumed, subdivided and sold freehold to selectors (NSW Department of Lands, 1884). Much of the timbered crown land was gazetted as the Apple Tree Flat Gold Field Reserve proclaimed on 15 January 1869 (later renamed the Gulgong Gold Field in May 1899).

Land reform was designed to break the domination of land tenure by a few wealthy individuals, but this failed to stop the establishment of pastoral agglomerations. For example, Cox's brothers Edward King Cox, a member of the NSW Legislative Council, and Richard William Cox, and their wives and children, purchased many of the freehold allotments including parts of the present Mine Site (NSW Department of Lands, 1883, 1884, 1894, 1895, 1903, 1905, 1915, 1917, 1924, 1933a, 1933b; Teale, 1969). Thomas Jarman Hawkins, a member of the NSW Legislative Council for East Macquarie and Commissioner for Crown Lands in the Western Division, also purchased freehold allotments including parts of the present Bowdens Project Site (NSW Department of Lands, 1883, 1895, 1905, 1917, 1933a). Hawkins gave his surname to Hawkins Creek.

When the railway line from Lithgow was extended to Mudgee in 1884, Lue was chosen as the site for a station because the grade was too steep at Dungeree (Potts, 1984; Sheedy, 1988). A town grew up around the railway station, which included several stores, churches, a school and a hotel.

The population of Lue and the amount of commercial activity declined with the contraction of the pastoral industry over the twentieth century. The railway line from Rylstone through Lue to Mudgee was closed in 2005.

Types of Historic Heritage Site in the Region

The types of historical heritage sites that occur on the southwest slopes include the following.

- Pastoral Sites – These include old homesteads and associated structures such as work sheds, shearing sheds and labourers' quarters but also include less conspicuous sites such as survey markers, particularly those blazed on Eucalypt and Cypress Pine trees, which are also of historical interest.
- Urban Sites – These include historically significant commercial, public and residential buildings from the nineteenth and early twentieth centuries.
- Industrial Sites – Though not common these sites include abandoned mining sites and sawmills which may contain old sheds and abandoned machinery such as steam engines and boilers.

- Transport Sites - These include small bridges made from River Red Gum timber or stone cobbles. Railway sites comprise stations and sidings, rail track, stabling yards and water towers and hydrants. Mileage markers and navigation markers may also be present.

Previously Recorded Historical Heritage Items in the vicinity of the Mine Site, Water Supply Pipeline Corridor and Proposed Relocated Maloneys Road

The NSW State Heritage Inventory contains items listed by the Heritage Council under the Heritage Act. The Mudgee Shire Local Environmental Plan (LEP) also lists historical heritage sites within the former Mudgee Shire, the precursor to the current Mid-Western Regional LGA, in which the Mine Site and water supply pipeline corridor are located (Mudgee Shire, 1998).

There are no previously registered historical cultural heritage sites located within the Mine Site or in or near the water supply pipeline corridor and relocated Maloneys Road. The historical cultural heritage site closest to the Mine Site is Lue Railway Station complex (State Heritage Register Database Number 5012084). This structure is located adjacent to the Wallerawang-Gwabegar Railway in Lue, approximately 2km southwest of the Mine Site (OEH, 2019). **Table 4.76** and **Figure 4.15.1** present the historical cultural heritage sites located within a radius of approximately 2.5km from the Mine Site.

Table 4.76
Historical Cultural Heritage Sites near the Mine Site

Heritage Inventory Number*	Description	Distance and Direction from Mine Site
5012084	Lue Railway Station complex	2 km southwest
2070361	Lue Station homestead	2.5 km southwest
2070362	James John Riley's grave	2.5 km southwest
2070364	Lue Hotel and residence	2 km southwest
2070366	Lue railway viaduct	2 km southwest
2070365	John Thompson's butcher/draper/grocer	2 km southwest
4280433	Lue road railway underbridge	1.8 km south
Source: Landskape (2020) – Modified after Table 4		

4.15.3 Field Survey

Survey Method and Timing

Five survey events were undertaken by Dr Cupper to support the historical heritage assessment and Aboriginal cultural heritage assessment over a total period of 19 days between 2011 and 2019.

A summary of the timing and methods implemented during these surveys are described in Section 4.14.5. Full details of the field survey program are provided in Section 5 of Landskape (2020).

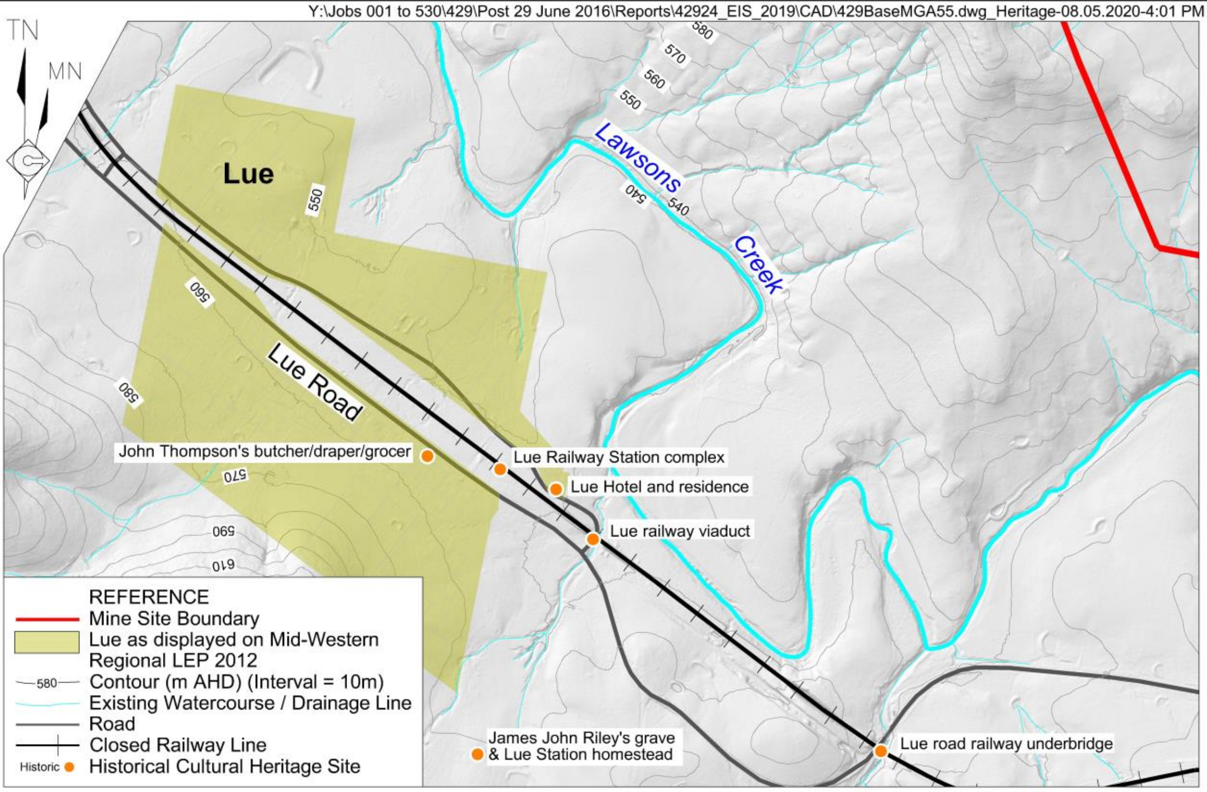


Figure 4.15.1
HISTORICAL CULTURAL HERITAGE SITES IN LUE

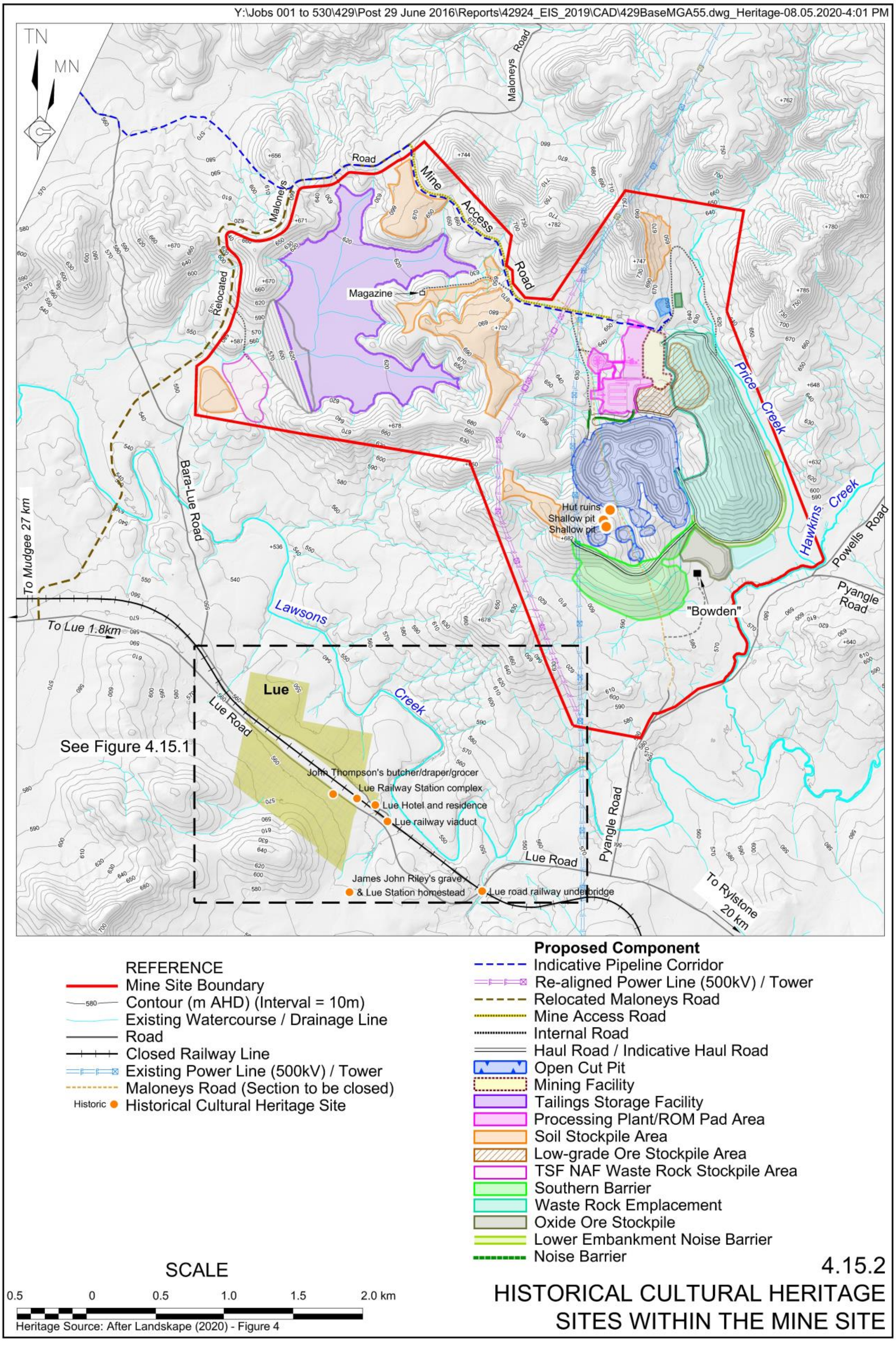
4.15.4 Survey Results

Three historical features thought to be associated with nineteenth century gold mining activities in the Apple Tree Flat Goldfield Reserve (Richard Smart *personal communication*, 23 November 2011) are located in areas of proposed disturbance within the Mine Site. These historical cultural heritage sites are located on the western flanks of Blackmans Gully and include the ruins of a (possible prospector's) hut and two shallow pits thought to be the beginnings of abandoned attempts to dig mine shafts.

A summary of the historical cultural heritage sites is contained in **Table 4.77** and their locations are shown on the map in **Figure 4.15.2**. A more detailed description of the sites, including photographs is provided in Section 5 and Section 6 of Landskape (2020).

Table 4.77
Historical Cultural Heritage Sites at the Mine Site

Site Name	Location	GDA94 mE (Zone 55)	GDA94 mN (Zone 55)	Contents
Hut ruins	Western flank Blackmans Gully	768822	6385348	3 sandstone blocks, fragments of cast iron stove, sheet iron, broken glass bottles, broken ceramic vessels
Shallow pit	Western flank Blackmans Gully	768794	6385227	Earthworks
Shallow pit	Western flank Blackmans Gully	768774	6385273	Earthworks
Source: Landskape (2020) – Modified after Table 9				



4.15.2
HISTORICAL CULTURAL HERITAGE SITES WITHIN THE MINE SITE

4.15.5 Potential Impacts on Historic Heritage

Potential negative direct and indirect impacts may result from the construction and development of the mine and would include the destruction of the sites or indirect physical effects (e.g. dust deposition) or aesthetic effects. In addition, of those areas surveyed, there remains the potential for historical cultural heritage sites to be located within this area, although Landskape (2020) notes that the likelihood of additional historical heritage sites within the Mine Site is very low.

Direct impacts on cultural heritage values typically fall into three categories:

- the loss of information which could otherwise be gained by conducting research today;
- the loss of the cultural heritage resource for future research using methods and addressing questions not available today; and
- the permanent loss of the physical record.

The three identified historical cultural heritage sites identified within the Mine Site would be directly impacted.

Potential indirect impacts to cultural heritage sites could include.

- deposition of dust generated by mining;
- damage from blasting and vibration from operations and potential instability as a result of open pit operations and layout;
- accidental disturbance by peripheral activities; and
- inappropriate visitation including the unauthorized removal of cultural heritage objects.

There are no identified historical heritage sites located within the Mine Site that would be indirectly impacted by the Project.

Cumulative Impacts

The Project is located within a region with a number of currently approved or operational mines and other large-scale infrastructure projects. These existing operations have caused adverse heritage impacts to a range of historical cultural heritage sites, principally archaeological ones. For the most part, these adverse impacts have been associated with the disturbance or destruction of historical cultural heritage sites subsequent to archaeological investigation and assessment.

4.15.6 Management and Mitigation Measures

Additional Archaeological Field Survey

Those sections of the water supply pipeline corridor and the relocated Maloneys Road, not accessible for field survey as part of the current assessment would be subjected to detailed field survey and assessment prior to any surface disturbance in those locations. It may be that the outcomes of these surveys require adjustment to the route of the proposed water supply pipeline corridor, however these adjustments would be minor in nature.

Heritage Management Plan

All proposed proactive and reactive management strategies relating to historic cultural heritage would be collated in a Heritage Management Plan (HMP) for the Project. The HMP would reflect the proposed management of the historic cultural heritage within the Mine Site and along the water supply pipeline corridor, including the following.

- Cultural awareness training for all personnel and contractors with specific focus on those involved in surface disturbing activities.
- Protocols for the management of unexpected finds.

Cultural Awareness Training

The effective application of historic heritage management strategies would rely on an understanding and appreciation of the historic setting and context for the Project.

Bowdens Silver would provide training to all on-site personnel regarding the HMP strategies relevant to their employment tasks and responsibilities.

Management of Historical Cultural Heritage within the Disturbance Areas

The potential areas of disturbance associated with the Project has been selected following a careful and thorough assessment of options and feasibility. Therefore, there is limited opportunity to avoid the historic cultural heritage sites within the Mine Site.

The Applicant would arrange for the salvage of items of historical interest at the ruined dwelling located within the Mine Site. Salvaged items would be properly curated and archived at a location to be determined.

Management of Previously Unidentified Historical Cultural Heritage within the Disturbance Areas

In the event that a previously unidentified historical cultural heritage site is encountered during construction or operation of the mine or ancillary infrastructure, work would stop immediately in the vicinity and the site protected from any further inadvertent impact. The find would be reported to BCD and a suitably qualified archaeologist who would assess the significance of the site.

4.15.7 Assessment of Significance

An assessment of historic heritage significance for identified historical cultural heritage sites was undertaken using the NSW OEH Heritage Branch's assessment criteria detailed in *Assessing Significance for Historical Archaeological Sites and 'Relics'* (NSW Heritage Branch, 2009). The NSW criteria cover the generic *Australia ICOMOS Charter for the Conservation of Places of Cultural Significance* (Burra Charter) values of historic, aesthetic, scientific and social significance, but express the values in a more detailed form to maintain consistency and facilitate comparison of assessments across jurisdictions.

A summary of the historical significance assessment of the identified sites that would be impacted by the Project is presented in **Table 4.78**.

Table 4.78
Assessment of Significance of Identified Historical Cultural Heritage Sites

Site Name	Significance						
	Historical	Historical Assoc.	Aesthetic	Social	Research Potential	Rarity and Representativeness	
Hut Ruins	Local (Low)	Local (Low)	N/A	Local (Low)	Local (Moderate)	Local (Low)	Local (Low)
Shallow Pits	Local (Low)	Local (Low)	N/A	Local (Low)	Local (Low)	Local (Low)	Local (Low)
Source: Landskape (2020) – Modified after Table 11							

4.15.8 Assessment of Impacts

Table 4.79 presents a summary of the outcomes of assessment for three identified sites within the Mine Site identified by Landskape (2020) including the archaeological significance of each site and proposed management measures. Each of the sites would be directly impacted.

Table 4.79
Summary Historical Cultural Heritage Assessment

Site Name	Type	Summary Archaeological Significance	Potential Impacts	Proposed Management Measures
Hut ruins	Hut ruins	Low-Moderate	Direct	Salvage historical relics
Shallow pit	Shallow pit	Low	Direct	None
Shallow pit	Shallow pit	Low	Direct	None
Source: Landskape (2020) – Modified after Table 12				

Salvage of historical relics would be required from a single identified site within the Mine Site with salvaged items archived at a location to be determined. It is noted that the historical heritage sites identified during the field surveys do not meet the thresholds of State-significance.

It is not likely that existing historical cultural heritage sites within Lue would be impacted by the Project.

4.15.9 Conclusion

The Project would result in the removal of three historical heritage sites comprising hut ruins and two shallow pits. Items from the hut ruins would be salvaged and archived at a place yet to be determined. Bowdens Silver would manage the identified and potential historic cultural heritage sites within the proposed disturbance areas over the Project life.

The preparation of an HMP would ensure that and unidentified historical cultural heritage sites and values would be protected in accordance with the requirements of the NSW Government and the expectations of the wider community.

4.16 PUBLIC SAFETY HAZARDS

The public safety hazards relevant to the Project relate principally to delivery, storage and use of dangerous goods and hydrocarbons on site together with bushfire hazards. The assessment of hazards relating to dangerous goods was undertaken by Sherpa Consulting Pty Ltd (Sherpa). The full assessment is presented in Volume 1 Part 4 of the Specialist Consultant Studies Compendium and is referenced throughout this section as Sherpa (2020). The bush fire assessment was prepared by R.W. Corkery and Co. Pty Limited.

4.16.1 Dangerous Goods

4.16.1.1 Introduction

The SEARs nominate that the EIS should consider any risks to public safety including the handling and use of any dangerous goods. Based upon the risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**), the potential impacts relating to dangerous goods and their risk rankings after the adoption of standard mitigation measures are as follows.

- Sodium cyanide or cyanide solution spill and/or leak event within the Mine Site leading to off-site impacts resulting in impacts to the biophysical environment including impacts on human health, aquatic life, birds, plants and animals (Low).
- Sodium cyanide loss of containment event during transport resulting in impacts to the biophysical environment including impacts on human health, aquatic life, birds, plants and animals. (Low).
- Unplanned decomposition of blasting agent (Low).

Sherpa Consulting Pty Ltd (Sherpa) undertook an analysis covering the proposed use of dangerous goods for the Project. The hazards assessment of dangerous goods comprised three components.

1. State Environmental Planning Policy 33 – Hazardous and Offensive Development (SEPP 33) Screening Study (Section 4.16.1.2).
2. Preliminary Hazard Analysis (Section 4.16.1.3).
3. Hazardous Materials Transport Route Evaluation Study (Section 4.16.1.4).

4.16.1.2 SEPP 33 Screening

Sherpa (2020) undertook a SEPP 33 Screening Study for the Project in accordance with *Hazardous & Offensive Development Application Guidelines – Applying SEPP 33* (DoP, 2011a). The results of this assessment identified that the proposed storage and use of sodium cyanide and cyanide solution on site could have the potential for significant off-site impact and therefore requires assessment in a Preliminary Hazard Analysis (PHA). The proposed quantities of Class 5.1 ammonium nitrate-based blasting agents were also found to trigger the threshold for assessment in a PHA. No other dangerous goods were identified as requiring assessment in the PHA.

The SEPP 33 screening further identified that a hazardous materials transport route evaluation study would be required for trucks carrying sodium cyanide. All other transport movements of dangerous goods were found to be well below SEPP 33 screening thresholds.

4.16.1.3 Preliminary Hazard Analysis

Methodology

Based upon the results of the SEPP 33 screening, Sherpa (2020) prepared a PHA in accordance with *Hazardous Industry Planning Advisory Paper No. 6 Hazard Analysis* (DoP, 2011b) and *Multi-Level Risk Assessment* (DP&I, 2011). The principal steps undertaken in this analysis were as follows.

- Identification of hazards and description of any potential incident scenarios.
- Analysis of the consequences of any potential incidents on the biophysical environment and human populations off site with the implementation of standard controls and safeguards.
- 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* (DoP, 2011c).

Due to the limited quantities of dangerous goods and large separation distances to the Mine Site boundary, a qualitative analysis was undertaken for the Project. This approach is classified as a Level 1 risk assessment under the *Multi-Level Risk Assessment* guidelines.

Potential Hazards

The SEPP 33 screening identified the following principal hazards associated with the Project.

- The transport, storage and use of solid sodium cyanide and the storage and use of cyanide solution and potential impacts to the surrounding biophysical environment in the event of unplanned discharges and/or spill events.
- The storage and use of ammonium nitrate-based blasting agents, such as ammonium nitrate fuel oil (ANFO) and/or ammonium nitrate emulsion (ANE), on site and the possibility of accelerated decomposition due to exposure to excessive heat leading to explosion or detonation.

<u>Sodium Cyanide</u>

Cyanide is an ion of carbon and nitrogen with the formula CN^-. When manufactured, it is commonly complexed with sodium to form sodium cyanide (NaCN). Sodium cyanide is a common commodity chemical used for a range of industrial and processing purposes worldwide. 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). There are also several companies that import sodium cyanide for use in Australia.

Sodium cyanide is a white solid with a faint 'bitter almond' odour. As a solid under normal ambient and storage and handling conditions, sodium cyanide is stable. However, sodium cyanide decomposes on contact with acids, acid salts, water, moisture, heat and carbon dioxide to produce toxic hydrogen cyanide and ammonia gases. These gases are strong irritants to eyes and the respiratory system. Short term exposure to cyanide is highly toxic to humans. Cyanide is also toxic to aquatic life, birds, plants and animals. Sodium cyanide is soluble in water where it can form cyanide or dissolved hydrogen cyanide. Spillages can potentially contaminate wetlands, rivers and groundwater. Cyanide, however, breaks down rapidly by a variety of mechanisms and is not persistent in the environment (NICNAS, 2010).

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 would be delivered to the Mine Site by truck in purpose-built sparge isotainers which would be unloaded and stored in the processing area adjacent to the reagent store. The isotainer would then be connected to the on-site sparging tank which would circulate water through the sparge isotainer to dissolve the solid sodium cyanide briquettes in batches. The cyanide solution would then be fed 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. Cyanide concentrations in the discharge water from the processing plant, (i.e. tailings discharge) would average approximately 2.5 mg/L (Free)[1], 6.5 mg/L (WAD)[2] and 6.7 mg/L (Total)[3] cyanide. It is noted that at concentrations of <10 ppm WAD cyanide, no acute mortalities and minimal sublethal effects are experienced by wildlife (NICNAS, 2010).

The environmental fate of cyanide is complex and depends upon a range of factors including concentration, pH, temperature and exposure to sunlight (NICNAS, 2010). However, free cyanide readily degrades and transforms via a number of processes. It is anticipated that 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.

Blasting Agents

The two blasting agents to be used within the Mine Site are ANFO or ANE. 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.

Blasting agents would be brought to the Mine Site as required from either a regional depot or from a local depot in quantities of 5 to 16 tonnes per day[4]. Blasting agents would be used within the main open cut pit and the satellite open cut pits. Overnight storage on site could occur on rare emergency situations. In this case, the supplier would invariably adopt their standard safety procedures although an on-site magazine would be available, if required.

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[1] Free cyanide is cyanide that is present in water as hydrogen cyanide or cyanide ion and is very reactive.

[2] Weak Acid Dissociable (WAD) Cyanide refers to cyanide species that are liberated at a moderate pH of between 4.5 to 6. WAD cyanide is moderately reactive.

[3] Total cyanide includes all free and WAD cyanide complexes, as well as strong metal and noble metal cyanide complexes. These strong cyanide complexes are largely non-reactive.

Comment: The preferred cyanide terminology used in this document is WAD cyanide given the EPA relies upon this term in all Environment Protection Licences issued in NSW.

[4] Orica Australia Pty Ltd maintains an explosive distribution centre near Ulan, principally for the despatch of ANE.

Controls and Safeguards

Sodium Cyanide and Cyanide Solution

Bowdens Silver would implement the following controls and safeguards to minimise the risks associated with the on-site storage and use of sodium cyanide.

- Solid sodium cyanide would be transported and stored on site in purpose-built isotainers designed and tested in accordance with the American Society of Mechanical Engineers (ASME) and International Cyanide Management Institute (ICMI) guidelines and the requirements of the *International Cyanide Management Code*.
- Bunding around the on-site mini sparge system would be constructed to AS NZS 4452:1997 *The storage and handling of toxic substances*.
- Bunding and containment would be constructed around the processing area to contain any spillages during processing.
- Routine inspections would be undertaken to ensure any spillages and/or leaks are detected and equipment is operating properly.
- Operators in contact with cyanide would be licenced and trained in emergency response and/or HAZMAT.
- Bush fire protection zones would be maintained in the area adjacent to the processing plant area to minimise the risk of fire impinging on stored sodium cyanide and cyanide solution.
- Flammable materials would be stored with separation distances to comply with AS1940:2017 *The storage and handling of flammable and combustible liquids* and AS4452:1997 *The storage and handling of toxic substances* to minimise the risk of interactions between fire and stored sodium cyanide and cyanide solution.
- The discharge of cyanide within the tailings would be maintained at a concentration of <10ppm WAD cyanide.
- Decant water within the TSF would be contained to avoid any cyanide, albeit at low concentrations from being discharged into the surrounding environment (see Section 4.7.4.4).

Blasting Agents

Bowdens Silver would implement the following controls and safeguards to minimise the risks associated with the on-site use and storage (if required) of ANFO and/or ANE.

- Quality assurance procedures would be implemented to ensure that all products meet required specifications.
- Visual inspections of the blasting agent would be undertaken to detect venting of fumes and potential fire sources.

- Blasting agents would be used within areas with separation distances to the Mine Site boundary complying with AS 2187.1 Explosives – Storage, transport and use - Storage.
- Blasting agents would be packaged in accordance with the *Australian Dangerous Goods Code*.
- The quantity of combustible material / fuel in the area surrounding the explosives magazine would be minimised.
- Separation distances between the explosives magazine and surrounding land uses would be maintained.
- Emergency response and evacuation procedures would be in place.

Consequence Analysis

Table 7 of Sherpa (2020) provides a qualitative consequence analysis for potential hazard incident scenarios involving solid sodium cyanide, cyanide solution and ANFO/ANE. In all scenarios, the analysis determined that incidents involving sodium cyanide, cyanide solution and ANFO/ANE would not pose any potentially significant off-site environmental or safety consequences.

Assessment of Impacts

<u>Sodium Cyanide and Cyanide Solution</u>

Given the adoption of the nominated safeguards and controls, in particular the commitment to store and use sodium cyanide and cyanide solution within bunded areas only, and the fact that very few materials that are incompatible with cyanide would be used or stored on site, Sherpa (2020) found that a spill of sodium cyanide or cyanide solution would be very unlikely to have any potentially significant off-site impacts.

The discharge of tailings with WAD cyanide concentrations of <10mg/L would ensure that any wildlife that has contact with the water within the TSF would not be adversely affected. Bowdens Silver's plans to prevent any runoff from the TSF entering the downstream environment would also avoid any adverse environmental impacts within and beyond the Mine Site.

<u>Blasting Agents</u>

Blasting agents (AN based) would be brought on site as required on the day of each blast, mixed and transferred to pre-drilled holes. All drill holes within the open cut pits would be located with large separation distances to the Mine Site boundary in compliance with AS 2187.1:1998 *Explosives – Storage, transport and use Storage*. Consequence modelling has confirmed that separation distances within the Mine Site are adequate.

<u>Summary</u>

Qualitative analysis of the risk of potential off-site safety effects to surrounding land uses or environmental effects to surrounding ecosystems indicate the risk would be very low and all qualitative environmental risk criteria identified in *Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning* would be met by the Project.

4.16.1.4 Hazardous Materials Transport Route Evaluation

Methodology

A transport route evaluation for the transportation of solid sodium cyanide was undertaken by Sherpa (2020) in accordance with *Hazardous Industry Planning Advisory Paper No. 11 – Route Selection* (DoP, 2011d). The assessment included the following principal components.

- Identification of the proposed route for sodium cyanide transportation.
- Summary of the potential incident scenarios.
- Identification of potentially sensitive areas in the event of an incident.
- Review of the section of the proposed route located off main highways to identify any risk factors that could potentially preclude the use of the proposed route or require the implementation of additional risk reduction measures.

Proposed Sodium Cyanide Transport Route

Solid sodium cyanide would most likely be sourced from the Orica sodium cyanide manufacturing facility in Yarwun near Gladstone in Queensland and would be transported to the Mine Site via road in purpose-built sparge isotainers. The proposed route from Yarwun to Mudgee is shown in **Figure 4.16.1.** Access to the Mine Site from Ulan Road would be from Lue Road via the relocated Maloneys Road (**Figure 4.16.2**).

Potential Hazards

The event of most concern during the transport of sodium cyanide has been identified by Sherpa (2020) as a loss of containment from the isotainers that would result in the mixing of solid sodium cyanide with water to form aqueous cyanide. This hazard would be most likely to occur during an impact or loss of load event such as a vehicle accident.

Sensitive Areas

The proposed route has been selected, wherever practicable, to avoid populated areas, congested crossings, tunnels, narrow streets, alleys, or sites where there is a high concentration of people. It is noted that Lue would be avoided and the route only passes through a small section of Mudgee using the approved heavy vehicle route.

Several creek crossings are traversed by the proposed transport route between Mudgee and the Mine Site.

Road Quality

Road quality was found to be suitable for heavy vehicles and no specific risk factors leading to higher than average accident rates were identified.

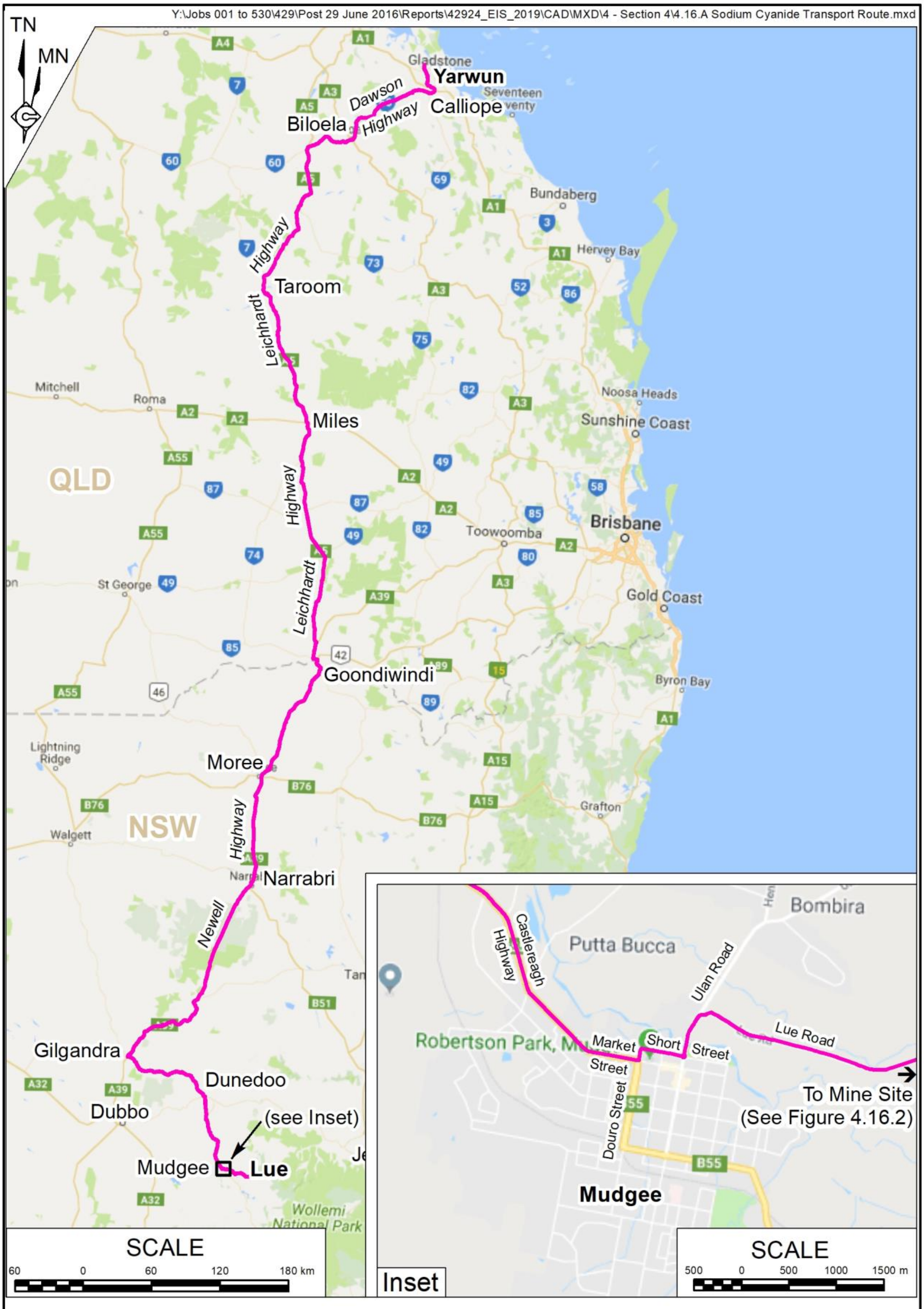

Figure 4.16.1
SODIUM CYANIDE TRANSPORT ROUTE

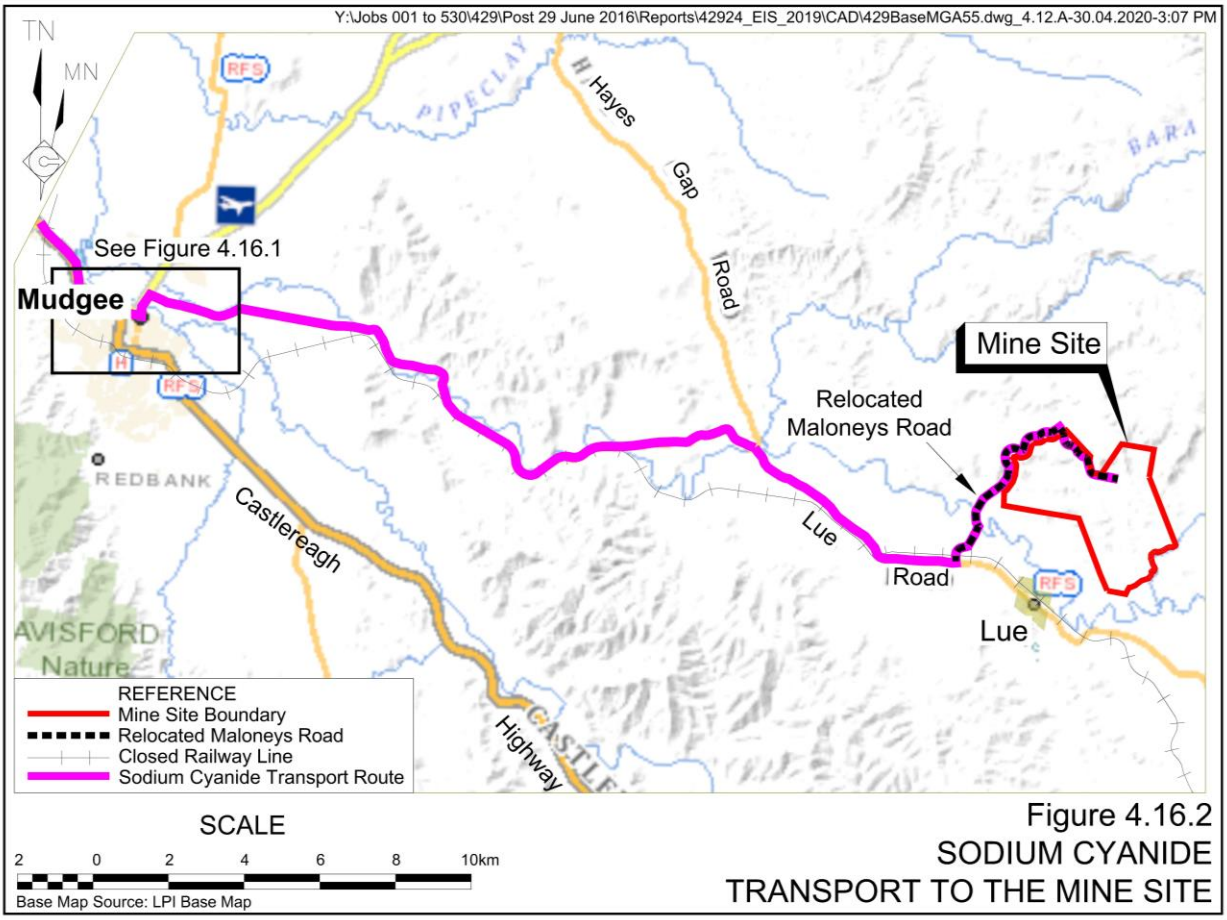

Figure 4.16.2
SODIUM CYANIDE
TRANSPORT TO THE MINE SITE

Controls and Safeguards

The following controls and safeguards would be implemented to ensure the safe transport of solid sodium cyanide to the Mine Site.

- Bowdens Silver would source solid sodium cyanide from a manufacturer who is a signatory to the *International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide* (Cyanide Code).
- Bowdens Silver would ensure sodium cyanide transporters are certified as compliant with the Cyanide Code's Principles and Transport Practices.
- Bowdens Silver would ensure that sodium cyanide transporters are compliant with the Australian Dangerous Goods Code with drivers and vehicles licensed to transport dangerous goods. A detailed route specific risk assessment would also be undertaken by the transporter prior to despatch.
- Purpose-built isotainers designed and tested in accordance with the requirements of the *International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide* would be utilised during the transportation of solid sodium cyanide (see **Plate 4.16**).
- All drivers would be required to undergo emergency response training for incidences such as vehicle accidents or vehicle fires.

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Plate 4.16
PURPOSE-BUILT SPARGE ISOTAINER

Assessment of Impacts

Given the implementation of the above controls and safeguards, the transport route of sodium cyanide from Mudgee to the Mine Site has been assessed to be a low risk to the biophysical and human environment.

4.16.2 Handling, Storage and Disposal of Hydrocarbons

This subsection reviews the proposed controls and safeguards and assessment of impacts of hydrocarbons utilised within the Mine Site.

4.16.2.1 Controls and Safeguards

In order to minimise the potential for hydrocarbon contamination and impacts upon public safety, the following controls and safeguards would be implemented.

- Hydrocarbons and similar materials would only be received by licensed suppliers for the transport of dangerous goods in accordance with *Dangerous Goods (Road and Rail Transport) Act 2008 No 95.*
- Diesel fuel would be stored adjacent to the workshop within the mining facility in self-bunded above-ground tanks with a total capacity of approximately 220 000L in accordance with *AS 1940 – 2004 and Amendment – 2004 The Storage and Handling of Flammable and Combustible Liquids*, or updated or replacement standard.

- Fuelling of mobile equipment would be conducted either within a bunded refuelling pad or within the pit(s) using a mobile service truck.
- Hydrocarbon waste would be stored in a 5 000L self-bunded waste oil tank within the mining facility from where it would be removed by a licenced waste contractor to a licenced waste facility.
- Hydrocarbon spill kits would be appropriately located to ensure spill response and clean up can be carried out immediately following the detection of any spills.
- In the event of a hydrocarbon leak or spill, Bowdens Silver would implement the following spill management procedure.
  - Phase 1 – Source Control: isolate the source of the spill or leak and stop the leak either by maintenance or placing the leaking item within or over the fuel/oil storage area.
  - Phase 2 – Recovery: recover as much as possible at the source by pumping free hydrocarbon from the surface and excavating hydrocarbon-contaminated materials. Contaminated materials would be stockpiled on site under cover and on an impermeable surface, e.g. a high-density polyethylene sheet. This material would later be bio-remediated on site and/or transported to an approved waste facility.
  - Phase 3 – Remediation: transport the contaminated material to a facility licensed to accept and treat hydrocarbon contaminated material.
- Spillages or leaks of other materials would be handled in accordance to the relevant Materials Safety Data Sheet.

4.16.2.2 Assessment of Impacts

It is anticipated that with the proposed controls and safeguards that potential hazards arising from the storage and use of hydrocarbons to be used on the Mine Site would be minimised.

4.16.3 Bush Fire Hazards

4.16.3.1 Introduction

The SEARs nominate that the EIS must consider bushfire risks. Based upon the risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**), the potential impacts relating to bush fire and their risk rankings after the adoption of standard mitigation measures are as follows.

- Fire initiated off site threatening mine operations, impacting on-site stock and infrastructure (Medium).
- Fire initiated on site threatening mine operations or spreading off site (Low).

Section 4.14 of the EP&A Act details the requirement for developments to conform to the specifications and requirements of the document entitled "*Planning for Bush Fire Protection*" (RFS, 2006), however, Subsection (1B) states that Section 4.14 does not apply to State significant development. While the requirement for a bush fire assessment in accordance with RFS (2006) is not required, the procedure detailed in that document has been adopted to identify the potential bush fire hazard for the Project. The addendum to Appendix 3 of RFS (2006), published by the Rural Fire Service (RFS) in 2010 has also been considered for assessment of the bush fire attack level (RFS, 2010). Proposed management of the identified hazards is also described.

For the management of bush fire hazards, Mid-Western Regional Council refers to the Bush Fire Risk Management Plan (BFRMP) (2012) authored by the Cudgegong Bush Fire Management Committee. The 2012 BFRMP identifies bush fire risks and sets out treatments to reduce risks. No treatments specific to the Mine Site are identified in this document. The nearby Lue is identified in this document as a “medium” risk with “minor” consequences and an overall priority of “4”, which is the second lowest risk rating.

The bush fire assessment was prepared by R.W. Corkery & Co. Pty Limited based, in part, on information on local vegetation provided in EnviroKey (2020). Vegetation communities identified within the Mine Site are described further in Section 4.10.

4.16.3.2 Bush Fire Management Objectives

The objectives of RFS (2006) considered in this assessment are to:

- afford occupants of any building adequate protection from exposure to a bush fire;
- provide for a defendable space to be located around buildings;
- provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;
- ensure that safe operational access and egress for emergency service personnel and residents is available;
- provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the Asset Protection Zone (APZ); and
- ensure that utility services are adequate to meet the needs of fire fighters (and other assisting in bush firefighting).

4.16.3.3 Assessment of Bush Fire Hazard

Introduction

The following subsections use the RFS (2006) and RFS (2010) procedure to determine the Category of Bush Fire Attack (or bush fire hazard) for the following Project components.

- Administration Office, Processing Plant and Mining Facility
- Exploration Office
- Explosives Magazine

These components have been identified as the primary Mine Site components at risk of bush fire attack. **Figure 4.16.3** displays the location of the bush fire hazard assessment areas within the Mine Site.

Fire Weather

The Mid-Western Regional LGA occurs within the Central Ranges Fire Area and is designated a Fire Danger Index of 80 (RFS, 2006).

Vegetation Formation

Vegetation within the Mine Site has been classified in accordance with RFS (2006) and RFS (2010) using the vegetation descriptions provided in EnviroKey (2020), as follows.

- Forest – maximum fuel load of 25t/ha
- Woodland – maximum fuel load of 15t/ha
- Grassland – maximum fuel load of 6t/ha

Figure 4.16.4 displays the classification of the vegetation within 140m of the key Project components based upon the classifications provided in RFS (2010) and the field surveys undertaken by EnviroKey (2020). It is noted that vegetation types within areas to be disturbed have been determined based on the proposed vegetation to be established during progressive rehabilitation activities.

Effective Slope

Figure 4.16.4 displays the sections used to calculate the effective slopes within 100m of the Administration Office, Processing Plant, Mining Facility, Explosives Magazine and Exploration Office. **Table 4.80** presents the effective slopes for representative sections within approximately 100m of the identified Mine Site components.

4.16.3.4 Hazard Assessment

It is possible to calculate the bush fire hazard (referred to as the Bush Fire Attack Category in RFS, 2006 and RFS, 2010) from a combination of the Fire Danger Index, effective slope, vegetation formation and the proximity of activities to the bush fire hazard. **Table 4.80** summarises the bush fire attack characteristics calculated for the key Project components and the recommended minimum APZs which were calculated in accordance with Table A2.5 of Appendix 2 of RFS (2006).

Activities located with a separation distance greater than 100m have a Category of Bush Fire Attack classification of “low”.

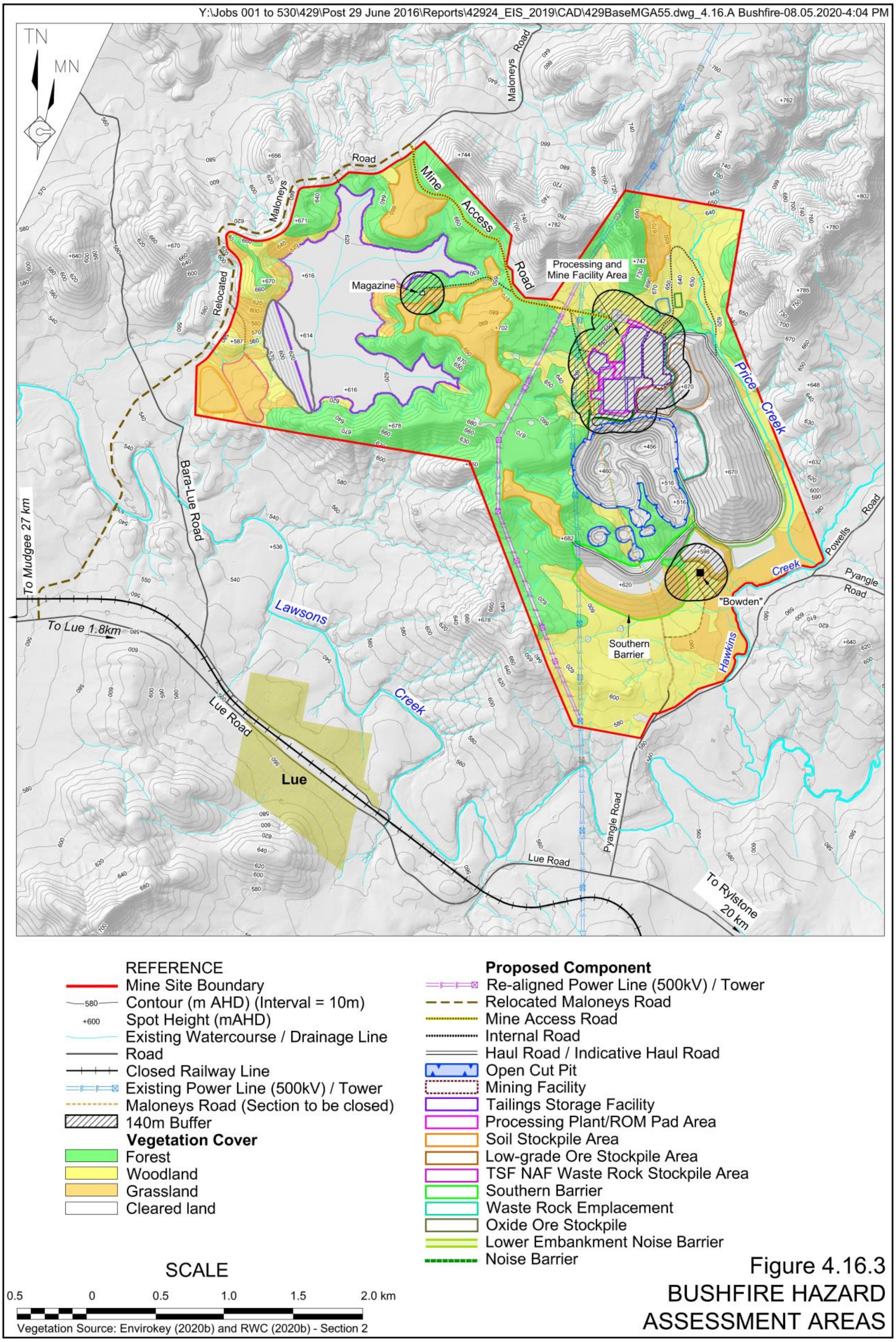

Figure 4.16.3
BUSHFIRE HAZARD ASSESSMENT AREAS

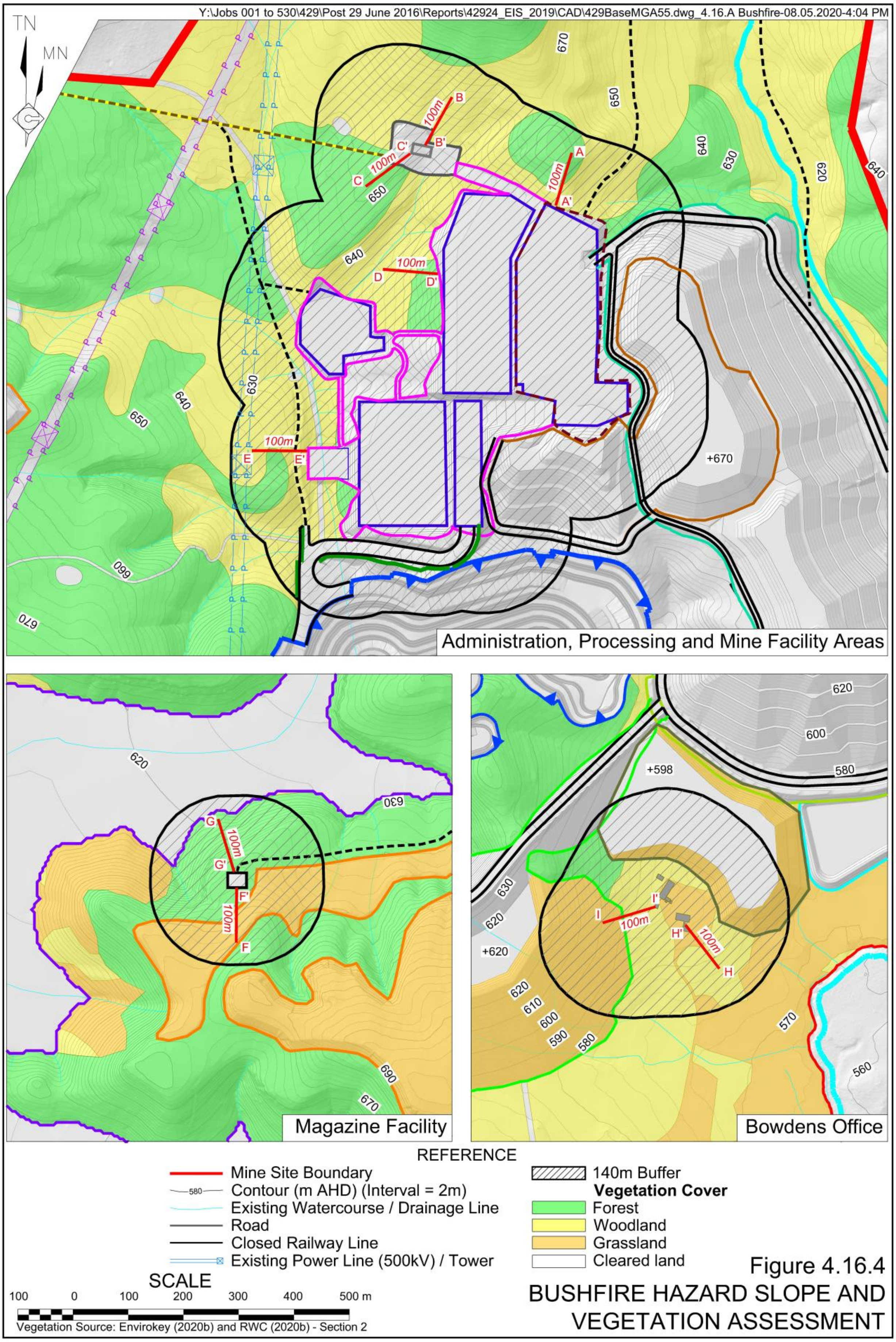

Figure 4.16.4
BUSHFIRE HAZARD SLOPE AND VEGETATION ASSESSMENT

Table 4.80
Bush Fire Attack Levels for Key Project Components

Section	Fire Danger Index	Effective Slope	Vegetation Formation	Separation Distance (m)	Bush Fire Attack Level	Minimum Asset Protection Zone (m)
Administration Office, Processing Plant, Mining Facility						
A-A[1]	80	0*	Woodland	0	BAL-FZ	10
			Forest	38	BAL-19	
B-B[1]		0*	Cleared	0	-	10
			Woodland	28	BAL-19	
C-C[1]		0.6	Cleared	0	-	20
			Forest	32	BAL-29	
D-D[1]		14.8	Forest	0	BAL-FZ	40
			Woodland	39	BAL-19	
E-E[1]		0*	Woodland	0	BAL-FZ	10
			Forest	49	BAL-12.5	
			Woodland	72	BAL-12.5	
Explosives Magazine						
F-F[1]	80	0*	Forest	0	BAL-FZ	20
			Grassland	40	BAL-12.5	
G-G[1]		25.8	Forest	0	BAL-FZ	-^
Exploration Office						
H-H[1]	80	5.2	Grassland	0	BAL-FZ	10
			Woodland	48	BAL-12.5	
I-I[1]		0*	Woodland	0	BAL-FZ	10
			Grassland	62	-	
*All upslopes and flat land considered to be 0 degrees as per RFS (2006) ^ A detailed performance assessment would be required to determine whether an APZ can be maintained in this area as slopes exceed 18 degrees.						
Based on RFS (2006) and RFS (2010)						

The following descriptions of the predicted bush fire attack and levels of exposure are provided for the Category of Bush Fire Attack (or bush fire hazard) in AS3959.2009.

- BAL-Low: There is insufficient risk to warrant specific construction requirements.
- BAL-12.5: Ember attack.
- BAL-19: Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux.
- BAL-29: Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux.
- BAL-40: Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux with the increased likelihood of exposure to flames.
- BAL-FZ: Direct exposure to flames from fire front in addition to heat flux and ember attack.

Based on the above information, it is likely that the Project would be able to provide suitable APZs within the Mine Site and comply with all requirements stipulated in RFS (2006) and RFS (2010). It is noted that a more comprehensive bush fire hazard assessment would be undertaken by the Bowdens Silver in consultation with NSW RFS after development consent is granted. This assessment would consider the management of an APZ surrounding the explosives magazine and ensure the Project is compliant with all requirements of the RFS and any other relevant standards and guidelines.

4.16.3.5 Management and Mitigation Measures

It is recognised that the Mine Site includes heavily wooded areas, and therefore the potential for bush fire to spread both within the Mine Site and adjacent to the Mine Site would be high if management measures are not adopted to mitigate this hazard.

In terms of potential impacts, the assets considered at risk include employees, surrounding landowners and the broader local community. In order to protect these assets, a proposed bush fire management plan would be incorporated in a *Landscape and Rehabilitation Management Plan* that would be prepared in consultation with the local Rural Fire Service. The bush fire management section of the *Landscape and Rehabilitation Management Plan* would include the following.

- A review of bush fire hazards and identification.
- A summary of controls and management measures including fire response equipment and locations.
- Emergency contact details.
- Training requirements and timetable.

Various activities that may increase the risk of fire on the Mine Site and the controls proposed to limit the risk posed by these are presented in **Table 4.81**.

Table 4.81
Bushfire Hazard – Activities and Controls

Activity	Possible Ignition Source	Safeguards and/or Controls
Refuelling	Spilt fuel or dry grass ignited by spark.	• Refuelling undertaken within dedicated areas of the Mine Site. • Engines in all vehicles to be turned off during refuelling. • No smoking policy to be enforced in designated areas of the Mine Site.
General Activities	Cigarettes, Rubbish, e.g. glass, metal.	• No smoking policy to be enforced in designated areas of the Mine Site. • No throwing cigarette butts from trucks travelling to and from the Mine Site. • Focus on ‘housekeeping’ to be maintained by all site personnel. • Water trucks available. • All site vehicles and mobile equipment to carry a fire extinguisher, all of which would be serviced regularly.

More general bush fire management measures to assist in the event of a local bush fire event are as follows.

- APZs would be maintained, as required.
- All employees would be trained in the proper use of firefighting equipment held on the Mine Site.
- Water would be especially set aside for firefighting on site and the on-site water trucks made available for firefighting purposes both within and surrounding the Mine Site.
- A protocol would be developed for restricting work in heavily vegetated areas during high fire danger periods of the bush fire season (in accordance with the hazard category notifications).
- Procedures for hot works would be developed to prevent ignition sources for a bush fire.
- The local Rural Fire Service would be consulted prior to each bush fire season.
- Mine Site firefighting equipment would be made available to the local Rural Fire Service, if required, in the event of a bush fire on the land surrounding the Site.
- The local Rural Fire Service would be consulted regarding any controlled burns planned for asset protection and/or ecological management.

Emergency and Evacuation Management Procedures would be developed that would include procedures in the event of a local bush fire.

4.16.3.6 Assessment of Impacts

This assessment of bush fire hazard has concluded that the Project is likely to satisfy the objectives of RFS (2006) and RFS (2010), and would minimise the risk of a Bush Fire Hazard ignited from within the Mine Site while effectively limiting the spread and damage from any bush fire ignited outside the Mine Site.

4.17 LOCAL INFRASTRUCTURE AND SERVICES

4.17.1 Introduction

The following subsections address the interaction between the Project and the existing and proposed infrastructure and services within the Application Area. Electricity networks (TransGrid and Essential Energy), telecommunications assets (Telstra) and the local road network are considered.

4.17.2 Mine Site and Surrounds

4.17.2.1 Existing Infrastructure and Services

Figure 4.17.1 displays the services known to occur within and surrounding the Mine Site. The key services and public infrastructure are as follows.

1. A 500kV power transmission line oriented generally north-south in the centre of the Mine Site.
2. A network of 415V power transmission lines in the southern section of the Mine Site, providing power to local residences and farm buildings.
3. Various buried telecommunications cables located largely within the local road reserves within and surrounding the Mine Site.
4. Several underground earths and wires, poles and switches to the southwest of the Mine Site, all located a sufficient distance from any mining operations and would not be impacted by the Mine.

Lue Road (Sub Arterial Road), to the south of the Mine Site, is the main thoroughfare between Mudgee to the west and Rylstone to the southeast. Battens Road (Local Road) is a gravel track connecting Lue with properties to the east of the Mine Site.

4.17.2.2 Electricity Networks

TransGrid Network

TransGrid is the owner, operator and manager of the NSW high voltage electricity network connecting generators, distributors and major end users in NSW and the ACT. The Mine Site is traversed by the existing No. 5A3 Bayswater to Mt Piper and 5A5 Wollar – Mt Piper 500kV power transmission line. **Figure 4.17.1** displays the existing alignment of the power transmission line.

As discussed in Section 2.11.3.2, the Applicant proposes to realign the 500kV power transmission line to the west of the main open cut pit. The proposed re-aligned power transmission line would be approximately 3km in length comprising 10 to 14 new steel towers, each approximately 45m to 60m high, i.e. comparable to the existing towers. The re-aligned section of line would be located wholly within the Mine Site on land owned by Bowdens Silver. Section 2.11.3.2 provides further details regarding the proposed realignment of the 500kV power transmission line. **Figure 4.17.1** displays the proposed alignment of the 500kV power transmission line.

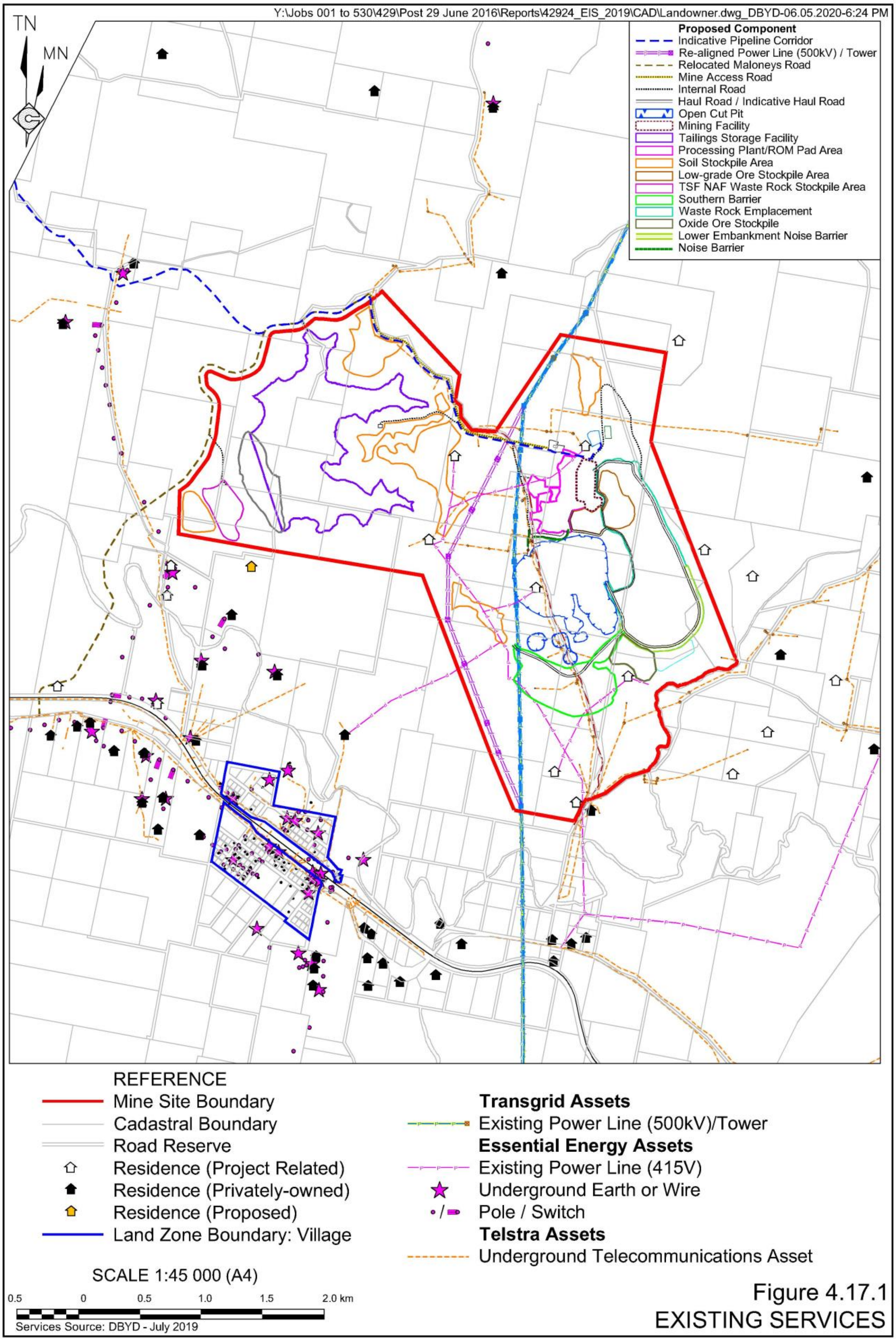

Figure 4.17.1
EXISTING SERVICES

Essential Energy Network

Essential Energy, the owner and electricity distributor of the low-voltage electricity network within the Mudgee region, currently maintains a series of low voltage power transmission lines which provides power to a number of properties within and surrounding the Mine Site. The existing Essential Energy network within and immediately surrounding the Mine Site is displayed on **Figure 4.17.1**.

A number of Essential Energy assets would be demolished to permit the activities within the Mine Site. It is noted that existing power supplies to impacted properties would be disconnected and the poles / power transmission lines removed, and recycled, where practicable. Alternative power supplies would be established to impacted privately-owned residences surrounding the Mine Site in consultation with Essential Energy prior to the demolition of the existing power network.

4.17.2.3 Telecommunications Assets

Figures 4.17.1 presents the existing underground telecommunications assets within and immediately surrounding the Mine Site. The existing telecommunications network within the Mine Site would be largely removed during the development of the Project, potentially impacting surrounding residences. Alternative telecommunications services would therefore be established at impacted privately-owned residences surrounding the Mine Site in consultation with Telstra.

4.17.2.4 Local Roads

A 4.5km section of the existing Maloneys Road traverses the Mine Site. Consequently, Bowdens Silver proposes to permanently relocate the southern section of Maloneys Road to a new location west of its current alignment (see **Figure 2.17**), forming a new section of public road. The relocated section of Maloneys Road would link the retained northern section of Maloneys Road with Lue Road and include a newly constructed “T-intersection” 1.8km west of Lue , a new railway bridge crossing and a new crossing of Lawsons Creek. The section of road which is to be closed and relocated would require closure pursuant to the relevant provisions of the *Roads Act 1993*.

Once the relocated Maloneys Road is opened to traffic and the section of road through the Mine Site is formally closed by Mid-Western Regional Council, Bowdens Silver would place a gate at the southern end of the section of the former Maloneys Road that has been closed and removed from public use. A short 250m section of the former Maloneys Road would be maintained to provide access to Lot 121 DP 755435 and Lot 7008 DP 1029652. Bowdens Silver would continue to use the southern section of road (principally with light vehicles) to access the existing Bowdens exploration office and core library facilities. Sections 2.9.2 and 2.11.1 provide further details regarding the proposed off-site and on-site road networks.

4.17.3 Water Supply Pipeline Corridor

4.17.3.1 Existing Infrastructure and Services

Figure 4.17.2 displays the services known to occur within and surrounding the water supply pipeline corridor. The key services and public infrastructure are as follows.

1. A network of low voltage power transmission lines providing power to local residences and farm buildings.
2. Various buried telecommunications cables located largely within the local road reserves.

The principal sealed roads within and immediately surrounding the water supply pipeline corridor include Hayes Gap Road (Sub Arterial Road), Wollar Road (Arterial Road) and Ulan Road (Arterial Road).

4.17.3.2 Electricity Network (Essential Energy)

Figure 4.17.2 displays the power transmission lines intersected by the water supply pipeline corridor. It is anticipated that the construction of the water supply pipeline would not require the demolition or realignment of any power transmission lines.

4.17.3.3 Telecommunications Assets

The water supply pipeline would intersect a number of Telstra assets (**Figure 4.17.2**), however, these assets would be avoided wherever possible to minimise any potential disruption to telecommunications services in surrounding residences.

4.17.3.4 Local and Regional Roads

The water supply pipeline would intersect approximately six section of sealed roads and approximately 18.5km of unsealed rural roads (**Figure 2.22**). All roads traversed by the pipeline would involve underboring beneath or trenching across the roads. The approach to crossing beneath or through roads would be determined in consultation with the Mid-Western Regional Council.

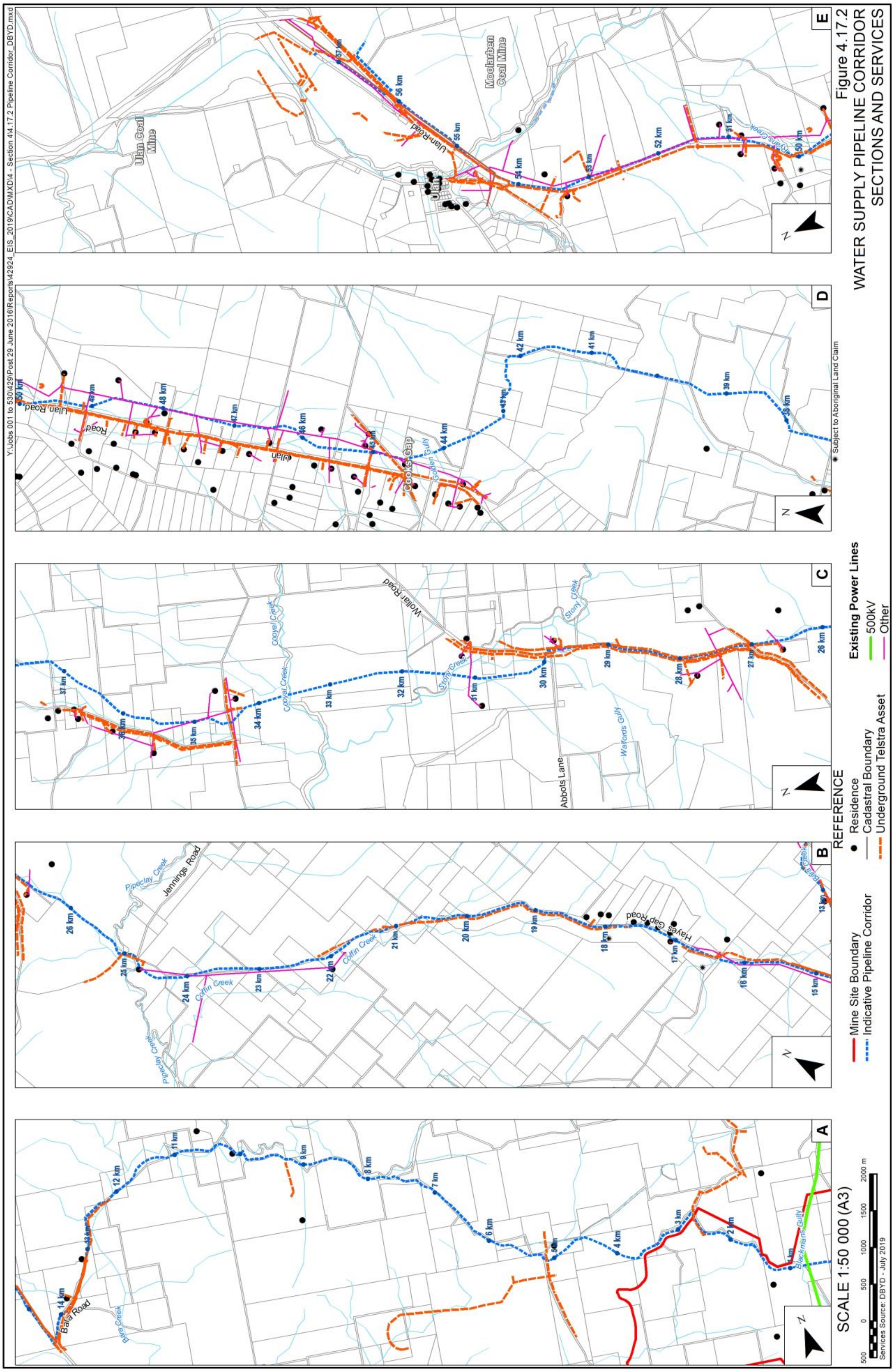

Figure 4.17.2
WATER SUPPLY PIPELINE CORRIDOR
SECTIONS AND SERVICES

4.18 AGRICULTURAL LANDS AND ENTERPRISES

The agricultural impact assessment of the Project was undertaken by R.W. Corkery & Co. Pty Limited. The full assessment is presented in Volume 5 Part 14 of the Specialist Consultant Studies Compendium and is referenced throughout this section as RWC (2020b).

An assessment of the interaction of the Project and the agricultural lands and enterprises at regional, local Mine Site and water supply pipeline corridor scales was undertaken. The full assessment is presented in Volume 5 Part 14 of the Specialist Consultant Studies Compendium.

4.18.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in impacts upon agricultural land and enterprises. These risk sources and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Reduced groundwater levels and availability for existing authorised users due to interception of the groundwater table by open cut mining (High).
- Reduction in flows downstream of Mine Site due to the construction of Mine components within natural catchments (Medium).
- Reduction of land and soil capability within the Mine Site (Medium).
- Increased dust load on crops and pastures on surrounding land used for agriculture (Low).
- Potential stress on livestock on surrounding lands due to exposure to loud noise levels and/or vibration from blasting (Low).
- Release of contaminated water downstream adversely impacting downstream water users (Low).
- Impacts on surrounding agricultural enterprises and agri-tourism businesses due to changes to existing land uses (Low).
- The fragmentation or alienation of land used for agriculture (Low).
- Reduction in regional agricultural productivity due to the removal of agricultural land during the Project life (Low).
- Inadequate soil available for rehabilitation purposes within the Mine Site (Low).
- Degradation of soil in stockpiles leading to less successful rehabilitation and increased rehabilitation costs and maintenance across the Mine Site (Low).
- Erosion of soil stockpiles due to inappropriate soil management (Low).

In addition, the SEARs issued by the former DPE identified “agricultural land and enterprises” as a key issue requiring assessment. The principal assessment requirements identified by the DPE relating to agricultural land and enterprises included the following.

- An assessment of the likely agricultural impacts of the development, including identification of any strategic agricultural land.

- An assessment of the compatibility of the development with other land uses in the vicinity of the development, paying particular attention to the agricultural land use in the region.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the Division of Resources and Energy, Department of Industry – Agriculture, DPI Agriculture and the Mid-Western Regional Council. A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC.

4.18.2 Agricultural Areas of Assessment

4.18.2.1 Introduction

In order to quantify and adequately assess the potential impacts on land used for agriculture and enterprises as a result of the Project, four areas, namely the “Region”, “Lue district”, “Mine Site” and “Water Supply Pipeline Corridor” were defined.

The following subsections present an overview of the existing agricultural setting and land uses within the above areas. A more detailed discussion on each area of assessment, as well as additional information relating to agricultural resources, land uses and enterprises is discussed within RWC (2020b).

4.18.2.2 Regional Agricultural Setting and Land Uses

The geographic extent of the Region, as defined within RWC (2020b), generally conforms with the Mid-Western Regional LGA which covers an area of approximately 8 700km^2 (**Figure 4.18.1**). When referring to ABS statistics, the “Region” aligns with the combined areas of the Mudgee, Mudgee Region-West and Mudgee Region-East SA2 Statistical Areas (**Figure 4.18.1**). This footprint was chosen to most closely align available ABS agricultural statistics with the boundaries of the Mid-Western Regional LGA. The township of Mudgee is the principal commercial and urban centre within the LGA and is located approximately 26km to the west of the Mine Site.

Agricultural enterprises within the Region are predominantly livestock-related with cattle and sheep comprising the greatest market share. ABS data (ABS, 2016) indicate livestock within the Region comprise approximately 112 000 cattle and 635 000 sheep. These numbers may vary and are subject to climatic conditions such as drought. Grazing land accounts for the bulk of land used for agriculture within the Region with livestock enterprises accounting for approximately 94.6% of total farmland within the Region.

The Region has a long history of grape production, with the first vineyard planted in the 1850s during the Gold Rush. A total of approximately 645ha of land is utilised for grape production across the Region comprising a total of 27 agricultural holdings (ABS, 2016). The vineyards tend to be concentrated to the north of Mudgee, typically between altitudes of 450m AHD to 600m AHD, although some vineyards are located up to 1 180m AHD. The primary grape varieties grown in the Region are Shiraz, Cabernet Sauvignon and Merlot due to the combination of reliable warm day-time temperatures and cool nights.

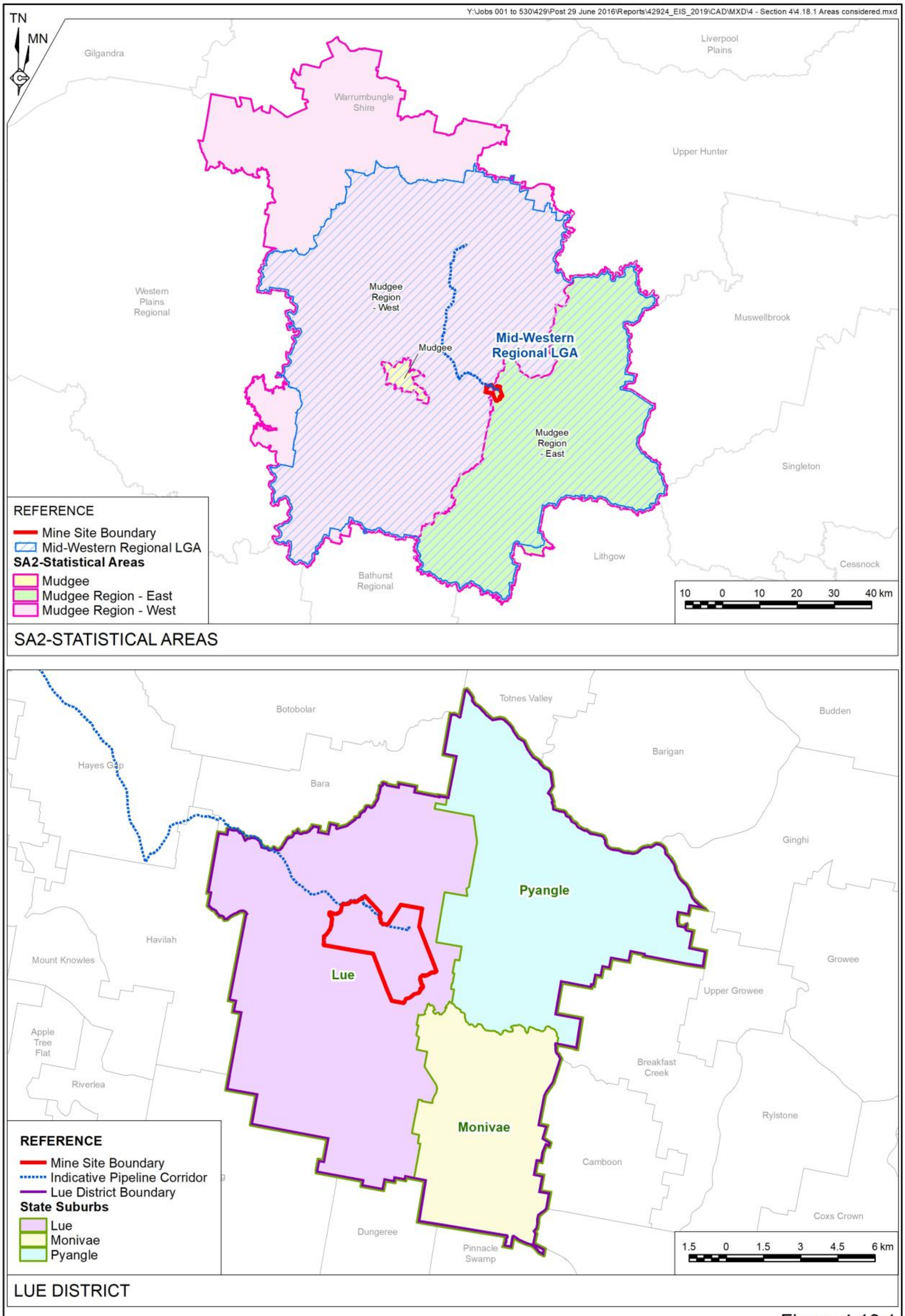

Figure 4.18.1
STATISTICAL AREAS CONSIDERED FOR AGRICULTURAL ASSESSMENT

Source: Australian Bureau of Statistics - Geographical Boundaries 2016

The Region also has an expanding olive production industry comprising a total of seven holdings. There are approximately 19 000 olive trees in the Region which accounts for approximately 3% of total olive production in NSW.

A notable component of the wider tourism sector throughout the Region is agri-tourism, principally comprising guesthouses and B&Bs catering to the Region's wine industry. Guesthouses and B&Bs are interspersed throughout the Region with the numerous wineries and scenic nature of the area being the principal attractions for tourists. Tourist Drive 2 connects Capertee on the Castlereagh Highway with the towns of Kandos, Rylstone, Lue and Mudgee and is a popular drive which showcases the Capertee and Lue Valleys (Rylstone Kandos Chamber of Commerce, 2015).

4.18.2.3 Lue District Agricultural Setting and Land Uses

The Lue district encompasses the State Suburbs of Lue, Pyangle and Monivae and was chosen to draw together the key agricultural land uses in the vicinity of the Mine Site (**Figure 4.18.1**). Apart from Lue, all land immediately surrounding the Mine Site comprises a combination of grazing, lifestyle lots and heavily vegetated areas with minimal land use. Grazing is the predominant land use immediately surrounding the Mine Site.

Minor areas surrounding the Mine Site are utilised for horticultural activities, in particular, the Rylstone Olive Press and East Ridge Olives which are both notable olive growers. These two enterprises are located approximately 5.3km southeast and 2.6km east of the Mine Site, respectively. It is noted that Rylstone Olive Press has obtained organic certification under Australian Certified Organic (ACO), Japanese Organic Standard (JAS) and the United States Department of Agriculture (USDA). Viticulture enterprises are also established within the region, with Elephant Mountain Wines being the closest vineyard to the Mine Site (3.8km east). Elephant Mountain Wines also operates a bed and breakfast (B&B), known as Elephant Mountain House and a wedding venue.

Guesthouses and B&Bs are interspersed within and immediately surrounding the Lue district and include the 'WYUNA' Lue Farmstay (1.1km south), Odd Frog Lodges (1.1km south), the Old Bara Guesthouse (5.5km northwest), Rokbara Cottage (4.7km north) and Camphill Cottage (11.4km southeast). The Louee Enduro and Motocross Complex is located approximately 3.0km south of the Mine Site. This complex is located within Lue Station, a working sheep and cattle property, and provides over 150km of off-road motorbike trails, a workshop, canteen and accommodation (Shearer's Quarters, Dungeree House, Lue Cottage, Lue Station and a campground). This complex is also a destination of visitors to the local area when staying at local guesthouses and B&Bs.

Figure 4.1.13 displays the principal land uses within and immediately surrounding the Lue District.

4.18.2.4 Mine Site Agricultural Setting and Land Uses

Figure 4.1.14 displays the various land uses and their respective areas within and immediately surrounding the Mine Site. **Table 4.5** lists the area of each land use within the Mine Site together with its proportion of the Mine Site. Further detail regarding land uses within the Mine Site are detailed in Section 4.1.4.3.

The Bowdens Farm

Bowdens Silver owns and operates a farming operation (the "Bowdens Farm") on part of the land it currently owns which comprises approximately 1 655ha of land within and immediately surrounding the Mine Site (**Figure 4.1.14**).

The Bowdens Farm is currently used for grazing approximately 1 330 Merino sheep and 16 Black Angus cattle, comprising 11 yearling heifers and 5 weaner calves, on areas with (684ha) and without (188ha) pasture improvement as well as lower capability land comprising heavily vegetated and/or steeply sloping land (662ha).

Pasture improvement typically involves weed control (principally for blackberry, Bathurst Burr, Scotch Thistle, Serrated Tussock and saffron thistle) and/or the selective application of fertiliser. Control of weed species assists to encourage growth of the pasture species. At times, these areas are sown with a subterranean clover after the level of weed growth is reduced. Areas that are not pasture improved are still subject to selective weed control.

Cropping areas within Bowdens Farm (46ha) are typically sown with a winter forage crop, such as oats, together with a diammonium phosphate (DAP) fertiliser at a rate of 100kg/ha. After two seasons of cropping, these areas are planted with either a summer crop of coxfoot, phalaris and clover, or a winter crop of premier digit grass and clover. Approximately 80kg/ha of startup fertiliser is applied with both summer and winter crops.

Other land uses within the Bowdens Farm include an Aboriginal heritage exclusion zone (25ha) and water supply dams (4ha).

A range of agricultural infrastructure are located within the Bowdens Farm, as follows.

- 76 x dams (combined capacity = ~ 49.6ML)
- 3 x cattle yards
- 2 x sheep yards
- 2 x 30 tonne (wheat) silos
- 3 x cement troughs
- 2 x shearing sheds
- 1 x hayshed
- 1 x windmill
- 2 x stock watering tanks
- 7 x water bores for water supply

The existing agricultural activities and infrastructure within the Bowdens Farm are serviced by local roads.

4.18.2.5 Water Supply Pipeline Setting and Land Uses

Figure 4.1.15 displays the land uses within the 58.5km long water supply pipeline corridor in five sections with chainages commencing at 0km within the Mine Site. Each section traverses approximately 12km.

The land traversed by the water supply pipeline corridor beyond the Mine Site is predominantly used for grazing with approximately 48km of the corridor used for this purpose. Of this grazing land, approximately 25km intersects modified pasture whilst 23km intersects land covered by remnant native vegetation. Approximately 3.5km of the water supply pipeline corridor is currently used for cropping with these areas likely to be used for a combination of forage crops and pasture improvement. It is noted that the corridor does not traverse any land used for viticulture or any other form of horticulture.

4.18.3 Mine Site Environmental Setting

4.18.3.1 Introduction

This subsection summarises the relevant environmental features of the Mine Site and immediate surrounds. Focus is placed upon the key agricultural resources of soils, surface water and groundwater. RWC (2020b) provides further commentary regarding other agricultural resources.

4.18.3.2 Land and Soil Capability

A detailed Land and Soil Capability Assessment for the Project was undertaken by SMD (2020). The key outcomes of the SMD (2020) relating to the existing agricultural setting of the Mine Site are summarised as follows.

- No biophysical strategic agricultural land (BSAL) was identified within the Mine Site.
- A total of seven SLUs were identified within the Mine Site with land capability constraints including erosion, acidity and stony soils with poor water holding capacities.
- The existing land within the proposed disturbance areas is predominantly LSC Class 6 (362.8ha) with subordinate areas being Class 4 (18.9ha) or Class 5 (17.6ha) and minor areas being Class 3 (21.2ha). The generally low LSC reflects the steep topography and heavy vegetation over much of the Mine Site.

Further detail regarding the existing soils and land and soil capability within the Mine Site is provided in Section 4.13.2.3.

4.18.3.3 Surface Water

The Mine Site is located within the Macquarie-Bogan Rivers Catchment which covers an area of approximately 74 000km^2 within the Murray-Darling Basin. The major regional drainage feature in the area surrounding the Mine Site is Lawsons Creek, a tributary of the Cudgegong River. Lawsons Creek is covered by the Water Sharing Plan (WSP) for the Lawsons Creek Water Source within the Macquarie Bogan Unregulated and Alluvial Water Sources. A total of 47 water access licences (comprising 35 unregulated river licences and 12 domestic and stock licences) have been granted for the Lawsons Creek Water Source. Of the 42 licences which have associated works approvals, extraction is approved at 27 properties located downstream of the Project, and account for 1 014 unit shares granted from the water source. **Figure 4.7.4** displays the spatial distribution of the Works Approvals within the Lawsons Creek Water Source.

Further detail regarding the existing surface water environment within and immediately surrounding the Mine Site is provided in Section 4.7.2.

4.18.3.4 Groundwater

The Mine Site is located within the following Water Sharing Plans (WSPs).

- Sydney Basin Groundwater Source of the NSW Murray Darling Basin Porous Rock Groundwater Sources.
- Lachlan Fold Belt Groundwater Source of the NSW Murray Darling Fractured Rock Groundwater Sources.
- Lawsons Creek Water Source of the Macquarie Bogan Unregulated and Alluvial Water Sources.

A total of over 100 bores are located within approximately 10km of the Mine Site comprising nine bores for irrigation, 23 bores for stock and domestic use, 38 bores for general water supply, 29 bores for groundwater monitoring, one bore for commercial and industrial use and one bore for unknown purposes. Six groundwater bores have associated WALs relevant details of which are provided in **Table 4.82**.

Table 4.82
Summary of Groundwater WALs within Lue district

WAL	Associated Groundwater Work	Use	Water Source	Extraction Limit (ML)
27907	GW011493	Stock, Irrigation, Domestic	Sydney Basin Murray Darling Basin Porous Rock Groundwater Source	50
35671	GW065121	Irrigation	Sydney Basin Murray Darling Basin Porous Rock Groundwater Source	60
28443	GW802732	Irrigation	Lachlan Fold Belt Murray Darling Basin Fractured Rock Groundwater Source	19
28946	GW042966	Stock, Irrigation, Domestic	Lachlan Fold Belt Murray Darling Basin Fractured Rock Groundwater Source	35
29014	GW066291	Stock, Irrigation, Domestic	Lachlan Fold Belt Murray Darling Basin Fractured Rock Groundwater Source	6
29247	GW062111	Industrial	Lachlan Fold Belt Murray Darling Basin Fractured Rock Groundwater Source	30
Source: Jacobs (2020) – Table 7				

Further detail regarding the existing groundwater setting within and immediately surrounding the Mine Site is provided in Section 4.6.3.

4.18.4 Water Supply Pipeline Environmental Setting

4.18.4.1 Land and Soil Capability

The water supply pipeline corridor intersects a number of soil types and landscapes. The water supply pipeline would traverse SLUs with an LSC Class of between 3 and 6 (i.e. land with moderate to very severe limitations). The majority (approximately 34km) of the pipeline would be constructed within land with an LSC Class of 4 (i.e. moderate capability land) with land uses typically restricted to grazing with restricted cultivation, pasture cropping, grazing and nature conservation. Approximately 0.6km of the WSPC would intersect Lawson's Creek SLU which has an LSC Class of 3. Land within this SLU generally has high agricultural capability and is suitable for both grazing and cropping.

4.18.4.2 Surface Water Drainage

The water supply pipeline corridor traverses the catchment divide between the Macquarie-Bogan Catchment (approximately 74 000km^2) and the Hunter River Catchment (approximately 37 000km^2). Major drainage features within the Macquarie-Bogan Catchment include the Macquarie River, Cudgegong River and the Bogan River. The pipeline would intersect six perennial watercourses and numerous unnamed minor watercourses.

4.18.5 Management and Mitigation Measures

A range of environmental, social and economic management outcomes and measures would be implemented to avoid or reduce the potential environmental, social and economic impacts of the Project upon the regional and local agricultural resources and enterprises. The principal management and mitigation measures that would be implemented to minimise impacts to agricultural resources and enterprises are as follows.

Soil Resources

Soil stripping and stockpiling protocols would be developed and implemented to ensure the successful rehabilitation of disturbed areas. Specific measures would be taken to improve soil quality including the addition of lime and/or gypsum to address salinity or soil structure issues, as required. Rehabilitation would be undertaken with the aim of returning land to its former use wherever practicable and would include direct seeding of native vegetation or pasture grasses. Fertiliser would be applied as required to address soil fertility issues. It is noted that all rehabilitation activities would be guided by a Rehabilitation Management Plan.

Further details regarding the proposed measures to be implemented to manage soils resources is provided in Section 4.13.4.

Surface Water Resources

As part of the design process, a range of surface water management measures have been included in the Project including clean water diversions, sediment-laden water catchment and containment systems, and catchment and containment systems for water coming into contact with tailings or potentially acid forming (PAF) waste rock. A Water Management Plan (WMP) would be prepared to guide surface water monitoring and establish a trigger action response plan (TARP) for when certain thresholds are reached.

The water supply pipeline would be constructed below perennial watercourses and other watercourses where significant water flows are present at the time of construction using underbore techniques in order to minimise impacts to surface water flows and aquatic environments.

Further details regarding the proposed measures to be implemented to manage surface water resources is provided in Section 4.7.4.

Groundwater Resources

Bowdens Silver has secured options to purchase water access licences through the 2017 Controlled Allocation Order (Various Groundwater Sources), to the value of 885 unit shares in the Lachlan Fold Belt Groundwater Source (equivalent to 885 ML/year) and 118 unit shares in the Sydney Basin Groundwater Source (equivalent to 118 ML/year). Additional shares, required to meet the predicted maximum take are currently being sought through the third Controlled Allocation Orders. For the groundwater sources to be intersected during the mine life, an additional 97ML/year would be required.

A WMP would be prepared and implemented for the Project which would stipulate requirements for groundwater levels and water quality monitoring to enable determination of any mine-related impacts on surrounding groundwater users. A TARP would be established to determine what further management actions are required when certain triggers are reached. A Tailings Seepage Management Plan and final Void Management Plan would also be prepared to monitor and manage these aspects of the Project.

Further details regarding the proposed measures to be implemented to manage groundwater resources is provided in Section 4.6.8.

Social and Economic Management

Bowdens Silver proposes to adopt a range of management and mitigation measures for the Project to minimise or avoid social and economic impacts. Further details on the management of social and economic impacts are provided in Sections 4.20.4 and 4.19, respectively.

A critical contribution of the Project to the social and economic setting would be the creation of regional jobs. Whilst the bulk of the jobs associated with the Project would be full-time, Bowdens Silver would be supportive, where practical, to offer a range of part-time jobs that would be suited to a number of local workers e.g. off surrounding properties to earn an off-farm income.

4.18.6 Assessment of Impacts

4.18.6.1 Land to be Removed from Agricultural Production

Areas of land used for agriculture would be temporarily or permanently removed from production during and/or after mine closure. **Figure 4.18.2** displays the land uses within and immediately surrounding the Mine Site during the Project life. **Table 4.83** presents the areas of existing land uses within the Mine Site and the proposed land uses during and after the Project life.

The Project would remove a maximum of approximately 1 498ha of land currently used for agriculture (principally low value grazing) out of production throughout the Project life due to land use changes. This land would comprise approximately 901ha of land within the Mine Site, 20ha of land within the footprint of the relocated Maloneys Road and a further 577ha in the area immediately surrounding the Mine Site which would be set aside as part of the Project's biodiversity offset area.

A total of 469ha would be retained for agricultural purposes within the Bowdens Farm throughout the Project life. Of this land, approximately 24ha would be located within the Mine Site with a further 445ha of land located in the area surrounding the Mine Site. The majority of this land would comprise modified pasture suitable for improvement and/or cropping thus ensuring stocking rates are maintained or improved, wherever possible.

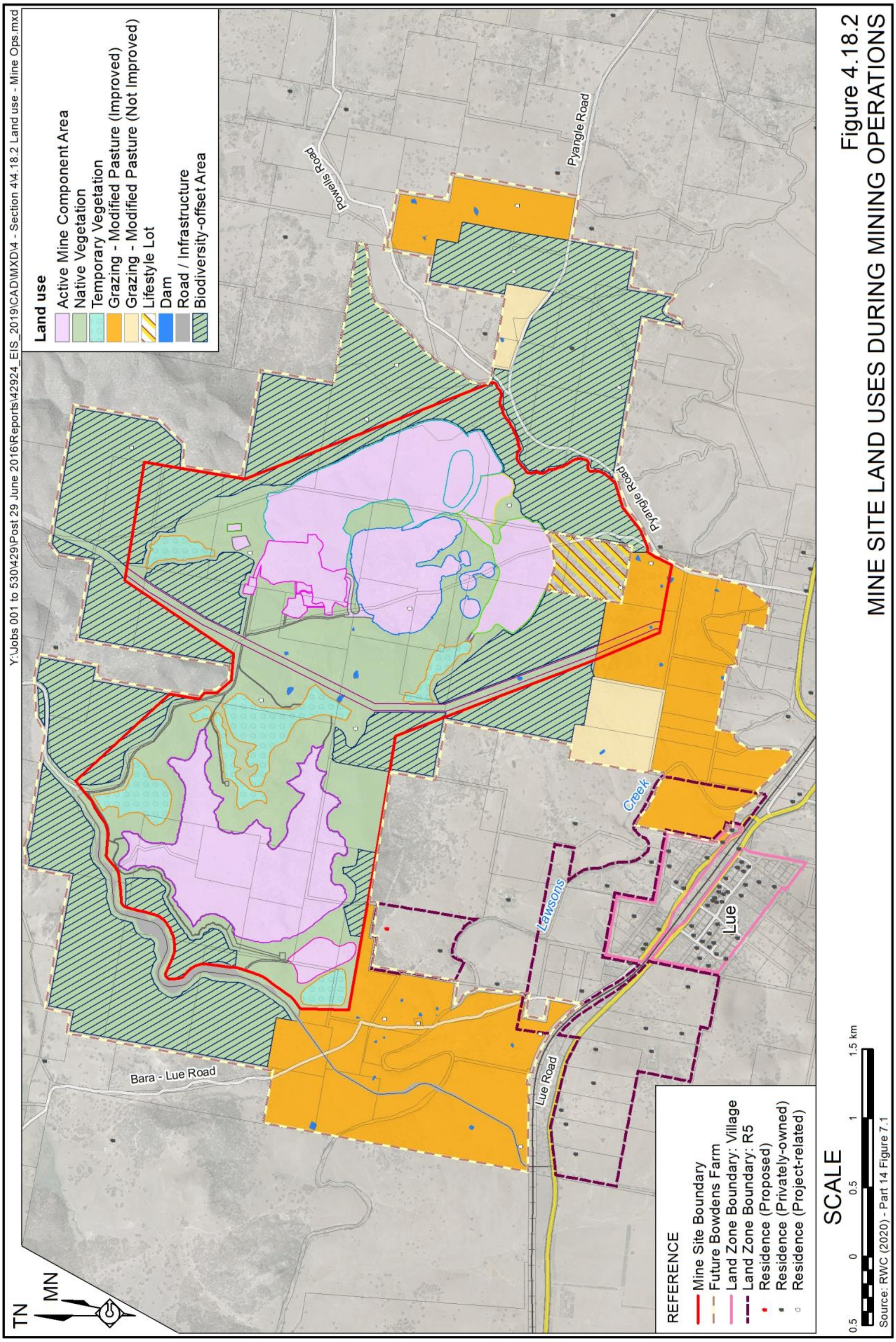

Figure 4.18.2
MINE SITE LAND USES DURING MINING OPERATIONS

Table 4.83
Existing Land Uses within the Mine Site and Proposed Land Uses during and after the Project Life

Land Use	Existing		During Project Life		After Project Life	
	Area	%	Area	%	Area	%
Cropping	13	1	-	-	-	-
Grazing – Modified Pasture (Improved)	333	33	24	2	109	11
Grazing – Modified Pasture (Not Improved)	150	15	0	-	-	-
Grazing – Native Vegetation	427	43	-	-	-	-
Exclusion Zone (Aboriginal Heritage)*^	25	3	-	0	-	-
Dams	3	0	1	0	1	0
Lifestyle Lot*	49	5	22	2	49	5
Mine Component Area*	-	-	329	33	50	5
Grazing Controlled	-	-	-	-	191	19
Temporary Vegetation Area*	-	-	62	6	-	-
Native Vegetation*#	-	-	343	34	382	38
Biodiversity Offset Area*	-	-	218	22	218	22
Total	999	100	999	100	999	100

* Area with no agricultural capability.

^ The "Exclusion Zone" would be maintained during and after the Project life and would be incorporated within the Biodiversity Offset Area.

This area would be used for sporadic grazing of livestock principally for the purpose of reducing bush fire fuel loads, however, for the purposes of this assessment, this area is considered to have no agricultural capability.

A total of approximately 795ha of land within (218ha) and immediately surrounding (577ha) the Mine Site would be set aside as biodiversity offset areas as part of the Project's Biodiversity Offset Strategy. This land would require active management including weed control, fencing, targeted supplementary planting and active placement of habitat features such as nest boxes, logs or hollow-bearing trees. Grazing would not be undertaken within areas set aside as biodiversity offset areas.

Beyond the end of the Project life, it is anticipated that approximately 1 170ha of land within the Bowdens Farm would be either retained for or returned to agricultural use with approximately 865ha permanently removed from production. The land within the Mine Site to be permanently removed from production would include the void left by the main open cut pit (50ha) and the on-site biodiversity offset area (218ha). The footprint of the relocated Maloneys Road (20ha) and off-site biodiversity offset area (577ha) would similarly be permanently removed from agricultural production. It remains Bowden Silver's long-term objective to remove the leachate management dam following the cessation of leachate generation from the WRE (**Appendix 5** – Section A5.8.5.4. It is noted that controlled grazing would be undertaken in the rehabilitated areas covered by the TSF and WRE, however, stocking rates would be low and grazing would be undertaken principally to reduce bush fire fuel levels. **Figure 4.18.3** displays the land uses within the Mine Site beyond the end of the Project life.

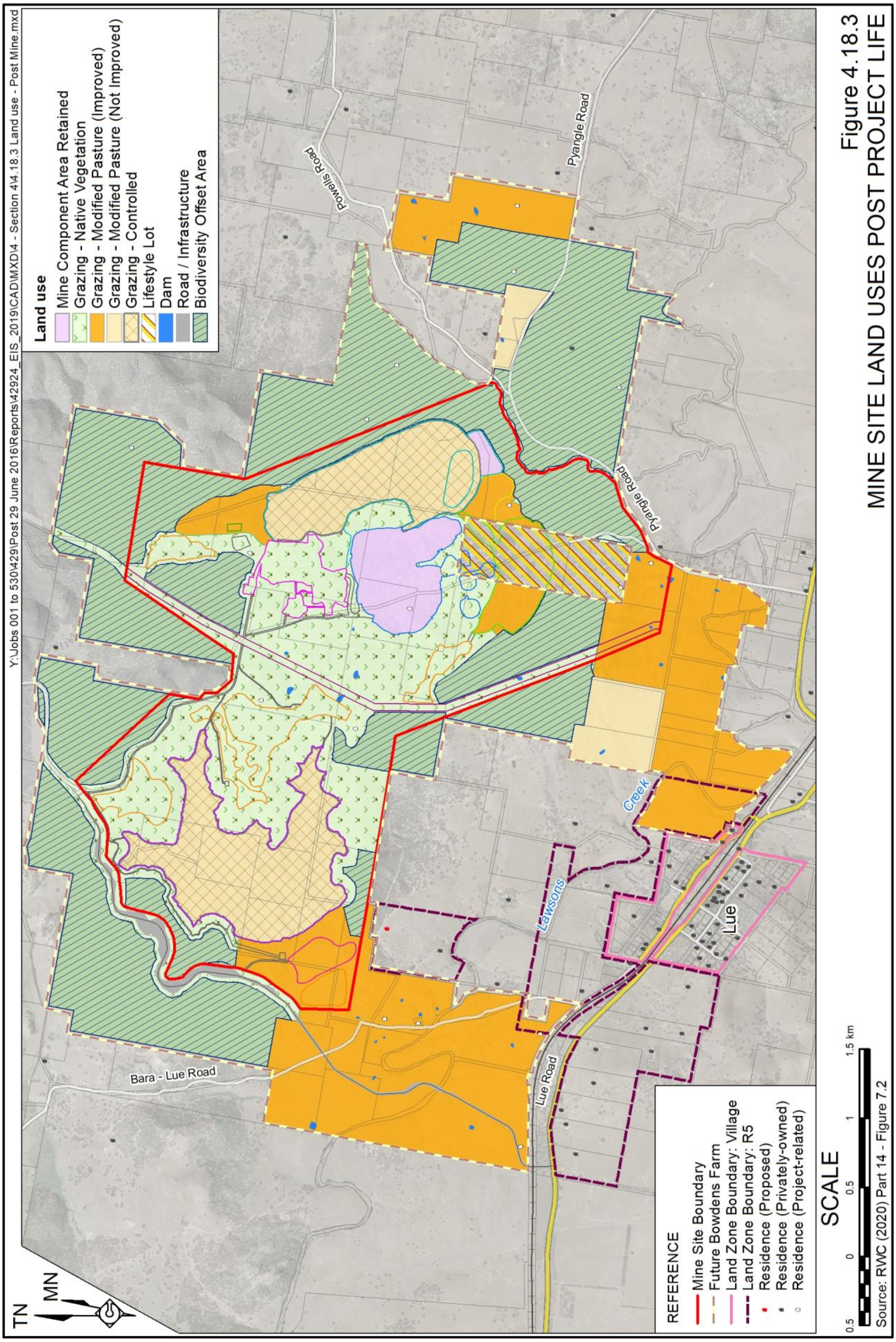

Figure 4.18.3
MINE SITE LAND USES POST PROJECT LIFE

Water Supply Pipeline Corridor

Approximately 54.7ha of land beyond the Mine Site would be temporarily and sequentially disturbed during the construction of the water supply pipeline. It is estimated that the water supply pipeline would be constructed over a period of up to approximately 10 months, however, the period of disturbance when agricultural activities would be curtailed would be in the order of approximately 1 month or less. All land disturbed during the construction of the water supply pipeline beyond the Mine Site would be returned to its previous land use within a few months of the completion of construction of the pipeline. No land used for agriculture beyond the Mine Site would be permanently removed from production.

4.18.6.2 Soils and Land and Soil Capability

No BSAL would be impacted within the Application Area. Apart from the final void area, the soils in the rootzones of the modified landscapes would retain or improve their qualities required for the long-term rehabilitation of the Mine Site. The topsoil and subsoil resources throughout the Mine Site would enable suitable substrates to be created on the final landform to sustain an appropriate level of vegetation across the Mine Site for minimisation of the risk of soil erosion. No soil resource impacts from the Project are anticipated on adjoining land used for agriculture.

The existing land within the Mine Site is predominantly LSC Class 6 with subordinate areas being Class 4 or Class 5 and minor areas being Class 3. A similar level of LSC would be maintained following the rehabilitation of the land disturbed within the Mine Site i.e. with the exception of the final void that would be retained as a lake. All disturbed land would be returned to its previous use and the existing level of LSC would be maintained upon rehabilitation.

All disturbed land within the water supply pipeline corridor would be returned to its previous use and the existing level of LSC would be maintained upon rehabilitation.

Further detail on the potential impacts to soils and land and soil capability are provided in Section 4.13.5.

4.18.6.3 Surface Water

The Project would involve the capture and retention of some surface water within the Mine Site and hence some reduction in surface water outflows entering Hawkins Creek and Lawsons Creek. The principal mechanism by which the Project would affect the quantity of water supplies available to other downstream surface water users would be by reducing flows to the extent that the frequency and duration of cease-to-flow periods is increased.

During operations, the maximum impact of the Project on downstream flow would be a decrease of flows in:

- the downstream 3.5 km of Hawkins Creek from its confluence with Lawsons Creek by up to 4.4%;
- Lawsons Creek downstream of Hawkins Creek and the Mine Site and upstream of the Walkers Creek confluence by up to 1.2%;
- Lawsons Creek downstream of the Walkers Creek confluence by up to 2.2%.

Post-mine closure:

- the flow in Hawkins Creek for a distance of 3.5km from its confluence with Lawsons Creek would decrease by 1.4%;
- the flow in Lawsons Creek between the confluence of Hawkins and Walkers Creeks would decrease by 0.4%; and
- the flow in Lawsons Creek downstream from its confluence with Walkers Creek would decrease by 0.4%.

WRM (2020) concludes that the impacts of the Project on surface water flows would be minimal, and therefore the impact of the loss on the availability of water to downstream water users would be negligible.

The proposed underboring of the perennial watercourses would be undertaken in a manner that would avoid impacts to the watercourses and their flow. Similarly, the proposed trenching through ephemeral watercourses would be undertaken using standard techniques and mitigation measures to minimise impacts to the ground surface and their surrounds.

Further detail on potential impacts to surface water resources are provided in Section 4.7.5.

4.18.6.4 Groundwater

Mine dewatering take has been partitioned between the applicable groundwater and surface water sources, including allowance for incidental surface water take through baseflow reduction in Hawkins and Lawsons Creeks. The maximum predicted take from each of the applicable water sources, and therefore the volume of share components for each of the water sources required to be held during mining are as follows.

- Lachlan Fold Belt Groundwater Source (Other) – 907 ML
- Sydney Basin Groundwater Source – 194 ML
- Lawsons Creek Water Source – 12.9 ML

Potential groundwater drawdown may impact groundwater availability for registered users beyond the Mine Site. Drawdown predicted in modelling indicates that potential drawdown of more than 2m could occur at two registered bores (GW061475 and GW802888) located on privately-owned land near the Mine Site. As impacts at these two bores are predicted to become evident post-mining (impacts at GW061475 may also be evident at the end of mining), contingency measures including ‘make good’ provisions would be required for these landowners. Regardless, monitoring of potential impacts at these bores would be an objective of the groundwater monitoring program for the Project.

Further detail on potential impacts to groundwater resources are provided in Section 4.6.7.

4.18.6.5 Agricultural Enterprises and Production

Cattle and Sheep Industry

There would be negligible impacts upon the overall total land available for grazing throughout the Region or the Lue district as a result of the Project. The maximum area of land currently used for agriculture to be removed throughout the Project life would be approximately 1 498ha of 500 458ha, or approximately 0.3% of the total land used for agriculture available within Region. Additionally, much of this land used for agriculture has low productivity rates and is used only for sporadic grazing due to steep terrain and dense vegetation. The total amount of land that would be permanently removed from agricultural production after rehabilitation would be approximately 865ha, or 0.17% of the total land used for agriculture within the Region. The scale of the land withdrawn and its productive capacity are considered insignificant when compared to the Region's overall production capacity. As a result, it is expected that there would be no consequential impacts on associated infrastructure or agricultural enterprises.

Horticulture and Viticulture

It is anticipated that no agricultural industries or infrastructure within the vicinity of the Mine Site would be adversely impacted by the Project. The closest commercial, non-livestock related operations occurring within the Lue district are East Ridge Olives, Rylstone Olive Press and Elephant Mountain Wines. These operations are respectively located approximately 2.6km, 5.3km and 3.8km from the Mine Site and are not likely to be adversely impacted upon as a result of the mitigation measures proposed to address potential land and soil capability (see Section 4.13.4), surface water (see Section 4.7.4), groundwater (see Section 4.6.8), biodiversity (see Section 4.10.5), air quality (see Section 4.4.2.3), noise and vibration (see Sections 4.2.2.5 and 4.3.4) and socio-economic impacts (see Section 4.20.5).

It is noted that potential impacts to the above enterprises as a result of deposited dust (and any minor concentrations of heavy metals) are expected to be negligible given their significant distances from the Mine Site and the ability of the Project to comply with the relevant criteria at surrounding privately-owned residences. Given the above, it is considered very unlikely that the Project would adversely impact upon the organic certifications held by the Rylstone Olive Press.

4.18.6.6 Social and Economic Impacts

Agricultural Land Values

It is assessed that the value of land beyond the Mine Site that is used for agriculture commercially within the Region would be unlikely to change as a result of the Project as the agricultural productivity would not change. Bowdens Silver would continue to graze stock on sections of the land surrounding the Mine Site to ensure that the land remains productive and maintains its land value. Furthermore, Bowdens Silver would return the post-mining landform to the existing or improved agricultural value, wherever possible.

Cost of Lost Opportunities / Productivity

The key impact of the Project on agricultural resources would be the temporary or permanent removal of grazing land from the Mine Site. It is estimated that a maximum reduction in gross revenue in the order of $160,000 per annum would be experienced. Based on the continued operation of the Bowdens Farm over an area of approximately 470ha area throughout the Project life, and a conservative return of approximately $107 (gross) per hectare. This impact would be reduced to approximately $88,000 in gross revenue after mine closure given that a similar level of soil condition and land capability would be maintained following the rehabilitation of land disturbed within the Mine Site over an area of approximately 1 170ha i.e. with the exception of the final void, relocated Maloneys Road footprint and biodiversity offset areas.

Local and Regional Agricultural Employment

Bowdens Silver currently employs a farm manager to manage livestock and maintain the land which comprises the Bowdens Farm. This employment would continue throughout the Project life and, therefore, no labour losses are expected, particularly given the extended Bowdens Farm would comprise an area of approximately 470ha throughout the Project life.

Following mine closure, approximately 865ha of land currently used for agriculture would be removed from production. Based on current carrying capacity (i.e. 0.8 sheep per hectare with a nominal 0.01 cattle per hectare), this represents a maximum of approximately 9 head of cattle displaced and 692 head of sheep if all the land was unavailable for grazing. At the current production rates, the removal of this land would result in a total net reduction of approximately 0.116 full time equivalent (FTE) positions.

Off-farm Income

A notable trend in regional areas of Australia is the increasing reliance upon off-farm employment to maintaining farm incomes. Since 1990, the proportion of farm families deriving off-farm income has increased from 30 to 45% (Productivity Commission, 2005). In 2017-2018, it was estimated that Australian farming businesses received approximately 11% of their income from off-farm employment or business activities (ABS, 2018). Off-farm income is particularly important to small agricultural enterprises to offset low or variable farm incomes, especially during poor seasons.

Given that Bowdens Silver has committed to the implementation of flexible work arrangements for employees (see Section 4.18.5), it is anticipated that the Project would provide a significant economic contribution to local farm families throughout the Region. This income would provide families and their agricultural enterprises with much needed capital and improve the viability of marginal and/or small operations.

Agri-tourism

Mining and tourism are not mutually exclusive activities. Areas such as Cessnock and Gunnedah in NSW, and Carnarvon Gorge and Arcadia Valley in Queensland, have recorded strong and sustained growth in visitor numbers in parallel with growth in mining and mining employment. This trend is reflected in the Mid-Western Regional LGA, where there has been a steady expansion of mining since 1986 in conjunction with tourism growth. This trend has continued in recent years with the Mudgee Region Visitor Information Centres recording a total of 28 202 visitors in 2015-16 (MRT, 2016), 28 079 visitors in 2016-17 (MRT, 2017) and 33 225 visitors in 2017-2018 (MRT, 2018).

The fact that visitor numbers have not declined, despite the growth of mining, suggests that the major visitor attractions and their customer base would be reasonably secure from perception impacts. This is especially true as most cellar doors, the major regional attraction, are located to the northeast of Mudgee. Given the measures that would be taken to mitigate the impacts of the Project on visual amenity, and the fact that the majority of visitors travelling to Mudgee would utilise the Castlereagh Highway, it is not anticipated that the Project would result in any significant adverse impacts on tourism.

Adverse impacts to local agri-tourism businesses (principally B&Bs and guesthouses) are expected to be minimal due to the implementation of the proposed mitigation measures to manage impacts to noise, air quality and visual amenity. Further details on the proposed management measures for these matters are provided in Sections 4.2.2.5, 4.4.2.3 and 4.9.4, respectively.

4.18.7 Conclusion

The Project would have negligible to minor adverse impacts upon the agricultural resources and enterprises through the Region. Whilst the Project would marginally reduce the availability of land used for agriculture throughout the Project life, the continued operation of the Bowdens Farm and the proposed progressive rehabilitation schedule, would ensure that the Project would only have minor to negligible impacts on land used for agriculture and agricultural enterprises both during and after the Project life. Furthermore, the commitment from Bowdens Silver to provide a range of part-time jobs throughout the Project life would provide an opportunity to acquire off-farm income to local farmers which in turn would benefit a number of agricultural enterprises within the Region.

4.19 ECONOMIC IMPACT ASSESSMENT

The economic impact assessment of the Project was undertaken by Gillespie Economics. The full assessment is presented in Volume 5 Part 15 of the Specialist Consultant Studies Compendium and is referenced throughout this section as Gillespie Economics (2020). A peer review of the economic impact assessment was undertaken by Mr Drew Collins of BDA Group Pty Ltd. A copy of the peer review is included as Annexure 11 in Gillespie Economics (2020).

4.19.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in economic impacts. These risk sources and the assessed risk of impacts <u>after</u> the adoption of standard mitigation measures are as follows.

- A downturn in silver prices or increase in operating costs results in the Project becoming uneconomic and closing prematurely (Medium).
- Local amenity impacts negatively affect the housing market and lead to decreased housing and land prices (Medium).
- Increased employment and population reduce available housing stock resulting in increased property values and constrained housing market leading to rent increases (Low).
- Construction and operational activities consume natural and human resources resulting in constraints / increased operational costs for other local industries (Low).

In addition, the SEARs issued by the former DPE identified "economic" as a key issue requiring assessment. The principal assessment requirements identified by the former DPE relating to economics included the following.

- Assessment of the significance of the resource[5].
- Economic benefits of the development for the State and region.
- Demand for the provision of local infrastructure and services[6].

Additional economic matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the then DRG. These requirements are summarised as follows.

- Price forecasts, revenue and royalty calculations including justification for these estimates.
- Capital and operational expenditure requirements.
- Estimates of employment.

[5] The significance of the resource is addressed in Sections 1.6 and 2.2.3.
[6] The demand is addressed principally in the Social Impact Assessment.

- How the Project would interact with other mines.
- Explanation of why the proposed ROM production rate is the optimum rate[7].

A range of economic considerations were also raised by the Lue and district community, with key issues summarised as follows.

- Financial viability of the Project.
- Distribution of costs and benefits and cost / benefit conditions beyond the life of the mine.
- Impacts upon local business and property values.
- What will be the employment benefits?

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where each matter is addressed within the EIS and/or SCSC.

It is noted that social and economic considerations are often interlinked. A separate social impact assessment has been completed by Umwelt (2020) and is presented as Volume 6 Part 17 of the *Specialist Consultant Studies Compendium* and summarised in Section 4.20.

4.19.2 Approach to Economic Impact Assessment

In addition to the requirements outlined within the SEARs, Gillespie Economics (2020) has undertaken an economic assessment for the Project in accordance with the following.

- Clause 7(1)(f) of Schedule 2 of the EP&A Regulation which requires environmental impact statements to provide "*the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations*…". The Note to Clause 7(1)(f) provides as follows. "*A cost benefit analysis may be submitted or referred to in the reasons justifying the carrying out of the development, activity or infrastructure*."
- Section 4.15 of the EP&A Act which requires the following matters to be taken into consideration.
  - The public interest (taken as the collective public interest of households in NSW).
  - The likely impacts of the development, including environmental impacts on both the natural and built environments, and social and ***economic impacts in the locality***.
- The following standards, guidelines and policies.
  - NSW Government (2015) Guideline for the economic assessment of mining and coal seam gas proposals.

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[7] The ROM production rate is addressed in Section 1 – **Table 1.2**.

– NSW Government (2018) Technical Notes supporting the Guidelines for Economic Assessment of Mining and Coal Seam Gas Proposals.

– NSW Treasury (2017) NSW Government Guide to Cost-Benefit Analysis.

In order to meet the above requirements, two types of analysis are required, namely:

- a cost benefit analysis (CBA) which is the primary way that economists evaluate the net benefits of projects and policies, provide economic justification for a project and address the public interest; and
- a local effects analysis (LEA) to assess the impacts of the Project in the locality, specifically:
  - effects relating to local employment;
  - effects relating to non-labour project expenditure; and
  - environmental and social impacts on the local community.

It is noted that a supplementary LEA was also undertaken using input-output (IO) analysis which allows for divergence from full employment, inclusion of job chain effects, and in-migration of labour to the local area[8]. The use of the LEA prepared in accordance with the standard requirements and a supplementary LEA provides a better understanding of the likely lower and upper bounds of the local effects of the Project.

The key assumptions underpinning these analyses are summarised in **Table 4.84**.

Table 4.84
Key Assumptions Underpinning the Economic Assessment

Page 1 of 2

Item	Assumption
Mining Methods	Open cut operations
Total Production	29.9 Mt of primary and low grade ore at average grade of: 69g/t silver i.e. 66.3 million oz silver 0.44% zinc i.e. 130,000 t of zinc 0.32% lead i.e. 95,000 t of lead
Ore Processed	2 Mtpa
Payable Metals Recovered	48M oz silver 92 000 t zinc 75 000 t lead
Mine Life	16.5 years - comprising *Construction* - 1.5 years and *Operation* – 15 years
Project Life	23 years

[8] For the Economic Assessment, the local area refers to the Mid-Western Regional Council – Local Government Area.

Table 4.84 (Cont'd)
Key Assumptions Underpinning the Economic Assessment

Page 2 of 2

Item	Assumption
Workforce	Construction • average annual FTE of 131 (on site) – 30% already reside in local area • up to 246 personnel (on site) • average annual FTE of 74 (off site) Operations • average annual FTE of 210 – 75% already reside in local area – 15% migrate into local area – 10% commute from outside local area
Prices	USD 20.91/oz silver USD 2 756/t zinc USD 2 205/t lead
AUD:USD Exchange Rate	0.75
Average Annual Revenue	AUD 119M
Capital Expenditure	Initial Capital - AUD 247M Sustaining Capital - AUD 54M Mitigation, compensation and offset costs - AUD 25M
Average annual operating costs (site, treatment and refining costs, transport costs)(net of royalties)	AUD 79M
State Royalties	4% ex mine value (value less allowable deductions) Average annual royalty of AUD 2.3M
Third Party Royalty	2% of net revenue ex-site (including deductions) for the first nominal $5M of royalty payments and then at 1% of net revenue ex-site thereafter Average annual royalty of AUD 1.2M
Source: Gillespie Economics (2020) – Table 2.2	

4.19.3 Cost Benefit Analysis

4.19.3.1 CBA Methodology

Economic assessment is primarily concerned with identifying changes in aggregate community welfare, associated with alternative resource use patterns. CBA is the standard technique applied to estimate these wealth changes and provides a comparison of the present value of aggregate benefits to society, as a result of a project, policy or program, with the present value of the aggregate costs.

These benefits and costs are defined and valued based on the microeconomic underpinnings of CBA. In particular, the values held by individuals in the society are relevant, including both financial and non-financial values. Provided the present value of aggregate benefits to society exceeds the present value of aggregate costs (i.e. a net present value of greater than zero), a project is considered to improve the well-being of society and hence, relative to the 'without project' scenario, is desirable from an economic efficiency perspective.

Relative to the base case / "without Project" scenario, the Project may have the potential incremental economic benefits and costs shown in **Table 4.85**. The main potential economic benefit is the producer surplus (net production benefits) generated by the Project and any wage benefits to employment, non-market benefits to employment, economic benefits to existing landholders, and benefits to suppliers. The main potential economic costs relate to any environmental, social and cultural costs, including any net public infrastructure costs and loss of surpluses to other industries.

Table 4.85
Potential Economic Benefits and Costs of the Project

Category	Costs	Benefits
Net production benefits1	• Opportunity costs of capital equipment. • Opportunity cost of land. • Development costs including labour, capital equipment, sustaining capital, and mitigation, compensation and offset costs. • Operating costs, including administration, mining, on-site treatment and refining costs, transportation to port, port charges, labour costs. • Decommissioning and rehabilitation costs at cessation of the Project.	• Value of silver, zinc and lead concentrate. • Residual value of capital and land at the cessation of the Project.
Potential environmental, social and cultural impacts	• Agricultural impacts[2]. • Groundwater and surface water impacts. • Air quality impacts. • Noise and vibration impacts. • Ecology and biodiversity impacts. • Aboriginal heritage impacts. • Historic heritage impacts. • Traffic and transport impacts. • Visual amenity impacts. • Greenhouse gas generation. • Net public infrastructure costs. • Loss of surplus to other industries.	• Wage benefits to employment. • Non-market benefits of employment. • Economic benefits to existing landholders. • Economic benefits to suppliers.

1 Some of the net production benefits of the Project would be redistributed to the local area via the Planning Agreement with MWRC and in the form of support for local initiatives in the areas of education, community, sport, safety and arts and culture.
2 The value of foregone agricultural production is included in the value of land.

Source: Gillespie Economics (2020) – Table 4.1

Notably, the potential environmental, social and cultural costs listed in **Table 4.85** are only economic costs to the extent that they affect individual and community well-being. If the potential impacts do not occur or are otherwise mitigated, compensated or offset to the extent where community wellbeing is insignificantly affected (i.e. the costs are borne by the Applicant), then no environmental, social or cultural economic costs need to be included in the Project CBA apart from the mitigation, compensation or offsetting costs.

Most applications of CBA are performed at the National level but also end up estimating the global net benefits. With respect to the CBA for the Project, the NSW Government (2015) guidelines define the public interest, and hence society, as the households of NSW. NSW Treasury (2017) also makes it clear that a CBA should focus on impacts (costs and benefits) to the NSW community. The SEARs for the Project also refer to the requirement to provide consideration of the economic benefits of the Project for the State.

Consequently, the CBA is initially undertaken from a global perspective i.e. including all the costs and benefits no matter who they accrue to, and is then truncated to assess whether there are net benefits to Australia and then to NSW.

Consistent with NSW Government (2015) and NSW Treasury (2017), the analysis was undertaken in 2019 real values, with discounting at 7% and sensitivity testing at 4% and 10%. The analysis period is 19 years, coinciding with one year pre-Project, the mine life (16.5 years) plus one year post mine life where all final rehabilitation and decommissioning costs are included as a terminal value.

Where competitive market prices are available, they have generally been used as an indicator of economic values. Environmental, cultural and social impacts have initially been left unquantified and interpreted using the threshold value method where the unquantified costs must exceed a threshold to make the Project questionable from an economic perspective. An attempt has also been made to estimate environmental, cultural and social impacts using market data and benefit transfer and incorporate these into an estimate of the net social benefit of the Project. Net social benefits have been calculated with and without the value of employment benefits. Further detail regarding the assumptions and breakdowns of the assumed costs and benefits is provided in Section 4.4 of Gillespie Economics (2020).

Important definitions used in the CBA are as follows.

Net production benefit:	net benefits accruing from production which is based on revenues and costs to the proponent. It includes royalties, company tax and net producer surplus. It also takes account of mitigation, offset and compensation costs.
Net social benefit:	net production benefits plus any positive or negative environmental, social and cultural impacts that have not been mitigated, offset or compensated for, any economic benefits to existing landholders and suppliers or associated with employment, and any net public infrastructure costs or loss of surplus to other industries.

4.19.3.2 Global Cost Benefit Results

The global and National present value of costs and benefits is provided in **Table 4.86**. The top half of the table identifies production costs and benefits of the Project, which includes an estimated $25M of capital and operating costs associated with the mitigation, offset and compensation of environmental, social and cultural impacts. The bottom of the table summarises the residual environmental, social and cultural impacts of the Project after the implementation of the mitigation, offsetting and compensation costed into the capital and operating costs.

Table 4.86
Global and (National) Cost Benefit Analysis Results of the Project
(Present Values @7% discount rate)

	Costs	**$M**	**Benefits**	**$M**
Production	Opportunity cost of land	$14	Value of silver, zinc and lead concentrate	$1 033
	Opportunity cost of capital	$0	Residual value of land	$0
	Development costs including sustaining capital and mitigation, compensation and offset costs	$264	Residual value of capital	$0
	Operating costs ex royalties	$657		
	Rehabilitation and decommissioning costs	$0		
	Production Sub-total	***$935***		***$1 033***
			Net Production Benefit	**$98 ($89)**
Externalities	Agriculture	Reflected in land costs which are included in opportunity costs of land and development costs	Wage benefits of employment	$25
	Surface water	WAL cost included in development costs. No material residual impacts	Non-market benefits of employment	$78
	Groundwater	WAL cost included in development costs. No material residual impacts	Economic benefits to existing landholders	Not quantified
	Air quality	Cost of acquiring impacted properties or negotiated agreement included in development costs. No material residual impacts	Economic benefits to suppliers	No material impacts
	Noise and vibration	Costs of acquiring impacted properties or negotiated agreement, and receiver mitigation costs included in development costs. No material residual impacts		
	Ecology and biodiversity	Some loss of values but offset. Cost of offset included in development costs		
	Aboriginal heritage	No material impacts		
	Historic heritage	No material impacts		
	Transport and traffic	No material impacts. Costs of road relocation and access upgrade included in development costs		
	Visual amenity	Mitigation measures included in development costs. No material residual impact		
	Greenhouse gas	$20 ($0.06)		
	Net public infrastructure costs	No material impacts		
	Loss of surplus to other industries	No material impacts		
	Externality sub-total	***$20($0.06)***		***$103***
Net Social Benefits – including employment benefits				**$181 ($192)**
Net Social Benefits – excluding employment benefits				**$78 ($89)**

Notes: Totals may have minor discrepancies due to rounding.
When impacts accrue globally, the numbers in brackets relate to the level of impact estimated to accrue to Australia
"No material impacts" does not mean that there would be no impacts, but that impacts are not likely to amount to more than 5% in aggregate of the quantified net production benefits of the Project (NSW Government, 2012).
Royalties are part of the net production benefits
Rehabilitation and decommissioning costs are included in the operating costs.

Source: Gillespie Economics (2020) – Modified after Table 4.9

The Project is estimated to have global total net production benefits of $98M. Global residual environmental, cultural and social impacts of the Project are estimated at $20M whilst potential employment benefits (market and non-market value) are estimated at $103M. In total, the Project is estimated to have global net social benefits of between $78M and $181M (the latter including employment benefits).

4.19.3.3 National Cost Benefit Results

As Bowdens Silver is 7% foreign owned, the net production benefits that accrue to Australia include government royalties, private royalties to an Australian third party, company tax, and 93% of residual producer surplus. The net production benefits that accrue to Australia are estimated at $89M, comprising (rounded to the nearest $1M) $21M in NSW Government royalties, $11M in Australian third party royalties, $48M in company tax, and $9M in residual producer surplus (being 93% of the total residual producer surplus).

For the Project to be questionable from an Australian economic efficiency perspective, all incremental residual environmental, social and cultural impacts from the Project, that impact Australia, would need to be valued by the community at greater than the estimate of the Australian net production benefits i.e. greater than $89M in present value terms.

The majority of the potential impacts are already internalised into the $25M capital and operating costs via the proposed mitigation, offset or compensation measures, and hence are incorporated into the estimate of net production benefits. Other quantified impacts to Australia are estimated at less than $1M for greenhouse gas impacts, considerably less than the estimated $89M net production benefits of the Project to Australia.

Overall, the Project is estimated to have net social benefits to Australia of between $89M and $192M (the latter incorporating the benefits of employment) and hence, relative to the "without Project" scenario, is desirable and justified from an economic efficiency perspective.

While the major environmental, cultural and social impacts have been quantified and included in the Project CBA, any other residual environmental, cultural or social impacts that remain unquantified would need to be valued at greater than between $89M and $192M for the Project to be questionable from an Australian economic perspective.

4.19.3.4 NSW Cost Benefit Results

The NSW Government (2015) guidelines have a particular focus on the costs and benefits to NSW. **Table 4.87** identifies the present value of costs and benefits to NSW. Impacts that have a National or global dimension are apportioned to NSW as follows.

- 100% of government royalties are attributed to NSW.
- 32% of third party royalties are attributed to NSW i.e. NSW's share of the Australian population.
- 32% of the estimated company tax generated from the Project is attributed to NSW (NSW Guidelines 2015).

Table 4.87
NSW Cost Benefit Analysis Results of the Project (Present Values @7% discount rate)

Costs	Value ($M)	Benefits	Value ($M)
Environmental, Social and Cultural Impacts		***Share of Net Production Benefits***	
Agriculture	Reflected in land costs which are included in opportunity costs of land and development costs.	Royalties to the State of NSW	*$21*
Surface water	WAL cost included in development costs. No material residual impacts.	Royalties to third party	*$4*
Groundwater	WAL cost included in development costs. No material residual impacts.	Company tax	*$15*
Air quality	Cost of acquiring impacted properties or negotiated agreement included in development costs. No material residual impacts.	Residual producer surplus	*$4*
Noise and vibration	Costs of acquiring impacted properties or negotiated agreement, and receiver mitigation costs included in development costs. No material residual impacts.	***Sub-total***	***$44***
Ecology and biodiversity	Some loss of values but offset. Cost of offset included in development costs.	***Additional benefits***	
Aboriginal heritage	No material impacts.	Wage benefits to employment	*$25*
Historic heritage	No material impacts.	Non-market benefits of employment	*$78*
Transport and traffic	No material impacts. Costs of road relocation and access upgrade included in development costs.	Economic benefits to existing landholders	Not quantified
Visual amenity	Mitigation measures included in development costs. No material residual impact.	Economic benefits to suppliers	No material impacts
Greenhouse gas	$0.02		
Net public infrastructure costs	No material impacts		
Loss of surplus to other industries	No material impacts		
Total	***$0.02***	***Sub-total***	***$103***
Net Social Benefits – including employment benefits			***$146***
Net Social Benefits – excluding employment benefits			***$44***

Notes:

Any errors in total are due to rounding.

"No material impacts" does not mean that there would be no impacts, but that impacts are not likely to amount to more than 5% in aggregated of the quantified net production benefits of the Project (NSW Government, 2012).

Source: Gillespie Economics (2020) – Modified after Table 4.10

- 45% of the Australian residual net producer surplus is attributed to NSW i.e. the percentage of shareholders that are from NSW (based on Silver Mines Limited's share registry).
- 100% of potential wages benefits are attributable to NSW based on an assumption that all incremental employment would be filled by NSW residents.
- 100% of the potential non-market values of employment are attributable to NSW based on benefit transfer from a study that surveyed the willingness to pay of NSW households.
- Greenhouse gas impacts (which accrue globally) are attributed to NSW based on NSW's share of the global population.

- All other potential environmental, social and cultural impacts would accrue to NSW households. However, these impacts are already largely mitigated, compensated or offset.

On this basis, the estimated Net Social Benefits of the Project to NSW are between $44M and $146M (the latter including employment benefits). Consequently, as well as resulting in net benefits to Australia, the Project would also result in net benefits to NSW.

Any unquantified residual impacts of the Project to NSW after mitigation, offsetting and compensation would need to be valued at greater than $44M and $146M, present value for the Project to be questionable from an NSW economic efficiency perspective.

4.19.3.5 Financial Viability and Sensitivity Analysis

The main areas of environmental risks associated with mining projects generally relate to:

- the financial viability of a project from unexpected downturns in prices and any consequential environmental impacts from premature cessation of operations;
- ecological risk associated with whether the biodiversity offsets would adequately compensate for the direct ecological impacts; and
- other environmental, social and cultural impacts estimations and required mitigation measures.

DPIE has previously identified that the financial viability of projects is a risk assumed by the project owners. It is highly unlikely that Bowdens Silver would invest in the Project if it were not financially viable. Notwithstanding, should the Project be approved, prior to any ground-disturbing activities, Bowdens Silver would be required to pay a rehabilitation security deposit to the Department of Regional NSW – Mining, Exploration and Geoscience (DRNSW-MEG) to cover the financial liability associated with rehabilitation in the event of an unexpected closure.

Similarly, a biodiversity offset would be secured prior to commencement of disturbance and then progressively increased prior to subsequent stages of disturbance. The offset strategy would be a conditional requirement of the Development Consent and the implementation of the offsets would be undertaken in accordance with the processes required by the Biodiversity and Conservation Division of DPIE. Furthermore, offsets provided through Stewardship sites would be funded through the Biodiversity Stewardship Payments Fund and would be subject to auditing by the Biodiversity Conservation Trust and/or Biodiversity and Conservation Division. EIS Sections 4.10.5.4 and 4.10.7 provide further detail regarding biodiversity offsets.

There is some risk associated with the estimation of environmental, social and cultural impacts of the Project and the level of mitigation measures proposed. However, it should be noted that impacts have generally been assessed based on the maximum annual levels of production and worst case scenarios and hence are likely to be overstated.

The net present value of the Project to NSW (presented in **Table 4.87**) is based on a range of assumptions around which there is some level of uncertainty. Uncertainty in a CBA can be dealt with through changing the values of critical variables in the analysis (James and

Gillespie, 2002) to determine the effect on the net present value[9]. In this sensitivity analysis, the CBA results for NSW were tested for changes to the following variables at a 4%, 7% and 10% discount rate.

- Opportunity costs of land.
- Development costs.
- Operating costs.
- Value of silver, zinc and lead concentrate i.e. USD price/exchange rate.

The results of the sensitivity analysis are presented in **Table 4.88**.

Table 4.88
NSW CBA Sensitivity Testing (Present Value $Millions) (Excluding Employment Benefits)

	4% Discount Rate	7% Discount Rate	10% Discount Rate
Central Analysis	$69	$44	$25
Increase			
Opportunity cost of land - 20%	$68	$43	$24
Development costs - 20%	$46	$22	$5
Operating costs - 20%	($1)	($9)	($16)
Value of concentrates - 20%	$174	$126	$90
Decrease			
Opportunity cost of land - 20%	$70	$45	$26
Development costs - 20%	$92	$65	$45
Operating costs - 20%	$138	$96	$66
Value concentrates - 20%	($38)	($40)	($41)
Source: Gillespie Economics (2020) – Table 4.12			

The sensitivity analysis indicate that the CBA results are most sensitive to revenue estimates in AUD i.e. USD price of concentrates and the AUD:USD exchange rate. Silver is the major driver of revenue. The USD price of silver was assumed at 20.91/oz with an AUD:USD exchange rate of 0.75. Whilst some short term forecasts for silver price are bullish i.e. USD22/oz in 2020 and USD28/oz in 2021 (Investing Haven, 2019), the long term price is highly uncertain. A 14% sustained reduction in silver price over the Project life would be required for the Project to have a zero net social benefit to NSW (excluding employment benefits). A devaluation of the AUD:USD exchange rate to 0.65 would completely offset a 14% reduction in USD silver price. At the time of preparing the economic assessment the AUD:USD exchange rate was 0.68. Silver price reductions have also generally been associated with reductions in operating costs and hence any sustained lower silver prices are likely to also be associated with sustained reductions in operating costs.

After revenue, the results are most sensitive to changes in operating costs. A sustained 16% increase in operating costs would result in zero net economic benefits to NSW. However, the operating costs assumed for the Project are 15% greater than the average globally. Also, S&P (2019) indicates that silver's global average all-in sustaining cost have been on a downward trend since 2012.

[9] Quantitative risk analysis could also potentially be undertaken. However, this requires information on the pprobability distributions for input variables in the analysis. This information is not available and so the sensitivity testing is limited to uncertainty analysis.

The CBA results are less sensitive to capital cost estimates. Since mitigation, offset and compensation costs are a small component of the capital costs of the Project, it is unlikely that large changes in these cost levels would have any significant impact on the CBA results. For instance, a 50% increase in offset costs is equivalent to a 3% increase in the estimated capital costs (including sustaining capital) of the Project.

4.19.4 Local Effects Analysis

4.19.4.1 LEA Methodology

LEA aims to address the consequences of the Project in its "locality" as required by Section 4.15 of the EP&A Act. It is intended to complement the CBA by translating effects at the NSW level to impacts on the communities located near the Mine Site. It also provides additional information to describe changes that are anticipated within a locality, such as employment changes. LEA is intended to inform the scale of change rather than being representative of costs and benefits to the local community.

For the purpose of the LEA for the Project, the locality is defined as the Mid-Western Regional LGA and is considered likely to be the main source of labour and non-labour inputs for the Project. The local effects required to be analysed in a LEA are:

- local employment and income effects;
- other local industry effects, for example on suppliers; and
- environmental and social change in the local community.

4.19.4.2 Direct Local Employment Effects

The Project would provide:

- an average annual full-time equivalent (FTE) construction workforce of 131, with an FTE peak on-site workforce of 246. It is assumed 30% already reside in the local area with the remainder living in temporary accommodation within the local area during their shift; and
- an average annual FTE operational workforce of 210 per year over the Project life, with an FTE peak of 230. It is assumed that 75% already reside in the local area, 15% are assumed to migrate into the local area to live, and 10% are assumed to commute from outside the local area.

Assuming that future employees residing in the local area are already employed and that job vacancies created by these people filling the construction and mining positions remain unfilled (consistent with the NSW Government Guideline, 2015), the incremental disposable wages accruing to the local area is $1.8M pa during construction and $6.2M pa during Project operations. This is equivalent to 20 direct full time equivalent (FTE) jobs during construction and 73 direct FTE jobs during operations. This is a minimum estimate as it assumes existing full employment in the LGA and no in-migration of labour.

Alternatively, if it were assumed that all future employees already residing in the local area are directly drawn from the unemployed[10], the incremental disposable wages accruing to the local area is $3.0M pa during construction and $11.0M pa during Project operations. This is equivalent to 33 direct FTE jobs during construction and 129 direct FTE jobs during operations. This estimate ignores income associated with in-migration of labour.

4.19.4.3 Direct Non-Labour Expenditure Effects

In addition to the incremental direct regional employment and wages generated, the other major economic effect would be expenditure in the region on other, non-labour, inputs. The total annual non-labour expenditure (operating costs of the Project after subtraction of wages to employees) is in the order of $51M per annum of which it is estimated that $30M per annum would accrue to the local area economy.

4.19.4.4 Second Round and Flow-on Effects

The incremental expenditure by employees and non-labour expenditure that is captured by the local area provides flow-on economic activity to the local economy, which can be estimated in terms of economic activity indicators of output, value-added, income and employment. Applying the applicable multipliers to the direct net employment and net income effects the flow-on effects and total employment and income benefits are summarised in **Table 4.89**.

Table 4.89
Flow-on Effects Associated with Net Direct Employment and Income

	Net Direct	Flow-on	Total
ALL LOCAL LABOUR SOURCED FROM EMPLOYMENT			
Construction			
Employment	20	12	31
Net income (M)	$1.8	$0.8	$2.5
Operation			
Employment	73	74	147
Net income (M)	$6.2	$4.0	$10.3
Net non-labour expenditure (M)	$30		
ALL LOCAL LABOUR SOURCED FROM UNEMPLOYMENT			
Construction			
Employment	33	20	52
Net income (M)	$3.0	$1.3	$4.3
Operation			
Employment	129	132	260
Net income (M)	$11.0	$7.2	$18.2
Net non-labour expenditure (M)	$29		
Source: Gillespie Economics (2020) – Table 5.3			

[10] This approach was suggested by the Peer Reviewer to give a range of potential impacts under the LEA method.

4.19.4.5 Effects on Other Industries

Agriculture

The Project would potentially result in a reduction in local area economic activity associated with a reduction in land available for agricultural activity. The reduction would occur due to the disturbance area, establishment of the biodiversity offset area, and the purchase of surface water and groundwater WALs. The key impact would be due to the removal of low productivity grazing land from the Mine Site and the footprint of the relocated Maloneys Road during the Project life. The Agricultural Impact Statement estimates a maximum reduction in gross revenue during mining operations of in the order of $160,000 per annum. The impact would be reduced to around $88,000 in gross revenue post mining given that a similar level of soil condition and land capability would be maintained following the rehabilitation of land disturbed within the Mine Site i.e. with the exception of the final void which would be retained as a lake.

The total annual impact of the Project on agricultural economic activity in the local area economy is up to:

- $0.25M in annual direct and indirect output or business turnover;
- $0.12M in annual direct and indirect value added;
- $0.04M in annual direct and indirect household income; and
- 0.74 direct and indirect jobs.

Gillespie Economics (2020) concludes that the magnitude of these impacts is very small and inconsequential to the local area economy and agricultural support industries.

Wages

In the short-term, increased local area demand for labour as a result of the Project (relative to the “without Project” scenario) could potentially result in some increased pressure on wages in other sectors of the economy. The magnitude and duration of this upward wages pressure would depend on the level of demand for labour, the availability of labour resources in the local area and the availability and mobility of labour from outside the local area. The incremental direct employment and income impacts of the Project operation would contribute in the order of 2.2% and 3.2% of direct local area employment and direct local area wages, respectively. The main employment sectors in the local area economy have, on average, 10% of their labour residing outside the local area, reflecting the mobility of labour. Wage impacts are therefore not likely to be significant. Where upward pressure on local area wages occurs, it represents an economic transfer between employers and owners of skills and would attract skilled labour to the local area leading to downward pressure on wages.

Housing Prices

The Project would generate some migration of workers and their families into the local area and hence increase demand for housing. However, the level of increased demand during construction is temporary and the increased demand during operation is modest, in the order of 32 workers and their families (say 76 people with the assumed 15% of the operational workforce migrating into the region and an average household size of 2.4), in comparison to the existing population (24,076) and forecast growth in population over time i.e. 90 people per annum between 2016 and 2021, 60 people per annum between 2021 and 2026, and 50 people per annum between 2026 and 2031 (NSW Planning and Environment, 2016). In addition, at the time of the 2016 Census, 15.9% (1,660) of the private dwellings in the Mid-Western Regional LGA were unoccupied. Consequently, the impact on housing and rental prices across the local area is expected to be positive but negligible. Further discussion regarding housing impacts is presented in the Social Impact Assessment (Umwelt (Australia) Pty Ltd, 2020).

Property Value Impacts

An issue raised during consultations with the community, was concern about the impact of the Project on property values around the Mine Site. The value of land is a function of the attributes of the property including structural, access and environmental attributes. For remote rural properties, there is a simple relationship between the agricultural income earning potential of the land and the capital value of the property.

There has been much conjecture about the impact of mines on surrounding property values but little rigorous study has been conducted. Conceptually, if surrounding properties are likely to be impacted by noise, air, vibration or visual impacts, then there would be some impact on property values, with the greatest impact on property values being felt by properties experiencing the greatest impacts. Logically, where impacts exist or are expected to exist, they are likely to be greatest with closer proximity to the mine and therefore there is likely to be some gradient of property value impact that decreases with distance from the mine.

However, the existence of property value impacts and the distance gradient of these impacts are expected to be related to actual or expected physical impacts from the site rather than a simple distance relationship. Where noise, dust, vibration, air, and visual impacts are contained, no impacts would be expected to occur.

4.19.4.6 Environmental and Social Effects (Externalities)

Externalities that potentially accrue to the local area are summarised in **Table 4.90.** The main potential residual impacts after mitigation, compensation and offsets relate to noise, air quality and visual impact on adjoining residents.

4.19.5 Supplementary Local Effects Analysis

4.19.5.1 Supplementary LEA Methodology

The LEA summarised in Section 4.19.4 has been prepared consistent with the NSW Government Guidelines (2015). However, in addition to this, a supplementary LEA has been prepared using an input/output (IO) analysis. An IO analysis allows for divergence from full employment, job chain effects and in-migration of labour to the local area. The IO method is based on a number of assumptions which are outlined in Annexure 5 of Gillespie Economics (2020), however, most notably, IO analysis assumes that the regional economy has access to sufficient labour and capital resources (from both inside and outside the region) so that an individual project does not result in any regional price changes e.g. wages in other industries or house rentals, which would lead to contractions ("crowding out") of economic activity in other sectors in the same region.

Table 4.90
Main Potential Environmental and Social Impacts on the Local Community

Environmental, Social and Cultural Costs	Incidence of Costs and Benefits	Comment
Agricultural impacts	Farmers whose land is required for the Project	Impacted farmers compensated via purchase of land. No material residual impact.
Surface water	Local surface water users who hold WALs	Willing sellers compensated via purchase of WALs. No material residual impact.
Groundwater	Local groundwater users who hold WALs	Willing sellers compensated via purchase of WALs. No material residual impact.
Air quality impacts	Adjoining landholders	Impacted owners compensated via acquisition of their property or negotiated agreement. No material residual impacts.
Noise impacts	Adjoining landholders	Impacted owners compensated via acquisition of their property, negotiated agreement or mitigation actions. No material residual impacts.
Ecology and biodiversity	Local and NSW households	Some loss of non-use values but offset by provision of biodiversity offsets.
Aboriginal heritage	Aboriginal people and other local and NSW households	No material impacts.
Historic heritage impacts	Local and NSW households	No material impacts.
Transport and traffic	Local residents	No material impacts.
Visual amenity	Adjoining landholders	Impacted landowners compensated via mitigation measures. No material residual impacts.
Source: Gillespie Economics (2020) – Table 5.5		

The consequence of the assumptions of IO analysis, is that IO modelling results provide an upper bound economic activity impact estimate.

Further details regarding the approach and assumptions are presented in Section 6 of Gillespie Economics (2020).

4.19.5.2 Results of Supplementary LEA

Using this approach, the total annual impact of construction on the local area economy is estimated at up to:

- $113M in annual direct and indirect output or business turnover;
- $49M in annual direct and indirect value added;
- $20M in annual direct and indirect household income; and
- 131 direct and 79 indirect local jobs.

The Project operation is estimated to make up the following contribution to the local area economy.

- $185M in annual direct and indirect output or business turnover.
- $94M in annual direct and indirect value-added.
- $37M in annual direct and indirect household income.
- 210 direct and 214 indirect jobs.

4.19.5.3 Mine Cessation

The operation of the Project would provide the direct and indirect economic activity outlined in Section 4.19.5.2 in the local area economy for approximately 15 years. Conversely, the cessation of the mining operations in the future would result in a contraction in local area economic activity.

The magnitude of the local area economic impacts of cessation of the Project would depend on a number of interrelated factors at the time, including:

- the movements of workers and their families;
- alternative development opportunities; and
- economic structure and trends in the local area economy at the time.

Ignoring all other influences, the impact of Project cessation on the local area economy would depend on whether the workers and their families affected would leave the area. If it is assumed that some or all of the workers remain in the local area, then the impacts of Project cessation would not be as severe compared to a greater number leaving the local area. This is because the consumption-induced flow-on from the decline would be reduced through the continued consumption expenditure of those who stay (Economic and Planning Impact Consultants, 1989). Under this assumption, the local area economic impacts of Project cessation would approximate the direct and production-induced effects (in the order of 80% of the total effects). However, if displaced workers and their families leave the local area then impacts would be greater and begin to approximate the total effects.

Ultimately, the significance of the economic impacts of cessation of the Project would depend on the economic structure and trends in the local area economy at the time. For example, if the Project cessation takes place in a declining economy, the impacts may be significant. Alternatively, if Project cessation takes place in a growing diversified economy where there are other development opportunities, the ultimate cessation of the Project may have little impact.

Nevertheless, given the uncertainty about the future prospects in the local area economy, it is not possible to predict the likely circumstances within which Project cessation would occur. Notwithstanding, not proceeding with the Project would not only forego the predicted economic benefits but also future opportunities, including the potential for development of surrounding deposits and therefore extension of the mine life and associated economic benefits.

4.19.6 Conclusion

An economic assessment for the Project was undertaken by Gillespie Economics (2020) in accordance with relevant guidelines and feedback from an independent peer review. The economic assessment has analysed the Project using both CBA and LEA methodology.

The results of the CBA conclude that the Project is estimated to deliver net social benefits (i.e. following the inclusion of environmental, social and cultural costs) globally between $78M and $181M, Nationally between $89M and $192M, and for the NSW community between $44M and $146M. Therefore, any unquantified residual impacts of the Project would need to be valued at greater than these benefits for the Project to be questionable from an economic efficiency perspective.

The LEA and supplementary LEA has also considered the impacts at a local scale. In terms of employment, during operation the Project would generate between 73 and 129 net direct FTE jobs and, with flow-on effects, between a further 74 and 131 net indirect FTE jobs. Employment effects would be even greater when allowance is made for people who migrate into the region. Furthermore, the potential for negative effects on other industries and wages is expected to be very small.

The peer review of the Economic Assessment concluded that, whilst some assumptions will remain contestable, in most instances the scale of these uncertainties is at the margin of the analysis such that they would not impact the conclusions. Where there is potential for significant deviations, such as anticipated metal prices or exchange rates, these have been appropriately examined in the sensitivity analysis.

4.20 SOCIAL IMPACTS

The social impact assessment of the Project was undertaken by Umwelt (Australia) Pty Ltd. The full assessment is presented in Volume 6 Part 17 of the Specialist Consultant Studies Compendium and is referenced throughout this section as Umwelt (2020).

4.20.1 Introduction

The risk assessment undertaken for the Project (Section 3.3.1 and **Appendix 7**) identifies key risk sources with the potential to result in social impacts. It is noted that other environmental risks, such as air, noise, visual etc, may also have social implications / impacts. These risk sources have been assessed throughout the respective sections of the EIS. Risk sources specifically relating to social impacts and the assessed risk of impacts after the adoption of standard mitigation measures are as follows.

- Land acquisitions by the Applicant resulting in loss of community and generational properties (High).
- Population increases associated with employment growth leading to changes in way of life (High).
- Population increases associated with employment growth resulting in the inability of existing health and community services to accommodate additional demand (Medium).
- Population increases associated with employment growth resulting in poor relationships between the existing community and mine workers / new arrivals (Medium).
- Population increases associated with employment growth leading to reduced housing availability and increased housing costs (Low).

In addition, the SEARs issued by the former DPE identified “social” as a key issue requiring assessment. The principal assessment requirements identified by the former DPE relating to social matters included the following.

- Assessment of the likely social impacts of the development on the local and regional community generally in accordance with the Social Impact Assessment Guidelines for State Significant Mining, Petroleum Production and Extractive Industry Development (DPE, 2017), including:
  - likely impacts of the development on the local community;
  - cumulative impacts (considering other mining developments in the locality); and
  - consideration of workforce accommodation.

It should be noted that the provision of on-site workforce accommodation is not a component of the Project.

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the SEARs from the Mid-Western Regional Council and the Lue and District Community. These requirements are summarised as follows.

- Identify likely housing and potential construction required for the workforce.
- Undertake a full analysis of the impacts on housing, rental housing, infrastructure, traffic, health and other social impacts and provide realistic measures to mitigate those impacts.
- Address impacts on the way of life and 'sense of community' in Lue.
- Address the long-term effects of the mine on current and future generations of residents.
- Assess the impact of the mine on the tourism industry in the area.

A full summary of these matters is provided in **Appendix 3**, together with a cross reference to where these are addressed within the EIS and/or SCSC.

4.20.2 Existing Social Context

4.20.2.1 Geographic Context

The Mine Site is located approximately 26km east of Mudgee and 2km to 3km northeast of Lue. The Mine Site is proximal to the State suburbs of Lue, Pyangle, Bara, Havilah and Monivae, all of which fall within the Mid-Western Regional LGA (**Figure 4.20.1**). The Mid-Western Regional LGA is located in the Central West of NSW with the township of Mudgee being the major commercial and urban centre. The Mid-Western Regional LGA also includes a number of small villages and towns including Lue, Windeyer, Gulgong, Ulan, Wollar, Bylong, Rylstone and Kandos (see **Figure 4.20.1**).

4.20.2.2 Governance

Lue lies within the Mid-Western Regional LGA and is governed by the Mid-Western Regional Council (MWRC, the Council). Council has developed a range of key plans and strategies for the governance of the LGA. These include the:

- *Mid-Western Regional Local Environmental Plan 2012*;
- Mid-Western Region Towards 2030 Community Plan; and
- Mid-Western Regional Comprehensive Land Use Strategy (2010).

These are further discussed in Section 3.2.3.6.

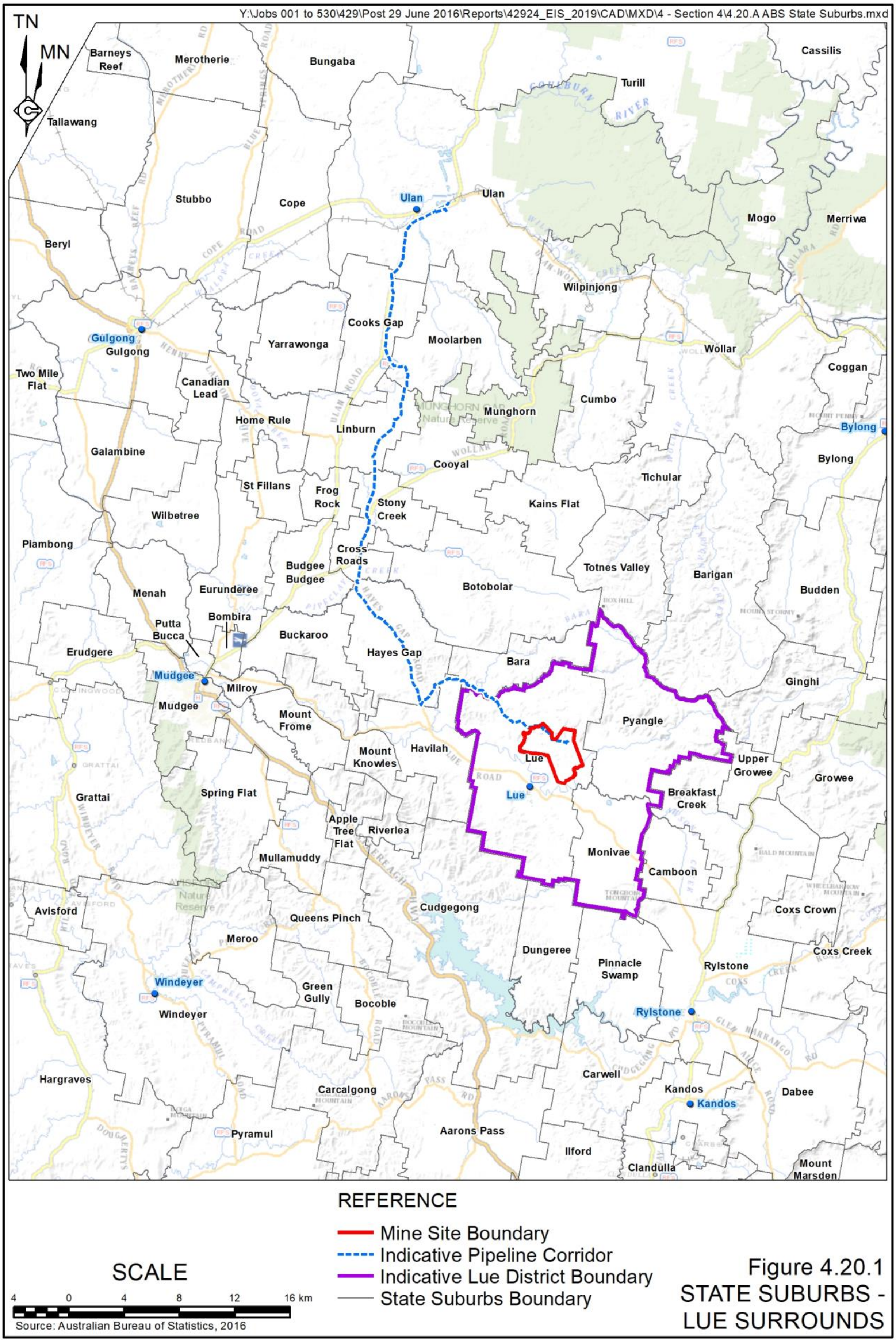


Figure 4.20.1
STATE SUBURBS - LUE SURROUNDS

4.20.2.3 Cultural and Historic Context

Aboriginal people of the Wiradjuri language group occupied the land in the vicinity of the Mine (the southwest slopes region) at the time of first contact with Europeans (Landskape, 2020). The first Europeans to visit the southwest slopes arrived in an 1818 expedition of the Macquarie River. Over time, interactions between Europeans and the Wiradjuri led to violent conflict in the area. The historical presence of both Aboriginal people and pastoral and mining activities are reflected in the written histories, buildings and artefacts present in the vicinity of Lue.

An assessment of the Aboriginal cultural heritage and historic heritage setting for the Project was undertaken by Landskape (2020) and is provided as Volume 4 Part 13 of the *Specialist Consultant Studies Compendium*. Sections 4.14.2 and 4.15.2 of the EIS provide a summary of the Aboriginal cultural heritage and historic heritage setting for the Project.

Consultation for the preparation of the Aboriginal and Historical Cultural Heritage Assessment included the following Aboriginal parties.

- Mudgee Local Aboriginal Land Council.
- Murong Gialinga Aboriginal and Torres Strait Islander Corporation.
- Mingaan Wiradjuri Aboriginal Corporation.
- Wellington Valley Wiradjuri Aboriginal Corporation.
- North Eastern Wiradjuri Company Limited.
- Warrabinga Native Title Claimants Aboriginal Corporation.
- Gallanggabang Aboriginal Corporation.
- Mr Bradley Bliss.
- Mr Paul Brydon.

4.20.3 Social Profile

4.20.3.1 Introduction

The social impact assessment provides an extensive social profile through the use of fundamental 'capital assets' of a community which include the following.

- Natural Capital
- Human Capital
- Social Capital
- Economic Capital
- Physical Capital

The following subsections provide a very brief summary of key aspects of each capital asset with a full description and background provided in Section 5 of the social impact assessment Umwelt (2020).

4.20.3.2 Natural Capital

Natural capital includes the stock of natural resources e.g. minerals, oil and gas, agricultural lands, oceans, forests etc. that provide natural beauty, generate sustainable economic and commercial activities and which provide ecosystem services.

Key aspects of the local and regional natural capital within the Mid-Western Regional LGA include quality agricultural land, community value for the natural environment and the area's rich mining resources. Specific examples include the following.

- The Mid-Western Regional LGA hosts a number of natural reserves, including the Munghorn Gap Nature Reserve, Cudgegong River, Dungeree State Forest, Avisford Nature Reserve and Capertee Valley.
- Mudgee is a well-known food and wine destination and features an annual Food and Wine Festival.
- Other tourist attractions in the region include Gulgong, a historic goldmining town with over 130 heritage listed buildings, Windamere Dam, Munghorn Gap Nature Reserve, Dunns Swamp (Ganguddy), the Henry Lawson Centre, the Colonial Inn Museum (Mudgee), Kandos Museum, Gulgong Pioneers Museum and the Mudgee Observatory.
- As at the 2016 ABS Census, approximately 9% of workers in the Mid-Western Regional LGA reported the census category of 'agriculture, forestry and fishing' as their industry of employment, compared with 2% across NSW more broadly.
- The Mid-Western LGA has a long history of mining with three operating coal mines, twenty-six current mineral exploration licences and over 680 known mineral occurrences including silver, gold, copper and lead.

Risks to natural capital relate to heightened concern around water supply and the need for the environmental impacts of mining activity across the region to be managed.

4.20.3.3 Human Capital

Human capital incorporates the health and welfare of human beings, their knowledge and skills, as well as their overall capacities to contribute to ongoing community sustainability. **Tables 4.91** and **4.92** provide summaries of the key human capital indicators for the key State suburbs relevant to the Project compared with data for the Mid-Western Regional LGA and NSW.

Umwelt (2020) identified that the key issues or restraining factors relating to the Mid-Western Regional human capital included limited health services, exacerbated by difficulties in attracting and retaining medical personnel (general practitioners). There are also limited tertiary education options available and evidence of an ageing population. However, it is noted that the local population is growing, and the Mudgee hospital redevelopment will provide opportunities to enhance the skills base of the local population by attracting and providing employment opportunities for additional health professionals.

Table 4.91
Summary of Key Human Capital Indicators for Key State Suburbs

Indicator	Kandos	Gulgong	Lue	Mudgee	Rylstone	Mid-Western Regional	NSW
Population	1 318	2 518	193	10 927	920	24 074	7 480 231
Indigenous (%)	5	8	5	6	4	5	3
Gender – Males/Females (%)	51:49	49:51	52:48	49:51	49:51	50:50	49:51
Median Age (years)	52	41	46	37	50	42	38
Proportion born overseas (%)	10	7	10	8	11	8	30
Education to Year 12 or equivalent (%)	24	33	36	42	35	39	59
Equivalent Post-Secondary Education (%)	28	35	31	43	41	41	49
Bachelor's degree level attainment (%)	7	10	9	16	14	14	26
Living with a profound or severe disability (%)	-	-	-	-	-	5.8	5.6
Earning or learning (%)	-	-	-	-	-	77.2	85
Children Developmentally vulnerable in two or more domains (2015)	-	-	-	-	-	7.6	9.6
Source: Umwelt (2020) – Modified after Table 5.7							

Table 4.92
Summary of Key Human Capital Indicators for Additional Lue and Water Pipeline State Suburbs[11]

Indicator	Monivae	Pyangle	Bara	Havilah	Hayes Gap	Budgee Budgee	Cross Roads	Stony Creek	Linburn	Moolarben	Cooks Gap	Ulan
Population	33	17	25	20	14	196	19	56	56	17	533	58
Indigenous (%)	-	-	-	-	-	-	-	-	-	-	9	-
Gender – Males/Females (%)	49:51	64:36	59:41	52:48	35:65	57:43	48:52	53:47	52:48	54:46	65:35	50:50
Median Age (years)	38	37	27	46	53	51	46	37	34	41	57	43
Proportion born overseas (%)	30	0	0	18	0	0	2	13	7	7	0	10
Education to Year 12 or equivalent (%)	65	0	20	77	0	37	100	63	23	0	32	46
Equivalent Post-Secondary Education (%)	68	27	60	33	30	53	41	63	27	18	39	35
Bachelor's degree level attainment (%)	17	0	27	21	0	18	0	13	23	0	10	0
Source: Umwelt (2020) – Modified after Table 5.8												

[11] Note that all these State Suburbs, except for Cooks Gap and Budgee Budgee, are considered to have too small a population for proportions to be considered accurate. As such, data should be interpreted as indicative only.

4.20.3.4 Social Capital

Social capital refers to how individuals, groups, organisations and institutions within a community interact and cooperate; and is a multifaceted concept that can broadly be defined as the dynamics and strength of relationships and/or interactions within a given community, including the degree of social cohesion and interconnectedness between community members.

Tables 4.93 and **4.94** provide summaries of the key social capital indicators for the key State suburbs relevant to the Project compared with data for the Mid-Western Regional LGA and NSW.

Umwelt (2020) identified that the issues affecting social capital in the region include risks from isolation, substance abuse, family breakdown, lack of youth awareness of existing support services and facilities, under-utilisation of existing facilities, lack of regular recreational events especially in outlying areas, and youth access to existing recreational/cultural activities. There is a shortage of short and long-term accommodation (that is perceived to be connected to mining industry growth) and temporary accommodation options often segregate people from the local community. Conversely there are opportunities available through high rates of volunteering in the region, local support for the arts and cultural development across the Region, Council programs to improve housing, burgeoning tourism including a new art gallery and the generally tight-knit community.

Table 4.93
Summary of Key Social Capital Indicators for Key State Suburbs

Indicator	Kandos	Gulgong	Lue	Mudgee	Rylstone	Mid-Western Regional	NSW
Married (%)	36	45	55	45	45	48	49
Families with children (%)	31	40	37	43	30	41	46
Families with no children (%)	47	40	49	37	49	42	37
Single parent family (%)	21	18	14	18	18	16	16
Group households (%)	3	2	0	3	4	3	4
Single (or Lone) person households (%)	42	31	28	29	31	29	24
Proportion living at a different address 1 year ago (population mobility) (%)	12	13	9	17	14	14	14
Proportion living at a different address 5 years ago (population mobility) (%)	28	34	20	45	33	37	39
Volunteered through an organisation or group (last 12 months) (%)	21	21	20	20	25	22	18
Proportion of the population over 65 receiving a pension (%)	-	-	-	-	-	66.1	63.2
Poor proficiency in English (%)	-	-	-	-	-	0.3	3.8
Source: Umwelt (2020) - Table 5.15							

Table 4.94
Summary of Key Social Capital Indicators for Additional Lue and Pipeline State Suburbs[12]

Indicator	Monivae	Pyangle	Bara	Havilah	Hayes Gap	Budgee Budgee	Cross Roads	Stony Creek	Linburn	Moolarben	Cooks Gap	Ulan
Married (%)	63	40	70	73	50	63	76	56	58	76	48	33
Single (or Lone) person households (%)	0	0	46	0	60	16	0	14	13	0	22	21
Proportion living at a different address 1 year ago (population mobility) (%)	0	0	72	18	0	21	18	8	5	0	9	5
Proportion living at a different address 5 years ago (population mobility) (%)	44	63	72	45	0	38	0	40	30	0	33	53
Volunteered through an organisation or group (last 12 months) (%)	50	0	40	45	30	28	35	34	27	18	16	15
Source: Umwelt (2020) – Table 5.16												

4.20.3.5 Economic Capital

Economic capital is the extent of financial or economic resources within a town or community, including employment opportunities, income levels and cost of living. **Tables 4.95** and **4.96** provide summaries of the key economic capital indicators for the key State suburbs relevant to the Project compared with data for the Mid-Western Regional LGA and NSW

Table 4.95
Key Economic Capital Indicators for Key State Suburbs

Indicator	Kandos	Gulgong	Lue	Mudgee	Rylstone	Mid-Western Regional	NSW
Median total personal income ($/ weekly)	420	523	504	623	474	547	664
Median total household income ($/ weekly)	698	1,086	825	1 256	856	1 131	1 486
Median mortgage repayment ($/monthly)	867	1 517	1 322	1 733	1 495	1 690	1 986
Median rent ($/weekly)	190	250	250	300	220	270	380
Labour force participation (15-85 years) (%)	33.0	52.4	51.9	57.9	45.9	54.1	59.2
Unemployment (%)	16.5	8.6	5.0	5.8	8.4	6.5	6.3
Financial stress from mortgage or rent (2016) (%)	-	-	-	-	-	22.4	29.3
Employment in mining (%)	8.9	19.6	3.7	16.9	11.2	15.0	0.9
Source: Umwelt (2020) – Table 5.18							

[12] Proportions, medians and averages for all State suburbs except for Cooks Gap and Budgee Budgee are impacted by random adjustments to Census data and should be interpreted as indicative only.

Table 4.96
Key Economic Capital Indicators for Additional and Pipeline State Suburbs[13]

Indicator	Monivae	Pyangle	Bara	Havilah	Hayes Gap	Budgee Budgee	Cross Roads	Stony Creek	Linburn	Moolarben	Cooks Gap	Ulan
Median total personal income ($/ weekly)	784	887	379	824	725	568	900	687	486	389	491	462
Median total household income ($/ weekly)	1 625	1 812	1 687	2 250	1 562	1 062	2 583	1 096	1 375	1 625	1 812	1 687
Median mortgage repayment ($/monthly)	-	-	-	-	-	1950	-	2295	1813	-	1600	-
Median rent ($/weekly)	-	-	-	250	-	280	-	-	230	-	240	210
Labour force participation (15-85 years) (%)	58.3	20.0	35.0	86.4	40.0	63.9	76.5	80.5	71.1	64.7	49.1	43.6
Unemployment (%)	-	-	-	-	-	3.2	-	-	-	-	4.3	-
Employment in mining (%)	-	-	-	-	-	18.6	-	9.4	20.0	50.0	19.3	42.9
Source: Umwelt (2020) – Table 5.19												

The region has increasingly strong and diverse industries including mining, tourism and agriculture with Council support for projects that are intended to create new jobs in the region and help to build a diverse and multi-skilled workforce as well as the expansion of essential infrastructure and services to match business and industry. The business services sector is strongly represented in the region. Barriers to economic capital in the region include labour force competition due to mining activity and an increasing retirement age population that reduces the skilled employee base. Notwithstanding, at a more localised level, there are high levels of unemployment in Kandos (16.5%), Gulgong (8.6%) and Rylstone (8.4%), compared to Mid-Western Regional LGA (6.5%) and NSW (6.3%) (see **Table 4.95**).

4.20.3.6 Physical Capital

Physical capital is broadly defined as a town or community's built infrastructure and services, including hospitals and schools as well as social services, e.g. health care, aged care, child care. **Tables 4.97** and **4.98** provide summaries of the key physical capital indicators for the key State suburbs relevant to the Project compared with data for the Mid-Western Regional LGA and NSW.

[13] Medians and proportions may be impacted by random adjustments in low population areas, particularly in the smallest communities of Pyangle, Hayes Gap, Crossroads, and Moolarben (population 14-19); and the small communities of Monivae, Bara, and Havilah (population 20-33).

Table 4.97
Summary of Key Physical Capital Indicators for the State Suburbs

Indicator	Kandos	Gulgong	Lue	Mudgee	Rylstone	Mid-Western Regional	NSW
Total Occupied Dwellings (%)	87	89	82	88	82	84	90
Total Private Dwellings	660	1 020	87	4 511	472	10 426	2 889 057
Separate houses[14] (%)	92	91	94	86	97	91	66
Owned outright (%)	47.6	37.3	46.5	28.2	48.1	38.0	32.2
Owned with a Mortgage (%)	18.7	30.5	38.0	31.5	24.8	30.6	32.3
Rented (%)	29.3	28.2	7.0	36.5	24.3	27.4	31.8
Other Tenure Type (%)	0.5	0.7	0.0	0.3	0.0	0.7	0.9
Average Household Size	2	2.4	2.6	2.4	2.2	2.4	2.6
Number of people per bedroom (average)	0.7	0.8	0.7	0.8	0.7	0.8	0.9
Internet accessed from dwelling (%)	64	76	78	78	75	77	85
Travel to Work as a Driver – Car (%)	63	67	59	69	66	66	58
Average number of cars per dwelling	1.4	1.7	1.7	1.6	1.8	1.8	1.6
Rent assistance from the Australian Government - 2017 (%)	-	-	-	-	-	19.3	16.3
Overcrowding (%)	-	-	-	-	-	2.1	5
Source: Umwelt (2020) – Table 5.24							

Table 4.98
Summary of Key Physical Capital Indicators for Additional Lue and Pipeline State Suburbs[15]

Indicator	Monivae	Pyangle	Bara	Havilah	Hayes Gap	Budgee Budgee	Cross Roads	Stony Creek	Linburn	Moolarben	Cooks Gap	Ulan
Total Occupied Dwellings (%)	-	-	-	-	-	88	-	-	-	-	81	-
Total Private Dwellings	13	16	12	10	5	78	10	16	24	7	230	26
Separate houses[16] (%)	100	100	100	89	100	94	-	100	100	100	98	86
Owned outright (%)	50.0	0.0	38.5	33.3	60.0	44.9	75.0	14.3	39.1	42.9	39.8	21.4
Owned with a Mortgage (%)	30.0	-	30.8	-	-	47.8	-	42.9	30.4	-	42.5	-
Rented (%)	-	-	23.1	55.6	-	11.6	-	14.3	17.4	71.4	15.1	85.7
Average Household Size	3.3	0	1	2	1.5	2.6	2	2.9	2.5	2	2.7	2.1
Number of people per bedroom (average)	-	0.6	0.6	-	0.8	0.7	0.5	0.8	0.5	-	0.6	0.6
Internet accessed from dwelling (%)	100	80	85	100	76	91	43	75	64	100	80	85
Travel to Work as a Driver – Car (%)	93	100	50	40	75	59	-	63	56	50	73	57
Average number of cars per dwelling	0.8	-	1.3	1.7	1.2	2.4	2.0	1.1	2.0	1.3	2.0	2.0
Source: Umwelt (2020) – Table 5.25												

[14] As a proportion of total dwellings.
[15] Proportions, medians and averages for all community's except for Cooks Gap and Budgee Budgee are impacted by random adjustments to Census data and should be interpreted as indicative only.
[16] As a proportion of total dwellings.

Umwelt (2020) identified the following issues relating to physical capital in the region.

- Traffic congestion and the need for road infrastructure and road surfaces upgrades.
- A lack of public transport options.
- Waste and sewer systems require upgrade (e.g. Kandos.)
- Broadband and mobile coverages need upgrading.
- Expansion of the mining industry has the potential to place strain on infrastructure.
- Limited commercial flights per week
- Waste services (including kerb side pickup) are reaching capacity.

However, the following opportunities were also identified.

- Continued investment in road upgrades including Wollar Road.
- Historic character of region.
- Upgrades and development of recreational infrastructure for youth including a water park, skate park upgrades and district adventure playground.
- Recent stormwater drainage improvements (e.g. Mudgee) an improvements to footpaths and shared cycleways.
- Food and garden waste collection service being implemented.
- Mudgee hospital redevelopment which will upgrade the available health services and facilities.

4.20.4 Social Impact Assessment Engagement

4.20.4.1 Summary of Engagement and Assessment Methods

In addition to consultation undertaken by Bowdens Silver (see Section 3.2.2), Umwelt (2020) has undertaken an extensive program of engagement to inform the social impact assessment. Engagement has been undertaken at key phases throughout the Project and has provided the opportunity for Bowdens Silver to identify key community issues, address these through the Project design and assessment (see Section 4.20.5) and then seek feedback on these measures.

Table 4.99 provides a summary of the engagement and assessment methods that have been adopted during each phase of the social impact assessment.

Table 4.99
Summary of Social Assessment Methods by Social Impact Assessment Phase

Page 1 of 2

Method	Description
Phase 1	**Community Profiling**
Community Capitals Analysis	Assessment and analysis of ABS Census data and other relevant social and community indicators and data sets to develop a detailed social baseline profile of the study communities. Areas of existing community resilience and vulnerability have been identified through application of a community capitals analysis.
Township Resource Cluster (TRC) Analysis	Documentation of the potential social and economic linkages/associations between Bowdens Silver and communities within the LGA and across the State, through analysis of existing employee and community investment data.
Indigenous profile and issues analysis	Review of socio-economic statistics relevant to the Aboriginal population. Face to face and telephone interviews with Aboriginal groups and service providers in the Mid-Western Regional LGA.
Community Visioning Assessment	Visioning workshop held with the local Lue Public School Students (1 teacher, 6 students). Interviews with key stakeholders with an interest in Lue and its surrounds.
Phase 2	**Scoping of Issues and Opportunities**
Key Stakeholder Issues Analysis	Survey of near neighbours/landholders residing, or who own property, in proximity to the Mine Site and key stakeholders, to identify perceived issues and opportunities relating to the Project n=69 (Round 1 interviews). Mechanisms have included face to face and telephone interviews, Project briefings, community information sessions, town forums. Provision of three Project information sheets - 1) outlining the Project and the assessment process; 2) summarising the outcomes of the engagement and scoping phase of the Project; and 3) outlining the outcomes of the technical assessment studies and proposed mitigations and enhancements. Ranking of perceived issues and opportunities by relative frequency.
Consultation and Complaints data analysis	Review and analysis of Bowdens Silver engagement data including meetings, phone calls, newsletter and community complaints.
Service Provider Survey	Survey of service providers (n=37) across the Mid-Western Regional LGA in sectors including education, childcare, health, recreation, youth, housing, employment and social services. The purpose of this survey, was to: • provide an update to the findings of the Manidis Roberts (2012) community infrastructure and services capacity assessment and assess the realisation of predictions made in the 2012 report; • assess capacity to accommodate additional population change as a result of the Project, due to proposed construction and operational workforce influx; • better understand key drivers in the Mid-Western Regional LGA in relation to the provision of community services and the capacity of these services to respond to change; • gain a detailed understanding of the potential impacts of the proposed Bowdens Silver workforce (construction and operation) on Mudgee, Gulgong, Lue, Kandos and Rylstone; and • identify strategies to minimise impacts on community services.

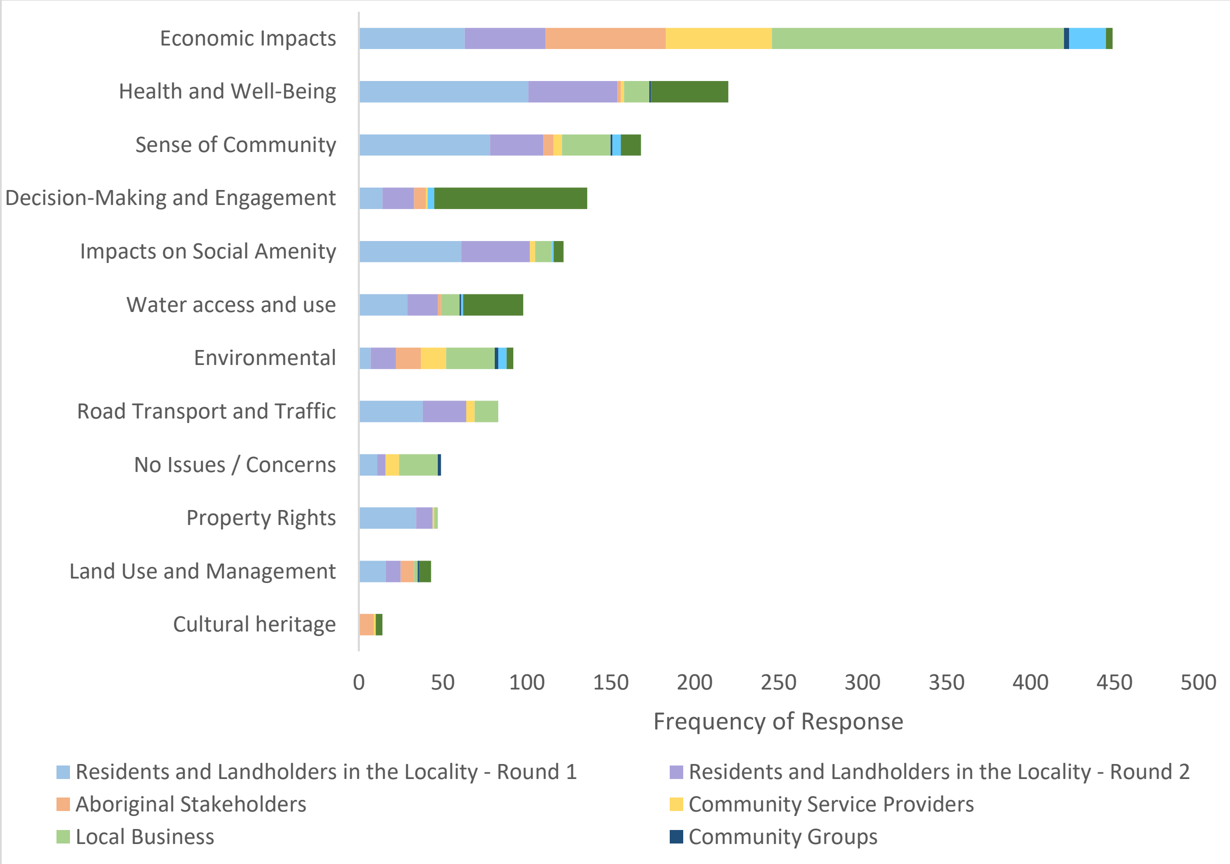
Table 4.99 (Cont'd)
Summary of Social Assessment Methods by Social Impact Assessment Phase

Page 2 of 2

Method	Description
Phase 2	**Scoping of Issues and Opportunities (Cont'd)**
Local Business and Supplier Survey	In order to understand the types of services and skills available in the region, a skills and capacity audit was conducted amongst businesses throughout the Mid-Western Region. The survey was conducted between 30 May and 10 July 2019. To ensure as many local businesses as possible were included in the survey, Umwelt contacted the local business associations within the region. These included: • Mudgee Chamber of Commerce • Gulgong Chamber of Commerce • Rylstone Kandos Business and Tourism Inc. A total of 195 businesses were contacted, via email and direct calls, to participate in the survey. Of those businesses contacted, 87 chose to participate in the survey (with one business participating anonymously), 97 did not respond; 10 declined and 1 business had ceased operations, yielding a response rate of 45%.
Phase 3	**Assessment and Impact Prediction**
Social Risking	Assessment of social risks/impacts associated with the Project through review of relevant social and environmental consequence and likelihood ratings and defined impact characteristics as defined in the SIA Guideline (extent, duration, sensitivity/vulnerability and severity). Prediction of social impacts associated with the Project.
Key Stakeholder issues analysis - impacts and opportunities	Engagement with residents and landholders in the locality, proximal landholders and regional community members to discuss outcomes of the social and environmental technical studies and further identify perceived issues and opportunities relating to the Project. Provision of a dedicated Project Information Sheet (No.3) summarising the key preliminary outcomes of the assessment studies and proposed mitigation measures and enhancements. In summary, mechanisms have included the following. • Face to face meetings and telephone interviews with proximal landholders and residents and landholders in the locality, n=60 (Round 2 interviews). • Open Day (held at the Bowdens Silver Mine Site, approximately 100 people in attendance) to afford input from residents and landholders in the locality, key stakeholders and the regional community on the impacts and opportunities relating to the Project. • Targeted briefings with key stakeholder groups to provide feedback on the outcomes of key assessment studies, n=4. • Two Community Information Sessions to provide an overview of the Project and its assessment outcomes (25 attendees). • Community survey to gather feedback on the Project, distributed to attendees at the Open Day (June 2019) and the Community Information Sessions (June 2019); and also distributed to regional community members at local community venues, n=59.
Phase 4	**Mitigation and Management**
Social Risk Matrix	Categorisation of impacts by social impact category and theme. Identification of perceived and technical Project risk. Prediction of significant social impacts relating to the Project based on assessment of key impact characteristics: extent, duration, severity and sensitivity.
Social Impact Management and Residual Risk Ranking	Identification and development of appropriate strategies (mitigation and enhancement) to address significant predicted impacts (moderate, high, extreme) from the Project and residual risk post strategy implementation.
Source: Umwelt (2020) – Modified after Table 3.4	

4.20.4.2 Summary of Social Engagement Outcomes

Figure 4.20.2 provides a summary of the frequency that categories of potential issues and opportunities associated with the Project were identified by stakeholders across each of the stakeholder groups engaged. This provides an indication of the importance of each potential impact theme to the various stakeholder groups consulted.



Residents and landholders Round 1 n=69; Residents and landholders Round 2 n=60; Aboriginal stakeholders n=8; Community service providers n=37; Local business n=87; Community groups n=4; Bowdens Silver employees n=16; CCC n=13.
Note: Multiple responses

Source: Umwelt (2020) – Figure 6.1

Figure 4.20.2
PERCEIVED POSITIVE AND NEGATIVE IMPACTS - ALL STAKEHOLDERS

A number of consistent themes were identified across each of the stakeholder groups, with certain themes more prominent for particular stakeholder groups than others. These are discussed as follows.

Economic

As illustrated in **Figure 4.20.2**, when considering all stakeholder categories together, the most commonly identified impacts were those related to the economy and economic aspects of the Project. Whilst stakeholders naturally tend to focus on negative issues/impacts, all stakeholder groups surveyed acknowledged the positive impacts of the Project associated with employment and opportunities for local and regional businesses and community contribution and investment by the Company within the LGA to varying degrees. The potential for the Project to provide a much needed economic stimulus, and to further diversify the regional economy was also acknowledged.

Health and Well-Being

The potential negative impact of most concern across all the stakeholder groups consulted related to human health and well-being, including perceived health impacts associated with exposure to lead, particularly in dust/air and water. Health and well-being concerns were heavily discussed among CCC members at scheduled meetings, with the potential for lead contamination of specific concern to residents and landholders in the locality and those residing in proximity to the proposed Project.

Within the health and well-being aspect, a key sub issue of concern was the potential for the contamination of local creeks, waterways and storage dams due to the leaching of contaminants into groundwater and surface water. This concern was noted by local business representatives, members of the Lue Action Group and neighbouring residents. The impacts on local farming and domestic livelihoods were also noted, due to potential contamination of crops and food grown in the locality.

Sense of Community

Sense of Community was the third most frequently raised issue across all stakeholder groups, with a focus on the rural amenity and sense of community associated with living in the Lue area. Those living in closest proximity to the Project were more concerned that the sense of community in the locality would be in jeopardy as a result of local residents exiting the area and due to new residents with differing values relocating into the area. However, for other groups, there was a view that sense of community could be strengthened by the influx of a new population to the area as a result of employment and business opportunities generated by the Project, and through infrastructure improvements related to the Project e.g. roads, Company investment in the community.

Decision-Making and Engagement

Aboriginal stakeholders and proximal residents/landholders indicated a preference to see the Company engage actively with the community and to build and maintain respectful relationships. There was also a desire to receive regular Project updates, details around Project planning and assessment and Project milestones. CCC members strongly expressed a desire for clear, open and transparent information provision and engagement opportunities. Local business and service providers generally indicated a level of trust in the Company and industry more broadly to address environmental concerns appropriately, through the provision of appropriate impact management approaches. Further conversations centred around the assessment and approvals process for State significant developments; with additional questioning of the Project's scope and design. Legacy issues associated with the history of the Project in the community, and the historical 'stop-start' nature of the Project to date were also noted.

Social Amenity

Social amenity impacts were of most concern to those residing within and around Lue, with residents and landholders in the locality concerned that the Project would create significant change to the area. These concerns were intricately linked to the perceived impacts on sense of community, with stakeholders suggesting that operational noise, noise from blasting, dust and visual impacts, would ultimately affect local residents' rural lifestyle and sense of place.

Water Access and Use

Considering the prevailing drought conditions within the Mid-Western Regional LGA, water access and use was an impact frequently raised across multiple stakeholder groups. Consequently, Bowdens Silver has attempted to address this issue through the proposal to develop a water pipeline from mine(s) in the Ulan coal fields to provide water to the Project. The proposed pipeline elicited mixed sentiment across stakeholders consulted, with some perceiving the pipeline as a positive strategy, in utilising excess water from coal mines operating in the area, and leaving current water supply untouched; with others questioning the water quality and that obtaining water from one catchment to support another would still result in an impact on water resources in the region.

Environmental

While specific environmental impacts were more likely to be noted by residents and landholders residing in closer proximity to the Project, other stakeholders such as community service providers and local businesses were more likely to raise environmental issues more generally in relation to the Project.

Road Transport and Traffic

Traffic related impacts were also of greater concern to those living in proximity to the Project, with safety and access to private property contributing to negative perceptions. It was also raised that increased traffic movements by employees, contractors and trucks transporting equipment and concentrate product could potentially impact on existing traffic movements within Lue and the LGA. Community service providers and businesses however, suggested that road infrastructure improvements and economic contributions of the Project would benefit the LGA.

Property Rights

Concerns regarding property rights were largely raised by landholders proximal to the proposed operations. However local businesses and service providers from the real estate sector also perceived that property impacts may occur as a result of the Project. Expressed stakeholder views were largely based on perceptions of the impacts associated with the development of other industries in the region, namely coal mining operations, the cement works, and solar farm, and included fluctuations in property values during influx and outflux of industry workforces. A minority of stakeholders within each group were of the view that property values could potentially increase in response to increased demand for housing, however, the majority of stakeholders across each group, felt that property values could decline due to the proximity of the proposed mining operations or the presence of the water supply pipeline within their landholding.

Land Use and Management

Land use and management issues attracted a number of responses from multiple stakeholder groups, although differences were noted within the sub-themes discussed by each group. Rehabilitation was most frequently noted by Aboriginal stakeholders, who expressed a desire to be included in the progressive rehabilitation of the operation and in the consideration of post mining land uses. There was also a desire to ensure that cultural heritage should be protected and that any removed artefacts should be replaced in due course. CCC members also expressed land use and management concerns and repeatedly questioned the Company’s ability to ensure adequate and secured funding for rehabilitation during and post mining.

The potential conflict in land use in the Lue locality was noted by residents and landholders, given Lue's historical agricultural focus and regional tourism capacity. There was a view, among these stakeholders, that the Project would impact on these values and inhibit further development of these industry sectors.

Cultural Heritage

The cultural heritage of Aboriginal people was considered to be intrinsically linked with the protection of the environment and the preservation of the natural and spiritual landscape. Aboriginal stakeholders held concerns for their cultural heritage and required assurance that protocols for cultural site integrity be followed and maintained. Overall, Aboriginal stakeholders were appreciative of the Company's engagement efforts and respect for cultural issues.

4.20.5 Management and Mitigation Measures

Potential social impacts have initially been minimised as part of the mine planning process. Mine planning has been an iterative process taking into consideration various matters including issues identified by the community during consultation and engagement. Section 1.5.7 provides further detail relating to design alternatives considered with the following providing a summary of the key design aspects which have avoided or minimised potential social impacts.

- Development of a water supply pipeline from Ulan Coal Mine and/or Moolarben Coal Mine for a make-up water supply thereby reducing the use of other productive water supplies.
- Relocation of the processing plant further north, away from Lue, thereby reducing dust and noise impacts.
- No worker accommodation on site reducing potential impacts upon social cohesion and mental health of workers and their families.
- Relocation of Maloneys Road to the west of Lue to reduce traffic impacts and avoid transportation through Lue.

In addition to these design considerations, the following strategies are proposed to address potential social impacts relating to the Project as proposed.

Landholder Mitigation Measures and Environmental Management Plans

In addition to those landholders that would have acquisition or mitigation rights under the Voluntary Land Acquisition and Mitigation Policy (VLAMP), Bowdens Silver have committed to offering mitigation rights to landholders in a broader management zone that may experience negligible impacts that would not otherwise fall under the scope of VLAMP. In consideration of privacy, details of these landholders and the property specific measures offered will be provided separately to DPIE. However, the proposed mitigation would involve visits to the properties by an acoustic specialist and qualified builder to identify the most effective manner in which to reduce the impact of noise levels generated by the Project and commissioning of that work.

A range of environmental management plans, including for noise, air quality, blasting, traffic, visibility and water would also be prepared which outline the broader management measures and monitoring programs associated with the Project. Further detail relating to the proposed management and monitoring for each of these aspects is provided within Sections 4.2 to 4.9 and 4.12. The plans would be prepared at various stages, though all would be finalised within 12 months of commencement of the site establishment and construction activities commencing.

Lue and Regional Community Investment Program

A Community Investment Program (CIP) would be developed with the following objectives.

1. Work collaboratively with near neighbours/proximal landholders and key stakeholders to develop environmental and community benefits for the Lue, Rylstone and Kandos localities that enhance local values of the areas and address community needs.
2. Facilitate enhancement initiatives specifically for those residents living in closest proximity to the Mine Site.
3. Develop projects and programs that are consistent with community needs, values and aspirations.
4. Contribute to the local community and better target community investment spend locally.

As part of the social impact assessment engagement process, a range of potential enhancement projects have been identified in the following areas.

- Education, youth and recreation.
- Health.
- Sense of community, including infrastructure and organisations.
- Land management and rehabilitation.
- Heritage and tourism.
- Aboriginal community.
- Public utilities.

The development of the CIP would involve further engagement with the community and key stakeholders such as through a workshop process to identify further potential community enhancement opportunities and to prioritise concepts for development. The program would be implemented by a Community Investment Committee and relevant community reference groups with a charter and governance process to guide decision making as well as an evaluation framework.

The CIP would be funded through a monetary contribution by Bowdens Silver. It is intended that the quantum of the monetary contribution and mechanism for management of the CIP would be developed prior to determination of the application and implemented once the scope and timing of projects to be funded has been agreed. Project themes or priorities would be determined in consultation with the local community with a focus on the distribution of the economic benefits of the Project within Lue and other key localities in the LGA.

It is noted that, as a result of the engagement and assessments undertaken to date, Bowdens Silver has committed to the appointment of a general practitioner (GP) or medical officer on a contract basis to mitigate the potential impacts of the Project workforce on health services.

Mid-Western Regional Council Planning Agreement

Planning agreements are agreements entered into between a developer and the Minister for Planning or council to provide either monetary contributions to or the physical provision of public amenity and public services, transport or other infrastructure. Bowdens Silver has initiated discussions with MWRC regarding a planning agreement between the Company and Council to provide monetary or in-kind contributions to Council. It is intended that the contributions made to MWRC would complement Bowdens Silver's CIP which is planned to target the distribution of funds for a range of projects and initiatives within the Lue, Rylstone and Kandos and district communities.

The terms of the Planning Agreement would be finalised (including the quantum of financial contributions) prior to determination of the development application in agreement with Council and as a result of consultation with the local community and planning officers within Council.

Local Employment and Procurement Strategy

Bowdens Silver would develop a Local Employment and Procurement Strategy aimed at maximising the economic impacts of the Project in the LGA. The key aspects that would be considered as part of the strategy are outlined in **Table 4.100**.

Table 4.100
Key Aspects of the Local Procurement and Employment Strategy

Aspect	Description
Local Business Procurement	• Further development of the local business register. • Consideration of the development of a Local Buying Program. • Engagement with relevant stakeholders e.g. local Chambers of Commerce, employment service providers, local businesses, to maximise business procurement e.g. information sessions. • Maximise local and regional spend through company direct and contractor arrangements – monitoring of local and regional spend.
Local Employment	• Maximising local employment of community members through company direct and contractor arrangements and monitoring of employment numbers. • Support completing Aboriginal grant applications. • Subsidised medical checks for Aboriginal people applying for employment. • Encourage employees to live within the LGA and to utilise services in local communities – Kandos, Rylstone, Lue - e.g. Lue Public School.
Education and Training	• Support education programs and pathways. • Support pre-employment training / upskilling programs to increase job readiness. • Provision of traineeships or apprenticeships targeted at vulnerable groups, including low income earners, job seekers, and youth. • Support graduate programs including on-site work experience and placements. • Support youth training, particularly trades skills.

Source: Umwelt (2020) – Modified after Table 8.6

It is noted that, Phase 2 of engagement activities (see **Table 4.100**) included a 'skills and capacity audit' involving local businesses and suppliers. The results of the audit indicate that businesses within the LGA are both interested and well equipped to provide Bowdens Silver with skills and services of benefit to the Project. The audit has also resulted in the preparation of an initial local business and supplier register which would provide a foundation for further discussion with local business chambers and their membership, local businesses and suppliers and employment service providers in the development and implementation of the strategy. It is anticipated that the local employment and procurement strategy would be developed prior to the commencement of site establishment and construction so as to maximise procurement and employment opportunities in both construction and operational phases.

Bowdens Silver would also monitor relevant employment and procurement statistics through the construction and operational phases of the Project in accordance with the Social Impact Management Plan (SIMP). Relevant statistics would be reported in annual reporting documents that would be publicly available (Bowdens Silver website).

Good Neighbour Program

Bowdens Silver would continue to foster their 'open door policy' in the development of a structured 'Good Neighbour Program' that affords further development of Company-community relationships through regular and effective engagement and communication. In implementing this program Bowdens Silver would continue to employ a dedicated Community Liaison officer within the operational team to manage the ongoing engagement and monitoring and management commitments relating to social and environmental impacts.

Ongoing engagement activities would be outlined within the program and updated / adapted as required to meet needs and preferences. Ongoing engagement activities would be formalised in the SIMP.

Initially, ongoing engagement would be achieved through the following.

- Regular (quarterly) provision of environmental monitoring results via the Company website.
- Development of a formal complaints procedure.
- Provision of site visits to view construction activities and operations.
- Continued operation of the CCC (consistent with the latest version of the DPIE's Community Consultative Committee Guidelines) and publishing of meeting minutes on the Company website.
- Use of the local community noticeboards.
- Regular information provision and community engagement including Open Days, newsletters etc.

Social Impact Management Plan

Bowdens Silver would develop a Social Impact Management Plan (SIMP) that defines and guides the monitoring and evaluation of the social / community related impacts and aspects of the Project. The SIMP would be developed in accordance with the SIA Guideline and would:

- identify opportunities to enhance positive and mitigate negative social and economic impacts of the Project on communities;
- detail adaptive management and mitigation strategies to address potential impacts of the Project;

- identify appropriate stakeholder responsibilities;
- identify appropriate monitoring, reporting and review mechanisms, including the purpose of monitoring and the parameters that would be monitored and how and when monitoring data would be collected;
- outline a process to engage with relevant stakeholders and communities, with a focus on practical mechanisms for the community to collaborate and record their observations and experiences of social impacts and any proposed community participation in monitoring;
- include an incident notification and reporting process, including providing applicable information to the community;
- develop a process for reviewing the above elements to assess whether they are still appropriate, and whether any new issues have emerged that should be included in ongoing monitoring; and
- develop a process for making monitoring results and associated information publicly available, including any revisions to the monitoring and management framework.

The SIMP would outline suitable and proportionate social impact monitoring and adaptive management arrangements for the Project that include the above elements, as well as proposed timing and frequency of monitoring and public reporting of results.

The plan would be developed in consultation with the local community and Council and would be approved by DPIE. The plan would be finalised prior to the commencement of mining operations.

4.20.6 Assessment of Impacts

4.20.6.1 Introduction

This section provides an assessment and ranking of the social impacts identified in relation to the Project, with the aim of assessing the forecast/anticipated changes to the current baseline social environment as a result of the Project proceeding. In order to prioritise the identified social impacts, a risk-based framework has been adopted consistent with the NSW *Social Impact Assessment Guideline* (DPE, 2017) and as outlined in detail in Section 7 of Umwelt (2020).

Table 4.101 presents a summary of the social risk assessment outcomes presented by Umwelt (2020). The review of risks only presents those considered the most significant and that would require mitigation or management. It is also notable that social risks are individual in nature and therefore the perceived social impacts would vary between individuals and groups with no single perception more important than another. The outcomes of the social risk assessment consider the most common, or what is judged to be the general perception/sentiment of a stakeholder group. Therefore people in the community may perceive the social impacts as either higher or lower then are presented here. Notwithstanding, **Table 4.101** provides a useful summary of the assessed outcomes.

Table 4.101
Social Risk Assessment Outcomes

Project Aspect	Relevant Social Impact Category	Social Impact	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Mitigated)
Construction Workforce							
Construction	Way of Life Health and Well-being Surroundings	Social amenity - noise	Lue SSC	1 to 2 months	5 residences (marginal/moderate)	High	High
					Locality residents	High	Moderate
Construction	Way of life Surroundings Access to and use of infrastructure, services and facilities Community	Social amenity – traffic volume and disruption	Lue SSC Mid-Western Regional LGA	Construction period – 18 months	Locality residents	High	High
					LGA Road Users	High	Moderate
Construction	Way of Life Health and Well-Being Surroundings	Social amenity - noise	Lue SSC	Construction period – 18 months	Locality residents	High	Moderate
Construction Workforce (Scenario 1)[17]	Way of Life Community Culture Fears and Aspirations	Population change – influx of construction workers	Mid-Western Regional LGA	Construction period – 18 months	Locality residents	High	Low
					Regional LGA Community	High	Moderate
Construction Workforce (Scenario 1)	Access to and use of Infrastructure, Services and Facilities	Population change – impact of construction workers on housing and accommodation	Mid-Western Regional LGA	Construction period – 18 months	Regional LGA Community Tourists/Visitors Housing and Accommodation Service Providers	High	Moderate
Construction Workforce (Scenario 1)	Access to and use of infrastructure, services and facilities	Population change – impact of construction workers on Health Services	Mid-Western Regional LGA	Construction period – 18 months	Regional LGA Community Health Service Providers	Moderate	Moderate

[17] Scenario 1 assumes that 80% of the workforce would migrate into the region (see Section 4.20.6.3).

Table 4.101 (Cont'd)
Social Risk Assessment Outcomes

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Project Aspect	Relevant Social Impact Category	Social Impact	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Mitigated)
Construction Workforce (Cont'd)							
Construction Workforce (Scenario 1)	Way of Life Community Culture Fears and Aspirations	Population change – influx of construction workers	Mid-Western Regional LGA	Construction period – 18 months	Locality Residents	High	Low
Construction Workforce (Scenario 1)	Access to and use of infrastructure, services and facilities	Population change – impact of construction workers on Emergency Services	Mid-Western Regional LGA	Construction period – 18 months	Emergency Service Providers and users Regional LGA Community	Low	Low
Construction Workforce (Scenario 1)	Access to and use of infrastructure, services and facilities	Population change – impact of Construction workers on Youth and recreation Services	Mid-Western Regional LGA	Construction period – 18 months	Youth and Recreational Service Providers Regional LGA Community	Low	Low
Construction Workforce (Scenario 1)	Access to and use of infrastructure, services and facilities	Population change – impact of construction workers on Public Utilities	Mid-Western Regional LGA	Construction period – 18 months	Regional LGA Community	Low	Low
Operational Workforce							
Operational Workforce (Scenario 2) [18]	Way of Life Community Culture Access to and use of infrastructure, and services and facilities	Population change – influx of operations workers and their families	Mid-Western Regional LGA	Operational period – 15 years	Locality residents	High (Negative)	Low (Negative)
					Regional LGA Community	High (Positive)	Moderate (Positive)
Operational Workforce (Scenario 2)	Access to and use of infrastructure, services and facilities	Population change – impact of Operational workers and families on Health Services	Mid-Western Regional LGA	Operational period – 15 years	Regional LGA Community Health Service Providers	High	Moderate
Operational Workforce (Scenario 2)	Access to and use of infrastructure, services and facilities	Population change – impact of Operational workers and families on housing and accommodation	Mid-Western Regional LGA	Operational period – 15 years	Regional LGA Community Housing and Accommodation Service Providers	High	Moderate

[18] Scenario 2 assumes 40% of the workforce would migrate into the region (see Section 4.20.6.3).

Table 4.101 (Cont'd)
Social Risk Assessment Outcomes

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Project Aspect	Relevant Social Impact Category	Social Impact	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Mitigated)
Operational Workforce (Cont'd)							
Operational Workforce (Scenario 2)	Access to and use of infrastructure, services and facilities	Population change – impact of Operational workers and families on Childcare Services	Mid-Western Regional LGA	Operational period – 15 years	Childcare service providers Regional LGA Community	High	Low
Operational Workforce (Scenario 2)	Access to and use of infrastructure, services and facilities	Population change – impact of operational workers and families on Emergency Services	Mid-Western Regional LGA	Operational period – 15 years	Emergency Service Providers Regional LGA Community	Low	Low
Operational Workforce (Scenario 2)	Access to and use of infrastructure, services and facilities	Population change – impact of Operational workers and families on Youth and recreation Services	Mid-Western Regional LGA	Operational period – 15 years	Youth and Recreational Service Providers Regional LGA Community	Low	Low
Operational Workforce (scenario 2)	Access to and use of infrastructure, services and facilities	Population change – impact of Operational workers and families on Education & Training Services	Mid-Western Regional LGA	Operational period – 15 years	Education Service Providers Regional LGA Community	Low	Low
Operational Workforce (Scenario 2)	Access to and use of infrastructure, services and facilities	Population change – impact of Operational workers and families on Public Utilities	Mid-Western Regional LGA	Operational period – 15 years	Regional LGA Community	Low	Low
Acquisition of Properties and Historic Purchase							
Acquisition of properties under the VLAMP and historic purchase	Way of Life Community Culture Health and Wellbeing Personal and property rights Decision making systems Fears and Aspirations	Acquisition	Lue SSC	Project life	Four properties in the acquisition zone Previous purchase of 16 properties.	High	High

Table 4.101 (Cont'd)
Social Risk Assessment Outcomes

Page 4 of 6

Project Aspect	Relevant Social Impact Category	Social Impact	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Mitigated)
Presence of the Operation							
Presence of the operation	Way of Life Health and Well-being Surroundings	Social amenity - noise	Lue SSC	Mine life (approx. 16.5 years)	Four properties in acquisition zone	High	Extreme
					Locality residents (10 properties in the management zone)	High	High
					Locality residents	High	High
					Regional LGA Community	Low	Low
Presence of the operation	Surroundings Way of life	Visual amenity due to: Change to landscape Light spill (at night)	Lue SSC Mid-Western Regional LGA	Mine life (approx. 16.5 years)	Locality residents where Project would be visible (n=6)	High	High
					Locality residents	High	Low
					Regional LGA community	Low	Low
Presence of the operation	Way of life Health and well-being Surroundings Community	Social amenity – dust	Lue SSC	Mine life (approx. 16.5 years)	Specified Locality residents	High	Moderate
					Regional LGA community	Low	Low
Presence of the operation	Way of life Surroundings Access to and use of infrastructure, services and facilities Community	Social amenity – traffic volume and disruption	Lue SSC Mid-Western Regional LGA	Mine life (approx. 16.5 years)	Locality residents	High	Moderate
					LGA road users	High	Low

Table 4.101 (Cont'd)
Social Risk Assessment Outcomes

Project Aspect	Relevant Social Impact Category	Social Impact	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Mitigated)
Presence of the Operation							
Presence of the operation	Personal and property rights Way of life Community	Economic livelihood	Lue SSC Mid-Western Regional LGA	Mine life (approx. 16.5 years)	Locality residents	High (Positive & Negative)	High (Positive)
					Regional LGA Community	High (Positive)	High (Positive)
					Local business	High (Positive)	High (Positive)
					Service providers	High (Positive)	High (Positive)
					Aboriginal Community	High (Positive)	High (Positive)
Presence of the operation	Community Culture Way of life Surroundings	Sense of community – Cohesion, character, sense of place, rural lifestyle	Lue SSC	Project life	Locality residents	High	High
					Regional LGA community	Moderate	Low
Presence of the operation	Surroundings Community Culture	Conflict as a result of competing land use	Lue SSC Mid-Western Regional LGA	Mine life (approx. 16.5 years)	Locality residents	Moderate	High
					Regional LGA community	Low	Low
Presence of the operation	Health and wellbeing Surroundings Way of life	Impact on Water quality as a result of TSF failure	Lue SSC Mid-Western Regional LGA	Mine life (approx. 16.5 years)	Locality residents	High	Moderate
Presence of the operation	Culture Community Surroundings	Aboriginal cultural heritage	Lue SSC	Mine life (approx. 16.5 years)	Aboriginal community	High	Moderate
Presence of the operation	Personal and property rights	Declining property values	Lue SSC	Mine life (approx. 16.5 years)	Locality residents	High	Moderate
					Regional LGA community	Low	Low
			Pipeline route	Permanent Change	Landholders along the pipeline	High	Moderate

Table 4.101 (Cont'd)
Social Risk Assessment Outcomes

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Project Aspect	Relevant Social Impact Category	Social Impact	Extent	Duration	Affected Parties	Perceived Social Impact/ Sensitivity	Social Impact Ranking (Mitigated)
Presence of the Operation (Cont'd)							
Presence of the operation	Health and wellbeing Way of life	Health and wellbeing – stress and anxiety	Lue SSC	Mine life (approx. 16.5 years)	Locality residents	Moderate	Moderate
Presence of the operation	Health and wellbeing Surroundings Way of life	Exposure to lead in dust	Lue SSC Mid-Western Regional LGA	Mine life (approx. 16.5 years)	Locality residents	High	Low
Presence of the operation	Health and wellbeing Surroundings Way of life	Exposure to lead in water	Lue SSC Mid-Western Regional LGA	Mine life (approx. 16.5 years)	Locality residents Water users	High	Low
Presence of the operation	Surroundings Way of life Personal and property rights	Access to and use of water	Macquarie River Catchment	Mine life (approx. 16.5 years), possibly ongoing	Locality residents Private bore owners	High	Low
					Regional LGA Community	High	Low
Presence of the operation	Surroundings	Ecological impacts – terrestrial and aquatic	Lue SSC	Mine life (approx. 16.5 years)	Locality residents Regional LGA Community	Low	Low
Presence of the operation	Surroundings Community Culture	Impact on agricultural land	Mid-Western Regional LGA	Mine life (approx. 16.5 years)	Locality Residents Regional LGA Community	Low	Low
Presence of the operation	Personal and property rights	Property damage and access	Lue SSC	Mine life (approx. 16.5 years)	Locality residents – 4 properties identified as impacted	Low	Low
Project Assessment and Development Process							
Project assessment and development process	Decision making systems	Community engagement and information provision	Lue SSC Mid-Western Regional LGA	Mine life (approx. 16.5 years)	Locality residents	Moderate	Moderate
					Regional LGA community	Low	Low

Source: Umwelt (2020) – Table 7.64

The following subsections provide a brief overview of the social issues assessed by Umwelt (2020) and the outcomes of assessment based on engagement and the information available at the time of assessment. The outcomes of assessment are presented from the perspective of local impact (in the vicinity of Lue) and regional impact within the Mid-Western Regional LGA.

4.20.6.2 Population Change

Population change (influx and outflux) is usually described as a first order social impact which has the potential to create second order social impacts, such as impacts on community infrastructure and services, changes in sense of community, social cohesion and networks. The social impact assessment has assessed the following three scenarios for both the construction and operational workforce.

- Scenario 1 – 80% of the workforce would migrate into the region;
- Scenario 2 – 40% of the workforce would migrate into the region;
- Scenario 3 – 20% of the workforce would migrate into the region.

Construction Workforce

Table 4.102 summarises the population change estimates based on the three workforce scenarios.

Table 4.102
Construction Workforce Population Change Estimates

Scenario	Mid-Western Regional LGA	
	Population Increase	**%**
Scenario 1 (80% migration into LGA)	197	1.0
Scenario 2 (40% in-migration into LGA)	98	0.5
Scenario 3 (20% in-migration into LGA)	49	0.3
Source: Umwelt (2020) – Table 7.4		

Whilst there appears to be potential scope for Bowdens Silver to engage local contractors and recruit workers from the local employment pool for many positions available during the construction phase require skills and experience specific to mine construction. As such, Scenario 1 is conservatively suggested to be the most likely Project scenario for the construction workforce requirements.

At a regional level, the predicted temporary population influx is less than 5% and is consequently assessed as a ‘minor’ social impact for all three scenarios. Based on the outcomes of the engagement during the social impact assessment, service providers consulted suggested that they would be able to adapt to this potential temporary increase in population for the types of services noted (see also Section 4.20.6.3).

Therefore, considering Scenario 1 as the most likely:

- the temporary population change for Lue has been ranked as a ***low*** social impact, as it is *unlikely* that the construction workforce would be housed in Lue itself (given limited accommodation options), with a *minor* consequence; and

- the temporary population change at a regional level has been ranked as a ***moderate*** social impact, as it is *likely* that the construction workforce would result in a temporary population influx across the Mid-Western LGA, again with a *minor* consequence.

Operational Workforce

It is expected that the operational workforce would permanently reside in the LGA with none (or very few) of the employees driving in and out. Given that the operational phase is expected to run for approximately 15 years, it is assumed that family members of workers who relocate from outside the LGA would also move into the area. **Table 4.103** summarises the population change estimates based on the three workforce scenarios and an average household size of 2.4 (ABS, 2016).

Table 4.103
Operational Workforce Population Change Estimates

Mid-Western Region				
	Workforce Influx	**Average Household Size**	**Population increase (Family level impact)**	**%**
Scenario 1 (80% migration into LGA)	182	2.4	438	1.8
Scenario 2 (40% in-migration into LGA)	91	2.4	219	0.9
Scenario 3 (20% in-migration into LGA)	46	2.4	109	0.5
Source: Umwelt (2020) – Modified after Table 7.6				

Scenario 2 (40% in-migration of workers) is considered the most likely workforce operational scenario, although Bowdens Silver is targeting 75% of the operational workforce being sourced from within the Mid-Western Regional LGA.

All predicted population change associated with the Project, under the three scenarios assessed, appears reasonably consistent with annual average growth rates in the LGA. For example, the average annual population growth in the LGA from 2007 to 2018 has been 1.2% and ranged from 1.7% (in 2013) to 0.70% (in 2016). Consequently, the predicted worst-case scenario of 1.8% (80% in-migration), is only 0.60% higher than the annual average growth rate and similar to the 2013 growth rate.

Consequently:

- population change across the region has been ranked as a ***moderate*** social impact (likely to occur, with a minimal consequence); and
- population change in the Lue locality has been ranked as a ***low*** social impact (possible to occur, with minimal consequence), given that only a small proportion of the workforce may reside in the Lue locality, given limited housing availability.

Property Acquisition

The population changes to Lue and surrounding localities, as a result of acquisition, can be viewed both in the long term as a result of property acquisitions made by Silver Standard and Kingsgate and those acquisitions made by Bowdens Silver in relation to the current Project.

Since 1989, when silver mineralisation was first discovered at the site, to July 2016 when Bowdens Silver purchased the Project from Kingsgate, 13 properties in and around the Mine Site were purchased. These properties included:

- 2 vacant lots/farm blocks
- 7 residential properties
- 4 weekenders, shacks or houses used on a temporary basis.

The seven residential properties which were progressively acquired over 27 years were owned by a mix of family and couple households. Overall, this equates to approximately 21 people. The owners who utilised the four weekender properties were estimated to equate to approximately 10 people with a connection to the area at that time.

Since commencing the Project in July 2016, Bowdens Silver has purchased, or has an option to purchase, three properties. Two of these properties were occupied full time (four persons), while the third was used as a weekender (two persons). As such, the historical impact of property acquisitions made by Bowdens since July 2016 on population change equates to approximately 1.5% (four permanent persons) of the current population in Lue and surrounding rural localities.

Since this time, and as a result of the current Project, Bowdens Silver has approached the owners of an additional four properties where there are predicted noise and/or dust impacts associated with the Project, as required in accordance with the VLAMP (further discussed in Section 7.6.1.2). Contracts of sale have been exchanged for two of the four properties. Three of the properties have been used as weekenders by several families, with owners permanently residing elsewhere.

These additional (4) acquisitions could result in a minor change to the population of Lue and its surrounding rural localities, bringing the overall loss of full-time population in the community since Bowdens commenced the Project in 2016 to approximately 1.8%. Furthermore, acquisition of the properties that are used currently as weekenders could also potentially result in the loss of visiting families to the area.

Consequently, when taking into account both the historical and Projected changes to population numbers associated with the Bowdens Silver Project through property acquisitions of full-time residents (associated with the presence of the Project), the impact is categorised as a ***high*** social impact (*likely* to occur, with *minor* consequence given a predicted population change of less than 5%).

Notwithstanding the above, Bowdens Silver is committed to leasing out or utilising acquired properties wherever possible, helping to maintain population within the area. Of the properties owned, 11 have habitable residences. Currently three are leased to four-person families, two to couples, and one to a single person (total of 17 persons). The remaining five residences are used for either full-time or regular staff and consultant accommodation and the Project office.

4.20.6.3 Community Services

The impact of a project on community infrastructure and services is often one of the more tangible social impacts and is considered a secondary order impact largely influenced by population changes associated with construction and operational workforce influx (see Section 4.20.6.2).

Project aspects or factors that can impact on access to, and use of, community services include:

- changing demand due to an increase or decrease in population;
- changing behaviours of users, such as workforce rosters determining patterns of peak service utilisation; and
- direct impacts on physical infrastructure during Project construction and/or operation.

The following section assesses the impacts on key service sectors for both the construction and operational workforces.

Housing and Accommodation

Construction Workforce

As outlined in Section 4.20.6.2, the construction workforce population change estimates range from 49, 98 and 197 based respectively on three scenarios of 20%, 40% and 80% in-migration. The construction workforce would be required over an 18-month period. The following additional assumptions have been made in assessing the impacts of the construction workforce on housing and accommodation services.

- Due to the temporary nature of the construction schedule, families associated with the workforce are unlikely to relocate with the worker.
- The workforce would most likely be accommodated close to the Project, i.e. within the Mid-Western Regional LGA in Mudgee, Kandos or Rylstone. The distance from Gulgong to the Project makes it less likely that any of the workforce would reside in the Gulgong locality.
- All other factors would remain proportionally the same over the construction period.

Based on the results of the social impact assessment research and survey, there is a limited pool of rental properties across the LGA that could accommodate the construction workforce. However, there are a number of accommodation providers that may be able to provide accommodation for the construction period. Furthermore, results of the skills audit suggest that the accommodation providers consulted have a strong interest in working with Bowdens Silver to address workforce accommodation options.

Given the current average occupancy rates, there would be approximately 400 rooms available across the identified towns. Noting that occupancy rates tend to increase during peak tourist periods, this indicates a potential stretch in the capacity of accommodation facilities to accommodate the non-resident construction workforce under the worst-case 80% in-migration scenario (197 workers). However, anecdotal evidence from service providers and local businesses, and as reported in the Mudgee Regional Tourism Annual Report 2018, highlight that weekend visitation in Mudgee and the region is higher than mid-week. This indicates that there may be additional capacity for accommodation facilities to house the construction workforce, depending on workforce day and shift arrangements.

Accommodation of the construction workforce under both the 40% (98 workers) and 20% (49 workers) in-migration scenarios is considered likely to be manageable. Umwelt (2020) considers the lower in-migration scenarios are possible to achieve should adequate mitigation measures be put in place to ensure maximum utilisation of local contractors in the construction phase of the Project.

Therefore, depending on the extent of the construction workforce required to be accommodated and construction rosters, the construction workforce has the potential to impact on the capacity of housing and accommodation facilities in the region in a ***moderate*** way (*possible* with a *minor* consequence) under the worst-case 80% in-migration scenario.

Operational Workforce

As outlined in Section 4.20.6.2, during the operational phase, the workforce population change estimates range from 109, 219 and 438 based respectively on three scenarios of 20%, 40% and 80% in-migration. These scenarios provide for employees bringing their families and, assuming an average household size of 2.4, would require approximately 45, 91 and 182 residential dwellings respectively.

Based on the results of the social impact assessment research and survey, as at 9 August 2019 there were 411 properties available to rent or purchase across the Mid-Western Regional LGA. In addition, a further 162 vacant lots were listed for sale, including several plots located on housing estates that would become available as the estates are further approved and developed. Therefore, it is likely that the region would have sufficient capacity to house the operational workforce and their families under all scenarios.

It is noted, however, that local estate agents indicated that there is current growth in the housing market across the LGA, particularly in relation to rental properties, which are able to be leased quickly. A requirement for rental homes by the operational workforce may, therefore, place additional strain on the rental market, and may also potentially increase both rental and real estate prices.

Under the worst-case 80% in-migration scenario, the impact of population changes due to operational workforce influx on the provision of housing and accommodation is categorised as ***high*** (*possibl*e with *moderate* consequence).

However, in relation to the 40% in-migration scenario, considered the most likely, the social impact on housing and accommodation, as a result of the influx of an operational workforce for the Project, would result in a ***moderate*** impact (*possible* with a *minor* consequence), with the ability for impacts to be further mitigated through local employment and training strategies that further reduce the need for in-migration.

Health Services

Construction Workforce

Given the short timeframe of the construction period and the assumption that any population influx associated with the workforce would be temporary, the impacts of construction phase workers on health services is expected to be minimal.

Impacts on GPs and other specialists, as a result of regular check-ups, is expected to be relatively low, given that workers temporarily relocating to the area would most likely prefer specialists in their hometown. Impacts on emergency departments could occur in the event of serious workplace medical incidents which cannot be treated by medical and/or first aid staff on site. This would depend on the level of medical assistance available on site and any agreements in place between relevant health and emergency services and Bowdens Silver.

It is noted that previous research on temporary (non-resident) workforces suggests that mine workers living away from home can experience a range of negative psychological health impacts, particularly in the case of fly-in fly-out (FIFO) workers and workers based in isolated workers camps. Bowdens Silver do not intend to utilise FIFO workers and no workers camp is proposed. Notwithstanding, the results of the social impact assessment research and survey indicated there are low levels of psychological and psychiatric services available in the LGA. As a result, any elevated mental health issues in the workforce could result in strain on what are currently limited services within the region. The potential for this impact may be mitigated by maximising local employment for both construction and operational phases, and in the design of employee rosters, which encourage healthy social behaviour and community participation.

Consequently, the influx of the construction workforce, as a result of the Project, may (*possibly*) result in a *minor* reduction in the capacity of local health services under the worst-case 80% in-migration scenario, resulting in a ***moderate*** social impact.

Under the 40% in-migration scenario, the Project would have a ***low*** impact on local health service capacity (*unlikely* with *minimal* consequence).

Operational Workforce

Based on the current estimates of the regional population and the proportion of GPs per 100 000 people, the worst-case 80% in-migration scenario would potentially increase the workload of GPs in the LGA by a factor of 0.4, leading to slightly longer wait times for GP services. At an LGA level, this indicates that the impact of the maximum population increase predicted for the operational phase of the Project could be mitigated to current levels of service by recruitment of a part time GP role or the provision of a medical officer on site.

As part of the social impact assessment engagement process emergency service and hospital care providers indicated that the population influx associated with the maximum workforce migration scenario could place additional strain on the current capacity of emergency departments and emergency response units within the region. The primary impact identified by these providers was an increase in wait times. Furthermore, given the current shortage in specialist services, particularly in specialist mental and allied health services, the influx in new residents under the 80% in-migration scenario may also place strain on these health services.

Under the 80% and 40% in-migrations scenarios, it is considered *possible* that the increase in population due to the operational workforce may result in a *minor* impact on the capacity of the local health services and is therefore ranked as a ***moderate*** social impact. However, the impacts associated with a 20% in-migration scenario are considered to be significantly less.

As noted in Section 4.20.5, as Bowdens Silver has committed to the appointment of a general practitioner or medical officer on a contract basis, as a result, the potential for these impacts would be substantially mitigated.

Child-care Services

As the families of the construction workforce are not expected to relocate, there would be negligible impact on child-care services due to the construction workforce.

For the operational workforce, under the worst-case 80% in-migration scenario, a potential increase of approximately 38 children aged between 0-4 years may result. Notably, population projections for the Mid-Western Regional LGA released by the NSW DPE (2016) predict little change in this age bracket between 2011 and 2036, with a slight decrease anticipated towards the end of this period.

During engagement with childcare providers, four out of six providers consulted indicated that they were currently at nearing or at capacity and two providers indicated that more children could be accommodated provided they were able to recruit additional qualified staff. It is noted that two new childcare services have recently opened in Mudgee to accommodate a need in this regard and childcare service providers also acknowledged that the influx of a workforce population could potentially bring new childcare employees to the area.

Consequently, the impact of the Project under the 80% in-migration scenario is considered *possible* and of *minor* consequence, resulting in a ***moderate*** social impact. However, the 20% and 40% in-migration scenarios would result in a ***low*** social impact (*unlikely* with *minimal* consequences).

Emergency Services

The main emergency services in the Mid-Western Regional LGA include police, ambulance, fire, State Emergency Services (SES) and volunteer rescue. There are also additional regional emergency services including the Westpac Rescue Helicopter.

Service providers consulted noted that, even under the worst-case 80% in-migration scenario, the number of mining workforce personnel required during the construction or operational phases of the Project is not expected to be a large enough increase in population to trigger the recruitment of additional staffing resources.

It is also noted that many mine operations provide employees with corporate volunteering opportunities, allowing selected workers to be on call during work hours should they be needed in the event of a large scale emergency (e.g. SES surge capacity assistance). One member of the Bowdens Silver Project team is a current volunteer with the local RFS; with the Company supportive of such volunteering efforts.

Given the strong track record of safety within the mining industry, the impact of the influx of the construction and operational workforce on emergency services is *unlikely* to occur with a *minor* consequence resulting in a ***low*** social impact for both construction and operational phases.

Youth Services and Recreational Facilities

Using the ABS Census data (2016), it is estimated that the influx of the operational workforce and their families could result in a population influx of around 14, 35 or 55 young people (aged between 15 and 24 years), respectively for the three in-migration scenarios of 20%, 40% and 80%.

Engagement with youth service providers indicated that several services would have the capacity to accommodate additional youth wishing to utilise their service, with these providers also indicating that an influx of families may also increase participation and utilisation of their services. For those youth services which were currently at capacity e.g. Scouts, providers indicated that they would require parents to assist if their children wished to participate.

The LGA is also relatively well-serviced in terms of recreation facilities and activities and recreational service providers interviewed expressed that an increase in population would result in further access and use of existing recreational facilities in the region.

Therefore, the perceived stakeholder risk associated with the impact on youth and recreational services associated with the construction and operational Project workforces, have both been ranked as a ***low*** social impact (*unlikely* with *minimal* consequence).

It is noted that, to date, Bowdens Silver has sponsored several youth programs, sporting teams, and recreational events in the region and would continue sponsorships throughout operations (see Section 4.20.5).

Education and Training Services

Some residents and landholders in the locality expressed concerns that the Project would cause parents to withdraw their children from the Lue Public School, due to its proximity to the Mine Site. However, others felt that the influx of operational workforce and their families to the region may see further utilisation of the local Lue Public School resulting in the need for additional classes and teaching staff. Stakeholders also suggested that the Lue Public School may benefit further from the Project through Company investment. In relation to training, Aboriginal stakeholders suggested that the Project could result in the provision of traineeships and apprenticeships for Aboriginal youth.

With the exception of St Matthews Catholic School in Mudgee, both Primary and Secondary service providers interviewed stated an ability to accommodate an increase in school aged children as a result of the influx of the Project's operational workforce and their families into the area. The St Matthews Catholic School in Mudgee will, however, be constructing a secondary campus to accommodate up to 680 secondary students, with the eventual plan to transfer all existing school services to the new campus. The Lue Public School also stated they would welcome a growth in student numbers, should the operational workforce be situated close to the Mine Site and should workforce families choose to send their children to the local school.

Overall, education service providers were in support of the Project, acknowledging more families in the area would contribute to economic sustainability within the region and would encourage more professional educators to settle in rural communities.

Whilst education providers interviewed indicated that they could adapt to increases in student numbers, the potential loss of families in Lue as a result of acquisitions and other families choosing to move away from the area to seek employment was considered a perceived threat to the Lue Public School viability, particularly if a corresponding boost in numbers from worker's families was not realised.

In regard to training, employment and training service providers from the Mid-Western Regional LGA that were surveyed showed strong interest in working with the Company to maximise local training and employment opportunities.

Consequently, the impacts on education services as a result of the influx of the operational workforce and their families is classed as a ***low*** social impact (*likely* to occur, with a *minimal* consequence).

Access to Public Utilities

The provision of public infrastructure and utilities is considered to be relatively sound across the LGA, the exception being sewerage and waste with some capacity limitations related to water treatment plants within the LGA. The current landfill cell at Mudgee Waste Depot is also expected to reach capacity in 4 years and Council is currently in the process of investigating designs and locations for a new facility.

During engagement with key stakeholders and service providers, very few impacts were raised in relation to utilities. Responses related primarily to how the Project would source water and electricity with a positive response to the proposed sourcing of water for the Project via a pipeline from the Ulan and/or Moolarben Coal Mines.

While the Project would involve the influx of a temporary construction and a more permanent operational workforce, it is not envisaged that the predicted population change (1.8% under a worst-case 80% in-migration scenario) would impact significantly on public utilities. Therefore, the impact of the proposed incoming Project workforce on public utilities is considered *unlikely* with a *minimal* consequence, resulting in a ***low*** social impact

4.20.6.4 Health and Wellbeing

Stakeholders consulted as part of the social impact assessment engagement program perceived that the Project would impact negatively on the health and wellbeing of the local and regional community in a number of ways, namely through impacts on physical health as a result of potential lead contamination of air, water and soil; and impacts on mental health through psychosocial factors including stress and anxiety.

Physical Health

A comprehensive human health risk assessment has been completed and is summarised in Section 4.8. Based on the outcomes of the human health risk assessment the Project is assessed as *unlikely* to have an impact on human health through exposure to lead in air and water, with a *minor* consequence and is therefore ranked as a ***low*** social impact.

Impacts to human health and safety as a result of TSF spillage are also considered *unlikely* but with a *moderate* consequence and is therefore ranked as a ***moderate*** social impact.

Mental Health

Mental health has also been considered as part of the human health risk assessment (see Section 4.8.8). In considering the proposed management measures and potential impacts, the impacts on mental health as a result of the Project are considered *possible*, with a *minor* consequence and are therefore assessed as a ***moderate*** social impact.

4.20.6.5 Sense of Place and Community

The following outlines the potential impacts that the Project may have on:

- the composition, character and cohesion of the community; and
- the sense of place and rural lifestyle experienced by locality residents.

Population change, including the introduction of new groups of people to an area and/or the outflux of a proportion of the population, can alter existing values and sense of community. Population change as a result of property acquisitions relating to the Project were noted by some locality residents, with some noting that members of the community had already relocated, or were considering relocation, due to the presence of the Project and the fear of potential impacts on local properties. As outlined in Section 4.20.5.2, the impact of property acquisition since Bowdens Silver's purchase of the Project in July 2016 (including currently proposed acquisition) is estimated to be an 1.8% reduction of the full-time population in the proximal localities surrounding the Project. Whilst this is partially offset by the leasing back of a number of these properties to a total of 17 people, these property acquisitions have the potential to result in changes in the community sense of place.

Conversely, the workforce for the Project is not expected to significantly affect population change in the MWR LGA, resulting in a 1.0% and 1.8% change in population for the construction and operational workforces respectively under the worst-case 80% in-migration scenario. The workforce is also unlikely to significantly affect population change in Lue but may increase population slightly if opportunities for rental and purchase of properties in Lue are further developed.

Whilst some stakeholders perceived the Project as a risk, other stakeholders and regional community members highlighted that the Project may see a renewed sense of community for Lue and other towns in the LGA as a result of an increase in population and flow on benefits to local businesses and services (e.g. Lue Hotel and Lue Public School).

The presence and discussion of the Project in the community, was also considered to have influenced community cohesion and raised fears around potential impacts on sense of place. While some residents have responded by forming a dedicated community group - the Lue Action Group – which is opposed to the proposed Project development; other residents expressed concerns that the development of this group had also served to divide the community.

Aboriginal stakeholders also raised concerns about the existing divisions that exist between the Aboriginal and non-Aboriginal community within the region more broadly; with some Aboriginal stakeholders outlining that the Project could increase social cohesion, through providing employment opportunities for Aboriginal people; with others suggesting, that the Project may cause conflicts due to differing opinions on mining.

In addition, residents and landholders in the locality value the rural amenity (peace, tranquillity) and lifestyle the area affords. Residents were concerned that the presence and proximity of the Mine Site would change the nature of Lue and its surrounding localities. Therefore, changes in land use and impacts on social amenity are considered to have the potential to result in a loss of sense of place. These matters are addressed further in Sections 4.20.6.7 and 4.20.6.8.

During consultation and engagement, stakeholders identified that there were key assets that were important to the community in Lue, including the Lue Hotel and buildings of heritage value, particularly the old railway station building and cottage. The Lue Public School was also identified as important to Lue and its sense of community. Potential effects on the viability of the Lue Public School are discussed in Section 4.20.6.3.

It is noted that a key objective of the CIP (see Section 4.20.5) would be to maintain a sense of community, through enhancing Lue and its key community assets. Development of these projects/programs under the CIP would be undertaken in consultation with community members to address community needs and aspirations. This would also assist in maintaining community cohesion.

A key Project design change aimed at improving community cohesion has involved removing consideration of a worker's camp on site, which was originally proposed (by Kingsgate). Those who saw this as a positive Project design change, suggested that it would be better for the workers' health and wellbeing not to be housed on site and that this would also create opportunities for local business and accommodation providers in the LGA. Others, who rated this change more negatively, stated that by not housing the workers on site this would lead to increased traffic on local roads, and less business for local businesses in Lue, especially the Lue Hotel. Bowdens Silver is proposing a bus service for workers to help reduce the traffic congestion caused by construction and operation traffic.

Considering the proposed management measures and strategies, the impact of the Project on sense of community and social cohesion is considered:

- *Likely* with a *minor* consequence, for the locality, resulting in a ***high*** social impact ranking; and
- *Unlikely* with a *minor* consequence for the region, resulting in a ***low*** social impact ranking.

4.20.6.6 Engagement and Decision Making

This category of social impact refers to the extent to which stakeholders and community members can have a say in the decisions that affect them and have access to complaint, remedy and grievance mechanisms.

As outlined in Section 4.20.5, Bowdens Silver has committed to continuing to engage proactively with local and regional community representatives, providing information regarding Project updates and assessment and monitoring of environmental results. This would principally be managed through the Good Neighbour Program and Social Impact Management Plan.

It is also noted that, since 2016, Bowdens Silver has appointed a dedicated community liaison officer to develop relationships with local landholders and other stakeholders, with this role to continue should the Project be approved. Bowdens Silver would also develop and implement a formal complaints procedure and complaints line to provide a formal grievance mechanism for community members. As part of the complaints procedure, all complaints would be formally recorded together with the action/response taken. A summary of complaints and corresponding actions/responses would be provided as part of annual reporting.

Considering the proposed mitigation measures, the perceived lack of trust in decision-making and engagement processes, is assessed as *possible* with *minor* consequence, and has been ranked as a ***moderate*** social risk.

4.20.6.7 Social Amenity

Potential impacts upon social amenity could arise from construction and operational noise, traffic, air quality and visual impacts. These aspects have been comprehensively assessed through a range of specialist studies as outlined in Section 4.2, 4.3, 4.4, 4.9 and 4.12 respectively. Those sections outline in detail the management measures and extent of predicted impacts with a brief summary provided as follows.

Noise

Noise was a key issue raised by residents and landholders in the locality. Impacts on social amenity as a result of noise largely related to concerns around the potential audibility of the operation, particularly at night and blasting noise.

Assessment of noise during operations predicted four residences would fall within a significant impact zone, an additional four residences would fall within a marginal to moderate impact, 3dB(A) to 5dB(A) exceedance zone and a further six residences within a negligible impact 1dB(A) to 2dB(A) exceedance zone. Mitigation measures have been offered to landowners within both of these impact zones. It should be noted that residents beyond these zones are likely to hear the mine operation at times, despite noise levels being within the guidelines.

With the proposed mitigation measures in place, operational noise from the Project is assessed as having an ***extreme*** impact on the four properties in the acquisition zone (*likely* with *major* consequence), given these property owners have been provided an option to relocate; a ***high*** impact on properties in the management zones (*likely* with *moderate* consequence) and in Lue (*likely* with *minor* consequence), and a ***low*** impact on the regional community (*unlikely* with *minimal* consequence).

Traffic

The impacts of traffic on social amenity, as a result of the Project, were raised frequently by residents and landholders in the locality, local businesses and service providers. Respondents raised concerns that additional mine-related traffic may cause increased disruption and safety concerns for road users, residents and pedestrians.

Traffic generated for the Project would principally comprise light vehicles and buses used to transport personnel to work. In addition, Bowdens Silver has proposed to relocate Maloneys Road and avoid the need for much of the Project-related traffic to travel through Lue. Improvements to the local road network would benefit all road users and any negative impacts would be most likely experienced as a change to the capacity and efficiency of the local road network. However, TTPP (2020) have concluded that, with the implementation of the proposed mitigation and management measures, the traffic travelling to and from the Mine Site would be accommodated on the surrounding road network with virtually no adverse impacts to road users, the condition of the road network and the amenity of the residents of Lue.

The impact of operational traffic associated with the Project is therefore assessed as having a ***moderate*** (mitigated) social impact on residents in the locality and a ***low*** (mitigated) social impact on road users in the broader LGA.

Air Quality

The impacts of dust from the Project were raised by stakeholders principally in relation to social amenity and health and wellbeing.

Air quality modelling completed by Ramboll (2020) predicts that there would be no exceedance of the relevant air quality criteria for particulate matter (TSP, PM_{10}, $PM_{2.5}$) at any privately-owned residences or receivers, either from the Project alone or cumulatively. It is also predicted that there would be no exceedance of the impact assessment criteria at any receivers (Project-related or private) for metal dust concentrations, respirable crystalline silica or HCN.

The HHRA has also concluded that air quality impacts derived from the Project make a negligible contribution to overall exposures to the assessed metals and there are no health risk issues of concern relevant to the Project (during both the site establishment and construction stage and operational stage). These conclusions apply to all members of the community, adults and children as well as sensitive individuals.

Therefore, the Project is assessed as having a ***moderate*** (mitigated) social impact on locality residents and a ***low*** (mitigated) social impact on the regional community

Visual

Residents and landholders in the locality noted that they valued the natural views and rural aesthetic of the area and did not want to be able to view the proposed operations and associated infrastructure. In addition, concerns were raised in relation to the potential for light spill / glow at night from the operations.

For day time impacts, RLA (2020) concluded that the Project:

- would not be visible from Lue;
- would be visible from sections of Pyangle Road and Powells Road, and distant sections of Lue Road; and
- would be directly visible from six privately-owned residences within 5km of the Mine Site.

The assessment of light spill and night glow concluded that there would be no perceivable increase in the sky glow except when there is low cloud, in which case there would be a slight glow over the Mine Site. While the effect may be visible, it was considered that this would not constitute a reduction in amenity for proximal residents.

Considering the above the Project is assessed as having a ***high*** (mitigated) impact on the six proximal properties; a ***low*** (mitigated) impact on properties within the locality and a ***low*** (mitigated) impact on properties in the broader region.

4.20.6.8 Access to and Use of Ecosystem Services

Concerns raised by stakeholders also included potential for impacts upon use of 'ecosystem services', namely on water and ecology, including flora and fauna. These aspects have been comprehensively assessed through a range of specialist groundwater, surface water, terrestrial ecology and aquatic ecology studies as outlined in Sections 4.6, 4.7, 4.10 and 4.11 respectively. A brief summary of these aspects is provided as follows.

Water Access and Use

The groundwater assessment (Jacobs, 2020) predicts that, with the exception of one groundwater user located to the north of the Mine Site, the Project would meet the Level 1 Minimal Impact Considerations, including potential water level and water pressure impacts to other groundwater users and to groundwater dependent ecosystems, and water quality impacts. It is noted that the modelled groundwater drawdown at two residences is considered conservative and it is unlikely that the predicted drawdown at this location would eventuate. The groundwater assessment considers that in accordance with the Aquifer Interference Policy, the predicted impacts of the Project are considered to be acceptable.

The surface water assessment (WRM, 2020) also assessed that there would be a negligible change in availability of surface water for downstream users adjacent to Lawsons Creek. Similarly, the impact on cease-to-flow periods would be minimal, with flows greater than 0.1ML/d reducing in frequency from 90.2% to 89.8% of the time during operations, and 89.6% of the time post-mine closure..

The HHRA (enRiskS, 2020), also assessed the potential for adverse health impacts within the off-site community associated with impacts to surface water and groundwater as a result of the Project as negligible.

Considering the above, the impact of the Project on access to and use of water by locality residents, private bore owners and the broader regional community, is considered *unlikely* to occur, with a *minor* consequence and is therefore assessed as a ***low*** social impact (mitigated).

Environmental Impacts

The Project would result in the removal of a total of 381.71ha of native vegetation of variable condition. This includes 182.26ha of BC Act listed Box-Gum Woodland, of which 147.82ha also meets the classification under the EPBC Act. Notably, out of the 182.26ha of Box-Gum Woodland, approximately 88.18ha comprises derived grassland only, having had the trees and shrubs cleared by past agricultural activities. A total of 19 threatened species (two flora and 17 fauna species) have also been recorded or are predicted to occur within the impact footprint. The assessment of these impacts is further discussed in EnviroKey (2020) and Section 4.10.

The aquatic ecology assessment (Cardno, 2020) concluded that the Project would have no more than minor impacts to aquatic ecology with no impacts to key fish habitat and potential threatened species in either Hawkins or Lawsons Creeks. The aquatic ecology assessment also concludes that there would be no direct impacts to Hawkins and Lawsons Creeks and these creeks would not be displaced or re-aligned during construction, operation or decommissioning. Sections of several un-named and ephemeral watercourses would be displaced and realigned within the Mine Site. These watercourses have limited aquatic habitat and their loss/disturbance is expected to result in very minor to negligible associated impacts to aquatic ecology in the context of the local and regional area, within which comparable habitat is abundant. Further, these would be replaced by newly created watercourses resulting in no net-loss of watercourse habitat.

With proposed mitigation measures in place, it is predicted that ecological impacts from the Project would occur with *minimal* consequence and are therefore considered a ***low*** social impact.

Land Use Conflict

Land use conflict can often materialise through impacts (e.g. noise, dust, lighting and visual impacts) from differing land uses or more indirectly through having to share scarce resources (e.g. water, workforce, transportation infrastructure). Land use conflicts can sometimes have intergenerational components which are associated with equity considerations for project development. Intergenerational equity is the idea of applying fairness or facilitating distribution of well-being between/across generations, preserving natural resources and/or caring for the environment for the benefit of future generations.

From a land use perspective, the main legacy of the Project for future generations would be a final landform, post closure; of which only a small proportion would be unable to support other land uses for future generations. Based on the results of Bowdens Silver exploration activities, there may be sufficient additional resources in proximity to the Mine Site for further expansion, subject to further technical definition and future approvals. Whilst a future expansion may exacerbate the final landform impacts, it would also provide a positive impact on intergenerational equity in the form of sustained employment and community investment.

Furthermore, given current drought conditions, the diversification of local industry could also provide a measure of resilience to economic pressures and afford those working in other industry sectors the opportunity to supplement their income with additional employment.

During engagement, residents and landholders in the locality identified the agricultural, rural residential and tourism uses of the area as valued land uses, which are considered important to the locality's sense of place. Some respondents stated the Project was not compatible with these existing land uses and had the potential to compete with these land uses for resources such as fertile land, water, workforce; and detrimentally impact on rural residential and tourism through operational impacts such as dust and noise.

The MWRC's Land Use Strategy suggests that extensive and intensive agriculture, mining, tourism and rural living continue to be the key land uses across the LGA; and that sufficient land, services and facilities need to be available to support these industries. The Strategy also states that, while mining currently has a relatively small percentage of land use (1%), exploration titles and applications currently cover two-thirds of the LGA.

As part of the EIS, an assessment of Biophysical Strategic Agricultural Land (BSAL) has been completed (see Section 4.18). This assessment confirms that there is no contiguous BSAL within the boundary of the Mine Site. Considering the limited availability of BSAL land, and other factors including the decrease in agriculture-based employment, the increase in the tourism industry and the objectives outlined in the MWRC's Comprehensive Strategic Land Use Strategy, it is unlikely that the Project would impact on the productivity of current agricultural land in the area. Bowdens Silver has also committed to continue to operate the Bowdens Farm throughout the Project life, with a focus on grazing of livestock including sheep and cattle.

Notwithstanding, from a social perspective, the likelihood of the Project contributing to land use conflict, particularly in the Lue locality, is considered a possibility, even with relevant mitigation measures in place. During the engagement program for the social impact assessment, respondents raised concerns about final land use and rehabilitation of the Mine Site post-mining. There was a desire from the community to see the area rehabilitated to a pre-mining state or used for farming or grazing, consistent with current land use in the area. Rehabilitation was of most concern to Aboriginal stakeholders, with a number of participants stating that rehabilitation needs to be both effective and progressive and involve the Aboriginal community where possible to ensure the protection of Country.

The EIS outlines that rehabilitation would be progressive and would involve landform construction and either temporary or permanent revegetation. Final slopes would be designed to be stable with watercourses re-instated. Temporary revegetation would focus on the use of exotic pastures to ensure rapid growth whereas emphasis would be placed upon native vegetation (trees, shrubs and ground covers) on all permanently vegetated areas. Both temporary and permanent revegetation would be undertaken progressively. A substantial portion of the Mine Site would be returned to grazing purposes with other areas retained for their biodiversity values.

Furthermore, the Project could be considered to provide sustainability for the region (including within Lue) through the provision of additional economic, human and social capital. Areas of vulnerability within the region, based on the capitals analysis include limited employment opportunities and high unemployment, decreasing capacity in certain infrastructure areas (e.g. roads and housing), low levels of post-secondary education opportunities and limited access to particular community services (e.g. specialist health services).

The Project is not predicted to result in impacts to land capability or water resource availability that extend for long periods post-mining, influencing the viability of future land use options. In fact, the Project may have a positive impact on future generations through providing an important precious metal that is used in nearly every major industry today, from biocides (pesticides and antimicrobials e.g. germicides, antibiotics) and electronics to solar panels and batteries for use by current and future generations.

Therefore, considering the proposed mitigation strategies, the potential for the Project to increase land use conflict in the locality and the region is considered *possible*, with a *minor* consequence resulting in a ***moderate*** predicted social impact more locally; and a minimal consequence more regionally, resulting in a ***low*** predicted social impact; and is considered to have a ***low*** impact on agricultural land use in the region.

4.20.6.9 Livelihood Impacts and Property Rights

Property Damage

A blast impact assessment (SLR, 2020) has been undertaken for the Project which addresses the impacts of the Project in terms of ground vibration, overpressure and fly rock on the surrounding environment, including private residential landholders, cultural heritage sites, rock formations and infrastructure.

The blast impact assessment considers there is negligible potential for structural damage as a result of blasting. Whilst blasting and vibration is not expected to cause property damage, Bowdens Silver would implement a Blast Management Plan which would ensure that ground vibration and potential blast emission impacts are minimised. Furthermore, Bowdens Silver has committed to undertaking structural inspections for properties within a 2km radius of the open cut pits prior to the first blast, subject to landowners'/occupant's permission.

Considering the above mitigation measures and technical assessment, property damage as a result of blasting is *unlikel*y to occur with *minor* consequences and is therefore ranked as a ***low*** social impact.

Decline in Property Values

Residents in the locality and regional community members raised concerns that the Project may affect their property values. While some respondents suggested that towns in the LGA would be affected, the majority of concerns were that the property prices in Lue and surrounding the Project may decline due to the presence of the Project. Other landholders in the locality suggested that property prices in the Lue locality and other towns in the LGA could increase as a result of the Project, due to a greater demand for houses in the area.

Potential impacts upon property values have also been considered as part of the economic impact assessment (Gillespie Economics, 2020). The value of land is a function of the attributes of the property including structural, access and environmental attributes. Conceptually, if surrounding properties are likely to be impacted by noise, dust, vibration or visual impacts, then there would be some impact on property values, with the greatest impact on property values being felt by properties experiencing the greatest impacts from the mine. Logically, where impacts exist or are expected to exist they are likely to be greatest with closer proximity to the mine and therefore there is likely to be some gradient of property value impact that decreases with distance from the mine. However, the existence of property value impacts and the distance gradient of these impacts are expected to be related to actual or expected physical impacts from the site rather than a simple distance relationship.

Umwelt (2020) reviewed a case study concerning the outcomes of a recent assessment of a coal mine within the Muswellbrook LGA and the impacts upon property values. The assessment concluded that there is evidence to suggest that detrimental impacts on property prices occur as a result of mining operations, however, this impact appears to be limited to the areas where factors such as noise and air quality exceed environmental standards and criteria. No evidence outside these areas was determined through analysis of available market sales data.

For properties that would be affected by physical impacts, the VLAMP provides voluntary acquisition rights for those properties identified as adversely impacted by noise or dust. Those properties that are still impacted, but to a lesser degree, fall within the management zone and are afforded a range of mitigation rights that they can choose to receive to mitigate the impacts of a Project. This may include measures such as air conditioning and electricity subsidies; double-glazing of windows and other noise and dust mitigation measures, such as the cleaning and provision of water filters on drinking water tanks and pool cleaning. Those properties that are in the negligible impact zone are not required to be afforded these mitigation rights, however, in order to further minimise the social impact due to noise, Bowdens Silver would also extend mitigation to properties located within the negligible impact zone.

It is noted that, between the Mine Site and Lue a substantial ridge line ("Bingman Ridge") is present (see Section 4.1.1.1) which affords significant topographic screening. As a result, there would be no views of the Mine Site or visual impacts to Lue and therefore impact upon property value due to visual amenity.

In addition, some concerns were raised by landholders along the pipeline route that related to the perceived potential for a decrease in property values due to an easement crossing their land. Also raised, were concerns about disruption to their farming activities during construction and the need for reasonable compensation to be paid for not only the pipeline but for relevant rehabilitation. To address these concerns, Bowdens Silver has engaged with landholders along the proposed route, to provide them with information regarding the proposed pipeline development, to discuss potential compensation, easement creation and the process of pipeline approval and construction. Where possible the proposed preliminary pipeline route has also been located within road reserves.

Considering the proposed mitigation strategies, the impact of the Project on property values of locality residents is considered *possible* with a *minor* consequence, resulting in a ***moderate*** social impact ranking.

The impact of the water pipeline on property values and land access, for those landholders on which the pipeline is located, is also considered *possible* with a *minor* consequence, resulting in a ***moderate*** social impact ranking.

The impact on the broader regional community is considered ***low*** (*unlikely* and *minimal*).

Employment, Procurement of Local Business and Community Investment

The positive economic impacts associated with the Project i.e. local employment, workforce expenditure, procurement of local businesses and services and community investment, were raised extensively across differing stakeholder groups during the social impact assessment engagement program. Participants were interested in seeing the economic benefits of the Project maximised through local employment and limiting of both FIFO and drive-in drive-out (DIDO) employees.

For Aboriginal stakeholders, while the employment of Aboriginal people was considered as a positive impact of the Project, responses were divided between those stakeholders that believed that employment of Aboriginal people should be limited to involvement in cultural heritage assessments only; while others saw the Project as being able to offer a variety of job opportunities to Aboriginal people, particularly Aboriginal youth.

Locality residents suggested that the employment generated by the Project would not be enough to outweigh the negative impacts of the Project, with some suggesting that the residents of Lue and surrounds were mainly retired and therefore not in need of employment. However, the Project would provide additional benefits other than employment, with a range of potential community investment and enhancement projects identified in areas such as education, youth, recreation, health, heritage and public utilities. These projects would be implemented through the CIP and selected through engagement with the local community.

Members of the regional community, local businesses and service providers suggested that the Project would bring in much needed employment for the LGA. Respondents also noted there was a current lack of employment opportunities in the LGA, specifically for youth, resulting in younger people relocating out of the area. In addition, the Project was also considered to be able to provide training for, and upskilling of, the regional workforce.

A further positive economic impact, identified by those consulted, included the opportunity for increased procurement from local businesses and use of local community services; thus, impacting positively on the region's economy. As noted by regional community members, the region has experienced a number of shocks due to closure of other businesses in the area e.g. cement and lime works and the recent rejection (September 2019) of a proposed coal mine in the Bylong Valley. These respondents saw the Bowdens Silver Project as an opportunity to further develop and diversify the mining industry in the region into commodities other than coal.

Respondents also outlined that the Project would have a positive economic benefit to the local and regional community through the potential for community investment, funding and sponsorships. These benefits would be maximised through the proposed Local Employment and Procurement Strategy and the CIP (see Section 4.20.4).

Further details on the economic benefits of the Project are provided in Section 4.19.

Considering the proposed mitigation and management strategies, the impact of the Project on economic livelihood is considered a ***high*** positive social impact (*likely* to occur with a *moderate* consequence) for all stakeholder groups.

4.20.6.10 Community Culture and Heritage

During consultation and engagement, impacts to culture and heritage were the most frequently raised negative impact of the Project by Aboriginal stakeholders; with stakeholders suggesting that appropriate care and cultural responsibility would be needed (particularly through the construction phase of the Project) to minimise the impact on Aboriginal sites of significance. Some stakeholders also identified the heritage values associated with a number of buildings in Lue including the Lue Hotel and Lue Railway Station and cottage. The Project would not impact upon these items of historic heritage.

A heritage assessment has been undertaken by Landskape (2020) and is summarised in Sections 4.14 and 4.15. On the basis of the heritage assessment and proposed management measures, including the development of a dedicated 'Keeping Place' and engagement of Aboriginal parties in salvage and rehabilitation efforts, as well as the development of a dedicated Aboriginal pathways and employment program, the mitigated social impact is assessed as being a ***moderate*** impact.

4.20.7 Conclusion

The social impact assessment has provided a description of the baseline social profile and social context in which the Project would be located, including an analysis of issues and opportunities facing key stakeholders and communities. The social impact assessment has also included an extensive community engagement program undertaken at key phases of the assessment. In particular, engagement was undertaken during the scoping of potential Project impacts, in receiving feedback to the draft assessment studies, and in the development of appropriate strategies to mitigate Project impacts / enhance Project benefits.

It is noted that the level of concern relating to the Project varies across stakeholder groups and geographic location. Whilst a number of social and environmental issues have been raised by local landholders in proximity to the Mine Site, particularly the impact of the Project on social amenity and sense of place and community in Lue; the broader LGA community has appeared more accepting of the Project due to the predicted positive economic benefits.

Key negative social impacts identified include impacts relating from property acquisitions, impacts on social amenity (as a result of noise, visual and traffic impacts); changes to sense of community, community cohesion and culture; and conflict as a result of competing land uses. In addition to these impacts, stakeholders have raised concerns relating to impacts upon health and wellbeing; Aboriginal cultural heritage; population change as a result of construction and operational workforce influx and subsequent impacts to community services.

Key positive impacts identified include potential economic benefits to the region through employment, procurement and business opportunities – providing a much needed social and economic stimulus. In addition, regional community members also suggested that the increase in population as a result of workforce influx associated with the Project, may have a positive impact on the LGA in relation to service provision.

As a result of the identified social issues and concerns, a range of Project design changes have been implemented to remove or reduce those concerns. A range of management, mitigation and enhancement strategies have also been proposed in order to minimise the potential negative social impacts and enhance the positive benefits.

As has been highlighted in the social impact assessment, the benefits and costs from projects are not always evenly distributed across individuals and stakeholder groups. Negative impacts would primarily be borne by residents and landholders surrounding the Mine Site and within Lue. Therefore, the proposed mitigation and enhancement strategies have particularly focused upon residents surrounding the Mine Site and within Lue. In particular, the Community Investment Program would develop projects and programs that are consistent with the local community needs, values and aspirations.

Notwithstanding the proposed measures, it is acknowledged that some residents may, for example, experience a loss associated with their sense of place or expectations of the future. However, others, both locally and within the broader LGA, may benefit from improved opportunities available through the proposed community investment and distribution of benefits.

Therefore, Bowdens Silver would continue meaningful engagement throughout the Project life and monitor the social outcomes from the Project and the implementation of the various strategies. This would provide for adaptive management and refinement of enhancement strategies to ensure that benefits are distributed as equitably as possible and negative impacts minimised to the extent feasible. In addition to information that would be provided through the Good Neighbour Program, the outcomes of the engagement and monitoring would be reported annually through publicly available reporting in order to keep the community informed, maintain transparency, and to remain accountable to the community.

Section 5

Summary of Environmental Management and Monitoring Measures

PREAMBLE

This section has been compiled in accordance with Schedule 2, Part 3 (7)(1)(e) of the EP&A Regulation to record the full range of measures Bowdens Silver would adopt when planning and operating the Bowdens Silver Project to mitigate any adverse effects of the Project.

The measures are presented in tabular form (Table 5.1) and record the respective objectives, actions and timing. Many of these measures would be reflected in the final conditions of consent. However, where they are not formalised, Bowdens Silver would reflect the commitments in environmental management plans for the operation, thereby formalising them.

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Table 5.1
Proposed Environmental Management and Monitoring Measures

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Desired Outcome	Measure		Timing*
	1. Noise		
Minimise noise-related impacts from all mobile earthmoving equipment	1.1	Use noise attenuated mobile equipment comprising low noise or extra quiet mobile equipment where practical.	Ongoing
	1.2	Restrict bulldozers to operate in 1st gear when operating out of the open cut pits.	Ongoing
	1.3	Install broadband noise "quacker" style reversing alarms on all mobile equipment.	Ongoing
	1.4	Progressively construct the lower embankment noise barrier around the WRE and southern barrier.	Ongoing
	1.5	Position acoustic barriers up to 8.5m high adjacent to the main open cut pit haul road and northern exit to the ROM pad.	Prior to evening mining operations
Minimise noise-related impacts from fixed plant	1.6	Use full or partial enclosures to attenuate noise from fixed plant where practical.	Construction stage
	1.7	Use low noise specifications, low noise idlers, soft-flow chutes and silencers.	Ongoing
	1.8	Install mid-high frequency noise conveyor alarms.	Construction stage
	1.9	Position nearfield acoustic barriers around the TSF crushing/screening plant.	During TSF embankment construction stage
Continuous delivery of waste rock of an evening and ore at night	1.10	Optimise the evening waste rock haul route to maximise the barrier effect from the existing topography and temporary acoustic bunds within the active WRE areas.	Prior to evening mining operations
	1.11	Optimise the night-time ore haul route to maximise the barrier effect from the existing topography and acoustic barriers adjacent to the main open cut pit haul road to the ROM pad.	Prior to night-time mining operations
Manage noise generated by the Project to levels that are compliant with conditional noise criteria	1.12	Schedule potentially intrusive activities in day-time and/or favourable weather conditions, where feasible.	Ongoing
	1.13	Establish and operate a real-time noise monitoring network at key residential receivers or at intermediate locations to identify the need to modify operations or shut down plant and equipment during noise enhancing weather conditions.	Ongoing
	1.14	Establish and maintain a continuous meteorological monitoring network for the Project.	Ongoing
Proactive Liaison with potentially affected residents	1.15	Discuss planned activities and effectiveness of noise controls with residents in close proximity to each construction site.	During site establishment and construction stage
	1.16	Discuss with all residents/occupiers of properties at which noise levels are predicted to exceed the Project Noise Trigger Level their actual experience of the noise that is audible.	Ongoing

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

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Desired Outcome	Measure		Timing*
	2. Blasting and Vibration		
Proactively record baseline conditions for ongoing assessment of structural change impacts (where they are suspected to occur)	2.1	Commission structural surveys of all privately-owned residences within 2km of all open cut pits (subject to the agreement of the landowner and/or occupier).	Prior to the first blast (where agreement of the landowner and/or occupier has been provided)
Compliance with blasting criteria at all privately-owned residences / receivers	2.2	Design all blasts within the Mine Area to meet airblast overpressure and ground vibration criteria at all privately-owned residences / receivers without VLAMP agreements.	All blasts
	2.3	Provide notification of blasts to occupants of residences within 2km of each blast (subject to individual arrangements with landowners and/or occupiers).	At least 24 hours prior to each blast
	2.4	Maintain a blast notification board at locations in Lue with notifications posted at least 24 hours prior to each blast.	At least 24 hours prior to each blast
	3. Air Quality		
Reduce dust generated by vehicles on site	3.1	Apply site-wide vehicle speed limits and confine vehicle travel to designated routes.	Ongoing
	3.2	Actively maintain and water haul roads (with records kept of daily water use).	Ongoing
Reduce dust generated during extraction and processing	3.3	Minimise travel speed and the distance travelled by bulldozers and coordinate activities to reduce push and haul distances and double handling.	Ongoing
	3.4	Use of water sprays and/or dust aprons/collectors for drill rigs.	During drilling
	3.5	Confirm proper stemming column length in each hole.	Prior to each blast
	3.6	Minimise drop heights when loading ore, waste rock and soil.	Ongoing
	3.7	Enclose the ROM feed hopper on three sides and operate water sprays during ore placement into the hopper.	Ongoing
	3.8	Apply water during crushing operations.	During crushing operations
	3.9	Progressively rehabilitate (both temporary and long-term) disturbed areas as applicable to the temporary / long-term use.	Ongoing as areas become available

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

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Desired Outcome	Measure	Timing*
	3. Air Quality (Cont'd)	
Undertake site activities without exceeding EPA air quality criteria or goals	3.10 Implement a proactive dust management system through a combination of the following. i) Meteorological forecasts - to predict when the risk of dust emissions may be high (due to adverse weather) ii) Visual monitoring - to provide an effective mechanism for proactive control of dust at source, before it leaves the Mine Site. iii) Real-time meteorological and air quality monitoring – to provide alerts for appropriate personnel when short-term dust levels increase, to allow management of the location and intensity of activities or increased controls.	Ongoing during operations and rehabilitation works involving earthmoving
	3.11 Test the concentration of lead and other metals, initially monthly and then at frequencies determined through ongoing review.	At commencement of air quality monitoring and ongoing (with frequency regularly reviewed)
	4. Greenhouse Gas	
Reduce GHG emissions during the design, construction, and operation of the Mine	4.1 Rehabilitate and supplement areas cleared of vegetation within additional biodiversity offset areas, which would be improved through ongoing management of the vegetation.	Progressively during operations and ongoing
	4.2 Consider energy efficiency during the final design of processing plant with energy efficient systems installed where reasonable and practicable.	Prior to construction stage
	4.3 Operate plant and equipment to maximise efficiency, with mine planning used to minimise vehicle wait times and idling.	Ongoing
	4.4 Procure locally produced goods and services where feasible and cost effective to reduce transport fuel emissions.	Ongoing
	4.5 Review cut and fill balances for earthworks to make sure that material is transported the least possible distances.	Prior to and during construction activities
	5. Groundwater	
An accurate understanding of the characteristics of the groundwater inflows to the open cut pits from all sources	5.1 Conduct monitoring in nominated groundwater bores within and surrounding the Mine Site.	As documented in the Water Management Plan
	5.2 Record water pumped from the open cut pits and assess annual water use to compare against licenced entitlements.	Ongoing with review annually
Proactive awareness and understanding of potential changes to groundwater availability and quality	5.3 Conduct monitoring in nominated groundwater bores within and surrounding the Mine Site, including 'regional control' sites.	As documented in the Water Management Plan

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

Desired Outcome	Measure		Timing*
	5.	**Groundwater (Cont'd)**	
Minimal contamination of groundwater resources by surface activities	5.4	Management of surface water flows in accordance with the sites surface water management plan.	Ongoing
	5.5	Construction of the TSF in accordance with the design statement.	Ongoing
	5.6	Monitoring of groundwater quality and implementation of remedial actions.	Ongoing and in the event of an exceedance of any agreed parameters.
Appropriate compensation for any actual loss of groundwater availability in registered groundwater bores	5.7	Establish acceptable contingency measures with potentially impacted landowners, should they be required in the event that the predicted lowering of the groundwater table eventuates.	Prior to operations intercepting the groundwater table for those landowners predicted to be impacted. In response to monitoring data for all others
An accurate groundwater model.	5.8	Review groundwater model prepared by Jacobs (2020) once data is available on actual inflows to the open cut pits and use this data to re-calibrate the model.	Within 2 years of extraction intercepting the regional groundwater table
A plan for groundwater management post-mining	5.9	Prepare a Final Void Management Plan that takes into account management requirements post-mining.	Prior to completion of mining
	6.	**Surface Water**	
Maximise diversion of clean water around disturbed areas to maintain flows to downstream watercourses	6.1	Divert runoff from a 50ha area in upper Blackmans Gully catchment to Price Creek.	Site establishment and construction stage
	6.2	Divert Blackmans Gully away from the main open cut pit and satellite open cut pits.	Site establishment and construction stage
Maximise discharge of water from sediment dams to downstream watercourse (after treatment) as a preferential approach for management. Capture, store and re-use water where this is not feasible.	6.3	Construct and manage sediment dams to collect sediment-laden water from the TSF, TSF NAF stockpile area, southern barrier, oxide ore stockpile, WRE perimeter embankments.	Site establishment and construction stage and ongoing
	6.4	Construct all sediment dams in accordance with Volume 2E of *Soils and Construction – Managing Urban Stormwater* (DECC, 2008)	Site establishment and construction stage
Maintain the active storage capacity of all sediment dams	6.5	Discharge water satisfying EPL conditions within 5 days of rainfall event, i.e. after confirming acceptable water quality – assuming either sediment settlement or flocculation.	Following rainfall event causing storage capacity

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

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Desired Outcome	Measure		Timing*
	6.	**Surface Water (Cont'd)**	
Avoid discharge of any contaminated water from the containment zone	6.6	Pump all water from the open cut pits to the open cut dewatering pond (for use in the processing plant).	As required
	6.7	Pump all decant water to the raw water pond for use in the processing plant.	Continuous
	6.8	Collect all runoff from the processing plant area and mining facility in the processing plant dams.	Ongoing
	6.9	Pump water from the Leachate Management Dam to the raw water dam.	Continuous
	6.10	Pump brine from on-site Reverse Osmosis Plant to raw water dam.	Ongoing
	6.11	Construct and maintain bunding around all tanks containing chemicals	Site establishment and construction stage and ongoing
	6.12	Undertake regular inspections of all pipelines and containment structures to monitor for leaks.	Ongoing during use of water supply pipeline
Avoidance of overflow from the TSF to downstream watercourses	6.13	Monitoring the water level in the decant pond.	Continuously
	6.14	Cease pumping water from external supply source when TSF water level is ≤4.7m below the emergency spillway invert level.	As required
Ensure all hydrocarbons contained within the Mine Site	6.15	Store all diesel and waste oil in self-bunded above ground tanks	Ongoing
	6.16	Refuel all mobile equipment (in the mining facility) in dedicated areas with perimeter bunding and spill kits.	Ongoing
	6.17	Store all 205L/20L drums in bunded storage area(s)	Ongoing
	6.18	Collect and remediate hydrocarbons – contaminated earth.	As required
	6.19	Maintain an oil-water separator within the workshop / maintenance area.	Ongoing
Manage the storage, use and spill management of other potential contaminants	6.20	Store a range of potentially hazardous materials within bunded areas or containers at the Mine Site in accordance with a chemicals management system.	Ongoing
	6.21	Implement and maintain a pump-out sewage management system by a licenced contractor.	Ongoing
	6.22	Reuse all brine generated by the reverse osmosis plant in processing.	Ongoing

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

Desired Outcome	Measure		Timing*
	7. Health Risks		
Ensure dust is controlled on site to prevent further contamination	7.1	Prepare and implement an Air Quality Management Plan outlining the measures to manage air emissions (consistent with those considered and outlined in the Air Quality Impact Assessment).	Prior to site disturbance activities and ongoing
Prevent contamination of surface water downstream of the Mine Site to maintain water quality standards	7.2	Implement the Project's Water Management Plan.	Ongoing
Manage and minimise noise and blasting impacts from the Project on the surrounding population	7.3	Develop and implement a Construction Noise Management Plan, Blast Management Plan and Operational Noise Management Plan.	Ongoing
Management of perceived risks and confirmation of actual impacts.	7.4	Offer lead blood level testing to Lue and district residents.	Prior to site disturbance activities and at regular intervals during operation.
	7.5	Publication of environmental monitoring results relating to lead in air and water to reduce uncertainty regarding the extent of impacts.	Ongoing during operations.
	7.6	Maintain an open-door policy and implement a good neighbour program involving regular and ongoing community engagement, providing opportunity to discuss and provide information in relation to impact monitoring and management.	Ongoing
Management of potential mental health impacts and maximisation of positive mental health benefits.	7.7	Provide support for health service programs in the region as part of Bowden Silver's Community Investment Program.	Ongoing
	7.8	Maximise local employment to reduce fly-in/fly-out and drive-in/drive-out employees.	Ongoing
	7.9	Management of noise impacts so as to reduce potential for sleep disturbance (and associated mental health impact).	Ongoing
	8. Visibility and Lighting		
Reduce the impact of the Project on the visual amenity at private residences and public roads.	8.1	Undertake progressive rehabilitation of the Site focusing particularly on the revegetation of visible disturbed areas.	Ongoing
	8.2	Enhance the existing tree screen adjacent to Pyangle/Powells Roads.	Ongoing and expanded from site establishment and construction
	8.3	Plant tree screens around the outer southern perimeter of the southern barrier and TSF.	As it is developed
	8.4	Adopt a dark grey/green colour scheme for site buildings and roadside noise barriers.	During site establishment and construction

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

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Desired Outcome	Measure		Timing*
	8.	**Visibility and Lighting (Cont'd)**	
Ensure Project-related lighting does not unreasonably impact the surrounding environment or operations at the Siding Spring Observatory and local astronomical observatories	8.5	Ensure all lighting complies with AS/NZS 4282:2019 – Control of the Obtrusive Effects of Outdoor Lighting (as amended from time to time).	Ongoing
	8.6	Ensure all light sources have appropriate correlated colour temperatures.	Ongoing
	8.7	Ensure all floodlights have a maximum upcast angle of 10 degrees.	Ongoing
	8.8	Ensure that lights with diffusing covers or with visible bare lamps that emit light above the horizontal plane are not used on the outside of buildings or structures.	Ongoing
	8.9	Restrict the use of floodlight towers to periods of active operation.	Ongoing
	9.	**Terrestrial Ecology / Biodiversity**	
Avoid and minimise impacts on terrestrial vegetation and animal habitats wherever possible	9.1	Delineate areas of native vegetation that are to be removed to prevent accidental damage or removal of retained vegetation.	Prior to each vegetation clearing program
	9.2	Restrict vehicles, persons and machinery from entering areas of retained vegetation (unless for required environmental monitoring or other valid purpose) to avoid unnecessary impacts to vegetation and habitat.	Ongoing
	9.3	Implement a pre-clearance Survey Protocol for areas of native trees and shrubs including a two-stage clearing protocol for all hollow-bearing trees.	Prior to each vegetation clearing program
	9.4	Mark all hollow-bearing trees to be removed and catalogue their species and approximate dimensions.	Prior to each vegetation clearing program
	9.5	Implement a seed collection plan with measures and procedures to collect, maintain and propagate from native seed sources.	Ongoing to the extent required for rehabilitation
	9.6	Prepare and implement a feral animal management plan including an inspection program to monitor for feral animal issues.	Ongoing
	9.7	Prepare and implement a weed management plan to monitor and, as required, control weed species within the Mine Site.	Ongoing
Rehabilitate disturbed areas to create a final landform that maintains or improves biodiversity values of the Site	9.8	Prepare a Rehabilitation Management Plan in accordance with the latest NSW Resources Regulator requirements / guidelines.	Prior to any ground disturbance
Secure biodiversity offsets to offset residual biodiversity impacts.	9.9	Implement an approved biodiversity offset strategy.	Progressively in accordance with approved staging

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

Desired Outcome	Measure		Timing*
9. Terrestrial Ecology / Biodiversity (Cont'd)			
Minimise the risk of fauna interaction with the TSF / Cyanide	9.10	Construct the TSF in a way that minimises the risk of shallow ponds forming on uneven ground after rain events.	During TSF construction
	9.11	Contour the floor of the TSF during construction to avoid island formation.	During TSF construction
	9.12	Prepare and implement a Cyanide Management Plan including measures to contain cyanide, maintain levels within the prescribed limits, monitor and inform the need for contingency measures.	Prior to use of cyanide
10. Aquatic Ecology			
Avoid and minimise impacts on aquatic vegetation and habitats where possible	10.1	Where practical, treat water to be released from all existing dams to eradicate the invasive eastern gambusia.	Prior to any discharge of water from existing dams.
	10.2	Screen any discharge pipes to minimise any eastern gambusia from entering surrounding watercourses, if treatment in 10.1 is not successful.	Ongoing during water discharges.
	10.3	Underbore any watercourses where significant water flows are present at the time of the construction of the water supply pipeline.	During water supply pipeline construction.
	10.4	Implement a monitoring program within Hawkins and Lawsons Creeks and associated alluvial aquifers to monitor potential impacts to aquatic biota, habitat and stygofauna.	Prior to the commencement of construction activities and ongoing throughout operations.
11. Traffic and Transport			
Achieve safe and efficient road transport operations	11.1	Prepare and implement a detailed Traffic Management Plan, incorporating a Driver's Code of Conduct, to safely manage any traffic impacts during all stages of the Project.	3 months prior to commencement of the site establishment and construction stage and for the Project-life
	11.2	Deliver equipment and consumables necessary for the construction and operation of the Project and despatch mineral concentrates outside heavy vehicles restriction periods designated as school bus operation times.	Ongoing
Mitigate potential traffic impacts to local road users	11.3	Spread commencement and finish times of operational shifts at different times throughout the day.	Ongoing

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

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Desired Outcome	Measure	Timing*
	12. Soils and Land and Soil Capability	
Minimise the clearing of native vegetation for the stockpile	12.1 Undertake a weed control program (if required) in areas to be stripped of topsoil.	Prior to soil stripping
	12.2 Where practical, transfer salvaged subsoil and topsoil directly to rehabilitation areas.	During soil stripping campaigns
	12.3 Limit topsoil stockpile heights to 2m and stabilise with a well-fertilised non-persistent cover crop.	Ongoing
	12.4 Limit subsoil stockpiles height to 5m and 1m of topsoil and stabilise with a well-fertilised non-persistent cover crop.	Ongoing
Encourage organic carbon accumulation, promote microbial activity and minimise erosion	12.5 Increase the thickness of topsoil and subsoil placed on the southern barrier to effectively provide an additional area to stockpile soil.	During southern barrier construction
Minimise losses through erosion caused by the practices of soil stripping to maximise the value of soil as a resource for rehabilitation purposes	12.6 Selectively strip topsoil and place in rehabilitation areas or in nominated stockpile areas.	During soil stripping campaigns
	12.7 Add lime to the topsoil and subsoil prior to each scraping pass.	During soil stripping campaigns
	12.8 Apply coarse grade gypsum prior to stripping and stockpiling of the 'Alluvium – medium quality' Soil Landscape Unit where required.	During soil stripping campaigns
	12.9 Avoid stripping or spreading soils when either very dry or wet.	During soil stripping campaigns
Minimise the impact on soil resources, terrestrial vegetation during stockpiling	12.10 Prevent vehicle access on soil stockpiles, except where required for monitoring, seeding, addition of soil ameliorants, or weed control.	Ongoing
	12.11 Place silt-stop fencing immediately down-slope of all stockpiles until stable vegetation cover is established. Return all material recovered from the silt-stop fencing to the stockpile.	Ongoing
	12.12 Implement a weed eradication program should unacceptable weed generation be observed on soil stockpiles.	Ongoing
	12.13 Establish and maintain an inventory of topsoil and subsoil resources (available and stripped) and reconcile with rehabilitation requirements.	Ongoing

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

Desired Outcome	Measure	Timing*
	13. Aboriginal Cultural Heritage	
Provide appropriate protection to the existing and any unknown Aboriginal artefacts.	13.1 Undertake archaeological field surveys with the local Aboriginal community of the areas within the water supply pipeline corridor and the proposed relocated Maloneys Road corridor that have not yet been surveyed.	Prior to any surface disturbance within the subject areas.
	13.2 Prepare and implement a Heritage Management Plan to manage those identified and any potentially unknown sites of Aboriginal heritage value within the Mine Site, relocated Maloneys Road and the water supply pipeline corridor.	3 months prior to commencement of the site establishment and construction stage and for the Project-life
	13.3 Install and maintain protective barriers around all identified Aboriginal cultural heritage sites within the Mine Site that are located in areas that would not be disturbed by Project-related activities.	Prior to the commencement of the site establishment and construction stage
	13.4 Adjust the water supply pipeline route, where feasible, to avoid disturbance of any identified Aboriginal cultural heritage sites.	During the site establishment and construction stage
	13.5 Install and maintain protective barriers around identified Aboriginal cultural heritage sites in the vicinity of the water supply pipeline corridor and the proposed relocated Maloneys Road corridor for the duration of construction activities.	During the site establishment and construction stage
	13.6 Arrange for the full salvage and storage in a "Keeping Place" of Aboriginal objects at all identified Aboriginal cultural heritage sites that would be directly impacted as the result of Project-related disturbance.	Prior to disturbance commencing and in accordance with a Heritage Management Plan
Prevent further inadvertent impact if any Aboriginal cultural heritage sites are identified	13.7 Stop work immediately and report the find to BCD and a qualified archaeologist to assess the significance of the site. If the site contains bones indicative of a human burial, notify the Police immediately.	Ongoing
	14. Historic Heritage	
Provide appropriate protection to the existing and any unknown historic heritage sites	14.1 Prepare and implement a Heritage Management Plan to manage those identified and any potentially unknown sites of historic heritage value within the Mine Site, relocated Maloneys Road corridor and the water supply pipeline corridor.	3 months prior to commencement of the site establishment and construction stage and for the Project-life
Prevent further inadvertent impact if any historic heritage sites are identified	14.2 Stop work immediately and report the find to BCD and a qualified archaeologist to assess the significance of the site.	Ongoing

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

Desired Outcome	Measure	Timing*
15. Public Safety Hazards		
Ensure the risk of bush fire attack is minimised at key Mine Site components	15.1 Maintain appropriate Asset Protection Zones around key Mine Site components.	Ongoing
	15.2 Ensure employees are trained in the proper use of firefighting equipment held on site.	Ongoing
	15.3 Make Mine Site firefighting equipment available to the local Rural Fire Service in the event of a bush fire on land surrounding the Mine Site.	As required
Minimise the risk of bush fire ignition from mining operations	15.4 Restrict work in heavily vegetated areas.	During high fire danger periods
	15.5 Develop procedures for hot works to prevent ignition sources for a bush fire.	Ongoing
	15.6 Consult with the local Rural Fire Service.	Prior to each bush fire season and any controlled burns
Ensure leaks and spills of sodium cyanide and cyanide solution are avoided on site and leaks and spills of sodium cyanide during transport are avoided	15.7 Ensure bunding around the on-site mini sparge system complies with AS NZS 4452:1997.	Ongoing
	15.8 Ensure the processing area is bunded to contain any processing leaks.	Ongoing
	15.9 Ensure operators in contact with cyanide are licenced and trained in emergency response and/or HAZMAT.	Ongoing
	15.10 Ensure cyanide transporters are certified as compliant with the Cyanide Code's Principles and Transport Practices.	Ongoing
	15.11 Ensure cyanide transporters are compliant with the *Australian Dangerous Goods Code* with drivers and vehicles licensed to transport DGs.	Ongoing
Minimise risks associated with the on-site use and storage of blasting agents (e.g. ANFO and ANE)	15.12 Implement quality assurance procedures to ensure blasting agents meet required specifications.	Ongoing
	15.13 Ensure blasting agents are packaged in accordance with the *Australian Dangerous Goods Code*.	Ongoing
	15.14 Ensure appropriate separation distances between blasting agents and the Mine Site boundary are maintained.	Ongoing
	15.15 Ensure emergency response and evacuation procedures are in place.	Ongoing
16. Economic		
Maximise local employment training, and engagement	16.1 Develop and implement a Local Employee and Procurement Strategy.	Site establishment and construction
	16.2 Give preference to local employees.	Ongoing
	16.3 Provide ongoing training and certification opportunities for local community members to ensure they have the necessary skills to work in mining.	Ongoing

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

Desired Outcome	Measure		Timing*
16. Economic (Cont'd)			
Involvement with local businesses to boost local economy	16.4	Inform local businesses of the goods and services required for the Project.	Ongoing
	16.5	Provide service provision opportunities and compliance requirements of business to secure contracts.	Ongoing
	16.6	Collaborate with local businesses and encourage local businesses to meet the requirements of the Project for supply contracts.	Ongoing
	16.7	Develop relevant networks to assist qualified local and regional businesses tender for provision of goods and services to support the Project.	Ongoing
Support local sporting, social and community groups to ensure community directly benefits from the Project	16.8	Implement a Planning Agreement with the Mid-Western Regional Council.	Agreement in place prior to commencement of site establishment and construction
	16.9	Develop and implement a Community Investment Program.	Initial funding released within 12 months of commencement of mining operations. Then ongoing during operations.
17. Social			
To enhance local values and address community needs within the Lue, Rylstone, Kandos, Mudgee and surrounding localities.	17.1	Develop and implement a Community Investment Program.	Ongoing. Expanded program prior to commencement of mining operations. Then ongoing.
Contribution to the provision of public amenity and public services, transport or other infrastructure requirements as agreed with Council.	17.2	Implement a Planning Agreement with the Mid-Western Regional Council.	Agreement in place prior to commencement of site establishment and construction .
Maximisation of the economic benefits of the Project within in the Mid-Western Regional LGA.	17.3	Develop and implement a Local Employee and Procurement Strategy.	Prior to the commencement of site establishment and construction.
Maintenance and further development of Company-community relationships.	17.4	Develop and implement a Good Neighbour Program which outlines ongoing and effective communication and engagement.	Prior to the commencement of mining operations.
	17.5	Employ a dedicated Community Liaison officer to manage the ongoing engagement and monitoring and management commitments.	Ongoing.

Table 5.1 (Cont'd)
Proposed Environmental Management and Monitoring Measures

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Desired Outcome	Measure		Timing*
	17. Social (Cont'd)		
Wholistic and adaptive management based upon monitoring/feedback and evaluation to minimise potential negative impacts and enhance benefits from the Project.	17.6	Develop and implement a Social Impact Management Plan that provides for monitoring and evaluation of social and community aspects of the Project and applies adaptive management to minimise potential impacts and maximise benefits.	Prior to commencement of mining operations.
	17.7	Prepare and implement appropriate complaint receipt / response and incident notification / reporting processes.	Ongoing during operations.
Keeping the community informed, maintaining transparency, and remaining accountable.	17.8	Public reporting of relevant statistics, monitoring results and engagement outcomes.	Ongoing during operations.

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Section 6

Evaluation and Justification of the Project

PREAMBLE

This section concludes the assessment of the Bowdens Silver Project. Schedule 2 Clause 7(1f) of the Environmental Planning and Assessment Regulation 2000 requires the Environmental Impact Statement to include a justification of the Project having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development.

This section of the EIS presents an evaluation of the Project with regards to:

- *the Project design and consideration of alternatives;*
- *commitments relating to operational controls and environmental management as well as the distribution of benefits in the local community, including that directed towards Lue;*
- *consistency with the principles of ecologically sustainable development;*
- *the consistency of the Project with planning requirements and strategies; and*
- *the manner in which the Project objectives have been satisfied.*

This is followed by a justification of the Project as proposed, with regards to the assessed biophysical, economic and social impacts or benefits and a review of the consequences of not proceeding with the Project.

Finally, the EIS is concluded through consideration of whether the Project is, on balance, in the public interest.

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6.1 EVALUATION OF THE PROJECT

6.1.1 Emphasis Placed on Project Design and Consideration of Alternatives

As described in Section 1.5, mineral exploration within and surrounding the Mine Site has been undertaken since 1989 by Bowdens Silver and others. This has been accompanied by feasibility assessments and numerous environmental studies undertaken by a range of specialist consultants. Subsequently, the design of the proposed mine has evolved under different ownership and during the preparation of this EIS for the Project. The design process has therefore been iterative with feedback sought from the local community through consultation activities which has been taken into consideration in preparing the final design as presented in the EIS.

A review of the key alternatives to the Project design that were considered and rejected is presented in Section 1.5.7. **Table 6.1** presents a summary of the key changes to the design that have occurred since Bowdens Silver assumed ownership.

Table 6.1
Project Design Changes

Project Component	Previous Ownership	Current Design
Total Resource	Mining of 53 million tonnes of ore and 79 million tonnes of waste rock.	Mining of 30 million tonnes of ore and 47 million tonnes of waste rock.
Processing Rate	Processing of 4 million tonnes per annum of ore.	Processing of 2 million tonnes per annum of ore.
Water Use	Water requirements averaging 3.5GL per year.	Lower water requirements averaging 1.9GL per year.
Water Source	Water sourced from local groundwater, surface water and other sources (including the Cudgegong River).	Water sourced from groundwater and surface water recovered from within the Mine Site with make-up water supplied by a pipeline from the surplus water within the Ulan Coal Mine and/or Moolarben Coal Mine.
Water Infrastructure	Large water storage dam (3 500ML capacity) required for water capture and storage	No large water storage infrastructure planned.
Ancillary Mine Infrastructure	Infrastructure located closer to Lue	Relocation of processing plant further north, away from Lue
Personnel Accommodation	Construction workers accommodation within the site.	No on-site worker accommodation with all accommodation to be sought locally.
Open Cut Pit Scale	A single open cut pit covering approximately 73ha	A main open cut pit and two satellite open cut pits, collectively covering approximately 52ha
Tailings Storage Facility	TSF located to the east of the Open Cut Pit over an area of 181ha and with a capacity of 46 million tonnes.	TSF located to the northwest of the Open Cut Pit over an area of 117ha with a capacity of 30 million tonnes.
Mine Site Access	Access via a realignment of Maloneys Road that intersects with Pyangle Road with traffic entering Lue Road to east of Lue	Access via a realignment of Maloneys Road that intersects directly with Lue Road to the west of Lue, resulting in no product transport through Lue or Rylstone.

Emphasis has been placed on simplifying the design to reduce potential amenity impacts while maintaining the viability of the Project. This process has focused on the proximity of Mine Site components to Lue and surrounding privately-owned residences and improving the environmental outcomes of the Project. The changes to the Project design have been discussed with the local community (through direct consultation, Open Day events and the CCC). The social impact assessment (Part 17 of the SCSC) presents in detail the feedback received from the community in response to these changes.

6.1.2 The Applicant's Commitments

The review and development of the Project design has occurred in response to the outcomes of technical assessment and community feedback that has culminated in a range of commitments made by Bowdens Silver for the construction and operation of the Project. Some of these commitments relate to specific management and mitigation measures described in Section 4 and summarised in Section 5. The management and mitigation measures form the basis of environmental management of the Project, many of which are likely to be incorporated as conditions of the Project's development consent.

The Project also comprises a series of significant commitments that would influence how the Project is experienced from outside of the Mine Site, including the following.

- The relocation of Maloneys Road to the west of the Mine Site is a key Project component given the existing road alignment traverses the main open cut pit. The opportunity to develop an alternative alignment for this road has allowed Bowdens Silver to locate the principal access to the Mine Site west of Lue and therefore reduce the need for heavy vehicle traffic to pass through Lue. Bowdens Silver has committed to constructing a road that is sealed and accessible to the general public, with a new intersection with Lue Road and crossings for Lawsons Creek and the railway line.
- In order to supply the Project with a reliable source of water, Bowdens Silver has committed to sourcing the Project's make-up water requirements from surplus water available from the Ulan Coal Mine and/or Moolarben Coal Mine. The water would be supplied to the Mine Site via a buried dedicated water supply pipeline and incorporate locations for offtakes should it be required for fire-fighting purposes. Bowdens Silver would focus on recycling water used in processing as much as possible and using water that is removed from the main open cut pit. Importantly, the availability of this alternative water source would mean that the Project is not reliant on local sources such as Lawsons Creek.
- Comprehensive assessments of potential impacts to local amenity have been undertaken for the Project which have identified that, during worst-case scenarios, some residences may experience high levels of noise. Bowdens Silver has committed to the purchase of properties or the installation of suitable on-property mitigation in agreement with the affected landowners, where this is required under the NSW *Voluntary Land Acquisition and Mitigation Policy 2018* (VLAMP). The assessments also identified residences that may experience noise levels that

exceed the criteria levels for the Project but do not trigger the threshold for mitigation measures under the VLAMP. Bowdens Silver has discussed this change in noise level with the owners of these residences and offered to provide on-site noise mitigation measures where this is agreeable to the landowner. As a result, the process of compensating impacted landowners would be over and above what Bowdens Silver is legally required to provide.

- Bowdens Silver has also been discussing potential purchase agreements for certain properties in proximity to the Mine Site. It is recognised that the prospect of a mining development can create uncertainty for some nearby residents, and several residents have indicated that they are not certain whether they want to move or if they want to remain on their properties. For these landowners, Bowdens Silver has determined that purchase agreements may be made available should, at a time in the future, it be decided by the resident that sale of the property is preferred.
- An important aspect of the Project is the direct stimulus of the locality around the Mine Site due to the Project's economic outcomes. These benefits are keenly anticipated for those seeking employment and for the local businesses that may provide goods and services to Bowdens Silver. However, in order to ensure that the benefits of the Project are experienced in Lue, Rylstone and Kandos and the surrounding communities, Bowdens Silver has committed to developing a Community Investment Program that includes funding for community-focused initiatives. The program would complement a planning agreement that would be entered into with Mid-Western Regional Council. A range of potential enhancement projects have been identified by the community during community consultation and are discussed in Section 4.20.5 and in Section 8 of the Social Impact Assessment (Part 17 of the SCSC). The initial phase of the Community Investment Program would be commenced prior to the approval of the Project with community workshops aimed at developing priorities for investment.

Consultation and engagement for the Project has identified uncertainty in some sections of the Lue and district community regarding the outcomes of the Project. In order to develop trust with the community, Bowdens Silver has committed to transparent and accountable environmental management and reporting. This would include, but is not limited to, the following.

- Public access would be provided to all environmental management plans required to be prepared by the development consent, monitoring records and approval documents for the Project via the Bowdens Silver website.
- Annual reporting (in accordance with the conditions of the development consent) that presents the operational progress of the preceding 12 months and for the next 12 months, as well as a review of the outcomes and trends in environmental monitoring.

- A monthly summary of environmental monitoring results including noise levels, air quality, water quality and groundwater levels would be made available to interested parties.
- Notification of blasting events (via SMS or other preferred measures).
- Development of a formal complaints procedure to ensure that any concerns raised by the community are formally investigated/actioned and feedback on the outcomes is provided to the community.
- Annual open days for the local community and other interested parties.
- Continued engagement with the CCC and Aboriginal stakeholders.
- The use of local community noticeboards for Project updates.
- Regular information provision and community engagement including newsletters.

Bowdens Silver has also committed to maintaining a dedicated community liaison officer on staff, who would be responsible for maintaining communication with the community and where possible, modifying engagement to suit community preferences. Additionally, the Company has committed to the appointment of a general practitioner (GP) or medical officer on a contract basis who would also be available to the community for both physical and mental health needs.

Another key influence on the design and proposed development of the Project is Bowdens Silver's commitment to progressive and final rehabilitation of the Mine Site and to ensuring a positive legacy for the Project. Planning for rehabilitation would be an ongoing process throughout the mine life and would involve the collection of data to support rehabilitation strategies and technical trials of rehabilitation methods. Progressive rehabilitation of areas no longer required for mining would assist to minimise visual impacts and to improve the final rehabilitation outcomes and provide data to assist in planning for closure. Bowdens Silver would also report on the status and outcomes of progressive rehabilitation activities in its annual reporting.

6.1.3 Ecologically Sustainable Development

6.1.3.1 Introduction

The importance of ecologically sustainable development (ESD) has been acknowledged across all levels of government in Australia for almost three decades. The concept of ESD highlights the need for development that meets the needs of the Australian society today to occur in a manner that does not compromise the ecosystems on which life depends, so that future generations are able to meet their own needs. ESD involves integrating economic and social development with environmental protection in decision making and for balancing the interests of current and future generations.

The 1992 *Intergovernmental Agreement on the Environment* signed by the Australian Commonwealth, State and Territory governments enshrined the principles of ESD in the development application and assessment process including within environmental impact assessment[1]. Within NSW, Clause 7 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* specifies the required contents of an Environmental Impact Statement, with Clause 7(1f) describing the need for a justification of development in accordance with the principles of ESD and Clause 7(4) defining the principles of ESD as follows.

7(4) The principles of ecologically sustainable development are as follows—

a) the precautionary principle, namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by—

i) *careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and*

ii) *an assessment of the risk-weighted consequences of various options,*

b) inter-generational equity, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,

c) conservation of biological diversity and ecological integrity, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,

d) improved valuation, pricing and incentive mechanisms, namely, that environmental factors should be included in the valuation of assets and services, such as—

i) *polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,*

ii) *the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,*

iii) *environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.*

The following subsections evaluate the Project in terms of its consistency with ESD and, in particular, the above principles.

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[1] See the National Strategy for Ecologically Sustainable Development https://www.environment.gov.au/about-us/esd/publications/national-esd-strategy

6.1.3.2 The National Strategy for Ecologically Sustainable Development

The National Strategy for Ecologically Sustainable Development 1992 establishes a strategic policy framework for governments to cooperatively make decisions and take actions to pursue ESD in Australia. It provides a strategic framework for those key industry sectors which rely on natural resources as their productive base, including the mining industry. It summarises the key challenges for the mining industry in terms of ESD to ensure that future development manages the renewable and non-renewable resources on which it depends in an efficient manner that is consistent with the principles of ESD. The strategy highlights several strategic initiatives, with these initiatives and how they have been achieved for the Project summarised as follows.

- Enhanced decision making – Bowdens Silver has developed the design of the Project through an iterative process that has involved feedback from the local community, consultation with government agencies, and assessment by technical specialists. The level of external input and technical assessment has enhanced the outcomes of decision making.
- Achieving a high standard of environmental and occupational health and safety performance – Bowdens Silver would need to comply with strict conditional requirements and has made a range of environmental performance commitments for the Project. Occupational health and safety for the Project's workforce is not addressed in this document but would also be a key focus of the Project.
- Strengthening the geoscientific information base – The EIS has been informed by comprehensive technical assessments that have occurred over a number of years. The detailed consideration of predicted environmental outcomes has benefited from the extensive baseline information gathered to date. Ongoing monitoring of the operation would provide feedback and enable impacts to be further minimised through an adaptive management approach.
- Optimising the economic return to the community from mining – as described in Section 4.19.3, the Project is estimated to provide a direct economic benefit to NSW of $146 million. The economic return to the local community would also be enhanced by a Community Investment Program that would be formulated through community feedback mechanisms in conjunction with a planning agreement with Mid-Western Regional Council.
- Improving consultative mechanisms – Consultation for the Project has been comprehensive and informed the Project's detailed social impact assessment but also provided valuable feedback for Bowdens Silver during development of the Project design. Mechanisms for ongoing consultation and engagement throughout the operation have also been proposed, including a Good Neighbour Program and Social Impact Management Plan.

A final matter considered in the strategy is for mining development to ensure that rehabilitation is sound, certain and also provides for an environmentally sustainable and safe landform that is at least consistent with the condition of surrounding land. Bowdens Silver has committed to progressive rehabilitation that would occur throughout the mine life and that would provide a guide for final rehabilitation. The final landform would be constructed to provide for similar land uses to that which currently exists; namely, grazing within areas of low to moderate agricultural capability and native vegetation conservation. The non-renewable aspects of mining are acknowledged in the strategy with this aspect being the driver of social and economic benefits. The requirement for the rehabilitated TSF, WRE and the open cut pit lake to remain in the final landform is acknowledged, with these components to be subject to ongoing monitoring and environmental management until such time as DPIE is confident that any environmental risks have been resolved.

6.1.3.3 The Precautionary Principle

The precautionary principle requires consideration of two aspects of environmental assessment, firstly if there is a threat of serious and irreversible environmental damage, and secondly that precautions to prevent these risks should only be dismissed if there is full scientific certainty regarding the likely outcome(s). The precautionary principle has been considered during all stages of the design and assessment of the Project. The approach to the assessment of the Project has involved the following activities consistent with a preventative approach to environmental impact.

- Risk assessment of potential environmental outcomes.
- Collection of a comprehensive baseline environmental data set.
- Comprehensive consultation with Government agencies, businesses, community groups and individuals to gauge local knowledge and to understand the concerns in the community.
- Robust technical assessment of worst-case scenario outcomes with management and mitigations recommended from the outcomes of these assessments.
- Emphasis for preventative environmental management measures to be implemented on the basis of predictive assessment of worst-case scenario conditions rather than reactive measures.
- Provision of training and induction for all workforce personnel to ensure that they understand their obligations to prevent or minimise environmental impacts.
- Avoidance of long-term adverse impacts on the local environment through the design and rehabilitation of disturbed areas to a landform and land use equivalent or better than that of the pre-mining environment.

The technical assessments for the Project have considered a range of risks that may result in serious and irreversible harm including the following.

- Contamination of land or water resulting in permanent damage to these resources and impacts to those that rely on them (see Section 4.7 and Section 4.13).
- Alterations to the flow regime in local watercourses permanently altering water availability for human and ecosystem use (see Section 4.6 and Section 4.7)
- Permanent or long-term impacts to the regional groundwater system including risks to groundwater quality and impacting water use and accessibility (see Section 4.6).

- Removal of habitat for threatened native flora and fauna including the critically endangered Regent Honeyeater (see Section 4.10).
- Harm or desecration to significant sites of Aboriginal or historic heritage value (see Section 4.14 and Section 4.15).
- Permanently altering the landscape and impacting the visual outlook from homes or public vantage points (see Section 4.9).
- Poor driving practices or inappropriate use of the local road network that results in traffic accidents with severe or life-threatening outcomes (see Section 4.12).

Other matters that have been considered for assessment such as noise or air quality impacts are able to be mitigated or are reversible. Each of these matters has been thoroughly assessed with comprehensive scientific methods applied to understand potential risks and to predict environmental outcomes. On the basis of what is known with regards to environmental risks, Bowdens Silver has committed to preventative measures to reduce potential impacts, as much as is reasonable. Environmental monitoring and reporting would be implemented to track trends in environmental outcomes / performance and guide adaptive management practices. In this regard, Bowdens Silver has acknowledged where scientific uncertainty exists and has committed to proactive management of residual environmental risks.

6.1.3.4 Social Equity

The principle of social equity encompasses concepts of justice and fairness:

- within generations (intra-generational equity), that includes the fair distribution of costs and benefits between all sectors of society; and
- between generations (inter-generational equity) that embraces the concept that it is beholden on the current generation to ensure the non-material well-being or “quality of life” of future generations during and beyond the Project life.

Social equity in the context of ESD relates to the maintenance or enhancement of the natural environment and resources in order to provide benefit to future generations.

The Project would be consistent with the principle of intra-generational equity as the economic benefits would be experienced throughout Australia, at the scale of the State of NSW, within the local community including Lue, Rylstone, Kandos and Mudgee and for individuals employed within the Mine Site. Measures such as the CIP and aspects of the planning agreement that would be entered into with Mid-Western Regional Council would maximise the local distribution of benefits. The predicted residual impacts of the Project would not focus on any one specific social or demographic group. Individual landowners have been consulted on predicted outcomes and where appropriate, offered compensation or contingency measures in the event of unacceptable changes to their environment.

The residual environmental impacts of the Project are also predicted not to be prolonged such that they may represent an unacceptable cost to future generations. This is particularly relevant where impacts may continue post-mining such as for the groundwater system. Numerical groundwater modelling was extended to 200 years post-mining and identified that an equilibrium water level in the open cut pit lake would be established after 100 years and that the extent of drawdown would stabilise after 16 years with minor fluctuations for 50 years post-mining. Regardless of the duration of these impacts, the area of extent of impacts is predicted to be limited to be within 2km to 3km and subject to monitoring and contingency allowances.

One of the objectives of the Project is to provide for the sustainability of Lue and retention of its character, with a focus on ensuring that the scale of impact associated with the Project is sufficient to provide direct benefit but not of a scale that negatively impacts the character of the local community. Through direct investment, the attraction of families to the area, the provision of opportunities for gaining off-farm income and by providing funding for community programs, the Project would encourage a more diverse business base in Lue, Rylstone, Kandos and other locations in the region, that would benefit future generations. Although the Project is medium term in comparison to a number of other mining developments, Bowdens Silver is continuing to invest in exploration for mineral development opportunities in the region that would potentially see the benefits of employment and training extending beyond the current generation.

The natural environment would be enhanced through the in-perpetuity conservation of land proportionate to the offsetting obligations of the Project. This approach, which is consistent with NSW government legislation and policies, ensures that native vegetation clearing for the Project development, is offset through conservation of similar areas that would be available for future generations.

It is noted that the mining products (i.e. silver, zinc and lead) are recyclable and reusable and therefore would meet the needs of both the current generation and future generations.

Finally, it needs to be acknowledged that the significant economic benefits to the MWRC LGA, NSW and nationally through the payment of taxes, royalties and wages would provide funding for the development of local infrastructure that would be a direct benefit to future generations. This is dependent on the funding priorities of government at all levels but may include enhancement of schools, medical facilities and the funding of road and other infrastructure.

6.1.3.5 Conservation of Biological Diversity and Ecological Integrity

This principle establishes the need to consider the conservation of biological diversity and ecological integrity in decision making. It is important that developments do not threaten the integrity of the ecological system as a whole or the conservation of threatened species in the short or long term.

As noted in Section 6.1.2, the Project has been subject to comprehensive assessment as well as a series of design and planning iterations that have included changes to the area that would be disturbed by mining. As the area of disturbance of the Project has been reduced, e.g. through reduced native vegetation clearing for soil stockpiles, so has the area of potentially impacted native vegetation and flora and fauna habitat. In addition, measures would be implemented on site to conserve the integrity of soil resources for use in rehabilitation activities, which would in part aim to re-establish native ecosystems within the Mine Site.

In addition, the biodiversity offsetting obligations of the Project have been assessed in accordance with the *Biodiversity Conservation Act 2016* and the NSW Biodiversity Offset Scheme with the proposed offset strategy to principally involve the establishment of Biodiversity Stewardship Agreements over land owned by Bowdens Silver (proximal to the

Mine Site) or over land that is privately owned, with biodiversity credits sold to Bowdens Silver and subsequently retired. Payment for the credits would fund ongoing management of the land. This process maintains the integrity of native vegetation and habitat, assessed to be consistent with that removed for the Project.

6.1.3.6 Improved Valuation and Pricing of Environmental Resources

The issues that form the basis of this principle relate to the acceptance that only by appropriately valuing environmental resources can they be balanced with economic imperatives for development. The key elements of this principle include:

- the concept that the "polluter pays", that is, those that generate pollution and waste should pay the costs for abatement or containment; and
- environmental costs should be valued appropriately and considered over the entire life cycle, including end use and waste management.

Bowdens Silver has made a range of commitments relating to the implementation of safeguards to avoid or minimise environmental impacts, manage the by-products of development (waste rock and tailings) and manage wastes on site over the longer term. While this may present a short-term cost to the operation, it is acknowledged that the long-term benefit of management is of high value to the Company and to the local environment. Importantly, this includes Bowdens Silver's commitments regarding the long-term storage, monitoring and management of tailings material that is a waste product of the Project, with detailed planning and design effort undertaken to ensure that the rehabilitated landform would remain safe, stable, secure and non-polluting.

The planning process in NSW requires that Applicants adequately consider, assess and value the potential environmental outcomes of development. Through multi-agency input to the assessment requirements, the priorities of all levels of government are considered and included in assessment. By taking this approach the relevant agency(ies) determine the value that should be placed on the environmental resources within NSW. Bowdens Silver has addressed the assessment requirements of all government agencies that had input to the assessment requirements for the Project. This has also been extended to a specific focus on addressing the queries and concerns of the local community and in valuing the feedback of the community and the local experience of the natural environment.

6.1.3.7 Conclusion

The aim of ecologically sustainable development is to recognise the environmental and social outcomes of development that must be considered if the economic benefits are to be realised in the short and long term. The focus is not on the sustainability of a single action but the sustainability of society between and across generations and the preservation of the ecosystem processes on which life depends. In this regard, the non-renewable aspects of mining have been recognised with objectives for mining development that seek the efficient removal and beneficiation of natural resources for economic benefit alongside detailed consideration of the environmental and social outcomes of these processes.

Bowdens Silver has undertaken thorough scientific assessment of the potential impacts of the Project and assumed worst case scenario settings for the development of preventative measures that would limit the potential for adverse environmental impacts. This includes the conservation of biological diversity through offsetting of residual impacts to biodiversity values. Social equity would be achieved for the Project through the broad distribution of benefits including directly within the local community and across generations. The environmental impacts would not expand over the long term or result in a direct cost to future generations. Finally, through the commitment to a range of Project components designed to limit local impacts and manage the outcomes of development, the Company is placing appropriate value on the environmental resources within and surrounding the Mine Site including the need to manage the by-products of development.

6.1.4 Planning Considerations

6.1.4.1 State Planning Issues

Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the principal legislation regulating development in NSW. Development consent for the Project is being sought under Part 4, Division 4.7 of the EP&A Act as a State Significant Development (SSD).

Section 4.15(1) of the EP&A Act describes the matters for consideration by a consent authority in evaluating a Project for determination. **Table 6.2** presents each of the matters listed in this section of the legislation and where each matter has been addressed in the EIS.

Table 6.2
Section 4.15(1) of the EP&A Act – Matters For Consideration in Evaluating a Development Application

Page 1 of 2

Matter for Consideration	Comments
a) the provisions of—	
i) any environmental planning instrument, and	The environmental planning instruments relevant to the Project have been described in Section 3.2.3 and a summary of how these have been satisfied is included below.
ii) any proposed instrument that is or has been the subject of public consultation under this Act and that has been notified to the consent authority (unless the Planning Secretary has notified the consent authority that the making of the proposed instrument has been deferred indefinitely or has not been approved), and	This requirement is noted, however all relevant environmental planning instruments have been addressed in the EIS.
iii) any development control plan, and	Clause 11 of the State Environmental Planning Policy (State and Regional Development) 2011 provides that development control plans do not apply to State Significant Development.
iv) any planning agreement that has been entered into under section 7.4, or any draft planning agreement that a developer has offered to enter into under section 7.4, and	Discussions with Mid-Western Regional Council regarding the contents of a planning agreement have commenced but have not yet been formalised.

Table 6.2 (Cont'd)
Section 4.15(1) of the EP&A Act – Matters For Consideration in Evaluating a Development Application

Page 2 of 2

Matter for Consideration	Comments
v) the regulations (to the extent that they prescribe matters for the purposes of this paragraph), that apply to the land to which the development application relates,	The relevant provisions of the *Environmental Planning and Assessment Regulation 2000* have been considered in the preparation of this EIS.
b) the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality,	This EIS has addressed the potential impacts on the natural and built environments, and social and economic impacts in the locality
c) the suitability of the site for the development,	Locating mining development is limited principally by the location and accessibility of the mineral resource that is the target of the operation. Comprehensive exploration programs and assessment of ore characteristics has permitted Bowdens Silver to confirm that the Project would be viable (confirmed through an Ore Reserve Statement, compliant with the JORC Code). Detailed technical assessment has been undertaken to assess the environmental and social outcomes of the Project with the outcomes described throughout Section 4 indicating that the outcomes would be acceptable assuming the implementation of the proposed commitments and management and mitigation measures.
d) any submissions made in accordance with this Act or the regulations,	This is a matter for DPIE in preparing its assessment, however Bowdens Silver would review and respond to submissions provided to DPIE during the exhibition period of the EIS.
e) the public interest.	Section 6.4 discusses the public interest.

Section 1.3 of the EP&A Act presents the objects of the Act which are presented in **Table 6.3** with a short description of how the Project and this EIS have addressed and satisfy these objects.

Table 6.3
Objects of the EP&A Act

Page 1 of 3

Object	EIS Coverage
The objects of this Act are as follows:	
a) to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources,	It is considered that the Project would provide for the orderly and professional development and operation of the Mine. At all stages of design and planning for the Project the social and economic outcomes that would be experienced in the community have been considered. In addition, the Project has been designed to avoid environmental impacts as much as possible and would mitigate or manage residual impacts to an acceptable level. Consultation with the local community has resulted in refinement of the Project during the preparation of the EIS with these refinements presented to the community in order to gauge whether they are deemed acceptable. It is therefore considered that the Project achieves this objective.

Table 6.3 (Cont'd)
Objects of the EP&A Act

Page 2 of 3

Object	EIS Coverage
b) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment,	Section 6.1.3 discusses how the Project is consistent with the principles of ecologically sustainable development The Project has been subject to thorough technical assessment to understand the existing setting, predict potential impacts and identify those matter that require preventative measure to manage the risk of impact. It is considered that the Mine would be developed in an efficient manner that will take into account the value of environmental and social resources to the local and regional community both now and in the future.
c) to promote the orderly and economic use and development of land,	Detailed technical assessment has been undertaken to understand the existing setting including through comprehensive exploration programs and assessment of ore characteristics. This has permitted Bowdens Silver to design a Project that not only maximises the economic use of the land but also provides for appropriate staging, the ongoing management of by-products, staffing and supply planning, progressive and final rehabilitation and community-related programs and investment. In this regard the detailed planning and preparation would ensure that the Project is developed to promote the orderly and economic use and development of the site.
d) to promote the delivery and maintenance of affordable housing,	While not directly relevant to the Project, it is not expected that the supply and availability of housing in the region would significantly change due to the anticipated employment benefits of the Project.
e) to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats,	Consideration of residual impacts to biodiversity values has been undertaken in accordance with the *Biodiversity Conservation Act 2016*. Direct disturbance of native vegetation and potential native fauna habitat has been minimised as much as possible to reduce the need for impact to biodiversity values. An offsetting strategy would ensure that residual biodiversity impacts are offset in accordance with a technical assessment of their adequacy for the impact proposed.
f) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage),	The Project would require the salvage of artefacts from 25 sites that have high Aboriginal cultural heritage value. However, these sites have been assessed to have mostly low or low to moderate scientific, aesthetic or educational significance. A further 31 sites within the Mine Site would not be directly impacted and would be protected from inadvertent disturbance over the Project life. Three historic heritage sites have been identified within the Mine Site that have been assessed as having a generally low historic heritage value. It is not anticipated that the Project would significantly constrain the sustainable management of built and cultural heritage.

Table 6.3 (Cont'd)
Objects of the EP&A Act

Page 3 of 3

Object	EIS Coverage
g) to promote good design and amenity of the built environment,	The Project would not influence the design of the built environment. It is acknowledged that the community within Lue would experience mine noise for the first time. However, the noise that would be generated has been assessed and it is predicted that the noise levels experienced would be low and at a level recognised by the EPA's Noise Policy for Industry (2017) as being acceptable to most people and unlikely to cause annoyance. Potential amenity impacts within Lue would be managed over the Project life through: • commitments to upgrade or improve local infrastructure such as the relocation of Maloneys Road to the west of Lue such that Project-related heavy traffic through Lue would be limited; • physical components of the Mine Site such as the Southern Barrier that would obscure views of the Mine; • adoptive blast designs that consider potential impacts at privately-owned residences; • preventative management incorporating meteorological forecasting, comprehensive monitoring and response protocols; and • reactive management protocols to address community complaints.
h) to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants,	The buildings that comprise the processing facilities within the Mine Site have been carefully designed and located to permit their necessary function while providing reasonable access and facilities to maintain the safety of occupants.
i) to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State,	The assessment requirements addressed in this EIS include feedback from Council, relevant State government agencies and the Commonwealth Government.
j) to provide increased opportunity for community participation in environmental planning and assessment.	Section 3.2.2 of this document and Section 3 of the Social Impact Assessment for the Project describe the extensive community consultation and engagement activities that have been undertaken during the design and planning for the Project. Furthermore, Bowdens Silver has committed to ongoing consultation and community and stakeholder engagement post-approval and over the Project life.

In particular, Clause 12AB of the Mining SEPP describes the non-discretionary development standards for mining in relation to potential impacts associated with cumulative noise levels, cumulative air quality levels, blasting and aquifer interference. A brief summary of these standards and how they have been satisfied for the Project is provided as follows.

- **Cumulative air quality** level standards relate to cumulative annual average levels greater than 25µg/m^3 of PM_{10} or 8µg/m^3 of $PM_{2.5}$ for privately-owned residences. Air quality impacts are presented in Section 4.4 and the Air Quality Assessment prepared by Ramboll Australia Pty Ltd. It is confirmed that there would be no exceedances of the non-discretionary cumulative annual average levels at any privately-owned residence.

- **Cumulative noise** level standards relate to whether the cumulative amenity noise level is greater than the recommended amenity noise levels for privately-owned residences. Potential noise impacts have been assessed in Section 4.2 and the Noise and Vibration Assessment prepared by SLR Consulting Pty Ltd. It has been predicted that noise levels at some properties would trigger the acquisition or mitigation rights described under the NSW Government's Voluntary Land Acquisition and Mitigation Policy (VLAMP). Bowdens Silver would enter into agreements with affected properties to the satisfaction of the landowners to compensate for predicted impacts. Residences in Lue and places of interest in Lue are not predicted to experience noise levels that exceed the recommended amenity noise levels.
- **Airblast overpressure and ground vibration** standards relate to the industry accepted criteria for blasting as follows.
  - 120dB (Lin Peak) at any time and 115dB (Lin Peak) for more than 5% of blasts over a 12-month period for airblast overpressure; and
  - 10mm/sec (peak particle velocity) at any time and 5mm/sec (peak particle velocity) for more than 5% of blasts over a 12-month period for ground vibration.

  Potential blasting impacts have been assessed in Section 4.3 and the Noise and Vibration Assessment prepared by SLR Consulting Pty Ltd. It has been confirmed that it would be feasible for Bowdens Silver to control blasting activities to ensure that the blasting standards are not exceeded at any private residence. This would be achieved through careful planning, conservative initial blasts and progressive refinement of blast laws for the Mine Site.
- **Aquifer interference** standards relate to impacts within an aquifer associated with the water table, water pressure and water quality requirements specified in the NSW Aquifer Interference Policy. Potential impacts to aquifers have been described in Section 4.6 and assessed in the Groundwater Assessment prepared by Jacobs Pty Ltd. It has been confirmed that impacts to groundwater levels in two privately-owned bores may occur as a result of the Project but that these impacts are considered unlikely given the nature of the aquifer and location of the bores. Significant impacts to groundwater pressure and groundwater quality are not predicted to occur.

It should also be noted that a range of mitigation and management measures would be implemented to reduce the likelihood of impacts, including comprehensive environmental monitoring. This would further reduce the likelihood of impact or permit Bowdens Silver to plan for compensatory measures, should they be needed.

State Environmental Planning Policy (Infrastructure) 2007

A range of infrastructure has been identified which would potentially be affected by the Project including electricity, rail and road infrastructure. Bowdens Silver has consulted with the relevant stakeholders including TransGrid, John Holland (manager of the Wallerawang-Gwabegar closed railway line) and Mid-West Regional Council and considered their requirements in the preparation of the EIS.

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33)

Based on the risk screening method of *Applying SEPP 33 Final* (DoP, 2011a), the Project is classified as 'potentially hazardous. A Preliminary Hazard Analysis (PHA) was undertaken to assess the potential hazards associated with the management of sodium cyanide and blasting agents. A hazardous materials transport route evaluation study was also undertaken. Qualitative analysis of the risk of potential off-site safety effects to surrounding land uses or environmental effects to surrounding ecosystems indicate the risk would be very low and all qualitative environmental risk criteria identified in *Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning* would be met by the Project.

State Environmental Planning Policy (Koala Habitat Protection) 2019 (and the former State Environmental Planning Policy No. 44 – Koala Habitat Protection)

SEPP (Koala Habitat Protection) 2019 has been addressed within the Terrestrial Ecology Assessment prepared by EnviroKey (2020). It is noted that the Mine Site contains Rough-barked Apple, White Cypress Pine, White Box, Blakelys Red Gum, Ribbon Gum, and Scribbly Gum, all of which are listed as Koala feed tree species under Schedule 2 of this SEPP. Given the presence of Koala feed tree species and recent records within and adjacent to the Mine Site (not recorded as part of the terrestrial ecology assessment), it is considered likely that the Mine Site and its surrounds contains core Koala habitat as defined by both SEPP (Koala Habitat Protection) 2019 and the former SEPP 44.

The Project would result in the removal of 139.59ha of suitable habitat for the Koala, however assessment by EnviroKey (2020) concluded that the Project would not result in a significant impact to this species due to:

- the relatively localised nature of the disturbance when compared to the wider local and regional distribution of Koala; and
- the greater extent of habitat in the locality known to be used by Koala.

Regardless, the assessment of offsetting obligations for the Project has included the requirement to offset habitat for the Koala (3 629 species credits). The possible presence of Koala within the Mine Site would be managed through a Biodiversity Management Plan and the offsetting obligations managed in accordance with the Biodiversity Offset Strategy for the Project.

6.1.4.2 Regional Planning Issues

Regional planning considerations are presented in detail in Section 3.2.3.5 and relate to the *Central West and Orana Regional Plan 2036* (CWO Regional Plan) and the *Dark Sky Planning Guideline* (DPE, 2016).

The CWO Regional Plan presents a range of goals for the region that covers 125 666km^2 and 20 local government areas. These include to encourage:

- a diverse regional economy;
- a stronger, healthier environment and diverse heritage;
- quality freight, transport and infrastructure networks; and
- dynamic, vibrant and healthy communities.

The key consideration for the Project relates to the potential for land use conflicts to result between the proposed mining activities and the existing agricultural use of nearby land. An Agricultural Impact Statement has been prepared for the Project that concluded that the Project would have negligible to minor adverse impacts upon the agricultural resources and enterprises. Bowdens Silver sought and obtained a Site Verification Certificate on 8 November 2017 which confirms that there is no contiguous Biophysical Strategic Agricultural Land (BSAL) within the boundary of the Mine Site.

The Dark Sky Planning Guideline (DPE, 2016) provides guidance and technical information on lighting design requirements for developments within the Dark Sky Region – an area which comprises the land within a 200km radius of Siding Spring Observatory. The potential impacts of the Project on the Siding Spring Observatory are described in Section 4.9 and the Lighting and Sky Glow Assessment prepared by Lighting, Art & Science Pty Limited. Consultation was also undertaken with the Director of Siding Spring Observatory to establish the quantum of any potential impacts from the Project on astronomical operations at the Siding Spring Observatory. It has been confirmed that the night sky brightness above the observatory as a result of the Project would be negligible.

6.1.4.3 Local Planning Issues

The principal local planning instrument for the Project is the Mid-Western Local Environmental Plan (LEP) 2012. Under that plan, the Mine Site and relocated Maloneys Road are located wholly within land zoned RU1 – Primary Production with open cut mining permissible with consent within this zone. The water supply pipeline would traverse land zoned RU1 – Primary Production and R5 – Large Lot Residential. Water supply systems are permissible with consent on land zoned RU1 – Primary Production, however, they are prohibited on land zoned R5 – Large Lot Residential, however Section 4.38(3) of the EP&A Act applies to State significant development and states that "*development consent may be granted despite the development being partly prohibited by an environmental planning instrument*". Each of the Project components would comprise or traverse land mapped under additional local provisions for groundwater vulnerability (Clause 6.4) and biodiversity sensitivity (Clause 6.5) within the Mid-Western Regional LEP.

The objectives for the land zoning and for vulnerable and biodiversity sensitive land are discussed in detail in Section 3.2.3.6. In summary, it is considered that the Project would be consistent with the Mid-Western LEP and would not compromise the achievement of the relevant objectives of the plan.

6.1.5 The Objectives of the Project

Final evaluation of the Project is presented through consideration of Bowdens Silver's objectives presented in Section 2.1 and how the EIS and Project, as presented, would achieve those objectives.

Objective (i) Maximise the recovery of the silver, zinc and lead minerals from the defined ore reserves within the proposed open cut pits

This objective represents both the commercial imperative of the Project and consistency with the mining-related legislation in NSW including the *Mining Act 1992* and the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*

(Mining SEPP). The commercial imperative of the Project is to maximise the efficient extraction and processing of the silver, zinc and lead minerals in an environmentally and socially responsible manner in order to generate revenue and in turn profit for the Company. The success of the Project and the associated employment, spending and investment relies on the achievement of this objective. Maximising the recovery of minerals for the Project is also considered to be in the best interest of the Commonwealth, the State of NSW and the locality as this influences the payment of royalties and taxes which are subsequently re-invested in the locality through Government-sponsored initiatives and infrastructure development. A focus of the DRNSW - MEG in assessing the Project will be ensuring that the Project is supported by a comprehensive understanding of the rocks and minerals being mined and its management, as well as consideration of the efficiency of the Project design, ensuring that future resources and access to them is not compromised.

The EIS has demonstrated the detailed technical understanding of the Project by Bowdens Silver and its consultants. Comprehensive exploration programs and assessment of the ore characteristics have been undertaken to understand the potential for efficient outcomes in processing and the ongoing management of by-product tailings and waste rock. Potential environmental constraints associated with the Project have been identified and thoroughly assessed. The detailed understanding of the material and the balance of environmental and social outcomes justifies the scale and design of the Project. An assessment of the economic outcomes of the Project has demonstrated the substantial economic benefits of the Project to the Mid-Western Regional LGA, the State of NSW and the Commonwealth. Bowdens Silver is therefore confident that the Project, as presented, would achieve this objective.

Objective (ii) Undertake all activities in an environmentally and socially responsible manner to demonstrate compliance with relevant criteria and satisfy reasonable community expectations

Section 3.2.2 of this document and Section 3 of the Social Impact Assessment for the Project describe the extensive community consultation and engagement activities that have been undertaken during the design and planning for the Project. Engagement with the community, for example through open day events at which the authors of key technical assessments were in attendance has allowed those involved to directly answer questions and understand the concerns and priorities of the community. Through the detailed environmental assessments, Bowdens Silver has gained an understanding of the environmental constraints for the Project and environmental risks, a number of which require ongoing management.

These processes have culminated in a comprehensive series of management and mitigation measures which are a direct response to the Government and community feedback on the Project and the recommendations of assessment. Section 5 presents a summary of these measures and demonstrates how Bowdens Silver intends to achieve this objective.

Objective (iii) Ensure the health of its workforce and the surrounding community is not adversely affected.

The health of the Project workforce has been given the highest priority in planning how the operations would be developed and operated. This is a basic tenet of the employment process that involves the exchange of labour for payment but also the assumption of responsibility that the lives of the entire workforce would not be endangered. Occupational health and safety is not assessed through the environmental assessment process, however employee health is a primary consideration for Bowdens Silver.

It is also accepted that mining projects may present human health risks externally, predominantly in the event of catastrophe or as a result of poor management. Human health risks have been assessed for the Project with regards to the impacts associated with air quality, water resources and noise with the outcomes indicating negligible risk, including for exposure to lead, for all members of the community. It is also acknowledged that mining projects may cause mental health issues for some members of the local community. The MWRC community is very familiar with mining, including the changes and benefits that these projects bring. While experiences of stress and anxiety are individual, so are the positive mental health outcomes that result from employment and renewed confidence in the viability of the local community.

Bowdens Silver would implement a range of mitigation measures designed to limit negative health impacts including through the provision of contracted medical officer or general practitioner to assist with general health and mental health services, monitor for any trends in impact (such as dust generation) and to keep the community informed as the Project progresses. Support for local health services is also proposed to be included in the Community Investment Program.

Objective (iv) Preserve the existing character of Lue

This objective is focused on the sustainability and character of Lue and involves balancing stimulus through direct investment in the locality with limitations to the level of influence and change that may see the character of Lue affected. Substantial effort has been placed upon refining a number of the Project components to reach this balance with a summary of the substantial changes presented in **Table 6.1**. In addition, this process has resulted in several key commitments including the following (described in detail in Section 6.1.2).

- Relocating Maloneys Road to intersect with Lue Road to the west of Lue and remove the majority of heavy vehicle traffic for the Project from Lue.
- Arranging for the supply of surplus water from the Ulan Coal Mine and/or Moolarben Coal Mine via a dedicated water supply pipeline that would remove the need for water to be sourced locally.
- Agreements to compensate landowners predicted to experience high noise levels or to provide flexible agreements for purchase of their properties in the future.
- A Community Investment Program to be developed in conjunction with the local community to complement a planning agreement with Mid-Western Regional Council. The program would provide direct investment in local community programs and maximise the distribution of the benefits from the Project to the local community.
- Ongoing engagement with the community including transparent and accountable environmental management and reporting. These aspects would principally be managed through a Good Neighbour Program and Social Impact Management Plan. A dedicated community liaison officer would be responsible for maintaining communication with the local and district community.
- Progressive and final rehabilitation of the Mine Site to ensure a positive legacy for the Project.

It is difficult to predict the future of Lue in the absence of the Project as the Social Impact Assessment identified a strong sense of community supported by a diverse natural resource base (mining, agricultural and natural) and associated economic inputs. However, it is also recognised that several large local projects that would provide employment opportunities have closed or failed to receive the necessary approvals, which has affected the local economy, particularly in the Rylstone/Kandos area. In addition, a growing ageing population is evident in Lue, which may present challenges in coming years.

Bowdens Silver considers that the scale of the Project would be sufficient to provide a boost to the local economy but not cause substantial adverse environmental or social impacts. By balancing the stimulus of the local community with an appropriately scaled operation, it is anticipated that the Project would provide a substantial benefit to the growth and development of Lue in a manner consistent with its existing character.

Objective (v) Maintain a positive relationship with the surrounding agricultural industry and maximise productivity on land retained for agricultural production

The majority of land immediately surrounding the Mine Site comprises predominantly grazing land but also lifestyle lots and heavily vegetated areas with minimal productive land use. This is consistent with broader regional patterns of land use. While approximately 42% of the land within the Mine Site would be disturbed throughout the Project life, some areas within the Mine Site and on adjacent land that have been purchased by Bowdens Silver to provide a buffer to privately-owned residences, would continue to be used for agricultural production.

A key measure to ensure the ongoing coexistence of agricultural enterprises and the Project include mitigation of physical impacts that may be experienced off site such as through changes to water resource availability and quality and soil condition as well as the recognition that part-time employment offered at the Mine would provide an opportunity for surrounding farm owners to seek a second source of income to supplement on-farm income. It is anticipated that by implementing the proposed mitigation measures and maintaining communication locally, a positive relationship would be developed and maintained over time with local agricultural producers.

Objective (vi) Provide a stimulus for the Lue, Mudgee, Rylstone, Kandos and district economies

This objective recognises the historic and current importance of mining in the Mid-Western Regional LGA. Much of the feedback received by Bowdens Silver during the design and planning of the Project included requests regarding employment opportunities, supply contracts and general economic stimulus within the Mid-Western Regional LGA. While a focus of the Project is maintaining the balance of investment and conspicuous change in Lue, the broader centres of Mudgee and more particularly, Rylstone and Kandos are also experiencing growing unemployment and trends consistent with an ageing population that are placing strains on the local community. There are many opportunities for the development of tourism in the region to balance the existing and proposed mining and agricultural industries and it is anticipated that projects such as that proposed by Bowdens Silver would provide an economic base on which to grow more diverse opportunities.

Objective (vii) Achieve the above objectives in a cost-effective manner to ensure the Bowdens Silver Project is economically viable.

This objective reflects the first objective to the extent that the commercial viability of the Project is the foundation of all projected outcomes and benefits. Review of the Project design and planning for the ongoing environmental management of the Mine Site has taken into consideration the cost of mitigation and management. Bowdens Silver is confident that the Project would provide an acceptable balance between the scale and rate of production and the commitments of the Project. This is supported by the outcome of the Economic Impact Assessment. In addition, the scale of the Project has been refined in order to balance the environmental impacts with the economic benefits and the social development goals for the region as expressed in the planning strategies, legislation and guidelines relevant to the development of mining projects as well as the direct feedback received through community consultation. Bowdens Silver is confident that, after taking into account all the costs associated with the Project as it is proposed, the outcome would be a viable and profitable Project.

Through ongoing exploration in the region, it is anticipated that the success of this Project would provide the impetus and funding for investment in other prospective mining operations in the region thereby sustaining and diversifying the Mid-Western Regional LGA's mining industry, which is currently dominated by coal mining.

6.2 JUSTIFICATION OF THE PROJECT

6.2.1 Introduction

The Project has been subject to detailed review, refinement and assessment during design and planning and the preparation of this EIS. The following subsections present a justification for the design, scale and location of the Project, as proposed. A brief summary of the biophysical, health, social and economic outcomes of assessment is presented with particular focus on residual environmental impacts and environmental risks assuming the implementation of proposed mitigation and management measures. This is followed by a discussion of the consequences of not proceeding with the Project (the need for the Project) and finally, how the Project is, on balance in the public interest.

6.2.2 Biophysical Considerations

6.2.2.1 Noise and Blasting

The design of the Mine Site, the selection of the type and number of mobile equipment used on site and operational hours for the Project have largely been influenced by the noise assessment for the Project. Key design features that have been refined through this process include the following.

- A key component influencing noise would be the processing plant given it needs to operate continually 24 hours per day 7 days per week. Hence, the plant would be located as far as possible northeast of Lue with the noisier components positioned in topographically low and shielded areas. Primary crushing would not occur at night in order to satisfy the project noise trigger levels (PNTLs).

- The open cut pits have been designed with their exit ramps to the north and east, i.e. the furthest distance from Lue.
- It is important that the mining activities within the open cut pits operate 24 hours per day, 7 days per week. This would be achieved through limiting the number of items of mobile equipment operating of an evening and night and also confining areas of operation to specific areas where noise barriers are present.
- Evening and night-time mining operations would not commence until operations are sufficiently deep in the main open cut pit to enable the PNTLs to be satisfied. Evening and possibly night-time operations would most likely commence in about Years 2 or 3.

The above design features together with a range of specific mitigation measures, the adoption of predictive meteorological forecasting and real-time noise monitoring would enable the planned mining and processing operation to proceed in the manner proposed.

The noise assessment undertaken by SLR (2020) has concluded that the noise climate around the Mine Site would change and a number of residents of Lue and the surrounding area would hear mine noise for the first time. The noise levels experienced would be low and would be mainly audible during periods of adverse weather conditions, i.e. gentle winds towards residences or evening or night-time temperature inversion.

The noise assessment has predicted that the PNTLs would be exceeded at eleven residences, i.e. at one residence with a significant exceedance (>5dB(A); at four residences with a moderate exceedance (3dB(A) to 5dB(A)); and at six residences with a negligible exceedance 1dB(A) to 2dB(A). Despite being outside of the VLAMP requirements, Bowdens Silver has offered the owners of these six residences to install/construct a range of architectural treatments to reduce noise levels experienced.

Overall, whilst noise from the Mine Site activities would be periodically audible by Lue and district residents, the magnitude of the mine noise would be at a level recognised by the EPA's policy as being acceptable to most people and unlikely to cause annoyance.

Blasts would be designed to ensure that both ground vibration and airblast overpressure levels comply at all privately-owned residences without a VLAMP agreement. Blasts would be periodically heard but their effects would be within both comfort and damage criteria. Blasting notifications would be provided to interested parties that have registered with Bowdens Silver.

6.2.2.2 Air Quality

Through detailed and conservative modelling, the air quality assessment (Ramboll, 2020) has predicted that there would be no exceedances of the relevant air quality criteria for particulate matter (TSP, PM_{10}, $PM_{2.5}$) at any privately-owned residences or receivers, either from the Project alone or cumulatively. It is also predicted that there would be no exceedance of the impact assessment criteria at any receivers (Project-related or private) for metal dust concentrations, respirable crystalline silica or hydrogen cyanide.

Notwithstanding the fact that no air quality exceedances are predicted at surrounding residences, the existing static and real-time air quality monitoring network and the real-time meteorological monitoring network would be retained for the operation of the Project. This network would be essential for demonstrating compliance and confirming the modelling predictions for the local community. The network would also form part of the proposed proactive dust management system that would also incorporate predictive meteorological forecasting and visual monitoring. The proactive dust management system would identify potentially adverse conditions so appropriate measures can be taken in advance. The system would also provide alerts for appropriate personnel when short-term dust levels increase but do not yet exceed applicable criteria, thereby allowing proactive management of the location and intensity of activities and/or increased controls to prevent a Project-related exceedance of applicable criteria.

6.2.2.3 Greenhouse Gas

Based upon conservative assumptions, the total estimated GHG emissions over the Project life are as follows.

- Scope 1: 444 442 tonnes CO2-e (~31% total)
- Scope 2: 812 319 tonnes CO2-e (~57% total)
- Scope 3: 166 055 tonnes CO_2-e (~12% total)

Total: 1 422 816 tonnes CO_2-e

The GHG emission estimates are conservative as they do not account for the offset of emissions through the increase in vegetative biomass that would be achieved within the biodiversity offset areas to be established for the Project or the return of vegetative biomass through progressive rehabilitation. Therefore, the inclusion of GHG emissions from vegetation clearing without inclusion of the subsequent emission offsets provides a highly conservative estimate of the Scope 1 emissions.

Furthermore, in relation to Scope 3 emissions, allowance has not been provided for the use of silver in the production of 'green' power generation, such as the production of photovoltaic (solar) cells and other electrical applications. Based on world silver supply/demand data, approximately 7% to 8% of total silver demand is for use in photovoltaic cell production and a further 21% to 23% for other electrical fabrication purposes.

Notwithstanding, the annual average Scope 1 emissions represent approximately 0.02% of total GHG emissions for NSW and 0.004% of total GHG emissions for Australia. Given Australia's contribution to global greenhouse gas emissions is approximately 1.3%, the contribution of the Project to global emissions is approximately 0.000052%.

In comparison to other metal ore mining projects, the Project's Scope 1 emissions are less than half of the average. They are also significantly lower than emissions from coal mining operations and would produce a product that is an important component of 'green' power generation in the form of photovoltaic cells and which can be recycled for ongoing use and benefit.

6.2.2.4 Groundwater Resources

A Groundwater Assessment has been prepared by Jacobs (2020) to assess the possible risks associated with the Project to groundwater resources including impacts to water supply bores, streamflow and natural ecosystems that are dependent on groundwater. A numerical groundwater model has been developed that simulates the regional groundwater system and known influences on the existing hydraulic behaviour of the system. The numerical groundwater model was also subjected to peer review by Dr Noel Merrick of HydroSimulations.

The principal changes to the groundwater setting would be caused by groundwater inflows to the open cut pits as they are developed and subsequent localised drawdown to the regional water table and minor reduction to baseflow contributions to Hawkins and Lawsons Creeks.

Based on modelling predictions, the key residual impacts to the groundwater system as a result of the Project include the following.

- During the mine life, groundwater inflow rates are predicted at an average of 2.4ML/day, with a peak of 3.5ML/day and peak annual inflow of 1 066ML/year predicted in Year 4 of mining.
- Post-mining, the extent of drawdown would expand to an approximate maximum extent over 16 years, with further minor variations expected for 50 years. Post-mining inflows would progressively decrease over time as an equilibrium is reached in the open cut pit lake. Inflows of 133ML/year would be expected 200 years after mining has ceased due principally to evaporation from the surface of the open cut pit lake.
- In the final landform, the main open cut pit lake would act as a groundwater sink that would draw groundwater to the lake (as a result of evaporative pressure). As a result, salinisation of the water would intensify over time, however, would remain within the lake. Surface water would be diverted away from the open cut pit lake in the final landform with a final water level approximately 20m to 26m below any potential point of potential discharge.
- A potential decrease in water level of greater than 2m at two registered groundwater bores may occur on adjoining privately-owned properties. However, closer examination of these locations indicates that this level of impact is unlikely.
- There would not be any impacts to high priority groundwater dependent ecosystems. The terrestrial vegetation present in the vicinity of the predicted extent of drawdown is not likely to be obligate phreatophytes (i.e. groundwater dependent), and where it does draw on groundwater it is most likely rainfall infiltration that has seeped into the capillary zone, has reached the soil-rock interface, or is stored in perched aquifers. It is considered unlikely that terrestrial vegetation would be impacted by predicted drawdown within the regional groundwater table.
- Baseflow reductions at Hawkins and Lawsons Creeks would occur along relatively short sections of these creeks and would be most noticeable to water users in periods of drought when it would be experienced as a reduction in water levels in remnant pools.

- Potential changes to groundwater quality would be carefully monitored and managed throughout mining operations and in the final landform, including in the vicinity of the TSF, however, it is predicted that there would be no water quality impacts beyond 40m from the Mine Site boundary.

Water take through groundwater inflows and subsequent dewatering and reduced baseflow contribution to Hawkins and Lawsons Creeks would be accounted for in water licensing for the Project, including post-mining inflows to the main open cut pit lake.

Based on the outcomes of the groundwater modelling and assessment, it is considered that potential impacts to the groundwater setting are well understood and would be acceptably managed through the implementation of the Water Management Plan that includes a program for ongoing groundwater monitoring and management. Monitoring of groundwater levels and quality in the network of on-site monitoring bores and selected off-site private bores would provide valuable data to assess actual changes to the setting and enable comparison against groundwater model predictions.

Potential impacts to groundwater availability at the two registered bores would be subject to compensatory measures, should they be required. Remaining risks and potential impacts would be managed through implementation of a Water Management Plan for the Project.

6.2.2.5 Surface Water Resources

The outcomes of the Surface Water Assessment (WRM, 2020) have been used to refine the design of the Project to maximise the quantity of water that can practically be diverted around disturbance areas and away from the Mine Site and to provide for the long-term release of water collected on site (after settlement of suspended solids) to maximise downstream environmental flows. Only water contaminated with dissolved metals (through contact with the mineralised ore and waste rock) and processing chemicals would be retained and recycled on site and would not affect downstream water quality. Bowdens Silver's proposal to import surplus (treated) mine water from the Ulan Coal Mine and/or Moolarben Coal Mine as make-up water for processing and dust suppression would negate the need to seek water within the Cudgegong River Valley currently destined for agricultural or municipal uses.

A detailed site water balance incorporating water from each of the on-site water sources and water from the Ulan Coal Mine and/or Moolarben Coal Mine established that the Project's annual average water requirements would be met and that contaminated water captured in the containment zone could be contained on site without discharge or significant interruption to operations throughout the mine life.

The predicted reductions in flows in Hawkins and Lawsons Creeks of up to 4.4% and 1.2% respectively during operations and 0.35% and 1.3% beyond mine closure would not have a noticeable impact on flows or availability of water for downstream water uses. For example, the reduction in flows in Lawsons Creek would cause the flows greater than 1ML/day downstream from Walkers Creek to occur on approximately two fewer days per year.

The flood study for the Project has concluded that noticeable changes in flood levels and velocities would be largely confined to the Mine Site and on land owned by Bowdens Silver. Any expected increases in flood velocities in Hawkins and Lawsons Creeks would be negligible and would not adversely impact off-site property or infrastructure. The flood study also established that the proposed Lawsons Creek crossing on the relocated Maloneys Road would be inundated in a 10% (1 in 10) AEP flow event, thereby closing the road for up to 6 hours. This is consistent with similar crossings in the MWR LGA and would not represent a significant additional impact.

6.2.2.6 Terrestrial Ecology

Throughout the design process, Bowdens Silver has undertaken to minimise impacts upon biodiversity values to the greatest extent possible. This process involved the preparation of a 'traffic light' model upon completion of field surveys to visualise areas of high, medium and low biodiversity value. The model was first developed in 2017 and, as a result, a range of alterations were made to both the Mine Site layout and positioning of the water pipeline corridor so as to reduce the area of disturbance within areas of high and medium biodiversity value.

In total, the Project would result in the removal of 381.71ha of native vegetation of variable condition. This includes 182.26ha of Box-Gum Woodland which is listed as an endangered ecological community under the BC Act, of which 147.82ha is also classified as a critically endangered ecological community under the EPBC Act. Notably, out of the 182.26ha of Box-Gum Woodland, approximately 88.18ha (48%) comprises derived grassland only, having had the trees and shrubs cleared by past agricultural activities. A total of 19 threatened species (two flora and 17 fauna species) have also been recorded or are predicted to occur within the Project's impact footprint.

In assessing the potential for significant impacts, EnviroKey (2020) concluded that, excluding the Regent Honeyeater, the Project would not result in any significant impacts upon migratory or threatened species. In assessing the potential for impacts upon the Regent Honeyeater, EnviroKey (2020) considered the Project would:

- not lead to a long-term decline in the size of a population of the species;
- not reduce the area of occupancy to the detriment of the species; and
- be unlikely to result in the introduction of species or diseases that are potentially harmful to the Regent Honeyeater.

A range of management and mitigation measures have been proposed to avoid impacts to biodiversity and a significant biodiversity offset would be established providing in perpetuity security for areas of Box-Gum Woodland that may have otherwise been subject to intense agricultural activity over time. These offset areas would also provide foraging and breeding habitat for the Regent Honeyeater and other species.

Notably, the impact assessment has conservatively been undertaken without formally considering the fact that approximately 344ha of the Mine Site would be revegetated to native vegetation using species consistent with the existing vegetation communities. In the long-term, these rehabilitation areas would further reduce impacts to biodiversity.

6.2.2.7 Aquatic Ecology

An aquatic ecology assessment (Cardno, 2020) was undertaken for the Project informed by a total of five field surveys conducted between December 2011 and December 2018. The assessment concluded that the greatest potential impact to aquatic ecology would occur only in the event of an accidental release of poor-quality water. This risk would be effectively managed given the design of the Project and the ongoing management and monitoring measures that would be aimed at preventing the release of such water to watercourses. The invasive eastern gambusia (*Gambusia holbrooki*) has also been identified as a potential biosecurity threat with the proposed management within the Mine Site undertaken in accordance with a Biodiversity Management Plan.

The interception of surface flow on site and groundwater drawdown as a result of the open cut pits would result in a minor reduction in surface flow in Hawkins and Lawsons Creeks. It has been assessed that the likely impacts to aquatic habitat would be minor. The potential loss of stygofauna and their habitat due to direct displacement or groundwater drawdown has also been assessed to represent minor potential impacts upon these fauna.

Underboring techniques would be used to construct the water supply pipeline below any perennial watercourses and other watercourses where significant water flows are present at the time of construction. As such, impacts to fish passage and aquatic habitat within the water supply pipeline corridor are expected to be no more than minor and temporary.

6.2.2.8 Traffic and Transportation

A traffic impact assessment (TTPP, 2020) was undertaken for the Project that considered traffic-related impacts associated with:

- the initial 6-month construction period during which the relocated Maloneys Road would be constructed;
- the peak of the site establishment and construction stage (13 months into this stage); and
- the operational period for the Project.

Potential traffic-related impacts would be avoided or mitigated through improvements to the road network including the relocation of Maloneys Road and intersection treatments to suit traffic requirements. Additional management measures to avoid or mitigate the impacts of the increased traffic in the locality would be implemented in accordance with a Traffic Management Plan.

Project-related traffic during the site establishment and construction stage is expected to contribute approximately 10% of the daily traffic on Lue Road east of and within Lue and 15% of daily traffic on Lue Road towards Mudgee. During operations, Project-related traffic travelling through Lue would decrease with daily traffic expected to contribute 7% of the total traffic. During the morning and afternoon peak hours, the Project would contribute 22% and 19% of all traffic, respectively. This traffic would principally comprise light vehicles and buses transporting personnel to and from the site.

The predicted hourly traffic at intersections used by Project-related traffic would remain well below the thresholds at which intersection capacity may be impacted and therefore are predicted to continue to operate with acceptable delays.

It is concluded that traffic travelling to and from the Mine Site would be accommodated on the surrounding road network with virtually no adverse impacts to road users, the condition of the road network and the amenity of the residents of Lue, assuming the implementation of the proposed mitigation and management measures.

Traffic-related impacts associated with the pipeline construction program would be minimal, assuming the adoption of a communications strategy with the local road users and by minimising the periods and duration for any traffic disruption.

6.2.2.9 Soils and Land Capability

A soil and land capability assessment (SMD, 2020) was undertaken to guide the management of soils and to determine potential impacts to soils and land capability resulting from the Project. A total of seven soil landscape units (SLUs) were identified within the Mine Site with land and soil capability (LSC) Classes of between 3 to 6. The existing land within the proposed disturbance areas was determined to predominantly comprise LSC Class 6 (362.8ha) with subordinate areas being Class 5 (17.6ha), Class 4 (18.9ha) or Class 3 (21.2ha). The generally low LSC areas reflect the steep topography and heavy vegetation over much of the Mine Site.

Notwithstanding the inherent LSC constraints within the Mine Site, it remains the intention of Bowdens Silver to maintain or improve the capability of the land wherever possible throughout the Project life. In large part, this objective would be achieved through the implementation of a range of soil stripping and soil stockpile management measures. These measures would aim to maintain soil health and structure, ameliorate soil deficiencies and ensure that adequate topsoil and subsoil resources are available for progressive rehabilitation and closure activities. Given the implementation of these measures, a similar level of LSC would be maintained following the rehabilitation of disturbed areas within the Mine Site, except for the open cut pit lake. SMD (2020) further determined that no BSAL is located within the Mine Site. A Site Verification Certificate, confirming the absence of BSAL within the Mine Site, was issued by the former DPE on 8 November 2017.

The pipeline corridor traverses ten SLUs with LSC Classes of between 3 and 8 (i.e. land with moderate to very severe limitations). The majority (approximately 34km) of the pipeline would be constructed within land with an LSC Class of 4 (i.e. moderate capability land) with land uses typically restricted to grazing, pasture cropping and nature conservation. Given that all disturbed land within the water supply pipeline corridor would be rehabilitated to its previous use following construction of the pipeline, it was determined that there would be negligible impacts on LSC within the water supply pipeline corridor. No BSAL would be impacted by the construction of the pipeline.

6.2.2.10 Aboriginal Heritage

The Project would require the salvage of items of Aboriginal cultural heritage significance from 25 identified sites within the Mine Site, one of which (the rock shelter identified as site BL44) would be subject to test excavation. These artefacts would be properly curated and stored in an on-site “Keeping Place” in consultation with the local Aboriginal Community. The artefacts would eventually be replaced within rehabilitated areas in consultation with representatives of the local Aboriginal community and the Biodiversity and Conservation Division of DPIE.

A further 31 identified sites within the Mine Site, whilst not directly impacted, would require protection from inadvertent disturbance via the installation of protective barriers. All six identified sites within the water supply pipeline corridor have been avoided by minor adjustments to the corridor. The two sites previously identified in the vicinity of the Ulan Coal Mine would not be directly impacted. No sites were identified within the proposed relocated Maloneys Road.

All sites have been identified by the registered Aboriginal parties to be of high cultural significance. The majority of sites are considered by Landskape (2020) to be of low scientific, educational and aesthetic significance except:

- Lue 8, BL40, BL41, BL43, BL45 and BL53 that are of low to moderate scientific significance.
- BL44 (the rock shelter site) that is considered of moderate scientific, education and aesthetic significance.

It is acknowledged that approximately 20% of the water supply pipeline corridor and proposed relocated Maloneys Road were not surveyed for the Aboriginal and Historical Cultural Heritage Assessment due to access constraints at the time of the surveys. These areas would be surveyed prior to any ground disturbance in these locations. Landskape (2020) consider that the likelihood of finding additional sites in the remaining 20% of the corridor would be consistent with the areas surveyed. It is also likely that any identified sites may be avoided through minor adjustments to the alignment of the relevant areas as was the case with the six sites identified within the water supply pipeline corridor.

6.2.2.11 Historic Heritage

The Aboriginal and Historical Cultural Heritage Assessment undertaken by Landskape (2020) identified three sites of potential historical heritage significance within the Mine Site including the following.

- Hut ruins including three sandstone blocks, fragments of cast iron stove, sheet iron, broken glass bottles, broken ceramic vessels.
- Two shallow pits.

There were no sites of potential historic heritage significance identified within the proposed water supply pipeline corridor and the relocated Maloneys Road.

Landskape (2020) assessed the historic heritage significance of the identified sites in accordance with the NSW Heritage Branch’s assessment criteria detailed in *Assessing Significance for Historical Archaeological Sites and 'Relics'* (NSW Heritage Branch, 2009). It was concluded that the sites were of low significance on all criteria except for the potential for the hut ruins to be of moderate local significance for its research potential. None of the sites would meet the thresholds for consideration of State heritage significance.

All sites would be removed with salvage of the items identified within the hut ruins. All items would be archived for future access.

As noted for the assessment of Aboriginal cultural heritage, approximately 20% of the water supply pipeline corridor and relocated Maloneys Road were not surveyed for the Aboriginal and Historical Cultural Heritage Assessment due to access constraints at the time of the surveys. These areas would be surveyed prior to any ground disturbance in these locations, however it is considered unlikely that items of historic heritage significance are present in these locations.

6.2.2.12 Visibility

The visibility assessment of the Project (Lamb, 2020) established that the catchment in which the Project components would be visible is comparatively small in that these components would only be directly visible from six rural residences, a 1.5km section of Pyangle and Powells Road, a section of Lue Road, 2km south of the Mine Site and from scattered rural land throughout the Lue area. None of the Project components would be visible from Lue given the substantial ridges present between Lue and the Mine Site. These ridges constitute a significant visual barrier between Lue and the Mine Site.

The most visible feature of the Project would be the light-coloured rock being placed within the WRE, southern barrier and oxide ore stockpile. However, the visual impacts of these components would be managed through the progressive revegetation of the outer slopes. The design of the WRE as a ridge with variable slopes and elevations would enable this landform to blend within the surrounding natural landscape. Other visual controls would also assist to manage the visual impacts of the Project including enhancing the existing tree screens adjacent to Pyangle and Powells Roads, the establishment of vegetation on the upper benches of the main open cut pit and the use of grey/green coloured structures within the Mine Site. The re-aligned 500kV power transmission line would be located on an alignment within similar topography and have a similar character and appearance and hence visual impact as the existing transmission line.

Overall, the limited visibility of the mining activities within the Mine Site and the range of visual controls would achieve an acceptable level of impact.

A lighting and night glow assessment (LAS, 2020) determined that the Project would comply with the limits for dark rural environments as stipulated in AS/NZS 4282:2019 *Control of the Obtrusive Effects of Outdoor Lighting* with the implementation of the mitigation measures to be adopted for the Project. Lighting impacts on the local environment were assessed to be minimal. Furthermore, the impacts of sky glow on the local environment were assessed to be insignificant under both clear sky and cloudy conditions.

A number of calculations were undertaken to determine the total lumens, total upward lumens and the illuminance of sky particles at varying levels above the Mine Site. These calculations were provided to the Siding Spring Observatory who calculated that the night sky brightness above the observatory as a result of the Project would be negligible. Similar negligible impacts were identified for the local astronomical observatories in the Mudgee, Ilford and Breakfast Creek localities.

6.2.2.13 Public Safety Hazards

Dangerous Goods

The SEPP 33 Screening Study for Dangerous Goods undertaken by Sherpa (2020) for the Project identified that the storage and use of sodium cyanide, cyanide solution and blasting agents required assessment in a Preliminary Hazard Analysis (PHA). It was further identified that the transportation of sodium cyanide required assessment in a Hazardous Material Transport Route Evaluation Study.

It has been determined that, with the implementation of standard controls and safeguards, the use and storage of sodium cyanide, cyanide solution and Class 5.1 ammonium nitrate-based blasting agents would result in very low off-site environmental and safety risks. It was identified that all qualitative environmental risk criteria identified in *Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning* would be met by the Project. It has been further determined that the transport route for sodium cyanide would be a low risk to the biophysical and human environment with the implementation of standard controls and safeguards.

Bush Fire

A bush fire assessment undertaken by RWC assessed that it is likely that the Project would be able to operate with suitable Asset Protection Zones around key Mine Site components and comply with all requirements stipulated by the RFS.

It is recognised that the Mine Site includes heavily wooded areas, and therefore the potential for bush fire to spread both within the Mine Site and adjacent to the Mine Site would be high if management measures were not adopted to mitigate this hazard. The risk of bush fire hazard ignited from within the Mine Site would be minimal with the implementation of the proposed bush fire management measures.

6.2.2.14 Agricultural Resources, Land Uses and Enterprises

An Agricultural Impact Statement prepared by RWC (2020b) concluded that the proposed management and mitigation measures identified throughout the EIS to manage potential impacts to soil resources, surface water, groundwater, air quality and the existing noise and vibration environment, would also effectively minimise any potential impacts to agricultural resources within privately-owned land around the Mine Site and throughout the Mid-Western LGA.

Whilst the Project would marginally reduce the availability of agricultural land throughout the Project life, the continued operation of the Bowdens Farm and the proposed progressive rehabilitation schedule, would ensure that the Project would only have minor to negligible impacts on land used for agriculture both during and after the Project life. It is noted that these impacts would largely be contained to land with low agricultural activity and productivity comprising steeply sloping and/or heavily vegetation areas.

RWC (2020b) further identified that the commitment from Bowdens Silver to provide a range of jobs throughout the Project life would provide a significant source of off-farm income to local farmers and agricultural enterprises within the Region.

6.2.3 Social and Economic Considerations

6.2.3.1 Health Considerations

Given human health is a key social consideration, a detailed human health risk assessment (EnRiskS, 2020) has been undertaken to assess the potential physical health risks relating to the predicted / assessed changes in air quality, surface water, groundwater, and noise. Mental health matters and opportunities for health improvements have also been considered. The key outcomes for each aspect are summarised as follows.

Air

The assessment of air quality has focused on dust emissions from the Project, including the presence of lead and other metals that may be present in these dust emissions. The detailed assessment addressed multiple potential routes of exposure including the inhalation of dust, the deposition of dust onto roofs and the washing of these dusts into rainwater tanks where water may be used for drinking/household uses, the deposition of dust to soil and other surfaces where people may come into direct contact, and/or the accumulation of these metals into home-grown produce that may be consumed.

It has been determined that impacts derived from the Project would make a negligible contribution to overall exposures to the assessed metals and there are no health risk issues of concern relevant to the Project (during both the site establishment and construction stage and operational stage). These conclusions apply to all members of the community, adults and children as well as sensitive individuals.

An assessment of impacts resulting in emissions of respirable crystalline silica and hydrogen cyanide have also been undertaken with both predicted to be well below their respective health criteria at both Project-related and privately-owned residences and receivers.

Water

Based on the assessments undertaken, the potential for adverse health impacts within the off-site community due to impacts to surface water and groundwater as a result of the Project is considered to be negligible.

Noise

Based on the predicted noise levels and potential mitigation measures, the potential for adverse health impacts within the off-site community associated with noise generated during construction and operations is considered to be negligible.

Mental Health

The Project has the potential to result in negative mental health impacts, principally stress and anxiety due to uncertainties and perceived impacts, as well as mental health benefits, principally resulting from employment and income opportunities. The proposed management measures would minimise the negative impacts and maximise the mental health benefits. Support for health service programs, including the appointment of a GP or medical officer on a contract basis, as part of Bowdens Silver's Community Investment Program would assist in minimising any residual mental health impacts.

6.2.3.2 Social Considerations

A detailed social impact assessment has been completed for the Project together with extensive consultation and engagement with key stakeholders within both the Lue district and wider Mid-Western Regional LGA. A range of perceived social issues and impacts have been identified and have been considered in the design process for the Project (see Section 6.1.2). Careful consideration has also been given to the remaining matters that would need to be managed throughout both the construction and operational stages of the Project.

It is noted that the level of concern relating to the Project varies across stakeholder groups and geographic location. Whilst a number of social and environmental issues have been raised by local landholders in proximity to the Mine Site, particularly the impact of the Project on social amenity and sense of place and community in Lue; the broader LGA community has appeared more accepting of the Project due to the predicted positive economic benefits.

Key negative social impacts identified include impacts relating from property acquisitions, impacts on social amenity (as a result of noise, visual and traffic impacts); changes to sense of community, community cohesion and culture; and conflict as a result of competing land uses. In addition to these impacts, stakeholders have raised concerns relating to impacts upon health and wellbeing; Aboriginal cultural heritage; population change as a result of construction and operational workforce influx and subsequent impacts to community services.

Key positive impacts identified include potential economic benefits to the region through employment, procurement and business opportunities – providing a much needed social and economic stimulus. In addition, regional community members also suggested that the increase in population as a result of workforce influx associated with the Project, may have a positive impact on the LGA in relation to service provision.

It is acknowledged that, whilst mining projects can result in significant positive economic and social benefits, the negative impacts experienced need to be equally considered. Therefore, in order to minimise the potential negative social impacts relating to the Project and enhance the positive benefits, the following key mitigation and enhancement strategies are proposed.

- Development of a dedicated Community Investment Program that focuses on enhancement initiatives for Lue, Rylstone, Kandos and other key communities in the Mid-Western Regional LGA.
- Development of a local employment and procurement strategy to maximise the economic benefits of the Project within in the Mid-Western Regional LGA that would involve:
  - giving preference to hire of local employees; and
  - informing local businesses of the goods and services required for the Project and encouraging them to meet the requirements of the Project for supply contracts.
- Development of a Good Neighbour Program and employment of a dedicated Community Liaison Officer to maintain and further develop Company-community relationships and manage monitoring and management commitments.

- Implementation of a Planning Agreement with the Mid-Western Regional Council to contribute to the provision of public amenity and public services, transport and/or other infrastructure requirements.
- Development of a Social Impact Management Plan that provides for monitoring and evaluation of social and community aspects of the Project and the application of adaptive management to minimise potential impacts and maximise benefits.
- Prepare an appropriate complaint receipt / response and incident notification / reporting processes to respond to community concerns and complaints.
- Regular public reporting of relevant statistics, monitoring results and engagement outcomes in order to keep the community informed, maintain transparency, and to remain accountable.

With the implementation of these measures, the social benefit of the Project would be maximised and negative social impacts would be minimised.

6.2.3.3 Economic Considerations

The economic assessment for the Project has analysed the Project using both Cost Benefit Analysis and Local Effects Analysis methodologies.

In summary, the results of the Cost Benefit Analysis conclude that the Project is estimated to deliver the net economic benefits presented in **Table 6.4** (i.e. following the inclusion of environmental, social and cultural costs).

Table 6.4
Net Economic Benefits

Scale	Base Benefit	Base plus Employment Benefits
Globally	$78M	$181M
National	$89M	$192M
NSW	$44M	$146M

The Local Effects Analysis and supplementary Local Effects Analysis also considered the impacts at a local scale. In terms of employment, during operation the Project would provide between 73 and 129 net direct Full-time Equivalent jobs and, with flow-on effects, between a further 74 and 131 net indirect Full-time Equivalent jobs. Employment effects would be even greater when allowance is made for people who migrate into the region. The Full-time Equivalent jobs should not be confused for the proposed employment of up to 320 personnel during construction and site establishment and between 190 and 228 personnel during operations.

The Cost Benefit Analysis and Local Effects Analysis therefore demonstrate that there would be substantial economic and employment benefits resulting from the Project.

In relation to negative effects, the economic assessment concluded the following.

- There would be very small and inconsequential impacts upon agricultural economic activity.

- Impacts on wages would not likely be significant. Where upward pressure on local area wages does occur, it would attract skilled labour to the local area leading to downward pressure on wages.
- Based on 15% of the operational workforce migrating to the area, in comparison to the existing population and number of unoccupied dwellings located in the Mid-Western Regional Local Government Area, the potential impact on housing and rental prices would likely be positive but negligible.
- Some impact to property values would be expected where a property is likely to be impacted by noise, air, visual impacts etc. Where these impacts are contained / mitigated, no impact to property value would be expected to occur.

In order to mitigate potential negative economic impacts and to maximise positive economic and employment benefits, a range of measures would be implemented. These measures have been described in the review of social considerations for the Project (above) but it is noted that they would have an economic benefit.

- Development of a local employment and procurement strategy.
- Providing ongoing training and certification opportunities for local community members to ensure they have the necessary skills to work in mining.
- Implementation of a Planning Agreement with Mid-Western Regional Council.
- Development of a Community Investment Program dedicated to Lue, Rylstone, Kandos and other key communities in the Mid-Western Regional LGA.

6.3 CONSEQUENCES OF NOT PROCEEDING WITH THE PROJECT

The consequences of not proceeding with the Project relate principally to the lost opportunity to mine the silver, zinc and lead resources identified within the Mine Site. While the resource may continue to be explored and its status refined in the event of refusal of the Project, Bowdens Silver is confident that it has presented a Project that not only seeks the efficient development of the Mine but has taken into consideration the likely experience of the Mine for the local community and the predicted short, medium and long term environmental outcomes. Each of these matters has been considered in detail in designing the Project, with progressive design changes discussed in Section 6.1. It is concluded that the Project, as presented, provides an acceptable balance of environmental and social outcomes in achieving the economic benefits of the Mine.

Section 1.6 presents a brief description of the properties and uses of silver, zinc and lead, and their current sources both in Australia and internationally with a more detailed description presented in **Appendix 4**. The demand for these metals correlates directly with need, with this and relative scarcity (among other factors) driving pricing for the concentrates that would be the products of the Project. The Economic Impact Assessment for the Project has identified that the Project would provide benefits to NSW of between \$44M and \$146M. The concept of the 'mining town' is something that may create apprehension for some people and it is acknowledged that, where mining occurs in a community, the benefits are greatest where there is a diverse mix of economic opportunities to complement the mining benefits. In these situations, mining provides additional opportunities as it is often connected to other industries (manufacturing, retail and service-based industry) and often provides the training and education that is eventually of benefit to other aspects of the community.

Should the Project not proceed, not only would the anticipated broader economic benefits associated with local employment and procurement of services and consumables not be achieved, but the local enhancement projects and other community benefits resulting from the Project would be foregone. In particular, projects that would be undertaken through the Community Investment Program and Planning Agreement would not eventuate.

Throughout the planning and design of the Project and development of the EIS, Bowdens Silver has continued its exploration activities within the Mine Site and within its exploration tenements (see Section 1.3 and **Figure 1.2**). Should the Project not proceed it is likely that there would be an impact on future exploration by Bowdens Silver and others in the region and subsequently on the attractiveness of mineral development in the region. As a result, there would be lost opportunity to diversify the Mid-Western Regional LGA's mining industry from principally coal mining.

It is commonly understood that employment opportunities within the Mid-Western Regional LGA are a source of concern for Council and some members of the community. This is closely associated with concerns regarding the viability of some of the smaller towns and villages in the region. Concerns have been exacerbated by the closure of the Kandos Cement Works and the recent refusal of the Bylong Coal Project. It is noted that the level of support received to date for the Project was captured in consultation prior to the refusal of the Bylong Coal Project. Therefore, as the opportunities from the Bylong Coal Project may no longer eventuate, the perceived importance of the employment and economic opportunities provided by the Bowdens Silver Project has likely increased.

It is anticipated that the Project would improve outcomes for local people seeking employment in the mining industry. The community anticipation of this benefit has been reflected in the preliminary job information requests received by Bowdens Silver to date and the outcomes of engagement for the Social Impact Assessment, for which the most frequent topic raised was the economic outcomes of the Project. Therefore, should the Project not proceed, these anticipated employment benefits would not eventuate resulting in both economic and potentially social and mental health impacts as a result of continued lost opportunity.

It is also accepted that should the Project not proceed, a range of residual environmental and social impacts (summarised in Section 6.2.2 and 6.2.3) would be avoided

6.4 THE PUBLIC INTEREST

In accordance with Section 4.15(1e) of the EP&A Act, evaluation of a development application by a consent authority must consider the public interest. The public interest is generally difficult to define as it depends on contextual factors and intangible and variable matters such as public opinion and public need. It therefore requires a balancing of public expectations of impacts and benefits, as well as support and opposition, but may also be considered in terms of the principles of ecologically sustainable development and the aims or 'objects' of the guiding legislation for the application (in this case, the EP&A Act). Consultation and engagement throughout the development of the EIS (summarised in Section 3.2.2 and 4.20.4) has identified a range of supportive feedback as well as opposition to the Project. Furthermore, Section 6.1.3 reviews the Project against the principles of ecologically sustainable development and Section 6.1.4 considers the planning considerations that need to be satisfied for the Project. In addition, Section 6.2 summarises the outcomes of the assessment of potential environmental impacts focusing on predicted residual impacts including biophysical outcomes and the social and economic impacts and benefits. It is therefore considered that the EIS has been thorough in its consideration of matters relating to the public interest.

There is clearly evident support for the employment and other economic opportunities that the Project would provide across the Mid-Western Regional LGA. However it is also acknowledged that opposition increases in areas closer to the proposed Mine Site. This is to be expected given that those living closest to the Mine Site would be more likely to experience negative outcomes. Not only has Bowdens Silver focused on avoiding or mitigating the residual environmental impacts of the Project, but the proposed Community Investment Program would ensure that the economic outcomes are distributed locally, while programs for environmental and social monitoring, regular reporting and auditing of performance would ensure that the commitments to responsible environmental management are achieved. The conditions of development consent would provide the legal basis for regulating the agreed outcome of the Project. In this way, Bowdens Silver has made a range of clear commitments to the public that would be given legal force by way of conditions of a development consent.

As noted in Section 6.1.3 regarding the principles of ecologically sustainable development, it is important to consider the sustainability of society between and across generations and the preservation of the ecosystem processes on which life depends. This reflects the need for balance in the outcomes of the Project to ensure that it would remain in the overall interest of the entire public (society and the environment) and not just for the benefit of Bowdens Silver. As noted in Section 6.3, Bowdens Silver has designed the Project to ensure the efficient development of the Mine but has also taken into consideration the likely experience of the Mine for the local community and the predicted short term and longer-term environmental outcomes. This approach directly addresses the short term and long-term needs of society. It should also be noted that the outcomes of the Project are broader than the strict economic benefits of mining, with the proposed silver, zinc and lead products providing important elements for the manufacture of many products that would be used over a number of years and in some cases, generations.

The outcomes of environmental, economic and social assessments for the Project have confirmed that the Project would operate in accordance with the legislation, policies and guidelines developed to ensure responsible environmental practices for development. These assessments have not only considered the immediate impacts of the operation but also longer-term outcomes involving potential land use conflict and residual impacts to resources that may be utilised by others. In each case, worst case scenario outcomes were considered to ensure a precautionary and conservative approach was taken. In addition, the legacy of the Project has been considered with regards to the rehabilitation and final land use options and mechanisms to preserve the existing character of Lue, while providing sufficient economic stimulus to ensure its sustainability. Finally, the economic impact assessment considers the public interest in economic terms and concludes that the Project would deliver net social benefits (i.e. following the inclusion of environmental, social and cultural costs) globally between $78M and $181M, nationally between $89M and $192M, and for the NSW community between $44M and $146M.

The objects of the EP&A Act present the many aspects of planning and development that must be managed in ensuring that development in NSW remains in the public interest. **Table 6.3** demonstrates how each of these aspects would be managed for the Project to ensure that these objectives are achieved, where feasible, under the Project. In this manner the lives of all people in NSW (and arguably Australia) would be better served by the Project through its consistency with the planning and development preferences of the NSW Government. Some members of the NSW community may not agree with each of the objects or that Bowdens Silver would satisfy them, however this only reflects the inherent nature of the public interest. That is, that interests differ amongst individuals, but individual interests should not be prioritised in place of the interests of the broader public, when considering the public interest.

It is finally noted that the feedback from the community in the form of public submissions would provide some indication of the public interest. All submissions on the application received by DPIE at the end of the public exhibition process will be considered by Bowdens Silver and a response will be provided to the issues raised.

6.5 CONCLUSION

This EIS has described the identified mineral resources in detail and explained the procedures necessary to develop the Mine Site in a suitable manner. Each component of the assessment has been accompanied by a description of the environmental management commitments that are proposed in order that:

- predicted residual environmental impacts remain acceptable;
- ongoing management, monitoring and reporting ensures that compliance is maintained;
- there are measures to ensure the community is aware of how environmental risks are being be managed; and
- in the case of social commitments, benefits are distributed as equitably as possible.

The assessment of impacts for the Project has determined that noise will be a residual Project-related impact. Bowdens Silver would implement all reasonable and feasible noise mitigation measures and is in negotiation with those residents that would be unacceptably impacted under the VLAMP. Remaining residents would experience mine-related noise for the first time, particularly under noise enhancing conditions, however, those noise levels are expected to be less than the relevant criteria. All other environmental aspects have been mitigated to the maximum extent practicable and Bowdens Silver contends that these would not result in unacceptable or unreasonable impacts.

Planning and design of the Project has been an iterative process that has involved refinements in response to the outcomes of assessment and the feedback from community engagement. Bowdens Silver considers that the scale of the Project would be sufficient to provide a boost to the local economy but not cause substantial adverse environmental or social impacts. The Project, as presented, provides an acceptable balance of environmental and social outcomes in achieving the economic benefits of the Mine. In addition, the legacy of the Project has been considered with regards to the rehabilitation and final land use options and mechanisms to preserve the existing character of Lue while providing sufficient economic stimulus to support existing businesses and a reasonable level of growth.

Section 7

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PREAMBLE

This section lists the various source documents referred to for information and data used during the preparation of the Environmental Impact Statement.

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Section 8

Glossary of Technical Terms, Acronyms, Symbols and Units

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Acronyms

AADT – Average Annual Daily Traffic

ABS – Australian Bureau of Statistics

ADGC – Australian Code for the Transport of Dangerous Goods by Road and Rail

AEP – Annual Exceedance Probability. The probability of exceedance of a given discharge within the nominated period **(10% = 1 in 10 years, 1% = 1 in 100 years)**

AMC – AMC Consultants Pty Ltd

ANC – acid-neutralising capacity

ANCOLD – Australia National Council on Large Dams

ANE – ammonium nitrate emulsion used as a blasting agent

ANFO – mixture of ammonium nitrate and fuel oil (diesel) used as a blasting agent

ANZECC – Australian and New Zealand Environment and Conservation Council

ANZG – Australian and New Zealand Guideline

AR&R – Australian Rainfall and Runoff

ARD – acid rock drainage

ARI – average recurrence interval

AS – Australian Standard

ASX – Australian Securities Exchange

bcm – bank cubic metre – a volume of 1 m^3 in the ground prior to disturbance.

CEC – Cation Exchange Capacity

CCT – correlated colour temperature

COMEX – commodity futures exchange

CSIRO – Commonwealth Scientific and Industrial Research Organisation

CRAE – CRA Exploration Pty Limited

DA – Development Application

DBYD – Dial-Before-You-Dig

DG – Dangerous Goods

DICL – ductile iron cement lined

DTV – Default Trigger Value

DoEE – Commonwealth Department of Environment and

DPE – Department of Planning and Environment

DPIE – Department of Planning, Industry and Environment

DSC – Dam Safety Committee

EC – see electrical conductivity

EIS – Environmental Impact Statement

EP&A Act – Environmental Planning and Assessment Act 1979 (NSW)

EPA – Environment Protection Authority

EPBC Act – Environment Protection and Biodiversity Conservation Act 1999

ESD – Ecologically Sustainable Development

ETFs – exchange-traded funds

ETPs – Exchange Traded Products

GCA – Graeme Campbell and Associates

GCL – geosynthetic clay liner

GDE – Groundwater Dependent Ecosystem

HAZMAT – Hazardous Materials

HCN – hydrogen cyanide

HDPE – High Density Polyethylene

HPS – high pressure sodium lamp

ILZSG – International Lead and Zinc Study Group

IPC – Independent Planning Commission

KFH – Key Fish Habitat

KTP – Key Threatening Process

LED – light emitting diode

LEP – Local Environmental Plan

LGA – Local Government Area

MCA – Minerals Council of Australia

MIC – Maximum Instantaneous Charge

MH – metal halide lamp

MLA – Mining Lease Application

MOP – Mining Operations Plan

MRWA – Main Roads Western Australia

MWRC – Mid-Western Regional Council

NAF - non-acid forming

NAG – net acid generation

NAPP – net acid-producing potential

NFR – non-filterable residue of suspended solids

NP&W Act – National Parks and Wildlife Act 1974

NPWS – National Parks and Wildlife Service

OTC – over-the-counter

PAF – potentially-acid forming

pH – a measure of the degree of acidity or alkalinity of a solution; expressed numerically (logarithmically) on a scale of 1 to 14, on which 1 is most acid, 7 is neutral acid, and 14 is most basic (alkaline).

PHA – Preliminary Hazard Analysis

PMF – Probable Maximum Flood

PNTL – project noise trigger level

ppm – parts per million

PVS – peak vector sum

RCE – Riparian, Channel and Environmental Inventory

RMP – Rehabilitation Management Plan

RO – reverse osmosis

ROM – Run-of-Mine

RWC – R.W. Corkery & Co. Pty Limited

SAG – semi-autogenous grinding

SG – specific gravity

SEARs – Secretary's Environmental Assessment Requirements

SCSC – Specialist Consultants Studies Compendium

swl – standing water level

TDS – total dissolved solids (expressed in mg/L)

tph – tonnes per hour

TSF – tailings storage facility

WAD – weak acid dissociable

WRE – waste rock emplacement

WRM - WRM Water and Environment Pty Ltd

Symbols and Units

~ - approximately

ºC – degrees Celsius

ºC/100 m – degrees Celsius per 100m

µg/g – micrograms per gram

µg/L – micrograms per litre

µg/m^3 – micrograms per cubic metre

µm – micron, one millionth of a metre (one thousandth of a millimetre)

µS/cm – microsiemens per centimetre; a measure of electrical conductivity

% – percentage

$M – one million dollars

3-D – three dimensional

24-hour air quality standard – value of an air quality variable not to be exceeded when averaged over 24 hours

72-hour rainstorm – total rainfall recorded over a 72-hour period

100 year flood limit – predicted extent of a 1 in 100 year flood occurrence

'000 t – multiples of one thousand tonnes

< – less than

≤ – less than or equal to

> – greater than

≥ – greater than or equal to

95% exceedance – a value that is exceeded by 95% of sample values

Ag – silver

AHD – Australian Height Data (in metres)

As – arsenic, a metal-like element (i.e. a metalloid)

A-Scale – a sound level measurement scale. It disseminates against low frequencies and approximates the human ear

bcm – Bank cubic metre – a volume of 1m^3 in the ground prior to disturbance

Bi – bismuth

Ca – calcium

cd - candela

Cd – cadmium

cm – centimetre (unit of distance)

CN_{FREE} – free cyanide, generally includes the cyanide ion (CN^-) and hydrogen cyanide (HCN)

CN_{TOT} – total cyanide; the total amount of all cyanide whether free, weak acid dissociable, or bound in a stable complex

CN_{WAD} – weak acid dissociable cyanide; cyanide existing in complexes, generally with metal ions, which break up (dissociate) in the presence of weak acid; includes free cyanide

Cu – copper

dB – decibel, unit used to express sound intensity

dB(A) – the unit of measurement of sound pressure level heard by the human ear, expressed in "A" scale

dB(Linear) – the measurement of sound pressure level in which the amplitudes of the sound signal, though all frequencies of the signal, are treated equally, i.e. not weighted – relied upon for blasting

Fe – iron

g – gram (= 0.001 kilogram)

GL – gigalitre

g/m^2/month – grams per square metre per month unit for deposited dust

g/t – grams per tonne

GWh – gigawatt hours

H_2SO_4/t – kilograms sulphuric acid per tonne

ha – hectare (100 m x 100 m)

Hg – mercury

Hz – Hertz – a unit of frequency

K – potassium

K – degrees Kelvin

kg – kilogram (weight measure)

kL – kilolitre (thousand litre)

km – kilometre (= 1 000 metres)

km^2 – square kilometres

km/h – kilometres per hour

kV – thousand volts (Electrical Potential Unit)

kVA – kilovolt amps

kVh – kilowatt hours

kW – thousand Watts (energy unit)

L – litre

lcm – loose cubic metre

L_{A10} – sound level exceeded 10 per cent of the sampling time

L_{A90} – sound level exceeded 90 per cent of the sampling time

L_{Aeq} – the L_{Aeq} is the “equal energy” average noise levels, and is used in some instances for the assessment of traffic noise effects or the risk of hearing impairment due to noise exposures

$L_{Aeq\ 1\ hour}$ – the “equal energy” average noise level over 60 minutes – used for assessing impacts of motor vehicles on public roads

$L_{Aeq\ T}$ – Sound level of continuous noise which emits the same energy as the fluctuation sound over a given time period (T)

L_{Amax} – the absolute maximum noise level measured in a given time interval

L_{AN} – the A-weighted sound pressure level exceeded by N% of a given measured period

lux – the measure of illuminance.

m – metre

m AHD – metres Australian Height Datum

M – million

m^2 – square metre

m^3 – cubic metre

mg – milligram (weight unit)

mg/L – milligrams per litre (parts per million)

Mg – magnesium

MJ – mega joules (energy unit)

ML – megalitre

mm – millimetre (= 0.001 metres)

Mn – manganese

Mo – molybdenum

Mt – million tonnes (metric tonne = 1 000 kg)

Mtpa – million tonnes per annum

MW – megawatt

Na – sodium

NaCN – sodium cyanide

NaOH – sodium hydroxide

oz – ounce

Pb – lead

pH – measurement indicating whether water or soil is acid or alkaline

PM_{10} – particulate matter <10μm in diameter

Sb – antimony

t – tonnes

μg/m^3 – micrograms per cubic metre

μm – micron (1 micron=0.001 millimetre)

μS/cm – micro siemens per centimetre

V – volt

W – Watt (energy unity)

w/v – weight per volume

Zn – zinc

Technical Terms

A2 horizon – part of soil profile immediately below the topsoil.

A-weighted – an electronic filter having the frequency response corresponding approximately to that of human hearing.

accelerated oxidation testing – see net acid generation test.

acceleration lane – a lane used for increasing speed before merging with the through lanes.

acid – substance with a pH less than 7.0; the lower the pH, the higher the corrosive ability of the substance.

acid rock drainage (ARD) – runoff of acidic water, typically from mine waste rock, following acid formation within the rock.

acid-base results – data generated from test work investigating acid-generating and acid-neutralising properties, generally of mine waste rock and soil.

acid-neutralising capacity testing (ANC) – the ability of a substance (e.g. a particular mineral) to neutralise acid.

acidic – having a pH less than 7.0.

acoustic barrier – an earthen wall, bund or barrier formed to reduce noise and visual impact of extraction and processing activities.

acoustics – the science of sound and vibration.

activators – chemicals used to improve the selection of minerals in the flotation process.

adsorption – the attraction and adhesion of a layer of ions from an aqueous solution to the solid mineral surfaces with which it is in contact.

adverse weather conditions (in respect of noise and dust) – conditions, such as high wind, that assist the movement of dust or propagation of noise away from the Mine Site towards receivers.

aerial photographs – photographs of landscape taken from a plane (typically areas several kilometres across) used for the surveying and interpretation of vegetation type, geology, land use, etc.

airblast overpressure – a shock wave from a blast transmitted through the air, normally measured in dB(Linear).

air pollutant - a substance in ambient atmosphere, resulting from the activity of man or from natural processes, causing adverse effects to man and the environment (also called "air contaminant").

air pollution - presence of air pollutants.

alkaline – having a pH greater than 7.0.

alkalinity – in water analysis a measure of the carbonates, bicarbonates, hydroxides and occasionally the borates, silicates and phosphates in the water.

alluvial – pertaining to material, such as sand or silt, deposited by running water (e.g. a creek or river).

alluvium – a general term for stream-deposited sediment (sand, silt, gravel, etc.) within stream beds or on flood plains or alluvial fans.

ambient air quality – the quality of the ambient air near ground level, expressed as concentrations or deposition rates of air pollutants – also expressed as existing air quality.

ambient level – existing level of a phenomenon without the influence of the proposed Project.

amenity – the desirability of an area.

ammonia (NH_3) – a product from the chemical breakdown of cyanide.

ammonium nitrate – NH_4NO_3; used to make explosives (see ANFO).

amphibians – animals (such as frogs) adapted to live both on land and in water.

anaemometer - an instrument for measuring the speed of wind.

anion – a negatively charged ion that migrates to an anode.

anthropogenic – affected by, or relating to, human beings.

anti-seepage membrane – layer of natural or artificial material (e.g. clay or plastic) placed on the ground to prevent seepage (e.g. from a tailings storage).

aquatic – living in or on water, or concerning water.

aquifer - rock or sediment capable of holding and transmitting groundwater.

arboreal – tree dwelling.

archaeology – the scientific study of human history, particularly the relics and cultural remains of the distant past.

artefact – anything made by human workmanship, particularly by previous cultures (such as chipped and modified stones used as tools).

artesian water – water contained in an aquifer.

assay – a chemical analysis.

atmospheric stability - a measure of turbulence which determines the rate at which the effluent is dispersed as it is transported by the wind.

attenuation – reduction in sound pressure levels between two locations.

audio-visual bund – an earthen wall, bund or barrier formed to reduce noise and visual impact of quarrying and processing activities.

average annual daily traffic (AADT) – unit of assessment of traffic flow along a road.

Average Recurrence Interval (ARI) - statistical period in years for a design storm event.

avifauna – birds.

B horizon – subsoil material located below the A horizon material and above the parent rock.

backfill – material used to fill a created void.

background noise levels - the level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source; or sound generated for test purposes).

backhoe – a machine designed for small-scale excavation work.

ball mill – plant for fine grinding of ore using metal balls.

base-course – road material placed on sub-base to receive bitumen seal.

baseline data – a body of information collected over time to define specific characteristics of an area (e.g. species occurrence or noise levels) prior to the commencement of an activity (e.g. a mining operation); baseline data allows any impacts arising from the activity to be identified by comparison with previously existing conditions.

basic – having a pH greater than 7.0.

batter – an earth slope formed from placed fill material or cut into the natural hillside, during road construction.

beach – a deposit of tailings solids lying exposed to the atmosphere in a tailings storage facility.

bedrock – unweathered rock lying below the soil and weathering profile.

bench - a step in the face of the open cut pit which could be up to 25 m high.

berm – a low bank or steep slope built onto a slope to improve its structural stability and reduce erosion.

best management practice – the most effective actions which minimise human impact on the environment.

biodiversity – the full range of living things and the ecosystem in which they live.

biomass – the quantity of living material present at a given time within a given area. Synonymous with standing crop, stock and standing stock.

biota – living components of a habitat.

blasthole – hole drilled into rock to position explosive for blasting.

blasting – the operation of breaking rock by means of explosives.

bore – a well, usually of less than 20 cm diameter, drilled into the ground and from which water is pumped.

buffering – the chemical process by which some substances or mixtures can resist or retard changes to their pH.

bulldozer – an item of tracked mobile earth moving equipment fitted with a front blade and with rear rippers used for pushing and ripping soil and rock.

bund - embankment of clay or weathered rock emplaced for visual or acoustic screening.

bund wall – a man-made earth mound used to visually and acoustically screen nearby receivers.

burden distance – distance between rows of blast holes measured at right angles to the free face of a free face blast.

capped (drillholes) – drillholes sealed after use to prevent infiltration of water or soil and to protect livestock and native fauna.

catch drains – drains used to intercept and redirect runoff.

catchment – the entire land area from which water (e.g. rainfall) drains to a specific water course or waterbody.

catenary – the natural bending or curving shape of a line strung between two fixed points, such as the shape of power transmission lines between power poles.

cation – an ion having a positive charge and characteristically moving toward a negative electrode.

channel – river or irrigation channel, includes bed and bank.

chemically stable – a chemical substance that does not readily decompose.

chloride – the univalent negative iron of the element chlorine.

chronic effects – the effect on an organism of a continuous abnormal condition applied over 10% or more of its lifespan.

Class A pan evaporation record – Bureau of Meteorology standard method of measuring evaporation.

clay - a size term denoting particles, regardless of mineral composition, with diameter less than 0.004 mm.

CN_{FREE} – free cyanide, generally includes the cyanide ion (CN^-) and hydrogen cyanide (HCN).

CN_{TOT} – total cyanide; the total amount of all cyanide whether free, weak acid dissociable, or bound in a stable complex.

CN_{WAD} – weak acid dissociable cyanide; cyanide existing in complexes, generally with metal ions, which break up (dissociate) in the presence of weak acid; includes free cyanide.

coarse ore – ore that has been crushed but not ground.

colluvium – unconsolidated soil and rock material moved largely by gravity, deposited on lower slopes and/or at the base of a slope.

colonial species – plant species that are the first to grow in a disturbed area.

comfort criteria – controlling limits of ground vibration and airblast overpressure from blasting above which they may be harmful, offensive or interfere with the comfort or response of the person.

competent rock – rock having substance strength characteristics requiring significant energy to dislodge or fracture.

concentration – the amount of a substance, expressed as mass or volume, in a unit volume of air.

conditioner – a reagent added to improve the flotation response of target minerals.

conductivity – the measurement of the ability of a substance (either a measure of solid, liquid or gas) to transmit electricity; used to determine the amount of salt in a soil or water sample.

cone crusher – a type of crusher for reducing rock fragment size by means of appropriately positioned and spaced rotating or oscillating cones.

cone of depression – a depression of the potentiometric surface which has the shape of an inverted cone that develops around a well from which water is being withdrawn. It defines the area of influence of a well.

confined aquifer – an aquifer bounded by an impermeable upper surface. If the impermeable bounding layer is breached the water is under sufficient pressure to cause it to rise above the confining contact. The level to which the water rises is called the potentiometric or static water level or head.

confined aquifer – a saturated aquifer, overlain by a relatively impervious formation in which the pressure of the water at the top of the aquifer is greater than atmospheric pressure.

confluence - junction of watercourses.

conservation – the management of resources in a way that will benefit both present and future generations.

contaminant – a chemical compound or element which has been introduced as a result of human activity. It is noted, however, that some chemical compounds and elements also occur naturally in water and sediments.

contingency procedures – procedures put in place to handle an event considered unlikely to occur.

contractor – specialist brought in to perform a specific task, such as the construction of mine infrastructure or the excavation (mining) of the open cut pit.

conveyor - a device fitted with an endless rubber belt used for moving crushed rock within the processing plant.

correlated colour temperature (CCT) - assessment of the colour appearance of the light source with reference to the appearance of a black body radiator at a specific temperature. While it is indicative of the tendency of the light to warm or cool, it does not provide definitive information with respect to the spectral distribution.

cross-section – a two-dimensional diagram of an object presented as if the object had been cut along its length.

crushing – the mechanical process of reducing rock size usually by pressure or impact.

culvert – large pipe or channel carrying water underneath a structure (e.g. a road) or underneath the ground.

cumulative – increasing by successive additions.

cut-off drains – drains constructed to divert upslope runoff around disturbed areas.

cut-off grade – the lowest grade of mineralised material considered in the calculation of grade in a given deposit.

cyanate – a chemical species (CNO^-) formed by the oxidation of cyanide.

cyanide decay – the chemical and physical processes by which cyanide is degraded and lost from a system (e.g. a tailings storage facility).

cyanide pellets – a compressed form of cyanide as delivered to the Mine Site.

dB(A) – decibels, A-weighted scale; unit used for most measurements of environmental noise; the scale is based upon typical responses of the human ear to sounds of different frequencies.

decant pond – a pond, formed on the surface of the tailings storage facility by runoff of tailings supernatant liquor, from which water is pumped (decanted) from the pond and fed back to the processing plant as process water.

deceleration lane – a lane used for decreasing speed before leaving the road.

detection limit – the smallest concentration of a substance that an analytical procedure can accurately and precisely detect.

detonator – a device that triggers an explosive.

development application - an application to a consent authority for approval of an activity deemed to require an approval prior to commencement.

Devonian - a period of geological time from 395 to 345 million years before present.

diamond drill hole – drill hole constructed by equipment using rotary fluid flushing and a diamond faced bit to obtain core from the rock being drilled.

dip - the angle that rock strata make with a horizontal surface measured at right angles to the strike.

dispersibility - a characteristic of soils relating to their structural breakdown in water into individual particles.

dispersion model – a set of mathematical equations relating to the release of air pollutant to the corresponding concentrations in the ambient atmosphere or deposition on the surface.

dissolved oxygen – the amount of gaseous oxygen dissolved in water and available for a biochemical activity (e.g. breathing in by fish).

diversion bank – an earth bank constructed to divert water away from disturbed areas.

drainage grading works – earthmoving and levelling activities to carefully regulate drainage (e.g. from topsoil stockpiles).

drainage line – a passage along which water concentrates and flows towards a watercourse during or following rain.

drawdown – the difference between the water level observed during pumping and the non-pumping water level (static water level or static head).

drill core - the cylindrical sample of rock recovered by means of diamond drilling.

dry sclerophyll – sclerophyll forest with xeromorphic shrubs (that tolerate dry conditions).

dust - particles of mostly mineral origin generated by erosion of surfaces and the mining and handling of materials.

dust concentration – the amount of a substance, expressed as mass or volume, in a unit volume of air typically expressed in $\mu g/m^3$.

dust gauge – instrument set up to record the rate of deposition of dust.

ecology – the relationship between living things and their environment.

ecologically sustainable development (ESD) – development that improves the quality of life, in a way that maintains the ecological processes on which life depends.

ecosystem - the totality of biological processes and interactions within a specified physical environment.

ecotone – a region of transition between two plant communities, characterised by a transition between either the floristic components of the communities or the structures of the communities.

electrical conductivity (EC) – the ability of a substance (either solid, liquid or gas) to transmit electricity.

element – a substance consisting entirely of atoms of the same atomic number (e.g. silver, oxygen, carbon).

Elliot trap – a baited cage used in faunal surveys to capture small animals.

emission – a discharge of a substance (e.g. dust) into the environment.

emission factor – an expression for the rate at which a pollutant is generated as a result of some activity, divided by the level of that activity.

empirical evidence – evidence based on, and verifiable by, observation and experiment.

environment – a general term for all the conditions (physical, chemical, biological and social) in which an organism or group of organisms (including human beings) exists.

environmental constraints - limitations on a project by components of the environment.

Environmental Impact Statement (EIS) – a formal description of a project and an assessment of its likely impact on the physical, social and economic environment. It includes an evaluation of alternatives and an overall justification of the project. The EIS is used as a vehicle to facilitate public comment and as the basis for analysing the project with respect to granting approval under relevant legislation.

environmental officer – person at a mine in charge of environmental compliance and monitoring.

environmental planning – planning (e.g. of a mining operation) that places emphasis on the possible environmental impacts of a development.

ephemeral – not permanent, e.g. a watercourse that flows only seasonally or after rainfall.

erodibility – the tendency of soil, earth or rock to erode.

erosion – the wearing away of the land surface (whether natural or artificial) by the action of water, wind and ice.

ethnography – the branch of anthropology that deals with the regional distribution and characteristics of the human race.

evapotranspiration – loss of water from a land mass through transpiration from plants and evaporation from the soil.

excavate – to dig into natural material or fill using an excavator or other machinery.

excavator - item of earth moving equipment fitted with a bucket on an articulated boom and used for digging material from a face in front of, or below the machine.

existing air quality – the quality of the ambient air near ground level, expressed as concentrations or deposition rates or air pollutants – also expressed as ambient air quality.

exotic - introduced or foreign, not native.

exploration licence (EL) – a licence issued for exploration in a defined area.

explosive column – the explosive in a blasthole which is initiated by the primer.

face – sub-vertical slope generally forming limits of benches.

fallout – the sedimentation of dust or fine particles in the atmosphere.

fault - a fracture in rock along which there has been observable displacement.

fauna – animals including birds, mammals, fish, etc.

feasibility study – a preliminary technical and economic study to assess the viability of a project.

fill – material placed to raise the general surface level of a site.

fire regime – the history of fire at a particular place expressed in terms of frequency, intensity and season of occurrence; may relate to wildfires or prescribed burning.

flitch – a section of a mining bench – e.g. blasted rock on a 5m bench can be extracted and loaded into haul trucks in two x 2.5m flitches, one flitch at a time.

flocculant – an additive to fine material suspended in water which causes fine particles to agglomerate together resulting in a larger "flocculated particle" which will naturally settle out of the suspension to result in clean water.

flora – plants including trees, shrubs, grasses and herbs.

flotation – the separation of a mixture (e.g. sulfide minerals and waste material) in water, often by the addition of chemicals that carry one component (e.g. sulfides) to the surface as a froth.

flowsheet – diagram representing the sequence of events and decision-making logic of a particular process.

flyrock - rock that is propelled into the air by the force of an explosion. Usually comes from pre-broken material on the surface or upper open face.

formation (or unit) - a (named) succession of sedimentary beds having some common characteristics.

fragmentation – the extent to which rock is broken into small pieces by primary blasting.

freeboard – the vertical distance between a dam spillway or overflow and the top of a dam's embankment.

free cyanide – cyanide in a chemically available and generally toxic form; the cyanide ion (CN^-) and molecular hydrogen cyanide (HCN).

fresh rock – rock unaffected by natural weathering processes.

front-end loader – machine used to lift and place soil, earth, rocks, etc. on a construction site.

froth – material (e.g. sulfides and flocculant) that has floated to the surface during the process of flotation.

fugitive emissions – emissions not entering the atmosphere from a stationary vent (stack). Examples of fugitive dust sources include vehicular traffic on unpaved roads, handling of raw materials, wind erosion of dusty surfaces, etc.

gangue – minerals associated with an ore, such as quartz, that do not contain the metal(s) being extracted.

geochemistry – the study of the chemical composition of the earth or of the chemical interaction of elements, molecules, or particles derived from the earth.

geological reserves - the measured total quantity of in-situ mineralisation in a deposit, prior to consideration of mining parameters.

germination – the time at which a seed sprouts and the embryonic plant begins to grow.

grade – the concentration of gold either in an individual rock sample or averaged over a specified volume of rock; gold grade is usually given in grams per tonne.

grader – an item of earthmoving equipment, rubber tyred and fitted with a centrally mounted blade and rippers used to shape and trim the ground surface.

gradient – rate of change of a given variable (such as temperature or elevation) with distance.

grazing capability – the maximum amount of stock able to be maintained on a given area of land.

grinding – a process used to reduce the particulate size of a mine rock or soil, typically occurs after crushing.

ground level concentration – applied to the concentration, calculated or observed, in the neighbourhood of the ground surface.

ground vibration – oscillatory motion of the ground caused by the passage of seismic waves originating from a blast.

groundcover – vegetation that grows close to the ground (such as grasses and herbs) providing protection from erosion.

groundwater – water contained in voids such as fractures, cavities and inter-particle spaces in rocks.

groundwater surface – the upper surface of the water table.

habitat – the place where an organism normally lives; habitats can be described by their floristic and physical characteristics.

haul road – road used in a mine for haulage of waste rock and ore from the active face to its destination on site.

haul truck – a truck specifically designed for hauling and tipping soil or rock within the Mine Site.

heavy metals – metals of high density.

heritage – the things of value which are inherited.

heritage significance – of aesthetic, historic, scientific, cultural, social, archaeological, natural or aesthetic value for past, present or future generations.

hydraulic conductivity (k) – the rate of flow of water in an aquifer through a cross section of unit area under a unit hydraulic gradient, at the prevailing temperature. Usually expressed in units of metres per second or metres per day.

hydraulic drill – an item of mobile mechanical equipment fitted with a hydraulically operated drilling apparatus for drilling 75-150mm diameter holes in rock.

hydraulic gradient - the direction of flow of groundwaters.

hydrogeology – the study of groundwater and the related geologic aspects of surface waters.

hydrology – the study of water, particularly its movement in streams, rivers, or underground.

hydroseeding – the application of a mixture of seed, fertiliser and mulch in water to disturbed surfaces.

ignimbrite – a pyroclastic rock characterised by welding and banding of tuff layers.

illuminance – the amount of light that falls on a surface or plane. The illuminance is independent of the characteristics of that surface or plane. Illuminance is measured in Lumens/metre2 or lux.

impervious – a layer (e.g. a bed of rock) that does not allow water to pass through.

in-fill drilling – exploratory drilling in a specific area of interest conducted at a closer drillhole spacing than initial drilling of the area.

in situ – a term sued to distinguish material (e.g. rocks, minerals, fossils, etc.) found in its original position of formation, deposition, or growth, as opposed to transported material.

indigenous – belonging to, or found naturally in, a particular environment (see also exotic).

infiltration – the process of surface water soaking into the soil.

infrastructure – the necessary buildings, roads and equipment associated with a mining operation.

inter-generational equity – the principle that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

intermittent – flows periodically, irregularly.

inversion - generally used in meteorology with respect to an increase of temperature with height in contrast with the usual decrease of temperature with height in the troposphere. An inversion layer is distinguished by its large stability, which limits the turbulence and therefore the dispersion of pollutants.

invertebrates – commonly, animals without a backbone (jellyfish, worms, molluscs, etc.).

jaw crusher – a crusher which uses the pressure applied to the rock between the fixed and moving plate to reduce rock size.

jointing – planes of discontinuity in rockmass which exhibit no evidence of relative movement.

katabatic – topographically generated wind; flow of cold air downslope onto valleys at night.

Kevlin – Correlated Colour Temperature – is a specification of the colour appearance of light emitted by a lamp relating its colour to the colour of light from a reference source when heated to a particular temperature.

laminite – a sedimentary rock comprising alternate layers (lamallae) of sand and clays.

landform – a specific feature of a landscape (such as a hill) or the general shape of the

leachate – the liquid which has percolated through solid waste and has dissolved soluble components.

lithology – refers to the general characteristics of rocks or sediments.

low-grade – a mineralised deposit with uneconomic or only marginally economic metal concentrations.

low loader – is a trailer which has a relatively low carrying deck and used to transport large items of equipment such as bulldozers or scrapers.

luminance – the amount of light leaving a surface. It may be reflected or transmitted. Luminance is typically measured in candelas / metre^2.

luminous intensity – the amount of luminous flux leaving the light source in a given direction. It is measured in lumens / steradian or candelas.

mammal – animal of the class mammalia, distinguished by the presence of hair and mammary glands.

migratory – passing, usually predictably (based on aquatic species), from one region or climate to another, for purposes of feeding, breeding, or other biological purposes.

mill – a cylindrical item of equipment that rotates to reduce the size of the rocks fed into it.

mitigation measures – measures employed to reduce (mitigate) an impact (such as the construction of a bund wall to reduce sound emissions).

mobile equipment - wheeled or tracked self-propelled equipment such as trucks and front-end loaders.

monitoring - the regular or event-related measurement of components of the environment to establish environmental standards are being met.

mulch - straw, leaves, loose earth, etc. spread on the ground or produced by tillage to protect the roots of newly planted trees, crops, etc.

net acid-generating capacity – capacity of a rock to generate acid upon exposure to air and water as determined by NAG testing.

net acid-generation (NAG) testing – experimental determination of the potential of a material (e.g. mine waste) to generate acid upon exposure to air and water; testing involves pH monitoring as: 1) acid is generated by the accelerated oxidation of reactive sulfides and 2) other minerals within the rock react with the acid generated and partially or completely neutralise it.

net acid-producing potential (NAPP) – potential of a material (e.g. waste rock) to generate acid upon exposure to air and water as predicted by 1) its total sulphur content (indicative of its acid-forming capability) and 2) its reaction with hydrochloric acid (indicative of the acid-neutralising capacity of other minerals within the rock).

neutral weather conditions – weather conditions that neither particularly exacerbate nor mitigate the dispersal of pollutant emissions (dust, noise etc.) from the project area.

noise contours – theoretical lines connecting points of equal noise value.

non-perennial - refers to streams which do not flow the whole year through - also known as intermittent streams.

noxious – introduced species considered to be harmful to native species or to the habitat of native species.

nuisance dust – relatively large dust particles which settle out – not detrimental to health.

nutrients – generally refers to nitrogen and phosphorus, which are essential for biological growth.

open cut pit – large hole excavated in an open-cut mining operation to remove ore and waste rock.

operational constraints - limitations upon a project by equipment or machinery.

ore – a mineral or mixture of minerals containing a metal in sufficient amounts for its extraction to be profitable.

orebody – a solid mass of ore (both high and low grade) that is geologically distinct from the rock that surrounds it and that is commercially extractable.

oxide ore reserve – that component of the ore reserve composed of weathered (oxidised) rock.

particulate matter - small solid or liquid particles suspended in or falling through the atmosphere - sometimes expressed by the term particulates.

peak airblast – the maximum level of the airborne shockwave resulting from the detonation of explosives.

peak particle velocity – a measure of ground vibration reported in millimetres per second (mm/sec).

percussion drill hole – drill hole performed by equipment using the repetitive impact of tungsten tipped bit onto rock; rock cuttings are usually returned uphole by flushing with compressed air.

perennial – refers a watercourse which has flow throughout the year.

permeability - a material property relating to the ability of the material to transmit water.

Permian - the geological period of time from 280 to 225 million years.

piezometer – a drill hole specifically drilled for the monitoring of groundwater levels and water quality.

piezometric surface – water table surface.

podzolic – soil descriptive term for soils that are strongly acid and highly differentiated.

pollution – the alteration of air, soil, or water as a result of human activities such that it is less suitable for any purpose for which it could be used in its natural state.

porosity – the porosity of a soil or rock is its property of containing cavities that can hold liquid (e.g. between grains of sand).

potable - water suitable for human consumption.

precipitation – natural water phenomena producing quantities of water measurable by standard methods (e.g. rainfall, snow).

prestripping – the removal of waste or overburden, before mining, to expose an orebody.

primary ore – unweathered mineralised rock.

process liquors – solutions used and produced in ore treatment.

process reagents – the chemicals and solutions used to recover the economic elements from the ore.

processing plant – a group of equipment used to recover the economic elements from the ore.

progressive rehabilitation – rehabilitation of disturbed areas as soon as practicable after they are no longer required during the life of the mine.

propagation – reproduction of plants by the natural or artificial germination of seeds or cuttings.

pump test – the systematic pumping of water from a bore to test the response of an aquifer.

pyrite – the most wide-spread sulphide material FeS_2. Found throughout the ore and waste rock within the Mine Site.

raw water pond – storage pond for make-up water for the processing plant.

reagent – substance used to produce or control a chemical reaction.

receptor – a designated place at which an impact may occur (e.g. a residence).

recharge – addition of water to the zone of saturation; also, the amount of water added.

recharge – the addition of water to an aquifer, directly from the surface, indirectly from the unsaturated zone, or by discharge from overlying or underlying aquifer systems.

recolonise – the process of animal and plant species re-establishing themselves in a disturbed area.

recovery – the difference between the observed water level during the recovery period following pumping and the maximum drawdown when pumping stopped.

rehabilitation - the preparation of a final landform after land disturbance and its stabilisation with trees, shrubs and ground covers.

relative humidity – the ratio of actual moisture in the air to the amount the air could hold if saturated, at a given temperature.

reptiles – cold-blooded vertebrates, including lizards, snakes, turtles, and crocodiles.

reserves - in the mining context refers to those parts of a resource where sufficient information is available to undertake mine planning.

residual environmental impacts – impacts from an activity (e.g. mining) that remain after mitigation measures are implemented.

respirable dust – dust that is capable of being breathed in.

revegetated – an area that has been planted with trees, shrubs and groundcovers after being disturbed.

riparian – pertaining to or situated on the bank of a river or creek.

road base – road pavement usually made up of densely graded crushed rock in varying sizes.

road grades – the longitudinal slope of the road surface commonly expressed in per cent gradient (i.e. 10 per cent is a gradient of 1 vertical in 10 horizontal).

run-of-Mine (ROM) – ore or overburden in condition as loaded from the open cut pit.

salinity – the dissolved content of water expressed in terms of milligrams per litre.

sandstone – general term for sedimentary rock with grain size from 0.063mm to 2mm - grains may be minerals or rock fragments.

scarify – to stir the soil without altering its form, or disturbing its sequence of layers.

sclerophyll – hard, leathery-leafed plants (e.g. eucalyptus).

secondary crusher – the second crusher from which rock passes to be further reduced in size.

sediment basin – a small excavation designed to trap the coarse material washed from disturbed areas.

seepage – subsurface movement of water.

seepage paths – the path that seepage water takes through the ground.

semi-autogenous grinding (SAG) mill – a revolving mill where coarse rock fragments are ground partly under their own weight and partly with the aid of stainless steel balls.

silica – silicon dioxide (SiO_2).

siliceous – having a high silica (quartz) content.

siltstone – general term for sedimentary rock with grain size from 0.004 mm to 0.063 mm – individual grains not discernible with unaided eye.

silt-stop fencing – fine mesh fencing normally installed downslope of a sediment source, designed to trap silt and sediment and allow the water to pass through.

Siluran – a period of geological time from 435 to 395 million years ago.

sky glow – Sky glow is the brightening of the night sky that results from the reflection of radiation (visible and non-visible), scattered from the constituents of the atmosphere (gas molecules, aerosols and particulate matter) in the direction of observation.

slurry – mixture of fluid and solid (e.g. tailings water and solids).

smelting – extraction of a metal from its ore at great heat.

sodic – having a high Na content.

soluble salts – salts that are capable of being dissolved.

spatial – related to areal extent.

species – a taxonomic grouping of organisms that are able to interbreed with each other but not with members of other species.

species diversity – a measure of the number of different species in a given area.

specific gravity – the weight of any body or substance considered with regard to the weight of an equal bulk of pure water.

sphalerite – zinc-containing ore, ZnS (zinc sulfide).

stable – used with respect to the atmospheric boundary layer, when the vertical temperature gradient is greater than the adiabatic lapse rate. Vertical air motions are suppressed. The turbulence intensity is low resulting in poor dispersion conditions.

standing water – water that is pooled and still.

stemming – the fine material placed in a blast drill hole after the explosive to ensure blast force is directed laterally.

Sterilisation drill hole – a drill hole designed to confirm the absence of mineralisation that could be considered as economic in the future which would be sterilised by the construction of one or more of the proposed mine components.

stockpile – a pile used to store material (such as low-grade ore) for future use.

subaerial – exposed to the atmosphere.

subsoil – the layer of soil lying below the topsoil; usually contains less organic matter and is less fertile.

sulphide – a concentration of sulphide minerals, derived from ore by grinding and flotation.

sulphate – a bivalent negative ion of sulphur and oxygen (SO_4).

sump (surface) – a dam within the lowest point of the open cut pits or processing plant site designed to collect the first runoff or aggregate nuisance flow.

surface waters – all water flowing over, or contained on, a landscape (e.g. runoff, watercourses, etc.).

suspended solids – solids held in suspension by the turbulent flow of a fluid.

tailings – by-product of the metal extraction process consisting of crushed rock from which the metal has been extracted (the solid fraction or portion) and a liquid fraction or portion composed of water and residual chemicals used in the extraction process.

tailings cells – an individual deposition cell that, combined with other cells, forms the tailings storage.

tailings supernatant – the liquid portion of a tailings slurry after the solids have settled.

temperature inversion – an increase in air temperature with height.

terrestrial – of the land as distinct from water.

throughput – quantity of material (ore, chemicals, etc.) moving through a system (e.g. an ore processing plant).

topsoil – the upper layer of soil, usually containing more organic material and nutrients than the subsoil beneath it.

total cyanide – total concentration of cyanide in waters, includes free cyanide and cyanide complexed with metals.

total sulfur – the total mass of all forms of sulfur in a sample.

total suspended particulate matter (TSP) – the mass of all particulate matter suspended in a solution.

total suspended solids – a common measure used to determine suspended solids concentrations in a waterbody and expressed in terms of mass per unit of volume (e.g. milligrams per litre).

transect – a fixed line along which observations are made of flora and fauna.

transect – a line across a study area along which observations are made and changes can be observed (e.g. changes in vegetation).

transmissivity – the rate at which groundwater is transmitted at a specific hydraulic gradient through rock of a specified width.

Triassic – a geological period extending from 245 to 208 million years before present.

tubestock – tree seedlings supplied with roots enclosed in soil.

tuff – a pyroclastic rock.

underdrainage – artificial drainage that removes infiltration or seepage water from underneath a structure (e.g. a tailings storage facilities or waste rock emplacement).

understorey – the layer of forest vegetation between the overstorey (or canopy) and the ground layer.

undulation – the gentle rise and fall or wave-like structure of a landscape.

upward light ratio (ULR) - the proportion of the flux of a light fitting and/or installation that is emitted at or above the horizontal, excluding reflected light, when the light fitting is mounted in its installed position.

vehicle movement – a one-way trip.

volcanic rocks – rocks that have formed from molten rock extruded near to or over the surface of the earth (lava).

waste rock – uneconomic rock extracted from the ground during a mining operation to gain access to the ore.

waste rock emplacement – structure to hold waste rock, formed by the placement of waste rock in stacked layers (typically 2 metres thick in each layer), engineered in such a way as to maximise stability and minimise erosion.

waste oils – old oils and lubricants retrieved from machinery.

water table – the upper limit of the saturated zone within a rock mass, generally at atmospheric pressure. It is characteristic of unconfined aquifers.

watercourse – creek or river, running water.

weathered rock – rock affected to any degree by the processes of chemical or physical weathering.

weathering – the in-situ physical disintegration and chemical decomposition of rock materials at or near the earth's surface.

weed – any plant (in particular an herbaceous one) that survives in an area where it is harmful or troublesome to the desired land use.

wildlife – non-domesticated fauna.

wind direction – the direction from which the wind is blowing.

wind rose – diagrammatic representation of wind direction, strength, and frequency of occurrence over a specified period.

woodland – plant communities dominated by trees whose crowns shade less than 30% of the ground.

yield – (of a water bore) 1) the capacity of the bore to produce water. 2) the amount of water actually withdrawn.

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