APPENDIX 10
Blasting Impact Assessment

ENVIRO STRATA CONSULTING Pty Ltd
A.B.N. 35 122 301 795

24 Albert Street
Valentine NSW 2280

T: (02) 4946 1864
M: 0407 005 352
Email: enviro.strata@gmail.com

Thomas Lewandowski
B.E. (Mining), M.M.Mgt,
M.Aus.I.M.M.,
M.I.S.E.E.,
M.EFEE.

UMWELT (AUSTRALIA) PTY LIMITED
on behalf of
MANGOOLA COAL OPERATIONS PTY LIMITED

BLASTING IMPACT ASSESSMENT FOR MANGOOLA COAL CONTINUED OPERATIONS PROJECT

REPORT NO. UM-1910-080519

FINAL

Thomas Lewandowski
08th May 2019

EXECUTIVE SUMMARY

OVERVIEW

Mangoola Coal Mine is an open cut coal mine located approximately 20 kilometres (km) west of Muswellbrook and 10 km north of Denman in the Upper Hunter Valley of NSW. Mangoola Coal Operations Pty Limited (Mangoola) has operated the Mangoola Coal Mine in accordance with Project Approval (PA) 06_0014 since mining commenced at the site in September 2010.

The Mangoola Coal Continued Operations Project (MCCO Project) will allow for the continuation of mining at Mangoola Coal Mine into a new mining area to the immediate north of the existing operations. The MCCO Project will extend the life of the existing operation providing for ongoing employment opportunities for the Mangoola workforce.

The MCCO Project will continue with the same open cut coal seam extraction method as currently used at Mangoola Coal Mine. The MCCO Project will continue utilising the same mining equipment, similar drill and blasting methods, and existing procedures.

Operations within the MCCO Additional Project Area aim to extract four main coal seams, down to the Upper Pilot A seam. The average extraction depth will be in the order of 60 m with some extraction of hilly areas reaching thickness up to approximately 125 m.

The Blasting Impact Assessment (BIA) for the MCCO Project was undertaken in accordance with Australian and New Zealand Environment and Conservation Council Guidelines and the Australian and British Standards. The BIA was also undertaken in accordance with the Secretary of the Department of Planning and Environment's Environmental Assessment Requirements (SEARs) for the Project issued on 15 February 2019 (replacing a previous version of the SEARs issued on 22 August 2017).

The BIA addresses the impact of the MCCO Project in terms of ground vibration, overpressure and flyrock on the surrounding environment including private residential receivers, cultural heritage sites, rock formations, infrastructure, the Crown land and livestock.

Due to mining operations moving into a new mining area, north of the existing Mangoola Coal Mine, private residences in the north and north-west will be exposed to closer blasting operations relative to the existing approved operations.

BLAST DESIGN

The BIA incorporated the actual geological model of the area, which identified highly variable interburden thicknesses (material scheduled for blasting) potentially resulting in variable bench sizes ranging from 5 to 25 m. Based on the bench data, the proposed drill rig sizes of 229 and 203 mm hole diameter and the proposed explosive products, the estimated charge masses for the MCCO Project could be in the order of 40 to 1,030 kg with variance depending on mining requirements and the location of each blast.

ASSESSMENT METHODOLOGY

The BIA utilised conceptual stage plans for the following three representative project years of operation:

- Project Year 1
- Project Year 5
- Project Year 8.

For the purpose of the assessment ground vibration and airblast overpressure predictive models specific for Mangoola conditions were developed. The models generated are based on the actual blast data collected between 2015 and 2017 and a sample size of approximately 800 readings. The models were used to identify potential worst-case scenario impacts of ground vibrations and airblast on the sensitive receivers when undertaking blasting within the proposed Additional Mining Area. The models were used to determine optimum blast sizes to achieve compliance with the limits. Where there was a predicted exceedance of the applicable limits due to a particular blast design, alternative blast designs were identified that can be applied to achieve compliance.

The estimated ground vibration and airblast exposure levels are discussed in the context of applicable ground and air vibration criteria as stated in Project Approval (PA 06_0014) or recommended by the Australian Standard (AS 2187.2-2006) and other relevant studies.

RESULTS OF BLAST IMPACT ASSESSMENT

Impact on Private Residential Receivers:

- The assessment identified a high level of variability in the blast impacts for both ground vibration and airblast dependent upon the charge mass; with negligible impact for low charge masses.
- The assessment determined that both ground vibration and airblast overpressure emissions can be managed to remain below the relevant criteria by reducing blast sizes, achieved through blasting smaller benches or the application of deck charges (i.e. lower charge mass).
- The results of ground vibration modelling show all vibration estimates to be below the allowable limits of 5 mm/s (for 95% of blasts) and 10 mm/s (not to be exceeded) for all modelled blast designs. The maximum ground vibration prediction (at the maximum charge mass) is in the order of 3.9 mm/s.
- The results of airblast overpressure modelling indicate a gradually increasing impact on the private residences located to the north as the MCCO Project progresses towards the north, with the highest exposure expected in the final years of the Project. However, blasting would be managed in order to achieve compliance within the limits. The assessment demonstrated that using smaller blast sizes, airblast level will be maintained below the applicable limits of (i.e. 115 dBL (for 95% of blasts) and 120 dBL (not to be exceeded)) for all private residences.
- The assessment determined that the potential risks due to flyrock are considered negligible. This is due to substantial distances between the private residences and the MCCO Additional Mining Area.

Impact on Heritage Sites, Rock Formations and Infrastructure:

- The vibration exposures for the heritage items assessed are below the applicable criteria of 5 mm/s for ground vibrations and 133 dBL for airblast overpressure.
- The assessment shows that the rock shelter sites and rock formations will be exposed to ground vibration levels well below the assessable criterion of 50 mm/s.
- The assessment determined that the impact on the TransGrid 500 kV Electricity Transmission Line (ETL) can continue to be managed effectively to remain below the existing vibration limit criteria of 60 mm/s for tension and 125 mm/s for suspension pylons, via the application of lower charge masses.
- The assessment determined that ground vibration exposure for the Ausgrid 11kV powerlines and Telstra buried telecommunication cables can be managed effectively to below the 100 mm/s vibration limit via the application of lower charge masses.
- The two prescribed water dams (PWD, RWD) and two prescribed tailings dams (TD1, TD2) will be exposed to vibration levels below the applicable vibration limits of 50 mm/s and 100 mm/s respectively.
- The assessment determined that ground vibration exposure for the public roads surrounding the MCCO Project can be managed effectively to below the 100 mm/s vibration limit via the application of lower charge masses.
- The impact of flyrock on the closest infrastructure (i.e. less than 500 m), that is the public roads, powerlines, and the Crown land located to the immediate north west and immediate south of the MCCO Additional Project Area, can be managed effectively according to blast management measures similar to the current system already developed when blasting in the proximity of public roads and powerlines.
- The impacts on mine-owned infrastructure will be managed in order to maintain safe work practices in consultation with the relevant infrastructure operators.

BLAST MANAGEMENT AND MONITORING

Blast management for the MCCO Project will continue to be conducted in accordance with the Mangoola Blast Management Plan (BMP) (2017). The document covers a number of blast control measures designed to minimise blast impacts and to comply with the relevant criteria.

It is recommended that, should approval be granted for the MCCO Project, Mangoola Coal review and refine the blast mitigating measures in the current BMP and associated documents to account for changed/reduced distances from the blasting area to sensitive receivers.

Due to the new location of blasting activities, it is recommended that Mangoola Coal relocate monitoring stations to provide adequate coverage for the closest private residences and other points of interest.

UMWELT (AUSTRALIA) PTY LIMITED
on behalf of
MANGOOLA COAL OPERATIONS PTY LIMITED

BLASTING IMPACT ASSESSMENT FOR MANGOOLA COAL CONTINUED OPERATIONS PROJECT

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1.0 INTRODUCTION

Enviro Strata Consulting Pty Limited (ESC) has been engaged by Umwelt (Australia) Pty Limited (Umwelt) on behalf of Mangoola Coal Operations Pty Limited (Mangoola) to complete a Blasting Impact Assessment (BIA) for the Mangoola Coal Continued Operations Project (MCCO Project). The assessment is to form part of an Environmental Impact Statement being prepared by Umwelt to support an application for development consent under Division 4.1 and 4.7 of Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the MCCO Project.

The BIA has been undertaken in accordance with the guidelines produced by the Australian and New Zealand Environment and Conservation Council (ANZECC), the latest Australian Standard and references to the British Standard and ACARP Report No. C14057. It also addresses the Secretary's Environmental Assessment Requirements (SEARs) as issued by the Department of Planning and Environment (DPE) for the MCCO Project on 15 February 2019 (replacing a previous version of the SEARs issued on 22 August 2017).

The MCCO Project Area includes the existing Approved Project Area for Mangoola Coal Mine and the MCCO Additional Project Area as shown on **Figure 2.1**. The approved mine plan for Mangoola Coal Mine will not be subject to additional production beyond that currently approved. In the transition period, when both operations would be active, blasting will be managed across both mining areas to provide compliance with the imposed conditions (i.e. vibration limits, frequency of blasting and the number of allowable blasts will be maintained). Continued blasting will occur in the existing Approved Project Area however as there is no change to the previously assessed and approved locations of mining, target coal seams or blasting practices the existing Approved Project Area is not part of this BIA. Existing blast management and controls would continue to apply as relevant to the MCCO Project.

In this regard the BIA has evaluated the impact of blasting associated with mining operations within the MCCO Additional Project Area on the following:

- adjacent community; including private residential receivers
- heritage items and historic sites of interest
- rock formations / rock shelter sites
- existing and proposed infrastructure
- adjacent mines
- nearby parcels of Crown land
- livestock.

The report includes ground vibration and airblast overpressure modelling, utilising parameters representative for the MCCO Additional Project Area. The results of this assessment are presented in the context of the relevant vibration and overpressure limits for the local community, heritage items, and infrastructure.

2.0 PROJECT DETAILS

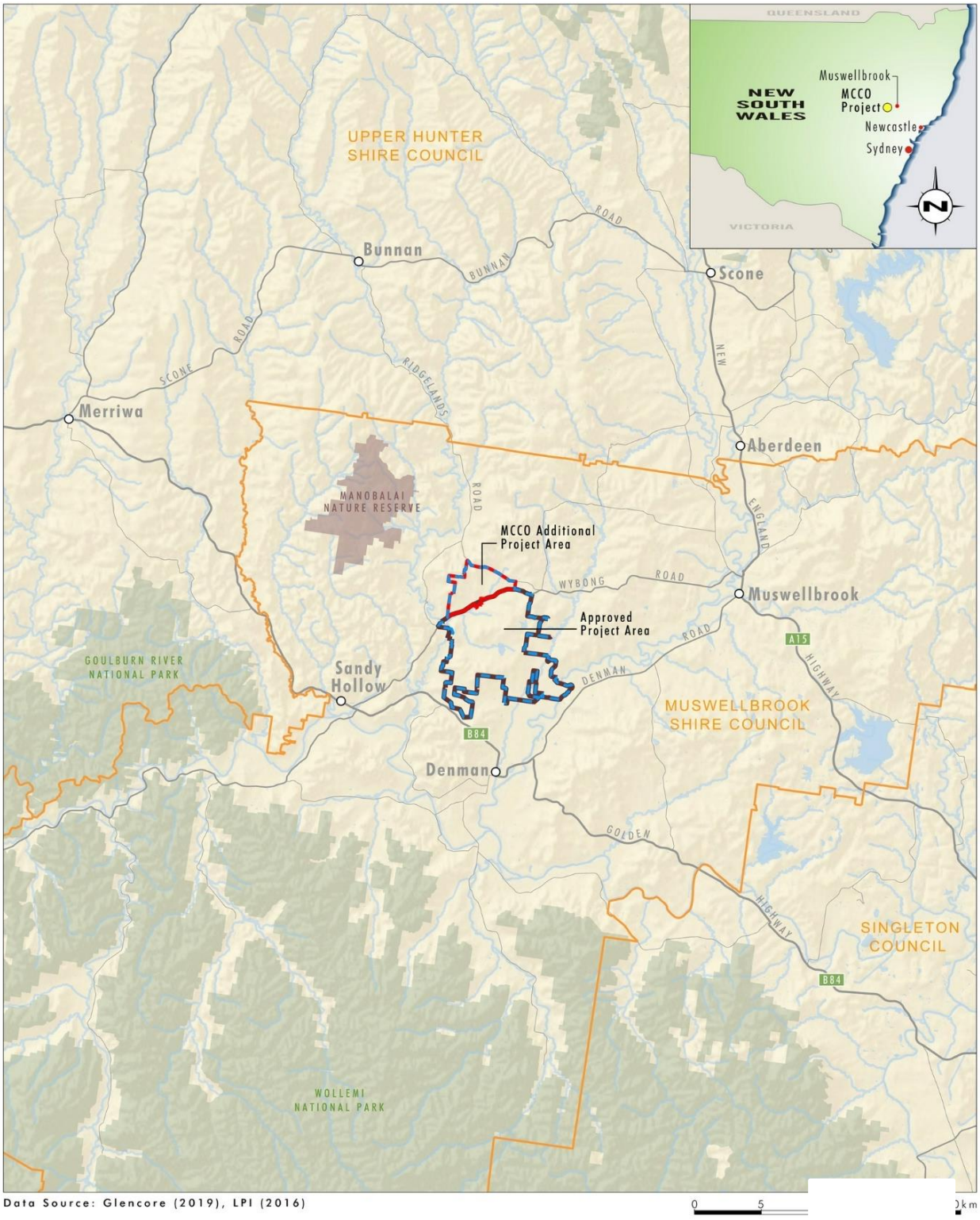
Mangoola Coal Mine is an open cut coal mine located approximately 20 kilometres (km) west of Muswellbrook and 10 km north of Denman in the Upper Hunter Valley of NSW (refer **Figure 2.1**). Mangoola has operated the Mangoola Coal Mine in accordance with Project Approval (PA 06_0014) since mining commenced at the site in September 2010.

The MCCO Project will allow for the continuation of mining at Mangoola Coal Mine into a new mining area to the immediate north of the existing operations. The MCCO Project will extend the life of the existing operation providing for ongoing employment opportunities for the Mangoola workforce. The MCCO Project Area includes the existing Approved Project Area for Mangoola Coal Mine and the MCCO Additional Project Area as shown on **Figure 2.2**.

The MCCO Project generally comprises:

- open cut mining peaking at up to the same rate as that currently approved (13.5 Million tonnes per annum (Mtpa) of run of mine (ROM) coal) using truck and excavator mining methods
- continued operations within the existing Mangoola Coal Mine
- mining operations in a new mining area located north of the existing Mangoola Coal Mine, Wybong Road, south of Ridgelands Road and east of the 500 kV Electricity Transmission Line (ETL)
- construction of a haul road overpass over Big Flat Creek and Wybong Road to provide access from the existing mine to the proposed Additional Mining Area
- establishment of an out-of-pit overburden emplacement area
- distribution of overburden between the proposed Additional Mining Area and the existing mine in order to optimise the final landform design of the integrated operation
- realignment of a portion of Wybong Post Office Road
- the use of all existing or approved infrastructure and equipment for the Mangoola Coal Mine with some minor additions to the existing mobile equipment fleet
- construction of a water management system to manage sediment laden water runoff, divert clean water catchment, provide flood protection from Big Flat Creek and provide for reticulation of mine water. The water management system will be connected to that of the existing mine
- continued ability to discharge excess water in accordance with the Hunter River Salinity Trading Scheme (HRSTS)
- establishment of a final landform in line with current design standards at Mangoola Coal Mine, including the use of natural landform design principles consistent with the existing site

- rehabilitation of the proposed Additional Mining Area using the same revegetation techniques as at the existing mine
- a likely construction workforce of approximately 145 persons. No change to the existing approved operational workforce
- continued use of the mine access for the existing operational mine and access to/from Wybong Road, Wybong Post Office Road and Ridgelands Road to the MCCO Additional Project Area for construction, emergency services, ongoing operational environmental monitoring and property maintenance.



Legend

- MCCO Project Area
- Approved Project Area
- MCCO Additional Project Area
- Local Government Area

FIGURE 2.1

Regional Locality Plan

File Name (A4): 4004_342.dgn
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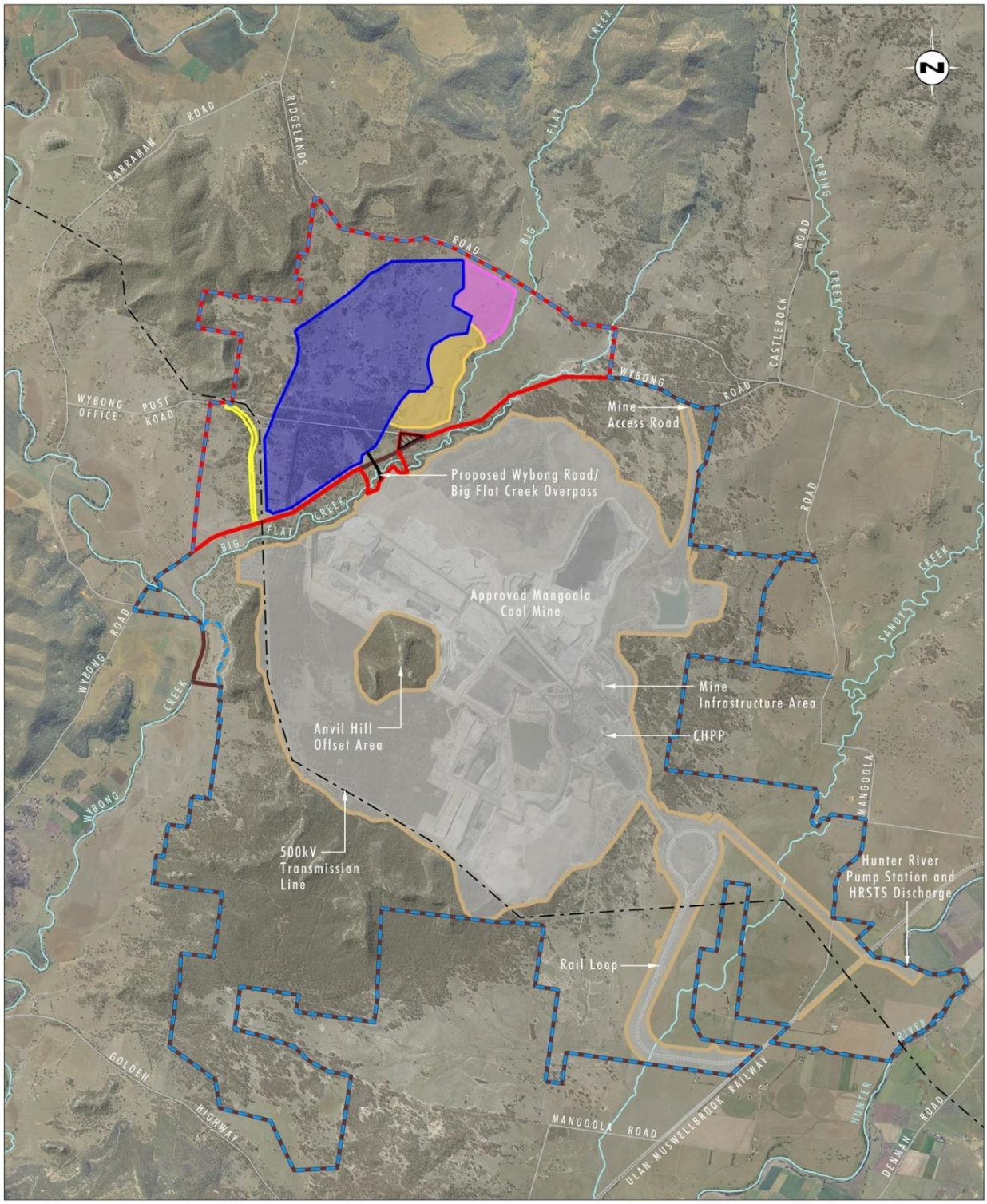


Image Source: Glencore (April 2018)
Data Source: Glencore (2019)

0 1.0 2.0 3.0km

Legend

- MCCO Project Area
- Approved Project Area
- Approved Mangoola Coal Mine Disturbance Area
- MCCO Additional Project Area
- Proposed Additional Mining Area
- Proposed Emplacement Area
- Proposed Topsoil Stockpile Area
- Wybong Post Office Road Realignment
- Crown Land (TSR) Excluded from MCCO Project Area

FIGURE 2.2

Key Features of the Mangoola Coal Continued Operations Project

File Name (A4): 4004_343.dgn
20190328 11.19

3.0 EXISTING ENVIRONMENT AND IDENTIFIED RECEIVERS

The BIA has evaluated the impact of blasting associated with mining operations within the MCCO Additional Project Area on identified sensitive receivers including private residences, cultural heritage sites, rock formations and infrastructure. The impact of blasting has been undertaken in accordance with the existing criteria as specified in the Project Approval **(**PA 06_0014) and Environment Protection Licence (EPL 12894). The criteria have been discussed in detail in **Section 6.2**. This section introduces the identified sensitive receivers, their location and distance relative to the MCCO Proposed Additional Mining Area (refer to **Figure 3.1**).

3.1 PRIVATE RESIDENTIAL RECEIVERS

The location of private residential receivers is shown in **Figure 3.1.** In general, the highest density of residential receivers is located to the north-west of the MCCO Additional Project Area. Private residential receivers are located as follows from the Proposed Additional Mining Area:

- 7 private residential receivers within 2 km
- 11 private residential receivers within 2 to 3 km
- 17 private residential receivers within 3 to 4 km
- 14 private residential receivers within 4 to 5 km.

The closest private residential receivers (ID 157 and 139) are located to the north of the MCCO Additional Project Area and are approximately 1.15 km and 1.37 km respectively of the Proposed Additional Mining Area.

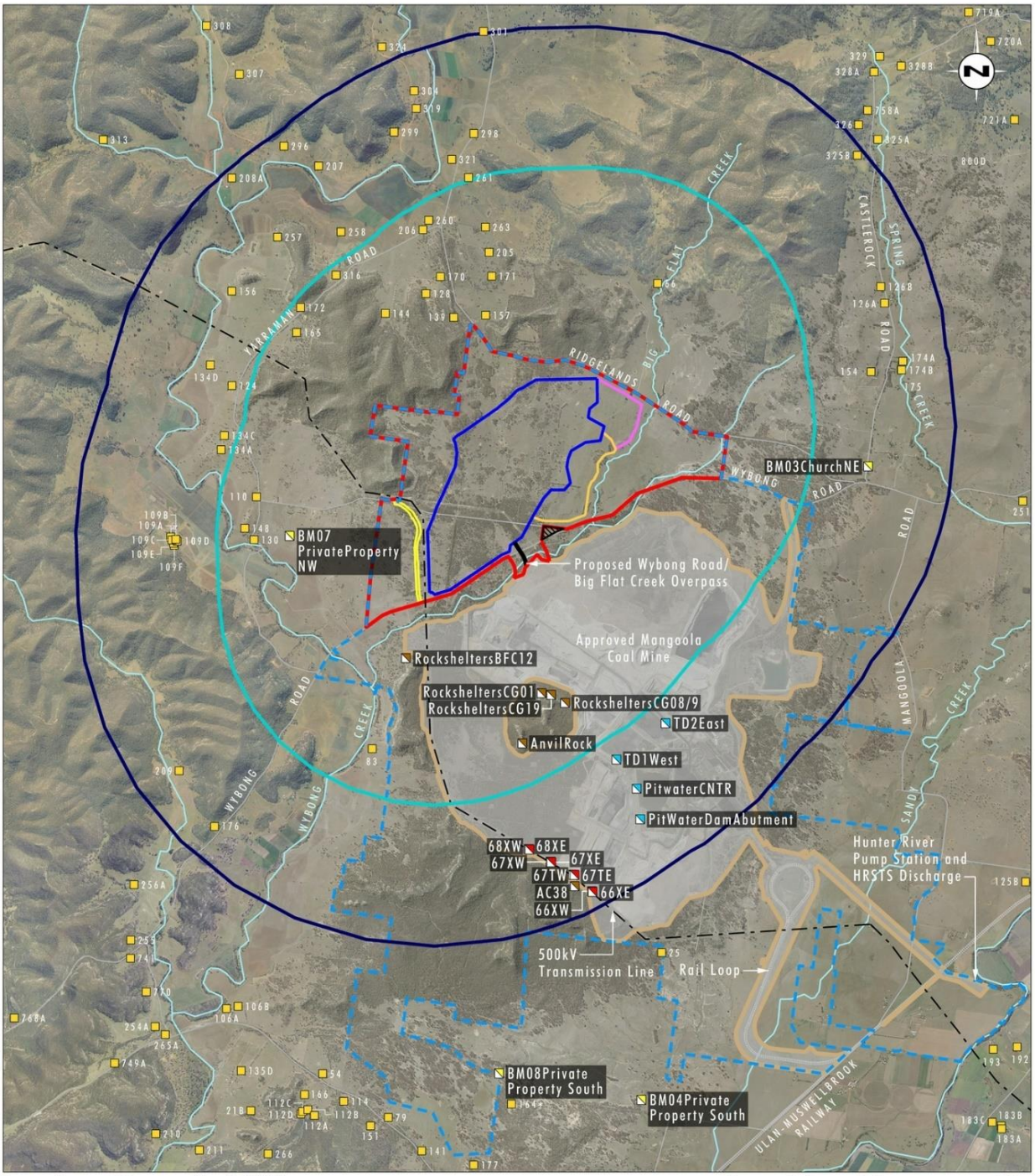


Image Source: Glencore (April 2018)
Data Source: Glencore (2019)
Note: *Subject to Negotiated Agreement

0 1.0 2.0 4.0km

Legend

- MCCO Project Area
- Approved Mangoola Coal Mine Disturbance Area
- MCCO Additional Project Area
- Proposed Additional Mining Area
- Proposed Additional Mining Area 3km Buffer
- Proposed Additional Mining Area 5km Buffer
- Proposed Emplacement Area
- Proposed Topsoil Stockpile Area
- Wybong Post Office Road Realignment
- Crown Land (TSR) Excluded from MCCO Project Area
- Private Residence
- Private Residence Monitor
- Water Dam Monitor
- TransGrid Pylon Monitor
- Rock Formation Monitor

FIGURE 3.1

Location of Private Residential Receivers

File Name (A4): 4004_216.dgn
20190327 13.06

3.2 ABORIGINAL AND EUROPEAN CULTURAL HERITAGE SITES

Heritage items including Aboriginal cultural heritage and European historic heritage have been identified as part the Environmental Impact Statement being prepared by Umwelt for the MCCO Project. The identified heritage items that are potentially blast sensitive are described below and shown on **Figure 3.2**.

Aboriginal Heritage – Rock Shelter Sites

The identified Aboriginal cultural heritage sites that are potentially blast sensitive are eroded, shallow cave-like openings in the sedimentary rock outcroppings, they are referred to as rock shelters. The rock shelters are located at variable distances ranging from 500 to 4,620 m from the Proposed Additional Mining Area. They include the following and are shown on **Figure 3.2**:

- Rock Shelter Sites: AC38, CG19, CG01, CG08/9, BFC12, BFC128, BFC129, BFC130, BFC131, BFC132.

Historic Heritage

The identified historic heritage items that are potentially blast sensitive are located at variable distances ranging from 1,680 to 3,490 m from the Proposed Additional Mining Area. These heritage items vary greatly in the materials used, their construction and state of disrepair. They include the following and are shown on **Figure 3.2**:

- Wybong Cemetery, (representing stone monuments and fencing embedded in the ground, i.e. local cemetery, late 19th century graves with stone and marble headstones / grave markers)
- Wybong Hall, (local hall of timber and corrugated iron on piers)
- Brogheda, (timber building with corrugated iron roofing and old timber fencing present. New brick construction dwelling also present)
- Yarraman, (relocated old timber slab hut on concrete slab)
- Yarlett, (weatherboard house, old timber fence and corrugated iron sheds)
- Minnie Vale, (modern horizontal timber cladding house with corrugated iron roof and timber sheds)
- Collareen, (modern horizontal timber cladding house with corrugated iron roof. Horizontal cladding timber sheds and vertical cladding timber cottage with brick chimney)
- Catholic Church, (horizontal timber cladding structure erected above ground on piers, including slate roofing. Concrete stairs and concrete pathway also present).
- Castle Hill, (various timber slab structures and sheds; in addition brick toilet block present)
- 'Dwelling', (relocated timber slab hut on piers and survey marker on tree)
- 'Structure', (weatherboard dwelling as well as a corrugated iron and timber shed).

Rock Formations

There are two rock formations of European heritage significance located in the proximity of the MCCO Additional Project Area. The identified sandstone rock formations are located 2,450 and 2,300 m (as per the order listed below) from the MCCO Proposed Additional Mining Area. They include the following and are shown on **Figure 3.2**:

- Anvil Rock (a geographical feature near the top of Anvil Hill, the rock formation resembles the shape of an anvil)
- 'The Book' (a geographical feature representing a sheer rock face approximately 11.2 m high with natural colouring that resembles an open book).

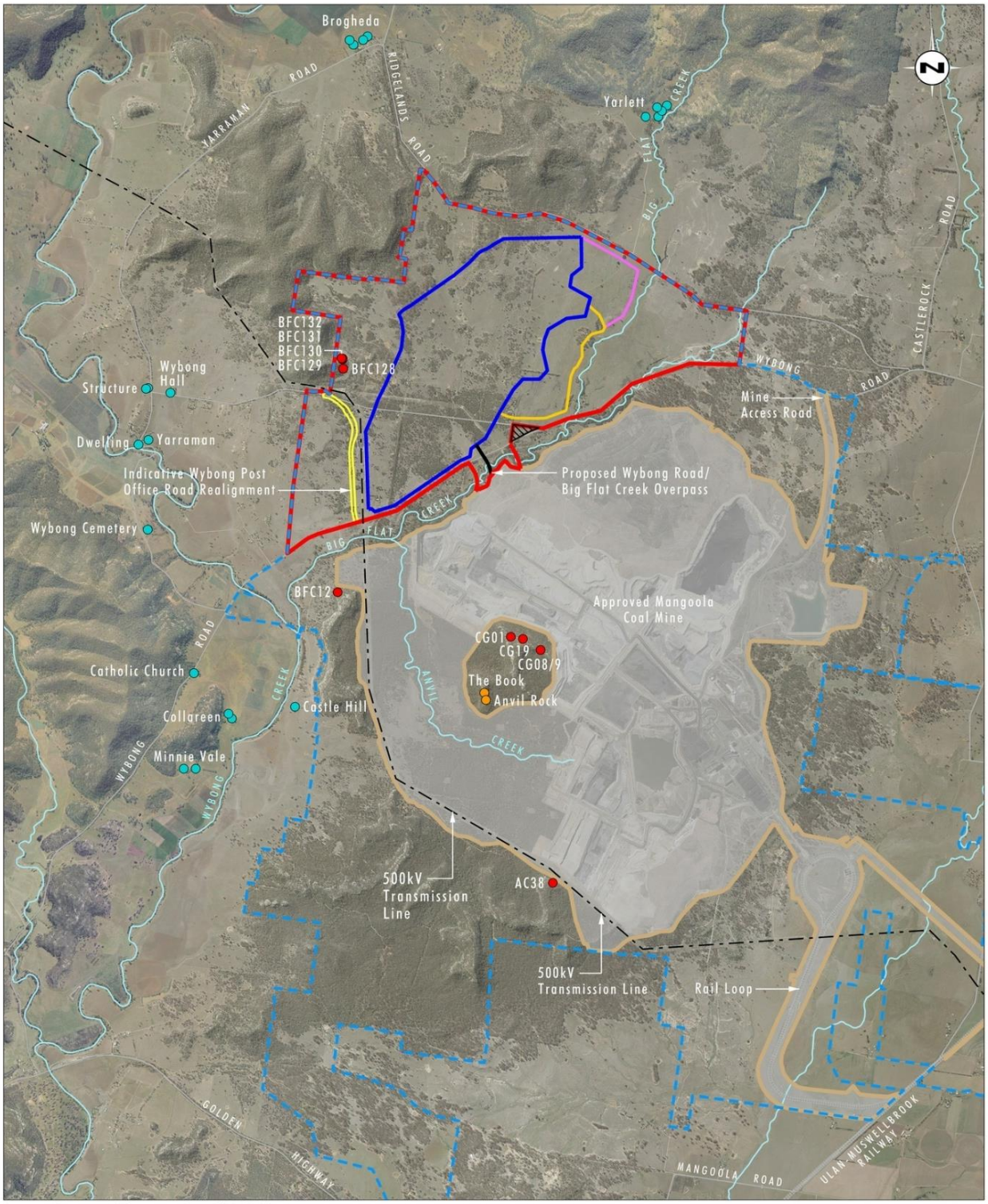


Image Source: Glencore (April 2018)
Data Source: Glencore (2019)

0 1.0 2.0 3.0km

Legend

- MCCO Project Area
- Approved Mangoola Coal Mine Disturbance Area
- MCCO Additional Project Area
- Proposed Additional Mining Area
- Proposed Emplacement Area
- Proposed Topsoil Stockpile Area
- Wybong Post Office Road Realignment
- Crown Land (TSR) Excluded from MCCO Project Area
- Heritage Items
- Rock Formations
- Rock Shelter Sites

FIGURE 3.2

Locations of Potentially Blast Sensitive Aboriginal and European Cultural Heritage Sites

File Name (A4): 4004_222.dgn
20190327 13.34

3.3 INFRASTRUCTURE

A number of infrastructure receivers were identified in the vicinity of the MCCO Additional Project Area, between 35 m and 3,570 m from the Proposed Additional Mining Area.
The identified infrastructure receivers are highlighted in **Figure 3.3** and detailed below:

- 500 kV ETL Pylons - the powerlines and transmission pylons are managed by TransGrid who is the operator of the high voltage electricity transmission network in New South Wales
- 11 kV Powerlines - the powerlines and timber poles form a part of a rural network, owned, maintained and operated by Ausgrid, an electricity distribution company
- Any powerlines located within the MCCO Additional Project Area have not been assessed or shown on the plan as they will be decommissioned prior to the commencement of the MCCO Project
- Telecommunication Infrastructure - Telstra buried telecommunication cables located mainly along Wybong Road and Ridgelands Road
- Prescribed Water Dams - there are two prescribed water dams identified within the Approved Project Area being the Pit Water Dam (PWD) and the Raw Water Dam (RWD)
- Prescribed Tailings Dams - there are two prescribed tailings dams identified within the Approved Project Area being Tailings Dam 1 (TD1) and Tailings Dams 2 (TD2)
- Public Roads – Wybong Post Office Road, Wybong Road, Ridgelands Road and Yarraman Road are the closest roads to the MCCO Additional Project Area
- Proposed section of the Wybong Post Office Road Realignment
- Mine-owned Infrastructure including the proposed Wybong Road and Big Flat Creek overpass.

Neighbouring mines

There are a number of coal mines in the Upper Hunter Valley. The closest mines are Bengalla Open Cut Mine located approximately 12 km to the east of the MCCO Project and Mount Pleasant Mine located immediately north of Bengalla. Due to the significant distance, cumulative impacts are not considered likely and it is not considered necessary to assess potential impacts on other mining operations.

3.4 CROWN LAND

Parcels of Crown land located to the north west and south of the MCCO Additional Mining Area have been identified. These are shown on **Figure 3.3** and have been considered in this BIA.

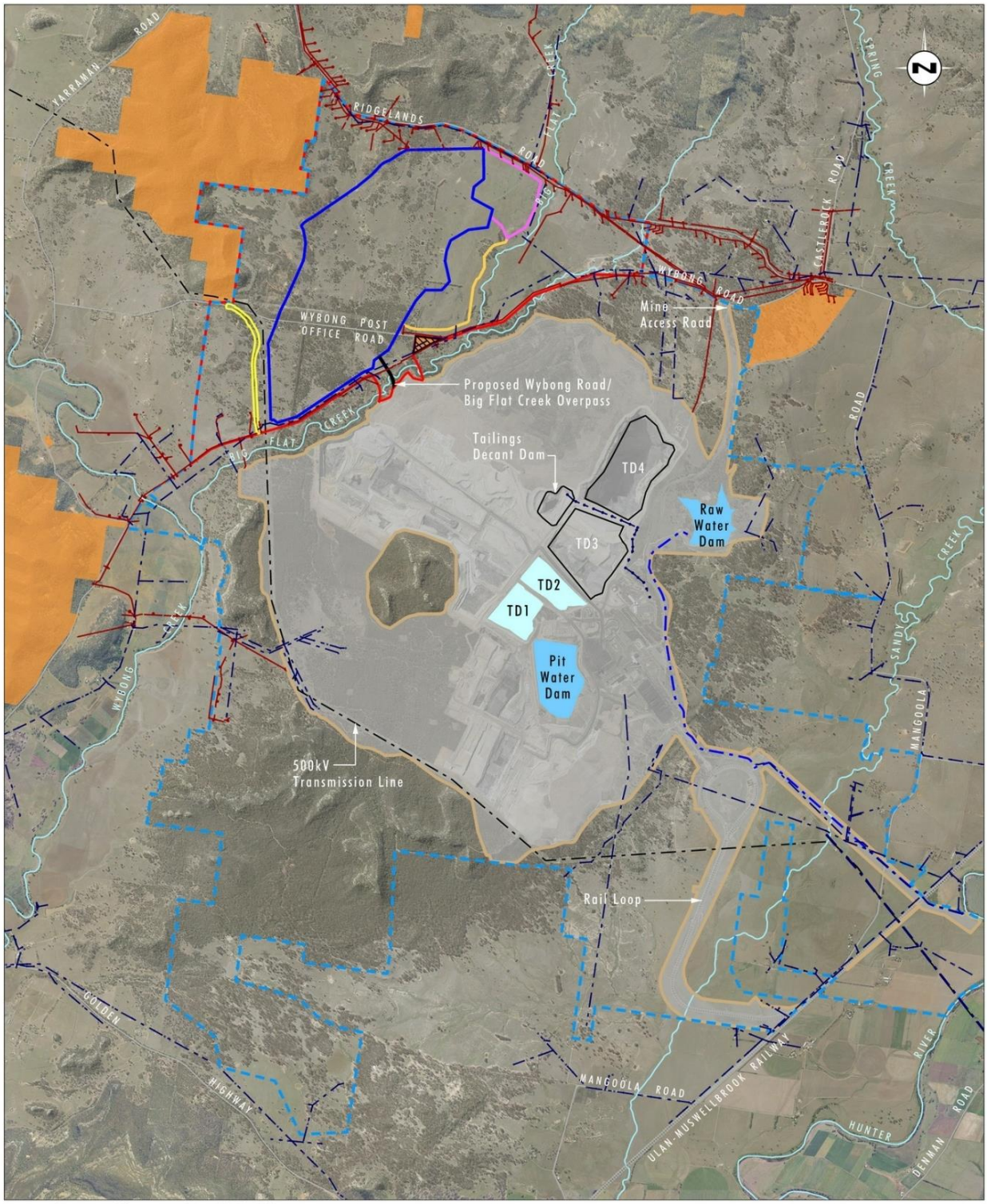


Image Source: Glencore (April 2018)
Data Source: Glencore (2019)
Note: Ausgrid Powerlines and Buried Telstra Cables shown and assessed in BIA assume relevant relocations have been made from within the MCCO Additional Disturbance Area as proposed in the EIS main volume

Legend

- MCCO Project Area
- Approved Mangoola Coal Mine Disturbance Area
- MCCO Additional Project Area
- Proposed Additional Mining Area
- Proposed Emplacement Area
- Proposed Topsoil Stockpile Area
- Wybong Post Office Road Realignment
- Crown Land (TSR) Excluded from MCCO Project Area
- Hunter River Pipeline
- Prescribed Water Dam
- Prescribed Tailings Dam
- Crown Land
- Ausgrid Powerlines
- Buried Telstra Cables

FIGURE 3.3

Location of Infrastructure and Crown Land

File Name (A4): 4004_221.dgn
20190412 13.05

4.0 REVIEW OF SITE BLASTING INFORMATION AND DATA

A detailed review of site blasting information and monitoring data was undertaken as a component of this BIA and included a review of ground vibration and airblast overpressure monitoring results for the 2014 to 2018 period. The analysis aimed to assess the adequacy of coverage of the existing blast monitoring system and the results were analysed in the context of airblast overpressure and ground vibration limits imposed on the mine.

A summary of the blasting data review is presented in **Table 4.1**.

Table 4.1: Blast Performance Analysis for Years 2014 to 2018 (Mangoola Coal Mine)

Assessment Type / Criterion	Strategic Objective	Current Standing	Deficiency	Action Plan
Private Residences				
Quantitative: Ground Vibration **Criterion 1**	No more than 5% of all yearly blasts may produce vibration values between 5 mm/s and 10 mm/s	Year 2014 – 0% Year 2015 – 0.8% Year 2016 – 0% Year 2017 – 0% Year 2018 – 0% percentage of yearly blasts with ground vibration values between the specified limits	None	Continue mining operations without any major procedural and operational alterations
Quantitative: Ground Vibration **Criterion 2**	No blast may exceed 10 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural and operational alterations
Quantitative: Airblast **Criterion 3**	No more than 5% of all yearly blasts may produce overpressure values between 115 dBL and 120 dBL	Year 2014 – 1.5% Year 2015 – 3.1% Year 2016 – 2.1% Year 2017 – 0.9% Year 2018 – 0% percentage of yearly blasts with overpressure values between the specified limits	None	Continue mining operations without any major procedural and operational alterations
Quantitative: Airblast **Criterion 4**	No blast may exceed 120 dBL	No blast has exceeded the overpressure limit at private receivers	None	Continue mining operations without any major procedural and operational

Assessment Type / Criterion	Strategic Objective	Current Standing	Deficiency	Action Plan
				alterations
500 kV ETL				
Quantitative: Ground Vibration at the tension tower **Criterion 5**	No blast may exceed 60 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural and operational alterations
Quantitative: Ground Vibration at the suspension tower **Criterion 6**	No blast may exceed 125 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural and operational alterations
Prescribed Water Dams				
Quantitative: Ground Vibration at a water dam **Criterion 7**	No blast may exceed 50 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural and operational alterations
Quantitative: Ground Vibration at a tailings dam **Criterion 8**	No blast may exceed 100 mm/s	No blast has exceeded the vibration limit	None	Continue mining operations without any major procedural and operational alterations

The review of site blasting information and monitoring data which was used to inform this assessment concluded the following:

- A good overall blast performance with a low impact on the local community. Low blast impacts were identified for the assessed calendar years of 2014 to 2018. During the 2016 calendar year, there was one instance of an airblast event in the order of 121.1 dBL at one monitoring location. The measurement was not classed as a 120 dBL exceedance as the station was no longer representative of the closest private residence (this particular residence had been purchased by Mangoola). The monitoring station (BM01) was in the process of being relocated to a new location (BM07) representative of a new closest private residence. The assessment of the blast indicated that the closest residence was exposed to a level of 117 dBL. This

event was caused by a timing sequence issue which contributed to a wavefront reinforcement producing an elevated airblast level. The recommendations included improvement to delay sequencing, including reinforcement modelling (in consultation with Orica Blast Services) to minimise blast overpressure risks.

- The vibration monitoring requirements are stated in Mangoola BMP (2017). The requirements are based on conditions specified in Mangoola Coal Mine's existing approvals (PA 06_0014 and EPL 12894) and the TransGrid Agreement. In addition to these requirements, Mangoola undertakes additional data gathering to provide coverage of other potential sensitive receivers. The current multi-station vibration monitoring system at Mangoola Coal Mine includes permanent and portable monitors which monitor up to twenty-two locations throughout the year. The monitors are placed strategically to provide coverage of sensitive receivers, see **Figure 4.1**. Four of the stations provide coverage for private residences and a heritage site (i.e. church), another four monitor water and tailings dams, other monitoring stations have variable locations depending on blast location and are dedicated to monitoring 500 kV transmission pylons and rock formations and shelters.
- The current monitoring system is considered to provide adequate coverage for the existing approved operations to monitor vibration impacts for private residences, heritage sites and infrastructure. Due to the proposed mine footprint changes, detailed recommendations in regards to relocation / modification of monitoring stations for private residences and infrastructure have been made (see **Section 8**).

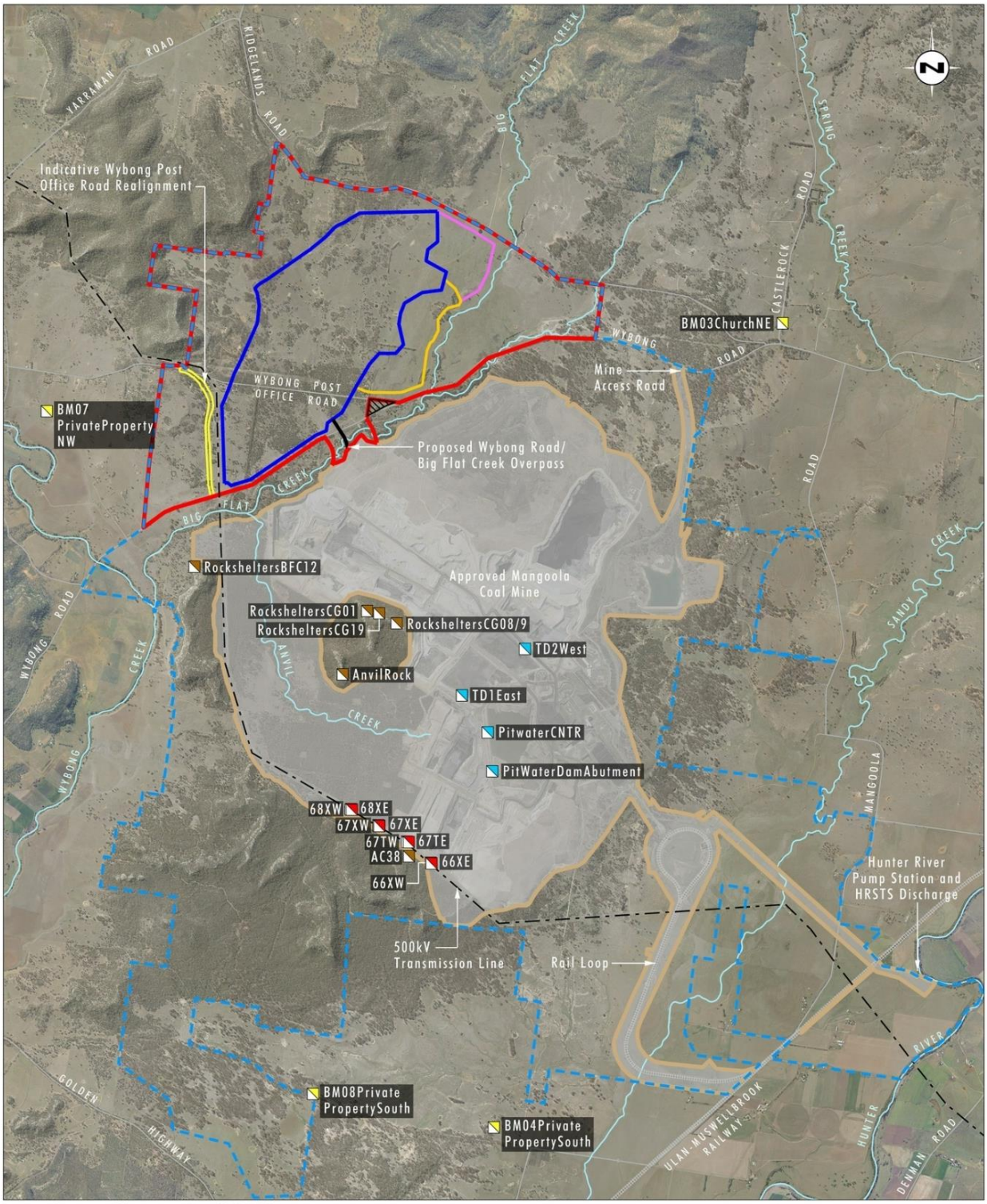


Image Source: Glencore (April 2018)
Data Source: Glencore (2019)

Legend

- MCCO Project Area
- Approved Mangoola Coal Mine Disturbance Area
- MCCO Additional Project Area
- Proposed Additional Mining Area
- Proposed Emplacement Area
- Proposed Topsoil Stockpile Area
- Wybong Post Office Road Realignment
- Crown Land (TSR) Excluded from MCCO Project Area
- Private Residence Monitor
- Water Dam Monitor
- TransGrid Pylon Monitor
- Rock Formation Monitor

FIGURE 4.1

Mangoola Coal Mine
Existing Blast Monitoring System

File Name (A4): 4004_220.dgn
20190327 13.40

5.0 CONCEPTUAL BLAST DESIGN

The MCCO Project will continue to employ open cut extraction utilising drill and blast methods for coal recovery. The MCCO Project will continue with the same open cut extraction method as currently used at Mangoola Coal Mine.

The operational sequence commences with a bench survey and blast design. The surveyed bench is then drilled in accordance with the blast design parameters. A typical bench at Mangoola Coal Mine is rectangular in shape with approximately 500 holes and a uniform drilling pattern.

The holes are loaded with explosive material such as standard ammonium nitrate fuel oil (ANFO) for dry strata conditions or Heavy ANFO and emulsion blends for wet conditions. The top part of the loaded holes is filled with a gravel material (i.e. stemming material) to contain the energy release and achieve a low airblast emission (i.e. lower environmental impact). The loaded explosives are then initiated through a detonating cord, connected to each hole, which delivers a signal to the primer / booster, placed within each hole. The primer / booster then initiates the explosives.

A delay system (i.e. NONEL system), which allows for single hole initiation, results in a small delay between each blasted hole. This system controls the ground and air vibration impacts (i.e. facilitates a lower environmental impact). Alternatively, pre-programmed electronic detonators can also be used with similar effect, but with higher accuracy. Following firing of the blast, the blasted and fractured rock strata (i.e. overburden or interburden material) is then removed using a truck and excavator method. Depending on the strength of the coal the same blasting process can be undertaken for coal strata blasting.

5.1 BLASTING STAGES

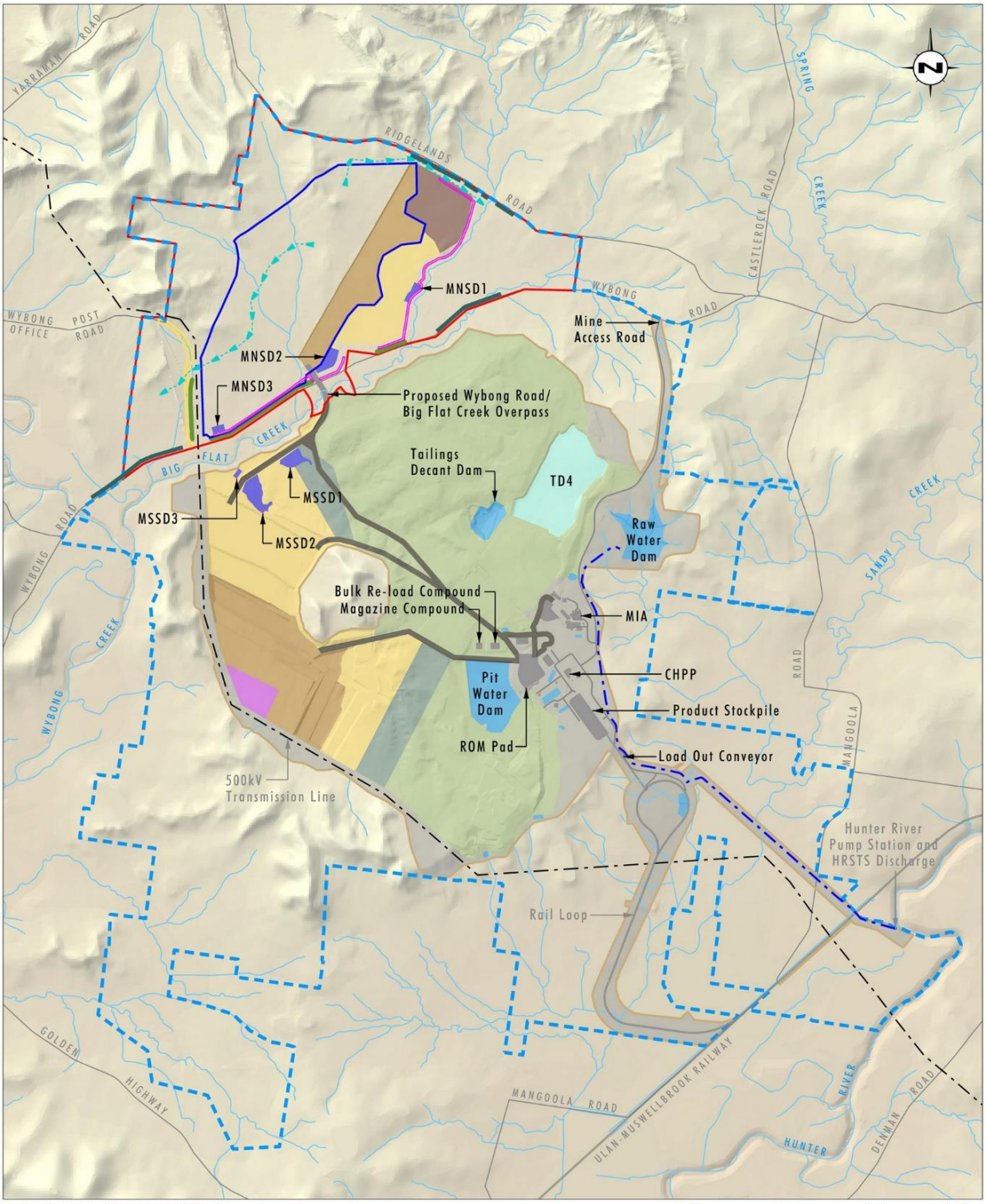
As an integrated operation the MCCO Project will operate for approximately eight years. Based on the conceptual stage plans for the Project the following three representative project years of operation have been selected for assessment in this BIA:

- Project Year 1
- Project Year 5
- Project Year 8.

The conceptual stage plans were selected as the most representative of the proposed mine development activities as outlined below:

- **Project Year 1**: As shown in **Figure 5.1** Project Year 1 nominally represents the first year of the integrated operations for the MCCO Project. Prior to this initial stage of the MCCO Project a haul road overpass of Wybong Road and Big Flat Creek will be constructed. This will provide access to the MCCO Additional Project Area and a connection with the existing infrastructure in the south. As indicated in **Figure 5.1**, the proposed mining activities will commence in the south and progress in a north-westerly direction. The blasting activities will be concentrated within this area. The proposed overburden emplacement area will be established in the south-east section.

- **Project Year 5**: As shown in **Figure 5.2** during this stage the proposed blasting activities are modelled in a central band of the MCCO Additional Project Area. The open cut area (and related blasting activities) generally advances in a north-westerly direction, towards rural properties and receivers located along Ridgelands Road and Yarraman Road.
- **Project Year 8**: As shown in **Figure 5.3** Project Year 8 nominally represents the final year of mining operations. During this stage the blasting activities are modelled in the open cut area and continue to progress primarily in a north-westerly direction. The distance to nearest receivers is reduced by approximately 600 to 750 m from that in Project Year 1.



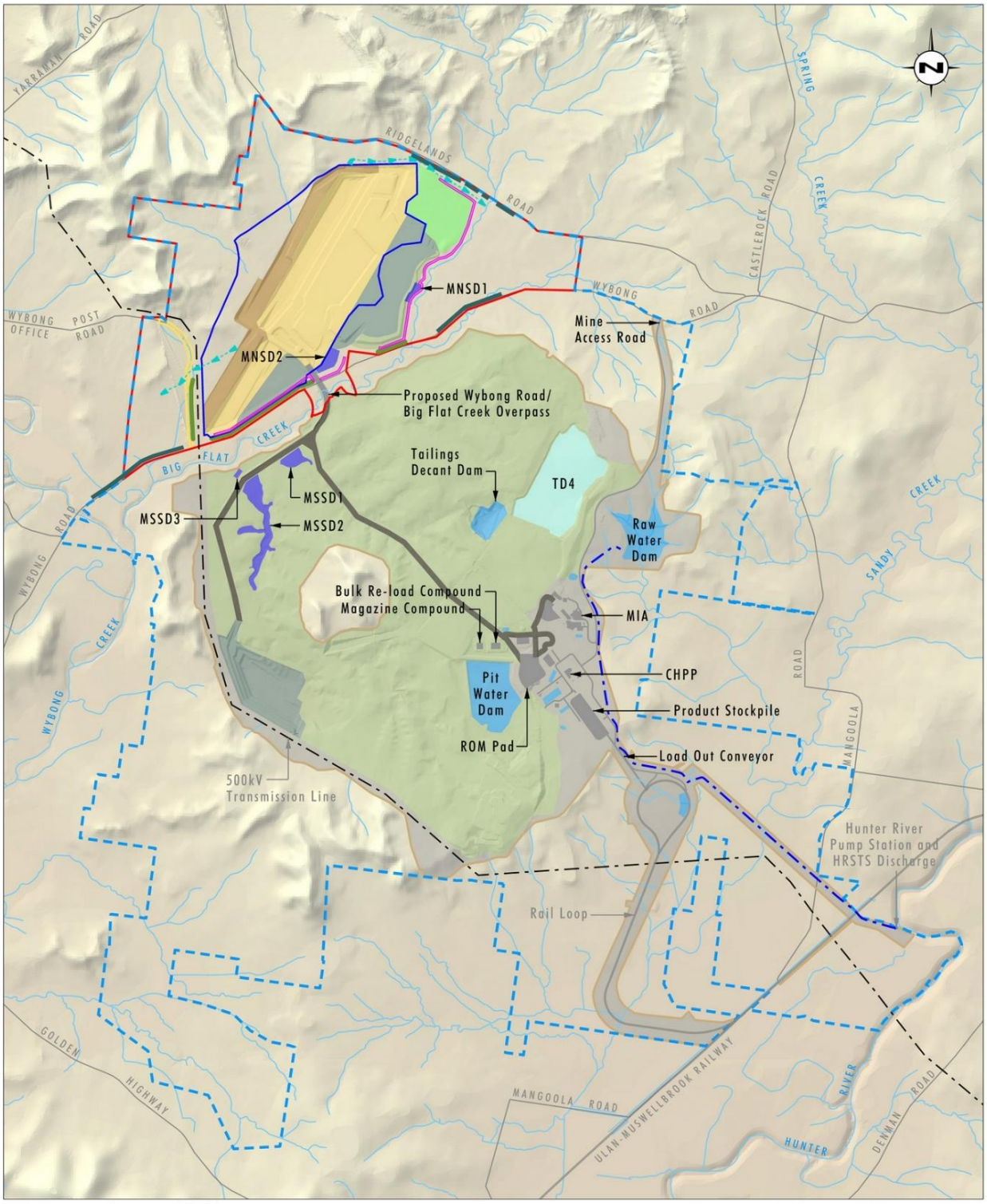
Legend

- MCCO Project Area
- Approved Mangoola Coal Mine Disturbance Area
- MCCO Additional Project Area
- Proposed Additional Mining Area
- Proposed Topsoil Stockpile Area
- Wybong Post Office Road Realignment
- Hunter River Pipeline
- Proposed Tree Screen
- Flood Levee
- Clean Water Diversion Drain
- Infrastructure
- Infrastructure Domain
- Active Mining
- Overburden Emplacement - Active
- Overburden Emplacement - Reshaped
- Prestrip
- Approved Dam
- Proposed Dam
- Tailings Dam
- Haul Road
- Visual Bund
- Rehabilitation

FIGURE 5.1

Conceptual Stage Plan Project Year 1

File Name (A4): 4004_338.dgn
20190327 13.41



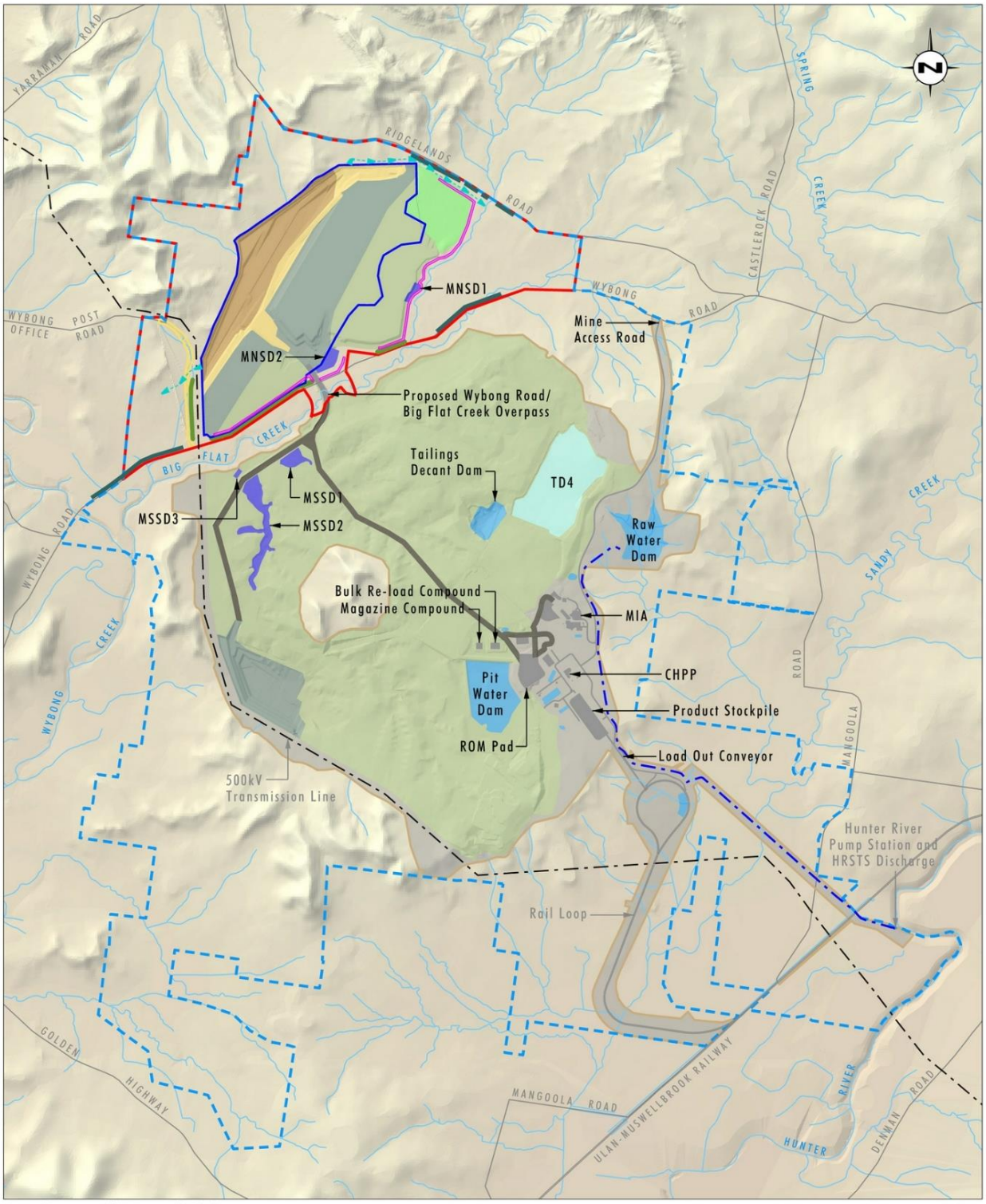
Legend

- MCCO Project Area
- Approved Mangoola Coal Mine Disturbance Area
- MCCO Additional Project Area
- Proposed Additional Mining Area
- Wybong Post Office Road Realignment
- Hunter River Pipeline
- Proposed Tree Screen
- Flood Levee
- Clean Water Diversion Drain
- Infrastructure
- Infrastructure Domain
- Active Mining
- Overburden Emplacement - Active
- Overburden Emplacement - Reshaped
- Rehabilitation
- Rehabilitation - Temporary
- Approved Dam
- Proposed Dam
- Tailings Dam
- Haul Road
- Visual Bund

File Name (A4): 4004_339.dgn
20190327 13.43

FIGURE 5.2

Conceptual Stage Plan Project Year 5



Legend

- MCCO Project Area
- Approved Mangoola Coal Mine Disturbance Area
- MCCO Additional Project Area
- Proposed Additional Mining Area
- Wybong Post Office Road Realignment
- Hunter River Pipeline
- Proposed Tree Screen
- Flood Levee
- Clean Water Diversion Drain
- Infrastructure
- Infrastructure Domain
- Active Mining
- Overburden Emplacement - Active
- Overburden Emplacement - Reshaped
- Rehabilitation
- Rehabilitation - Temporary
- Approved Dam
- Proposed Dam
- Tailings Dam
- Haul Road
- Visual Bund

FIGURE 5.3

Conceptual Stage Plan Project Year 8

File Name (A4): 4004_340.dgn
20190327 13.45

5.2 BLASTING FREQUENCY AND CONDITIONS

Mangoola's existing Project Approval (PA 06_0014) and Environment Protection Licence (EPL 12894) limit blasting times to between 9 am to 5 pm Monday to Saturday inclusive and allow for up to two blasts per day or six blasts a week, averaged over a calendar year. No blasting is permitted on Sundays, public holidays, or at any other time without the written approval of the EPA.

The exception to these conditions are:

- blasts that generate a 0.5 mm/s vibration level or less at any residence or privately-owned land
- blast misfires
- blasts required to ensure the safety of the mine or its workers.

Additional conditions are imposed when blasting is within 500 m of any public road or any land within this distance not owned by Mangoola. In this situation blasting can only be undertaken when:

- blasting will not compromise the safety of people or livestock, or cause damage to infrastructure (as demonstrated to the satisfaction of the Secretary)
- specific measures are implemented (as specified in the current Mangoola BMP (2017)).

The same conditions will apply to operations within the MCCO Additional Project Area.

5.3 GEOLOGY OF THE AREA AND BLASTING IMPLICATIONS

Operations within the MCCO Additional Project Area aim to extract four main coal seams (see **Figure 5.4**), down to the Upper Pilot A seam. In order of increasing depth, the key target seams for mining within the proposed Additional Mining Area include the:

- Wallarah seam – typically less than 1 m thickness where present
- Great Northern seam – between 2 and 4 m thickness
- Fassifern seam – between 5 and 6 m thickness
- Upper Pilot A seam – approximately 1 m thickness.

The average extraction depth for the proposed Additional Mining Area will be in the order of 60 m with some extraction of hilly areas taking the extraction thickness to approximately 125 m, see **Figure 5.5**.

Exploration of the MCCO Project Area confirmed that the area is relatively free of major faulting although some occasional faults with throws of less than 2 m are to be expected. Some minor dykes and sills are expected to be within the footprint of the MCCO Project. Based on this information there is no indication that the MCCO Project would generate any unusual elevated vibration readings as might occur in the presence of major faults and the potential vibration magnification around them.

The site geological model is based on integrated data from various phases of the exploration programs undertaken within Assessment Lease (AL) 9 by Mangoola Coal Mine. The most recent exploration program conducted during 2014 to 2018 included drilling of eighteen fully cored holes to assist with geotechnical assessment and evaluation of coal quality.

Assessment of the geological model for the proposed MCCO Project concluded that bench sizes could be in the order of 2 to 25 m. This is mainly due to localised ground undulation in this area. For interburden / overburden blasts it was concluded that the bench heights could be in the order of 5 to 25 m. For coal blasts typical 2 to 6 m bench heights are anticipated.

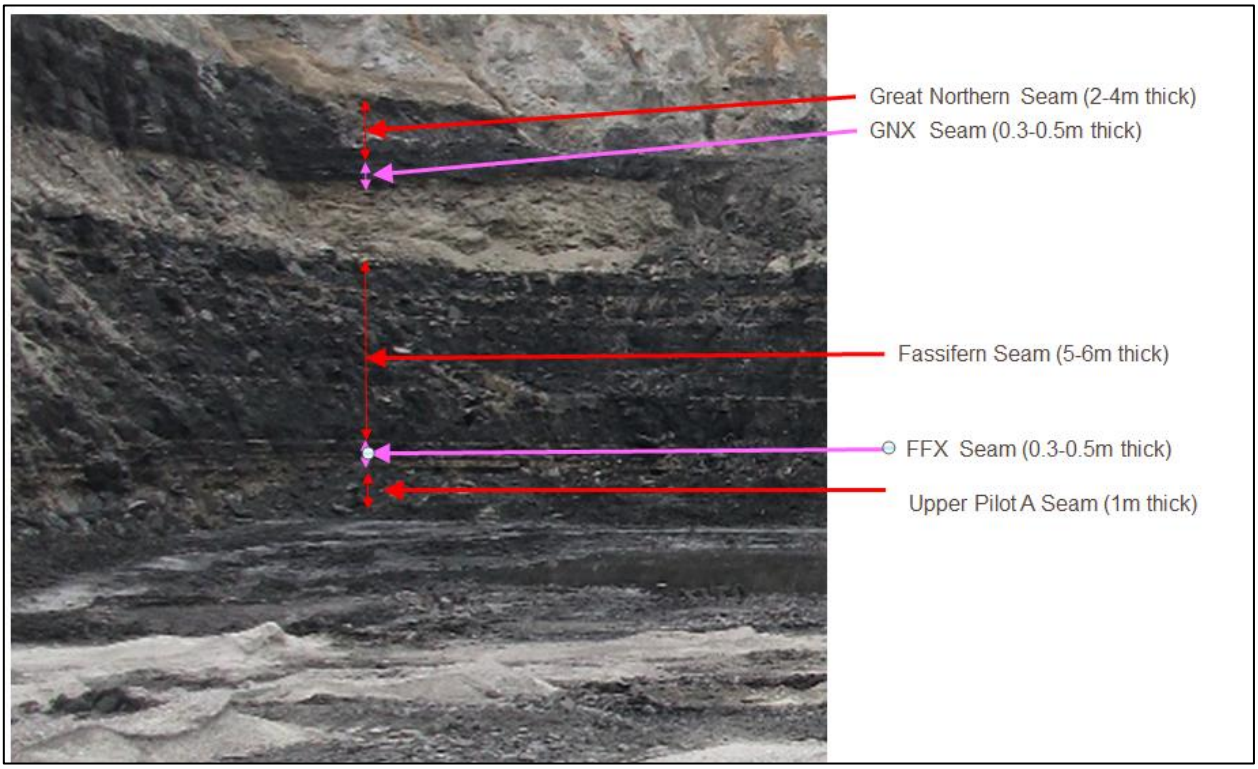


Figure 5.4 – Coal Seams Proposed for Extraction (the three bottom seams) (adopted from Mangoola)

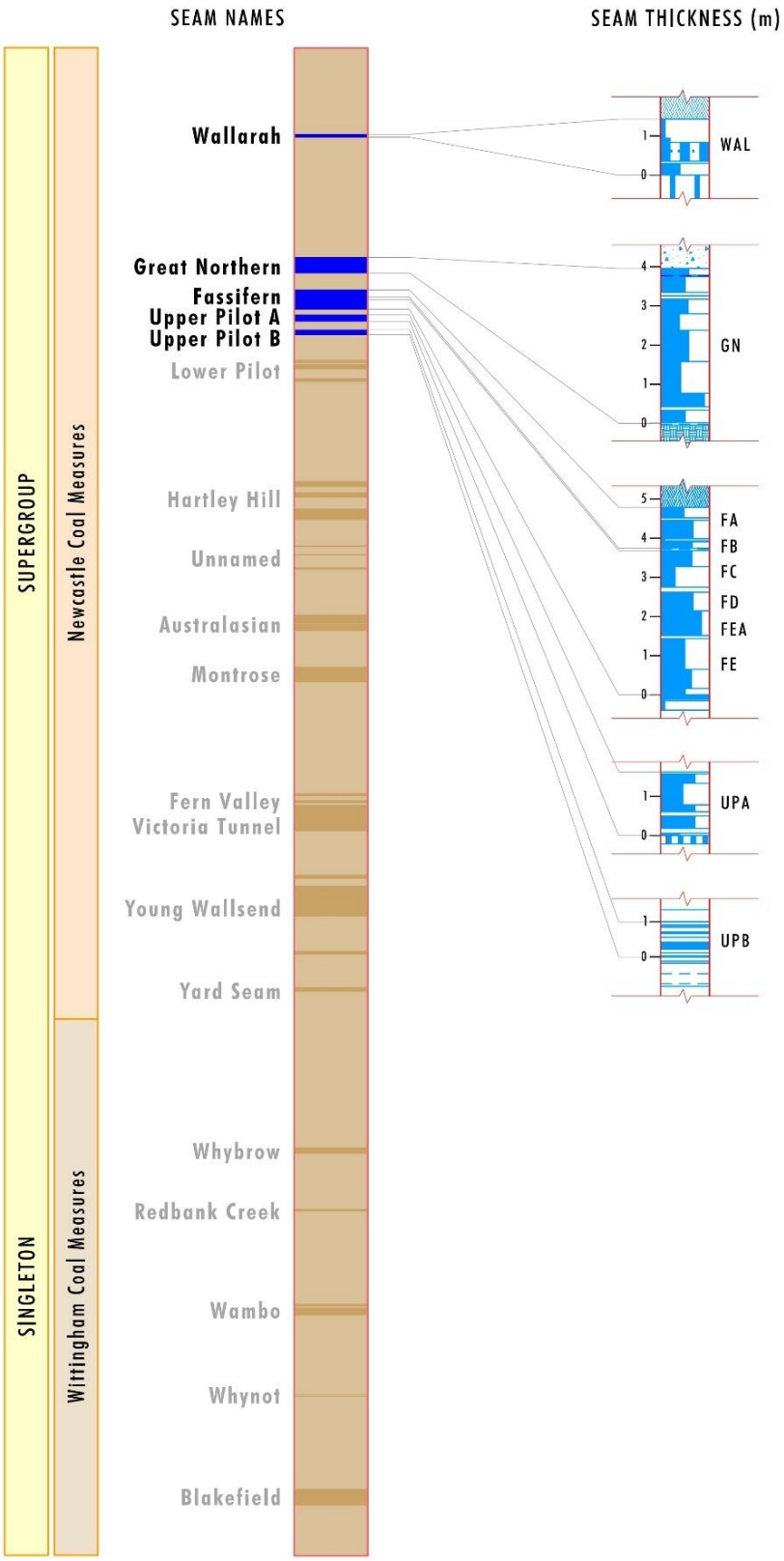


FIGURE 5.5

Typical Stratigraphy for MCCO with Highlighted Targeted Seams

Data Source: Glencore (2015)

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20190111 15.19

5.4 BLAST DESIGN DETAILS

The drill and blast activities proposed within the MCCO Additional Project Area will be generally consistent with the current blasting activities undertaken at Mangoola Coal Mine. The primary focus of the drill and blast activities will be to uncover coal material by blasting the overburden and interburden rock strata material for further handling. Coal seam blasting could also take place depending on the strength of the coal. As indicated, the proposed open cut blasting will allow for the extraction of several coal seams down to the Upper Pilot A seam in the MCCO Additional Project Area (the extraction depth will vary from 16 to 125 m with an average depth of 60 m from the surface level).

The proposed operations within the MCCO Additional Project Area will utilise the same drill rig sizes (currently 229 and 203 mm diameter) and similar blasting bench sizes as those currently used. Mangoola will also continue to utilise blasting products for dry and wet strata conditions**.**

Table 5.1 outlines current blast design parameters used at Mangoola Coal Mine. These parameters have been utilised to derive scenarios modelled in this BIA.

Based on the geological model findings for the MCCO Additional Project Area, bench heights in the order of 5 to 25 m were chosen for modelling of blast vibration impacts. According to **Table 5.1**, current blast size in terms of charge mass can vary between 20 and 1,030 kg. Accounting for the estimated blasting bench heights, the biggest drill rig size (i.e. 229 mm diameter) and product type proposed to be used at the MCCO Project, the potential charge masses for the MCCO Project have been determined. The projected charge masses are in the order of 40 to 659 kg for dry strata conditions (ANFO product) and 62 to 1,030 kg for wet strata conditions (Heavy ANFO product).

In summary, the blast impact assessment is based on ten different scenarios / blast designs incorporating the five bench sizes (i.e. 5, 7.5, 10, 15 and 25 m) and two blasting products (for dry and wet strata conditions for each bench) giving rise to the charge masses in the range of 40 to 1,030 kg as used in vibration modelling tables.

Table 5.1: Drill and Blast Design Details at Mangoola Coal Mine used in Blast Model

Parameter	Value
Drilling Capacity	1 x SKS, 2 x SKF drills. Approx. 750,000m drilled / year
Drill Rig Hole Diameter (mm)	229 mainly used and 203 for lower MIC requirements
Number of Holes per Blast (min/max/avg)	10 / 2,500 / 500
Blast Types	Presplit / overburden / interburden / coal
Product Type / density (kg/m3)	ANFO (0.8), Heavy ANFO (1-1.28), Emulsion (1.1-1.25)
Initiation System	95% Nonel, 5% electronic (ICON)
Burden x Spacing (min/max/avg) (m)	(4 x 4) / (9 x 10) / (6 x 7)
Powder Factor (min/max/avg) (kg/m^3)	0.3 / 0.95 / 0.65
Bench Height (min/max/avg) (m)	2.0 / 25.0 / 16.0
Stemming Height (min/max) (m)	1.8 / 5.0
MIC (min/max) (kg)	20 / 1,030
Blast Volume Range (bcm)	1,000 - 1,500,000 (avg 300,000)
Operational Period	52 weeks / year Shots fired Mon-Fri
Blasting Frequency	2-3 blasts / week on average (however, this could increase to over 5 on a given week)

The Mangoola BMP (2017) enables the design of each blast to minimise ground vibrations, airblast overpressure, dust, flyrock and fumes on the surrounding environment while at the same time maximising blast efficiency. This facilitates compliance with the site-specific blasting conditions. A similar approach will be implemented for the MCCO Project's BMP.

6.0 PREDICTIVE MODELS AND BLAST EMISSION CRITERIA

6.1 PREDICTIVE MODELS

6.1.1 Ground Vibration Predictive Model for Surface Conditions

To provide an estimation of potential vibration levels for a given point, including residential receivers, heritage items / historic sites, or infrastructure, a site law formula has to be developed. The site law formula recommended by the Australian Standard (AS 2187.2-2006) is accepted by the relevant NSW Government agencies as being appropriate for mining blast assessments.

The site law formula is specified as follows:

$$PPV = k\left(\frac{D}{\sqrt{m}}\right)^{a}$$

where:
- ***PPV*** = Ground vibration as vector Peak Particle Velocity (mm/s)
- ***D*** = Distance between charge and point of measurement (m)
- ***m*** = Maximum Instantaneous Charge (MIC), effective charge mass per delay (kg)
- ***a*** = Site exponent
- ***k*** = Site constant

The developed ground vibration predictive model is based on vibration monitoring data collected from blasts undertaken at Mangoola Coal Mine. The analysed sample is in excess of 800 readings collected over a three-year period (i.e. 2015 – 2017). The data includes measurements from permanent monitoring stations located around Mangoola Coal Mine.

As the monitoring data was collected from the Approved Project Area, the results are considered representative for the analysis undertaken in this BIA.

These results were used to develop a site law formula which is generally site specific for the given strata conditions. The collected monitoring results were plotted using a standard log / log plot, see **Figure 6.1**.

The parameters governing ground vibration behaviour for Mangoola conditions, derived through the site law analysis (corresponding to the 95% confidence level), are specified as follows:

$$V = 1{,}198\left(\frac{D}{\sqrt{m}}\right)^{-1.6}$$

Where:
- ***a*** = -1.6 (Site exponent)
- ***k*** = 1,198 (Site constant)

The 95% confidence level, advocated by the Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines (1990), allows for an inherent variation in emission levels. This is by allowing for a 5% exceedance of general criterion. Also, for completeness, the site law diagram includes a median level, that is, Peak Particle Velocity (PPV) 50% level, see **Figure 6.1**.

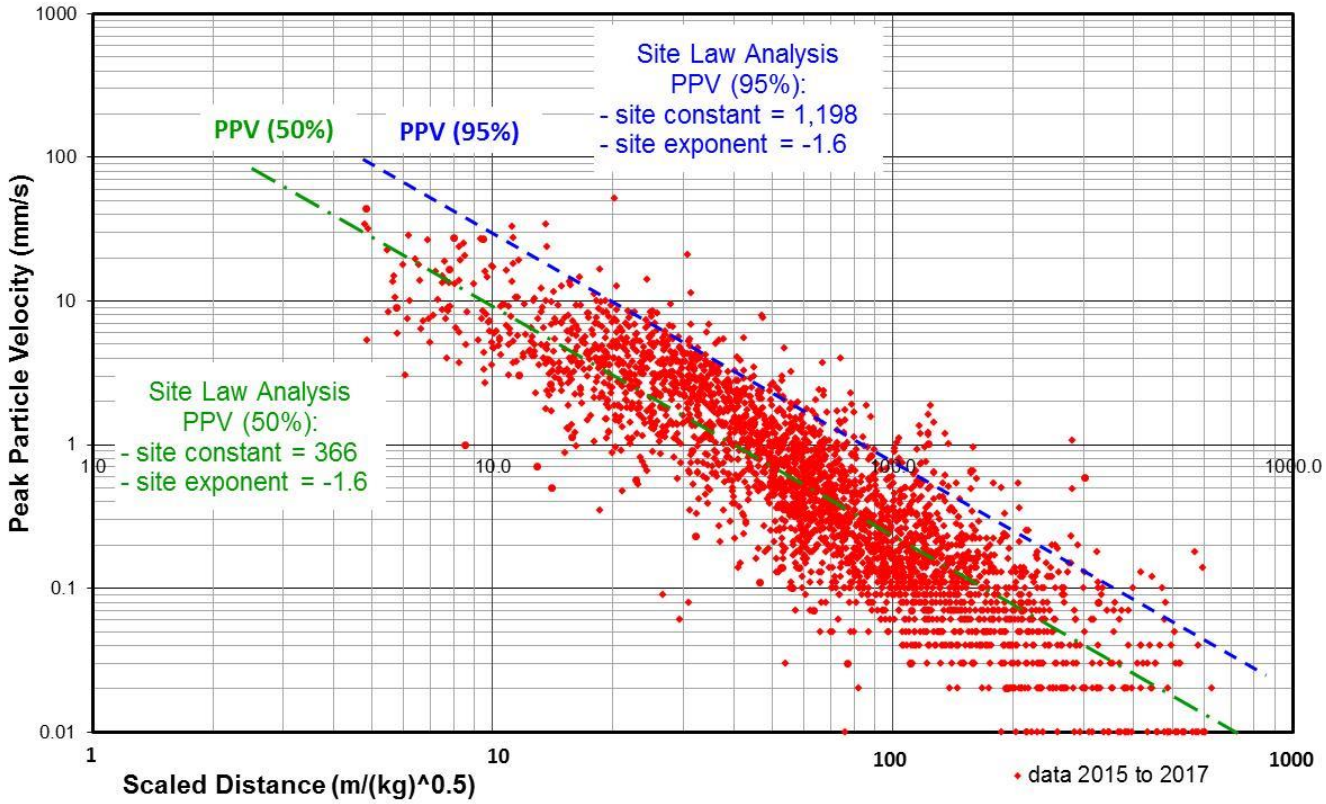

Figure 6.1 – Site Law Analysis for Mangoola Coal Mine Conditions

6.1.2 Airblast Overpressure Predictive Model

To address the airblast overpressure (or air vibration) impacts from the proposed operations within the MCCO Additional Project Area on the adjacent area, including residential receivers, heritage items / historic sites and infrastructure, an airblast predictive model has been developed.

The impact of the generated airblast levels from the source of the blast is generally guided by the sonic decay law as recommended in the Australian Standard (AS 2187.2-2006). For the airblast impact assessment, the cube-root scaled distance is more appropriate than the square root used for ground vibration as detailed in the Australian Standard (AS 2187.2-2006).

The sonic decay formula is specified as follows:

$$P = k\left(\frac{D}{\sqrt[3]{m}}\right)^{a}$$

Where:

P	=	Peak Pressure (kPa)
D	=	Distance between charge and point of measurement (m)
m	=	Maximum Instantaneous Charge (MIC), effective charge Mass per delay (kg)
a	=	Site exponent
k	=	Site constant

There are some limitations to this type of assessment, for example the impact of weather conditions is excluded from this calculation. This can generally be justified as the impact of some of these factors can be controlled or eliminated by an appropriate pre-blast check procedure, which as an example, can eliminate blasting in adverse weather conditions.

The predictive model has been derived from existing air vibration monitoring data from the Approved Project Area using similar blasting parameters to those proposed within the MCCO Additional Project Area and is therefore considered to be representative.

The air vibration monitoring data corresponds to the 2015 - 2017 monitoring period and was based on approximately 800 monitoring points. The airblast monitoring measurements were plotted and, together with other parameters, gave rise to the models shown in **Figure 6.2**. The presented sonic decay law analysis features two lines. The first corresponds to the median of the measured data set (marked as Sound Pressure Level (SPL) 50%), and the second marked as SPL 95% corresponding to 95% of the total population of data. Note that the 95% criteria is utilised following ANZECC guidelines (1990), which allow for an inherent variation in emission levels by allowing a 5% exceedance of general criterion.

Also, to facilitate the accuracy of the assessment, the forced exponent of - 1.45 has been used which corresponds to an attenuation rate of 8.6 dBL with a doubling of distance, as specified in Australian Standard, Explosives – Storage and use, Part 2 – Use of explosives (AS 2187.2-2006).

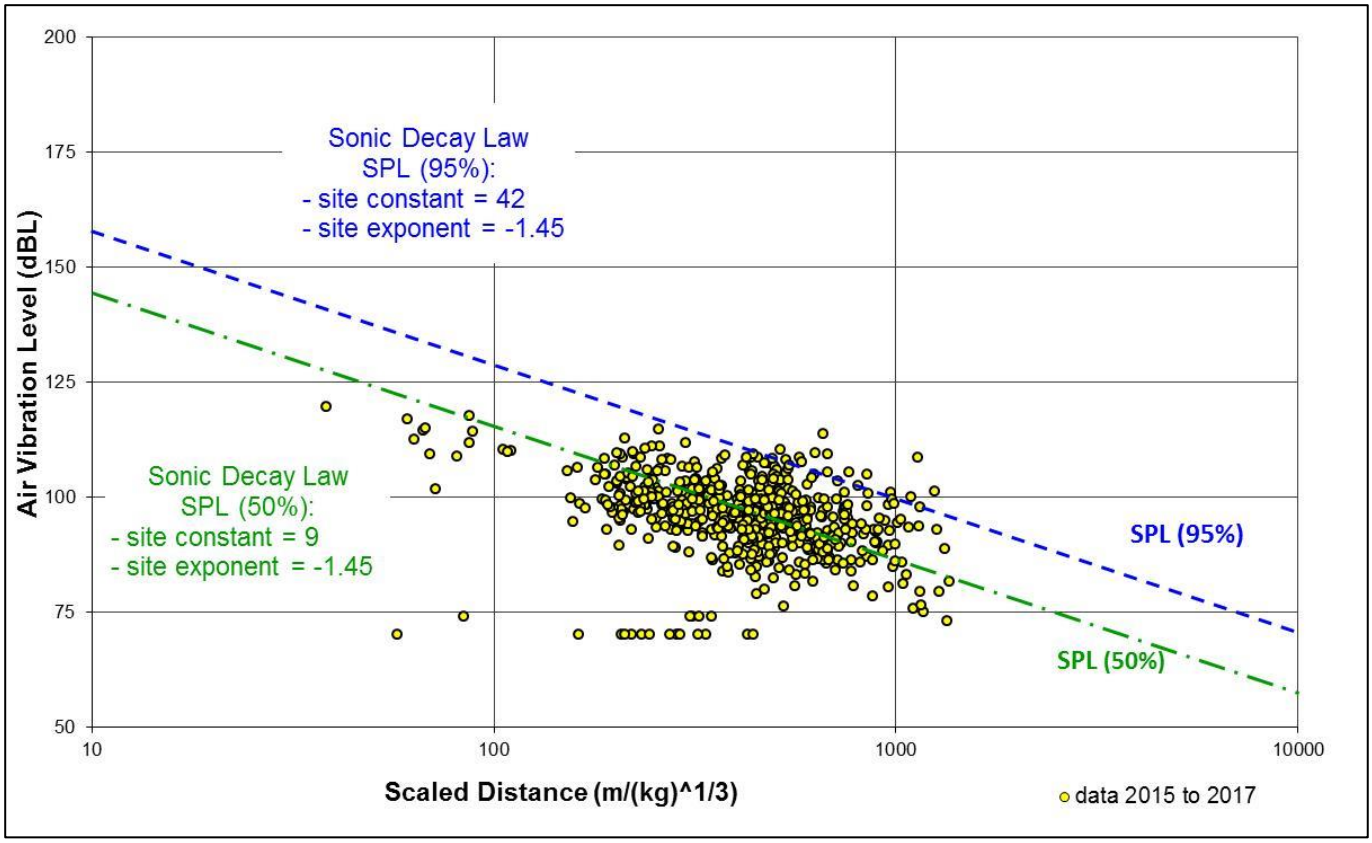

Figure 6.2 – Sonic Decay Law Analysis for Mangoola Conditions

Therefore, based on the above assessment, the estimated sonic decay parameters (using the 95% confidence level) are as follows:

$$\boldsymbol{P} = 42\left(\frac{D}{\sqrt[3]{m}}\right)^{-1.45}$$

Where: $\boldsymbol{a}$ = -1.45 (Site exponent)

$\boldsymbol{k}$ = 42 (Site constant)

6.2 BLAST EMISSION CRITERIA

6.2.1 Criteria for Residential Receivers

Blast Emission Criteria for Human Comfort

To minimise the impact on residential receivers, the NSW Environment Protection Authority (EPA) adopts the ANZECC guidelines (1990) "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration". The guidelines indicate the following:

- The general criterion for ground vibration is 5 mm/s, Peak Particle Velocity (PPV)
- The PPV of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The upper PPV level of 10 mm/s should not be exceeded at any time
- The general airblast criterion is 115 dBL (decibel Linear)
- The level of 115 dBL may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The airblast level should not exceed 120 dBL at any time.

The same criteria are specified in Mangoola Coal Mine's existing approvals (PA 06_0014 and EPL 12894). Accordingly, the impacts associated with the proposed operations within the MCCO Additional Project Area have been assessed against these criteria.

Blast Damage Criteria – Ground Vibration

For blast damage criteria for residential structures the Australian Standard AS2187.2-2006, refers to other available standards, such as British Standard BS 7385-2:1993 and American (USBM) RI8507.

The blast damage criteria are frequency dependant; based on the British Standard BS 7385-2:1993 for unreinforced or light framed structures (such as residential) these range from 15 mm/s at 4 Hz to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above, see **Appendix 1**. The lowest transient vibration value for cosmetic damage is estimated as 15 mm/s at 4 Hz. The cited range is well above the blast emission criteria for human comfort (i.e. 5 mm/s and 10 mm/s) as discussed above. It therefore follows that when vibration limits for human comfort are imposed, compliance with blast damage criteria for residential structures will be achieved.

Blast Damage Criteria – Airblast

The Australian Standard AS2187.2-2006, specifies a conservative limit of 133 dBL as a safe level, implying no damage to the structure. AS2187.2-2006 also states that damage to windows (regarded as the most fragile / sensitive material) is considered improbable for airblast level exposures below 140 dBL.

Therefore, when vibration limits for human comfort are imposed (i.e. 115 and 120 dBL, as indicated above), by default, the possibility of structural damage for the surrounding residential structures is eliminated.

6.2.2 Criteria for Heritage Items, Rock Shelter Sites / Rock Formations and Infrastructure

The ground vibration and airblast emission criteria for the identified heritage items, rock formations / rock shelter sites and infrastructure are presented below and summarised in **Table 6.1**. The identified assessment items have been discussed in **Section 3** and are shown on **Figures 3.2** and **3.3**.

Historic Heritage Items

The historic heritage items have been presented in **Section 3.2** and are shown on **Figure 3.2**. The items vary greatly in the materials used and their construction. Considering the variety of structures, the applicable assessment criteria are 5 mm/s and 133 dBL. It is noted however that the airblast assessment criterion is applicable to buildings / sheds only.

The specified assessment criteria are well below the blast damage levels as discussed in **Section 6.2.1** (i.e. the lowest transient vibration value for cosmetic damage is estimated as 15 mm/s at 4 Hz) and highlighted in **Appendix 1**. The assessment criteria are in line with the ACARP Report (No. C14057) findings for Heritage Sites, which recommends 'safe' vibration limits such as those used by British Standard BS7385. Note that these assessment criteria are not limits that must be met, but indicate the levels at which no impacts are predicted.

Rock Shelter Sites / Rock Formations

As described in **Section 3.2**, there are several Aboriginal rock shelter sites and two rock formations of European heritage significance located in the proximity of the MCCO Project.

The current Mangoola BMP states that there is no set vibration limit for the rock shelter sites or rock formations, however a safe blasting limit as determined by specialist analysis is applicable if such was determined.

A specialist report (Moore (2018)) based on the latest data examination determined the safe blast vibration limit of 50 mm/s.

On this basis, the 50 mm/s vibration criterion has been used for the rock shelter sites and rock formations as applicable to the MCCO Project.

Infrastructure

500 kV ETL Pylons

The 500 kV ETL has been presented in **Section 3.3** and shown on **Figure 3.3**.

There are two types of transmission pylons being suspension and tension pylons. Typically, as tension pylons are located at the corners/bends lower vibration limits would apply. This is dictated by the greater design complexity and difficulties in rectifying any damage to footings of tension pylons which are exposed to significant permanent loads.

There is a written agreement between Mangoola and TransGrid (2015) the ETL operator, approved by the Department of Planning and Environment (refer to Mangoola BMP (2017) Appendix 2) which modifies the original ground vibration limit of 50 mm/s as specified in the Project Approval (PA 06_0014).

According to the agreement currently approved ground vibration limit criteria are as follows:

- 125 mm/s for suspension pylons and
- 60 mm/s for tension pylons.

These vibration limits are used as the assessment criteria for the MCCO Project.

11 kV Powerlines

The 11 kV powerlines have been presented in **Section 3.3** and shown on **Figure 3.3**.

An overview of the existing allowable vibration limits for various infrastructure (including timber power poles) was presented in ACARP Report No. C14057. The vibration limit for timber power poles is 100 mm/s.

This vibration limit is used as the assessment criteria for the MCCO Project.

Telecommunication Infrastructure

Telstra buried telecommunication cables have been presented in **Section 3.3** and shown on **Figure 3.3**.

An overview of the existing allowable vibration limits for various infrastructure (including buried telecommunication cables and pipelines) was presented in ACARP Report No. C14057. The vibration limit for buried cables is 100 mm/s.

This vibration limit is used as the assessment criteria for the MCCO Project.

Prescribed Water Dams

The prescribed water dams (PWD and RWD) have been presented in **Section 3.3** and shown on **Figure 3.3**.

The vibration limits for the prescribed water dams were originally imposed by the NSW Dam Safety Committee (DSC) on Mangoola Coal Mine.

The vibration limit for PWD and RWD are currently set at 50 mm/s, as stated in the conditions imposed by the NSW DSC (DSC Correspondence - Annexure “D” General conditions apply to the Mangoola 3 and Mangoola 4, issued in 2012 and 2014).

The same vibration limits are used as the assessment criteria for the MCCO Project.

Prescribed Tailings Dams

TD1 and TD2 prescribed tailings dams have been presented in **Section 3.3** and shown on **Figure 3.3**.

The original vibration limit applicable to the dam walls was set at 50 mm/s level. However, this limit was revised to 100 mm/s, as stated in a letter dated the 15.07.14 and approved by the Director, Mine Safety Operations and Chief Inspector.

On this basis, the current 100 mm/s vibration criterion has been used for both TD1 and TD2 and is applicable to the MCCO Project.

Public Roads

Public roads relevant to the assessment have been presented in **Section 3.3** and shown on **Figure 3.3**.

A comprehensive overview of the existing allowable vibration limits for various infrastructure (including public roads) was presented in ACARP Report No. C14057. The vibration limit for public roads is 100 mm/s.

This vibration limit is used as the assessment criteria for the MCCO Project.

Mine-owned Infrastructure

There is a range of mine-owned infrastructure in operation, or proposed to be erected (i.e. haul road overpass over Big Flat Creek and Wybong Road, shown on **Figure 3.3**) in the vicinity of the MCCO Project. Blast impacts will be managed as part of the MCCO Project with the objective to maintain safe working practices for both equipment and personnel present, as well as infrastructure functionality after the blast.

Crown Land

Crown land relevant to the assessment has been presented in **Section 3.4** and shown on **Figure 3.3**.

There is no applicable vibration limit for the Crown land. Blast impacts will be managed as part of the MCCO Project to maintain safe environmental practices for the possible users of the land.

Table 6.1: Summary of Blast Emission Criteria for the MCCO Project

Item	Vibration Criteria (mm/s)	Airblast Criteria (dBL)
Private Residences [1]	5 / 10	115 / 120
Heritage Items [2]	5	133
Rock Formations and Rock Shelter Sites [3]	Yearly assessment 50	
INFRASTRUCTURE		
500 kV Transmission Pylons [4]	60 / 125	n/a
11 kV Powerlines - Timber Poles [5]	100	n/a
Buried telecommunication Cables [5]	100	n/a
Public Roads [5]	100	n/a
Prescribed Water Dams (PWD and RWD)[6]	50	n/a
Prescribed Tailings Dams (TD1 and TD2)[6]	100	n/a
Mine Owned Infrastructure	Managed internally	-

1 – Specified in the existing Project Approval (PA 06_0014);

2 – Ground vibration criterion - as presented in ACARP Report No. C14057

Airblast criterion – based on the airblast limit for damage control as specified in the Australian Standard AS2187.2-2006 (applicable to buildings / sheds only);

3 – Currently no specific limit is stated in the Mangoola BMP (2017), however the 50 mm/s safe blasting limit has been determined by specialist analysis (Moore (2018); an annual assessment by a qualified specialist and ongoing vibration monitoring apply;

4 – As per written agreement between Mangoola and TransGrid (2015);

5 – As presented in ACARP Report No. C14057;

6 – As specified by the NSW DSC;

7.0 BLAST IMPACT ASSESSMENT

The blast impact assessment was undertaken for the sensitive receivers as identified in **Section 3** including private residences, cultural heritage sites, rock formations and infrastructure.

As described in **Section 5.4,** the blast impact assessment included ten different simulations incorporating the bench sizes and blasting products proposed to be used in the MCCO Project. The ten simulations account for five different bench sizes (i.e. 5, 7.5, 10, 15, and 25 m) and two blasting products (for each bench), one for dry and one for wet strata conditions.

The modelling is based on the worst-case scenario, that is when blasting is undertaken at the edge of the Proposed Additional Mining Area, which corresponds to the minimum distance

between the blasting area and the sensitive receiver. The process allows for the identification of potential maximum ground vibration and airblast exposure which may be generated over the lifetime of the MCCO project. The purpose of such an approach is to inform the blasting design process of potential limitations.

7.1 COMMUNITY

The assessment addresses the potential impact of blasting within MCCO Additional Project Area on the surrounding area, specifically the private residential receivers. The locations of these receivers were discussed in **Section 3.1** and shown on **Figure 3.1** The aim is to identify potential ground vibration and airblast exposure as well as any flyrock which may be generated when undertaking blasting within the proposed Additional Mining Area. The estimated ground and air vibration exposure levels are discussed in the context of applicable ground and air vibration criteria as defined in **Section 6.2**.

7.1.1 Assessment Results

The initial worst-case scenario analysis for ground vibration exposure identified no exceedances of the ground vibration criteria, therefore no further analysis was required. With regards to airblast overpressure assessment, the initial worst-case predictions showed some areas where additional management would be required. In this regard, an additional level of analysis was undertaken using a staged mine plan assessment approach, in order to understand at which points during the project life and in which areas of the Proposed MCCO Additional Mining Area additional management of blasting parameters would be required.

7.1.1.1 Ground Vibration

The potential impact of ground vibrations from blasting within the MCCO Additional Project Area on private residential receivers was assessed in detail using ground vibration modelling. The modelling utilised the site law formula as explained in **Section 6.1.1**.

The ground vibration modelling estimates ground vibration levels for private residential receivers located within a 5 km radius of the proposed MCCO Additional Mining Area (see **Figure 3.1)**. Detailed predictions for residential receivers located in excess of 5 km are not required as these receivers should generally be exposed to ground vibration levels less than 0.4 mm/s (for the highest charge mass). Note that the 0.4 mm/s level is difficult to detect for most of the residential population. In addition, the nominal level of 0.4 mm/s is well below the 5 mm/s ground vibration limit criteria used in the assessment. The impact of blasting (ground vibration) on residential receivers located beyond the 5 km radius is therefore considered negligible.

Table 7.1 highlights the maximum vibration impacts for private residential receivers within a 5 km radius that will be generated over the lifetime of the MCCO Project. The distances

stated in the table represent the minimum distances between the residential receivers and the extraction area boundary, as such they give rise to the most extreme scenario over the lifetime of the MCCO Project in terms of the vibration impact.

The results of the ground vibration modelling for the private residential receivers are summarised as follows:

- There is a level of variability in the blast vibration impact dependent upon the charge mass; with negligible impact for low charge masses.
- The ground vibration modelling for private residential receivers indicates that the ground vibration impacts can be managed effectively to a level below the applicable vibration limit criteria of 5 mm/s (for 95% of blasts) and 10 mm/s (not to be exceeded).
- The estimated maximum vibration exposure for all residential receivers, using variable charge masses of 40 to 1,030 kg, is predicted to be in the order of 0.1 to 3.9 mm/s. Therefore, compliance with vibration limits is predicted to be achieved at all private residences for all scenarios assessed. When considering the use of smaller bench sizes, such as 5 to 10 m, the ground vibration impact for all residences (with the exception of two residences) is considered low / negligible, i.e. below 1 mm/s. The corresponding vibration exposure for the two residences (ID 139 and 157) would be 1.2 and 1.5 mm/s respectively, well below the applicable vibration limits specified as 5 mm/s (for 95% of blasts) and 10 mm/s (not to be exceeded).

Table 7.1: Results of Ground Vibration Modelling for Residential Receivers (within a 5 km radius of the MCCO Project) when blasting is undertaken from the edge of the pit (i.e. worst-case scenario)

Residential ID	Min. Distance[1] (m)	Estimated Max. Ground Vibration (mm/s) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
66[2]	1,600	0.2	0.2	0.4	0.6	0.6	0.9	1.0	1.4	1.6	2.3
83[2]	2,360	0.1	0.1	0.2	0.3	0.3	0.5	0.5	0.8	0.9	1.2
109 A	3,660	<0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.6
109 B	3,580	<0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.6
109 C	3,630	<0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.6
109 D	3,560	<0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.6
109 E	3,620	<0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.6
109 F	3,600	<0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.6
110[2]	2,480	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.7	0.8	1.1
124	3,250	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.5	0.7
126 A	4,230	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5
126 B	4,250	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5
128	1,890	<0.1	0.2	0.3	0.5	0.5	0.7	0.8	1.1	1.2	1.8
130[2]	2,470	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.7	0.8	1.1
134 A	3,150	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.5	0.8
134 C	3,190	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5	0.5	0.8

Residential ID	Min. Distance[1] (m)	Estimated Max. Ground Vibration (mm/s) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
134 D	3,620	<0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.6
139[2]	1,370	0.2	0.3	0.5	0.8	0.8	1.2	1.3	1.8	2.1	3.0
144	2,010	0.1	0.2	0.3	0.4	0.4	0.6	0.7	1.0	1.1	1.6
148[2]	2,600	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.7	0.7	1.1
154	3,520	<0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.7
156	3,790	<0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.6
157	1,150	0.3	0.4	0.7	1.0	1.1	1.5	1.7	2.4	2.7	3.9
165	2,710	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.6	0.7	1.0
170	1,950	0.1	0.2	0.3	0.4	0.5	0.7	0.7	1.0	1.2	1.7
171	1,590	0.2	0.2	0.4	0.6	0.6	0.9	1.0	1.4	1.6	2.3
172	2,860	0.1	0.1	0.2	0.2	0.2	0.4	0.4	0.6	0.6	0.9
174 A	4,360	<0.1	<0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5
174 B	4,310	<0.1	<0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5
176	4,530	<0.1	<0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4
205[2]	1,930	0.1	0.2	0.3	0.4	0.5	0.7	0.7	1.1	1.2	1.7
206	2,670	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.6	0.7	1.0
207	4,270	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5
208 A	4,870	<0.1	<0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4
209	4,380	<0.1	<0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5

Residential ID	Min. Distance[(1)] (m)	Estimated Max. Ground Vibration (mm/s) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
257	3,810	<0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.4	0.4	0.6
258	3,320	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.7
260	2,730	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.6	0.7	1.0
261	3,030	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.8
263	2,290	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.3
296	4,810	<0.1	<0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4
298	3,600	<0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.6
299	4,050	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5
301	5,000	<0.1	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4
304	4,450	<0.1	<0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4
316	2,860	0.1	0.1	0.2	0.2	0.2	0.4	0.4	0.6	0.6	0.9
319	4,200	<0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5
321	3,360	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.7
325 B	4,880	<0.1	<0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4

(1) - Minimum distance to the MCCO Additional Mining Area over the lifetime of the Project;

(2) - *Private receivers predicted to experience noise from the MCCO Project at levels where it is expected that voluntary acquisition rights will apply as outlined in the Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments 2018 (VLAMP) should the MCCO Project be approved.*

7.1.1.2 Airblast

To perform the airblast overpressure modelling the sonic decay formula specified in **Section 6.1.2** was utilised.

The modelling provides estimations of the maximum airblast levels (i.e. worst-case scenario) for private residential receivers located within a 5 km radius of the MCCO Additional Mining Area. The modelling incorporates variable charge masses according to the proposed bench height and blasting product.

Detailed predictions for residential receivers located in excess of 5 km are not considered necessary as these residential receivers should generally be exposed to airblast levels less than 108 dBL (below the 115 dBL air vibration limit) for the modelled parameters.

The initial analysis based on the worst-case scenario which utilises the minimum distance between each residence and the overall mining area (over the lifetime of the MCCO Project), identified areas where increased management would be required. To gain further information, an additional level of analysis was undertaken using a staged mine plan assessment which utilised the minimum distance between each residence and the boundary of a particular stage. With such an approach, areas within the proposed mining area and stages in the timeline of the MCCO Project which require more detailed management of blasting parameters were identified. The results are presented in **Tables 7.2** to **7.4.**

To further inform the blasting design process, an analysis of potential MICs and their spatial distribution with respect to the airblast overpressure limit was undertaken. **Figure 7.1** presents the MCCO Additional Mining Area subdivided into sections for assessment purposes, each section has been labelled with an MIC value, bench size and an explosive product. The areas and blasting parameters have been calculated to facilitate a range of airblast overpressures with the maximum value of 114 dBL at any private residence. The 114 dBL level used in the analysis is below the applicable 115 dBL criterion; it was selected to demonstrate that compliance can be achieved within the required range. The analysis confirms that even in the latest stages of the MCCO Project, larger blasts (25 m benches) can be undertaken depending on the location of the blast while the emissions maintained below the 115 dBL level. The analysis demonstrated that blasting in the MCCO Additional Mining Area can be conducted in accordance with the conditions of the applicable airblast limits for private residences (115 dBL (for 95% of blasts) and 120 dBL (not to be exceeded)) via the application of smaller blast sizes (lower charge masses) while blasting in some locations.

The results of the airblast modelling, for private residential receivers, are summarised as follows:

- There is a high level of variability in the airblast overpressure impact, dependent upon the charge mass and location of the blast.
- The airblast overpressure modelling for private residential receivers indicates that the airblast impacts can be managed effectively to a level below the applicable limit criteria (i.e. 115 dBL (for 95% of blasts) and 120 dBL (not to be exceeded)) via the application of lower charge masses.

- **Figure 7.1** shows that by controlling the size of the blast (bench size and charge mass) airblast overpressure compliance will be achieved for all private residences; using the indicated MICs within each mining section would generate airblast overpressure below the applicable 115 dBL level for all private residences.
- The staged mine plan assessment (**Tables 7.2** to **7.4**) confirmed gradually increasing overpressure results, with the highest exposure expected in the final years of the MCCO Project aligning with the stage of mining closest to private receivers. The assessment demonstrated that through the management of charge mass, all blasts can be managed to achieve compliance with airblast limits.
- As the proposed MCCO Project reaches greater depths, some topographical shielding will emerge due to a change in the contours of the area. This will assist and lessen the risk of airblast impacts on the surrounding communities with large blast sizes.

Table 7.2: Results of Airblast Modelling for Residential Receivers (within a 5 km radius of the MCCO Project) - Project Year 1

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
66[2]	1,600	109	111	114	116	116	118	118	120	121	123
83[2]	3,560	99	101	104	105	106	108	108	110	111	113
109 A	4,740	95	97	100	102	102	104	105	106	107	109
109 B	4,670	96	97	100	102	102	104	105	107	107	109
109 C	4,720	95	97	100	102	102	104	105	107	107	109
109 D	4,660	96	97	100	102	102	104	105	107	107	109
109 E	4,700	95	97	100	102	102	104	105	107	107	109
109 F	4,690	95	97	100	102	102	104	105	107	107	109
110[2]	3,550	99	101	104	106	106	108	108	110	111	113
124	4,390	96	98	101	103	103	105	106	107	108	110
126 A	4,230	97	99	101	103	104	105	106	108	109	110
126 B	4,250	97	99	101	103	104	105	106	108	108	110
128	2,640	103	105	107	109	110	111	112	114	114	116
130[2]	3,540	99	101	104	106	106	108	108	110	111	113
134 A	4,180	97	99	102	103	104	106	106	108	109	111
134 C	4,200	97	99	102	103	104	106	106	108	109	110
134 D	4,810	95	97	100	102	102	104	104	106	107	109
139[2]	2,140	105	107	110	112	112	114	115	116	117	119

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
144	3,020	101	103	106	108	108	110	110	112	113	115
148[2]	3,680	99	100	103	105	105	107	108	110	110	112
154	4,420	96	98	101	103	103	105	105	107	108	110
156	5,050	95	96	99	101	101	103	104	106	106	108
157	1,750	108	110	113	114	115	117	117	119	120	122
165	3,950	98	99	102	104	104	106	107	109	109	111
170	2,590	103	105	108	109	110	112	112	114	115	117
171	2,030	106	108	111	113	113	115	115	117	118	120
172	4,090	97	99	102	104	104	106	106	108	109	111
174 A	4,350	96	98	101	103	103	105	106	108	108	110
174 B	4,310	97	98	101	103	103	105	106	108	108	110
176	5,880	93	94	97	99	99	101	102	104	104	106
205[2]	2,320	104	106	109	111	111	113	114	115	116	118
206	3,200	100	102	105	107	107	109	110	111	112	114
207	4,910	95	97	100	101	102	104	104	106	107	109
208 A	5,860	93	95	97	99	100	101	102	104	104	106
209	5,790	93	95	97	99	100	102	102	104	105	106
257	4,870	95	97	100	102	102	104	104	106	107	109
258	4,120	97	99	102	104	104	106	106	108	109	111

Residential ID	Min. Distance[(1)] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
260	3,230	100	102	105	107	107	109	109	111	112	114
261	3,350	100	102	104	106	107	108	109	111	111	113
263	2,630	103	105	107	109	110	111	112	114	115	116
296	5,480	94	95	98	100	100	102	103	105	105	107
298	3,860	98	100	103	104	105	107	107	109	110	112
299	4,490	96	98	101	103	103	105	105	107	108	110
301	5,170	94	96	99	101	101	103	103	105	106	108
304	4,800	95	97	100	102	102	104	104	106	107	109
316	3,880	98	100	103	104	105	107	107	109	110	111
319	4,580	96	98	100	102	103	104	105	107	108	109
321	3,700	98	100	103	105	105	107	108	110	110	112
325 B	4,880	95	97	100	102	102	104	104	106	107	109

(1) - Minimum distance to the boundary of the MCCO Additional Mining Area for Project year 1;

(2) - Private receivers predicted to experience noise from the MCCO Project at levels where it is expected that voluntary acquisition rights will apply as outlined in the VLAMP should the MCCO Project be approved.

Grey cells – vibration estimate (measured to one decimal point) exceeding the applicable limit (115 dBL for 95% of blasts and 120 dBL not to be exceeded); however, compliance is achievable through the application of an appropriate blast design.

Table 7.3: Results of Airblast Modelling for Residential Receivers (within a 5 km radius of the MCCO Project) - Project Year 5

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
66[2]	1,870	107	109	112	114	114	116	116	118	119	121
83[2]	2,360	104	106	109	111	111	113	113	115	116	118
109 A	3,700	98	100	103	105	105	107	108	110	110	112
109 B	3,620	99	101	103	105	106	107	108	110	110	112
109 C	3,680	99	100	103	105	105	107	108	110	110	112
109 D	3,610	99	101	103	105	106	107	108	110	111	112
109 E	3,650	99	100	103	105	105	107	108	110	110	112
109 F	3,630	99	101	103	105	106	107	108	110	110	112
110[2]	2,660	103	104	107	109	109	111	112	114	114	116
124	3,350	100	102	104	106	107	108	109	111	111	113
126 A	4,650	96	97	100	102	102	104	105	107	107	109
126 B	4,660	96	97	100	102	102	104	105	107	107	109
128	1,920	107	109	111	113	114	115	116	118	118	120
130[2]	2,510	103	105	108	110	110	112	113	114	115	117
134 A	3,380	100	101	104	106	106	108	109	111	111	113
134 C	3,380	100	101	104	106	106	108	109	111	111	113
134 D	3,960	98	99	102	104	104	106	107	109	109	111
139[2]	1,410	111	112	115	117	117	119	120	122	122	124

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
144	2,190	105	107	110	112	112	114	114	116	117	119
148[2]	2,680	103	104	107	109	109	111	112	114	114	116
154	3,950	98	99	102	104	104	106	107	109	109	111
156	4,270	97	98	101	103	103	105	106	108	108	110
157	1,150	113	115	118	120	120	122	122	124	125	127
165	3,170	100	102	105	107	107	109	110	112	112	114
170	1,980	106	108	111	113	113	115	116	117	118	120
171	1,590	109	111	114	116	116	118	118	120	121	123
172	3,290	100	102	105	106	107	109	109	111	112	114
174 A	4,790	95	97	100	102	102	104	104	106	107	109
174 B	4,770	95	97	100	102	102	104	105	106	107	109
176	4,530	96	98	101	102	103	105	105	107	108	110
205[2]	1,930	107	108	111	113	113	115	116	118	118	120
206	2,670	103	104	107	109	109	111	112	114	114	116
207	4,290	97	98	101	103	103	105	106	108	108	110
208 A	5,080	94	96	99	101	101	103	104	106	106	108
209	4,380	96	98	101	103	103	105	106	107	108	110
257	4,060	97	99	102	104	104	106	107	108	109	111
258	3,390	100	101	104	106	106	108	109	111	111	113

Residential ID	Min. Distance[(1)] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
260	2,730	102	104	107	109	109	111	112	113	114	116
261	3,030	101	103	106	108	108	110	110	112	113	115
263	2,290	104	106	109	111	111	113	114	116	116	118
296	4,820	95	97	100	102	102	104	104	106	107	109
298	3,600	99	101	103	105	106	108	108	110	111	112
299	4,050	97	99	102	104	104	106	107	108	109	111
301	5,000	95	97	99	101	102	103	104	106	106	108
304	4,450	96	98	101	103	103	105	105	107	108	110
316	3,070	101	103	105	107	108	110	110	112	113	114
319	4,210	97	99	102	103	104	106	106	108	109	110
321	3,360	100	102	104	106	107	108	109	111	111	113
325 B	5,210	94	96	99	101	101	103	103	105	106	108

(1) - Minimum distance to the boundary of the MCCO Additional Mining Area for Project year 5;

(2) - Private receivers predicted to experience noise from the MCCO Project at levels where it is expected that voluntary acquisition rights will apply as outlined in the VLAMP should the MCCO Project be approved.

Grey cells – vibration estimate (measured to one decimal point) exceeding the applicable limit (115 dBL for 95% of blasts and 120 dBL not to be exceeded); however, compliance is achievable through the application of an appropriate blast design.

Table 7.4: Results of Airblast Modelling for Residential Receivers (within a 5 km radius of the MCCO Project) - Project Year 8

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
66[2]	2,290	104	106	109	111	111	113	114	116	116	118
83[2]	2,930	101	103	106	108	108	110	111	113	113	115
109 A	3,660	99	100	103	105	105	107	108	110	110	112
109 B	3,580	99	101	104	105	106	108	108	110	111	113
109 C	3,630	99	101	103	105	106	107	108	110	110	112
109 D	3,560	99	101	104	105	106	108	108	110	111	113
109 E	3,620	99	101	103	105	106	107	108	110	110	112
109 F	3,600	99	101	103	105	106	108	108	110	111	112
110[2]	2,480	103	105	108	110	110	112	113	115	115	117
124	3,250	100	102	105	107	107	109	109	111	112	114
126 A	5,140	94	96	99	101	101	103	104	105	106	108
126 B	5,150	94	96	99	101	101	103	104	105	106	108
128	1,890	107	109	112	113	114	116	116	118	119	121
130[2]	2,470	104	105	108	110	110	112	113	115	115	117
134 A	3,150	100	102	105	107	107	109	110	112	112	114
134 C	3,190	100	102	105	107	107	109	110	111	112	114
134 D	3,620	99	101	103	105	106	107	108	110	110	112
139[2]	1,370	111	113	116	118	118	120	120	122	123	125

Residential ID	Min. Distance[1] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
144	2,010	106	108	111	113	113	115	115	117	118	120
148[2]	2,600	103	105	108	109	110	112	112	114	115	117
154	3,520	99	101	104	106	106	108	108	110	111	113
156	3,790	98	100	103	105	105	107	107	109	110	112
157	1,150	113	115	118	120	120	122	122	124	125	127
165	2,710	102	104	107	109	109	111	112	113	114	116
170	1,950	107	108	111	113	113	115	116	118	118	120
171	1,610	109	111	114	115	116	118	118	120	121	123
172	2,860	102	104	106	108	109	110	111	113	113	115
174 A	5,260	94	96	99	101	101	103	103	105	106	108
174 B	5,240	94	96	99	101	101	103	103	105	106	108
176	4,970	95	97	99	101	102	103	104	106	106	108
205[2]	1,950	107	108	111	113	113	115	116	118	118	120
206	2,670	103	104	107	109	109	111	112	114	114	116
207	4,270	97	98	101	103	103	105	106	108	108	110
208 A	4,870	95	97	100	102	102	104	104	106	107	109
209	4,730	95	97	100	102	102	104	105	106	107	109
257	3,810	98	100	103	105	105	107	107	109	110	112
258	3,320	100	102	104	106	107	109	109	111	112	113

Residential ID	Min. Distance[(1)] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
260	2,730	102	104	107	109	109	111	112	113	114	116
261	3,050	101	103	106	107	108	110	110	112	113	115
263	2,310	104	106	109	111	111	113	114	116	116	118
296	4,810	95	97	100	102	102	104	104	106	107	109
298	3,630	99	101	103	105	106	107	108	110	110	112
299	4,060	97	99	102	104	104	106	107	108	109	111
301	5,040	95	96	99	101	101	103	104	106	106	108
304	4,470	96	98	101	103	103	105	105	107	108	110
316	2,860	102	104	106	108	109	110	111	113	113	115
319	4,240	97	99	101	103	104	105	106	108	109	110
321	3,390	100	101	104	106	106	108	109	111	111	113
325 B	5,660	93	95	98	100	100	102	102	104	105	107

(1) - Minimum distance to the boundary of the MCCO Additional Mining Area for Project year 8;

(2) - Private receivers predicted to experience noise from the MCCO Project at levels where it is expected that voluntary acquisition rights will apply as outlined in the VLAMP should the MCCO Project be approved.

Grey cells – vibration estimate (measured to one decimal point) exceeding the applicable limit (115 dBL for 95% of blasts and 120 dBL not to be exceeded); however, compliance is achievable through the application of an appropriate blast design.

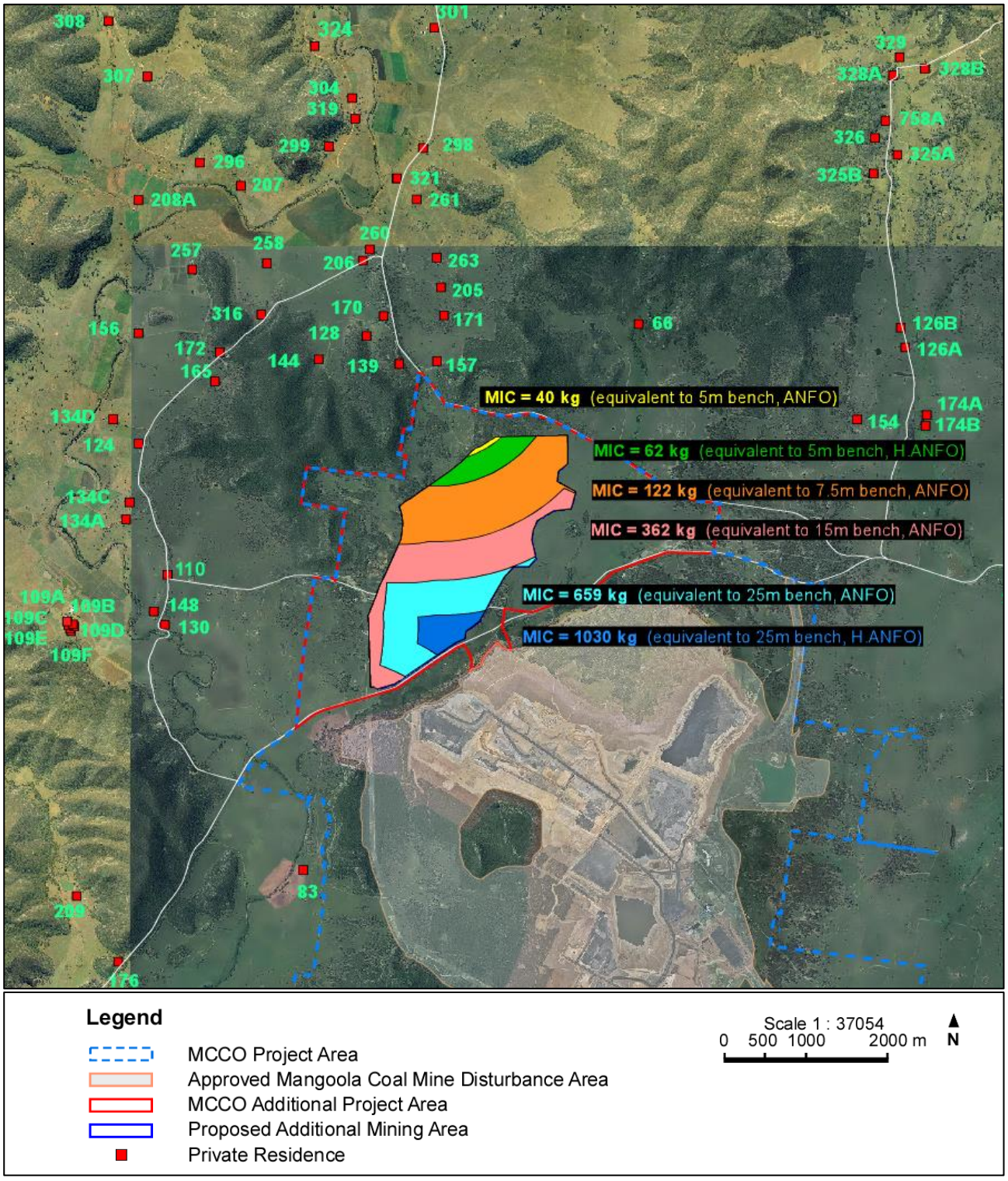

Figure 7.1 – Distribution of Charge Masses (MIC) to Generate Maximum Airblast Overpressure of 114 dBL at any Private Residence

7.1.1.3 Flyrock

Mangoola Coal Mine will operate using an appropriate exclusion zone (i.e. 500 m radius from the blasting area) to manage the risk of flyrock. The closest private residence (i.e. residence ID 157) is located approximately 1,150 m from the Proposed Additional Mining Area. Therefore, the potential risks of flyrock on the surrounding residential receivers are considered negligible.

7.2 HERITAGE ITEMS, ROCK FORMATIONS AND INFRASTRUCTURE

The analysis below presents an assessment of vibration exposures from blasting within the MCCO Additional Project Area on the identified heritage items, rock formations and infrastructure. As identified and discussed in **Sections 3.2** and **3.3** the locations of these items are presented in **Figures 3.2** and **3.3**. As in the assessment above, the analysis is based on vibration modelling using the applicable vibration predictive models, see **Section 6.1**. The vibration modelling estimates have been analysed, including references to relevant vibration limits as stated in **Section 6.2**.

7.2.1 Assessments Results

As described in **Sections 3.2** and **3.3**, the identified heritage items, rock formations and infrastructure are located at variable distances with respect to the proposed MCCO Additional Mining Area ranging from 35 to 4,620 m. A haul road overpass over Big Flat Creek / Wybong Road, 500 kV ETL, 11 kV powerlines, Telstra telecommunication cables, Wybong Post Office Road Realignment, Wybong Road and part of Ridgelands Road will be adjacent to the Proposed Additional Mining Area. This section assesses the potential impacts on them from blasting within the MCCO Additional Project Area.

7.2.1.1 Ground Vibration

The vibration modelling undertaken in this section has been performed according to the formula specified in **Section 6.1.1**. The results of the modelling capture the worst-case scenario and are summarised in **Table 7.3**. The analysis can be summarised as follows:

Heritage Items and Rock Formations

- Vibration exposures for the heritage structures are no higher than 2.1 mm/s, which is below the applicable criterion of 5 mm/s. This is for all modelled charge masses.
- Ground vibration modelling for the rock shelter sites and rock formations (located between 500 and 4,620 m distant) showed that the vibration predictions will be no higher than 15 mm/s, which is below the assessable criterion of 50 mm/s. As per the current operation, an assessment of blast impacts will be undertaken on a yearly basis by an independent consultant for the MCCO Project.

Infrastructure

- The modelling shows that the impact of ground vibrations on the infrastructure can be managed effectively to facilitate compliance with the imposed vibration limits via the application of reduced charge masses.
- The ground vibration modelling for the 500 kV powerlines; (with the closest distances being in the range of 53 – 130 m from the edge of the Proposed Additional Mining Area), indicates that the ground vibration impacts can be managed effectively to a level below the applicable vibration limit criteria (i.e. 60 mm/s for tension pylons and 125 mm/s for suspension pylons) via the continued application of lower charge masses as is current practice at Mangoola.
- The vibration impacts on the 11 kV powerlines, located approximately 35 m from the southern edge of the Proposed Additional Mining Area can be managed effectively to a level below the applicable vibration limit criterion of 100 mm/s via the application of lower charge masses, i.e. up to 40 kg permitted. With the increasing blasting distance, the application of higher charge masses will be allowed.
- Telstra buried telecommunication cables will be located approximately 48 m from the edge of the Proposed Additional Mining Area. The modelling shows that the ground vibration impact can be managed effectively to a level below the applicable limit criterion of 100 mm/s via the application of lower charge masses, i.e. up to 62 kg. When blasting at further distances the application of higher charge masses will be allowed.
- The prescribed water dams and tailings dams will be exposed to vibration levels of less than 1 mm/s, which is well below the applicable criteria of 50 and 100 mm/s respectively.
- The vibration impacts on Wybong and Ridgelands Roads, located approximately 50 and 90 m from the edge of the Proposed Additional Mining Area, can be managed effectively to a level below the applicable vibration limit criterion of 100 mm/s via the application of lower charge masses, i.e. up to 62 and 319 kg permitted respectively. When blasting at further distances the application of higher charge masses will be allowed.
- The proposed realigned section of Wybong Post Office Road will be located approximately 95 - 145 m from the edge of the Proposed Additional Mining Area. The modelling shows that the ground vibration impact can be managed effectively to a level below the applicable vibration limit criterion of 100 mm/s via the application of lower charge masses, i.e. up to 362 kg for 95 m distance and up to 659 kg for 145 m.
- The vibration exposure for the MCCO Project infrastructure, including Wybong Road / Big Flat Creek overpass will be managed internally to ensure safe operation of these structures when blasting in their vicinity.

Table 7.3: Results of Ground Vibration Modelling for Heritage Items, Rock Formations and Infrastructure – MCCO Project; when blasting is undertaken from the edge of the pit (i.e. worst-case scenario)

Residential ID	Min. Distance[(1)] (m)	Estimated Max. Ground Vibration (mm/s) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
Heritage Items											
Wybong Cemetery	2,460	0.1	0.1	0.2	0.3	0.3	0.5	0.5	0.7	0.7	1.2
Wybong Hall	2,220	0.1	0.1	0.2	0.4	0.4	0.5	0.6	0.8	0.8	1.4
Brogheda	2,710	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.6	0.6	1.0
Yarraman	2,430	0.1	0.1	0.2	0.3	0.3	0.5	0.5	0.7	0.7	1.2
Yarlett	1,680	0.2	0.2	0.4	0.6	0.6	0.8	0.9	1.3	1.3	2.1
Minnie Vale	3,490	<0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.7
Collareen	2,770	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.6	0.6	1.0
Catholic Church	2,680	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.6	0.6	1.0
Castle Hill	2,360	0.1	0.1	0.2	0.3	0.3	0.5	0.5	0.8	0.8	1.2
Dwelling	2,530	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.7	0.7	1.1
Structure	2,480	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.7	0.7	1.1
Rock Formations											
Anvil Rock	2,450	0.1	0.1	0.2	0.3	0.3	0.5	0.5	0.7	0.7	1.2
The Book	2,300	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.8	1.3
Rock Shelter Sites											
AC38	4,620	<0.1	<0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4
Rock shelter CG01	2,000	0.1	0.2	0.3	0.4	0.4	0.6	0.7	1.0	1.0	1.6
Rock shelter CG19	2,070	0.1	0.2	0.3	0.4	0.4	0.6	0.7	0.9	0.9	1.5

Residential ID	Min. Distance[(1)] (m)	Estimated Max. Ground Vibration (mm/s) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
Rock shelter CG08/9	2,310	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.8	1.3
Rock shelter BFC12	980	0.4	0.5	0.9	1.3	1.4	2.0	2.2	3.1	3.1	5.0
Site BFC128	500	1.1	1.6	2.7	3.8	4.1	5.8	6.4	9.2	9.2	15
Site BFC129	550	0.9	1.3	2.3	3.3	3.5	5.0	5.5	7.9	7.9	13
Site BFC130	550	0.9	1.3	2.3	3.3	3.5	5.0	5.5	7.9	7.9	13
Site BFC131	550	0.9	1.3	2.3	3.3	3.5	5.0	5.5	7.9	7.9	13
Site BFC132	570	0.9	1.3	2.2	3.1	3.3	4.7	5.2	7.4	7.5	12
Infrastructure											
500 kV Powerlines											
Suspension Pylon (average minimum distance)	60	33	47	80	114	121	172	191	273	274	440
Suspension Pylon (minimum distance)	53	40	57	97	139	147	210	233	333	334	537
Tension Pylon	130	10	14	23	33	35	50	55	79	80	128
11 kV Powerlines											
Timber Power Poles	35	78	110	189	270	286	408	452	646	730	1,043
Telecommunication Infrastructure											
Telstra Buried Cables	48	47	66	114	163	172	246	273	390	440	629
Prescribed Dams											
Tailings Dam 1	3,000	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.5	0.8
Tailings Dam 2	2,910	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.5	0.9
Raw Water Dam	3,470	<0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.7

Residential ID	Min. Distance[(1)] (m)	Estimated Max. Ground Vibration (mm/s) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
Pit Water Dam	3,570	<0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.6
Roads											
Wybong Road	50	44	62	107	152	161	231	255	365	412	589
Ridgelands Road	90	17	24	42	60	63	90	100	143	143	230
Yarraman Road	2,000	0.1	0.2	0.3	0.4	0.4	0.6	0.7	1.0	1.0	1.6
Proposed Wybong Post Office Road Realignment (average minimum distance)	145	8	11	20	28	29	42	47	67	67	107
Proposed Wybong Post Office Road Realignment (minimum distance)	95	16	22	38	55	58	83	91	131	131	211

(1) - Minimum distance to the MCCO Additional Mining Area over the lifetime of the Project;

Grey cells – vibration estimate equal to or exceeds the applicable limit; however, compliance is achievable through the application of an appropriate blast design.

7.2.1.2 Airblast

The presented assessment did not reveal any imposed airblast limits on infrastructure nor on rock formations / rock shelter sites.

The modelled worst-case scenario shows that the impact of airblast on the analysed heritage items is estimated to be in the order of 99 - 125 dBL (for all proposed charge masses), which is below the applicable 133 dBL limit criterion (see **Table 7.4**).

Table 7.4: Results of Airblast Modelling for Relevant Heritage Items – MCCO Project; when blasting is undertaken from the edge of the pit (i.e. worst-case scenario)

Residential ID	Min. Distance[(1)] (m)	Estimated Max. Airblast (dBL) (229 mm hole diameter)									
		5 m bench (3.8 m stemming)		7.5 m bench (3.8 m stemming)		10 m bench (3.8 m stemming)		15 m bench (4 m stemming)		25 m bench (5 m stemming)	
		MIC (kg)									
		ANFO 40	Heavy ANFO 62	ANFO 122	Heavy ANFO 190	ANFO 204	Heavy ANFO 319	ANFO 362	Heavy ANFO 566	ANFO 659	Heavy ANFO 1,030
Heritage Items											
Wybong Cemetery	2,460	104	105	108	110	110	112	113	115	115	117
Wybong Hall	2,220	105	107	110	111	112	114	114	116	116	119
Brogheda	2,710	102	104	107	109	109	111	112	113	114	116
Yarraman	2,430	104	106	108	110	111	112	113	115	115	117
Yarlett	1,680	108	110	113	115	115	117	118	120	120	122
Minnie Vale	3,490	99	101	104	106	106	108	108	110	110	113
Collareen	2,770	102	104	107	109	109	111	111	113	113	116
Catholic Church	2,680	103	104	107	109	109	111	112	114	114	116
Castle Hill	2,360	104	106	109	111	111	113	113	115	115	118
Dwelling	2,530	103	105	108	110	110	112	112	114	114	117
Structure	2,480	103	105	108	110	110	112	113	115	115	117

(1) - Minimum distance to the MCCO Additional Mining Area over the lifetime of the Project

Grey cells – vibration estimate equal to or exceeds the applicable limit; however, compliance is achievable through the application of an appropriate blast design.

7.2.1.3 Flyrock

Blasting undertaken within the MCCO Additional Project Area, will operate using an appropriate exclusion zone to manage the risk of flyrock (i.e. 500 m exclusion zone). The impact on public roads, adjacent powerlines and the Crown land (when located within a 500 m radius) will be managed in accordance with an updated road closure protocol and updated Blast Management Plan (revised specifically for the MCCO Additional Project Area) to be developed in consultation with the relevant infrastructure owners should approval of the MCCO Project be granted.

7.3 CROWN LAND

There is no applicable vibration or blast overpressure limit for the Crown land, therefore there is no need for vibration or overpressure impact assessment. Blast impacts will be managed as part of the MCCO Project to maintain safe environmental practices for the possible users of the land. As described in **Section 7.2.1.3** blasting undertaken within the MCCO Additional Project Area, will operate using an appropriate exclusion zone to manage the risk of flyrock (i.e. 500 m exclusion zone).

With regard to the areas of Crown land identified surrounding the MCCO Additional Project Area (refer to **Figure 3.3**) this indicates that there will be no risk or negligible risk to most of the Crown Land. There are two small triangular areas that will be within 500 m from blasting during the initial and final stages of the MCCO Project. The small triangle located to the immediate north west (260 m at the closest point) will at times be within 500 m of blasting proposed in Project Year 8; the area will not be affected by earlier project stages. With regard to the small triangle located to the south, initially during Project Year 1 blasting will be required within 500 m (200 m at the closest point) however as operations move to the north west an appropriate buffer will be in place. Mangoola will manage any potential interactions closely during the initial and final stages of the MCCO Project.

7.4 LIVESTOCK

As part of the blast impact assessment for the MCCO Project, an assessment of potential ground vibration, airblast overpressure and flyrock exposure was completed for surrounding private properties, including land potentially used for grazing. In the absence of accepted blasting criteria for livestock, potential impacts on livestock have been considered in a conservative manner in the context of the relevant residential blasting amenity criteria, which are set to maintain human comfort. The assessment concluded that based on predicted ground vibration and blast overpressure, there were no concerns for the wellbeing of livestock on private land surrounding the MCCO Project Area. Given the significant distances from any potential blasting to private grazing land (at least 950 m, well outside the 500 m flyrock exclusion zone), there is no risk of injury to livestock from flyrock.

With regard to livestock on Mangoola owned land, grazing has occurred on Mangoola land throughout the mining undertaken to date without any adverse impacts from blasting and this will continue with the MCCO Project.

8.0 MANAGEMENT AND MITIGATION MEASURES

Mangoola Coal Mine operates according to the Mangoola BMP (2017). The plan covers a number of blast control measures designed to minimise blast impacts and to comply with the relevant criteria.

Due to the relocation of mining activities associated with the MCCO Project into the new area, the existing measures in the BMP remain appropriate, however the blast management plan will be revised to also cover the MCCO Additional Mining Area. Refinement of blast mitigation measures will target the reduced distances between mining areas and residential receivers, especially in the north-west section of the proposed Additional Mining Area where impacts from blasting, i.e. dust, fume and vibration are predicted to be more pronounced than from the current operation.

Blast management for the MCCO Project will continue to be conducted in accordance with the Mangoola BMP (2017). A summary of the key blast management measures that will continue to be applied are specified below:

Control measures for ground vibration:

- Use of a ground vibration predictive model to estimate potential ground vibration levels for the critical points of concern
- Based on the site law parameters for the area, use an appropriate charge mass design and loading
- Use of an appropriate initiation sequence to minimise the possibility of hole interaction, i.e. avoid reinforcing effect.

Control measures for airblast:

- Use of an airblast predictive model to estimate potential overpressure levels for the critical points of concern
- Based on the airblast predictive model parameters, use an appropriate charge mass design and loading
- Use of a suitable initiation sequence to avoid the possibility of hole interactions, i.e. avoid build-up in wavefront reinforcement
- To minimise airblast emission use of an appropriate quality stemming material and use an appropriately designed stemming column height
- To avoid face burst and related high airblast emission maintain appropriate burden specification for the front row holes
- Use of an approved pre-blast check protocol to avoid blasting in unfavourable weather conditions.

Control measures for flyrock:

- To avoid face bursts and related flyrock incidents maintain appropriate burden specifications (according to blast design specifications) for the front row holes
- To avoid a potential flyrock incident use of an appropriate blast design around identified geological features
- To minimise the possibility of stemming ejection / flyrock incidents use of an appropriate quality stemming material and stemming height (according to design specifications).

Based on the results of modelling presented in **Section 7**, all blasts will be managed to meet the specified criteria utilising the methods outlined above. The following management and monitoring measures are also recommended for the MCCO Project.

Blast Monitoring System

There are a number of sensitive receivers surrounding the MCCO Additional Project Area as considered and assessed by this BIA, including private residential receivers, heritage items, rock formations and infrastructure. As these receivers are widely spread, a multi-station monitoring system will be required to monitor impacts from blasting.

The current multi-station vibration monitoring system at the Mangoola Coal Mine specified in Mangoola BMP (2017) provides coverage for private residential receivers, infrastructure, rock shelters and formations. The system is flexible and incorporates permanent and portable monitoring stations. The number of monitored locations varies with up to twenty-two monitoring sites used throughout the year. The system includes four permanent stations for coverage of residential receivers and a heritage site (i.e. church), and another four to monitor dams. Variable locations are used for monitoring 500 kV transmission pylons, rock shelters and rock formations as shown on **Figure 4.1**. The multi-station monitoring system is considered to provide adequate coverage to monitor vibration impacts from the existing operations.

It is proposed that the existing monitoring system be reviewed and expanded as required to cover the sensitive receivers as assessed in this BIA. Additional locations to be selected should reflect the nearest private receivers and provide compliance as shown on the **Figure 8.1.** To provide a minimum coverage for the private residential receivers it is recommended that the following receivers be represented in the monitoring program:

- N direction – residential receiver 66 or the closest to it
- E direction – residential receiver 154, or the closest to it
- S direction – residential receiver 83 or the closest to it
- NW direction – residential receiver 139 or 157 or the closest to them.

The proposed areas designated for monitoring are shown on **Figure 8.1**.

Periodic monitoring of infrastructure, including the transmission pylons and public roads will be required when blasting within 500 m of these structures.

Monitoring of the prescribed dams only applies when blasting within a 1 km radius. Following the cessation of mining of the current mining operations (i.e. located to the south

of the MCCO Additional Project Area and immediately adjacent to the prescribed dams), there will no longer be a necessity for monitoring of the prescribed dams. As blasting associated with operations within the MCCO Additional Project Area will be conducted in excess of 2.9 km the vibration monitoring of the four prescribed dams will not be required.

The monitoring of rock formations and rock shelter sites will continue as for the current Mangoola operations, i.e. they will continue to be monitored and inspected on a yearly basis for damage and a full assessment of their condition.

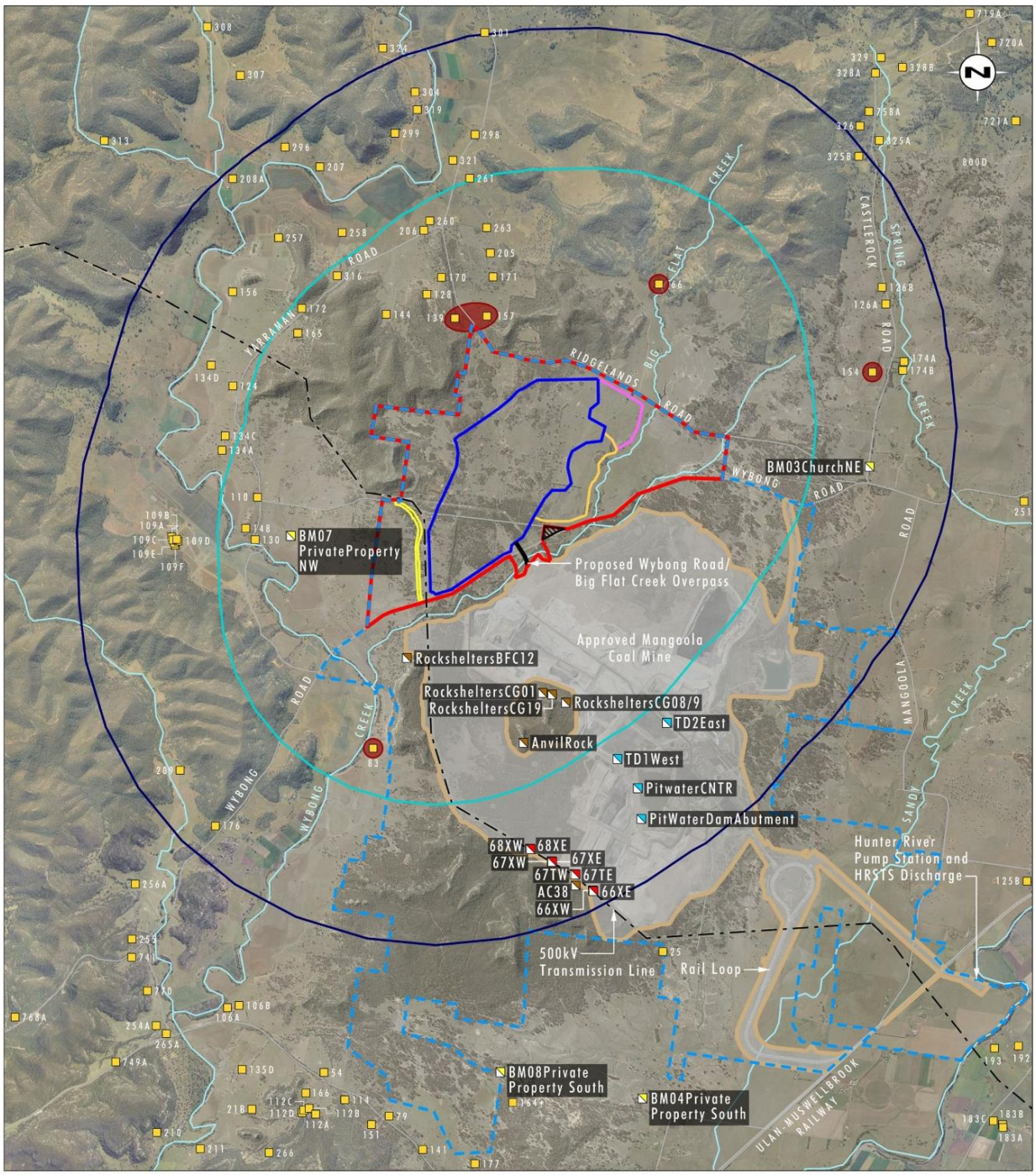

Image Source: Glencore (April 2018)
Data Source: Glencore (2019)
Note: *Subject to Negotiated Agreement

0 1.0 2.0 4.0km

Legend

- MCCO Project Area
- Approved Mangoola Coal Mine Disturbance Area
- MCCO Additional Project Area
- Proposed Additional Mining Area
- Proposed Additional Mining Area 3km Buffer
- Proposed Additional Mining Area 5km Buffer
- Proposed Emplacement Area
- Proposed Topsoil Stockpile Area
- Wybong Post Office Road Realignment
- Crown Land (TSR) Excluded from MCCO Project Area
- Private Residence
- Private Residence Monitor
- Water Dam Monitor
- TransGrid Pylon Monitor
- Rock Formation Monitor
- Proposed Monitoring Locations - Residences

FIGURE 8.1

Proposed Additional Monitoring Locations

File Name (A4): 4004_337.dgn
20190501 16.21

Pre-Blast Assessment Protocol

A pre-blast assessment protocol plays an essential role in managing blast impacts. Mangoola's Pre-Blast Environmental Assessment Procedure (2016), a component of the Mangoola BMP (2017), forms an effective pre-blast protocol to manage blast impacts.

Due to the proposed development of the MCCO Project into the MCCO Additional Project Area, a revision of the current pre-blast protocol will be required. The protocol developed for the MCCO Project will build on the existing protocol and update it to address the physical relocation of the open cut activities.

It is important to draw an appropriate and detailed protocol that minimises the impacts on the surrounding area, taking into consideration the changed angle of influence for the private residential receivers. The pre-blast protocol will take into account the significantly reduced distances to the north-west residential receivers and provide appropriate management. The pre-blast protocol would need to be reviewed on a regular basis.

Weather Monitoring System

The weather conditions can significantly affect the blast outcomes. They can affect noise distribution and intensity, as well as post-blast dust distribution.

The assessment of environmental conditions prior to blasting plays a vital role in the decision making process and as such is taken into consideration in the pre-blast assessment protocol under the existing Mangoola's Pre-Blast Environmental Assessment Procedure (2016).

Mangoola Coal Mine has been operating two weather monitoring stations, that is North and South stations. The same stations (or equivalent as the North location is in the disturbance area for the MCCO Project) will be used to provide input for the pre-blast assessment protocol for operations within the MCCO Additional Project Area. An additional weather monitoring station has also recently been installed in the Main Pit rehabilitation area.

Road Closure Protocol

Mangoola Coal Mine, when blasting within 500 m of a road, operates using the Mangoola Mining Procedure – Closing Public Roads (2017). A similar system (i.e. agreed with relevant authorities) will be required for the MCCO Project.

Blasting activities for the MCCO Project will be undertaken within close proximity of Wybong Road, Wybong Post Office Road and Ridgelands Road. Due to the change in the location of the mining activities, the MCCO Project will require the update of the road closure protocol in consultation with the relevant road authorities as part of the Blast Management Plan.

9.0 CONCLUSIONS

The Blast Impact Assessment for the MCCO Project was undertaken in accordance with ANZECC Guidelines and the Australian and British Standards. The BIA addresses the impact of the MCCO Project on the surrounding environment including private residential receivers, heritage sites, rock formations, infrastructure, Crown land and livestock based on the blast design details as outlined in **Section 5.0**.

The results of the assessment are summarised as follows:

- The potential for blast impacts due to ground vibration and airblast were identified for a number of private residential receivers at certain charge mass levels. The assessment demonstrates that the use of a modified blast design incorporating lower charge masses will meet the imposed criteria and therefore all impacts can be managed effectively.
- Blast vibration and airblast overpressure impacts on the heritage sites will be below the assessed criteria levels.
- Blast vibration impacts on the infrastructure (public roads, ETL pylons, timber power poles and Telstra buried telecommunication cables) can be managed effectively to below the assessment criteria by modifying the blast design and applying lower charge masses. Vibration impact on other assessed infrastructure will be negligible.
- The impact of flyrock on the sensitive receivers (with the exception of public roads, selected ETL pylons and timber power poles, and two small Crown land parcels) is considered to be negligible. Due to reduced distances to public roads, selected ETL pylons and timber power poles, and the Crown land the impact of flyrock will be managed in accordance with a suitably updated Mangoola BMP, in a similar manner to the currently implemented systems.
- Due to the substantial distances to grazing lands (i.e. minimum 950 metres) no significant concerns for the wellbeing of livestock on private land surrounding the MCCO Project Area were identified.

Thomas Lewandowski
08th May 2019
Enviro Strata Consulting

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Appendix 1 – Transient Vibration Guide Values for Cosmetic Damage - British Standard (BS 7385-2:1993)