Section 2

Description of the Proposal

PREAMBLE

This section describes the proposed recommencement of mining activities at the Broken Hill North Mine including:

- *the objectives of the Proposal;*
- *an overview of the Proposal and the approvals required;*
- *the infrastructure that would be established;*
- *the site preparation that would be undertaken;*
- *the proposed mining waste rock management, processing and transportation operations;*
- *ancillary activities that would be undertaken; and*
- *the proposed rehabilitation of the areas that would be disturbed throughout the life of the Proposal, including the development and implementation of a Biodiversity Offset Strategy.*

The Proposal is described in sufficient detail to provide the reader with an overall understanding of the nature and extent of the activities proposed, how the various activities would be undertaken and to enable an assessment of the potential impacts on the surrounding environment. The boundaries and dimensions of the various components described throughout this section are indicative only.

Details of the safeguards and management measures that the Applicant proposes to implement to minimise or negate the potential impacts on components of the surrounding environment are provided in Section 4 of this document.

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2.1 INTRODUCTION

2.1.1 Objectives

The Applicant's objectives for the recommencement of mining operations at the Broken Hill North Mine include:

- to safely mine the economically extractable resources;
- to minimise surface disturbance and impacts upon surrounding residents and the local environment during operations;
- to provide for the ongoing operation of the Applicant's mining operations in Broken Hill in a cost-effective manner to ensure security of employment and the continued economic contributions to the local, Regional, State and national economies;
- to continue to communicate and maintain transparent relationships with the relevant government agencies and the community; and
- to implement a level of management control and mitigation measures that ensures compliance with relevant statutory requirements and reasonable community expectations.

2.1.2 Overview of the Proposal

The Proposal would include the following activities (**Figure 2.1**).

- Remediate the existing Cosmopolitan access ramp, portal and decline to the 12 Level (limit of the existing decline) to facilitate safe and efficient access to the underground workings.
- Restore and upgrade existing electrical, ventilation, air and water services, including on surface and within the decline, No. 2 and No. 3 Shafts, No. 3 Return Air Rise.
- Extend the existing decline from the 12 Level to link with the existing decline between the 32 Level and the 38 Level.
- Undertake exploration drilling from underground to further define remnant ore and identify additional ore lenses and lodes.
- Develop access drives to permit access by modern mining equipment.
- Extract remnant ore and ore below the base of previous mining operations, including within the Fitzpatrick Area.
- Transport extracted ore to the surface ROM Pad using underground haul trucks, including establishment of a haulage route utilising existing roads and a proposed haul road cutting.
- Transport extracted waste rock for placement either within completed stopes underground or within the in-pit waste rock emplacement in the Cosmopolitan Open Cut.

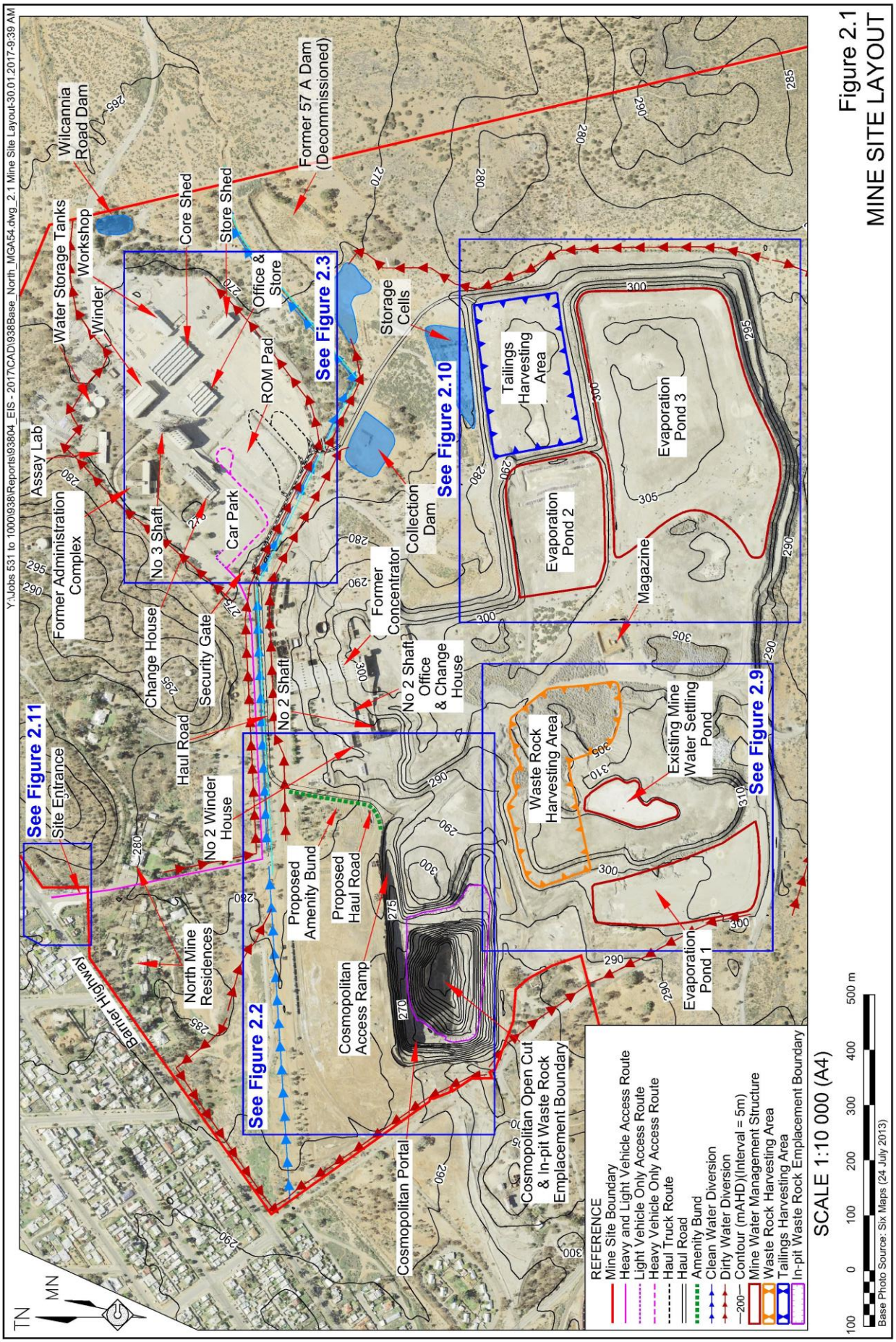

Figure 2.1
MINE SITE LAYOUT

- Extract waste rock from the existing surface waste rock emplacement for transportation back underground as required.
- Harvest tailings from the tailings harvesting area for mixing with water and cement in a proposed Paste Fill Plant for use backfilling completed stopes.
- Re-establish surface infrastructure required to support the mining operation, including a ROM pad, office and store, workshop and fuel store, change house and car park, services (power, water, air and communications), surface magazine and ancillary infrastructure.
- Stockpile and crush ore within the existing ROM Pad using a mobile crusher.
- Load and transport the crushed ore to the Southern Operations using A-double Road Trains utilising the Barrier Highway, Menindee Road, Crystal Street and Gypsum Street.
- Dewater the existing workings and transfer that water to proposed on-site evaporation ponds or the Southern Operations.

The transported ore would be processed using the Southern Operations Concentrator under the continuing use rights held for that operation.

2.1.3 Approvals Required

The Proposal would require development consent from the Minister for Planning and Environment and under Division 4.1 of the *Environmental Planning and Assessment Act 1979*. In addition, the following additional or amended approvals would be required to allow commencement of the proposed activities.

- An amendment to the existing Environment Protection Licence (EPL 2683) or a new licence issued by the Environment Protection Authority (EPA) under Section 47 of the *Protection of the Environment Operations Act 1997*.
- A Works Authority Deed with the Roads and Maritime Service and/or Broken Hill City Council under the *Roads Act 1993* for construction of the intersection of the Site Access Road and the Barrier Highway.

The Applicant holds a range of licences and approvals that would be relevant to the ongoing operation of the North Mine.

- Consolidated Mining Leases 4 and 5. The Applicant notes that a range of approvals under these leases will be required, including an approved *Mining Operations Plan* and a range of documentation and approvals related to the safe operation of the Mine.
- Water supply works 60WA583325 for the North Mine workings and Water Access Licence WAL40959 for extraction of up to 1.466GL of groundwater.
- Licence to Store explosives XSTR100008.

2.2 SITE ESTABLISHMENT AND REFURBISHMENT ACTIVITIES

2.2.1 Introduction

The Applicant anticipates that a range of site establishment and restoration operations would be required to facilitate the recommencement of mining operations. These would largely be completed prior to the commencement of mining operations. The following subsections provide a brief description of each of the proposed activities. It is noted that a range of the identified activities may be completed to facilitate the approved exploration activities (see Section 1.5.3.5). However, for completeness, those activities are described here and are the subject of the current application.

2.2.2 Re-establishment of Access to the Underground Workings

The Applicant notes that the underground workings were last regularly accessed in 2008. In late 2016, the Applicant commenced exploration activities identified in Section 1.5.3.5, including rehabilitation of the underground infrastructure to ensure safe and efficient access. Those activities include the following, some of which were in progress or complete at the time of finalising this document.

- Stabilise and make safe the northern wall of the Cosmopolitan Open Cut adjacent to the existing haul road (**Figure 2.2**). This would include scaling of the high wall and mesh draping, as required. **Plate 2.1** presents a view of the access ramp showing the high wall.
- Inspect and stabilise the existing Cosmopolitan portal and decline and associated access drives, ventilation shafts and escape ways. This would include replacement of ground support where required, including steelsets (metal arches that support the decline where it passes through the orebody). **Plates 2.2** and **2.3** presents a view of the Cosmopolitan Portal and access ramp.
- Re-establish surface and underground services to current standards, including:
  - update the existing site electrical infrastructure;
  - re-establish primary and secondary ventilation;
  - re-install and refurbish water management infrastructure (pumps, pipes, fittings, etc.);
  - re-install and refurbish compressed air distribution system;
  - install surface and underground communication infrastructure; and
  - re-establish the explosives magazine at the surface (**Figure 2.1**).

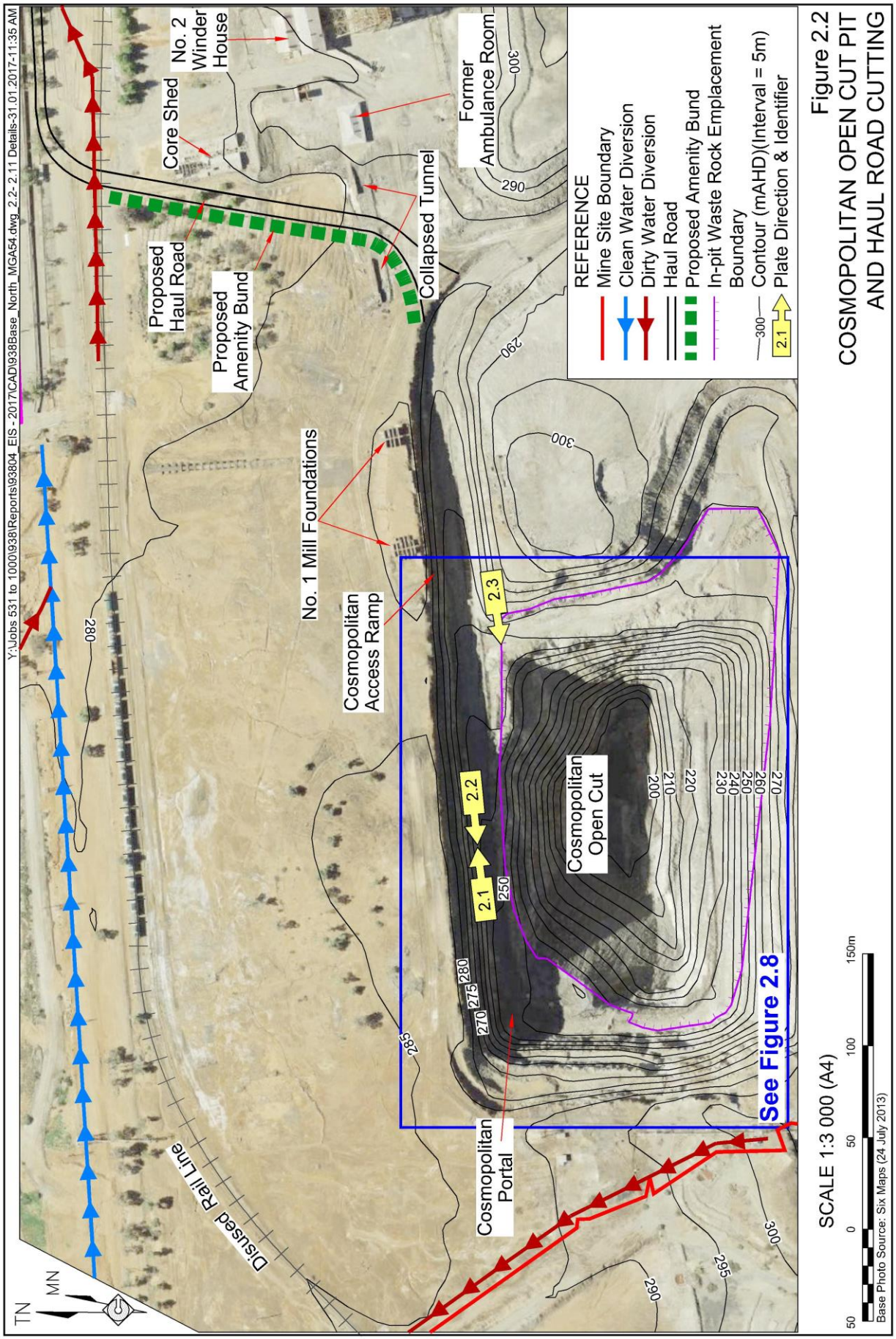

Figure 2.2
COSMOPOLITAN OPEN CUT PIT AND HAUL ROAD CUTTING

Plate 2.1: View of the Cosmopolitan Access Ramp looking east
(Ref: A130116_IMG_3292)

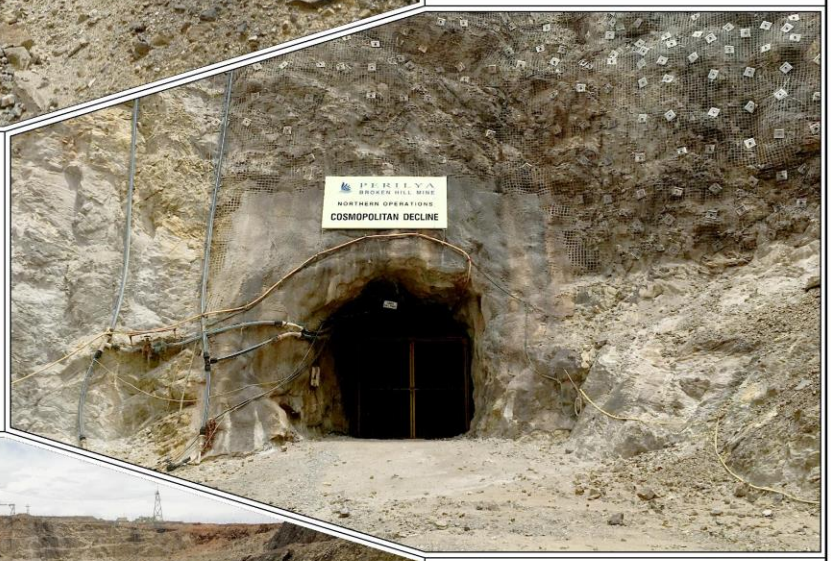

Plate 2.2: View of the Cosmopolitan Portal
(Ref: A130116_IMG3289)

Plate 2.3: View of the eastern section of the Cosmopolitan Open Cut, including the existing in-pit Waste Rock Emplacement
(Ref: A130116_IMG3294)

Plate 2.4: Internal view of the North Mine Change House
(Ref: A130116_IMG3204)

2.2.3 Re-establishment of the Haul Road Network

The Applicant would re-establish the existing haul road network from the Cosmopolitan Open Cut and the Tailings Harvesting Area to the ROM Pad. The roads to be upgraded have been previously used for transporting ore and waste rock and would require the following works.

- Re-sheeting with waste rock and grading.
- Re-establishment of roadside drainage in accordance with DECC (2008).

The Applicant also proposes to establish a new section of haul road from the top of the Cosmopolitan Access Ramp to the existing haul road network (**Figure 2.2**). The proposed haul road would be constructed between two sections of collapsed concrete tunnels that have been assessed as having no heritage significance (see Section 4.6.7). The haul road would also incorporate an approximately 4m high amenity bund on the western side to prevent the haul trucks from being visible to residents to the north of the Mine Site and to provide acoustic mitigation.

2.2.4 Refurbishment of Existing Surface Facilities

The Applicant proposes to re-use facilities previously used for mining operations between 2003 and 2008 (**Figure 2.3**). This would include the following.

- Carpark, include re-establishment of a light vehicle access road and line marking.
- Change house, including re-establishment of the facilities last used between 2003 and 2008. The Applicant notes the significance of the facility identified during the historic heritage assessment (see Section 4.6). **Plate 2.4** presents an internal view of the Change House.
- Office and store (**Plate 2.5**), including renewal of electrical and communications infrastructure, repainting and replacement of furniture and office equipment.
- Workshop (**Plate 2.6**), including re-establishment of electrical, mechanical hydrocarbon storage, refuelling and other infrastructure.
- Surface infrastructure associated with the No. 3 Shaft, including water tanks and pipework and in-shaft infrastructure.

The following facilities would continue to be used as they are currently used.

- Core shed for the storage and processing of drill core (**Plate 2.7**).
- Store shed for the storage of material required to be stored undercover (**Plate 2.8**).

Finally, the following facilities would not be modified or altered.

- No. 3 Shaft Headframe, Winder House, Crusher House and related infrastructure (**Plates 2.9** and **2.10**).
- Change house, with the exception of those areas that were previously used for mining-related activities between 2003 and 2008.
- Former Administration Complex.

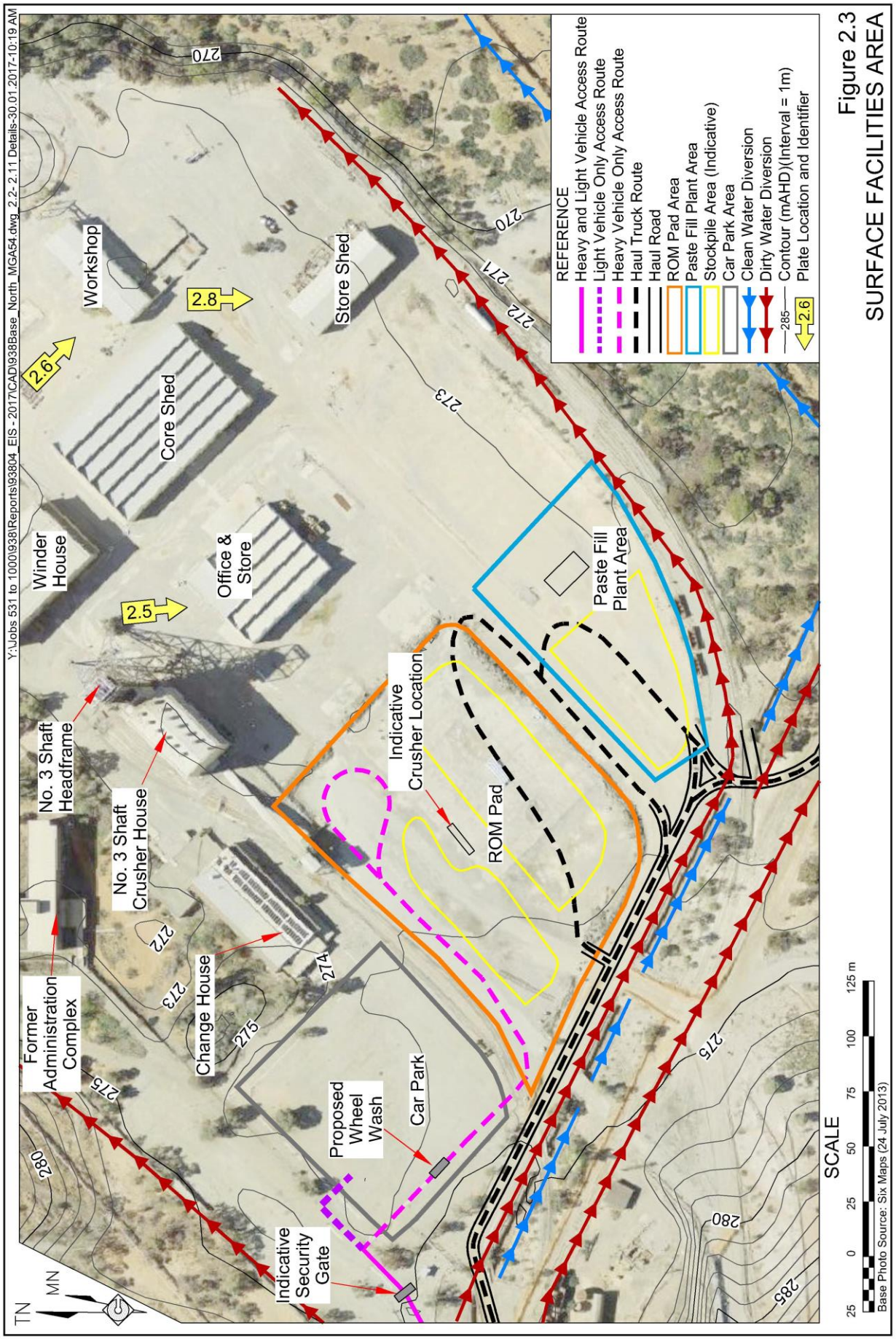

Figure 2.3
SURFACE FACILITIES AREA

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Plate 2.5: External view of the existing office
(Ref: A130116-IMG3265)

Plate 2.6: External view of the existing workshop
(Ref: A130116_IMG3275)

Plate 2.7: Internal view of the core shed
(Ref: A130116_IMG3276)

Plate 2.8: External view of the existing store shed
(Ref: A130116_IMG_3278)

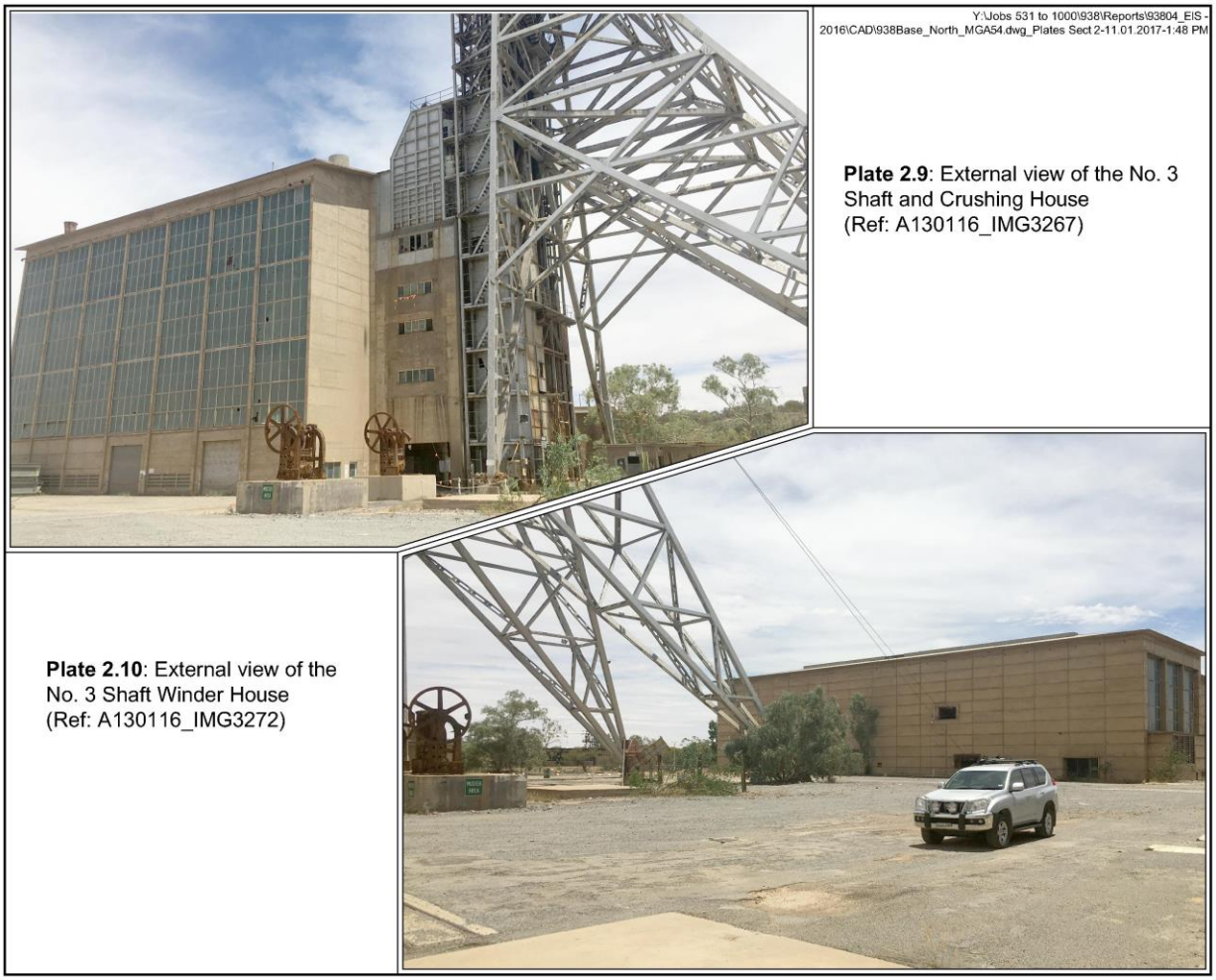


Plate 2.9: External view of the No. 3 Shaft and Crushing House (Ref: A130116_IMG3267)

Plate 2.10: External view of the No. 3 Shaft Winder House (Ref: A130116_IMG3272)

2.3 MINING OPERATIONS

2.3.1 Geological Setting

2.3.1.1 Regional and Local Geology

The Broken Hill Line of Lode is hosted by the upper Broken Hill Group of the Willyama Supergroup. The Willyama Supergroup is a 6km to 9km thick unit of sedimentary rocks that have been intruded by a series of granites which may have been formed by the partial melting of the sedimentary units within the Supergroup.

Rocks of the Willyama Supergroup have been extensively metamorphosed and deformed, with at least three deformational events resulting complex folding and shearing of both the Willyama Supergroup host rocks and the Line of Lode (**Figure 2.4**).

2.3.1.2 Line of Lode

Figure 2.5 presents a long-section and cross section through the Line of Lode. In summary, the Line of Lode is an approximately 9.5km long, northeast – southwest striking, roughly boomerang-shaped orebody, with the "arms" plunging to depth. A number of smaller, possibly satellite deposits occur along strike from the main Line of Lode.

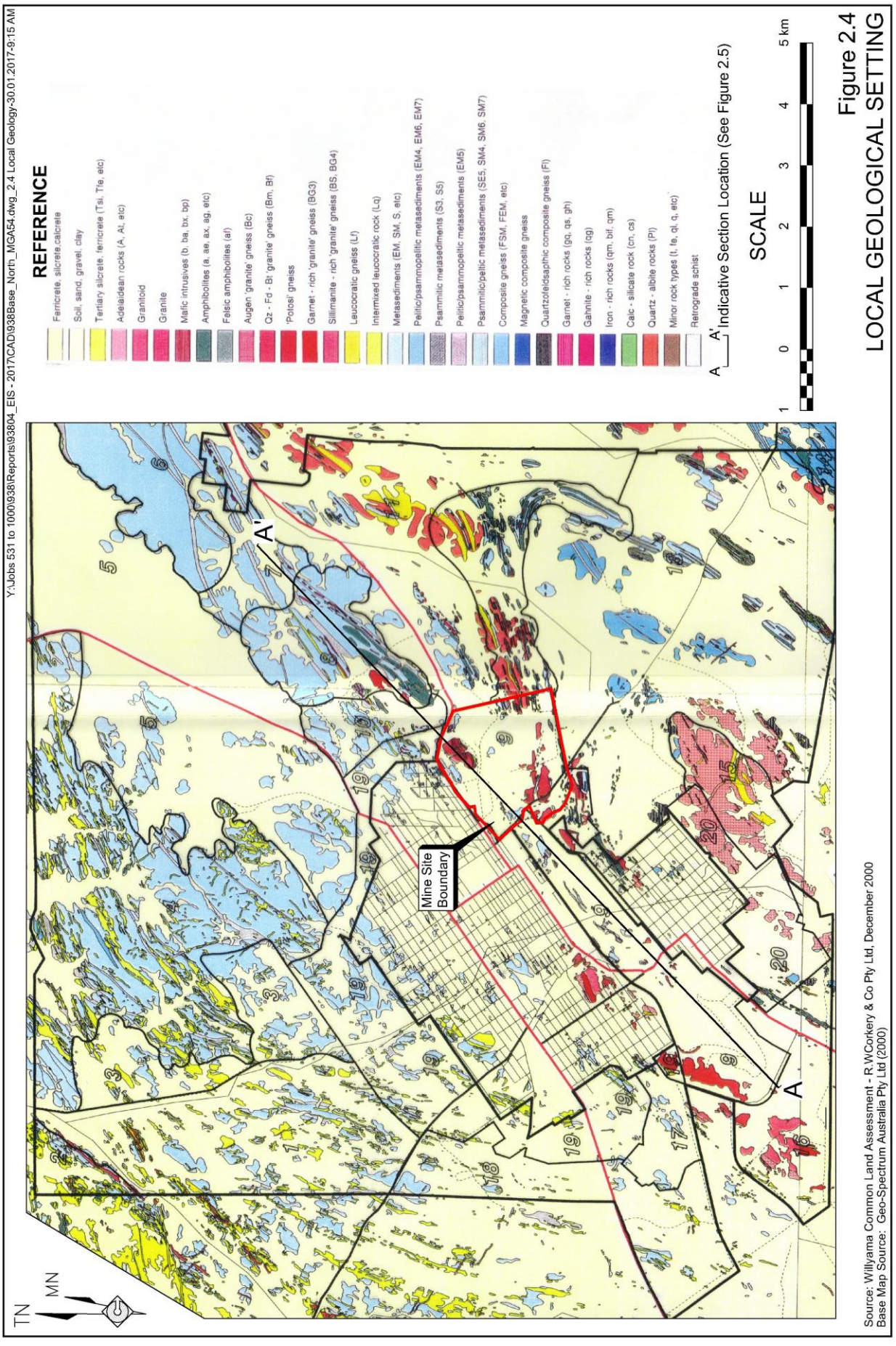
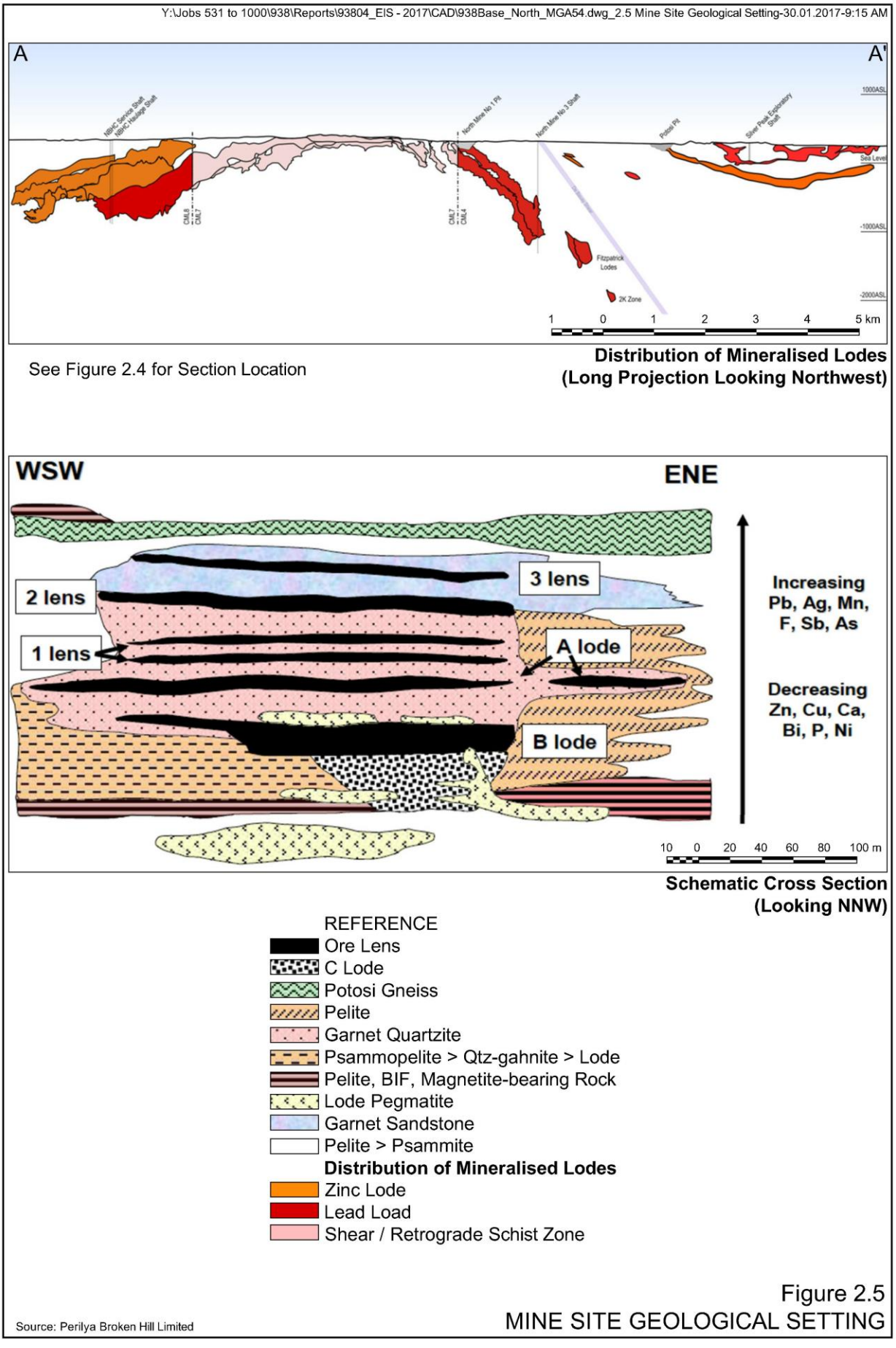


Figure 2.4
LOCAL GEOLOGICAL SETTING



Source: Perilya Broken Hill Limited

Figure 2.5
MINE SITE GEOLOGICAL SETTING

The Line of Lode consists of five major ore lenses (1, 2, 3, A and B Lenses) surrounded by a zone of disseminated mineralisation referred to as C Lens (**Figure 2.5**). Typically, the upper lenses (2 and 3 Lenses) are lead rich, while the lower lenses (1, A and B Lenses) are zinc rich.

2.3.1.3 North Mine Geology and Mineralisation

The geological setting of the North Mine is broadly similar to the rest of the Line of Lode, with each of the lenses occurring within the Lode. The lenses are typically steeply dipping with the plunge of the mineralisation steepening from 40° to 60° between surface and 20 Level to 70° between the 20 Level and 26 Level. Below the 26 level, the Globe – Vauxhall Shear Zone separates the Fitzpatrick Area from the main lode. Numerous other shears and folding offset and disrupt the mineralised sequence.

Mineralisation within the North Mine is typically associated with:

- Sphalerite (zinc sulphide);
- Galena (lead sulphide) with variable silver; and
- Tetrahedrite (copper antimony sulfosalt) with silver.

Typical combined grades of lead and zinc range from 5% to 40% within the high-grade zones, with silver grades between 50g/t and 400g/t in the galena rich lenses.

2.3.2 Mineral Resources and Reserves

A Joint Ore Reserve Committee (JORC) compliant resource statement for the North Mine was prepared by J. Broome, the then Geology Superintendent, Perilya Broken Hill Limited (Member – Australian Institute of Geoscientists) and C. Mroczek, the then Technical Services Manager, Perilya Broken Hill Limited (Member – Australian Institute of Mining and Metallurgy) in 2007. **Table 2.1** presents a summary of the resources identified within that statement.

Table 2.1
North Mine Resource Summary

Category	Tonnes	Zn	Pb	Ag	Pb + Zn
North Mine Uppers (Above 26 Level)					
Measured	400 000	7.4%	8.0%	155g/t	15.4%
Indicated	300 000	7.3%	8.4%	150g/t	15.7%
Inferred	300 000	7.0%	11.0%	109g/t	18.0%
Subtotal	**1 000 000**	**7.3%**	**9.0%**	**140g/t**	**16.3%**
North Mine Deeps (Below 26 Level)					
Measured	2 100 000	11.4%	13.9%	216g/t	25.3%
Indicated	1 200 000	11.7%	13.6%	239g/t	25.3%
Inferred	-	-	-	-	-
Subtotal	**3 300 000**	**11.5%**	**13.8%**	**224g/t**	**25.3%**
Total	**4 300 000**	**10.5%**	**12.7%**	**205g/t**	**23.2%**
Source: Perilya Broken Hill Limited					

The Applicant notes that as a result of uncertainty in relation to previous mining operations and mining envelopes, a JORC-compliant reserve (that component of the resource that could reasonably be expected to be mined) is not possible. As a result, **Table 2.2** presents a non-JORC compliant "mining inventory" for the North Mine. This mining inventory would be updated once further exploration and geotechnical drilling is completed from underground.

Table 2.2
North Mine Mining Inventory

Category	Tonnes	Zn	Pb	Ag	Pb + Zn
North Mine Uppers (Above 26 Level)	1 800 000	4.7%	5.6%	96g/t	10.3%
North Mine Deeps (Below 26 Level)	2 400 000	9.1%	10.7%	171g/t	19.8%
Total	**4 200 200**	**7.2%**	**8.5%**	**137g/t**	**15.7%**
Source: Perilya Broken Hill Limited					

2.3.3 Efficiency of Resource Recovery

Figure 2.6 presents a long-section through the North Mine. In summary, substantial mining has been undertaken between the surface and the 33 Level (approximately 1 400m below surface), with limited mining undertaken within the Fitzpatrick Area to a depth of approximately 1 725m below surface.

The Applicant proposes to extract remnant and undeveloped ore within the North Mine, noting that the amount of remnant ore increases with depth as increasing historic cut off grades and geotechnical challenges resulted less complete extraction of ore during historic mining operations.

To the greatest extent practicable, the Applicant would fully extract all available resources. In addition, the proposed activities would not adversely impact on future generations undertaking further mining operations to extract ore that may not be economically recoverable at present.

2.3.4 Indicative Mining Methods

Given the wide range of ore body geometries and geotechnical settings of the remnant ore within the North Mine, the Applicant anticipates that a range of mining methods would be employed. These may include the following.

Long Hole Open Stope / Modified Avoca – North Mine Uppers

Figure 2.7 presents an overview of Long Hole Open Stope mining. In summary, this method involves drilling rings of holes from one level to the level below, in this case approximately 22.5m. Those holes are progressively loaded with explosives and fired to fragment the ore which is withdrawn from the stope via draw points at the base of the stope. Once all drill holes have been fired and the ore removed, the void is backfilled with either waste rock or paste fill (a mixture of tailings and cement) to ensure the stability of the void. Mining then progresses to the next level up, with ore from that stope blasted onto the fill material below. This mining method has the advantage of being relatively low cost.

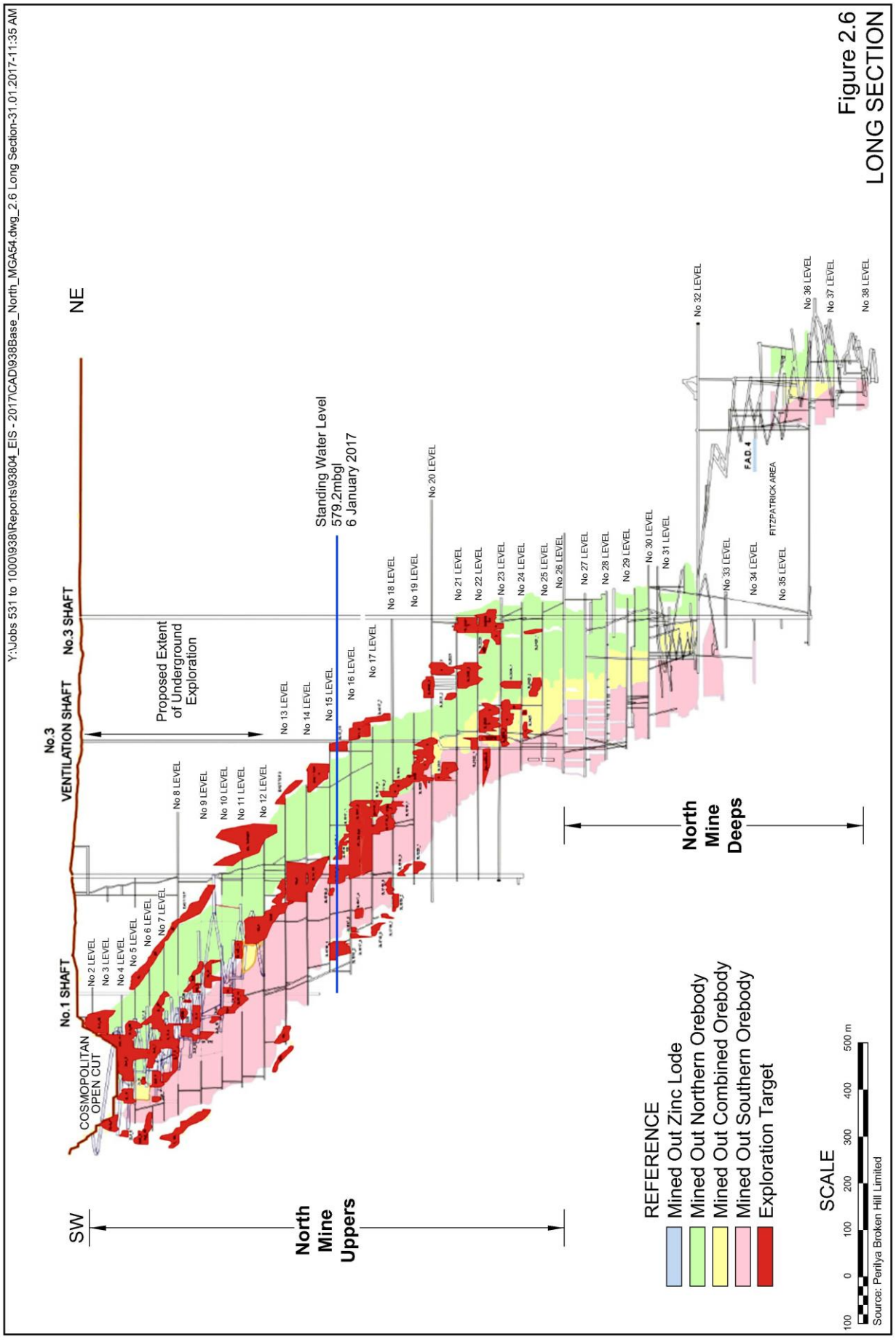

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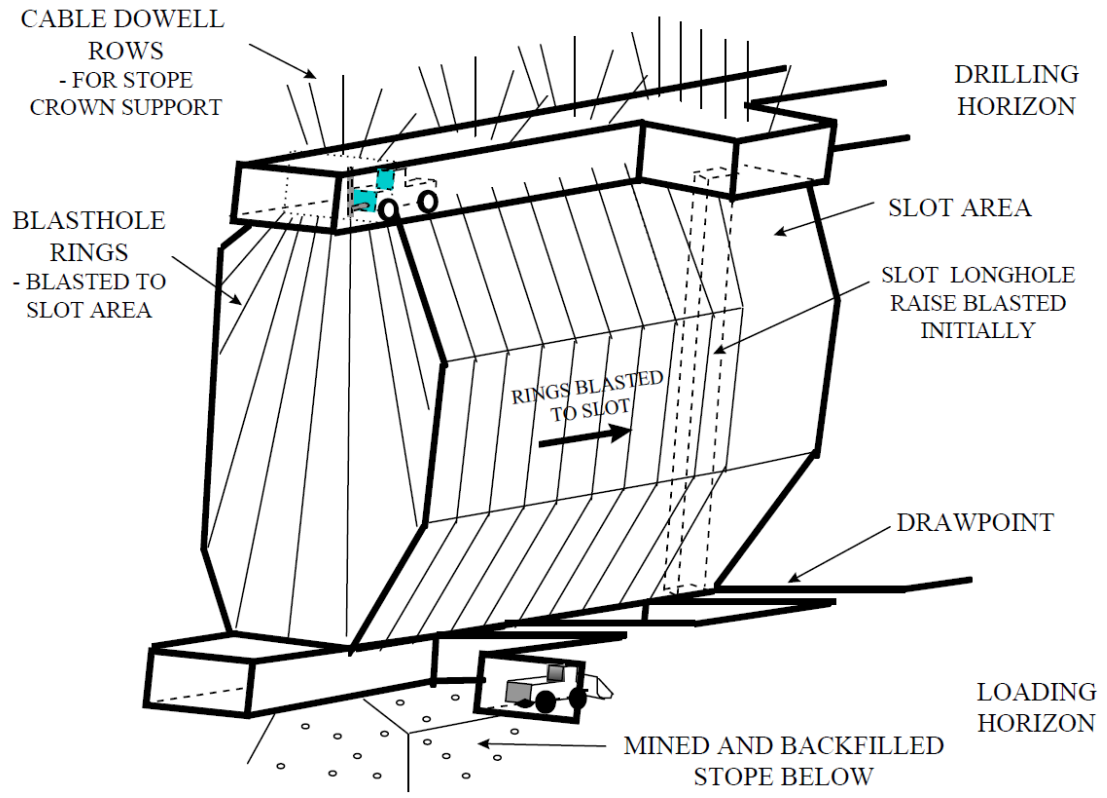
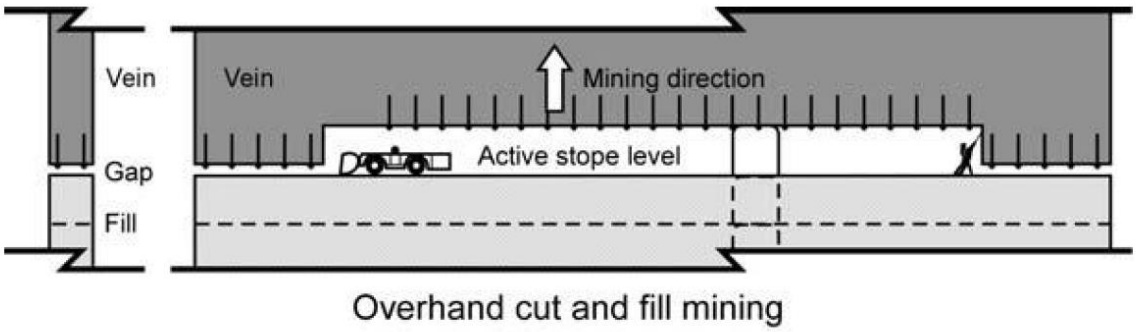
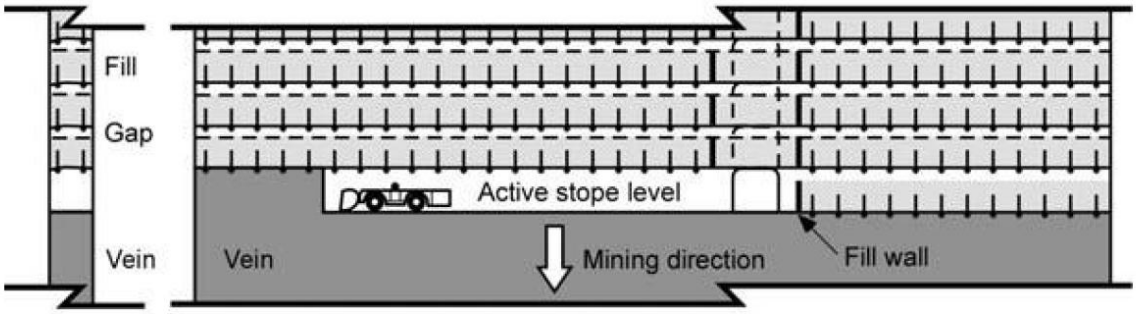
Figure 2.6
LONG SECTION
SW
NE
No.1 SHAFT
No.3 VENTILATION SHAFT
No.3 SHAFT
COSMOPOLITAN OPEN CUT
Proposed Extent of Underground Exploration
Standing Water Level
579.2mbgl
6 January 2017
North Mine Uppers
North Mine Deeps
FAD 4
FITZPATRICK AREA
REFERENCE
Mined Out Zinc Lode
Mined Out Northern Orebody
Mined Out Combined Orebody
Mined Out Southern Orebody
Exploration Target
SCALE
100 0 100 200 300 400 500 m
Source: Perilya Broken Hill Limited



Long hole open stope mining



Overhand cut and fill mining



Underhand cut and fill mining

Figure 2.7
SCHEMATIC OVERVIEW OF PROPOSED MINING METHODS

Source: Perilya Broken Hill Limited

Long Hole Open Stope / Sandfill Hanging Wall – North Mine Deeps

A variation of Long Hole Open Stope mining would be required to recover the remaining pillars where the pillars are surrounded on three sides by sand fill and timbers placed during historic mining operations. In summary, this mining method would extract remnant ore using a slightly modified Long Hole Open Stope method whereby sublevels approximately 20m apart would be established and the remnant ore would be drilled and blasted as described previously. The resulting void would be filled with cemented paste which would be allowed to cure before mining operations would progress to the next level down, using the cemented paste as the crown for the subsequent stope. This mining method has the advantage of stabilising the potentially unstable fill material.

Overhand Cut and Fill – North Mine Deeps

Figure 2.7 provides a schematic overview of the overhand cut and fill mining method. In summary, a drive is developed at the base of the lens to be mined. The completed drive is then filled with cemented paste and a second drive is developed adjacent to the first, with the cemented fill forming the wall of the drive. Once the full width of the lens has been extracted, mining progresses upwards, with the cemented fill forming the floor of the next drive. This mining method has the advantage of permitting highly selective mining.

Underhand Cut and Fill – North Mine Deeps

Figure 2.7 provides a schematic overview of the overhand cut and fill mining method. This mining method is similar to overhand cut and fill mining, with the exception that a drive is established at the top of the lens to be mined. The completed drive is then filled with cemented paste and a second drive is developed adjacent to the first, with the cemented fill forming the wall of the drive. Once the full width of the lens has been extracted, mining progresses downwards, with the cemented fill forming the backs or the roof of the next drive. This mining method has the advantage of minimising the potential for rock falls and instability.

2.3.5 Mining Schedule

Mining operations would be undertaken in three phases as follows.

Phase 1 – Remediation and Restoration

This phase is described in Section 2.2 and would principally prepare the Mine Site for the recommencement of routine mining operations. The Applicant anticipates that Phase 1 would require up to 18 months to complete, with Phase 2 mining operations commencing approximately 9 months after the commencement of Phase 1.

Phase 2 – Uppers Phase

The North Mine Uppers is defined as those sections of the North Mine above the 26 Level (**Figure 2.6**). Mining operations during this phase would include the following.

- Extension of the existing decline from the 12 Level to the 26 Level.
- Extraction of remnant ore above the 26 Level. Extraction rates during this phase are expected to be up to 295 000tpa of ore and 272 000tpa of waste rock, the

majority of which would be placed underground as backfill and the remainder placed in-pit in the Cosmopolitan Open Cut to facilitate rehabilitation of that open cut (see Section 2.4).

- Further exploration drilling to better define remnant ore boundaries, unmapped voids and explore for yet to be identified ore lodes or lenses.

The Applicant anticipates that Phase 2 would require up to 7 years to complete, commencing towards the end of Year 1 of the Proposal. Phase 3 mining operations would commence approximately 2 years prior to the completion of Phase 2.

Phase 3 – Deeps Phase

The North Mine Deeps are defined as those sections of the North Mine below the 26 Level (**Figure 2.6**), including ore lodes and lenses that may be identified during underground drilling operations.

- Extension of the existing decline and access drives to permit access to the known and yet to be identified ore lodes and lenses. The maximum depth of mining operations would be approximately 2 250m BGL.
- Extraction of ore below the 26 Level. Extraction rates during this phase are expected to be approximately 300 000tpa of ore and 180 000tpa of waste rock, the majority of which would be placed underground as backfill and the remainder placed in-pit in the Cosmopolitan Open Cut to facilitate rehabilitation of that open cut (see Section 2.4).
- Further exploration drilling to identify further ore lodes or lenses.

The Applicant anticipates that Phase 3 would require up to 9 years to complete, commencing during Year 6 of the Proposal.

Table 2.3 presents the indicative annual mining schedule for the North Mine. It is noted that this schedule is indicative only and is likely to change based on ground conditions, availability of mining areas, demand for ore at the Southern Operations Concentrator and production at the Applicant's other operations.

2.3.6 Mining Equipment

Table 2.4 presents the anticipated mining equipment that that will be used throughout the life of the Proposal.

Table 2.3
Indicative Production Schedule

Year	Mining Phase			Anticipated maximum depth (m BGL)	Develop-ment (m)	Ore (t)			Waste Rock (t)
	1	2	3			Stope	Develop-ment	Total	
Year 1				404	1 000				500
Year 2				546	4 750	61 000	70 000	131 000	223 000
Year 3				728	5 250	155 000	78 000	233 000	293 000
Year 4				866	5 250	147 000	109 000	256 000	266 000
Year 5				1 007	5 250	188 000	104 000	292 000	265 000
Year 6				1 144	5 250	192 000	100 000	292 000	272 000
Year 7				1 281	5 250	206 000	75 000	281 000	291 000
Year 8				1 465	11 500	232 000	66 000	298 000	180 000
Year 9				1 635	11 500	69 000	231 000	300 000	180 000
Year 10				2 250	11 500	69 000	231 000	300 000	180 000
Year 11				2 250	11 500	69 000	231 000	300 000	180 000
Year 12				2 250	11 500	69 000	231 000	300 000	180 000
Year 13				2 250	11 500	69 000	231 000	300 000	180 000
Year 14				2 250	11 500	69 000	231 000	300 000	180 000
Year 15				2 250	10 500	69 000	231 000	300 000	90 000
Year 16				2 250	5 500	69 000	231 000	300 000	-
Total					**128 500**	**1 733 000**	**2 450 000**	**4 183 000**	**2 960 500**

Note 1: Phase 1 = Remediation and restoration; Phase 2 = Uppers Phase; Phase 3 = Deeps Phase (see Section 2.3.5)

Source: Perilya Broken Hill Limited

Table 2.4
Proposed Mining Equipment

	Location		Year															
Plant	**Surf**	**U/G**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Jumbo		✓	1	3	3	3	3	3	3	6	6	6	6	6	6	6	6	3
Loader		✓	1	3	4	4	4	4	4	5	5	5	5	5	5	5	5	2
Truck	✓	✓		2	3	3	4		5	5	6	6	6	6	6	6	5	4
Production Rig		✓		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IT - Surface	✓		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IT – Underground		✓		1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
Charge up Vehicle		✓		1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
Water Truck	✓	✓		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Service Truck	✓	✓			1	1	1	1	1	1	1	1	1	1	1	1	1	1
Light Vehicles	✓	✓	11	12	12	12	12	12	16	16	16	16	16	16	16	15	14	12

Note: Surf = Surface, U/G= Underground

Source: Perilya Broken Hill Limited

2.4 WASTE ROCK MANAGEMENT

2.4.1 Introduction

The Applicant anticipates that approximately 3.0Mt of waste rock would be produced throughout the life of the Proposal. This material would preferentially be used for backfilling of completed stopes underground and would not be bought to the surface. However, where available stopes for backfilling are not available, waste rock would be transported to the surface and placed within the Cosmopolitan Open Cut in-pit Waste Rock Emplacement.

In addition, where waste rock is required for backfilling operations, but none is being produced at the time, waste rock would be harvested from the existing surface stockpiles and transported underground as back loads.

This subsection describes the characteristics of the waste rock to be produced and the procedures that would be employed during waste rock placement into the Cosmopolitan Open Cut in-pit Waste Rock Emplacement and waste rock harvesting from the surface stockpiles. The subsection concludes with an indicative waste rock balance.

2.4.2 Waste Rock Characteristics

Waste rock produced during the life of the Proposal would be similar to waste rock previously extracted from each of the Broken Hill deposits. As a result, it would comprise non-mineralised host rock with limited volumes of weakly mineralised halo material surrounding the mineralised lenses.

The Applicant notes that the host rock and halo material is silica-rich metasediments and metavolcanics. These rocks are typically non-reactive due to high percentages of contained quartz, feldspar, garnet and micaceous minerals. The mineralisation typically has low concentrations of acid generating minerals such as pyrite, chalcopyrite and pyrrhotite. Typical analysis for these minerals is <0.2% in waste rock. Higher concentrations of 0.5% to 5% are rare and, when they do occur, are invariably within the ore zones rather than waste rock or halo material. In addition, the host rock includes acid-neutralising minerals, including carbonates in varying forms.

The Applicant notes that throughout the history of mining in Broken Hill, the waste rock produced by each of the mines on the Line of Lode has been classified as non-acid forming and non-hazardous. There is no history of acid forming waste rock in Broken Hill. As a result, the Applicant contends that no particular measures are required to manage waste rock placed at the surface.

2.4.3 In-Pit Waste Rock Placement

Plate 2.3 presents a view of the existing Cosmopolitan Open Cut in-pit Waste Rock Emplacement. In summary, waste rock has previously been transported to the surface by haul truck and tipped off in the vicinity of the portal. This material has then been pushed into the Cosmopolitan Open Cut void. This has facilitated stabilisation of the open cut wall below the portal.

The Applicant would continue to emplace waste rock into the open cut void using similar methods. **Figure 2.8** presents the indicative design of the in-pit waste rock emplacement. In summary, assuming that 0.74 million loose cubic metres (Mlcm) of waste rock would be bought to the surface (see Section 2.4.5), the in-pit waste rock emplacement would largely backfill the Cosmopolitan Open Cut below the elevation of the access ramp. The final surface of the emplacement would form a west-facing slope with an average gradient of approximately 1:7 (V:H). In the event that substantially less waste rock is bought to the surface, the final in-pit waste rock emplacement would be lower than that indicated. In the event that substantially more waste rock is transported to surface, the final emplacement would be higher than that indicated, with the additional material used to stabilise the southern wall of the open cut. However, in the event that this occurred, the Applicant would ensure that the in-pit waste rock emplacement would remain below the level of the crest of the Cosmopolitan Open Cut.

In-pit placement of waste rock would provide the following benefits when compared with out-of-pit placement.

- Stabilisation of the walls of the Cosmopolitan Open Cut.
- Reduced vehicle movements and disturbance at surface, with all waste rock placement-related noise and dust generating activities restricted occurring within the open cut, limiting impacts for surrounding residents.
- Reduced energy consumption as a result of not having to lift transported waste rock a further 60m vertically.

2.4.4 Waste Rock Harvesting

Waste rock harvesting would be undertaken within the Waste Rock Harvesting Area to the southeast of the Cosmopolitan Open Cut (**Figure 2.9**). This area has previously been used for waste rock harvesting. In summary, harvesting operations have previously involved extraction of waste rock using a loader or excavator from unconsolidated or uncompacted stockpiles within the Waste Rock Harvesting Area. This material was loaded into underground haul trucks and transported underground as back loads.

The Applicant would continue to harvest waste rock using similar methods. Harvesting operations would be limited to above an elevation of 300m AHD and would essentially lower the existing waste rock emplacement surface by between 5m and 10m. The Applicant anticipates that approximately 0.44 million metres cubed (Mm^3) of waste rock occurs within the Waste Rock Harvesting Area above 300m AHD.

In order to minimise the potential impact of waste rock harvesting operation on surrounding residents, particularly to the north of the Mine Site, the Applicant would implement the following control measures.

- Undertake harvesting operations between 7:00am and 6:00pm only.
- Avoid, where practicable, undertaking harvesting operations when the wind is blowing from the southeast to the southwest.

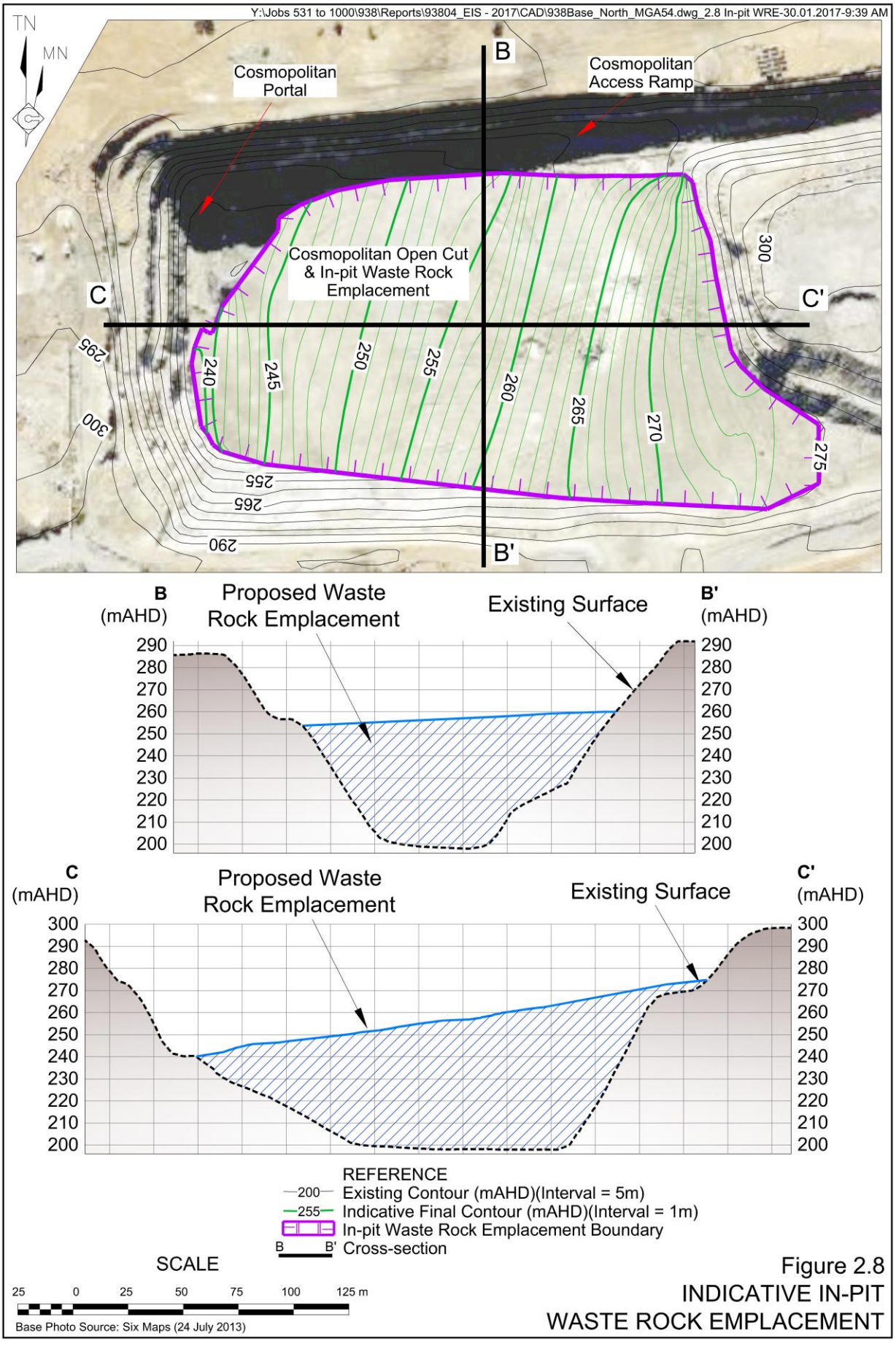
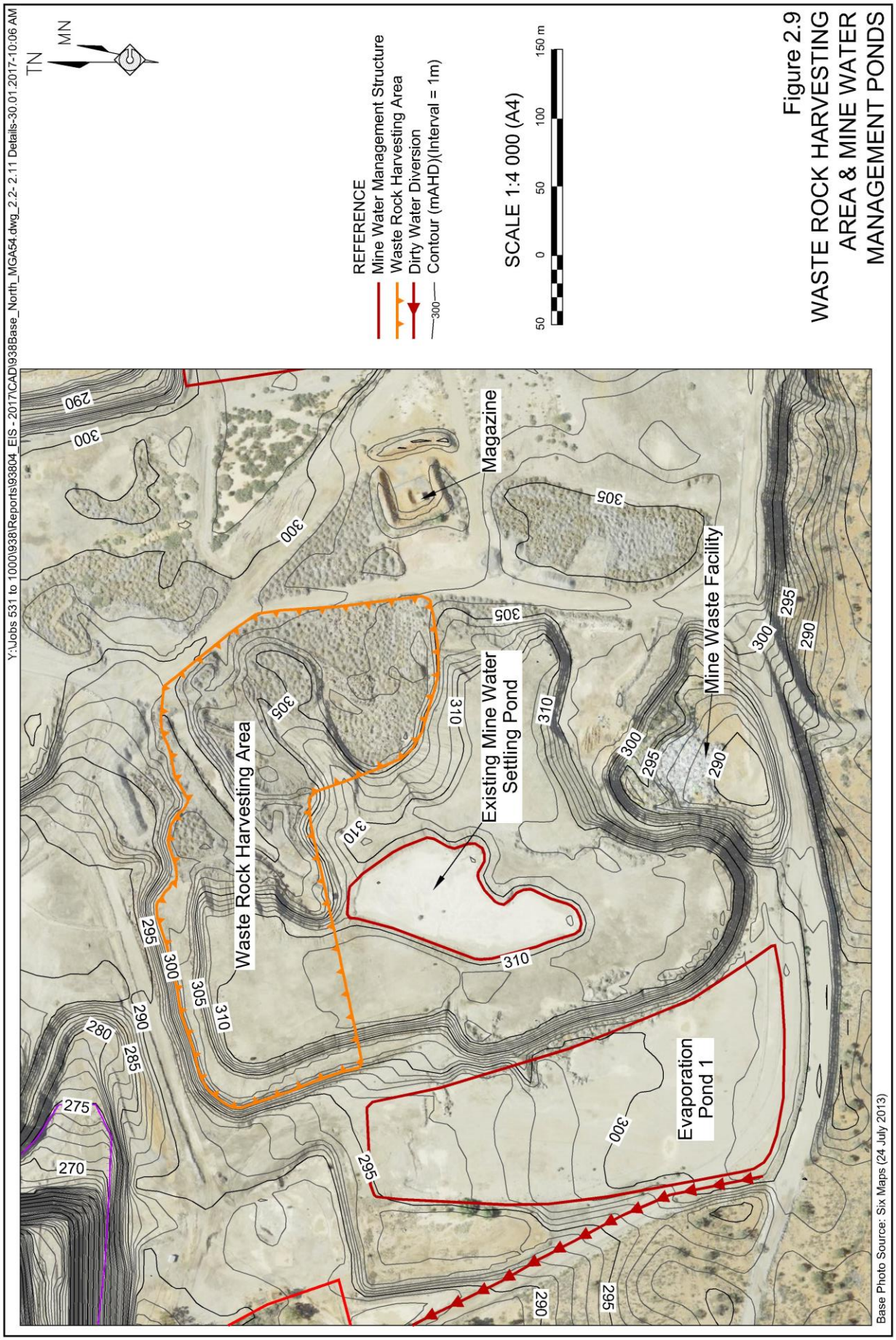


Figure 2.8
INDICATIVE IN-PIT
WASTE ROCK EMPLACEMENT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TN
MN
REFERENCE
Mine Water Management Structure
Waste Rock Harvesting Area
Dirty Water Diversion
Contour (mAHD)(Interval = 1m)
300
SCALE 1:4 000 (A4)
50
0
50
100
150 m
Figure 2.9
WASTE ROCK HARVESTING AREA & MINE WATER MANAGEMENT PONDS
Magazine
Waste Rock Harvesting Area
Existing Mine Water Settling Pond
Mine Waste Facility
Evaporation Pond 1
Base Photo Source: Six Maps (24 July 2013)

- Undertake, where practicable, harvesting operations on the southern side of an extraction face.
- Ensure that all material to be harvested, as well as the operational area, would be thoroughly watered using a water cart to minimise the potential for dust emissions during harvesting.

2.4.5 Waste Rock Balance

Table 2.5 presents the anticipated waste rock balance for the Proposal. In summary, the Applicant anticipates that approximately 0.74Mlcm of waste rock would be placed within the Cosmopolitan Open Cut In-pit Waste Rock Emplacement. Similarly, the Applicant anticipates that approximately 0.19Mm^3 of waste rock to be harvested from the Waste Rock Harvesting Area and that adequate reserves of waste rock are available within the identified area.

Table 2.5
Indicative Waste Rock Balance

Description	Assumption	Total
Waste Rock to be generated		
• Anticipated tonnage of waste rock to be produced.		2.96Mt
• *In situ* volume assuming a density of 3.0t/m^3.	2.96 ÷ 3.0	0.99Mm^3
• Loose volume of waste rock assuming a swell factor of 40%.	0.99 x 140%	1.38Mlcm
Available underground voids to be backfilled with waste rock		
• Anticipated tonnage of ore to be produced.		4.18Mt
• *In situ* volume of voids assuming a density of 3.2t/m^3.	4.18 ÷ 3.2	1.30Mm^3
• Volume of voids to be backfilled assuming 50% to be filled with waste rock, 25% with paste fill and 25% to remain unfilled.	1.30 x 50%	0.75Mm^3
In-pit waste rock emplacement surplus/deficit		
• Volume of waste rock to be bought to surface assuming 75% of voids to be filled with waste rock are available for direct placement.	1.38 – (0.75 x 75%)	0.81Mlcm
• Available volume within the Cosmopolitan Open Cut in-pit Waste Rock Emplacement (see **Figure 2.2**).		0.81Mm^3
• Available surplus storage capacity within the Cosmopolitan Open Cut at the end of the life of the Proposal.		nil
Available waste rock for harvesting		
• Volume of waste rock within the Waste Rock Harvesting Area above an elevation of 303m AHD.		0.45Mm^3
• Anticipated volume of waste rock required to be harvested assuming 25% of voids to be backfilled with waste rock utilise harvested waste rock.	0.75 x 25%	0.19Mlcm
• Available surplus within the Waste Rock Harvesting Area.	0.45 – 0.19	0.26Mm^3

Source: Perilya Broken Hill Limited

2.5 STOCKPILING AND PROCESSING OPERATIONS

2.5.1 Introduction

Ore transported to the surface would be stockpiled within the existing ROM Pad where it would be campaign crushed using a mobile crushing plant. The proposed stockpiling and processing operations would be very similar to those previously undertaken within the Mine Site.

This subsection describes the proposed stockpiling and crushing operations. Transportation of the crushed ore from the ROM Pad to the Southern Operations is described in Section 2.7.4.

2.5.2 Stockpiling Operations

Ore would be transported to the surface using underground haul trucks as described in Section 2.3.4. Once at the surface, the loaded haul trucks would travel via the Cosmopolitan Access Ramp to the proposed haul road cutting (**Figure 2.2**) and then via the existing haul road network to the existing ROM Pad. The ore would then be tipped off, typically in the western section of the ROM Pad, with the unladen haul trucks returning to the underground mine via the haul road network (**Figure 2.3**).

The Applicant would implement a Traffic Management Plan that would ensure that only authorised vehicles would be permitted to operate within the haul road network, with non-authorised light and heavy vehicles directed into the car park or the western section of the ROM Pad respectively.

The Applicant would ensure that all unsealed roads and the ROM Pad is watered regularly using a water truck or fixed sprinkler system to limited the potential for dust emissions, including the emissions of dust containing lead. In addition, the Applicant would ensure that a street sweeper is used in all sealed areas likely to accumulate dust to limit the potential for such emissions.

2.5.3 Crushing Operations

Crushing operations would typically be undertaken on a campaign basis using a mobile crushing plant. The proposed crushing operations would be very similar to those currently undertaken at the Potosi Mine and previously undertaken within the Mine Site.

Stockpiled ore would initially be watered down to limit the potential for dust emissions during material handling and crushing. It would then be transported from the ROM stockpile and fed into the crusher hopper using a front-end loader. The ore would be reduced in size to less than approximately 150mm and stockpiled on the ground by conveyor. Stockpiled material would then be transferred to the crushed ore stockpile by front-end loader.

The crusher would typically be operated by a contractor. As a result, the likely crusher throughput would be between 120t/hour and 180t/hour. The Applicant would require that the mobile crusher is fitted with water sprays and dust suppression and that these are utilised at all times during crushing operations.

2.6 TAILINGS HARVESTING AND PASTE FILL OPERATIONS

2.6.1 Introduction

The Applicant anticipates that the mining methods to be employed within the Mine Site will require completed stopes to be backfilled with a range of materials, including loose waste rock, cemented waste rock and paste fill. Paste fill is a type of back fill that was first used in 1979 and is now widely used in the mining industry in Australia and across the world. Paste fill is a mixture of selected tailings and cement that is pumped underground and used to backfill completed stopes. Once cured, the paste fill is sufficiently competent to permit mining immediately adjacent or underneath the filled area, resulting in maximum extraction of the resource.

Within the Mine Site, the Applicant proposes to harvest previously placed tailings within the Tailings Harvesting Area, transport the extracted tailings to the Paste Fill Plant Area where they will be stockpiled prior to being mixed with cement and water and pumped underground. This subsection describes the tailings harvesting, transportation, stockpiling and paste fill production operations.

2.6.2 Tailings Harvesting Area and Balance

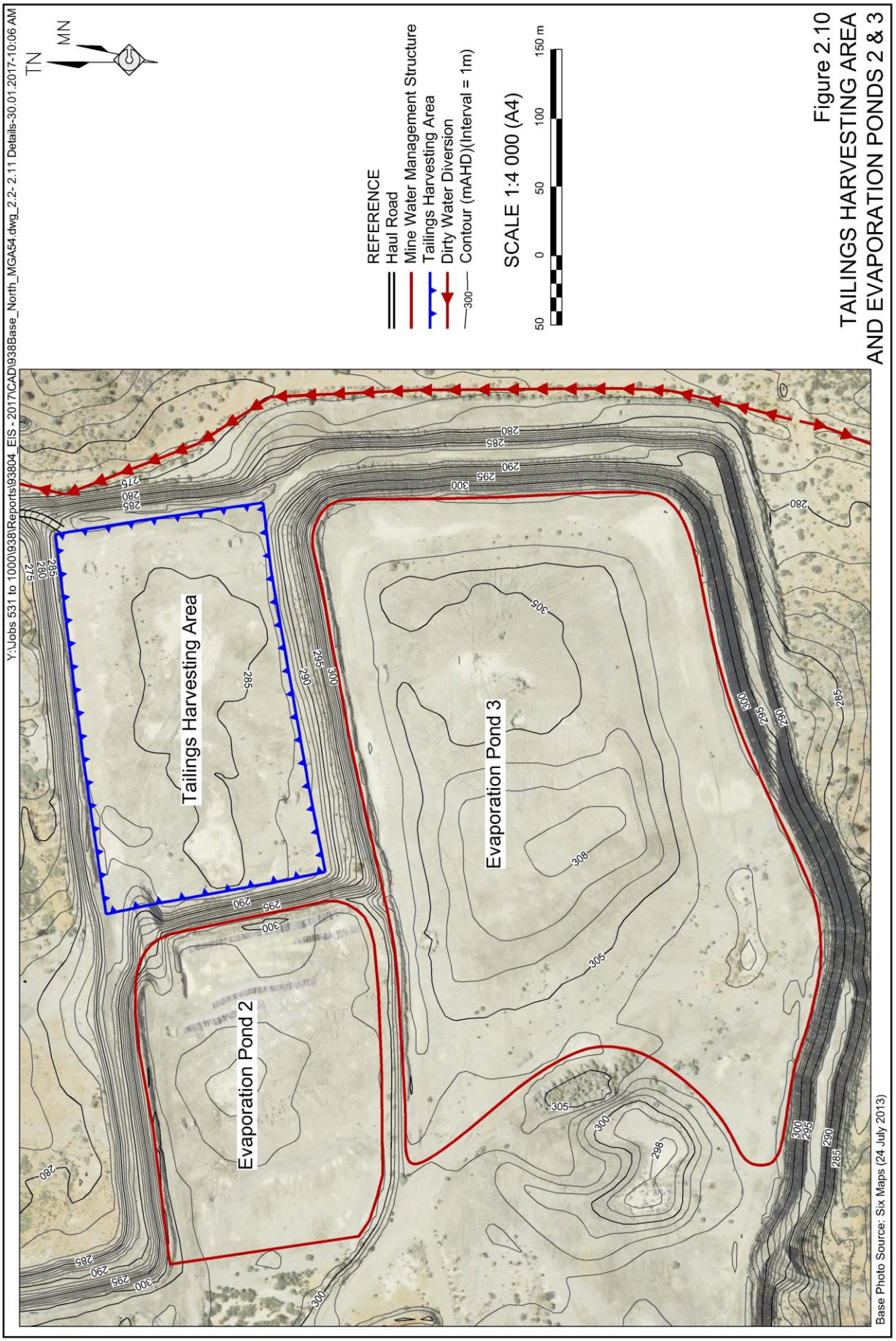
Figure 2.10 presents the Tailings Harvesting Area, an area comprising a former tailings storage facility that received tailings from the former Concentrator prior to 1990. The facility has subsequently been partially rehabilitated, with a cover of coarse material placed on the surface to prevent wind-blown dust.

Table 2.6 presents the tailings and paste fill balance. In summary, the Applicant anticipates that approximately 0.37Mm^3 of paste fill may be produced from the Tailings Harvesting Area, with approximately 0.32Mm^3 of paste fill required to stabilise underground voids.

Table 2.6
Indicative Tailings and Paste Fill Balance

Description	Assumption	Total
Available tailings to be harvested		
• Approximate area of Tailings Harvesting Area.		4.3ha
• Approximate thickness of contained tailings.		10m
• Contained volume of tailings.		0.43Mm^3
• Volume of tailings suitable for use in paste fill manufacture assuming 15% of material is unsuitable.		0.37Mm^3
Volume of voids to be backfilled with paste fill		
• Anticipated tonnage of ore to be produced.		4.18Mt
• *In situ* volume of voids assuming a density of 3.2t/m^3.	4.18 ÷ 3.2	1.30Mm^3
• Volume of voids to be backfilled assuming 25% to be filled with paste fill, 50% with waste rock and 25% to remain un-filled.	1.30 x 25%	0.32Mm^3

Source: Perilya Broken Hill Limited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TN
MN
REFERENCE
Haul Road
Mine Water Management Structure
Tailings Harvesting Area
Dirty Water Diversion
Contour (mAHD)/(Interval = 1m)
SCALE 1:4 000 (A4)
50 0 50 100 150 m
Figure 2.10
TAILINGS HARVESTING AREA
AND EVAPORATION PONDS 2 & 3
Tailings Harvesting Area
Evaporation Pond 2
Evaporation Pond 3
Base Photo Source: Six Maps (24 July 2013)

2.6.3 Tailings Harvesting Operations

The Applicant anticipates that paste fill will principally be required during mining operations below the 26 Level. As a result, tailings harvesting operations would be likely to commence in about Year 2023 of the Proposal.

Prior to commencing tailings harvesting operations, the Applicant would undertake required maintenance to the haul road between the Tailings Harvesting Area and the Paste Fill Plant Area (**Figure 2.1**). This would include ensuring suitable all weather access and installation of surface water controls in accordance with *Managing Urban Stormwater – Volume 2C – Unsealed Roads.*

Once suitable access has been re-established, the Applicant would remove the cover material from a small section of the Tailings Harvesting Area and would establish an extraction face. Tailings would be extracted using an excavator or front-end loader, with extracted material placed into haul trucks and transported to the Paste Fill Plant Area.

The Applicant would selectively extract tailings material for paste fill manufacture to ensure that appropriate particle size distribution for optimal paste fill strength and stability. Material that is not suitable for manufacturing of paste fill, including cover material and coarse material within the northern and eastern embankments of the Tailings Harvesting Area would be transported to the Cosmopolitan Open Cut in-pit Waste Rock Emplacement and emplaced with waste rock from the underground operations. Alternatively, this material may be transported underground to be used for backfilling of completed stopes, replacing material that would otherwise be harvested from the Waste Rock Harvesting Area.

The Tailings Harvesting Area, in particular the active harvesting area, would be regularly watered to limit dust emissions. Suitable polymer-based dust suppressants would be used in low traffic areas to limit the amount of water required to be used for dust suppression. In addition, sections of the Tailings Harvesting Area where all tailings have been removed would be progressively rehabilitated as described in Section 2.13, unless those areas are required for ongoing harvesting operations.

The Applicant anticipates that up to 46 000m^3 per year of paste fill would be required. As a result, tailings harvesting would be undertaken on a campaign basis, with between four and five harvesting campaigns per year. Tailings harvesting operations would be undertaken between 7:00am and 6:00pm 7-days per week.

2.6.4 Tailings Transportation and Stockpiling Operations

Tailings extracted from the Tailings Harvesting Area would be loaded into underground haul trucks or suitable off-road or road-registered trucks and transported via the haul road to the Paste Fill Plant Area (**Figure 2.1**). The speed limit on the haul road would be 40km/h.

The Applicant would ensure that the haul road and all trafficked areas are watered regularly using a water cart to limit dust emissions. The haul trucks would not be covered because the speed limit would ensure that dust emissions during transportation operations would be limited.

Transported tailings would be stockpiled within the Paste Fill Plant Area. Once constructed, tailings stockpiles would either be stabilised using a polymer-based dust suppressant or would be physically covered using tarpaulins to limit the potential for dust emissions. The Applicant anticipates that up to approximately 10 000m^3 of tailings material, sufficient for three months of operation of the Paste Fill Plant, would be stored within the Paste Fill Plant Area.

2.6.5 Paste Fill Operations

The Paste Fill Plant would comprise the following components.

- Cement/binder silo with an indicative capacity of 500t and a height of approximately 15m.
- A tailings feed hopper with belt feeder.
- A paste mixer, including feed and discharge chutes.
- Paste distribution infrastructure, including pumps, pipeline and boreholes into the underground workings.

The Paste Fill Stockpile Area, including the plant, would occupy an area of 1.2ha (or 140m by 90m).

Cement/binder would be delivered to the Mine Site in bulk and would be transferred the cement/binder silo. Silo would be fitted with a filter and over filling cut-off sensors to prevent emissions during filling operations.

During paste manufacture, tailings material would be extracted from the tailings stockpiles using a front-end loader and transferred to the tailings feed hopper. A belt feeder would extract the tailings from the hopper at a predetermined rate. This material would be combined with between 2% and 6% cement/binder and mixed with raw water to produce a paste fill mix with the required composition. This material would then be passed, via the paste distribution infrastructure to the relevant underground stopes.

The Paste Fill Plant would operate 24-hours per day, 7-days per week on an ad hoc basis as paste fill is required.

2.7 TRANSPORTATION

2.7.1 Introduction

This section describes the proposed transportation both within and beyond the Mine Site. An assessment of traffic and transportation-related impacts has been undertaken by Tonkin Consulting. The resulting report, referred to hereafter as Tonkin (2016) is presented as Part 4 of the *Specialist Consultant Studies Compendium* and is summarised in Section 4.5 of this document.

2.7.2 Internal Road Network

A range of internal roads would be required to permit movement of mobile plant within the Mine Site (**Figures 2.1**). The internal road network is defined as those roads within the site security gate that are not accessible by the public.

Separation of Vehicles and Speed Limits

The Applicant would implement a *Traffic Management Plan* that would ensure the separation of haul trucks, other heavy vehicles and light vehicles. In summary, only authorised vehicles and drivers would be permitted to access the haul road network. A separate heavy vehicle network would be established to permit access by road-registered heavy vehicles transporting crushed ore from the Mine Site, as well as other consumables and supplies (see for example **Figure 2.3**). Finally, a light vehicle only access would be established for all non-authorised light vehicles, including employee and visitors vehicles, to permit access to the car park (**Figure 2.3**).

Speed limits on the internal road network would be limited to 40km/h.

Haul Roads

With the exception of the proposed haul road cutting, all internal haul roads have previously been used for mining-related purposes. Section 2.2.3 describes the re-establishment of the haul road network. In summary, roads to be used for transportation of ore, waste rock and harvested tailings would be re-sheeted with waste rock and regularly maintained. All haul roads would be clearly demarcated, including those within the ROM Pad, Paste Fill Plant Area and on the waste rock emplacement using relocatable road markers.

Unsealed Roads

All unsealed roads, including haul roads and heavy vehicle roads, would be maintained in a manner that would permit all weather access. In addition, all proposed roads would be operated in accordance with the requirements of *Managing Urban Stormwater – Soils and Construction – Volume 2C Unsealed Roads* (DECC, 2008). Finally, the Applicant would ensure that all unsealed roads would be managed for dust using a water cart and / or chemical dust suppressants.

Wheel Wash and Management of Lead-contaminated Dust

The Applicant would install a wheel wash between the ROM Pad and the entrance to the car park. All vehicles, with the exception of those that only have access to the car park, would be required to pass through the wheel wash to ensure that potentially lead-contaminated dust is removed from vehicle tyres and bodies. In the event that the wheel wash is not operational, an alternative arrangement such as a manually operated high pressure washer would be used. A camera mounted at the security gate would ensure compliance with this requirement.

In addition, the Applicant would implement procedures to ensure that the car park and other sealed area, including the Site Access Road, are regularly swept with a street sweeper, with the collected material incorporated with the ore stream or placed within the in-pit waste rock emplacement.

2.7.3 Site Access Road and Intersection

2.7.3.1 Site Access Road

The Site Access Road would permit access from the Barrier Highway to the security gate. The road has previously been used for access to the Mine Site and is a sealed, two lane road. Kerb and guttering exists between the intersection with the Barrier Highway and the former gate house. The Site Access Road is used by the residents of the Applicant's North Mine Residences.

The Applicant would continue to use and maintain the existing Site Access Road throughout the life of the Proposal.

2.7.3.2 Site Access Road Intersection

Tonkin (2016) undertook an assessment of the adequacy of the proposed transportation route, including the Site Access Road intersection. Section 4.5 presents an overview of that assessment. However, in relation to the Site Access Road intersection with the Barrier Highway, Tonkin (2016) recommended the following (**Figure 2.11**). The Applicant proposes, in consultation with the Roads and Maritime Service and Broken Hill City Council, to implement the recommended works.

- Provide a minor change to the centre line of the Site Access Road.
- Provide a protuberance along the northern parking lane to reduce the risk of vehicle speeding on the left side of a vehicle turning right into the Site Access Road.
- Modification of the left turn island to provide better protection for vehicles turning left out of the Site Access Road.
- Provide for Give Way signs for vehicles exiting the Site Access Road.

All works would be undertaken in accordance with the relevant Austroads *Guide to Road Design.*

2.7.4 External Road Network

2.7.4.1 Introduction

The Applicant currently holds Development Consent DA448/2004 issued for the Potosi Mine to transport ore from the Potosi Mine Site to the Southern Operations. That approval identifies the maximum size of vehicles that may be used for transportation operations as well as the route that must be used. The Applicant has prepared an application to Broken Hill City Council to modify that consent to use slightly larger vehicles via a slightly different route to that approved. Determination of that application is awaited. The Applicant proposes to operate the proposed North Mine ore transportation operations in conjunction with the Potosi Mine ore transportation operations.

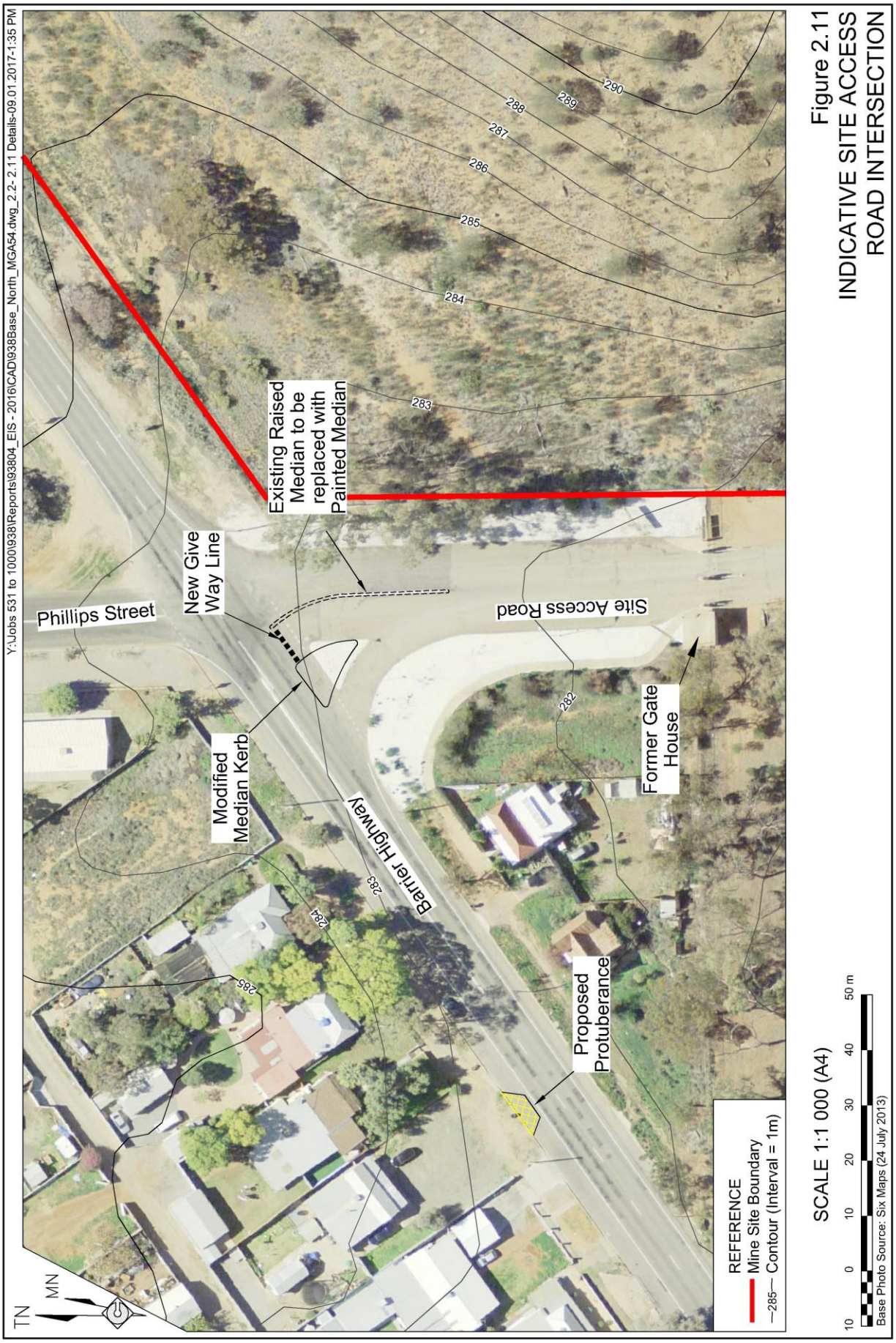
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Figure 2.11
INDICATIVE SITE ACCESS
ROAD INTERSECTION
Existing Raised Median to be replaced with Painted Median
New Give Way Line
Phillips Street
Site Access Road
Modified Median Kerb
Barrier Highway
Former Gate House
Proposed Protuberance
290
289
288
287
286
285
284
283
282
TN
MN
REFERENCE
Mine Site Boundary
285 Contour (Interval = 1m)
SCALE 1:1 000 (A4)
10 0 10 20 30 40 50 m
Base Photo Source: Six Maps (24 July 2013)

This subsection provides a description of the approved and proposed Potosi ore transportation operations, as well as those proposed for the North Mine, including the vehicles that would be used, the approved and proposed transportation routes and the proposed traffic levels. This subsection also describes the proposed non-ore transportation operations to allow the traffic-related impacts of the Proposal to be assessed.

2.7.4.2 Vehicle Types

Development Consent DA448/2004 for the Potosi Mine currently permits the use of B-double truck configuration to transport ore from the Potosi Mine Site to the Southern Operations. The Applicant has prepared an application to modify that consent to permit the use of "A-double Road Trains operating at higher mass limits." The Applicant proposes to use the same class of vehicles to transport ore from the North Mine to the Southern Operations.

Plates 2.11 and **2.12** present photographs of each class of vehicle and **Table 2.7** presents a comparison of the key attributes of each class.

Plate 2.11: B-double Truck

Plate 2.12: A-double Road Train

Source: Consolidated Mining and Civil

Table 2.7
Comparison of Vehicle Classes

	B-double Truck	A-double Road Train
Length (m)	22.5	28.6
No. axles	9	12
Tare (unloaded) weight (t)	28.3	32.5
Gross (loaded) weight (t)	68	91
Capacity (t)	39.7	58.5
Source: Consolidated Mining and Civil		

2.7.4.3 Transport Route

Approved Potosi Mine Transport Route

Figure 2.12 presents the approved Potosi Mine transport route which permits transportation of ore via the following roads.

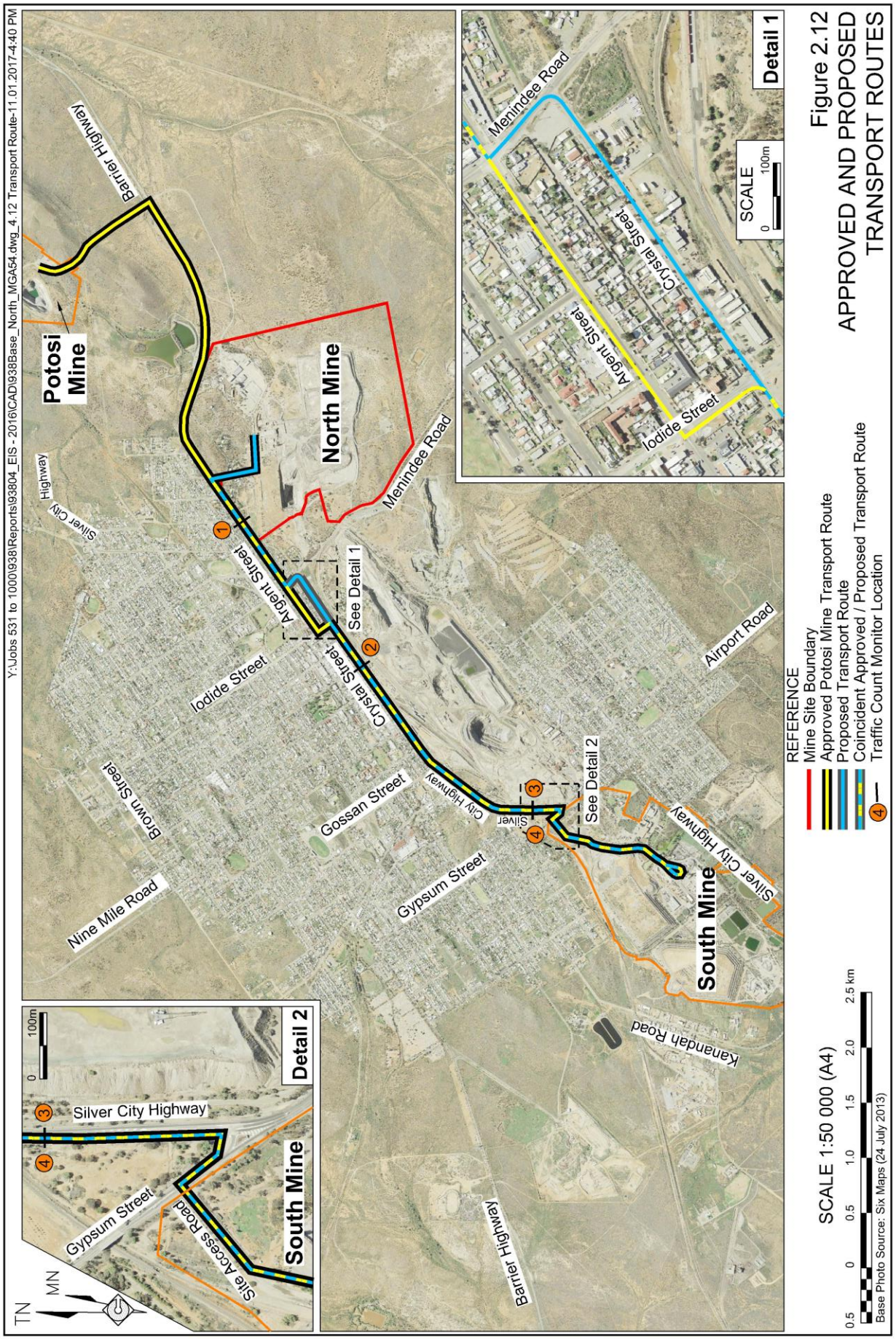
- Potosi Mine Site Access Road.
- Barrier Highway.
- Iodide Street/Silver City Highway.
- Crystal Street/Silver City Highway.
- Gypsum Street.
- Southern Operations Mine Site.

Proposed Transport Route

The proposed transport route would largely be the same as the approved Potosi Mine Transport Route, with the exception of an approximately 660m section of Menindee Road and Crystal Street. In summary, the proposed transport route would be as follows.

- North Mine Site Access Road.
- Barrier Highway.
- Menindee Road.
- Crystal Street/Silver City Highway.
- Gypsum Street.
- Southern Operations Mine Site.

The use of A-double Road Trains on the proposed amended route has been assessed by the Roads and Maritime Service and the required Class 2 – Heavy Vehicle Authorisation Permit has been issued (**Appendix 4**).


Y:\Jobs 531 to 1000\938\Reports\93804_EIS - 2016\CAD\938Base_North_MGA54.dwg_4.12 Transport Route-11.01.2017-4:40 PM
Potosi Mine
North Mine
South Mine
Barrier Highway
Silver City Highway
Menindee Road
Argent Street
Crystal Street
Iodide Street
Brown Street
Nine Mile Road
Gossan Street
Gypsum Street
Airport Road
Kanandah Road
Site Access Road
See Detail 1
See Detail 2
Detail 1
Detail 2
SCALE 0 100m
REFERENCE
Mine Site Boundary
Approved Potosi Mine Transport Route
Proposed Transport Route
Coincident Approved / Proposed Transport Route
Traffic Count Monitor Location
SCALE 1:50 000 (A4)
0.5 0 0.5 1.0 1.5 2.0 2.5 km
Base Photo Source: Six Maps (24 July 2013)
TN MN
Figure 2.12
APPROVED AND PROPOSED TRANSPORT ROUTES

Finally, the Applicant notes that the proposed transport route would apply only to vehicles transporting crushed ore. A range of other light and heavy vehicles would access the Mine Site, including employee's vehicles and delivery vehicles transporting equipment and consumables. These vehicles would predominantly access the Mine Site from the west, however, limited numbers of vehicles may access the Mine Site from the east. The routes taken by these vehicles would depend on the location within Broken Hill where their journey commenced and the Applicant does not propose to restrict the routes that such vehicles may use.

2.7.4.4 Existing Road Environment

Tonkin (2016) undertook an assessment of the section of the proposed transport route within the public road network. The following presents an overview of the findings of that assessment.

Barrier Highway – Site Access Road to Menindee Road

The Barrier Highway is a sealed, single carriageway (one lane in each direction), State Road (controlled and funded by RMS). The sign posted speed limit is 50km/h. This road forms the principal connection between Broken Hill and locations to the east, including Wilcannia, Cobar and Sydney.

The road is gazetted for A-double Road Trains operating under General Mass Limits and Higher Mass Limits.

The intersection between the Site Access Road and the Barrier Highway is controlled by a Give Way signs, with the Highway having priority. A left-turn lane protected by a raised traffic island is present for vehicles turning left out of the Site Access Road. Tonkin (2016) state that the sight distances at the intersection is adequate for the 50km/h speed limit.

Menindee Road – Barrier Highway to Crystal Street

This road is a sealed, single carriageway Regional Road (controlled by Broken Hill City Council and funded in part by RMS). The sign posted speed limit is 50km/h.

The road is gazetted for A-double Road Trains operating under GML only. Notwithstanding this, a Class 2 – Heavy Vehicle Authorisation Permit for Road Trains operating at Higher Mass Limits is held for this road (**Appendix 4**).

The intersection between the Barrier Highway and Menindee Road is concrete sealed, with a Give Way sign providing Barrier Highway traffic with priority.

The intersection between Menindee Road and Crystal Street is bitumen sealed, with a Give Way sign providing Menindee Road traffic with priority.

Crystal Street – Menindee Road to Gypsum Street

This road is a sealed, single carriageway road. The section of Crystal Street from Menindee Road to Iodide Street is a local road (managed and funded by Broken Hill City Council), while the section from Iodide Street to Gypsum Street is a State Road, forming a section of the Silver City Highway. The sign posted speed limit is 50km/h.

The section of this road from Menindee Road to Iodide Street is gazetted for A-double Road Trains operating under GML only. Notwithstanding this, a Class 2 – Heavy Vehicle Authorisation Permit for Road Trains operating at higher mass limits is held for this section of the road. By contrast, the section of Crystal Street from Iodide Street to Gypsum Street is gazetted for A-double Road Trains operating under General and Higher Mass Limits.

The intersection between Crystal Street and Gypsum Street is a channelized intersection, with a dedicated right hand turn lane into Gypsum Street and a left hand slip lane for traffic turning left out of Gypsum Street. The section of the intersection within the Silver City Road alignment is concrete sealed, with the remainder of the intersection within Gypsum Street bitumen sealed.

Gypsum Street – Crystal Street to Southern Operations site entrance

This road is a sealed, single carriageway local road.

Gypsum Street is not gazetted for Road Trains. Notwithstanding this, a Class 2 – Heavy Vehicle Authorisation Permit for Road Trains operating at Higher Mass Limits is held for this road (**Appendix 4**).

The intersection between Gypsum Street and the Southern Operations site entrance is bitumen sealed, with traffic islands in both Gypsum Street and the site entrance controlling traffic. A Give Way sign and broken painted line providing Gypsum Street traffic with priority.

The sign posted speed limit on Gypsum Street is 50km/h.

Proposed Works and Contributions

Tonkin (2016) presents a range of recommendations in relation to modifications to the existing road network. The Applicant would implement the following works in consultation with Broken Hill City Council and / or Roads and Maritime Service.

- Intersection of the North Mine Site Access Road and the Barrier Highway.
  - The proposed modifications are presented on **Figure 2.11** and are described in Section 2.7.3.2.
- Intersection of Gypsum Street – Crystal Street.
  - Widen the formation and seal of the left-turn lane from Gypsum Street to Crystal Street / Silver City Highway.
  - Broken Hill City Council has previously identified the surface of this intersection as an issue of concern for Council. The Applicant would enter into negotiations with Council as part a Voluntary Planning Agreement or consent condition in relation to Council's proposed upgrade of this intersection.
- Intersection of Menindee Road and Crystal Street.
  - Relocate the painted Give Way line for traffic turning left out of Crystal Street.

Finally, the Applicant would negotiate a Voluntary Planning Agreement in relation to maintenance of that section of the proposed transport route that is classified as a "Local Road", namely the section of Crystal Street between the intersection with Menindee Road and Iodide

Street. Maintenance of other sections of the proposed transport route that are classified as "Regional" or "State" roads is the responsibility of the Roads and Maritime Service and Broken Hill City Council.

2.7.4.5 Traffic Levels

Table 2.8 presents the anticipated traffic levels that would be generated by the Proposal, assuming the use of A-double Road Trains operating at Higher Mass Limits.

Table 2.8
Proposed Maximum Traffic Levels

Vehicle Type	Maximum Movements per day
Light vehicles	140 trips or 280 movements
Heavy Vehicles (non-ore transportation)	2 loads or 4 movements
Heavy Vehicles (ore transportation)	32 loads or 64 movement (maximum) 16 loads or 32 movement (average)
Source: Perilya Broken Hill Limited	

2.8 WATER MANAGEMENT

2.8.1 Introduction

Management of water within the Mine Site will be a critical aspect of the Proposal. Section 4.1.2 describes the topography and drainage and climate surrounding the Mine Site. This subsection describes the various classes of water that occur within the Mine Site, the topography and drainage within the Mine Site, as well as the existing and proposed surface water and groundwater management measures that would be implemented. The subsection concludes with a detailed water balance for the Proposal.

2.8.2 Classes of Water

The Proposal would include four principal classes of water as follows.

- Clean water – water that enters the Mine Site from surrounding lands or run off from undisturbed sections of the Mine Site. This water is permitted to pass through the Mine Site without mixing with other classes of water.
- Dirty or sediment-laden water – surface water runoff from disturbed or active sections of the Mine Site with the potential to contain suspended sediment but is unlikely to contain elevated dissolved solids. This water would be used for mining-related purposes, including dust suppression and would only be permitted to be discharged following testing to confirm acceptable water quality.
- Produced water – water pumped from the underground workings with the potential to contain elevated concentrations of dissolved solids. This water would be transferred to the Southern Operations for use in processing operations or would be managed through the proposed on-site evaporation ponds.

- Raw water – this water would be transported to site via an existing pipeline under a commercial arrangement with Essential Water. The water would be used for ablutions, dust suppression, including on the mobile crushing plant, within the underground mine and for manufacturing paste fill.

2.8.3 Surface Water Environment and Management

2.8.3.1 Introduction

Section 4.1.2 presents a description of the regional and local topography and drainage surrounding the Mine Site. This subsection provides a description of the existing Mine Site topography and drainage and should be read in conjunction with Section 4.1.2. This subsection also describes the existing surface water management measures employed by the Applicant, as well as the additional measures that would be implemented. An assessment of the anticipated surface water-related impacts is provided in Section 4.7.

2.8.3.2 Existing Mine Site Topography

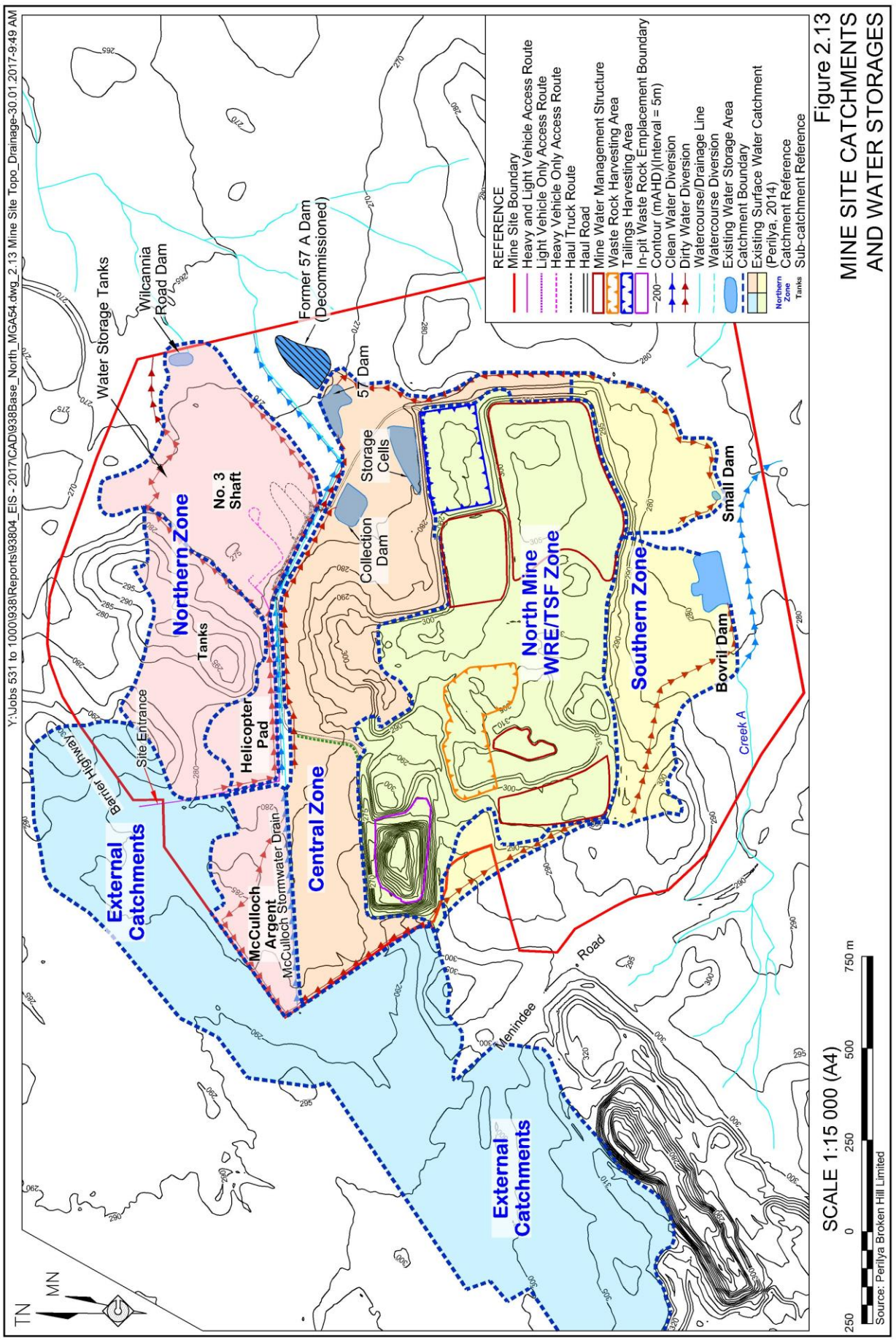
Figure 2.13 presents the existing topography and drainage within and immediately surrounding the Mine Site. In summary, a number of small hills dominate the northern, eastern and southwestern sections of the Mine Site, with maximum elevations of 290m AHD to 305m AHD. Undisturbed sections of the Mine Site between these hills typically have elevations ranging between 270m AHD to 290m AHD. The lowest undisturbed section of the Mine Site occurs in the vicinity of the Wilcannia Road Dam, with an elevation of approximately 267m AHD

The Mine Site has been the subject of substantial mining operations since 1883, with the pre-existing topography extensively modified. In summary, a range of waste rock emplacements and tailings storage facilities within the central section of the Mine Site, with maximum elevations varying between 300m AHD and 315m AHD. The floor of the Cosmopolitan Open Cut is the lowest point of the Mine Site, with an elevation of approximately 220m AHD.

2.8.3.3 Existing Mine Site Drainage and Surface Water Management

Information Source

Information presented in this subsection has been largely drawn from a document entitled *EPL2683 Pollution Reduction Program – 100-year ARI Assessment – North Mine (Broken Hill)* prepared by the Applicant and dated June 2014. This document, referred hereafter as Perilya (2014), was prepared in satisfaction of the requirements of a Pollution Reduction Program identified under EPL2683. Subsequent to preparation of Perilya (2014), a range of conditions were added to EPL2683 requiring completion of a range of measures identified in that document. Those conditions were removed on 22 July 2015, noting completion of each requirement. Perilya (2014) is presented as **Appendix 5**.


Y:\Jobs 531 to 1000\938\Reports\93804_EIS - 2017\CAD\938Base_North_MGA54.dwg_2.13 Mine Site Topo_Drainage-30.01.2017-9:49 AM
REFERENCE
Mine Site Boundary
Heavy and Light Vehicle Access Route
Light Vehicle Only Access Route
Heavy Vehicle Only Access Route
Haul Truck Route
Haul Road
Mine Water Management Structure
Waste Rock Harvesting Area
Tailings Harvesting Area
In-pit Waste Rock Emplacement Boundary
Contour (mAHD)(Interval = 5m)
Clean Water Diversion
Dirty Water Diversion
Watercourse/Drainage Line
Watercourse Diversion
Existing Water Storage Area
Catchment Boundary
Existing Surface Water Catchment (Perilya, 2014)
Catchment Reference
Sub-catchment Reference
Northern Zone
Tanks
Water Storage Tanks
Wilcannia Road Dam
Former 57 A Dam (Decommissioned)
57 Dam
Storage Cells
Collection Dam
No. 3 Shaft
Northern Zone
Tanks
Helicopter Pad
Site Entrance
Barrier Highway
External Catchments
McCulloch Argent
McCulloch Stormwater Drain
Central Zone
North Mine WRE/TSF Zone
Small Dam
Southern Zone
Bovril Dam
Creek A
Road
Menindee
External Catchments
TN
MN
SCALE 1:15 000 (A4)
0
250
500
750 m
250
Source: Perilya Broken Hill Limited
Figure 2.13
MINE SITE CATCHMENTS AND WATER STORAGES

Mine Site Drainage

Figure 2.13 presents the existing Mine Site drainage. In summary, drainage within the Mine Site has been substantially modified as a result of mining-related activities. The following presents an overview of the drainage and catchments within the Mine Site.

Two clean water drainages exist within the Mine Site as follows.

- McCulloch Stormwater Drain – this structure collects water from the urban area to the west and north of the Mine Site and conveys it to the east through the Mine Site via a buried stormwater pipe (west of the Site Access Road) and a lined channel (east of the Site Access Road). The lined channel is separated from the disturbed sections of the Mine Site and clean and dirty water are not permitted to mix. Clean water discharges from the channel to natural drainage to the east of the Mine Site.
- Creek A – an unnamed watercourse, referred to hereafter as Creek A, occurs within the southern section of the Mine Site. This watercourse drains an area to the west of Menindee Road and conveys that water to the east and southeast, exiting the Mine Site at the southern boundary. A short section of the watercourse has been diverted to prevent mixing of clean and dirty water within the Bovril Dam.

Dirty Water Catchments and Storages

Four dirty water catchments and a range of sub-catchments occur within the Mine Site as follows.

- Northern Zone – comprising an area to the north of the McCulloch Stormwater Drain. The Northern Zone comprises four sub-catchments as follows.
  - McCulloch / Argent Sub-catchment – comprising an area to the west of the Site Access Road and north of the McCulloch Stormwater Drain. This sub-catchment drains to a number of shallow depressions where stormwater is permitted to evaporate.
  - Helicopter Pad and Tanks Sub-catchment – comprising an area to the east of the Site Access Road and north of a dirty water diversion. This sub-catchment also drains to a number of shallow depressions where stormwater is permitted to evaporate. The dirty water diversion prevents potentially sediment-laden water entering the open McCulloch Stormwater Drain and directs limited volumes of such water to the No. 3 Shaft Sub-catchment.
  - No. 3 Shaft Sub-catchment – comprising the disturbed area surrounding the No. 3 Shaft and associated infrastructure. Potentially sediment-laden water within this sub-catchment is directed by one of two dirty water diversions to the Wilcannia Road Dam.
- Central Zone – comprising the area to the south of the McCulloch Stormwater Drain and north of the North Mine WRE/TSF Zone. A small section of this zone also occurs to the east of the North Mine WRE/TSF Zone and west of a dirty

water diversion. Potentially sediment-laden water within this sub-catchment is directed to the Collection Dam and/or the 57 Dam. If required, water from these storages may be pumped to a series of Storage Cells. The former 57A Dam previously formed a component of this catchment. That dam has, however, been decommissioned and no longer forms a component of this catchment.

- North Mine WRE/TSF Zone – comprising the existing waste rock emplacements, tailings storage facilities and the Cosmopolitan Open Cut. Perilya (2014) states that this catchment in internally draining. In the event that surface water is discharged from this catchment, it would report to the Central or Southern Zones.
- Southern Zone – comprising an area to west and south of the North Mine WRE/TSF Zone. Potentially sediment-laden water within this sub-catchment is directed to the Bovril Dam or the Small Dam.

Perilya (2014) presents an assessment of the adequacy of the storage capacity of each of the above dirty water storages under a 1 in 100 year ARI storm event. That assessment may be summarised as follows.

- Each of the above catchments were identified and their areas and runoff coefficients were determined.
- Intensity-Frequency-Duration data for the Mine Site was obtained and this data was used to determine total rainfall runoff volume and peak discharge using an approach similar to the Rational Method.

Based on that assessment, Perilya (2014) determined that:

- the Collection, Small and Wilcannia Road Dams required enlargement; and
- a range of additional minor works were required to ensure the ongoing proper functioning of the surface water managements system.

Table 2.9 presents the estimated volume of each of the dirty water storages, as currently constructed, within the Mine Site.

EPL2683 was subsequently amended to require those works to be completed. On 22 July 2015, the licence was amended again to remove those requirements, noting that each had been completed.

Table 2.9
Estimated Dirty Water Storage Volumes

Storage (see **Figure 2.13**)	**Estimated Volume (ML)**
Wilcannia Road Dam	4.4
Collection Dam	8.8
57 Dam	6.5
Storage Cells	10.4
Bovril Dam	18.4
Total	**48.5**
Source: Perilya Broken Hill Limited	

2.8.3.4 Proposed Surface Water Management

The Proposal would not result in changes to the surface water catchments within the Mine Site. As a result, the Applicant does not propose to amend the existing surface water management infrastructure. In addition, the Applicant would ensure that the following surface water management measures are implemented throughout the life of the Proposal.

- Water accumulated within the Collection Dam and 57 Dam and the Storage Cells would be removed as soon as practicable after it has accumulated and used for mining-related purposes. The water would not be permitted to flow to natural drainage or be discharged.
- Surface water management infrastructure would be inspected regularly to ensure it continues to operate as intended.

2.8.4 Groundwater Environment and Management

2.8.4.1 Introduction

Section 2.3.1 describes the geological setting of the Mine Site. This subsection describes the authorities and licences held by the Applicant, the existing groundwater environment with the Mine Site, the proposed dewatering operations and the proposed produced water management strategy. An assessment of the anticipated groundwater-related impacts in accordance with the NSW Aquifer Interference Policy is provided in Section 4.8.4.

2.8.4.2 Groundwater Licences

The Mine Site is located within the area covered by the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources* and is located within the Adelaide Fold Belt MDB groundwater source. **Table 2.10** presents the works approvals and water access licences held for its various operations within Broken Hill. The Applicant holds licences to extract 1.466GL of groundwater per year.

Table 2.10
Groundwater Licences and Approvals

Location	Water Access Licence	Water Supply Works Approval	Allocation (ML/y)
South Mine	WAL40959	60WA582773	1 466
		60WA58779	
Potosi Mine		85WA753477	
White Leeds		60WA582777	
North Mine		60WA583325	
Source: Perilya Broken Hill Pty Ltd			

2.8.4.3 Existing Groundwater Environment

Aquifer properties

The Mine Site occurs within a fractured rock aquifer associated with the Willyama Supergroup. Groundwater within the aquifer is limited to fractures and faults within the surrounding rock

formation. Such fracture-hosted aquifers are typically "tight" and low yielding. Groundwater recharge occurs via recharge by direct rainfall in subcrop areas or via leakage from the regolith or colluvial deposits associated with ephemeral water courses.

Standing water level

The aquifer has been the subject of extensive dewatering since the commencement of mining operations in 1883. Following the cessation of mining operations within the Fitzpatrick Area, dewatering operations ceased in February 1998 and the standing water level within the North Mine workings has steadily increased since then. Dewatering operations were not required during the period 2003 to 2008 as mining operations were undertaken between 1 Levels and 12 Level, above the standing water level (**Figure 2.6**).

Table 2.11 presents the water level within the No. 3 Shaft since the cessation of pumping in February 1998. In summary, the standing water level within the mine has risen approximately 1 135m in approximately 19 years, or 16cm per day. However, since the installation of an automated logger in the No. 3 Shaft in July 2014, water levels have risen 59.2m at a constant rate of 6.4cm per day. The Applicant notes that the apparent reduction in the rate of rise of the standing water level is likely to be a function of the fact that the workings in the deeper sections of the mine are substantially less extensive than the workings in the higher sections of the mine.

It is noted that as all workings within the North Mine are interconnected, the standing water level within the North Mine is considered by the Applicant to be representative of the water level throughout the remainder of the workings.

Table 2.11
Standing Water Levels within the No. 3 Shaft

Date	Standing Water Level (m BGL)
6 January 2017	579.2
10 October 2016	585.8
15 January 2016	610
20 July 2014	638.4
August 2011	724
February 1998	1 714
Note: m BGL = metres below ground level	
Source: Perilya Broken Hill Limited	

Water quality

The Applicant engaged C.M. Jewell & Associates Pty Ltd to prepare an assessment of the quality of water within the No. 3 Shaft. That report, referred to hereafter as Jewell (2011), is presented as **Appendix 6**. In summary, the groundwater assessment comprised:

- a video and physiochemical survey of the shaft from the surface to a depth of 1 176.3m; and
- collection and analysis of three samples at depths of 780m, 970m and 1 160m BGL.

Table 2.12 summarises the results of the video and physiochemical survey and **Table 2.13** presents the results of analysis of the three samples collected.

Table 2.12
Results of the Video and Physiochemical Survey

Depth (m below surface)	Resistivity (ohm/m)	Conductivity (mS/m)	Temperature (ºC)	Comment
724.4m – 758m	0.30	<800	Not stated	This upper layer was interpreted to reflect slightly less saline water sourced from surface water inflows.
758m – 1176.3m	-0.18 to -0.20	12 000 to 13 000	29	This layer was fairly uniform, without any evidence of significant stratification of the water within the shaft.
Source: Jewell (2011) – After Sections 4.2 and 5.1				

Table 2.13
Water Quality Analysis Results

Analyte	Units	Limit of Reporting	Adopted Criteria[1]	Analytical Results		
				780m bgl	970m bgl	1160m bgl
Physio-chemical Parameters						
pH	pH units	0.01	6.5 – 7.5	6.91	6.68	6.63
Electrical conductivity	µS/cm	0.1		≈ 12 972	≈ 12 833	≈ 12 698
TDS and TSS						
Total Dissolved Solids	mg/L	5	500	**6 470**	**8 200**	**8 610**
Total Suspended Solids	mg/L	5		98	32	33
Major Anions and Cations						
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1		76	67	67
Carbonate Alkalinity as $CaCO_3$	mg/L	1		<1	<1	<1
Hydroxide Alkalinity as $CaCO_3$	mg/L	1		<1	<1	<1
Total Alkalinity as $CaCO_3$	mg/L	1		76	67	67
Sulfate as SO_4	mg/L	1	500	**2140**	**2620**	**2560**
Chloride	mg/L	1	250	**1660**	**2220**	**2780**
Calcium	mg/L	1		518	682	728
Magnesium	mg/L	1		168	214	238
Potassium	mg/	1		48	62	67
Sodium	mg/L	1	180	**1390**	**1690**	**1870**
Heavy Metals						
Arsenic	mg/L	0.001	0.007	**0.073**	**0.099**	**0.098**
Cadmium	mg/L	0.0001	0.0002	**0.0101**	**0.0092**	**0.0101**
Chromium	mg/L	0.001	0.1	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0014	**0.005**	**0.006**	**0.006**
Iron	mg/L	0.05	0.3	**23.8**	**29.7**	**29**
Lead	mg/L	0.001	0.0034	**0.082**	**0.167**	**0.198**

Table 2.13 (Cont'd)
Water Quality Analysis Results

Analyte	Units	Limit of Reporting	Adopted Criteria[1]	Analytical Results		
				WC: 780	WC: 970	WC: 1160
Heavy Metals (Cont'd)						
Manganese	mg/L	0.001	0.5	**107**	**112**	**112**
Nickel	mg/L	0.001	0.011	**0.151**	**0.171**	**0.171**
Silver	mg/L	0.001	0.00005	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.008	**35.7**	**38.8**	**39**
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0001	<0.0001
Trivalent Chromium	mg/L	0.01		<0.01	<0.01	<0.01
Hexavalent Chromium	mg/L	0.01	0.001	<0.010	<0.010	<0.010
Sulfide						
Sulfide as S2	mg/L	0.1		<0.1	<0.1	<0.1
Ionic Balance						
Total Anions	meq/L[2]	0.01		92.9	118	133
Total Cations	meq/L[2]	0.01		101	127	13
Ionic Balance	%	0.01		4.36	3.36	2.17
Oil and Grease						
Oil and Grease	mg/L	5		<5	<5	<5

Note 1: Adopted Criteria based on a combination of the Australian Drinking Water Guidelines (aesthetic and health criteria) and ANZECC (2000) (Trigger Values for the Protection of 95% of species in Freshwater and agricultural irrigation

Note 2: meq/L = milliequivalents per litre

Note 3: Figures in **Bold** exceed the adopted criterion

Source: Jewell (2011) – Table 5

In summary, groundwater within the No. 3 Shaft, and by extension, within the remainder of the North Mine workings has a near neutral pH with elevated concentrations of dissolved solids and some metals, including arsenic, cadmium, copper, iron, lead, manganese and zinc. The water does not meet the criteria for discharge to natural drainage.

Contained water volume

The Applicant notes that as the standing water level within the North Mine workings has risen, each of the remaining voids and backfilled stopes has been filled with water. Given the uncertainty in relation to the extent of some older workings, as well as the nature of the fill used to back fill some stopes, it is not possible to accurately estimate the volume of water contained with the existing workings. As a result, based on available survey and production records, the Applicant anticipates that the workings contain between 1GL and 2GL of water that would need to be removed to permit mining below the standing water level of 585.8m BGL.

Estimated groundwater inflows

Dewatering operations within the North Mine ceased in February 1998. Pumping rates for water removed from the mine and transferred into the mine to enable an accurate estimate of groundwater inflows are no longer available. However, between that date and the date of

finalisation of this document, approximately 1GL to 2GL of water has flowed into the workings. Assuming that that flow has occurred at a constant rate, the rate of inflow would be expected to be between 55ML/year and 110ML/year. However, it is likely that groundwater inflows to the workings would have been higher initially when the groundwater gradient within the surrounding aquifer was steeper. As a result, a reasonable estimate of groundwater flow into the workings following the cessation of mining operations may be double the average inflow suggesting that the rate of groundwater inflow may have been as high as 110ML/year to 220ML/year.

The estimated rates of groundwater inflow may also be compared with the estimated rates of inflow at the following operations.

- Southern Operations ..... 470ML/year.
- Rasp Mine..... 725ML/year.

2.8.4.4 Existing Dewatering and Groundwater Transfer Operations

The proposed dewatering operations were the subject of a *Discussion Paper* prepared by RWC on behalf of the Applicant in January 2016. That *Discussion Paper* proposed the following activities.

- Dewatering of the North Mine workings using a submersible pump installed in the No. 3 Shaft.
- Transfer of that water via an existing services corridor from the Mine Site to the Applicant's Southern Operations.
- Use of that water within the Southern Operations for mining-related purposes.

The *Discussion Paper* was circulated to the following government agencies by way of consultation.

- Broken Hill City Council.
- Division of Resources and Energy.
- Essential Water.
- Environment Protection Authority.
- DPI-Water.

Each of the above agencies provided feedback on the proposed arrangement and, based on that feedback, it was determined that:

- the proposed dewatering operations were an activity that was permissible under the Applicant's Consolidated Mining Leases;
- the construction and use of a pipeline on a Mining Lease was complying development for which an application for a Complying Development certificate from Broken Hill City Council was required; and
- importation and use of water to the Southern Operations Mine Site was consistent with the Applicants Continuing Use Rights for that site.

An application for a Complying Development certificate was submitted to Broken Hill City Council on 2 May 2016. Determination of that application was awaited at the time of finalisation of this document.

2.8.4.5 Proposed Dewatering Operations

Introduction

Following a detailed engineering and metallurgical review of the existing dewatering operations, the Applicant determined that use of water from the North Mine workings, in particular the elevated concentration of dissolved solids, would be likely to have an adverse impact on processing operations at the Southern Operations. As a result, significant treatment of that water would be required to permit its use for processing operations.

In light of the above, the Applicant proposes to undertake dewatering operations as identified in the previous subsection, with produced water to be managed through a combination of use within the Southern Operations processing plant and management on site using the existing Mine Water Settling Pond and three proposed evaporation ponds (**Figure 2.1**). This subsection describes, for the sake of completeness, the existing permissible dewatering activities, as well as the design, construction and operation of the proposed evaporation ponds.

Proposed dewatering activities

In order to extract water from the North Mine workings, the Applicant proposes to install the following infrastructure in the No. 3 Shaft.

- A submersible pump and associated electrical and control infrastructure.
- A riser pipe to convey water to the surface.
- In-shaft infrastructure, including support structures and outer casing to protect the pump and pipework.
- Surface infrastructure, including pipework and existing storage tanks.

No substantial changes would be made to items of heritage significance, including the No. 3 Shaft headframe.

The Applicant proposes to install a pump that would be capable of removing water from the workings at a rate of approximately 30L/s. However, the actual extraction rate would be determined based on the following.

- The standing water level is lowered sufficiently slowly to ensure that voids and backfilled stopes to be evenly dewatered. In the event that dewatering operations are undertaken too quickly, perched water-filled stopes may develop, resulting in sudden inrush of water and resulting in a potential hazard to workers and potential damage to infrastructure. In an extreme case, backfill material may be washed out of a stope, creating geotechnical stability issues.
- The produced water would be adequately managed at surface, with the rate controlled by the rate at which the water may be used at the Southern Operations or the evaporation rate within the proposed evaporation ponds.

- The standing water level is below the level of the initial mining operations. However, **Table 2.3** presents the maximum depth of mining throughout the life of the Proposal. Based on that information, the Applicant would remove all water from the workings by midway through Year 9 when mining operations would be expected to reach the depth extent of the previous workings.

Based on a worst case assumption of a contained volume of 2GL and annual inflows of 220ML, the Applicant would be required to remove approximately 4GL of water from the Mine over a 9.5 year period, resulting in an annual extraction rate of approximately 423ML.

The Applicant holds water access licences that permit extraction of up to 1.466GL of groundwater per year. The Applicant would ensure that groundwater extraction rates from its combined operations are less that the licenced volume.

Design Criteria for the Evaporation Ponds

Section 4.1.3.3 presents an overview of rainfall and evaporation data for Broken Hill. In summary, mean annual rainfall is 259.8mm per year and mean annual evaporation is 2 581mm per year, a differential of 2 321mm. Mean monthly evaporation exceeds mean rainfall in all months by between 50mm and 365mm.

In order to facilitate management of the produced water, the Applicant proposes to construct three evaporation ponds and to use the existing Mine Water Settling Pond (**Figures 2.9** and **2.10**). **Table 2.14** presents the design criteria for each of the proposed structures. In addition, the Applicant would ensure that each of the proposed evaporation ponds is operated in a manner that would ensure a minimum freeboard of 500mm. This freeboard is approximately twice the maximum monthly rainfall of 258mm recorded in Broken Hill between 1889 and 2015.

Table 2.14
Evaporation Pond Design Criteria

Structure	Area (ha)	Lining	Maximum Monthly Evaporation (ML)[1]	Minimum Monthly Evaporation (ML)[2]	Annual Evaporation (ML)[3]
Mine Water Settling Pond	0.8	Welded HDPE liner	2.9	0.4	18.6
Evaporation Pond 1	3.3		12.0	1.7	76.6
Evaporation Pond 2	4.0		14.6	2.0	92.8
Evaporation Pond 3	12.1		44.2	6.1	280.8
Total	**20.2**		**73.7**	**10.1**	**468.8**

Note 1: Assuming maximum mean monthly net evaporation of 365mm
Note 2: Assuming minimum mean monthly net evaporation of 50mm
Note 3: Assuming mean annual net evaporation of 2 321mm

Construction of the Evaporation Ponds

Construction of the proposed evaporation ponds would be completed prior to the commencement of dewatering operations. In summary, the footprint of each of the ponds would be prepared initially to create a flat area suitable for establishing the liner. In the case of the

Evaporation Pond 1, this would require establishment of a series of cascading ponds to allow for the approximately 6m fall from the northern end of the structure to the southern end. Structures would be installed to control the flow from one pond to the next to prevent overtopping of the lowermost pond as a result of a rainfall event. In the case of Evaporation Ponds 2 and 3, earthworks would be required to level the slightly domed surface of the ponds. Limited earthworks would be required within the Mine Water Settling Pond as this structure has previously been used for dewatering purposes.

Following completion of the shaping and contouring of the Evaporation Ponds, the Applicant would prepare the base for the HPDE liner in accordance with the requirements of the supplier of the liner, prior to installation of the liner itself. The integrity of the liner would be confirmed by the supplier prior to the proposed evaporation ponds being commissioned.

Operation of the Evaporation Ponds

The proposed evaporation ponds would be operated in a manner that would ensure that the maximum rate of evaporation is achieved. In summary, this would involve maintaining the ponds at a relatively shallow depth that completely covers the base of the structure. The rate of inflow would be managed through automatic shut-off valves to ensure that the minimum freeboard of 500mm is maintained at all times.

Assuming a total volume of groundwater to be removed of 4GL, **Table 2.15** presents the estimate volume and thickness of precipitated solids that would accumulate within the proposed evaporation ponds. In summary, approximately 9cm of precipitated salt would be expected to accumulate over the life of the Proposal. As this thickness is too thin to be removed without damaging the liner the accumulated salt would remain within the proposed evaporation ponds until they are decommissioned.

Table 2.15
Estimated Volume of Precipitates

	Units	
Volume of water to be removed	GL	4.0
Concentration of dissolved solids	mg/l	7 750
Tonnes of contained salt	t	31 000
Assumed density	t/m^3	1.7
Volume of precipitated salt	m^3	18 235
Area of proposed evaporation ponds	m^2	202 000
Approximate thickness of accumulated salt	cm	9

Transfer of Produced Water to the Potosi Mine

In the alternative, the Applicant may seek development consent to transfer produced water from the Mine Site to the Potosi Mine workings. This would result in re-injection of produced water into the fractured rock aquifer. However, assessment of this Proposal is beyond the scope of this application. As a result, transfer of produced water would only be undertaken following receipt of all required approvals, including:

- a modification to DA448-2004 to permit importation and re-injection of produced water; and
- all required *Water Management Act 2000* approvals.

2.8.5 Water Balance

2.8.5.1 Operational Water Circuits

Figure 2.14 presents a conceptual water balance for the Mine Site. In summary, three water circuits would operate within the Mine Site as follows.

Raw Water Circuit

The Raw Water Circuit would provide raw water under a commercial arrangement with Essential Water for those operations for which dirty or produced water would not be suitable. In summary, these would include the following uses and the consequences of the use of produced water.

- Dust suppression on the mobile crusher. Use of produced water on the mobile crusher would result in unacceptable levels of corrosion of the plant.
- Dust suppression generally around the Mine Site using a water cart when raw water is not available. Use of produced water may result in elevated salt levels accumulating within the surface sediments, with potential adverse outcomes during rehabilitation or discharge events.
- Mixing with tailings and binder in the Paste Fill Plant. Use of produced water would adversely impact on curing of the paste.
- Use for ablutions. Use of produced water may have the potential to adversely impact on human health.
- Mining-purposes underground where the use of produced water would not be practicable.

Produced Water Circuit

The Produced Water Circuit would remove groundwater from the mine to permit mining operations. The water may be used in either processing operations at the Southern Operations or would be managed within the Mine Site, including use in limited quantities for mining-purposes underground.

Dirty Water Circuit

The Dirty Water Circuit would receive surface water following rainfall events. Water accumulated within the Northern and Central Zones would be used for dust suppression during crushing operations and generally around the Mine Site. Dirty water, when available, would be used in preference to Raw Water.

2.8.5.2 Water Balance

Table 2.16 presents the water balance for the each of the operational water circuits throughout the life of the Proposal.

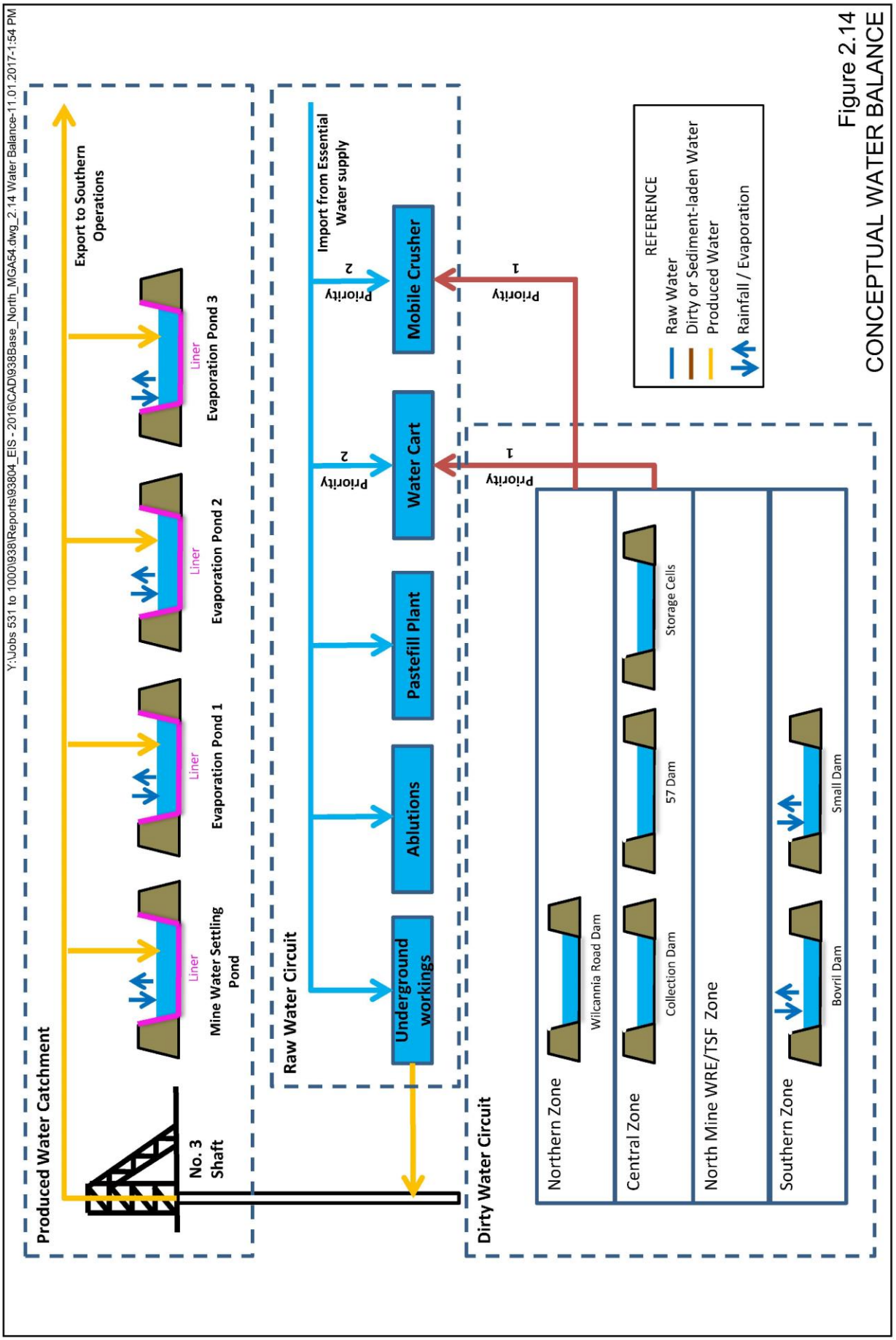

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Figure 2.14
CONCEPTUAL WATER BALANCE
REFERENCE
Raw Water
Dirty or Sediment-laden Water
Produced Water
Rainfall / Evaporation
Produced Water Catchment
Export to Southern Operations
No. 3 Shaft
Mine Water Settling Pond
Liner
Evaporation Pond 1
Evaporation Pond 2
Evaporation Pond 3
Raw Water Circuit
Import from Essential Water supply
Underground workings
Ablutions
Pastefill Plant
Water Cart
Mobile Crusher
Priority 1
Priority 2
Dirty Water Circuit
Northern Zone
Central Zone
North Mine WRE/TSF Zone
Southern Zone
Wilcannia Road Dam
Collection Dam
57 Dam
Storage Cells
Bovril Dam
Small Dam

Table 2.16
Water Balance

Water Source		Water Destination	
Annual Volume	**Comment**	**Annual Volume**	**Comment**
Raw Water Circuit			
Approximately 36ML	Purchased from Essential Water.	Approximately 36ML	Used for tasks for which Produced Water is not suitable or when Dirty Water is not available.
Produced Water Circuit			
Between 200ML and 500ML	Contained water within the existing workings, plus inflow once dewatering operations recommence.	up to 500ML	Transferred to the Southern Operations or managed within the proposed evaporation ponds.
Dirty Water Circuit			
Variable	Water accumulated within the dirty water management dams.	Variable	Northern and Central Zones – used for dust suppression. Southern Zone – permitted to evaporate. No discharge to a 1 in 100 year AEP event.

2.9 FACILITIES AND SERVICES

2.9.1 Facilities

Change House

As identified in Section 2.2.4, the Applicant would re-establish employee and contractor facilities within the Change House (**Figure 2.3** and **Plate 2.4**). These facilities would include the following.

- Male and female change rooms and showers, with clean and dirty areas.
- Toilet and hand washing facilities.
- Laundry facilities.

In summary, those personnel going underground or likely to be exposed to lead-contaminated materials would arrive on site, get undressed in the clean area of the change room, walk to the dirty area and get dressed in Applicant-supplied work clothes. At the end of each shift, these people would then remove all clothes with the potential to be contaminated with lead dust in the dirty area of the change room and shower before changing back into their own clothes. All potentially contaminated clothes would be laundered on site. This procedure has been the standard practice in Broken Hill for many years and the Change House has previously been used for this purpose.

The Applicant would upgrade the change room and laundry facilities that were previously used during the mining operations between 2003 and 2008. Consistent with the commitment in Section 2.2.4, sections of the Change House that were not used during that period would not be modified to ensure that their heritage significance is preserved.

Office and Store

The Applicant would also re-establish the Office and Store, including renewal of electrical and communications infrastructure, repainting and replacement of furniture and office equipment (**Figure 2.3** and **Plate 2.5**). This facility was previously used between 2003 and 2008 as the administration facility for the North Mine and the Applicant would re-instate this use.

Workshop

The Workshop would also be refurbished, including re-establishment of electrical, mechanical hydrocarbon storage, refuelling and other infrastructure (**Figure 2.3** and **Plate 2.6**). The Workshop has also been used for that purpose previously. The facility would be used to service and repair mobile and fixed plant.

Remaining Buildings

The remaining buildings would either continue to be used for the purposes for which they are currently used, including the Store and Core Sheds (**Plates 2.7** and **2.8**), or would not be used or disturbed for the Proposal, including the No. 3 Winder, Shaft and Crusher House and former Administration Complex.

2.9.2 Services

Electricity Supply

Power for electrical equipment within the Mine Site would continue to be provided by the 22kV transmission line from the Southern Operations. This underground feeder protection has been recently upgraded to meet current Australian Standards to facilitate the approved underground exploration activities.

Transmission of power within the Mine Site would continue to be via the existing overhead and buried transmission and distribution network.

The transmission network would continue to be maintained and upgraded as required to ensure the safe and efficient operation of the Mine.

Communications

External communications for site data and phone service would be provided via existing telephone lines, as well as via a combination of fibre optic and wireless technology.

Within the Mine Site, communications would be via the Applicant's two-way radio and a combination of landline and mobile telephone systems.

Hydrocarbons

All diesel fuel for mobile equipment operated by the Applicant would be stored in above ground tanks with a total indicative capacity of 30kL. These tanks would be self-bunded and located in the vicinity of the workshop. Bunding would be sized to meet the requirements of *AS 1940:2004 – Safe storage & handling of flammable & combustible liquid*s.

A sealed refuelling area would be located adjacent to the fuel bays, with all drainage directed to an oil/water separator. More mobile plant such as underground haul trucks, graders, front-end loaders and mine vehicles would utilise the refuelling areas. Less mobile plant such as underground loader and drill rigs (if diesel operated), would be refuelled at their work site using a mobile fuel tanker.

Static plant such as diesel operated generators and pumps would be refuelled using a mobile fuel tanker, with fuel tanks located within bunds with a capacity of at least 110% of the capacity of the fuel tank(s).

Any bulk oils, greases and waste oils would also be stored within a covered and bunded area within the workshop.

Finally, the Applicant would require the crushing contractor to refuel its equipment using industry best practice refuelling processes, including the use of a mobile fuel tanker. Fuel for the crushing operations would not be stored in a separate on-site diesel store.

Potable and Ablutions Water

Potable water and water for the ablutions facilities, would continue to be provided by the Broken Hill reticulated water system and managed by Essential Water.

Sewage and Waste Water

Sewage and waste water would continue to be removed from the site via the reticulated Broken Hill City Council-operated waste water system for treatment off site.

2.10 NON-PRODUCTION WASTE MANAGEMENT

2.10.1 Existing Mine Waste Facility

The Applicant currently operates the Existing Mine Waste Facility within the Mine Site (**Figures 2.1** and **2.9**). "Solid waste landfilling" is identified on EPL 2683 as a licenced activity. This application seeks development consent for the continued operation of that facility.

The Existing Mine Waste Facility is located in the southern section of the Mine Site, within a depression within the Waste Rock Emplacement. Material placed within the facility may be classified as General Solid Waste (non-putrescible) under Schedule 1 of the *Protection of the Environment Operations Act 1997*. In summary, the following types of wastes are placed within the facility. No waste is accepted from off site for placement within the facility.

- Ventilation bags, plastic and other consumables packaging, excluding packaging containing free liquids.
- Waste from underground, including timber supports for old workings and metal and other materials that cannot be recycled.

The following classes of waste are not and would not be placed within the facility. Management of these wastes is described in Section 2.10.2.

- Putrescible waste, including waste from crib rooms and offices that may contain food scraps. As the Applicant restricts the areas where food may be consumed, sources of putrescible waste are limited.
- Contaminated waste, including material contaminated with hydrocarbons.
- Liquid waste.
- Hazardous waste.
- Restricted solid waste.
- Special waste, including tyres.

2.10.2 Management of Non-production Wastes

The underlying principle for all non-production waste management would be to minimise waste generation, to recover, re-use and to recycle waste materials as much as possible, and to reduce environmental harm in accordance with the principles of ecologically sustainable development.

Table 2.17 lists the non-production wastes that would be generated throughout the life of the Proposal and briefly describes how each class of waste would be stored or managed on site and subsequently removed from the Mine Site.

2.11 PROPOSAL LIFE AND HOURS OF OPERATION

2.11.1 Hours of Operation

Table 2.18 presents the proposed hours of operation.

2.11.2 Life of the Proposal

The Applicant anticipates that Phase 1 to Phase 3 mining operations (see Section 2.3.5) would, based on known ore reserves, require approximately 16 years to complete. However, the Applicant anticipates that additional ore would be identified during mining operations. As a result, the Applicant proposed to undertake mining operations for a period of 25 years from the date of granting of development consent, with rehabilitation and mine closure activities expected to require a number of years following the completion of mining operations.

Table 2.17
Non-Production Waste Management

Waste Type	Storage	Removal Method	Anticipated Volume and Destination
General solid waste (non-putrescible)	Placed within the Mine Waste Facility.	Retained on site	Variable
General solid waste (putrescible)	Covered bins located within crib rooms and office areas. Where these bins would be located in open areas, they would be fitted with animal-proof lids.	Collected on a regular basis by licensed waste contractor and transported to a licensed waste disposal facility.	1 x 3m^3 skip per week to the Broken Hill Waste and Resource Recovery Facility.
Cardboard	A cardboard recycling skip within the workshop and paper recycling bins within the office area.	Collected as necessary by a licensed recycling contractor and transported to an appropriate recycling facility.	1 x 6m^3 skip per fortnight to the Broken Hill Waste and Resource Recovery Facility.
Waste oils and greases	Placed within bunded area(s) within or in the vicinity of the workshop areas.	Collected on a regular basis by a licensed waste contractor and transported to an appropriately licensed facility.	200L to 600L per week to the Broken Hill Waste and Resource Recovery Facility.
Oily water	All oily water would be collected in sumps (in the case of workshops and wash down bays) or in tanks (in the case of compressors and other plant).	All oily water would be passed through an oil-water separator, with the produced water used for mine-related purposes and the produced oily fraction added to the waste oil stream.	Variable volume to be treated onsite, with oily fraction added to the waste oil stream.
Batteries	Batteries would be placed within a covered and marked used battery storage area until removed from site.	Batteries would be collected as necessary by a licensed disposal contractor and recycled.	Variable volume to be removed by a scrap metal recycler.
Tyres	Tyres, where practicable, would be removed from site by the supplier. Where this is not possible, or temporary storage is required, tyres would be placed within a marked used tyre storage area until removed from site or used for another purpose.	Tyres would be removed from site for recycling, where practicable, or reused on site for construction of retaining walls, erosion protection, traffic control, etc.	Variable number to be removed by the supplier for recycling or for reuse.
Scrap Steel /Metal	Stored in a specified areas within the workshop area or elsewhere such as the laydown area, as required.	Collected as necessary by a scrap metal recycler.	Variable volume to be removed by a scrap metal recycler.
Source: Perilya Broken Hill Limited			

Table 2.18
Proposed Hours of Operation

Activity	Proposed Days of Operation	Proposed Hours of Operation
Surface site preparation activities	7 days per week during Year 1	Daylight hours
Underground site preparation activities	7 days per week	24 hours per day
Mining, paste production and stockpiling operations	7 days per week	24 hours per day
Crushing operations	7 days per week	7:00am to 7:00pm
Transportation operations	7 days per week	7:00am to 7:00pm
Tailings harvesting operations	7 days per week	7:00am to 7:00pm
Maintenance operations	7 days per week	24 hours per day
Rehabilitation operations	7 days per week	Daylight hours
Source: Perilya Broken Hill Limited		

2.12 EMPLOYMENT, CAPITAL COST AND ECONOMIC CONTRIBUTIONS

2.12.1 Employment

The Applicant anticipates that between 20 and 140 full time equivalent personnel would be required to operate the Mine. **Figure 2.15** presents the change in employment with time throughout the life of the Proposal. In summary, employment would increase from approximately 20 persons in Year 1 to 72 in Year 2 during the Phase 1 (Remediation and Restoration). As mining progressively develops the upper levels of the Mine during Phase 2, employment would gradually increase to approximately 100 persons. With the commencement of mining within the North Mine Deeps, a further increase to 140 persons would be required for Phase 3, before a decrease as production rates decrease in Years 15 and 16. However, in the event that further ore reserves are located and consent for ongoing mining operations is granted, employment levels beyond Year 16 would continue.

The Applicant notes that these positions would be likely to be made up of a combination of personnel progressively transferred from its existing operations and limited new positions. The Proposal would ensure the ongoing employment of a number of current employees who would otherwise not have a position as mining operations at the Potosi Mine wind up in the coming years.

Finally, the Applicant notes that positions would be offered on a residential basis, with fly in-fly out positions not offered. The Applicant notes that adequate housing exists within Broken Hill to accommodate the proposed workforce, particularly as the vast majority would already be residents of Broken Hill.

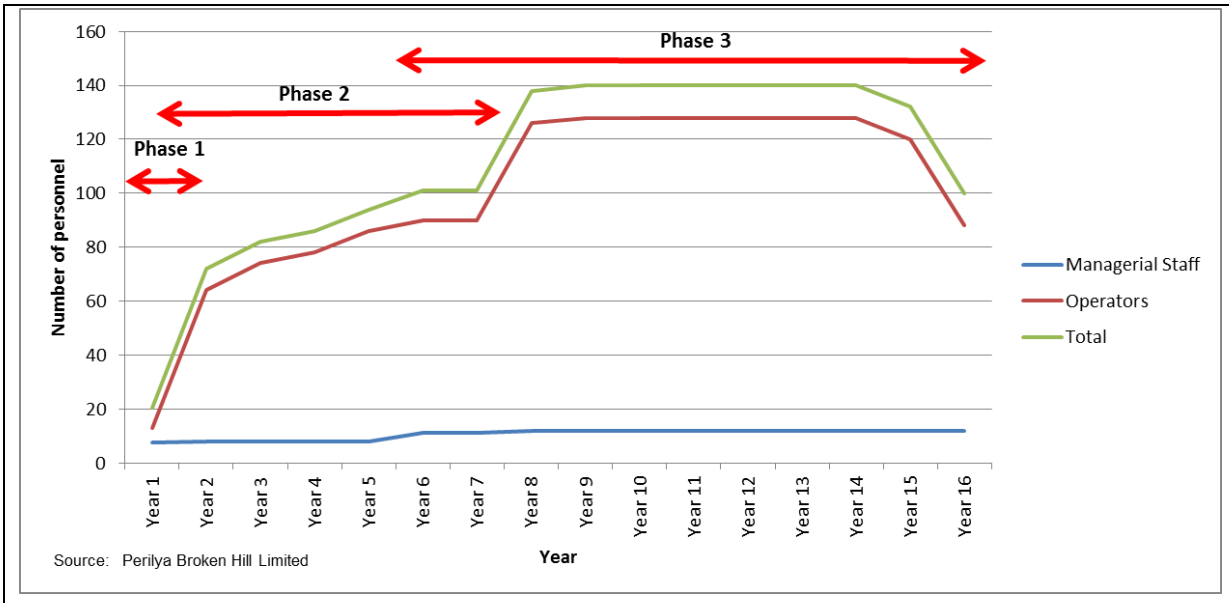

Figure 2.15
PROPOSED EMPLOYMENT

2.12.2 Capital Cost

The Applicant has undertaken a detailed assessment of the anticipated capital cost of the development. That assessment has assumed for the purpose of estimating the Capital Investment Value that all costs to refurbish and remediate the underground workings, including the cost of mobile plant, to the completion of Phase 1 – Remediation and Restoration should be considered. Capital costs associated with Phase 2 and 3 of the Proposal have been assumed to be operational costs and have not been considered when estimating the Capital Investment Value.

Table 2.19 provides an overview of the internal assessment undertaken by the Applicant. In summary, the Applicant anticipates that the Capital Investment Value to the end of Phase 1 would be approximately $39.4 million, comprising:

- $36.4 million for capital development (mining) during the initial 18 months of mining operations; and
- $17.7 million for capital expenditure (equipment) over the same period.

Table 2.19
Summary Capital Investment Value Estimate

Item	Value (A$ million)
Capital Development (Mining)	
Salaries and wages (during Phase 1 only)	8.1
Operating costs	28.3
Sub-total	**36.4**
Capital Expenditure (Equipment)	
Ancillary equipment	1.0
Fixed Plant	0.4
Electrical	1.6
Ventilation and egress	1.6
Ground support	0.5
Dewatering, including pumps	4.7
Mobile Plant	7.4
Sub-total	**17.2**
TOTAL	**53.6**

2.12.3 Ongoing Economic Contributions

The Applicant anticipates that that the Proposal's economic contributions would be between approximately between **$48** and **$98 million per year**. In summary, the Applicant anticipates that the Proposal would contribute the following annually.

- Wages and salaries.....between $9 and $20 million.
- Local and regional services and consumables.....between $24 and $68 million.

- National and international services and consumables . between $8 and $15 million.
- Local Government rates and contributions ..... between $0.6 and $0.85 million.
- State royalties, taxes and contributions ..... between $2.1 and $5.8 million.

Over the life of the Proposal, the Applicant anticipates that it will expend approximately **$1.1 billion** in both capital and operational expenditure.

The Applicant notes that the contributions through wages and salaries and local and regional services and consumables of between $33 million and $88 million would largely be retained within the Broken Hill community and would further support the economy of Broken Hill and ongoing employment of numerous, non-Mine personnel.

2.13 SITE REHABILITATION, DECOMMISSIONING AND MINE CLOSURE

2.13.1 Introduction and Mine Closure Considerations

The Applicant notes that the Mine Site has been the subject of mining operations since 1883. During that time, the original landform has been removed and replaced with an iconic, mining-related landform. In addition, the Mine Site includes abundant buildings and infrastructure with heritage and cultural significance to both the local Broken Hill and wider community. The Mine Site has also been the site of very significant historical events, including the birth of BHP, significant advances in mining and processing technology and changes in the industrial relations landscape. As a result, when planning site rehabilitation, decommissioning and mine closure, a range of considerations must be considered that would not typically form a component of mine closure planning at other sites. These include, but are not limited to the following.

- Presence of items of historical significance, some of which are in excellent condition (i.e. change house and former administration complex) and some of which are in poor condition, requiring substantial expenditure to make them safe (i.e. North Mine Concentrator and associated conveyors).
- Community expectations in related to the final landform and land uses, including the "vista" that the Mine Site provides travellers approaching Broken Hill from the east and the potential for the Mine Site to be used for non-mining purposes post mine closure.
- Presence of contaminated land associated with past mining operations.
- Absence of soil material and the harsh climate and the influence that this will have on any final vegetated outcome for the Mine Site.
- Preservation of access to remaining mineral resources for ongoing mining operations for future generations.

As a result, rehabilitation and decommissioning of the Mine Site will require substantial consultation and planning after determination of this application. In light of this, the following subsections describe the Applicant's conceptual site rehabilitation, decommissioning and mine

closure strategy, acknowledging that this strategy will be further refined and developed in consultation with the Broken Hill community and relevant government agencies throughout the life of the Proposal.

Rehabilitation activities, including a description of the consultation undertaken to determine the proposed final landform and land use, would be described in a *Mining Operations Plan* (MOP) to be submitted to the DRE and approved following the issue of development consent and prior to the commencement of activities under that consent. The *Mining Operations Plan* would also address any rehabilitation-related requirements nominated in the development consent for the Proposal. The Applicant acknowledges that the MOP is likely to be an evolving document, with the rehabilitation and mine closure activities likely to change and evolve with consultation and with time throughout the life of the Proposal.

2.13.2 Rehabilitation and Mine Closure Objectives

In the short term, the Applicant's rehabilitation and Mine Closure objectives would be as follows.

- Stabilise all earthworks and disturbed areas no longer required for Proposal-related activities.
- Implement a wide-ranging program of mine closure consultation with:
  - the wider Broken Hill community, including residents and the business community;
  - relevant government agencies;
  - CBH Resources Limited, operator of the Rasp Mine; and
  - any other interested stakeholder.
- Commence progressive rehabilitation of sections of the Mine Site that are not the subject of operational, heritage or other constraints.

The Applicant's longer term rehabilitation and Mine Closure objectives would be as follows.

- Establish a final landform that:
  - is safe, stable and non-polluting;
  - requires levels of maintenance commensurate with surrounding land;
  - minimises the size and depth of final voids;
  - preserves preserved items of heritage significance in a manner that permits their ongoing conservation; and
  - is suitable for the identified long-term final land uses.
- Remove all infrastructure not required for future land use while ensuring that items of heritage significance are retained in a safe condition.

- Contribute to the long-term, non-mining economic vitality of Broken Hill.
- Relinquish the mining lease(s) over the rehabilitated landform and have the security returned within a reasonable time after the completion of all mining and rehabilitation activities.

2.13.3 Conceptual Rehabilitation Domains and Final Landform

Figure 2.16 presents the final landform for the Mine Site, acknowledging that the conceptual landform would form the basis for the consultation program described in Section 2.13.1.

In preparing the design for the conceptual final landform, the Applicant has taken into account the following.

- The pre-mining landform has been largely modified by previous mining practices.
- The existing, mining-related landform, together with a range of highly visible items of heritage significance, including the No. 3 Shaft Headframe and the North Mine Concentrator, forms part of the "character" of Broken Hill. As a result, the final landform should be sympathetic with the mining heritage of Broken Hill.
- The requirement to minimise the size and depth of the final Cosmopolitan Open Cut void, while permitting ongoing access to the underground workings for future generations.
- Requirement to ensure that potentially contaminated or hazardous material is retained within the Mine Site.

In light of the above, the Applicant proposes that the rehabilitation domains and associated final landform would indicatively include the following (**Figure 2.16**). Domain numbering and naming convention is consistent *with ESG3: Mining Operations Plan (MOP) Guidelines* dated September 2013 published by Division of Resources and Energy.

Domain 1 – Infrastructure Area

This domain would have all items of significant heritage value capable of being maintained into the future in a safe and secure condition retained. All other infrastructure, including heritage infrastructure not capable of being maintained in a safe and secure condition would be removed. The landform would then be shaped and, if required, covered to ensure that it is safe, stable and non-polluting, having regard to the mining heritage of Broken Hill.

Domain 2/4 – Tailings Storage Facility and Waste Rock Emplacement

This domain would have all infrastructure associated with the proposed evaporation ponds and other mining-related infrastructure removed. The Mine Waste Facility would be covered and shaped and the Tailings Harvesting Area and proposed evaporation ponds would be shaped and covered as required to form a free draining landform.

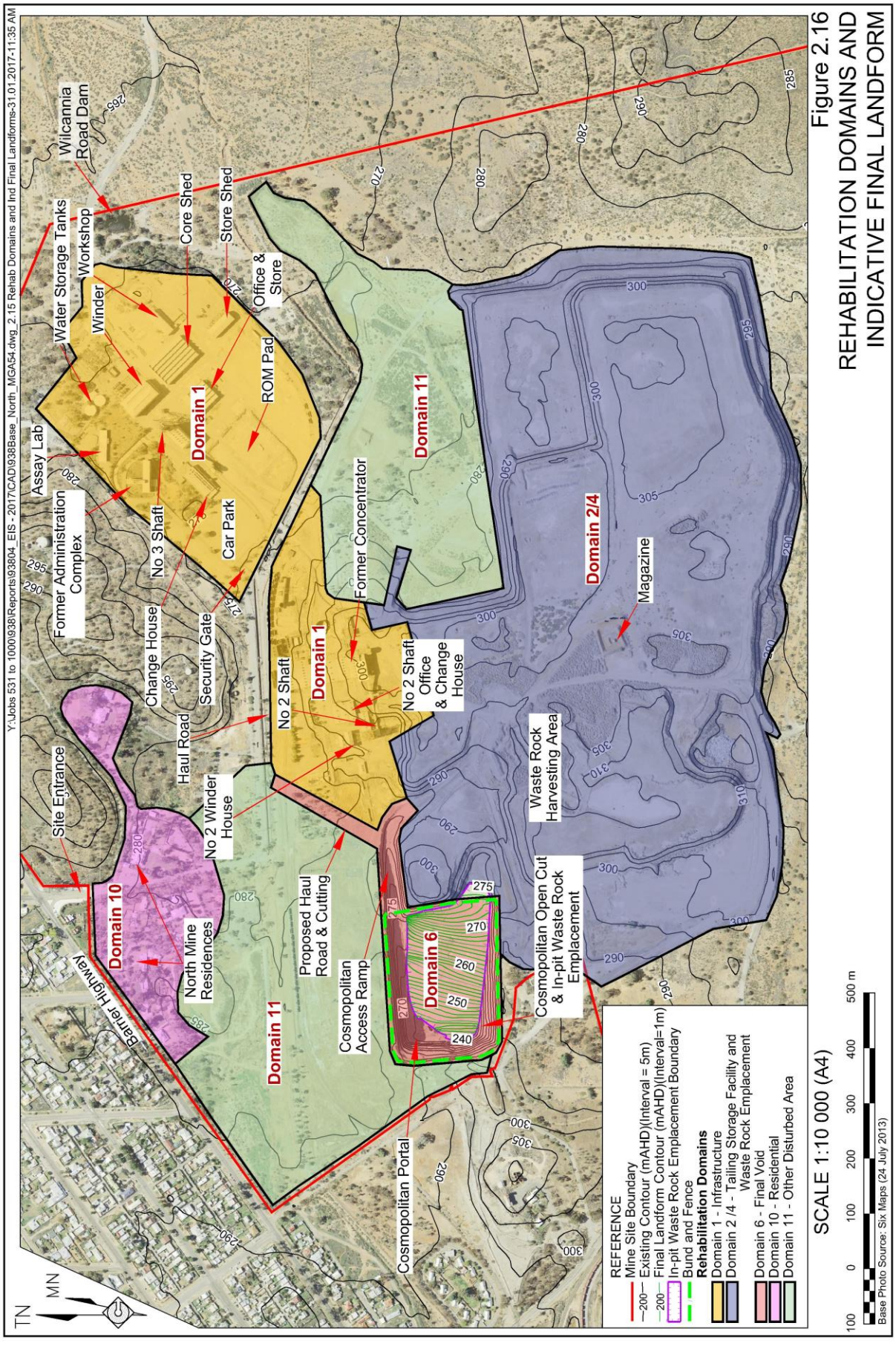
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Figure 2.16
REHABILITATION DOMAINS AND INDICATIVE FINAL LANDFORM
Wilcannia Road Dam
Water Storage Tanks
Workshop
Winder
Core Shed
Store Shed
Office & Store
ROM Pad
Assay Lab
Former Administration Complex
No 3 Shaft
Car Park
Change House
Security Gate
Haul Road
Site Entrance
No 2 Winder House
Former Concentrator
No 2 Shaft
Office & Change House
Magazine
Waste Rock Harvesting Area
Proposed Haul Road & Cutting
Cosmopolitan Access Ramp
Cosmopolitan Open Cut & In-pit Waste Rock Emplacement
Cosmopolitan Portal
North Mine Residences
Barrier Highway
Domain 1
Domain 2/4
Domain 6
Domain 10
Domain 11
TN
MN
REFERENCE
Mine Site Boundary
Existing Contour (mAHD)(Interval = 5m)
Final Landform Contour (mAHD)(Interval=1m)
In-pit Waste Rock Emplacement Boundary
Bund and Fence
Rehabilitation Domains
Domain 1 - Infrastructure
Domain 2 /4 - Tailing Storage Facility and Waste Rock Emplacement
Domain 6 - Final Void
Domain 10 - Residential
Domain 11 - Other Disturbed Area
SCALE 1:10 000 (A4)
100 0 100 200 300 400 500 m
Base Photo Source: Six Maps (24 July 2013)

Domain 6 – Final Void

This domain would be partially backfilled during mining operations. The domain would be bunded and fenced to prevent inadvertent access by unauthorised personnel. Access to the underground workings would be maintained for future generations to prevent sterilisation of resources in accordance with the principles of inter-generational equity.

Domain 10 – Residential

This domain would remain, with the existing residences continuing to be used for residential purposes.

Domain 11 – Other Disturbed Areas

This domain includes areas that have previously been disturbed by mining-related activities but are not proposed to be used or disturbed by the Proposal. These areas would be progressively rehabilitated during the life of the Proposal, with the final landform largely reflecting the existing landform.

2.13.4 Final Land Use

The final land use would be the subject of extensive consultation with the surrounding community. The final land use strategy would be described and updated in the various MOPs to be prepared for the Mine throughout the life of the Proposal. The Applicant anticipates, however, that the final land use strategy for the Mine Site would comprise areas set aside the following.

Heritage conservation / tourism / industrial / commercial / solar power generation

Sections of the Mine Site are likely to be suitable for non-mining final land uses, including heritage conservation, tourism, industrial, commercial or solar power generation uses. It is acknowledged that additional approvals would be required for some of these potential uses, however, the Applicant would consult with the Broken Hill community and relevant government agencies and non-government organisations throughout the life of the Proposal to ensure that those sections of the Mine Site potentially suitable for such uses are left in a manner that would facilitate that transition.

Covered, stable mining landscape

Sections of the Mine Site, in particular the former Tailings Storage Facilities and Waste Rock Emplacement would be retained as covered, stable emplacements. These emplacements form a component of the mining character of Broken Hill. In particular, the North Mine forms the backdrop for visitors approaching Broken Hill from the east via the Barrier Highway. As a result, the Applicant anticipates that the existing Tailings Storage Facilities and Waste Rock Emplacement would largely remain as a covered, stable landform with scattered vegetation.

Final void

The Cosmopolitan Open Cut would be retained as a partially filled open void. The Applicant anticipates that the final void would be retained for ongoing access to the underground workings.

Revegetated landform

The Applicant anticipates that sections of the Mine Site, in particular Domain 11 – Other Disturbed Areas would re progressively rehabilitated during the life of the Proposal and returned to a vegetated landform similar to the surrounding, non-disturbed landforms.

2.13.5 Rehabilitation and Mine Closure Consultation and Timing

The Applicant notes that rehabilitation and mine closure will require substantial consultation with the Broken Hill community and other stakeholders, including government agencies. The Applicant also notes that the Mine Site occupies one section of the Line of Lode and that development of a Rehabilitation and Mine Closure Plan for the Mine Site will be required to consider the Line of Load in its entirety. As a result, the Applicant proposes to undertake the rehabilitation and mine closure consultation described in **Table 2.20**.

2.13.6 Progressive Rehabilitation

During the initial stages of the Proposal, and prior to the final approval of the *Rehabilitation and Mine Closure Plan for the North Mine,* the Applicant would undertake a range of progressive rehabilitation activities within the Mine Site. These activities would be limited to Domain 11, or non-active sections of the Mine Site that do not include significant heritage-related constraints (**Figure 2.16**). **Table 2.21** presents the proposed progressive rehabilitation activities, timing and completion criteria.

2.13.7 Rehabilitation Documentation

The Applicant would include a detailed description of the progressive rehabilitation activities in the initial MOP to be prepared for the Proposal. That MOP would also include a series of commitments in relation to consultation and preparation of the *Rehabilitation and Mine Closure Plan for the North Mine.* Once that plan has been approved, a new MOP would be prepared, incorporating the approved plan.

Progress against annual commitments identified in the MOP, including the results of the rehabilitation trials and status of the progressive rehabilitation, would be described in each *Annual Review*, with further refinements to the mine closure strategy and rehabilitation plan described in that document.

2.13.8 Delayed Commencement

With the existing concurrent operation of both Southern Operations at 1.1Mtpa and the Potosi Mine at 0.45Mtpa, the Applicant has identified the benefits of having more than one source of ore in production at any one time.

With Potosi Mine scheduled to reach the end of its known resource in 2021, the Applicant has identified that a second ore source, will be essential to support the ongoing operation of the Southern Operations. In particular, the Applicant notes the high cost of maintaining the existing shaft, underground and surface infrastructure at the Southern Operations. Without the support offered by a second ore source this may result in early closure of the Southern Operations. In addition, the Applicant states that should operations be suspended at that operation, they would be unlikely to recommence at a future date.

Table 2.20
Indicative Rehabilitation and Mine Closure Consultation and Timing

Component	Proposed consultation	Anticipated Timing[1]	Anticipated deliverable
Identification of rehabilitation and strategic setting and mine closure objectives	On-site meetings with the following. • Broken Hill City Council. • Department of Industry. • Environment Protection Authority. • DPI – Water and Lands. • Office of Environment and Heritage. • Department of Environment & Energy (Cth). • Other interested stakeholders, including mine operators.	0 to 9 months	Draft *Line of Lode Conceptual Rehabilitation and Mine Closure Strategic Framework*
	Town hall, small group and individual meetings and presentations with the following. • Broken Hill residents. • Mine employees. • Special interest groups, including. – Business groups. – Tourism operators. – Social welfare groups. – Aboriginal community.	9 to 18 months	*Line of Lode Rehabilitation and Mine Closure Strategic Framework*
Preparation of site-specific rehabilitation and mine closure plans	Preparation of a draft *Rehabilitation and Mine Closure Plan for the North Mine* and circulation to all agencies for comment. • Broken Hill City Council. • Department of Industry. • Environment Protection Authority. • DPI – Water and Lands. • Office of Environment and Heritage. • Department of Environment & Energy (Cth).	18 to 27 months	Draft *Rehabilitation and Mine Closure Plan for the North Mine* incorporating agency comments
	Exhibition of the Draft *Rehabilitation and Mine Closure Plan for the North Mine* and the community is encouraged to make comment.	27 to 30 months	Final *Draft Rehabilitation and Mine Closure Plan for the North Mine*
	Submission of the Final *Rehabilitation and Mine Closure Plan for the North Mine* for approval by Division of Resources and Energy as the Mining Operations Plan for the Mine Site.	30 to 36 months	Approved *Mining Operations Plan*

Note 1: Timing commences with the earlier of granting of development consent or 30 September 2017

Table 2.21
Indicative Progressive Rehabilitation

<table>
<tr><th>Objective</th><th>Rehabilitation Activity</th><th>Completion Criteria</th><th>Anticipated Timing[1]</th></tr>
<tr><td>Determine the most effective rehabilitation/revegetation methodology</td><td>Establish a rehabilitation trial area comprising a grid with squares a minimum 15m x 15m in size.
Implement the following within the trial area. See discussion below in relation to rehabilitation methods.
<table>
<tr><th>Quadrant</th><th>Rip/scarify</th><th>Soil amelioration</th><th>Direct seeding</th><th>Tube stock</th><th>Watering</th></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>5</td><td>✓</td><td>✓</td><td></td><td>✓</td><td></td></tr>
<tr><td>6</td><td>✓</td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>7</td><td>✓</td><td></td><td></td><td>✓</td><td></td></tr>
<tr><td>8</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td></tr>
<tr><td>9</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>10</td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td></tr>
<tr><td>11</td><td>✓</td><td></td><td></td><td>✓</td><td>✓</td></tr>
</table></td><td>Program commenced.
Annual reports on results of the trials, including coverage, species composition and weed abundance included in Annual Review.</td><td>Years 1 and ongoing</td></tr>
<tr><td>Revegetate and stabilise the remaining areas of Domain 11</td><td>Complete rehabilitation activities using the methodology identified above, adapted as additional data becomes available, at a rate of 4ha per year.</td><td>4ha completed each year.
Evidence of completion provided in Annual Review.</td><td>Years 2 to 7</td></tr>
<tr><td>Revegetated area is self-sustaining</td><td>Ongoing monitoring of coverage, species composition and weed abundance.
Remediation of rehabilitated areas as required.</td><td>Monitoring indicates that coverage, species composition and weed abundance is consistent with surrounding, undisturbed areas.</td><td>Post Year 8</td></tr>
<tr><td colspan="4">Note 1: Timing commences with the granting of development consent</td></tr>
</table>

2.14 PROJECT RATIONALE AND ALTERNATIVES CONSIDERED

2.14.1 Introduction

This sub-section identifies the feasible alternatives considered and rejected during the design and planning phase of the Proposal. An evaluation of the Proposal in terms of Ecologically Sustainable Development and biophysical, socio-economic and planning considerations is provided in Sections 5.3.2 and 5.3.3.

Similarly, the Applicant notes that the North Mine would be unlikely to be able to operate as a standalone operation should the Southern Operations be non-operational. In particular, the high cost of developing the decline and access the higher grade ore within the North Mine Deeps below the 26 Level would be unlikely to be supported by extraction of the remnant ore above that Level.

Finally, production of higher grade ore from the North Mine Deeps as soon as practicable would assist to support the Applicant's ongoing operations in Broken Hill throughout the life of the Proposal. As a result, a delay in commencement of the North Mine would potentially result in permanent closure of both operations, incomplete extraction of the known resource and significant adverse economic impacts for the community of Broken Hill as a result of reduced time to transition to a non-mining economy.

2.14.2 No Recommencement

Failure to recommence mining operations at the North Mine would, similarly to delayed recommencement, likely result in the following.

- Reduced efficiency of the Southern Operations and increased potential for unplanned mine closure following closure of Potosi in 2021.
- Early closure of the Southern Operations as a result of approximately 4.3Mt of ore from the North Mine not being processed.
- Reduced rates of employment and economic and taxation contributions. As a minimum, the contributions identified in Section 2.12.3 would not eventuate. However, it is likely that with the early or unplanned shut down of the Southern Operations, that those impacts would substantially underestimate the actual impacts.
- Reduced confidence in the ongoing viability of the Broken Hill economy and reduced time to for a transition to a non-mining economy. This would have significant effects on the future prosperity of the City.

2.14.3 Shaft Operation

The Applicant considered the use of the No. 3 Shaft for haulage of ore and materials to surface. This alternative would require a substantial refurbishment of the shaft, winders and associated infrastructure. The Applicant anticipates that the capital costs for such works would be approximately $40 million. This capital cost would be on top of the existing $39.4 million Capital Investment Value identified in Section 2.12.2 as the proposed underground works would still be required.

In light of the above, use of the No. 3 Shaft for the Proposal is not currently viable. However, the Applicant would continue to review use of the shaft and would submit an application to modify the development consent should its use become viable.

2.14.4 Use of Larger or Smaller Road Trucks

The Applicant has transported ore from the Potosi Mine to the Southern Operations using B-double trucks of standard configuration. These vehicles transport a maximum of 39.7t of ore. The proposed A-double Road Trains with higher mass limits would be capable of transporting 58.5t of ore. Use of the larger A-double Road Trains has the following benefits.

- A reduction in transport costs compared with B-double trucks.
- A 32% reduction in vehicle movements.

As a result, the use of A-double Road Trains when compared with B-double trucks would result in a more efficient, robust and profitable project more capable of withstanding downturns in the commodity markets than would otherwise be the case.

While the same arguments would apply for the use of yet larger road trucks such as A-triple Road Trains, the Applicant anticipates that use of such vehicles would require substantial road modifications and would be unlikely to receive community support.

2.14.5 Use of Rail Transport

The Applicant has previously used rail to transport ore from the Mine Site to the Southern Operations. That operation was discontinued for the following reasons.

- Access to the ARTC-controlled section of the rail-network from the boundary of the Mine Site to the boundary of the Southern Operations Mine Site was limited.
- The substantial increase in movements of ARTC stock since the previous use of the rail corridor for ore movement to Southern Operations would limit movement capacity further.
- Previous use of the rail corridor limited movements to approximately 20 000t per month whereas the requirement for the current project is 25 000t per month.
- Additionally, road transport affords a greater level of flexibility to the operation allowing for the peaks and troughs of a mining operation.

As a result, the Applicant does not propose to use rail transport to move crushed ore from the Mine Site to the Southern Operations.

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