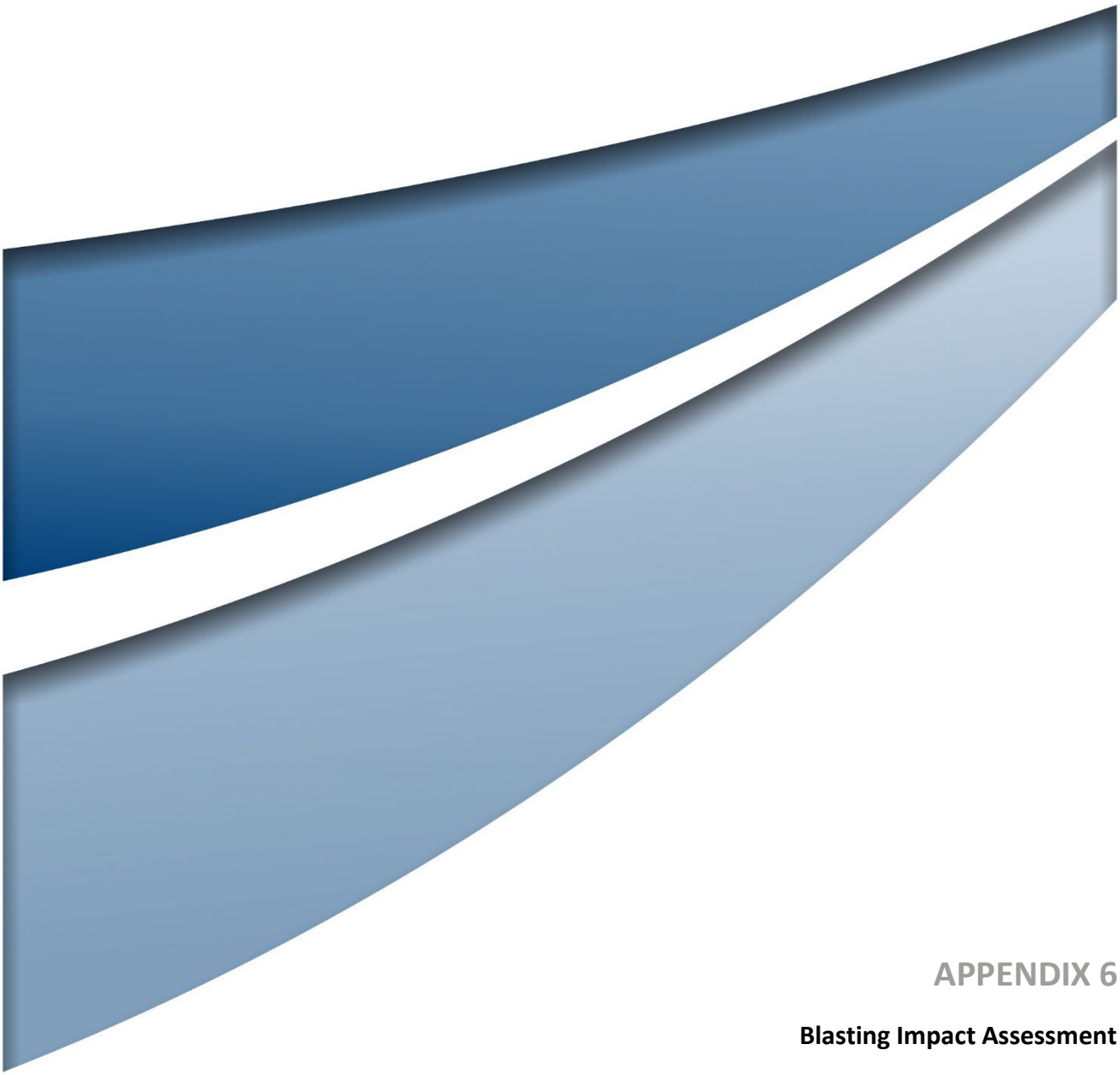

APPENDIX 6

Blasting Impact Assessment

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LIVERPOOL RANGE QUARRY - BLASTING IMPACT ASSESSMENT

Report prepared for ARDG Deans Quarry Pty Limited

Report No. AR-2305-010724

Thomas Lewandowski
1st July 2024

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1.0 INTRODUCTION

Enviro Strata Consulting Pty Limited (Enviro Strata Consulting) was engaged by ARDG Deans Quarry Pty Limited (the Proponent) to undertake a Blasting Impact Assessment (BIA) for the proposed Liverpool Range Quarry (the Project).

The Project is located approximately 10 km north of Cassilis in NSW (located 75 km north-east of Mudgee).

The Project will include drill and blast operations to extract hard rock material.

The presented BIA is based on ground vibration and airblast overpressure modelling, utilising parameters representative for the area. The assessment findings are presented in the context of the relevant ground vibration, airblast overpressure and flyrock limit criteria for the assessed items.

2.0 QUARRY PROJECT DESCRIPTION

2.1 BACKGROUND

The Project is proposed for the sole purpose of producing and supplying quarry products to support the construction of the Liverpool Range Wind Farm (LRWF) project for which State Significant Development Consent (SSD-6696) was granted in March 2018 (currently subject to a modification application). The Project is classified as State Significant Development (SSD) under the State Environmental Planning Policy (Planning Systems) 2021 and, an Environmental Impact Statement (EIS) is required to support the development application for the Quarry under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This report has been prepared as a part of the EIS being prepared to accompany a State Significant Development (SSD) application to the New South Wales Planning Secretary (Secretary of the Department of Planning, Housing and Infrastructure (DPHI)).

The proponent has undertaken detailed site geological investigations which indicate that the quarry resource is suitable for the production of a range of products (*e.g.* roadbase, concrete aggregates, drainage rock) required for construction of the public road upgrades, wind farm access tracks, hardstand areas, turbine foundations and other associated civil works associated with the LRWF project.

Approval for the quarry is being sought as an SSD project under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act), while an Environmental Protection Licence (EPL) will also be required for the quarry operation.

The Project is located on Lot 89 DP750749, whereas the access road that links the Project Area with Rotherwood Road is located on Lot 89 DP750749 and Lot 2 DP747190. Both lots are located within

the LRWF project area. **Figure 1** shows the location of the Project Area, surrounding features and nearest properties. Given its close proximity to the LRWF project area, sourcing of construction materials from the Project (compared to sourcing from commercial quarries in the broader region) would reduce LRWF project construction traffic on the local and regional road network. This would result in benefits for the local and broader community through:

- Focusing the majority of truck movements to within or close to the LRWF project area, during the proposed operational hours of 7am – 6pm, Monday to Saturday
- Improving road safety for all road users by minimising potential interactions between heavy and light vehicles;
- Improving residential amenity by reducing road traffic noise
- Reducing wear and tear on the road network and consequently, maintenance requirements; and
- Reducing fuel usage and associated greenhouse gas emissions

2.2 PROPOSED ACTIVITIES

It is estimated that the LRWF project may require approximately 2 million tonnes (Mt) of quarry materials to support the construction over an estimated period of 4 years, with peak production / transport from the site of approximately 700,000 tpa. Construction and operation would be undertaken during daytime hours, being Monday to Saturday 7 am to 6 pm, with minor non-audible works to be undertaken outside of these hours (*e.g.* maintenance activities).

Key features of the Project are illustrated on **Figure 1** and summarised as follows:

- Main extraction area ("Main Pit") covering an area of approximately 3.2 ha from where a high- quality basalt resource would be drilled, blasted and extracted, prior to processing. The Main Pit would be developed to a floor level of approximately 675 m AHD, with extraction undertaken as two benches with nominal height of 12.5 m.
- Satellite extraction area ("Borrow Pit") covering an area of approximately 1.9 ha, 250 m to the southeast of the Main Pit. Highly weathered rock and clay would be extracted from the Borrow Pit by dozer / excavator, prior to being transported by truck to the main processing area for blending with rock from the Main Pit. The Borrow Pit would be developed to a floor level of approximately 660 m AHD.
- Processing and stockpiling area covering an area of approximately 2 ha adjacent to the southern edge of the Main Pit. Processing of extracted rock would be undertaken in this area using mobile crushing and screening equipment, with finished quarry products transferred to discrete stockpiles. As the pit face progresses, processing / stockpiling will occur in pit (*i.e.* below the ground surface), further shielding operations.
- Operational areas (peripheral to the above areas) covering an area of approximately 7.1 ha. These areas would accommodate internal temporary administration (mobile crib room/toilet facilities), peripheral topsoil bunds, access tracks, light vehicle parking, and surface water management controls.
- Sealed access road linking the operational areas with Rotherwood Road (8 m wide road surface with 1 m wide shoulders). The access road corridor would be approximately 2.9 km long and have a width of 15 – 20 m to allow for construction works. It would contain several passing bays (30 m wide x 50 m long) and have a disturbance footprint of approximately 5.4 ha. Approximately 40 m of the access road crosses an unnamed Crown Road. Transport of

processed quarry material would be managed by the appointed civil contractor for the LRWF on an 'as needs' basis during quarry operations.

- Annual production from the Project is anticipated to be up to 700,000 tpa during construction phases. The initial higher production rate of up to 700,000 tpa is only anticipated to be required in Year 2 of the Project.
- It is not proposed to construct a weighbridge, as extraction quantities will be calculated by belt/loader scales and cross referenced with topographic survey taking account of rock density. All materials produced by the quarry will supply the LRWF Project only.
- At the completion of quarry operations, the site will be rehabilitated in consultation with the landowner to determine an appropriate, safe and stable landform(s) that can facilitate ongoing rural activities.
- Stabilisation of the processing and stockpiling area. To be returned to pre-disturbance existing condition in consultation with the landowner (*e.g.* re-seeded with appropriate pasture grass).

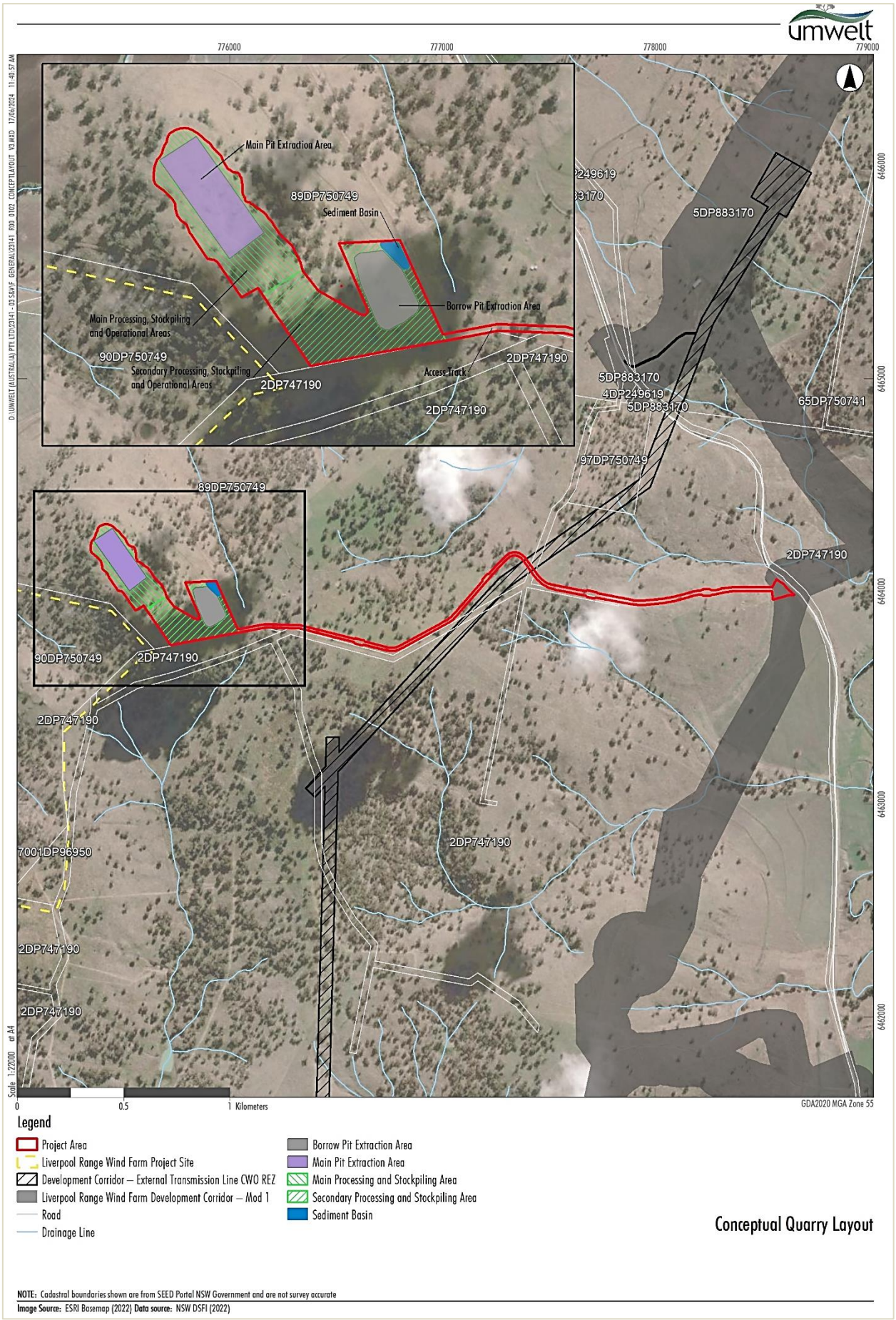

Figure 1 – Key features of Liverpool Range Quarry

3.0 ASSESSMENT REQUIREMENTS AND STUDY AREA

The BIA follows the guidelines presented in the Australian and New Zealand Environment Council guideline 'Technical Basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration' (ANZECC, 1990) and Australian Standard (AS 2187.2-2006).

This BIA represents a detailed assessment of the likely blasting impacts of the Project including ground vibrations, airblast overpressure and flyrock on the following:

- private residences including people
- adjacent infrastructure

This BIA has not assessed potential blast impacts on the Project-owned quarrying and associated assets. These will be managed by the quarry operator to maintain safe working practices.

4.0 EXISTING ENVIRONMENT AND IDENTIFIED RECEPTORS

The study addresses the impact of the proposed quarry blasting associated with the Project on identified sensitive receptors including private residences and infrastructure. The assessment covers a 4 km impact radius, beyond which the potential blasting impact is considered negligible (*i.e.* well beyond human perception level) and therefore does not require an assessment.

The impact of blasting has been assessed against criteria as specified in the ANZECC guideline (1990) or the Australian Standard (AS 2187.2-2006) or other relevant norms. The criteria are discussed in detail in Section 6.2. This section introduces the identified sensitive receptors, their location and distance relative to the Project (refer to **Figure 2**).

4.1 PRIVATE RESIDENTIAL RECEPTORS

The locations of residential receptors with respect to the Project's boundary are shown in **Figure 2.** The residential receptors are all privately-owned.

The main points to note are as follows:

- The area is sparsely populated with only four (4) residential receptors identified within a 4 km radius. Note that receptors F7-5, F8-1, F7-4 and F7-6 (with F7-6 just outside the 4 km radius) are associated with the quarry project (*i.e.* properties/residences owned by the quarry site landowner). Receptor 2(F) is currently a non-associated residence.
- The closest township of Cassilis, including a nearby cluster of residential receptors, is located approximately 10 km to the south east of the Project Area. Due to a substantial distance between the Project Area and the township (> 10 km), the potential blasting impact is considered negligible (*i.e.* well beyond human perception level) and does not require an assessment.

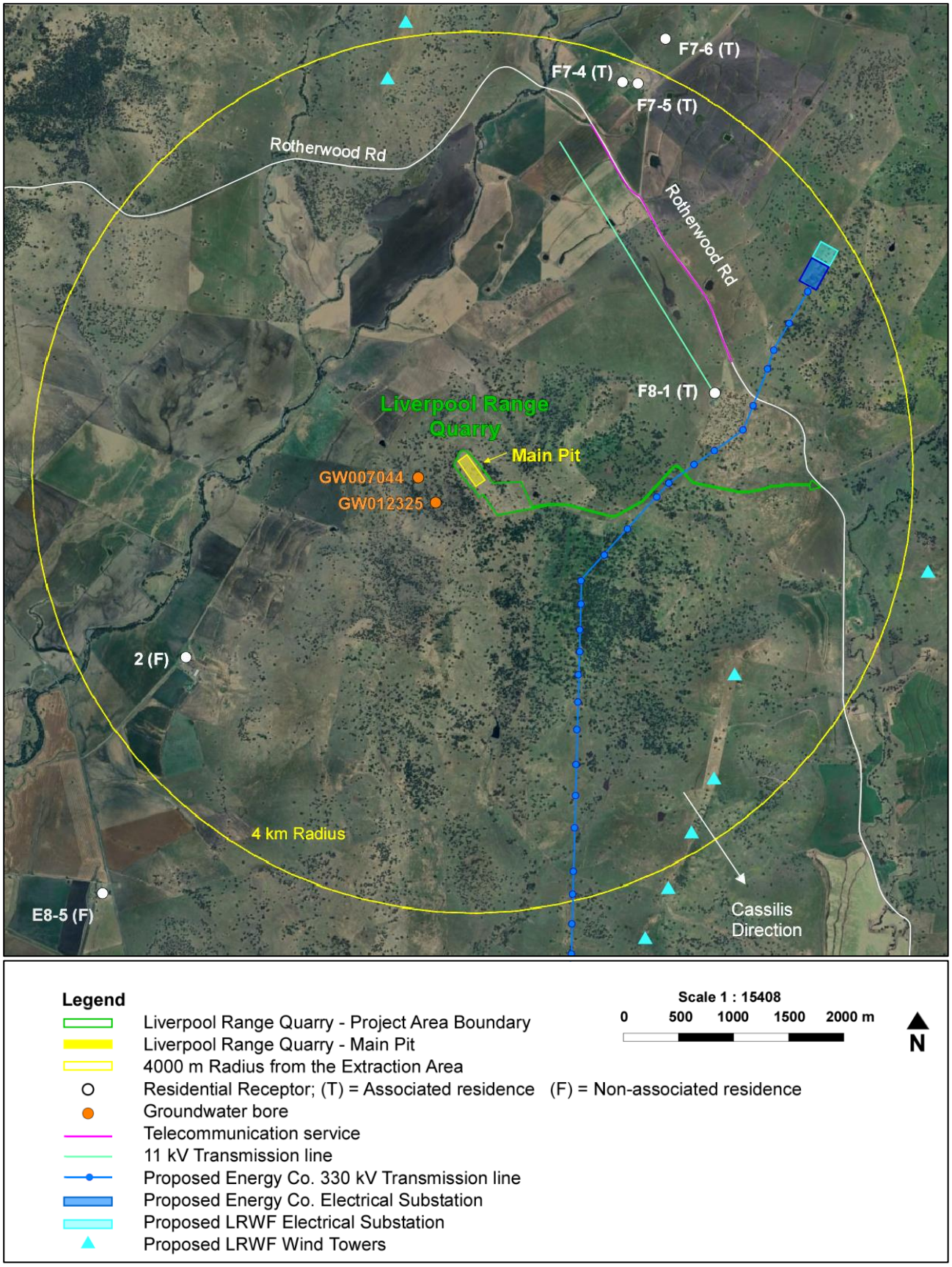

Figure 2 – Locations of the Project Area with respect to Residential Receptors, and Infrastructure within a 4 km Radius

4.2 INFRASTRUCTURE

As indicated above, the area surrounding the proposed Project is sparsely populated and as such, there is limited public infrastructure in this area. The identified locations of infrastructure with respect to the Project's hard rock extraction boundary are shown in **Figure 2** (nearest blasting point)**.**

The following infrastructure was identified as:

- Public roads: Rotherwood Road located in excess of 2 km from the extraction boundary,
- 11 kV powerlines running parallel approximately 360 m to the west of Rotherwood Road,
- Telecommunication: underground lines along Rotherwood Road approximately 2.5 km from the extraction boundary.
- Proposed Energy Co. 330 kV transmission line easement located approximately 1.2 km from the extraction boundary.
- Proposed Energy Co. electrical substation located approximately 3.4 km from the extraction boundary.
- Proposed LRWF electrical substation located approximately 3.6 km from the extraction boundary (north and adjacent to Energy Co. substation).
- Proposed LRWF towers located approximately 2.9 km from the extraction boundary.

Two private registered groundwater bores identified on the NSW Water as follows:

- GW007044 (Collar RL 635 m AHD), located approximately 390 m west of the Main Pit,
- GW012325 (Collar RL 654 m AHD), located approximately 390 m west of the Main Pit.

5.0 GEOLOGY AND EXTRACTION METHODS

Geology and Project Implications

Geological characteristics of the project site and surrounding area has been determined using available published mapping, detailed surface mapping and a downhole percussion and diamond drilling program undertaken by ARDG in 2023 with a total of 22 holes drilled, see **Appendix 1.**

The assessment was supported by laboratory rock testing (including Atterberg and core testing). The dominant rock formation targeted by the Project is a high-quality basalt. The geological assessment model concluded that the site could support a quarry pit with an extraction depth to at least 25 m below the surface level with additional resource likely.

The Project will extend for approximately 4 years with a scheduled transport of up to approximately 0.7 million tonnes of quarry products from the site per year (*i.e.* approximate total extraction of 2 Mt). The extraction will take place in two quarry pits including the Main Pit and the Borrow Pit, located to the southeast of the Main Pit.

Based on the geological assessment model, the conceptual Project extraction will involve:

- The Main Pit extraction will include drill and blasting operations. This will be employed to recover high quality basalt. The pit void will be extracted to approximately 25 m depth below the surface level (*i.e.* 675 m AHD). The blasting and extraction in this pit will be undertaken in two passes with a nominal bench height of 12.5 m. The approximate extraction area is in the order of 3.2 ha.
- The Borrow Pit excavation of highly weathered rock and clay materials will be undertaken by dozer / excavator. No blasting will be undertaken in this pit. The recovered materials will be

used for blending purposes with rock from the Main Pit. The extraction depth in the Borrow Pit is to be limited to 15 m (*i.e.* 660 m AHD). The recovered material will be transported by trucks to the main processing area for further blending. The approximate extraction area is in the order of 1.9 ha.

Drilling and Blasting Process

Only extraction from the Main Pit will involve drilling and blasting operations. Prior to blasting, the area is surveyed and proposed blasted holes are marked. This is followed by drilling of design pattern and loading the holes with explosives. The top section of each hole is filled with stemming material for better energy distribution and noise suppression.

A delay system, which is incorporated on the surface of the blast area, allows for single hole initiation.

Following the blast firing, the blasted and fractured rock strata will be removed for further processing (including crushing and screening) in the quarry's mobile plant.

Main Pit Blast Details

Based on the parameters assessed (provided within the quarry design), it is anticipated that maximum 12.5 m benches will be targeted, which corresponds to a maximum instantaneous charge (MIC) mass for blasting in the order of 100 kg per hole or 300 kg (allowing for 3 holes when fired simultaneously). The proposed blast hole diameter is 102 mm.

All these details together with other parameters (summarised in **Table 1)** were considered in the blasting impact study undertaken.

Table 1: Proposed Drilling and Blasting Design Details for the Main Pit.

Parameter	Value
Blast Hole Diameter (mm)	102
Number of Holes per Blast	200 (typically)
Drilling Length per Blast (m)	2,500
Burden (m)	2.8
Spacing (m)	3.8
Bench Height (m)	12.5
Stemming (m)	2.5 (typically)
Stemming Product:	10/14 stemming aggregate (*i.e.* 30t / blast)
Blasting Product	Bulk emulsion or water gel products
Blasting Product Density (t/m^3)	1.2
MIC (kg)	100 kg (single hole) – up to 300 kg (3 holes combined)
Rock Density (g/cm^3)	2.8
Powder Factor (kg/m^3)	0.75 nominal
Blast Size Volume (bcm)	26,000
Operational Period	48 weeks / year
Blasting Frequency	Variable (approximately 6 – 12 blasts / year)

Times and Frequency of Blasting

Blasting will be undertaken Monday to Friday (between 9am and 5pm); drilling activities will be undertaken Monday to Saturday (between 7am and 6pm).

The Project will be undertaken in such a manner as to ensure the consent conditions are met. It is anticipated that the quarry will only fire a limited number of blasts per year approximately 6 – 12 blasts per year, dependent on product demand.

6.0 PREDICTIVE MODELS AND BLAST EMISSION CRITERIA

6.1 PREDICTIVE MODELS

As the quarry has not commenced operations, the ground vibration and airblast overpressure models for the quarry conditions have not yet been developed. To overcome this issue, models from a mining operation comparable to the proposed quarry have been utilised which are considered as appropriate analogues.

These models were originally developed in one of the smaller coal mines in the Hunter Valley. The mine used similar blasting parameters to that proposed by the Project *i.e.* the mine used charge masses in the order of 42-225 kg, covering various blasts that include overburden and interburden blasts.

6.1.1 Ground Vibration Predictive Model

The site law formula recommended by the Australian Standard (AS 2187.2-2006) is accepted by relevant NSW Government agencies as appropriate for mining and quarrying blast assessments.

The site law formula equation 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 site law analysis (from a comparable blasting operation) presented below, utilises a standard log/log scale, where Peak Particle Velocity values (PPV) monitored are plotted against the scaled distance (see **Figure 3)**.

For the purposes of assessment, two lines had been drawn. The first line represents a median line (*i.e.* 50% level line), which indicates that 50% of vibration responses are located above the line and 50% are below the line. The second line is a 95% level line* where 95% of vibration responses are located below this line. The 95% level, advocated by the Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines (1990), allows for an inherent variation in emission levels. It allows for 5% exceedance of the general blast criterion.

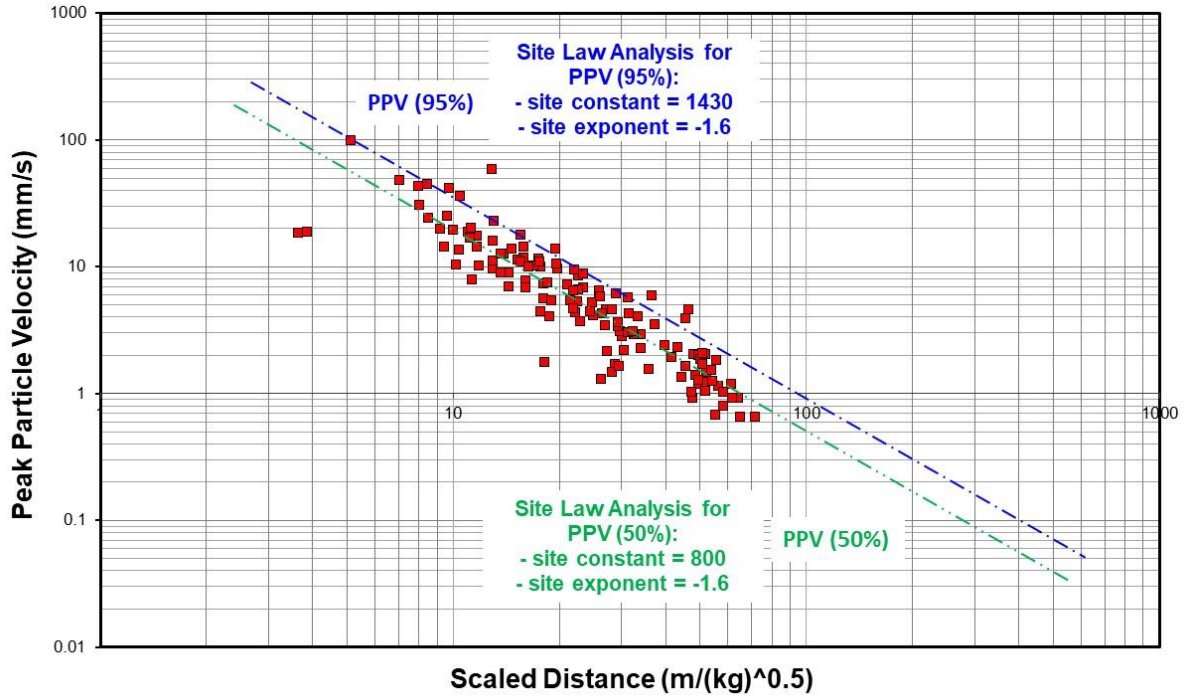

Figure 3 – Site Law Analysis from Comparative Blasting Operations

The estimated site law parameters, based on the assessment above (using the 95% confidence level), are as follows:

- site exponent a = -1.6
- site constant k = 1,430

Therefore, as an interim measure, the formula for ground vibration modelling for the quarry area is:

$$PPV = 1{,}430 \left(\frac{D}{\sqrt{m}} \right)^{-1.6}$$

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)

***Note**: 95% criterion is utilised following ANZECC guideline (1990), which allow for an inherent variation in emission levels by allowing 5% exceedance of general criterion.

6.1.2 Airblast Overpressure Predictive Model

The impact of generated airblast levels from the blast source is generally guided by the sonic decay law recommended 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

The airblast overpressure monitoring results (from the comparable mine) were plotted and together with other parameters, gave rise to the airblast predictive model shown in **Figure 4.** To facilitate accuracy of the assessment, the forced exponent of -1.45 has been used. This 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).

The sonic decay law analysis features two lines corresponding to the median of the measured data set (marked as Sound Pressure Level (SPL) 50%) and SPL 95% corresponding to 95% of the total population of data.

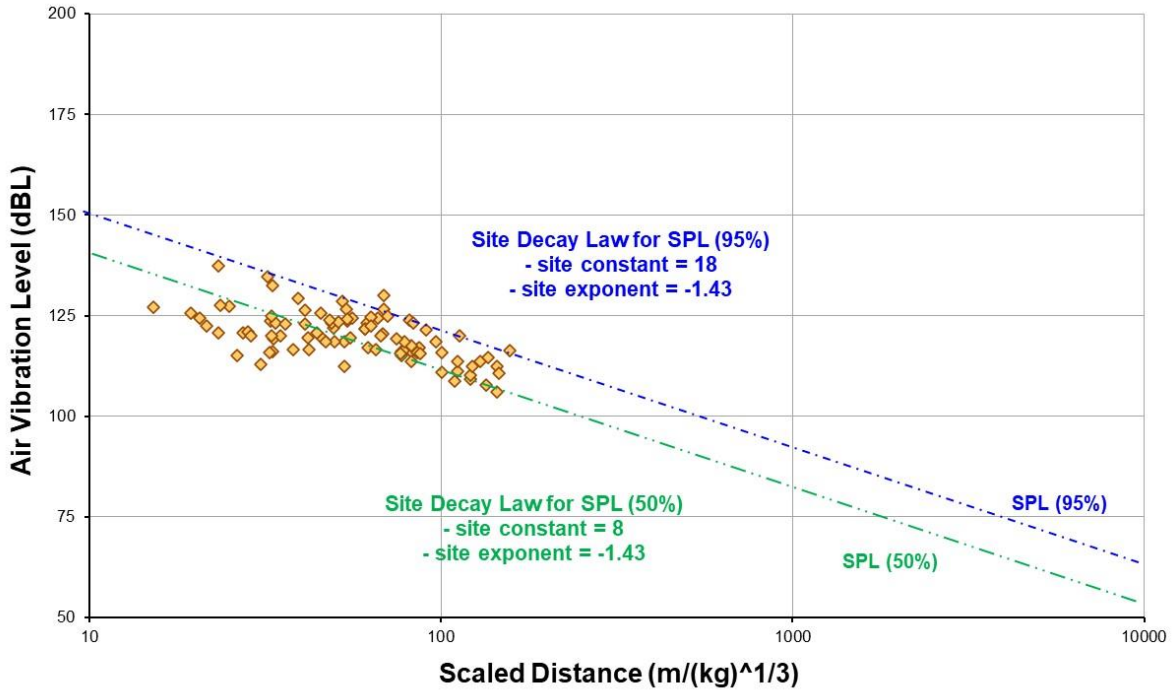

Figure 4 – Sonic Decay Law from Comparative Blasting Operations

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

- site exponent a = -1.45
- site constant k = 18

Therefore, as an interim measure, the formula for blast overpressure modelling for the quarry area is:

$$P = 18\left(\frac{D}{\sqrt[3]{m}}\right)^{-1.45}$$

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)

6.2 BLAST EMISSION CRITERIA

6.2.1 Criteria for Private Residential Receptors

Blast Emission Criteria for Human Comfort

To minimise the impact on residential receptors, the NSW Department of Planning and Environment (DPE) adopts the ANZECC guidelines, "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration" (1990). These 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 up to 5% of the total number of blasts over a 12-month period. The upper PPV level of 10 mm/s not be exceeded at any time.
- The general airblast criterion is 115 dBL (decibel Linear).
- The level of 115 dBL may be exceeded up to 5% of the total number of blasts over a 12-month period. The airblast level is not to exceed 120 dBL at any time.

The same criteria have been imposed on blasts required for construction of the LRWF project.

6.2.2 Criteria for Infrastructure

Guidelines on vibration limits for infrastructure are provided in Australian Standard AS 2187.2-2006 "Explosives – Storage and Use – Part 2: Use of Explosives". Also, the ACARP Report No. C14057 presented a comprehensive overview of existing allowable vibration limits for various infrastructure including buried communication cables and pipelines.

Ausgrid, one of the major electricity suppliers in NSW, typically applies a vibration limit of 100 mm/s for timber power poles. For high voltage powerlines, Ausgrid generally uses a vibration limit of 100 mm/s for suspension towers. However, for tension towers, which are usually located at corners or bends, a lower vibration limit of around 50 mm/s is applied.

Blasting in the vicinity of an electrical substation must be conducted in a controlled manner to minimize the risk of tripping electrical equipment. In the Hunter Valley, NSW, mines are operating with a maximum imposed vibration limit of 25 mm/s for electrical substations.

There are no explicitly defined vibration limits for wind turbine towers. However, some wind farms in the Western District of Victoria apply a vibration limit of 100 mm/s. This limit generally aligns with the Australian Standard AS 2187.2-2006, which specifies 100 mm/s for ground vibration for unoccupied structures made of reinforced concrete or steel construction. Tilt Renewables has confirmed that application of a vibration limit of 100 mm/s for the wind turbine towers is acceptable.

Therefore, the relevant vibration criteria include:

- 100 mm/s – for public roads
- 100 mm/s – for buried communication cables and pipelines
- 100 mm/s – for groundwater bore including steel case lining and pipelines
- 100 mm/s – for wind turbines
- 100 mm/s – for timber power poles
- 100/50 mm/s – for high voltage power line (330kV), for suspension and tension towers respectively
- 25 mm/s – for zone electrical substation (330kV)

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

NOTE: Generally, unoccupied infrastructure facilities are not assessed in terms of airblast overpressure exposure as the levels required to inflict damage are not applicable and/or not reached.

A summary of blast emission criteria used in the assessment is presented in **Table 2.**

Table 2: Summary of Blast Emission Criteria

Item	Vibration Criteria (mm/s)	Airblast Criteria (dBL)
Private residences (1)		
Limit applicable to 95% of blasts over a 12-month period,	5	115
Limit not to be exceeded	10	120
Unoccupied infrastructure including:		
Public roads and bridges Buried communication cables Groundwater bore / pipelines Wind towers (3) Timber power poles	100	n/a
High voltage transmission towers (330 kV)	100 / 50 (2)	n/a
Zone electrical substation (330kV)	25	n/a

1 – applies to buildings and sheds only (after ANZECC (1990))

2 – 100 mm/s applies to suspension towers, 50 mm/s applies to tension towers

3 – to be verified against wind turbine manufacturer's guidelines for specific vibration tolerance limits.

7.0 BLASTING IMPACT ASSESSMENT

The assessments presented below address the Project's potential blasting impacts on the surrounding area. These assessments are based on ground vibration and airblast overpressure modelling using the models presented in Section 6.1. The generated ground vibration and airblast overpressure estimates have been evaluated in the context of relevant limits and/or criteria as stated in Section 6.2. This allowed for identifying potential blasting risks at the proposed extraction area.

The modelling involved simulations incorporating the following charge masses, 100 and 300 kg. The charge masses were derived from the blasting parameters proposed to be employed by the quarry in the Main Pit. Modelling accounted for the worst-case scenario, *i.e.* blasting from the edge of the Main Pit, which corresponds to the minimum distance between the blasting area and the receptors. The result tables compiled therefore highlight the maximum ground vibration and airblast overpressure levels that will be generated at these receptors over the lifetime of the Project.

7.1 COMMUNITY

The modelling evaluated ground vibration and airblast overpressure levels for private residential receptors located within a 4 km radius of the Main Pit, see **Figure 2.** Note that for a small-scale quarry as in the case of the proposed Project, the impact of blasting (including ground vibration and airblast overpressure beyond 3-4 km radius) is difficult to detect *i.e.* beyond the human perception levels. Therefore, given its location > 4 km from the closest point of blasting in the proposed Main Pit, residential receptor F7-6 has been excluded from the results.

7.1.1 Assessments Results – Community

7.1.1.1 Ground Vibration and Airblast Overpressure

The results of the vibration modelling, with focus on the maximum vibration estimate for a particular MIC, for residential receptors located within a 4 km radius are summarised in the tables below. **Table 3** presents results for ground vibration modelling while **Table 4** presents results for the airblast overpressure modelling.

Table 3: Results of Ground Vibration Modelling for Residential Receptors

Residential Receptor ID	Min. Distance [1] (m)	Direction from Blasting Area	Estimated Max. Ground Vibration (mm/s)		Applicable Vibration Criteria (mm/s)
			MIC (kg)		
			100	300	
F7-5 (T) [3]	3710	NE	0.1	0.3	5 / 10 [2]
F8-1 (T) [3]	2230	E	0.3	0.6	
F7-4 (T) [3]	3650	NE	0.1	0.3	
2 (F) [3]	3040	SW	0.2	0.4	

1 – Minimum distance over the lifetime of the Project, i.e. from the edge of the blasting boundary

2 – 5 mm/s limit for 95% of blasts over a 12-month period, 10 mm/s not to be exceeded

3 – (T) = Associated residence (F) = Non-associated residence

Table 4: Results of Airblast Overpressure Modelling for Residential Receptors

Residential Receptor ID	Min. Distance [1] (m)	Direction from Blasting Area	Estimated Max. Airblast Overpressure (dBL)		Applicable Vibration Criteria (dBL)
			MIC (kg)		
			100	300	
F7-5 (T) [3]	3710	NE	95	100	115 / 120 [2]
F8-1 (T) [3]	2230	E	101	106	
F7-4 (T) [3]	3650	NE	95	100	
2 (F) [3]	3040	SW	97	102	

1 – Minimum distance over the lifetime of the Project, i.e. from the edge of the blasting boundary

2 – 115 dBL limit for 95% of blasts over a 12-month period, 120 dBL not to be exceeded

3 – (T) = Associated residence (F) = Non-associated residence

The ground vibration and airblast overpressure modelling results for residential receptors are summarised as follows:

- The potential maximum ground vibration exposure for two modelled scenarios was estimated to be in the range of 0.1 to 0.6 mm/s. These estimates are well below the applicable limits specified as 5 mm/s (for 95% of blasts) and 10 mm/s (not to be exceeded).
- The potential maximum airblast overpressure exposure for two modelled scenarios was estimated to be in the range of 95 to 106 dBL. These estimates are well below the applicable limits specified as 115 dBL (for 95% of blasts) and 120 dBL (not to be exceeded).

7.2 INFRASTRUCTURE

The closest / relevant infrastructure items were described in Section 4.2. In addition to existing infrastructure, modelling has been undertaken on infrastructure associated with the proposed LRWF that does not currently exist (*e.g.* wind turbines/CWO REZ 330kV transmission line/substations) and most likely will not be built and/or operational during blasting. **Table 5** indicates that the identified (existing and proposed) public infrastructure items are located at distances in excess of 1,200 m, while (existing and proposed) private infrastructure items are located at a distance of 390 m from the closest point of the Main Pit where blasting may occur. The nearest point of the proposed CWO REZ transmission line easement (and therefore closest potential point for a transmission tower) is approximately 1,260 m from the closest point of the Main Pit. The assessed items are shown on **Figure 2**.

7.2.1 Assessments Results

7.2.1.1 Ground Vibration

The results of the modelling with focus on the maximum ground vibration to be generated for a particular MIC are summarised in **Table 5.**

Table 5: Results of Ground Vibration Modelling for Existing and Proposed Infrastructure

Receptor	Min. Distance[(1)] (m)	Estimated Max. Ground Vibration (mm/s)		Applicable Vibration Criteria (mm/s)
		MIC (kg)		
		100	300	
Public Infrastructure				
Roads				
Rotherwood Road	2,500	0.2	0.5	100
Power				
11 kV Power poles	2,200	0.3	0.6	100
CWO REZ 330kV transmission line (proposed)	1,260	0.6	1.5	100 / 50
Energy Co. substation (proposed)	3,400	0.1	0.3	25
Telecommunication				
Telecommunication underground lines (along Rotherwood Road)	2,500	0.2	0.5	100
Private Infrastructure				
LRWF Wind Towers (proposed)	2,900	0.2	0.4	100
LRWF substation (proposed)	3,600	0.1	0.3	25
Groundwater Bores				
GW007044	390	4.1	9.8	100
GW012325	390	4.1	9.8	

1 – minimum distance over the lifetime of the Project, i.e. from the edge of the blasting boundary

The analysis of ground vibration impacts for infrastructure is summarised as follows:

- **Public roads** - the maximum estimated vibration exposure is 0.5 mm/s, this is below the specified vibration limit of 100 mm/s.
- **Power**
  - (11 kV power poles) - the maximum estimated vibration exposure is 0.6 mm/s, this is below the applicable vibration limit of 100 mm/s.
  - (Proposed CWO REZ 330 kV line) - the maximum estimated vibration exposure is 1.5 mm/s, this is below the applicable vibration limits of 100 / 50 mm/s.
  - (Proposed Energy Co / LRWF. substations) - the maximum estimated vibration exposure is 0.3 mm/s, this is below the applicable vibration limit of 25 mm/s.
- **Proposed LRWF towers -** the maximum estimated vibration exposure is 0.4 mm/s, this is below the applicable vibration limit of 100 mm/s.
- **Telecommunication infrastructure** - the maximum estimated vibration exposure for underground lines is 0.5 mm/s, this is below the specified vibration limit of 100 mm/s.
- **Groundwater bores** - the maximum estimated vibration exposure is under 10 mm/s, this is below the specified vibration limit of 100 mm.

In summary, the assessment concluded negligible impact of blast vibration, therefore no additional blast control measures are required to comply with the ground vibration criteria for public and private infrastructure (including monitoring or other measures).

7. 3 FLYROCK

The positioning of the Project area, being in excess of 2 km from private residential receptors and public infrastructure creates particularly favourable conditions to manage public safety blasting risks that include flyrock.

For the identified closest points of interest, the study concluded:

- The closest private residential receptor (located approximately 2.2 km distance) - the flyrock risk is negligible.
- The closest public infrastructure (located in excess of 1.2 km) - the flyrock risk is negligible.

Flyrock risk will be further mitigated and managed such that it is contained within the boundary of Lot 89 by adhering to the following:

- Implementing a blast methodology that ensure blasting heaves material in an easterly direction (*i.e.* away from neighbouring properties, in particular Lot 90 located to the south west).
- Adopting more conservative values (compared to those detailed in **Table 1**) for blast hole spacing and diameter, stemming and powder factor.
- Construction of a 2 – 3 m high earth mound along the Project disturbance boundary, located adjacent to the southern end of the pit in the vicinity of Lot 90.

Further, as pit development progresses to the north (and deeper into the second bench), the risk associated with flyrock is further reduced and the blast parameters in **Table 1** will be amended accordingly.

In accordance with standard operating procedures, a site-specific Blast Management Plan will be prepared by the proponent and drill and blast contractor that will address all occupational health and safety (OH&S) requirements, including procedures for neighbour notification of blasting.

Based on the location of the pit and proposed mitigation strategies outlined above, the flyrock impact can be adequately managed and potential risks are considered to be negligible.

7. 4 ANIMALS

The proposed Quarry site is located on a grazing property and is also adjacent to two grazing properties.

ANZECC guideline limits (ANZECC 1990) which apply to private residences are designed to protect human comfort and, as such, it can be inferred that blasting impacts will be fully managed in relation to cattle and pets/animals within these properties. Studies undertaken to assess potential impacts from blasting on feedlots have identified that blasting impacts have little to no impact on domestic stock (Nelson, 2011). Similar effects would be expected for native fauna and, anecdotally, it is noted that many fauna species have been recorded adjacent to active mining operations where larger and more frequent blasts than those proposed for the Project are undertaken. Due to the periodic (once every 6 – 8 weeks) and very short duration (1 – 2 s) nature of blasting proposed, blasting associated with the Project is not anticipated to have any significant impacts on domestic or native fauna.

The estimated ground vibration and airblast overpressure for the feedlot area on Lot 90 DP750749 (located approximately 3000 m from the quarry) are no higher than 0.4 mm/s and 102 dBL, which is well below the ANZECC criteria for human comfort.

8.0 MANAGEMENT AND MITIGATION MEASURES

There are various blast control measures and technologies available, which can minimise blasting impacts on the surrounding environment and enable blasts to be designed to conform to relevant criteria and/or constraints.

The recommended blast emission control and management measures for the Project are specified as follows:

Control measures for ground vibration:

- Use of appropriate charge mass design and avoid overcharging holes;
- Use of an appropriate initiation sequence to minimise the possibility of blast-hole interactions *i.e.* ideally aiming for single hole initiation.

Control measures for airblast:

- Use of appropriate charge mass design and avoid overcharging holes;
- Use of an appropriate initiation sequence to minimise the possibility of blast-hole interactions *i.e.* ideally aiming for single hole initiation.
- Apply appropriate quality stemming material and stemming height to enable correct confinement of explosive charges and therefore, minimise airblast overpressure emission.

Control measures for flyrock:

- Ensure appropriate quality of stemming material and stemming height to facilitate explosives confinement to minimise the possibility of stemming ejection and/or flyrock incidents.

Blast Monitoring System

Due to the limited number of private residences in the area, the monitoring system for private residences should consist of two (2) monitoring stations to capture ground vibration and airblast overpressure impacts from blasting at the Project site (including residences 2(F) and F8-1).

Pre-blast Assessment Protocol

The Project will implement an appropriate protocol (including assessing weather conditions) to manage blasting (including positioning of blasting sentries) to ensure that it is undertaken in a safe manner.

Public Notification

Adjoining landowners will be notified (notification preference [*e.g.* phone/text/email] to be determined with each landowner) of the scheduled blast dates and times, at least one (1) day prior to each blast, with confirmation provided on the day of each blast, several hours prior.

9.0 CONCLUSIONS AND RECOMMENDATIONS

Enviro Strata Consulting was engaged by the proponent to investigate blasting impacts from the proposed quarry, designed to supply quarry products to support the construction of the LRWF, a nearby wind farm.

This BIA provides an assessment of blasting impacts from the proposed quarry on the surrounding environment inclusive of people, houses, and public infrastructure.

The assessment was based on the following:

- The reviewed detailed geological model for the area which allowed for establishment of blasting parameters representative for the Main Pit conditions (including 12.5 m benches and the 102 mm drill rig size).
- Ground vibration and airblast overpressure models utilising parameters similar to the proposed quarry parameters.
- The blast emission criteria for assessed items are specified in Section 6.2 of this report.

The assessment outcomes are summarised as follows:

- **Impact on Residential Receptors**:
  - The impact of ground vibration and airblast overpressure was estimated to be well below the recommended ANZECC guideline limits and within the specified blasting parameters at all assessed private receptors. Only one non-associated residence is within the 4km radius and the ground vibration and airblast overpressure impacts are assessed as being negligible.
  - Blasting will be undertaken in a manner that ensures any flyrock is confined to Lot 89. Appropriate safety measures will be implemented and detailed in a Blast Management Plan to be prepared for the operations. With the implementation of the protocols outlined in Section 8, potential risks associated with flyrock are considered low / negligible.

- **Impact on Public and Private Infrastructure**:
  - The modelling for all infrastructure in the vicinity of the Project concluded no significant blast vibration impacts (*i.e.* well below assessment criteria). The risk of damage from airblast and flyrock is considered negligible or not applicable.

- **Impact on Animals:**
  - The assessment concluded no significant concerns for the wellbeing of livestock or pet animals. The modelling identified predicted blasting exposures to be below the assessment limits.

RECOMMENDATIONS

- Recommendations regarding management and mitigation measures for blasting with the aim of minimising blast impacts on the adjacent environment were provided in Section 8.
- Preparation of a Blast Management Plan that includes a recommended blast monitoring program, consisting of two monitoring stations, will assist the quarry in complying with vibration and overpressure limits, as detailed in Section 8.
- A notification system is to be developed to inform any adjoining landowners of scheduled blasts, as described above.

Thomas Lewandowski
1st July 2024
Enviro Strata Consulting

REFERENCES

1. ACARP Report Reference No. C14057 ‘Effect of Blasting on Infrastructure’ Alan Richards, Adrian Moore, 2008

2. Australian & New Zealand Environment and Conservation Council (ANZECC) (1990). ‘Guidelines Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration’ September 1990.

3. Australian Standard AS 2187.2:2006, Explosives – Storage and use, Part 2 – Use of explosives (AS 2187 Part 2).

4. British Standard BS 7385-2:1993, “Evaluation and measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground Borne Vibration”.

5. Nelson, N. (2011). Xstrata Coal Queensland Pty Ltd & Ors V Friends of the Earth – Brisbane Co-op & Ors (MLA’s 50229, 50230, 50231), a report prepared to support mining lease application made by Xstrata Coal Queensland Pty Ltd.

6. SSD 6696 - Liverpool Range Wind Farm Community Information Session – Monday 26 June 2016. Summary of Issues Raised. Documentation NSW Government Planning and Environment.

7. US Bureau of Mines, USBM RI8507.

APPENDICES

Appendix 1 – Location of Exploration Holes for Liverpool Range Quarry